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UNIVERSITY OF CALIFORNIA

California Agriculture
Dimensions and Issues

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

Giannini Foundation Information Series 20-01

These essays by leading agricultural economists 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 with a 1928 grant 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, and to Julie McNamara, the Giannini Foundation communications director, and Tiffany Loveridge, outreach coordinator, for editing and laying out the chapters. And special thanks to Julian Alston and Ria DeBiase for providing their expertise and careful review of the manuscripts. Each chapter is self-contained, which means that some basic parameters of the state's agriculture may be found in several chapters.

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Cover Illustration: Over 44 percent of California's $50 billion in farm sales in 2017 were fruits and nuts, followed by 24 percent for dairy and livestock, 17 percent for vegetables and melons, 14 percent for nursery and other horticultural specialties, and 4 percent for field crops. (Graphic created by Joshua Bingham)

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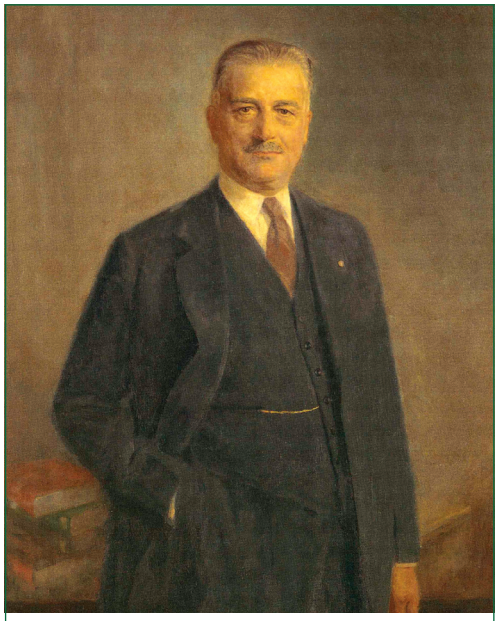
Book Table of Contents

GIANNINI FOUNDATION INFORMATION SERIES

The Giannini Foundation Information Series communicates selected research results to a broad range of stakeholders. The first Information Report was issued in 1963; reports are numbered serially within years.

The Giannini Foundation of Agricultural Economics began in 1930 with the support of the Bancitaly Corporation (later renamed Bank of America), which made a grant to the University of California in tribute to founder Amadeo Peter Giannini. The Giannini Foundation's mission is to support research and outreach activities in agricultural economics and rural development to promote California agriculture. The Giannini Foundation supports the research of member economists in the Departments of Agricultural and Resource Economics at UC Davis and UC Berkeley and of the agricultural and resource economists in the School of Public Policy at UC Riverside. Associate members include adjunct professors of agricultural and resource economics, environmental and resource economists in the Department of Environmental Science and Policy, UC Davis, and agricultural, environmental, and resource economists from UC San Diego, UC Merced, and UC ANR.



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).

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 $45 billion in 2017, according to the Census of Agriculture, were over $15 billion more than number two Iowa at $29 billion, is the dominance of high-value fruit, nut, and vegetable crops among the state's farm commodities. Over three-fourths of California'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 $33.4 billion in 2017 and the value of livestock was $11.8 billion.[1] California's leading commodities were milk, worth $6.6 billion in 2017; grapes, $5.8 billion; almonds, $5.6 billion; berries, $3.1 billion; cattle, $2.6 billion; and lettuce, $2.4 billion. These six commodities accounted for over half of California's farm sales. California exported farm commodities worth $21 billion (farm value) in 2017, led by almonds $4.5 billion; dairy products, $1.6 billion; and pistachios, $1.5 billion.

The COVID-19 pandemic disrupted California agriculture in 2020. People who stayed home were still eating, but the demand for many California commodities fell as schools and restaurants closed, reducing the farm prices of milk and fresh fruits and vegetables. The demand for fresh flowers evaporated as events were cancelled, while sales of nursery plants rose with more home gardening. Farms were essential businesses and expected their employees to continue to report to work, and most did. There were isolated reports of COVID-19 outbreaks in farm workplaces but, unlike meatpacking plants, farms did not become hotspots for COVID-19.

The longer-term effects of COVID-19 on agriculture are not yet clear. The consolidation of production onto fewer and larger farms is likely to accelerate as, for example, dairies that were already under stress exit. Higher labor costs and labor uncertainties are likely to speed mechanization in raisin grapes, olives, and canning peaches, commodities that can be harvested by machine.

The number of jobs certified to be filled with H-2A guest workers was higher in the first half of FY20 than in the first half of FY19. The U.S. government allowed H-2A workers to enter the United States as essential workers, suggesting that policy makers do not anticipate many jobless U.S. workers filling seasonal farm jobs. California agriculture has always been a dynamic industry capable of adjusting to challenges that range from transportation to water to labor, and will likely adjust to the COVID-19 pandemic as well.

1 These farm sales data exclude cannabis, which is covered in Chapter 13.

About the Editors

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Chapter 1. Table of Contents

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 local demand for food. The same entrepreneurial spirit animating those who were mechanizing gold mining led to an expansion of wheat production. California developed giant bonanza wheat farms that were much larger than the typical family farms found in the Midwest. California farmers developed a novel cropping system by planting spring-habit wheat varieties in the fall (as opposed to the spring) and harvesting in the summer. They also relied more on hired labor during the harvest than Midwestern operations.

Acreage of wheat and barley peaked at almost 4 million in the late 1880s, and about this time the acreage in fruit production began to expand rapidly. 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. Irrigated acreage also 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 and other high-value commodities, including the maturation of the transportation system in the 1880s, lower capital costs, biological learning, irrigation, and marketing cooperatives to sell California commodities. 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.

Figure 1.1. California Indian Pre-Contact Tribal Territories

California had 100,000 or more Native Americans in at least 70 distinct groups before the arrival of Europeans; they were a third of the indigenous people in what is now the United States.

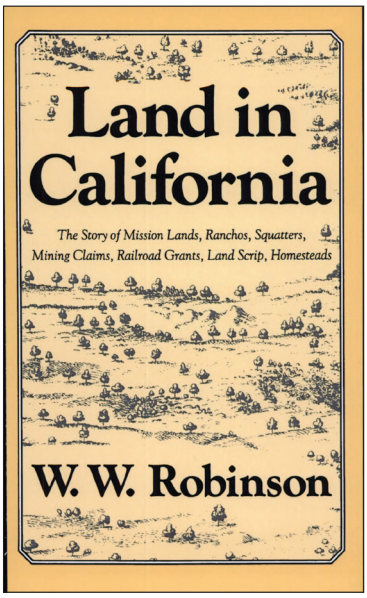
Source: California Indian Library Collections

Biological innovations allowed California farmers to plant the types of grains, fruits, and cotton best suited for the state's Mediterranean climate. Labor-saving machines handled first grain, and later cotton harvests on large-acreage farms. The switch from wheat to perennial fruits in the 1880s was motivated by biological innovations that developed varieties that were optimal for California, 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 Europe's Mediterranean basin, and they expanded fruit production behind U.S. tariffs that protected them from foreign competition despite high transport costs from California 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 employed in California agriculture. As on Southern plantations, farmers and farm workers in California are 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 farm workers in California become successful farmers. Instead, most find upward mobility in the nonfarm economy.



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

Land

California has over 100 million acres of land, almost half owned by government and a quarter in farms. The United States Department of Agriculture (USDA) considers 9.6 million acres, less than 10 percent, to be cropland. 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 gave 10.5 million acres in land grants to homesteaders, and awarded 11.6 million acres to private firms that built railroads.

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. The value of almond orchards ranged from $30,000 to $40,000 an acre, depending on soil quality and access to water. 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 California farmers to enroll their land under Williamson Act contracts with local governments. In exchange for continuing to farm 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.

Table 1.1 shows that between 1997 and 2017, the amount of irrigated crop land decreased by almost a million acres. The acreage of field crops decreased by almost two million acres over the past two decades, led by drops in cotton and grain acreage, while the acreage of tree nuts rose by over a million acres, led by almonds. One effect of fewer field crops and more tree nuts is the need for a reliable supply of water for irrigation: cotton and grain are annual crops that farmers can decide not to plant in dry years, while trees and vines need water each year.

Table 1.1. California Land, Cropland, and Irrigated Land in Farms by Major Crops, 1959–2017

	Census Year						
	1959	1969	1978	1987	1997	2007	2017
	Acres (Thousands)						
Land in Farms	36,887.9	35,722.3	33,130.4	30,598.2	28,795.8	25,364.7	24,522.1
Total Cropland	12,965.6	11,245.1	11,721.1	10,894.5	11,062.8	9,464.6	9,597.4
Harvested Cropland	8,021.8	7,649.0	8,899.4	7,676.3	8,676.2	7,633.2	7,857.5
Irrigated Land	7,395.6	7,240.3	8,603.7	7,596.1	8,886.7	8,016.2	7,833.6
Specialty Crops							
Vegetables	814.3	849.3	1,168.8	1,102.2	1,536.5	1,504.9	1,423.8
Non-Citrus Fruits	472.5	497.3	486.2	538.2	597.3	444.7	365.2
Grapes	469.2	458.3	644.3	707.8	870.5	868.3	935.3
Citrus Fruits	242.5	266.1	248.6	268.8	315.8	303.1	312.2
Nuts	250.6	365.9	540.7	637.9	869.4	1,210.2	2,023.7
Berries	14.3	10.5	14.2	16.6	31.4	42.1	52.9
Total Specialty Crop	2,263.4	2,447.6	3,102.9	3,271.4	4,220.8	4,373.3	5,113.1
Specialty Share of Irrigated Land (Percent)	30.60%	33.81%	36.06%	43.07%	47.50%	54.56%	65.27%
Field Crops							
Rice	NA	NA	485,416	399.2	514.1	531.1	436.7
Cotton	820.7	659.9	1,520.7	1,083.8	1,036.3	471.4	301.7
Hay, Haylage, Silage	1,369.3	1,286.9	1,204.4	1,279.4	1,465.5	1,554.2	1,344.1
Irrigated Pasture	NA	NA	868.8	631.9	733.5	741.9	484.9
Grain & Other	2,942.1	2,845.8	1,421.5	930.3	916.5	344.3	153.1
Total Field Crops	5,132.2	4,792.6	5,500.8	4,324.6	4,665.9	3,642.9	2,720.5

Source: USDA Census of Agriculture; Carman, H.F. 2019. Available at: https://giannini.ucop.edu/publications/are-update/issues/2019/23/2/californias-changing-land-use-patterns-for-crop-pr/

The fertility of the soil in some areas is threatened by farming practices that 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, eventually 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.

Labor

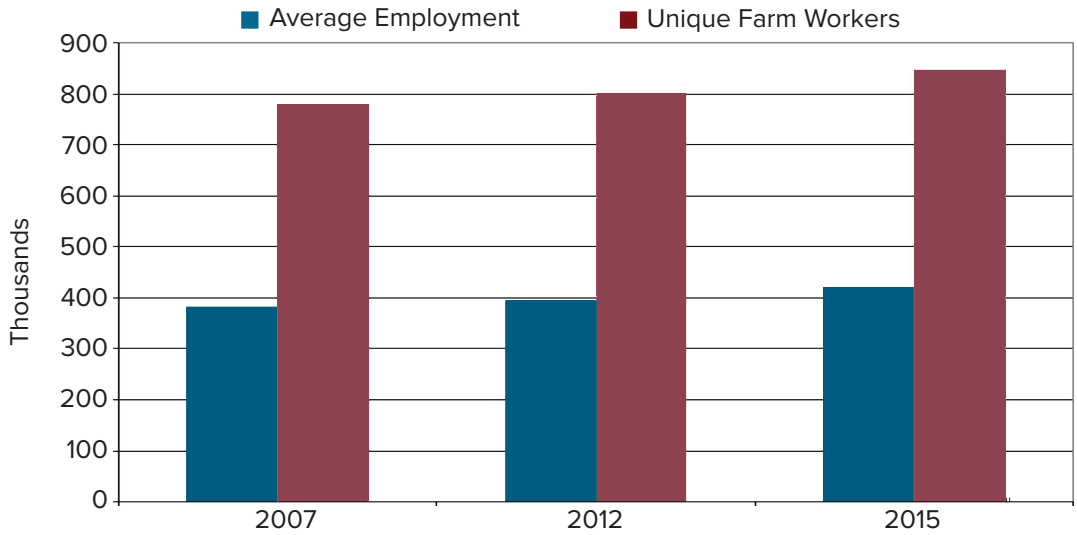
There are two major types of workers employed on farms. Farm operators and unpaid family workers have incomes that reflect the difference between farm revenues and costs. Hired workers, on the other hand, are paid wages that are independent of farm revenues and costs. Hired workers can be categorized 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.

The average annual agricultural employment of hired workers on California farms, a measure of year-round equivalent jobs, was 423,000 in 2018, 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 June 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 850,000. 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 between unions and growers, persuaded Governor Jerry Brown to sign the Agricultural Labor

Figure 1.2. California: Average Employment and Unique Farm Workers: 2007, 2012, 2015



Source: California EDD analysis of unemployment insurance payroll tax data

Relations Act of 1975, which gave California farm workers the right to organize and required employers to bargain with the union elected by a farm's employees, including those brought to farms by labor contractors. Intense union activity in the late 1970s was followed by a decline that has left the UFW with fewer than 10,000 members and 50 contracts today.

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 after the 2008–09 recession has prompted many farmers to turn to the H-2A guest worker program to obtain workers. Many farmers rely on FLCs to recruit, house, and supervise legal Mexican guest workers.

Water

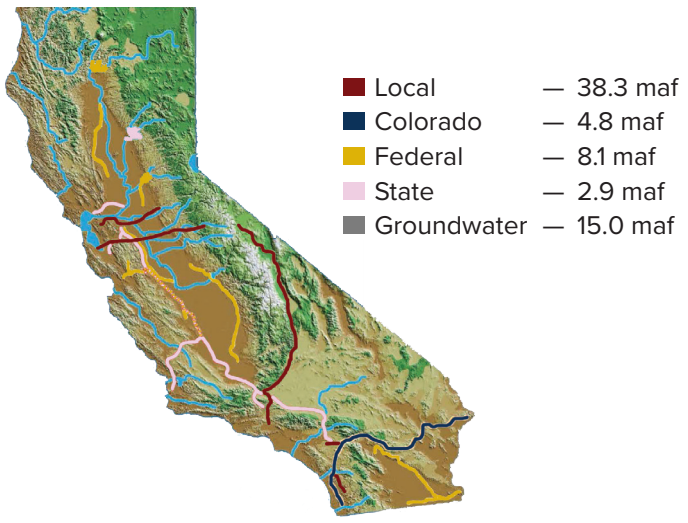
California farmers normally use about 33 million acre-feet (maf) of water a year to produce crops on 8 million acres of irrigated farmland, an average of 4 acre-feet per irrigated acre. An acre-foot is 43,560 square feet or about a football field covered with one foot of water.

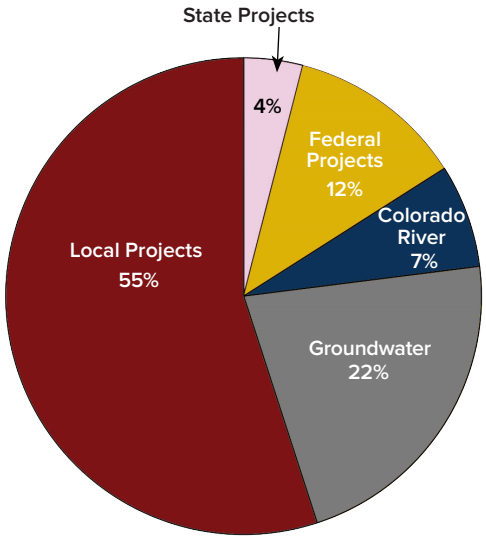
In normal water years, about 60 percent of the water used by farmers is surface water, which is water stored behind dams or in reservoirs and conveyed via canals to farmers. In dry years, farmers increase the use of groundwater, pumping water from underground aquifers and sometimes fallowing land used to produce lower-value crops such as cotton and buying water to keep high-value crops such as nuts alive. 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 winter 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 California to be closer to feed for their animals.

Second 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.

Figure 1.3. California Water Supply Systems





Source: Water Education Foundation. Available at: http://www.watereducation.org/photo-gallery/california-water-101

Note: Light blue lines on map represent major waterways.

Third, water marketing could shift water to its highest-value use. Ex-Governor Jerry Brown endorsed twin-tunnels 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 project could allow farmers who grow rice and other water-intensive crops in the Sacramento Valley to fallow their land and sell water to farmers who grow higher-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 agreed to contribute $11 billion, reasoning that it could recoup its investment by selling water to farmers and other users. If farmers were to acquire property rights to the ground water under their land, they would have incentives to buy water and recharge aquifers in wet years.

California has a complex federal, state, local, and private system to collect, transport, and distribute water. Several challenges arise with a looming scarcity of water in an arid state with a growing population and irrigated agriculture that produces high-value commodities, including how to move Northern California water through the Sacramento-San Joaquin Delta, how to ensure that groundwater basins are not depleted, and how to make more efficient use of treated wastewater to provide sufficient amounts of water for human, agricultural, and wildlife uses.

Major Commodities

Dairy

The U.S. had 9.4 million dairy cows in 2018, most on dairies that have 900 or more cows. Dairy farms exemplify the general agricultural trend of fewer and larger operations producing most of the U.S. production of a farm commodity. Most U.S. milk is produced in the northern and western states, led by California, with about 18 percent of milk production and Wisconsin with about 14 percent of milk production.

Milk and cream constitute the most valuable farm commodity produced in California; dairy sales of $6.6 billion in 2017 accounted for almost 60 percent of the total $11.2 billion in the state's animal agriculture sales. Farm milk is about 87 percent water, 9 percent protein and other solids, and 4 percent fat. Across the US, fluid milk consumption has been falling, while cheese and butter consumption has been rising.

California's dairy industry expanded rapidly between 1975 and 2007, when the state accounted for a peak 22 percent of U.S. milk before shrinking to less than 20 percent in 2019. The number of dairy farms is falling, 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, where the average dairy had 1,800 cows, produced 28 percent of California's milk in 2019. Over 90 percent of the state's milk is produced in the San Joaquin Valley; smaller organic and pasture-based dairies predominate along the Northern California coast where 2 percent of milk is produced.

Raw milk must be processed quickly, and 80 percent of California's milk is processed by farmer-owned cooperatives such as California Dairies Inc., which processes half of the state's milk. Almost 80 percent of California-produced milk is used to make butter, milk powder, or cheese that is sent to other states or exported. A third of the farm quantity of California milk is exported, including to Mexico, China, and Canada.

The major cost of producing milk is feed for cows; feed costs were 55 percent of average milk production costs of $16 per hundredweight in 2017. Labor is the second-largest cost. Some 1,152 California dairies hired an average 18,000 workers in 2018, and paid their employees an average $770 a week. Dairy labor costs are 12 percent of milk production costs and rising with the state's minimum wage, scheduled to reach $15 in 2022, and 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.

Rising labor costs may lead to more automation on dairy farms. Most dairies hire one employee for each 75 to 100 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, and cows in such systems are milked as they eat. Cows self-selecting when to eat and be milked average about 2.8 milkings a day.

There are dairy farms in every state, and the federal government has intervened in milk markets since the 1930s to bolster the farm price of milk. Dairy policies require processors to pay farmers a price for milk that reflects the

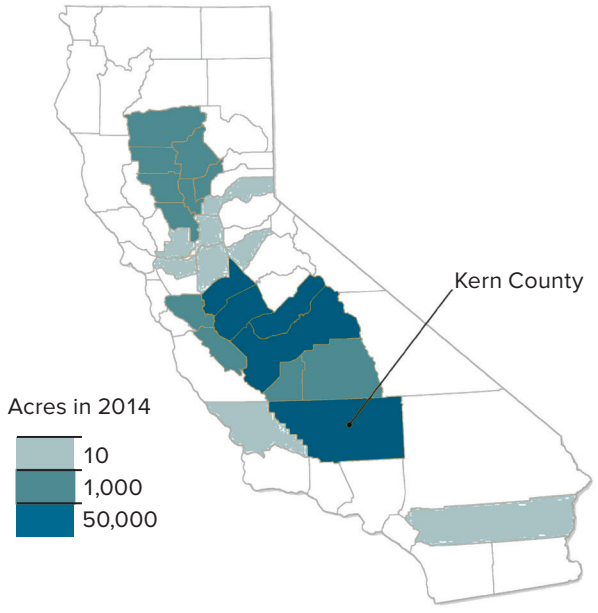
Milk, cheese, and dairy products are the most valuable commodity group produced in California, worth $6 billion in 2016 or 13 percent of the state's farm sales.

Photo Credit: ViaFilms, www.via-films.com

way their milk was used, whether sold as fluid milk or processed into yogurt, butter or cheese. The current federal Dairy Margin Coverage (DMC) policy makes payments to farmers who buy insurance to protect their margins, the difference between the price of milk and the cost of feed. The DMC benefits mostly smaller dairies in eastern and Midwestern states where a high share of milk is sold as fluid milk.

While the cost of feed is significant for dairy, field and row crops are not significant to California agriculture. 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 farmers sold field crops worth $2.2 billion in 2017, led by alfalfa hay, $758 million; rice, $678 million; cotton, $475 million; and potatoes (including sweet), $365 million. California produces many of the major grain crops, including corn and wheat, but the value of these mainstays of U.S. agriculture is less than $100 million a year. The major field crop changes over the past quarter century include the sharp decline in cotton and sugar beet acreage as more valuable nut crops expand.

Figure 1.4. Almond Acreage in California



The San Joaquin Valley is the center of California's almond crop. Kern County has the most acres—over 157,000.

Source: U.S. Department of Agriculture (*Sacramento Bee*)

Fruits and Nuts

Tree fruits and nuts are among the most valuable commodities grown in California: fruit and nut sales of $22 billion were 44 percent of farm sales of $50 billion in 2017. The most valuable include almonds worth $5.6 billion; walnuts, $1.6 billion; and pistachios, $1 billion in 2017. Grapes were worth $5.8 billion in 2017. Berries were worth $3.1 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, peach, and nectarine orchards as well as most of the almonds, walnuts, and pistachios. The most valuable tree fruits are oranges, worth $934 million in 2017; lemons, $608 million; and tangerines, $535 million. Avocados were worth $383 million in 2017; all types of peaches, $372 million; plums and prunes, $345 million; and cherries, $330 million.

Fresh fruit consumption has been declining as consumers eat fewer oranges, 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, which are pruning and harvesting, so that orchards without workers most of the year can have crews of dozens or hundreds during peak seasons. Cherries are an exception to the story of generally declining acreages of fresh fruit, with California's acreage more than tripling, from 10,000 in 1985 to 33,000 acres in 2017.

California produces most U.S. tree nuts and exports many of them. Almonds are the most valuable crop grown in the state, and 80 percent of the state's almonds are exported. The acreage of almonds has been rising rapidly, almost tripling since 2000 to over 1.5 million acres, as 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 from the Delta to preserve fish have made water for some nut growers scarce and expensive. Nut growers north of the Delta have much lower irrigation costs.

Labor accounted for half of the top-10 issues identified by the California Fresh Fruit Association each year over the past decade. The state's largest peach grower, Gerawan Farms, was embroiled in a dispute with the United Farm Workers union for five years that resulted in the California Supreme Court upholding the state's 2002 Mandatory Mediation and Conciliation (MMC) law that allows a mediator-turned-arbitrator to develop a contract that the employer must implement. However, Gerawan did not have to implement the MMC contract because Gerawan employees in 2013 voted to de-certify the UFW as their bargaining representative.

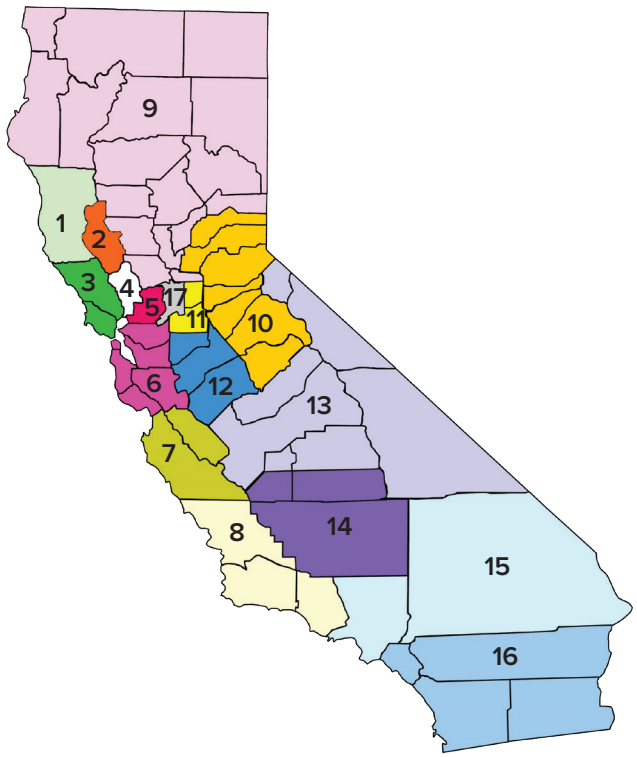
The major labor issue facing the fresh fruit industry is that labor represents 30 percent to 40 percent of variable production costs and over half of seasonal fruit pickers are not authorized to work in the U.S. California farmers have been unable to persuade Congress to enact an alternative to the H-2A program that admits Mexican guest workers to harvest most citrus in Florida and apples in Washington, but some are following in the footsteps of the berry and vegetable industries and relying more on H-2A workers.

Farm labor costs are likely to continue to increase, encouraging fruit farmers to adopt labor-saving changes. Nut farming is largely mechanized, but nut farmers face other challenges, including the need to make more efficient use of scarce water, reducing the dust that arises when shaking nuts from trees and sweeping them up, and preventing the spread of invasive species.

Grapes and Wine

California grapes were worth $5.8 billion in 2017, including two-thirds from wine grapes, a quarter from table grapes, and less than a tenth from raisins. The state had 840,000 acres of grape vineyards in 2017, with two-thirds devoted to wine grapes, a fifth to raisin grapes, and an eighth to table grapes. Wine grape acreage rose rapidly toward 600,000 acres by 2017, table grape acreage increased slowly to over 100,000 acres, and raisin grape acreage has been decreasing toward 150,000 acres. Most grape vineyards are in the southern San Joaquin Valley, including almost all of the raisin and table grape acreage and a quarter of the wine grape acreage.

Figure 1.5. California Grape Crush Districts



The 560,000 bearing acres in 2017 yielded 4.2 million tons of wine grapes. 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).

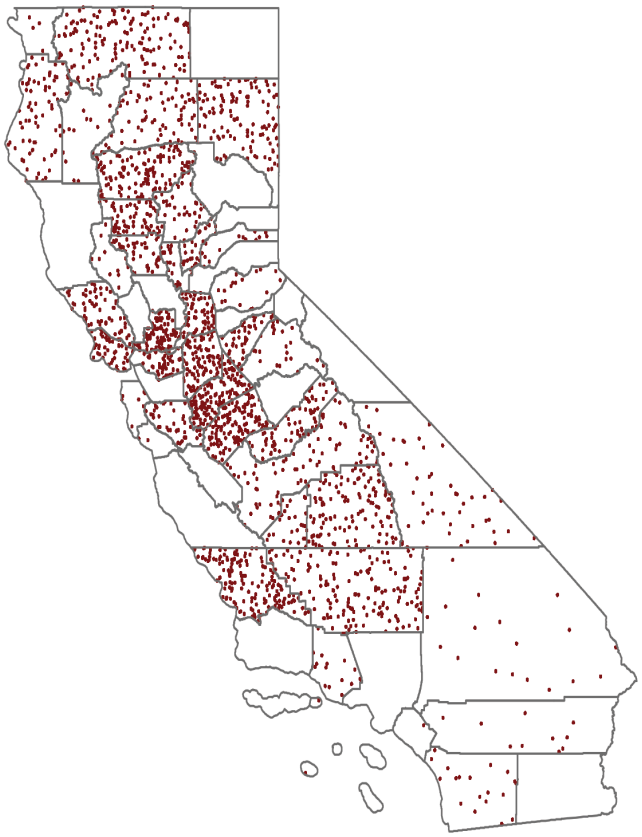
Source: USDA/NASS

The largest 100 grape growers had a 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, a third of raisin grapes are machine harvested, but table grapes are hand harvested and packed in bags and other retail packages 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 2017, a period during which table grape production rose by 50 percent. The acreage of raisin grapes is shrinking. Low raisin prices encourage smaller growers with older vineyards to switch from vineyards to tree nuts.

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 are grouped into five regions: North Coast, Central Coast, Northern San Joaquin, Southern San Joaquin, and other. The North Coast,

Figure 1.6. Dot Density Plot of California Beef Cattle Inventories by County, January 1, 2017



Most of California's beef cattle are in northern and central counties of the state.

Source: California Department of Food and Agriculture

Note: Each dot represents 500 head.

including Napa and Sonoma Counties, accounted for an eighth of the state's 4.1 million tons of wine grapes crushed in 2019, but over 40 percent of the $3.2 billion value of the state's wine grapes, due to high per ton prices. The Southern San Joaquin accounts for almost 40 percent of the state's wine grape tonnage but only an eighth of the value of wine grapes. Some wine grapes were not harvested in 2019 because of excess wine in storage, prompting the conversion of more San Joaquin vineyards into almond orchards.

Wine grapes are grown by the winery that uses the grapes to make wine and by independent growers, most of whom have contracts to sell their wine to a particular winery. The largest wineries in 2019, as ranked by 12-bottle cases sold in the U.S., were E&J Gallo, 70 million cases; Wine Group, 53 million cases; and Constellation Brands, 35 million cases; these three wineries accounted for half of U.S. wine sales, including U.S.-produced wine and imports. Most of the 12,000 U.S. wineries are very small, and some are virtual wineries, meaning that their wine is made for them by another winery.

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 remain a major player in the world of wine.

Cattle and Sheep

U.S. farm sales were $388 billion in 2017, including $193 billion (50 percent) from crops and $195 billion (50 percent) from livestock and animal products. Unlike many other states, where animal products have higher gross farm revenue than crops, 80 percent of California's farm sales are from crops. California's $11.2 billion in animal agriculture sales in 2017 were about 6 percent of U.S. animal agriculture revenue. California's cattle and calves sales were $2.6 billion in 2017, and poultry and eggs sales were $1.4 billion.

The beef cattle industry has two distinct subsectors. Some ranches breed cows to produce calves and others fatten cattle before slaughter. The major expense involved in fattening cattle is feed that is often over half of production costs.

California had 2 percent of the 31 million U.S. beef cows in 2017. Three counties, Kern, San Luis Obispo, and Siskiyou, have the largest beef cow herds. California livestock producers rely on public lands to provide forage for cattle, and they move cattle from place to place to access pasture-based forage resources.

Cow-calf operations are the first stage in the beef supply chain, raising calves until they are roughly 7 months old and weigh 600 pounds. Calves are sold to stocker operations that feed them on pasture until they are a year old and weigh 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. are in Nebraska, Texas, Kansas, Iowa,

and Colorado, meaning that many yearling cattle leave the state in trucks and return as beef.

California has over 10 percent of the 5.2 million sheep in the U.S., ranking second to Texas in sheep inventory. Like cattle, lambs are raised on grass until they are moved to feed lots for fattening and slaughter. Many California sheep producers rely on H-2A sheepherders from Peru who were paid $2,133 per month in 2020.

Cattle and sheep ranchers need low-cost forage, which is disappearing with increased regulation of grazing on federal lands. There are only a few meat-processing plants in California. Ranchers believe that the big four meatpackers that process 73 percent of U.S. cattle depress cattle prices, although research has not found convincing proof that meatpackers reduce farmers' prices. The use of antibiotics to prevent disease is being restricted in order to slow 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 for vegetables and melons from California, 57 percent of the U.S. total. Sales of the state's leading vegetables included $2.2 billion for lettuce, $1.7 billion for tomatoes, and $865 million for broccoli; these three commodities accounted for 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 per person per year. Most of these vegetables are consumed fresh, 135 pounds per person in 2017, compared with 110 pounds of vegetables processed by canning or freezing them. The leading fresh vegetables by per capita consumption 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.

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

Photo Credit: iStockPhoto

Some 1.4 million U.S. acres of fresh vegetables (excluding potatoes and dry beans) are planted each year, plus another one million acres of processing vegetables. The value of fresh vegetables was $10.8 billion in 2017, and the value of processing vegetables was $2 billion, excluding potatoes and dry beans.

Other important California fresh vegetables were carrots with $368 million in sales in 2017; garlic, $390 million; bell and Chili peppers, $368 million; melons, $367 million; cauliflower, $304 million; celery, $302 million; and onions, $256 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's big six fresh vegetables are broccoli, carrots, celery, lettuce, bell peppers, and fresh tomatoes. They are produced by a relative handful of large grower-shippers, that is, businesses that plant and harvest crops to supply fresh vegetables to buyers year-round. Many of the largest grower-shippers are not classified as farms in government statistics, including one of the largest, Dole Fresh Vegetables, which is considered a fruit and vegetable merchant wholesaler (NAICS 424480).

Most fresh vegetables are consumed raw, which makes food safety a major concern. Bagged spinach contaminated with E. coli O157:H7 killed three people and hospitalized over 100 in September 2006, setting in motion efforts to

improve food safety practices on farms and packing plants that were codified in the Food Safety Modernization Act (FSMA) of 2011. Later outbreaks in leafy greens, most recently in November 2019, have led to additional changes in food safety practices.

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 expenses. Among the major fresh vegetables, tomatoes are the most unionized, with the United Farm Workers representing workers employed by several major grower-shippers.

The slowdown in unauthorized Mexico-U.S. migration after the 2008-09 recession and the state's rising minimum wage are encouraging efforts to mechanize hand-labor tasks and increasing the employment of guest workers. New varieties of plants that ripen uniformly facilitate once-over machine harvesting, the next step after widespread use of machines to plant and weed vegetable fields. At the same time, some large vegetable growers are building housing for guest workers, suggesting that efforts to mechanize harvesting may not be successful.

Imports of fresh vegetables are rising. A third of the fresh vegetables available to Americans are imported, up from less than 10 percent in the early 1990s. Many California grower-shippers have operations in Mexico to produce tomatoes and other vegetables for U.S. consumers. Farmers, who receive an average of 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 convenient packaging, such as ready-to-eat salads and plastic containers of cherry tomatoes.

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

Photo Credit: Jon Bovay, UC Davis, 2013

Mushrooms are fungi but classified with vegetables. California had 70 mushroom farms with 6.2 million square feet of growing space according to the 2017 Census of Agriculture. The 20 largest mushroom farms account for over 85 percent of the state's mushroom-growing space and most of the $255 million in farm revenue from the sale of mushrooms. Santa Clara County had $76 million in mushroom sales, followed by $33 million in San Diego County (data are suppressed for privacy protection for many counties). California's mushroom production is concentrated in Monterey and Santa Clara Counties.

Mushrooms are grown in sealed houses that have wooden beds stacked three to five high. Spawning takes about 12 days, and mushrooms can be harvested 18 days later. Mushrooms are harvested by hand, and California's 35 mushroom farms that paid unemployment insurance taxes (NAICS 111411) had an average 2,200 employees in 2019, when weekly wages averaged $775. The UFW represents workers employed at Monterey Mushrooms and Countryside Mushrooms.

Berries

California's berry industry generated five percent of California's farm sales from less than one percent of the state's farm land in 2017. The berry industry includes two subsectors: strawberries planted each year and perennial cane or bush berries: blueberries, raspberries, and blackberries. Demand for berries is rising due to their perceived health benefits, 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 $3.7 billion in 2017, including 84 percent from strawberries and 12 percent from raspberries. Four firms market most U.S. fresh strawberries, led by market-leader Driscoll's, which is also the dominant marketer of raspberries. Naturripe

Farms is the leading U.S. marketer of blueberries, and also markets other berries. Most blackberries are imported from Central Mexico and marketed by Driscoll's and Naturripe.

California and Mexico can produce the four major berries almost year-round. Most of the strawberries available to U.S. consumers are produced in California, while most blackberries, blueberries, and raspberries are imported. The share of imports in U.S. strawberry consumption is 14 percent, compared to 53 percent for blueberries and 55 percent for raspberries. Some large Salinas vegetable growers also grow strawberries; the value of strawberries is second only to lettuce in the salad bowl of Monterey County.

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 a grower's production may peak during periods of low prices that cover harvesting costs but not the total costs of production. Growers want to plant strawberries in sterile soil, and used methyl bromide to fumigate soil to eliminate pests until 2016, when the use of methyl bromide ended 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 2 pounds per person in 2018 (compared to 7 pounds of fresh strawberries). The major U.S. blueberry-producing states are Georgia, Michigan, Oregon, and Washington, accounting for two-thirds of U.S. blueberries. The major sources of blueberry imports are Chile, Canada, and Mexico. California's blueberry production is expanding rapidly, pushing the value of the state's blueberries ($138 million in 2017) to more than the value of the state's nectarines ($133 million).

After expanding rapidly, raspberry prices fell sharply in 2015, prompting reduced acreage. California had 9,000 acres of red raspberries in 2017 that produced 75,200 tons of raspberries worth $452 million. 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 the failure of the UFW's Five Cents for Fairness campaign in the mid-1990s to secure contracts with major growers. Dole had a berry contract with the UFW, but stopped growing strawberries in 2017, leaving organic strawberry grower Swanton Berry Farms with the only UFW contract. The UFW has a contract with Gourmet Blueberry, and struggled to obtain a contract with Premiere Raspberries (previously Dutra Farms).

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 US, while most fresh blueberries, blackberries, and raspberries are imported. 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, and lower wages.

Better disease-resistant plant varieties and improved machines to harvest fresh berries could help to maintain or expand U.S. fresh berry production. The fresh berry market may divide into segments that distinguish hand-picked and machine-picked fruit, with different prices for berries picked by hand and machine.

Nursery and Floral

California's nursery and floriculture sector sales were $3.8 billion in 2017, including $3.4 billion from nursery products. Nurseries are often located in metro areas near their customers. Sales of nursery plants rise with more new housing, while expanding acreages of tree fruits and nuts and grapes boost farm demands for tree and vine seedlings.

San Diego County accounts for a third of the state's nursery and floriculture sales, and most of the other leading nursery counties are in south and central coastal areas with favorable climates and most of the customers for flowers and plants. San Diego, Orange, and Los Angeles counties have almost 16 million or 40 percent of the state's 40 million people.

The Census of Agriculture reported 2,800 nursery and floriculture farms in California with total sales of $2.9

Harvest Automation's robot moves plants in nurseries, replacing many workers.

Photo Credit: Dina Rudick/*The Boston Globe*/Getty Images

Note: https://www.public.harvestai.com

billion in 2017, down from 3,400 farms in 2012. Some of the state's nurseries and greenhouses went out of business after the 2008-09 recession.

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.

The floriculture sector is smaller than the nursery sector, with farm-level sales of $414 million in 2017. California florists reported $578 million in sales in 2018, 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. Cut flowers are often flown to Miami and then trucked to customers around the U.S.

Cannabis

California was the first state to legalize medical marijuana, after the approval of Proposition 215 in 1996, which gave people diagnosed with 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 such as California where marijuana use 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 use beginning January 1, 2018. California growers produce about 16 million pounds of raw dried marijuana flowers a year, and sell almost three million pounds in the state, including 20 percent in the legal market and 80 percent in the unlicensed market; 13 million pounds or 80 percent of the state's cannabis is shipped out of California.

The retail price of legal cannabis is higher than the price of illegal cannabis because of state and local taxes and fees. Many cities decided not to allow cannabis retailers to open, although licensed retailers can make home deliveries throughout the state.

The average wholesale price of medical marijuana was $1,200 a pound in 2020, and ranged from $850 a pound for marijuana grown outdoors to $1,800 a pound for marijuana grown indoors; greenhouse-grown marijuana was worth $1,200 a pound. About 60 percent of the state's marijuana is grown outdoors, and over 70 percent is grown north of the Sacramento-San Francisco corridor. Less than 10 percent of the state's marijuana is grown indoors, while a third is grown with mixed natural and artificial light sources in greenhouses. Yields on indoor marijuana farms can be ten times higher than on outdoor farms.

Producing 16 million pounds of marijuana worth $1,200 a pound makes cannabis a $1.9 billion a year commodity. Grower revenue is likely less, because sales in the illegal markets are at lower prices, but costs of production are also relatively low for outdoor cultivation. Taxes, license fees, and other levies can add $300 to $500 a pound, and are most likely to be paid by growers producing indoors and in greenhouses.

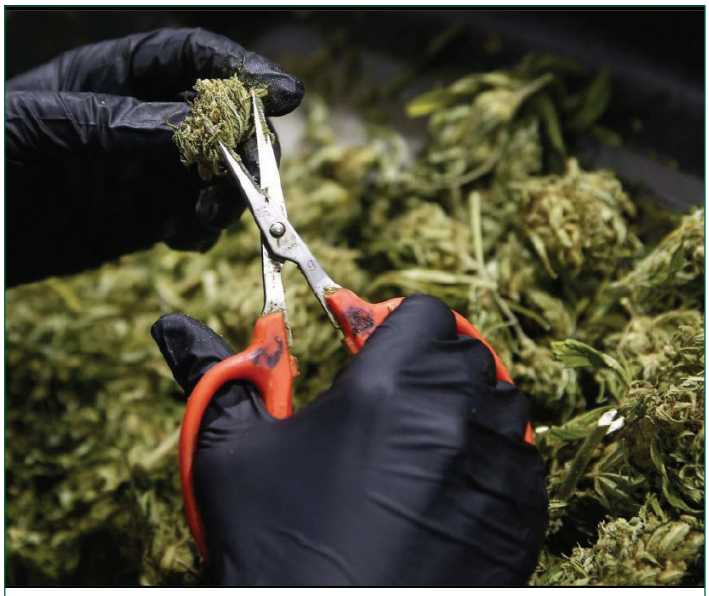
Growing marijuana requires farm workers who are granted special rights under Prop 64 and its implementing regulations. Tending and harvesting outdoor marijuana

plants takes about 20 hours of labor per pound of dry bud produced, and trimming marijuana flowers to obtain the buds requires 10 hours per pound, for a total of 30 hours per pound. At $15 per hour, labor costs are $450 per pound of dried leaves with an average grower price of $1,200 or almost 38 percent.

Most trimmers are paid piece rate wages per pound of leaves trimmed, and many earn $15 per hour trimming outdoor grown marijuana in Northern California; some growers pay their workers in kind, with marijuana buds. Many Northern California trim workers are family groups from Asia and Eastern Europe whose members aim to earn $200 to $600 a day trimming marijuana leaves. In Coastal California, where more marijuana is grown in greenhouses, wages are typically $20 an hour or more and farm workers are often ex-field workers who were born in Mexico. Up to 100,000 people may be employed in the state's cannabis industry sometime during the year.

Workers on cannabis farms are protected by the state's labor laws, including the Agricultural Labor Relations Act that gives farm workers the right to organize and bargain collectively with farm employers. Under a unique labor peace provision, AB 1291 requires marijuana growers with 20 or more employees to sign a neutrality agreement with a union trying to organize their workers within 60 days of a request. 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.

The 500-member California Cannabis Industry Association (CCIA), which represents legal cannabis growers and distributors, wants the state to lower cannabis taxes, while the United Food and Commercial Workers (UFCW) union wants CCIA members to promote unions and to lower the labor-peace threshold to 10 employees. The UFCW represented 10,000 workers employed in the cannabis industry in 14 states at the end of 2019. Most worked in retail cannabis shops, where workers are protected by the National Labor Relations Act.



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

Photo Credit: Paul Chinn, *SF Chronicle*

Demand, Marketing, and Trade

Consumer Demand

Farmers produce what consumers want to buy, making consumer demand the major factor influencing what farmers produce. People are the ultimate source of the demand for food, but many other factors influence how much and which foods are purchased. Children and the elderly consume different quantities and kinds of foods than working-aged adults, and the 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 higher incomes on food. Households in the lowest 20 percent of households grouped by income spend a third of their income on food, while those with the highest 20 percent of incomes spend less than a tenth of their income on food. Producers of various commodities often say they are competing for a "share of the 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 of one commodity increases the demand for the other.

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 (https://www.bls.gov/cex/) measures the spending of the 131 million "consumer units" or households, which in 2018 had an average of 2.5 persons, 1.3 earners, and 1.9 motor vehicles. Average consumer unit income before taxes was $78,635 and average annual expenditures were $61,225.

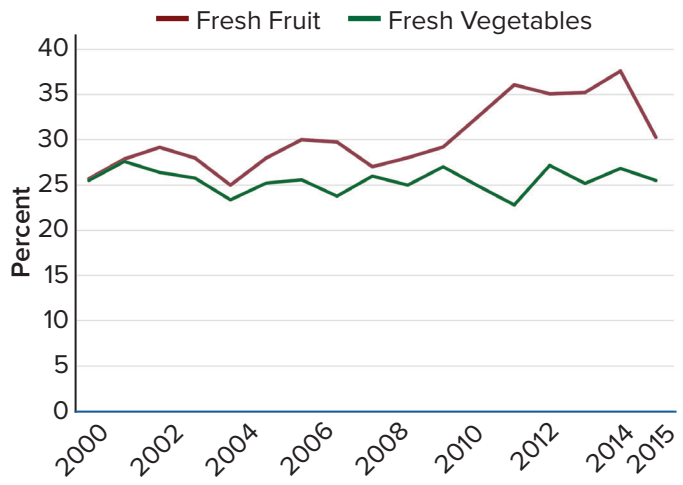
These expenditures included $7,900 for food, almost 13 percent of expenditures, and food spending was split 57-35 percent, with $4,465 or $86 a week spent for food eaten at home and $3,460 or $66 a week for food bought away from home. Other significant consumer expenditures were $20,100 for housing; $9,760 for transportation; $4,970 for health care; and $3,225 for entertainment.

The cost of food away from home largely reflects convenience, service, atmosphere, and other factors. Food costs are 35 percent of the cost of food purchased in cafeteria-style restaurants, 30 percent of the cost of food purchased at fast food restaurants, and 25 percent in fine dining establishments.

The largest food-at-home expenditures were for meat and poultry, an average of $960 in 2018. Expenditures on cereal and bakery products, $570, exceeded the $450 spent on dairy products. Expenditures on fresh fruits ($320) and fresh vegetables ($285) were $605 a year or $11.60 a week; consumer units spent an additional $115 on processed fruits and $145 on processed vegetables. Consumer units spent almost as much on alcoholic beverages, $585 per year, as on fresh fruits and vegetables, $605.

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 38 percent of the retail price of fresh fruits in 2015 and 28 percent of the retail price of fresh vegetables.

Figure 1.7. Farm Share of Retail Price of Fresh Fruit and Vegetables, 2000–2015



Source: USDA/ERS

Marketing

Agricultural marketing involves the movement of commodities from farm to consumer, including packing and processing, transportation, and retail sales. Most commodities have several "owners" as they move from farm to fork, as when they are sold by farmers to brokers

and then to supermarkets and other retailers. Farmers receive a relatively small share of retail food spending: less than half of the retail price of fluid milk and meat and only 5 percent of the retail price of cereal and bakery products.

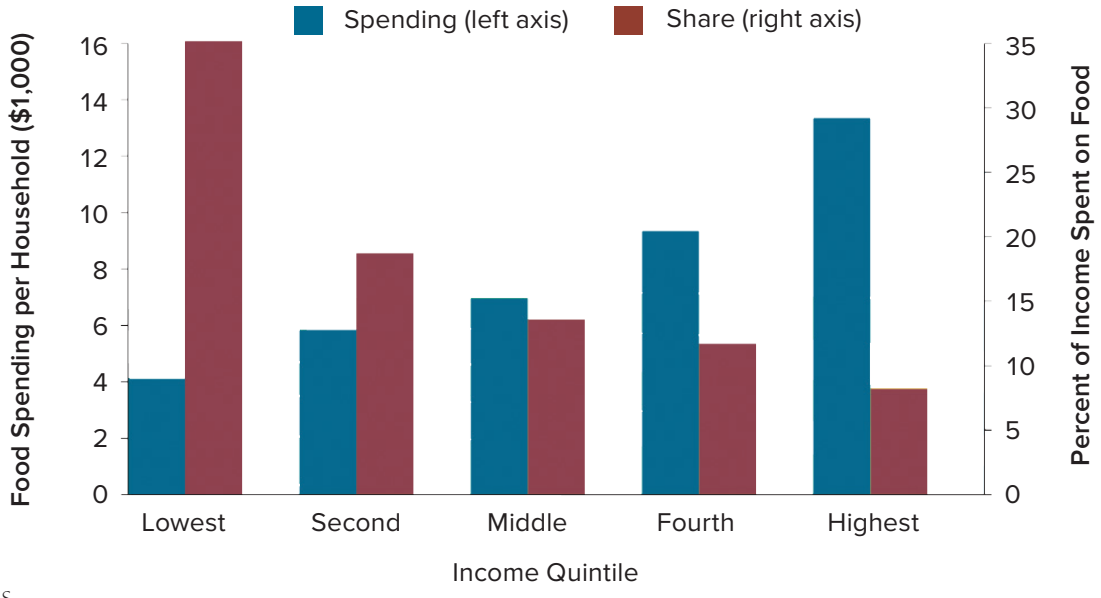
Most California farm commodities are specialty crops such as fruits and nuts, vegetables, and nursery and flower products that present special marketing challenges. Growers of some commodities have formed cooperatives such as Sunkist and Sunmaid to market their products, but the co-op share of sales in many commodities has declined as production expanded and retailers began to purchase directly from large farms that can provide commodities year-round.

California farmers use federal and state marketing programs to sell their commodities, including some that allow marketing boards to specify the quantity and quality of what is offered to consumers. Marketing orders and commodity commissions are approved after most growers representing most of the production of a commodity approve, and packers or first handlers are responsible for submitting small assessments for each box or carton to fund their activities. The number of marketing programs has been increasing, but more are approved under California rather than federal law; the number of commissions has increased faster than the number of marketing orders. The primary purpose of marketing orders and commodity commissions is to support research that deals with pest and other production problems and to advertise to increase the demand for the commodity.

Do marketing orders and commodity commissions increase grower returns? Volume controls that withhold some of the commodity from the market have been most contentious. The goal is to keep some share of output off the consumer market in order to raise grower prices. However, higher prices can increase production, so that ever more of the commodity must be withheld from the higher-price fresh market, and an ever-increasing share must be diverted to lower-priced processing markets or destroyed. This is what occurred in the fresh lemon industry, where growers agreed to terminate their federal marketing order in 1994.

Cooperative quality-control efforts are less controversial, since their purpose is to increase the demand for the commodity by keeping inferior products off the market; such as preventing the sale of immature peaches or nectarines early in the season so that shoppers do not avoid purchasing them when production peaks later in the season. Quality control has become more important in the fresh vegetable industry after several well-publicized incidents of consumers being sickened by contaminated lettuce and spinach.

Figure 1.8. Share of Income Spent on Food Declines as Incomes Rise, 2018



Source: USDA/ERS

Most mandatory assessments paid by growers are used for generic advertising and the promotion of particular commodities, such as the Got Milk or Dancing Raisins campaigns. Requiring all producers to pay for such ads reduces free-riding by some farmers who refuse to contribute to advertising campaigns that benefit them. Large growers with their own brand names have sued to avoid making contributions for generic advertising of peaches and other fruits, but the U.S. Supreme Court has upheld USDA regulations that require all growers to contribute.

Trade

California is a major international exporter of agricultural commodities, with exports worth an average 44 percent of the almost $50 billion a year in farm sales between 2012 and 2016. The U.S. is the world's leading exporter of agricultural commodities, and California exports a higher share of its farm commodities than other major farming states such as Iowa and Texas.

California's three leading agricultural exports in 2017 were almonds, dairy products, and pistachios. Tree nuts are a third of the total value of California farm exports, followed by fruits and vegetables that account for another third. California accounts for a third of U.S. dairy exports, all almond and walnut exports, and over 90 percent of wine exports. The European Union ($3.4 billion), Canada ($3.3 billion), China ($2.3 billion), Japan ($1.5 billion), and Mexico ($1 billion) collectively took over half of California's agricultural exports in 2017.

Most California farmers have more interest in free trade policies than traditional agricultural policies that protect the incomes of farmers. Reducing trade barriers allows California farmers to export more high-value almonds and similar commodities, making farmers interested in the value of the dollar and in non-tariff barriers, as when foreign countries try to block the entry of California commodities in the name of food safety.

California residents consume imported farm commodities, from avocados to zucchini. However, most of the fruits and vegetables for which the state is well known are produced in California, since few foreign competitors can compete when California production is at its peak. For example, California produces fresh strawberries year-round, but production peaks during the summer months, when imports almost cease.

Trade in fruits and nuts is growing rapidly, posing challenges and opportunities for California agriculture. On the one hand, rising incomes abroad increase the demand for California 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.

The North American Free Trade Agreement (NAFTA) divided agriculture, with most farmers seeing new opportunities but some fearing increased competition. However, the example of avocados shows the potential for win-win outcomes: Mexico reduced restrictions on other commodities that California exports and the total U.S. market for avocados expanded, allowing Mexico to export more avocados without reducing prices for U.S. growers. The United States-Mexico-Canada Agreement (USMCA) is expected to promote the continued integration of North American agriculture.

China is the world's largest producer of most fruits and vegetables. There are fears that the world's factory could become the world's farm as Chinese farmers increase production and exports of fruits and vegetables.

China has been a net agricultural importer since 2004, and rising Chinese incomes are increasing the demand for high-value fruits and vegetables, meat, and dairy products. Some Chinese consumers prefer the higher-quality and more attractive packaging of imported fruits and vegetables to local produce. The Trump Administration's trade disputes with China and other countries often result in retaliation that reduces exports of particular California commodities.

California farmers have largely embraced globalization and freer trade because they have more to gain from increased access to more affluent consumers abroad than they would lose in a protectionist U.S. that blocked imports. 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 be able to compete effectively against farmers abroad as well.

Climate and Technology

Climate Change

The drought of 2013–15 and the 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 tensions between the relatively wetter and sparsely populated northern part of the state and the drier and more populated and agriculture-intensive southern part of the state.

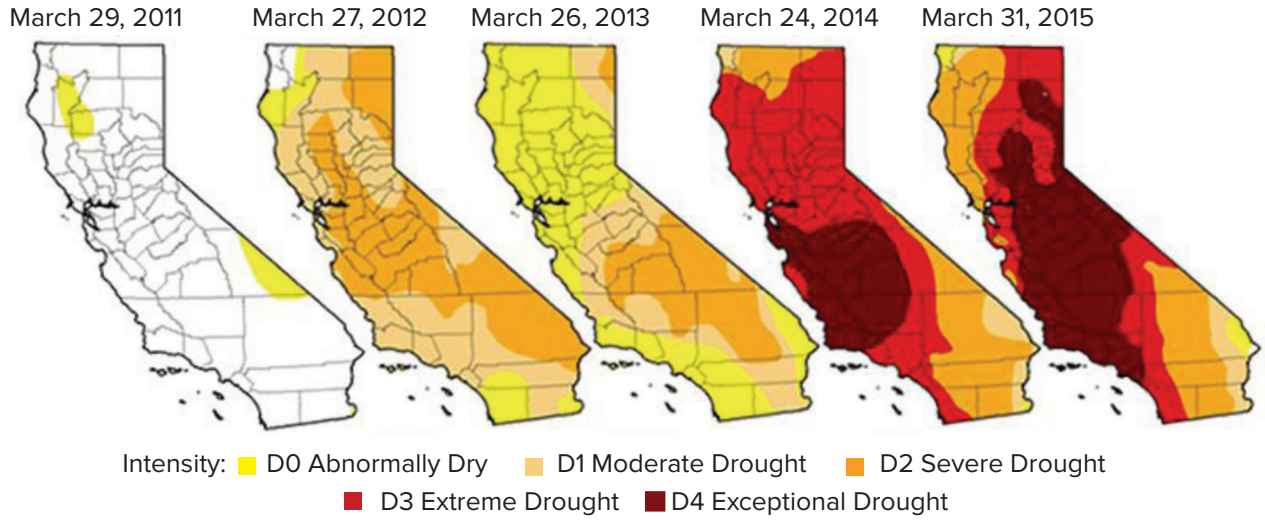
A warming climate could mean that more of the state's precipitation falls as rain rather than snow. The state's water system, which depends on snowmelt to provide surface water for irrigation in summer, would be less viable because dams and reservoirs have limited capacities to store winter rains. Climate change could also increase weather variability, leading to more floods and droughts, and could change the nature and severity of pest and disease infestations.

Rising temperatures affect crops and animals directly. The optimal number of degree days, defined as temperatures between 8°C and 32°C (46°F to 90°F), for many California crops is 2,500 over the growing season. Farm land prices reflect the number of degree days in a particular area, and are lower where there are too many or too few degree days. Average degree days in the Central Valley are currently 2,000, suggesting that global warming could lead to higher farm profits and land prices.

Climate change is expected to reduce the yields of many major field crops, including cotton and wheat, but to have mixed effects on the yields of fruit, nut, and vegetable crops, with some yields rising and others falling. Wine grape yields are less affected by rising temperatures than yields of nut and citrus crops in some models of the likely effects of climate change.

Animals will also be affected by rising temperatures, with milk yields likely declining due to heat stress. Workers also tend to be less productive at low (under 55 degrees) and high (over 100) temperatures. Agriculture could adapt by moving dairy cows to higher elevations, but this could increase the cost of transporting feed. Farm workers could work at night in order to work at lower temperatures, which would necessitate lighting systems and perhaps premium wages.

Figure 1.9. California Drought Years, 2011–2015



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 that are trained to grow for machine picking.

Source: http://cnb.cx/3nnJjgQ

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

Technology

California's high-tech agriculture is supported by an educational-industrial complex that begins with the education of students, includes research supported by public and private funds, and involves researchers transferring innovations and licensing technologies to commercial users. University of California Cooperative Extension (UCCE) specialists are important intermediaries between researchers and farmers, as are private consultants, and farmer associations.

Innovations are adopted by farmers when they increase profits. Early adopters are often the best-educated farmers, although specific factors also play important roles, as with the high cost of water encouraging San Diego avocado growers to be early adopters of drip irrigation. The continued rising price of water, along with technological improvements, spread drip irrigation throughout the state and across many crops.

California's arid climate reduces pest issues, and the relatively small yield penalty for organic farming encourages organic production in the state; a million acres of the state's cropland is certified as organic. California farmers are leaders in precision agriculture, using technology to ensure that particular plants and animals receive the optimal amount of water and other inputs. Technology holds more promise; for example, drones that can spray weeds only in the part of a 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 about the cow.

Prepackaged salads were an innovation motivated by a desire to reduce fluctuations in farm-level lettuce prices and to increase convenience for consumers. Fresh Express adapted technologies that were developed to preserve fresh fruit such as apples by altering the atmosphere and lowering the temperature in order to preserve quality. Vegetable firms learned that food service firms and consumers would pay premium prices for ready-to-eat salads. Some food-related innovations reflect the spread of technology developed for other purposes and adapted for agricultural needs, including sensors in fresh produce trucks that monitor temperature and consumer apps that facilitate purchases at grocery stores and restaurants.

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

Looking Forward

The Giannini Foundation of Agricultural Economics was established at the University of California in 1930 to support economic research beneficial to California agriculture. A. P. Giannini, the founder of Bancitaly (later Bank of America) donated $1.5 million to establish the Foundation. In the nine decades since its founding, the Giannini Foundation has supported agricultural economics faculty and graduate students throughout the University of California system, helping to ensure that the departments at UC Berkeley and UC Davis are among the best in the United States.

The Giannini Foundation supports small, innovative research projects regarding the economics of California agriculture led by faculty and graduate students, and communicates its findings to the agricultural industry and policy makers through *ARE Update*, its translational research journal, conferences, and other tools. Giannini Foundation research plays a key role in analyzing the challenges and opportunities facing California agriculture, ranging from land, labor, and water, to marketing commodities at home and abroad.

California agriculture faces the challenge of COVID-19 in 2020, adjusting to the changing demand for the specialty commodities that are the state's hallmark as restaurants and food service outlets close while striving to keep the people involved in agriculture safe. As with past challenges, California agriculture is likely to adjust and adapt, and remain the leading U.S. farm state for the foreseeable future.

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).

Painting by Arthur Cahill, 1930;
Photograph by Benjamin Blackwell, 2009