# California Agriculture's Role in the Economy and Water Use Characteristics[1]

by
Mechel Paggi, PhD
The Center for Agricultural Business (CAB)
California State University, Fresno

California agriculture has a significant effect on the state's economy. California's gross state product (GSP), the value added by all industries in the state, was $1,891 billion in 2009, according to the U.S. Bureau of Economic Analysis. Agriculture (farming), forestry, fishing, hunting, and support services accounted for 1.21 percent, around $ 22.8 billion, of the California GSP (Table 1). The share of agriculture, forestry, fishing and hunting in total GSP declined from 2008 value of $27 billion (Table 2).

**Table 1: California Gross State Product: 1997 - 2009**

| | Total Gross State Product | Agriculture, forestry, fishing, and hunting | Share of Agriculture, forestry, fishing, and hunting in Total GSP | Food product manufacturing | Share of Food product manufacturing in Total GSP |
|---|---|---|---|---|---|
| | ($ million) | | (%) | | |
| 1997 | 1,037,850 | 18,402 | 1.77% | 12,102 | 1.17% |
| 1998 | 1,112,800 | 17,272 | 1.55% | 12,716 | 1.14% |
| 1999 | 1,210,220 | 17,808 | 1.47% | 15,330 | 1.27% |
| 2000 | 1,317,340 | 17,891 | 1.36% | 15,504 | 1.18% |
| 2001 | 1,338,050 | 17,890 | 1.34% | 16,383 | 1.22% |
| 2002 | 1,385,750 | 18,678 | 1.35% | 17,589 | 1.27% |
| 2003 | 1,460,300 | 21,313 | 1.46% | 17,135 | 1.17% |
| 2004 | 1,571,200 | 25,018 | 1.59% | 16,189 | 1.03% |
| 2005 | 1,691,990 | 23,084 | 1.36% | 16,744 | 0.99% |
| 2006 | 1,800,780 | 23,800 | 1.32% | 18,563 | 1.03% |
| 2007 | 1,883,680 | 28,708 | 1.52% | 19,156 | 1.02% |
| 2008 | 1,921,490 | 26,998 | 1.41% | 19,795 | 1.03% |
| 2009 | 1,891,360 | 22,826 | 1.21% | n/a | n/a |

Source: U.S. Department of Commerce, Bureau of Economic Analysis

Determining the role of agriculture in California's economy depends in part on how agriculture is defined. In general, many industries are related to farm production; however, the degree of linkages varies significantly. From a broad perspective, over 99,000 commercial establishments (in addition to farms) in California are related to agricultural production, according to the economic census of 2007, this is an increase of 10.4 percent from the 2002 level of 89,774 (Table 3). Within this category, some industries, like food and beverage

manufacturing, are closely linked to the farming sector, but other industries, such as restaurants, may also be related to local farm production. In contrast, food produced in California and in other areas is consumed

worldwide, and thus the source of products in food retailing is more global and may not be as dependent on local farm production. With almost $81 billion in sales, the food beverage and tobacco manufacturing

| Table 2: California Gross State Product by Industry, 2008 | | | | |
|---|---|---|---|---|
| | Compensation to employees | Taxes on production and imports | Gross operating surplus | Value added |
| | | ($ million) | | |
| Agriculture, forestry, fishing, and hunting | 11,128 | (633) | 16,503 | 26,998 |
| Crop and animal production (Farms) | 5,446 | (862) | 13,948 | 18,531 |
| Mining and Utilities | 11,273 | 8,340 | 29,667 | 49,281 |
| Manufacturing and Construction | 175,077 | 9,280 | 116,452 | 300,809 |
| Food product manufacturing | 11,071 | 4,139 | 4,585 | 19,795 |
| Wholesale trade | 53,438 | 27,420 | 25,590 | 106,449 |
| Retail trade | 64,144 | 29,557 | 25,115 | 118,816 |
| Transportation and warehousing, excluding Postal Service | 26,427 | 1,998 | 15,151 | 43,576 |
| Information, Finance and Insurance | 118,412 | 6,721 | 109,123 | 234,255 |
| Real estate and rental and leasing | 16,499 | 22,976 | 268,685 | 308,161 |
| Professional and Management services | 131,968 | 2,629 | 64,081 | 198,678 |
| Administrative and waste services | 41,015 | 1,037 | 14,462 | 56,515 |
| Educational services | 14,713 | 731 | 1,084 | 16,528 |
| Health care and social assistance | 88,816 | 2,598 | 20,831 | 112,245 |
| Arts, entertainment, and recreation | 15,782 | 766 | 8,215 | 24,763 |
| Accommodation and food services | 33,252 | 5,102 | 15,153 | 53,506 |
| Other services, except government | 28,848 | 3,086 | 18,055 | 49,989 |
| Sub-total Private industries | 830,791 | 121,608 | 748,167 | 1,700,570 |
| Government | 201,638 | (2,884) | 22,173 | 220,928 |
| Total Gross State product | 1,032,430 | 118,724 | 770,340 | 1,921,490 |

industry employs over 203,000 workers according to the 2007 census. In the 2007 census there were a reported 4,564 establishments in the state that process farm products to produce food, beverages and tobacco, a 2.1 percent decline relative to 2002 census number. The largest decline observed was among textile mills while restaurants and eating places have had an increase in the number of establishments over the same time period.

## The Direct and Indirect Effects of Agriculture

Agriculture creates significant multiplier effects throughout the state's economy. Every dollar gained in agriculture stimulates additional activity in the form of labor income, job creation and value added. The Center for Agricultural Business (CAB) at California State University, Fresno utilized IMPLAN (Impact Analysis for Planning) version 3.0 software and accompanying 2009 dataset to determine multiplier effects created by the agriculture sector in California. IMPLAN uses a model developed by the USDA Forest Service, together with the Federal Emergency Management Agency and U.S. Department of Interior Bureau of Land Management. IMPLAN's secondary database is derived from published sources including the U.S. Department of Commerce, Bureau of Economic Analysis, the U.S. Department of Labor Bureau of Labor Statistics and the U.S. Department of Agriculture.

| Table 3: California's Agriculture-related Industries, 2007 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Establishments | Sales | Payroll | Employees | Establishments | Sales | Payroll | Employees |
| | | ($ million) | ($ million) | | (Percentage change from 2002 ) | | | |
| Food, Beverage and tobacco manufacturing | 4,564 | 80,786 | 7,667 | 203,894 | -2.08% | 31.11% | 17.69% | 3.76% |
| Textile mills | 401 | 1,527 | 292 | 9,669 | -18.33% | -12.92% | -19.11% | -26.58% |
| Wood product manufacturing | 1,202 | 6,462 | 1,239 | 35,357 | -10.10% | 6.61% | 8.51% | -10.47% |
| Paper manufacturing | 499 | 9,807 | 1,193 | 24,944 | -10.89% | 14.21% | -2.67% | -15.10% |
| Pesticide, fertilizer and other agricultural chemical | 97 | 1,156 | 96 | 2,023 | 1.04% | 73.03% | 24.28% | 0.15% |
| Farm machinery and equipment manufacturing | 96 | 400 | 79 | 1,904 | -7.69% | 40.98% | 32.26% | 10.12% |
| Food product machinery manufacturing | 65 | 356 | 84 | 1,761 | -10.96% | 49.72% | 21.03% | 8.97% |
| Grocery and related product merchant wholesalers | 5,425 | 91,495 | 5,135 | 115,345 | 0.52% | 32.16% | 27.33% | 6.23% |
| Farm product raw material merchant wholesalers | 298 | 4,308 | 127 | 2,641 | -6.88% | 49.39% | 36.22% | 5.72% |
| Beer, wine, and distilled alcoholic beverage merchant wholesalers | 519 | 17,721 | 1,231 | 21,977 | 1.57% | 46.81% | 30.70% | 16.63% |
| Grocery stores, supermarkets and convenience | 10,008 | 68,389 | 7,290 | 294,086 | 0.81% | 22.22% | 13.79% | 11.55% |
| Specialty food stores | 3,092 | 2,291 | 304 | 18,164 | 3.72% | 14.09% | 5.80% | 1.55% |
| Beer, wine, and liquor stores | 3,474 | 2,958 | 208 | 10,921 | 7.35% | 29.80% | 27.37% | 7.53% |
| Full-service restaurants | 26,968 | 25,593 | 8,393 | 540,731 | 15.86% | 37.74% | 38.84% | 22.63% |
| Limited-service eating places | 35,499 | 25,791 | 6,376 | 496,330 | 18.40% | 38.42% | 33.65% | 15.88% |
| Special food services | 3,426 | 4,493 | 1,234 | 59,470 | 12.33% | 62.14% | 48.01% | 17.67% |
| Drinking places (alcoholic beverages) | 3,457 | 1,764 | 428 | 32,286 | -8.28% | 28.54% | 30.94% | 4.16% |
| | | | | | | | | |
| Total agriculture-related industries | 99,090 | 345,297 | 41,377 | 1,871,503 | 10.38% | 30.31% | 24.06% | 12.99% |
| | | | | | | | | |
| Total California, not including farming, government, railroad and employed sectors | 891,997 | N/A | 653,887 | 13,771,650 | 8.65% | N/A | 28.00% | 7.12% |
| | | | | | | | | |
| Source: U.S. Census Bureau, 2007 Economic Census | | | | | | | | |
| Total is from the Census Bureau County Business Patterns | | | | | | | | |
| 2002 data are from Table 5.2 of The Measure of California Agriculture, University of California Agricultural Issues Center, | | | | | | | | |

IMPLAN is designed to model the interrelationships between the various sectors of the economy in the state and regional economies. The model employs input-output tables to show transactions among sectors. For any given industry, the model enables quantification of outputs (value of production), labor income, jobs and value added, both before and after taking into account the multiplier effects on the entire economy. These multiplier effects are expressed as a dollar value and as an industry multiplier. Industry multipliers are typically a ratio close to 2. For the agricultural production and processing industry sectors there is a value added multiplier of 2.56. This implies that for every dollar of value added in the sector, there is an additional $1.56 added to the state economy. Multiplier effects may also be measured in terms of employment added to the economy.

Multiplier effects are composed of three types – direct, indirect and induced. Direct effects measure the direct outputs of a particular industry and thus are determined directly by that industry's inputs. Indirect effects are the secondary inter-industry effects that one industry has on another. These direct and indirect effects result in changes in employment and income, which in turn affect household consumption. Induced effects are the changes in household consumption of goods and services measured in employment, income and value added. For example, increases in fertilizer use by one industry indirectly results in the production of additional fertilizer as well as usage of additional natural gas to produce the fertilizer and increased production and transport of the gas. Our analysis is based on the data available for use with IMPLAN, including their industry aggregations. In California, there are a total of 432 industries specified in the IMPLAN. Within this specification, 55 are considered as agriculture related industries.

Industry multipliers are essentially the ratio of total effects to direct effects for each industry. The results of our analysis of the economic impact of California's agricultural sector are presented in Table 4. The estimated direct effect from agricultural production and processing was 591,812 jobs, and the total effect (direct, indirect and induced) was 1,356,998 jobs. In Table 5, these values are given as a share of the state economy. In Table 6, the industry multipliers are presented. Overall the multiplier for agricultural production and processing was 2.29, or an additional 1.29 jobs created for every job in agricultural production and processing. It is important to note that the total effects (direct, indirect and induced) and industry multipliers for aggregated subgroups are not equivalent to the sums of the individual subgroups. Agricultural activities are related in several ways, which implies measurement of regional economic impacts of one industry will incorporate effects associated with the production of other industries. Thus one industry's output becomes another industry's input. In order to avoid double counting, each industry must be separately analyzed to determine 'net effect' on the regional economy. Thus the total economic effect of farming is not the sum of the effects of each of the subgroups – livestock, cotton, vegetables, fruit, etc.

**Table 4: Economic Impact of California's Agricultural Production and Processing, 2009**

**Direct and Total Effects**

| | Direct Effects | | | | Total Effects | | |
|---|---|---|---|---|---|---|---|
| | Industry output (sales) | Employment | Labor Income | Value Added | Employment | Labor Income | Value Added |
| | ($ million) | (jobs) | ($ million) | | (jobs) | ($ million) | |
| Agricultural Production and Processing | 150,383 | 591,812 | 30,082 | 42,979 | 1,356,998 | 69,888 | 110,213 |
| Agricultural Processing | 98,271 | 197,554 | 12,003 | 20,450 | 634,912 | 36,609 | 62,706 |
| Agricultural Production | 52,112 | 394,258 | 18,079 | 22,530 | 722,086 | 33,279 | 47,507 |
| Forestry, Fishing, Hunting | 1,266 | 10,375 | 351 | 563 | 19,863 | 769 | 1,161 |
| Ag-support Activities | 9,953 | 189,214 | 6,141 | 5,560 | 241,891 | 8,973 | 10,584 |
| Farming | 40,893 | 194,670 | 11,587 | 16,407 | 460,332 | 23,537 | 35,762 |
| Dairy/Poultry Production | 5,814 | 22,248 | 335 | 1,219 | 41,660 | 1,297 | 2,928 |
| Livestock | 1,987 | 13,700 | 137 | 391 | 22,669 | 526 | 1,134 |
| Cotton | 304 | 997 | 51 | 124 | 2,622 | 124 | 250 |
| Grain | 1,288 | 15,751 | 122 | 474 | 21,936 | 393 | 973 |
| Fruit | 11,776 | 48,383 | 4,530 | 5,455 | 146,331 | 8,792 | 11,937 |
| Vegetables | 8,001 | 28,997 | 2,506 | 3,642 | 83,847 | 4,933 | 7,632 |
| Tree Nuts | 3,651 | 29,164 | 1,469 | 1,891 | 57,435 | 2,708 | 3,799 |
| Sugar | 40 | 684 | 6 | 16 | 890 | 15 | 32 |
| All Other Crop | 3,966 | 13,120 | 582 | 1,159 | 37,630 | 1,690 | 3,056 |
| Green House, Nursery | 4,010 | 21,178 | 1,844 | 2,010 | 44,636 | 3,042 | 3,975 |
| Oilseed | 56 | 449 | 5 | 27 | 676 | 15 | 46 |
| | | | | | | | |
| Total California Economy | 3,223,296 | 19,856,986 | 1,159,872 | 1,874,562 | | | |

Source: Center for Agricultural Business, CSUFresno, using IMPLAN v3 software package and 2009 dataset.
Notes: Direct and total effects in Nominal dollars. Total effects include direct, indirect and induced effects of the industry named a left.
For Total Effects, vlues that utilize multiplier effects cannot be aggregated to get totals.
Industry ourput: value of production (i.e. total sales) by the group of industries named at the left.
Employment: number of jobs directly employed by the corresponding industry.
Labor income: value of wages and salaries and other proprietary income paid by industry.
Value added equals sum of labor income (employee compensation and proprietor income), property income and indirect business taxes. This is the same as total sales (industry output) less purchased inputs and services.
Agricultural processing: this group includes animal feed, food and beverage industries.
Agricultural support activities includes fertilizer and pesticides manufacturing, soil preparation and harvesting services, packing and cooling and cotton ginning.

Multiplier effects differ by commodity because the production of some commodities may be more related to input and processing industries located within the state or region than others.

## Agriculture and the State Economy

In 2009, the value of California goods and services were reported to be worth over $3.22 trillion, providing 19.8 million jobs, paying over $1.1 trillion in labor income, including employee compensation and proprietary income, and created $1.87 trillion of value added economic activity (Table 4). Considering only direct effects,

the agriculture production and processing industries combined accounted for 4.7 percent of state output, almost 3 percent of the jobs, 2.6 percent of labor income, and 2.3 percent of the value added in the state economy (Table 5).

**Table 5: Direct and Total Effects as Share of California Economy, 2009**

| | Direct Effects | | | | Total Effects | | |
|---|---|---|---|---|---|---|---|
| | Industry output (sales) | Employment | Labor Income | Value Added | Employment | Labor Income | Value Added |
| Agricultural Production and Processing | 4.67% | 2.98% | 2.59% | 2.29% | 6.83% | 6.03% | 5.88% |
| Agricultural Processing | 3.05% | 0.99% | 1.03% | 1.09% | 3.20% | 3.16% | 3.35% |
| Agricultural Production | 1.62% | 1.99% | 1.56% | 1.20% | 3.64% | 2.87% | 2.53% |
| Forestry, Fishing, Hunting | 0.04% | 0.05% | 0.03% | 0.03% | 0.10% | 0.07% | 0.06% |
| Ag-support Activities | 0.31% | 0.95% | 0.53% | 0.30% | 1.22% | 0.77% | 0.56% |
| Farming | 1.27% | 0.98% | 1.00% | 0.88% | 2.32% | 2.03% | 1.91% |
| Dairy/Poultry Production | 0.18% | 0.11% | 0.03% | 0.07% | 0.21% | 0.11% | 0.16% |
| Livestock | 0.06% | 0.07% | 0.01% | 0.02% | 0.11% | 0.05% | 0.06% |
| Cotton | 0.01% | 0.01% | 0.00% | 0.01% | 0.01% | 0.01% | 0.01% |
| Grain | 0.04% | 0.08% | 0.01% | 0.03% | 0.11% | 0.03% | 0.05% |
| Fruit | 0.37% | 0.24% | 0.39% | 0.29% | 0.74% | 0.76% | 0.64% |
| Vegetables | 0.25% | 0.15% | 0.22% | 0.19% | 0.42% | 0.43% | 0.41% |
| Tree Nuts | 0.11% | 0.15% | 0.13% | 0.10% | 0.29% | 0.23% | 0.20% |
| Sugar | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| All Other Crop | 0.12% | 0.07% | 0.05% | 0.06% | 0.19% | 0.15% | 0.16% |
| Green House, Nursery | 0.12% | 0.11% | 0.16% | 0.11% | 0.22% | 0.26% | 0.21% |
| Oilseed | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

Source: Table 4

When considering direct, indirect and induced effects, the measured share of agricultural production and processing increased to 6.8 percent of the state's 20 million jobs, 6 percent of the state labor income, and 5.9 percent of the state value added. The total effects from agricultural production alone accounted for 3.6 percent of state employment, 2.9 percent of labor income and 2.5 percent of value added in the state economy.

Farming directly accounted for 1.3 percent ($40.9 billion) of the state output. The largest valued subgroup within farming, fruit valued at around $12 billion in 2009, around 0.4 percent of the state output. The direct, indirect and induced effects of farming accounted for 2.3 percent of employment in California, over 460 thousand jobs; 2 percent of labor income, $23.5 billion; and 1.9 percent of value added, over $35.7 billion.

Fruit accounted for 0.7 percent of state employment, 0.8 percent of labor income and 0.6 percent of value added after including indirect and induced effects. Followed by vegetables accounting for around 0.4 percent of state employment, 0.4 percent of labor income and 0.4 percent of value added. The labor income multipliers are greatest for the dairy and livestock subgroup (Table 6).

**Table 6: Industry Multipliers for California, 2009**

| | Employment | Labor Income | Value Added |
|---|---|---|---|
| Agricultural Production and Processing | 2.29 | 2.32 | 2.56 |
| Agricultural Processing | 3.21 | 3.05 | 3.07 |
| Agricultural Production | 1.83 | 1.84 | 2.11 |
| Forestry, Fishing, Hunting | 1.91 | 2.19 | 2.06 |
| Ag-support Activities | 1.28 | 1.46 | 1.90 |
| Farming | 2.36 | 2.03 | 2.18 |
| Dairy/Poultry Production | 1.87 | 3.88 | 2.40 |
| Livestock | 1.65 | 3.84 | 2.90 |
| Cotton | 2.63 | 2.43 | 2.01 |
| Grain | 1.39 | 3.21 | 2.05 |
| Fruit | 3.02 | 1.94 | 2.19 |
| Vegetables | 2.89 | 1.97 | 2.10 |
| Tree Nuts | 1.97 | 1.84 | 2.01 |
| Suga | 1.30 | 2.59 | 2.03 |
| All Other Crop | 2.87 | 2.90 | 2.64 |
| Green House, Nursery | 2.11 | 1.65 | 1.98 |
| Oilseed | 1.50 | 2.94 | 1.68 |

Source: Table 4

Agriculture support activities comprise over 130 activities closely related to agricultural production, in addition fertilizer and pesticide and other agricultural chemical manufacturing industries are included in this group. This group includes soil preparation, fertilizer application, planting, and harvesting services, packing, and cotton ginning, estimating timber, and forest fire prevention, among others. In 2009 the value added directly attributable to this group was smaller than labor income, $5,560 million compared to $6,141 million. As mentioned earlier, value added is the sum of 4 components: employee compensation, proprietor income, other property income and indirect business taxes. Employee compensation is always positive. Proprietor income, a part of labor income, and other property income (corporate profit, capital consumption allowance, etc.) can be negative. If these other income sources are more negative than indirect business tax (the 4th

component) which is positive then value added will be less than labor income as suggested by these results for 2009.

## Agriculture and Regional Economies – The San Joaquin Valley

Given the size, geographical and economic diversity of California, agriculture plays a more important role in the economy of some regions of the state than others. For this study we provide a more detailed analysis of the regional impact of agriculture in our focus area, the San Joaquin Valley (SJV); Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus and Tulare counties. The regional output of the SJV including agricultural and non-agricultural industries was valued at $229 billion in 2009. The total number of jobs, around 1.6 million and the regional value added was over $119 billion. The relative importance of agricultural production and processing output of the San Joaquin Valley is observed from the results of the IMPLAN analysis provided in Table 7. Agriculture in this region accounted for over 37 percent of the value of agricultural production and processing in California. The direct value added for the San Joaquin Valley from agricultural production and the processing industry is estimated to be $16 billion, 13.4 percent of the value added in the regional economy, as expected, much larger than the 2.3 percent generated by the agricultural industry relative to California's total economy.

| Table 7: Economic Impact of San Joaquin Valley Agricultural Production and Processing, 2009 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Direct and Total Effects | | | | | | |
| | Direct Effects | | | | Total Effects | | |
| | Industry output (sales) | Employment | Labor Income | Value Added | Employment | Labor Income | Value Added |
| | ($ million) | (jobs) | ($ million) | | (jobs) | ($ million) | |
| Agricultural Production and Processing | 55,126 | 253,056 | 11,566 | 16,002 | 568,456 | 24,264 | 36,896 |
| Agricultural Processing | 30,815 | 57,135 | 3,237 | 5,515 | 199,699 | 9,532 | 16,315 |
| Agricultural Production | 24,312 | 195,921 | 8,329 | 10,487 | 368,757 | 14,732 | 20,580 |
| Forestry, Fishing, Hunting | 270 | 1,314 | 44 | 96 | 4,701 | 157 | 240 |
| Ag-support Activities | 4,685 | 106,129 | 3,022 | 2,710 | 131,150 | 4,093 | 4,602 |
| Farming | 19,356 | 88,478 | 5,263 | 7,681 | 232,906 | 10,482 | 15,739 |
| Dairy/Poultry Production | 4,011 | 17,145 | 207 | 859 | 33,874 | 889 | 2,061 |
| Livestock | 934 | 5,768 | 64 | 164 | 10,917 | 229 | 478 |
| Cotton | 285 | 941 | 48 | 117 | 2,672 | 111 | 220 |
| Grain | 463 | 6,385 | 45 | 170 | 8,816 | 130 | 321 |
| Fruit | 7,150 | 24,277 | 2,681 | 3,312 | 91,850 | 5,075 | 6,789 |
| Vegetables | 2,592 | 6,776 | 756 | 1,180 | 26,250 | 1,453 | 2,278 |
| Tree Nuts | 2,706 | 22,734 | 1,122 | 1,401 | 46,692 | 1,974 | 2,659 |
| Sugar | 15 | 391 | 3 | 6 | 492 | 6 | 12 |
| All Other Crop | 619 | 2,091 | 98 | 181 | 6,277 | 249 | 425 |
| Green House, Nursery | 567 | 1,856 | 238 | 284 | 4,895 | 362 | 485 |
| Oilseed | 13 | 114 | 1 | 6 | 172 | 3 | 10 |
| | | | | | | | |
| Total San Joaquin Valley Economy | 228,622 | 1,638,627 | 78,693 | 119,423 | | | |
| | | | | | | | |
| Source: Center for Agricultural Business, CSUFresno, using IMPLAN v3 software package and 2009 dataset. | | | | | | | |
| Notes: Direct and total effects in Nominal dollars. Total effects include direct, indirect and induced effects of the industry named a left. | | | | | | | |
| For Total Effects, vlues that utilize multiplier effects cannot be aggregated to get totals. | | | | | | | |
| Industry ourput: value of production (i.e. total sales) by the froup of industries named at the left. | | | | | | | |
| Employment: number of jobs directly employed by the corresponding industry. | | | | | | | |
| Labor income: value of wages and salaries and other proprietary income paid by industry. | | | | | | | |
| Value added equals sum of labor income (employee compensation and proprietor income), property income and indirect business taxes. This is the same as | | | | | | | |
| total sales (industry output) less purchased inputs and services. | | | | | | | |
| Agricultural processing: this group includes animal feed, food and beverage industries. | | | | | | | |
| Agricultural support activities includes fertilizer and pesticides manufacturing, soil preparation and harvesting services, packing and cooling and cotton ginning. | | | | | | | |

In terms of direct effects, farming accounted for 8.5 percent of regional output, 5 percent of regional employment, and 6.4 percent of regional value added. Within the farming subgroup, fruit production accounted for over 3 percent of regional output, 1.5 percent of employment, and 2.8 percent of value added (Table 8). The total direct, indirect and induced effects of agricultural production and processing industries in the San Joaquin Valley accounted for 34.7 percent of regional employment, almost 31 percent of regional labor income, and 31 percent of regional total value added. Agricultural production alone supported 369 thousand jobs, 22.5 percent of the region's jobs, generating almost 18.7 percent of labor income (some $15 billion), and 17.2 percent of value added, $20.6 billion, The farming subgroup accounted for 14.2 percent of employment, 13.3 percent of labor income, and 13 percent of value added. Within farming, the fruit industry in the San Joaquin Valley accounted for 5.6 percent of regional employment, 6.5 percent of labor income, and 5.7 percent of value added.

**Table 8: San Joaquin Valley Direct and Total Effects as Share of Regional Economy, 2009**

| | Direct Effects | | | | Total Effects | | |
|---|---|---|---|---|---|---|---|
| | Industry output (sales) | Employment | Labor Income | Value Added | Employment | Labor Income | Value Added |
| Agricultural Production and Processing | 24.11% | 15.44% | 14.70% | 13.40% | 34.69% | 30.83% | 30.90% |
| Agricultural Processing | 13.48% | 3.49% | 4.11% | 4.62% | 12.19% | 12.11% | 13.66% |
| Agricultural Production | 10.63% | 11.96% | 10.58% | 8.78% | 22.50% | 18.72% | 17.23% |
| Forestry, Fishing, Hunting | 0.12% | 0.08% | 0.06% | 0.08% | 0.29% | 0.20% | 0.20% |
| Ag-support Activities | 2.05% | 6.48% | 3.84% | 2.27% | 8.00% | 5.20% | 3.85% |
| Farming | 8.47% | 5.40% | 6.69% | 6.43% | 14.21% | 13.32% | 13.18% |
| Dairy/Poultry Production | 1.75% | 1.05% | 0.26% | 0.72% | 2.07% | 1.13% | 1.73% |
| Livestock | 0.41% | 0.35% | 0.08% | 0.14% | 0.67% | 0.29% | 0.40% |
| Cotton | 0.12% | 0.06% | 0.06% | 0.10% | 0.16% | 0.14% | 0.18% |
| Grain | 0.20% | 0.39% | 0.06% | 0.14% | 0.54% | 0.17% | 0.27% |
| Fruit | 3.13% | 1.48% | 3.41% | 2.77% | 5.61% | 6.45% | 5.68% |
| Vegetables | 1.13% | 0.41% | 0.96% | 0.99% | 1.60% | 1.85% | 1.91% |
| Tree Nuts | 1.18% | 1.39% | 1.43% | 1.17% | 2.85% | 2.51% | 2.23% |
| Sugar | 0.01% | 0.02% | 0.00% | 0.01% | 0.03% | 0.01% | 0.01% |
| All Other Crop | 0.27% | 0.13% | 0.12% | 0.15% | 0.38% | 0.32% | 0.36% |
| Green House, Nursery | 0.25% | 0.11% | 0.30% | 0.24% | 0.30% | 0.46% | 0.41% |
| Oilseed | 0.01% | 0.01% | 0.00% | 0.01% | 0.01% | 0.00% | 0.01% |
| Source: Table 7 | | | | | | | |

The employment multiplier for the agricultural production and processing industry in the San Joaquin Valley was 2.25. This implies that for every 100 agricultural production and processing jobs in the San Joaquin Valley, 125 additional jobs were created in related industries in the region (Table 9).

| Table 9: San Joaquin Valley Industry Multipliers, 2009 | | | |
|---|---|---|---|
| | Employment | Labor Income | Value Added |
| Agricultural Production and Processing | 2.25 | 2.10 | 2.31 |
| Agricultural Processing | 3.50 | 2.94 | 2.96 |
| Agricultural Production | 1.88 | 1.77 | 1.96 |
| Forestry, Fishing, Hunting | 3.58 | 3.57 | 2.50 |
| Ag-support Activities | 1.24 | 1.35 | 1.70 |
| Farming | 2.63 | 1.99 | 2.05 |
| Dairy/Poultry Production | 1.98 | 4.29 | 2.40 |
| Livestock | 1.89 | 3.58 | 2.91 |
| Cotton | 2.84 | 2.31 | 1.88 |
| Grain | 1.38 | 2.89 | 1.89 |
| Fruit | 3.78 | 1.89 | 2.05 |
| Vegetables | 3.87 | 1.92 | 1.93 |
| Tree Nuts | 2.05 | 1.76 | 1.90 |
| Sugar | 1.26 | 2.00 | 2.00 |
| All Other Crop | 3.00 | 2.54 | 2.35 |
| Green House, Nursery | 2.64 | 1.52 | 1.71 |
| Oilseed | 1.51 | 3.00 | 1.67 |
| Source: Table 7 | | | |

## Agricultural Water Use Characteristics

As demonstrated in the previous section, agriculture is an important element of California's economy. The California Department of Food and Agriculture reported that 81,500 farmers and ranchers received $34.8 billion for their output in 2009. The state produces more than 400 different agricultural commodities, supplying nearly half of U.S.-grown fruits, nuts and vegetables (Table 10). Such robust agricultural production in California has been made possible by irrigation supplied by a vast and integrated water infrastructure. The Department of Water Resources estimated irrigated acreage for 2005 was 8.7 million acres, with 540,000 acres of multi-crops, for a total of 9.2 million acres of irrigated cropped area (Table 11). The irrigated acreage changes from year-to-year. In 2001, California irrigated around 9.2 million acres of irrigated cropland with about 30.8 million acre-feet (MAF) of applied water as irrigation.

The significant expansion of California's irrigated acreage occurred over a long period of time. Irrigation is reported to have begun immediately following the gold rush in 1949 as ditches used for placer mining began to be used to supply water for agricultural crop production. The completion of the transcontinental railroad in 1869 began the opening of the markets in the east for California-grown produce. Irrigation expanded in the Central Valley for the next 30 years but remained at less than 1 million acres in 1900; continued expansion of irrigated acreage increased to an area of about 2.725 million acres by 1939. During this period sinking wells and pumping ground water to the surface was an increasing source for expanding acreage. By 1940 about a reported 1.5 million acres were irrigated from pumped below ground sources.[2]

An expansion of irrigated acreages to current levels was dependent on the completion of several water supply projects, including the federal Central Valley Project (CVP), All-American Canal (AAC), and the State Water Project (SWP). Construction of the initial units of the CVP began in 1937 with the Contra Costa Canal, completed in 1948. Construction of the Shasta Dam began in 1938 and completed in 1945. The Folsom Dam was completed in 1956. Work on the CVP system continued into the 1960s and 1970s.[3] Irrigated acreage continued to expand along with the completion of these projects. By the 1950's irrigated acreage increased significantly to 7.4 million acres (Figure 1). Irrigated acreage continued to expand and presently the exact number of irrigated acreage and agricultural water use is subject to some degree of debate. For example, a study by the USDA[4] reported irrigated acreage in California at 8.9 million acres in 1997, 8.7 million acres for 2002, 8 million acres for 2007 and 7.3 million acres for 2008 with total water applied for 2008 of 22.6 MAF.

**Table 10: California: Leading commodities for cash receipts, 2009**

| Rank | Items | Value of receipts | Percent of total receipts | Cumulative percent 1/ | Percent of U.S. value 2/ | Value of U.S. receipts |
|---|---|---|---|---|---|---|
| | | 1,000 dollars | ---------- | Percent | ---------- | 1,000 dollars |
| | All commodities | 34,840,647 | 100.0 | -- | 12.3 | 283,406,168 |
| | Livestock and products | 7,814,006 | 22.4 | -- | 6.5 | 119,751,629 |
| | Crops | 27,026,641 | 77.6 | -- | 16.5 | 163,654,539 |
| 1 | Dairy products | 4,537,171 | 13.0 | 13.0 | 18.6 | 24,342,440 |
| 2 | Greenhouse/nursery | 3,792,295 | 10.9 | 23.9 | 23.8 | 15,914,592 |
| 3 | Grapes | 3,267,848 | 9.4 | 33.3 | 88.6 | 3,689,412 |
| 4 | Almonds | 2,293,500 | 6.6 | 39.9 | 100.0 | 2,293,500 |
| 5 | Lettuce | 1,725,799 | 5.0 | 44.8 | 78.8 | 2,189,219 |
| 6 | Strawberries | 1,725,232 | 5.0 | 49.8 | 81.2 | 2,124,195 |
| 7 | Cattle and calves | 1,676,373 | 4.8 | 54.6 | 3.8 | 43,776,568 |
| 8 | Tomatoes | 1,509,647 | 4.3 | 58.9 | 59.4 | 2,541,986 |
| 9 | Rice | 928,173 | 2.7 | 61.6 | 30.5 | 3,041,344 |
| 10 | Hay | 864,163 | 2.5 | 64.1 | 15.1 | 5,726,526 |
| 11 | Walnuts | 738,530 | 2.1 | 66.2 | 100.0 | 738,530 |
| 12 | Broccoli | 698,376 | 2.0 | 68.2 | 94.1 | 741,900 |
| 13 | Oranges | 655,820 | 1.9 | 70.1 | 32.9 | 1,993,237 |
| 14 | Pistachios | 592,850 | 1.7 | 71.8 | 100.0 | 592,850 |
| 15 | Carrots | 499,766 | 1.4 | 73.2 | 84.9 | 588,942 |
| 16 | Lemons | 364,248 | 1.0 | 74.3 | 92.4 | 394,199 |
| 17 | Celery | 349,918 | 1.0 | 75.3 | 95.9 | 364,816 |
| 18 | Peaches | 326,331 | 0.9 | 76.2 | 54.9 | 594,248 |
| 19 | Chicken eggs | 319,771 | 0.9 | 77.1 | 5.2 | 6,155,825 |
| 20 | Cotton | 303,823 | 0.9 | 78.0 | 8.7 | 3,488,956 |
| 21 | Raspberries | 297,315 | 0.9 | 78.8 | 82.0 | 362,606 |
| 22 | Cauliflower | 255,766 | 0.7 | 79.6 | 89.2 | 286,612 |
| 23 | Plums and prunes | 251,923 | 0.7 | 80.3 | 97.6 | 258,043 |
| 24 | Wheat | 230,752 | 0.7 | 81.0 | 2.0 | 11,315,147 |
| | Broilers | 3/ | -- | -- | -- | -- |
| | Government payments 4/ | 568,427 | -- | -- | 4.6 | 12,262,587 |
| | Net farm income 5/ | 8,782,066 | -- | -- | 14.1 | 62,187,066 |

-- = Not applicable

1/ The cumulative percentage is the sum of the percent of total receipts for each commodity and all preceding commodities.

2/ Percent State receipts are of U.S. receipts for same line item.

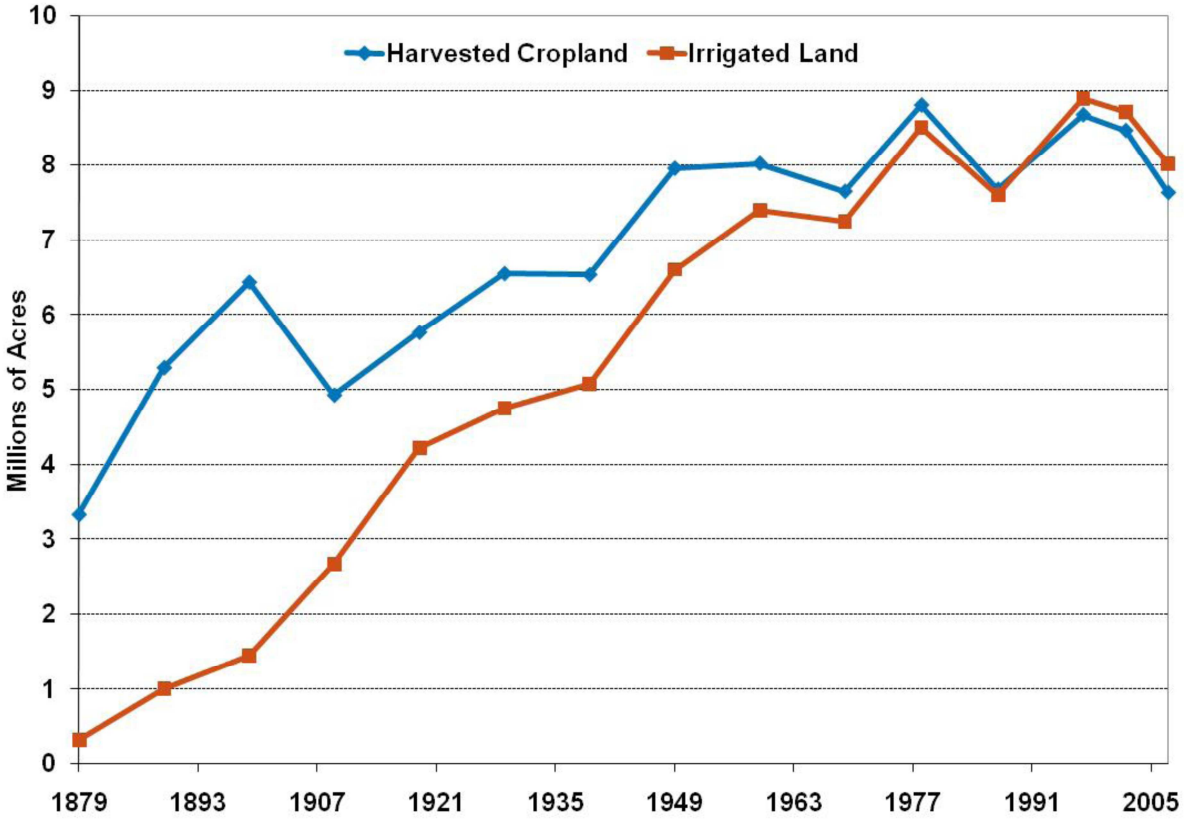
3/ Commodities at the bottom of the above ranked list of commodities and having no accompanying data would have appeared within the ranked list of leading commodities, but were excluded to avoid disclosure of confidential information about individual producers.

4/ Government payments made directly to farmers in cash or Payment-in-Kind.

5/ Net farm income, a value of production measure, is the farm operator's share of the sector's net value added to the National economy from production activities within a calendar year.

Source: Economic Research Service/USDA, Revised: August 31, 2010

Figure 1. Harvested cropland and irrigated land in California, 1879-2007




Note: Total land in farms includes cropland, rangeland, and pasture.

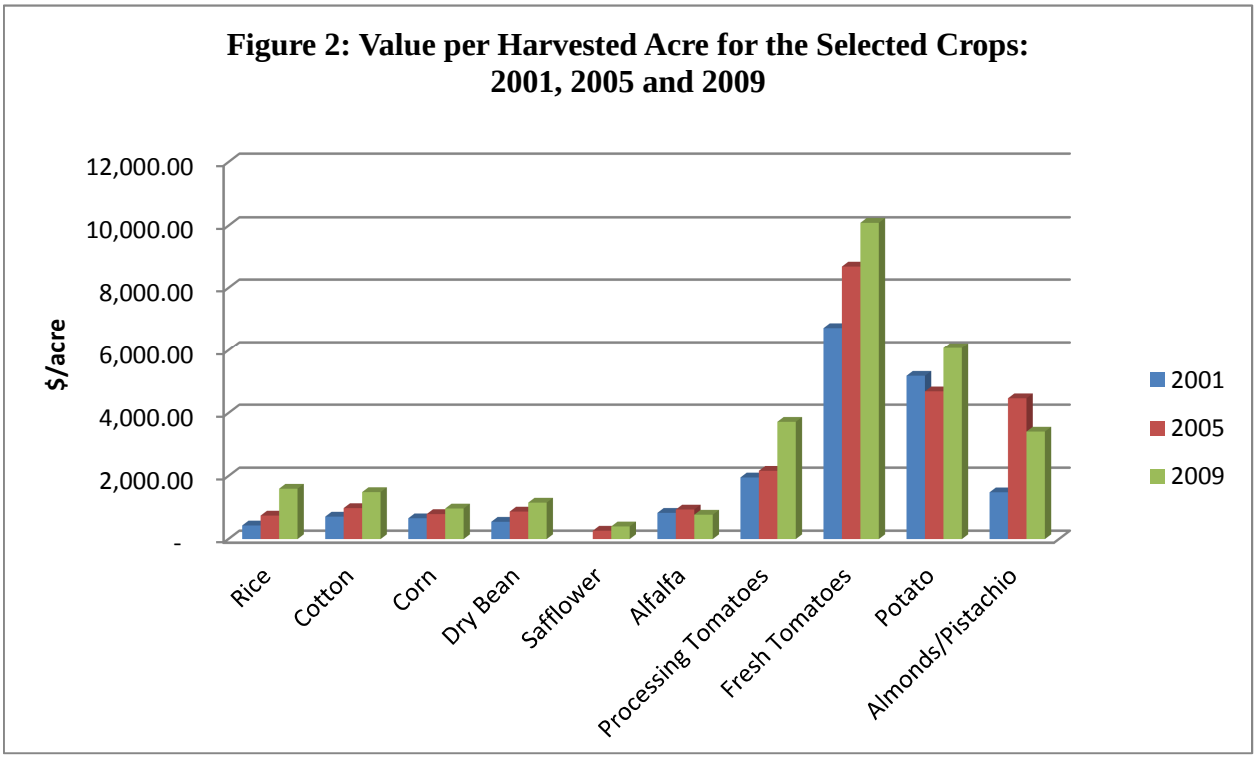
Source: Heather Cooley, J. Christian-Smith, and P. Gleick, 'Sustaining California Agriculture in an Uncertain Future' July 2009, p.18 (Source: Johnston and McCalla 2004 (1869–1987 from Olmstead and Rhode 1997; 1997–2007 from USDA 2002 and 2007)

Water use requirements vary considerably among the many different crops produced in California (Table 11). The largest water use is observed in rice and alfalfa production with water use reported at 5.88 acre feet and 5.3 acre feet in 2001 respectively. Over time water use requirements have reportedly declined to 4.98 and 4.62 acre feet in 2005 respectively. In contrast, the least use of water is reported for safflower production at 1.0 acre feet.

The current mix of commodities indicates both harvested acreage and total value has changed with a decline in cotton and alfalfa with rice and processing tomatoes increasing over the period of 2001, 2005 and 2009 (Table 12). Fresh tomatoes show the largest value per harvested acre, followed by potato for the period of 2001, 2005 and 2009 (Figure 2). Value per harvested acre for alfalfa has remained relatively constant for the same period.

| Table 11: Crop Acreage and Total Water Use by Crop (acre-feet): 2001 and 2005 | | | | | | |
|---|---|---|---|---|---|---|
| | 2001 | | | 2005 | | |
| | Irrigated Crop Area. | | Water Use | Irrigated Crop Area. | | Water Use |
| Crop | Acre | Acre-foot per Acre | Acre-feet | Acre | Acre-foot per Acre | Acre-feet |
| Grain | 833,460 | 1.51 | 1,255,576 | 484,080 | 1.05 | 509,095 |
| Rice | 513,000 | 5.88 | 3,015,577 | 575,020 | 4.98 | 2,866,023 |
| Cotton | 838,380 | 3.23 | 2,709,093 | 692,670 | 2.90 | 2,010,312 |
| Corn | 638,940 | 3.09 | 1,974,030 | 685,780 | 2.77 | 1,900,355 |
| Dry Bean | 99,030 | 2.47 | 244,615 | 69,150 | 2.27 | 157,037 |
| Safflower | 105,800 | 1.07 | 112,976 | 50,920 | 1.00 | 50,970 |
| Other Field | 191,590 | 2.81 | 538,192 | 516,960 | 2.57 | 1,328,124 |
| Alfalfa | 1,123,480 | 5.30 | 5,954,364 | 1,081,680 | 4.62 | 4,994,222 |
| Pasture | 780,040 | 4.31 | 3,359,855 | 822,140 | 3.81 | 3,128,806 |
| Processing Tomatoes | 267,440 | 2.98 | 796,982 | 303,340 | 2.44 | 740,364 |
| Fresh Tomatoes | 48,030 | 2.49 | 119,760 | 46,000 | 1.93 | 88,686 |
| Cucurbits | 126,510 | 2.53 | 319,674 | 117,550 | 1.83 | 214,560 |
| Onions and Garlic | 74,100 | 3.29 | 243,976 | 71,080 | 2.64 | 187,570 |
| Potato | 34,800 | 2.71 | 94,347 | 38,910 | 1.91 | 74,199 |
| Other Truck | 821,820 | 2.10 | 1,724,921 | 906,150 | 1.54 | 1,396,704 |
| Almonds/Pistachio | 712,390 | 3.66 | 2,605,163 | 799,660 | 3.40 | 2,722,654 |
| Other Deciduous | 622,070 | 3.80 | 2,366,449 | 633,790 | 3.26 | 2,067,971 |
| Subtropical | 427,720 | 3.35 | 1,431,510 | 436,050 | 2.78 | 1,211,702 |
| Vine | 896,350 | 2.12 | 1,896,439 | 867,310 | 1.69 | 1,469,924 |
| Total | 9,203,850 | | 30,763,500 | 9,198,240 | | 27,119,278 |
| Source: CA Water Plan Update 2009, "Calculating California Cropping Patterns in 2050" by Richard E. Howitt, J. Medellin and D. MacEwan, Department of Ag & Resource Economics, University of California, Davis, November 18, 2008, p.17 and p.20 With some modifications | | | | | | |

| Table 12: Harvested Acreage and Total Value for Selected Crops: 2001, 2005, and 2009 | | | | | | |
|---|---|---|---|---|---|---|
| | 2001 | | 2005 | | 2009 | |
| | Harvested | Total Value | Harvested | Total Value | Harvested | Total Value |
| Crop | Acre | $1,000 | Acre | $1,000 | Acre | $1,000 |
| Rice | 471,000 | 203,227 | 526,000 | 392,244 | 556,000 | 889,154 |
| Cotton | 864,000 | 615,986 | 657,000 | 646,243 | 186,000 | 277,320 |
| Corn | 497,000 | 328,175 | 580,300 | 460,983 | 569,900 | 552,734 |
| Dry Bean | 85,000 | 46,675 | 65,000 | 56,785 | 68,000 | 78,718 |
| Safflower | | | 54,000 | 14,340 | 58,000 | 23,304 |
| Alfalfa | 1,010,000 | 841,330 | 1,040,000 | 975,936 | 980,000 | 758,422 |
| Processing Tomatoes | 254,000 | 496,808 | 264,000 | 572,160 | 308,000 | 1,146,335 |
| Fresh Tomatoes | 42,000 | 282,366 | 40,000 | 347,200 | 36,000 | 363,312 |
| Potato | 35,900 | 186,139 | 40,200 | 188,543 | 37,600 | 228,452 |
| Almonds/Pistachio | 608,000 | 902,622 | 695,000 | 3,106,059 | 846,000 | 2,886,350 |
| Source: California Agricultural Resource Directly 2010-2011, California Department of Food and Agriculture. | | | | | | |



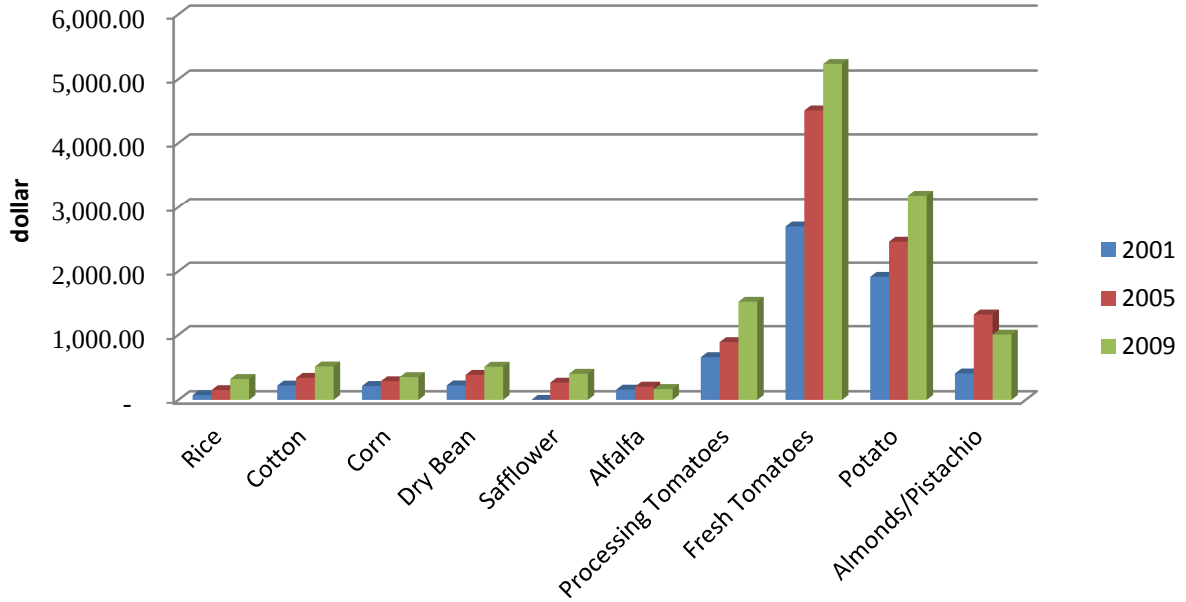
In order to understand the relationship between use of water by crop and its relative production value, an index of production value per acre-foot of water was developed for selected commodities (Table 13). For the periods of 2001, 2005 and 2009, alfalfa is the consistently lower valued commodity while fresh tomatoes is the highest valued commodity per acre-foot of water applied for the production (Figure 3).

**Table 13: Value per Acre, Water Use per Acre and Value of Crop per Water for the Selected Crops: 2001, 2005 and 2009**

| | 2001 | | | 2005 | | | 2009 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Value/Acre | Water Use | Index | Value/Acre | Water Use | Index | Value/Acre | Water Use (2005) | Index |
| Crop | $/acre | Acre-foot per Acre | $/acre-foot | $/acre | Acre-foot per Acre | $/acre-foot | $/acre | Acre-foot per Acre | $/acre-foot |
| Rice | 431.48 | 5.88 | 73.40 | 745.71 | 4.98 | 149.61 | 1,599.20 | 4.98 | 320.85 |
| Cotton | 712.95 | 3.23 | 220.63 | 983.63 | 2.90 | 338.92 | 1,490.97 | 2.90 | 513.73 |
| Corn | 660.31 | 3.09 | 213.73 | 794.39 | 2.77 | 286.67 | 969.88 | 2.77 | 350.00 |
| Dry Bean | 549.12 | 2.47 | 222.30 | 873.62 | 2.27 | 384.69 | 1,157.62 | 2.27 | 509.75 |
| Safflower | | 1.07 | - | 265.56 | 1.00 | 265.30 | 401.79 | 1.00 | 401.40 |
| Alfalfa | 833.00 | 5.30 | 157.17 | 938.40 | 4.62 | 203.24 | 773.90 | 4.62 | 167.62 |
| Processing Tomatoes | 1,955.94 | 2.98 | 656.35 | 2,167.27 | 2.44 | 887.97 | 3,721.87 | 2.44 | 1,524.91 |
| Fresh Tomatoes | 6,723.00 | 2.49 | 2,696.26 | 8,680.00 | 1.93 | 4,502.18 | 10,092.00 | 1.93 | 5,234.56 |
| Potato | 5,184.93 | 2.71 | 1,912.47 | 4,690.12 | 1.91 | 2,459.50 | 6,075.85 | 1.91 | 3,186.18 |
| Almonds/Pistachio | 1,484.58 | 3.66 | 405.96 | 4,469.15 | 3.40 | 1,312.62 | 3,411.76 | 3.40 | 1,002.05 |

Source: Table 11 and Table 12

**Figure 3: Value of Selected Crop per Acre-Foot of Water**



Agriculture is the largest user of water in California; as such it is often the subject of speculation regarding what might be done to economize on agricultural water use. In this respect it is sometimes suggested that shifting production away from water intensive crops to ones that use less water is an obvious solution and a win-win alternative to the status quo. In this section, we examine the effects of such a reallocation using the example of a 5 percent shift in acreage from a high water-use crop, alfalfa, to a low water-use crop, fresh tomato, employing the IMPLAN 2009 California data. This reallocation would create a savings of 131,810 acre-feet of water, based on the acre-foot per acre water use for the alfalfa crop in 2005. In this example using 2009 harvested acreage of alfalfa (980,000 acres), a reallocation of 5 percent (49,000 acres) leads to 931,000 harvested acres of alfalfa. A shift to fresh tomatoes would result in a total of 85,000 acres of fresh tomatoes, an increase of 136 percent from the base level of fresh tomatoes 36,000 acre (Table 14). If cropping patterns are shifted in this manner and prevailing price levels remain it would result in a decline in the total value of production of alfalfa of $37.9 million from the base value of $758.4 million to $720.5 million. On the other hand the increase in the value of additional fresh tomatoes production would increase by $494.5 million from the base value of $363.3 million to $857.8 million.

**Table 14: Reallocation of Alfalfa Acreage for IMPLAN: 2009**

| **BASE** | Harvested | Yield/Acre | Production | Value/Unit | Total Value | Total Water Use | | |
|---|---|---|---|---|---|---|---|---|
| | Acre | Tons | Tons | $/Ton | $1,000 | Acre-feet | | |
| Hay, Alfalfa | 980,000 | 7.10 | 6,958,000 | 109.00 | 758,422 | 4527600 | | |
| | | cwt | cwt | $/cwt | | | | |
| Tomatoes, Fresh Market | 36,000 | 290.00 | 10,440,000 | 34.80 | 363,312 | 69480 | | |
| | | | | | | | | |
| **NEW** | Harvested | Yield/Acre | Production | Value/Unit | Total Value | Total Water Use | | Total value ($) |
| | Acre | Tons | Tons | $/Ton | $1,000 | Acre-feet | change | change |
| Hay, Alfalfa | 931,000 | 7.10 | 6,610,100 | 109.00 | 720,501 | 4,301,220 | -226,380 | -37,921,100 |
| | | cwt | cwt | $/cwt | | | | |
| Tomatoes, Fresh Market | 85,000 | 290.00 | 24,650,000 | 34.80 | 857,820 | 164,050 | 94,570 | 494,508,000 |

Source: California Agricultural Resource Directry 2010-2011, California Department of Food and Agriculture, pp.44, 121

The direct effect of this re-allocation would be a decline in industry output for all crops, which includes alfalfa, declining by the amount of reduction in alfalfa production value of $37.9 million to $3.9 billion (Table 15). In contrast the industry output for vegetables which includes fresh tomatoes increases by $494.5 million to almost $8.5 billion. Assuming all other things remain the same, the overall effects for industry for the all crops declines by 0.96 percent and for vegetables, an increase of 6.18 percent in total effects.

Re-allocation of land from production of alfalfa to fresh tomato leads to changes in the use of other resources. Most of the industries in agriculture are indirectly affected by this re-allocation.

| Table 15: Economic Impact of Reallocation of Harvested Land from Alfalfa Production to Fresh Tomatoes Production for California, 2009 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Direct and Total Effects** | | | | | | |
| | Direct Effects | | | | Total Effects | | |
| | Industry output (sales) | Employment | Labor Income | Value Added | Employment | Labor Income | Value Added |
| | ($ million) | (jobs) | ($ million) | | (jobs) | ($ million) | |
| Agricultural Production and Processing | 150,839 | 593,479 | 30,231 | 43,193 | 1,361,821 | 70,177 | 110,656 |
| *percentage change from the base* | *0.30%* | *0.28%* | *0.50%* | *0.50%* | *0.36%* | *0.41%* | *0.40%* |
| Agricultural Production | 52,569 | 395,925 | 18,229 | 22,744 | 726,909 | 33,568 | 47,949 |
| *percentage change from the base* | *0.88%* | *0.42%* | *0.83%* | *0.95%* | *0.67%* | *0.87%* | *0.93%* |
| Farming | 41,350 | 196,337 | 11,737 | 16,621 | 465,154 | 23,826 | 36,205 |
| *percentage change from the base* | *1.12%* | *0.86%* | *1.29%* | *1.30%* | *1.05%* | *1.23%* | *1.24%* |
| Vegetables | 8,496 | 30,789 | 2,661 | 3,867 | 89,030 | 5,238 | 8,104 |
| *percentage change from the base* | *6.18%* | *6.18%* | *6.18%* | *6.18%* | *6.18%* | *6.18%* | *6.18%* |
| All Other Crop | 3,928 | 12,994 | 576 | 1,148 | 37,270 | 1,674 | 3,027 |
| *percentage change from the base* | *-0.96%* | *-0.96%* | *-0.96%* | *-0.96%* | *-0.96%* | *-0.96%* | *-0.96%* |
| Source: Center for Agricultural Business, CSUFresno, using IMPLAN v3 software package and 2009 dataset. | | | | | | | |

Reduced alfalfa production indirectly influences several industries negatively, including supporting activities for agriculture, fertilizer, pesticide and other agricultural chemical manufacturers, cattle ranching, dairy cattle and other livestock industry. However, large increases in production of fresh tomatoes would lead to positive influences in many industries which would help offset the negative effects caused by declining alfalfa production. Indirect and induced effects by the fresh tomato sector lead to overall positive effect in many industries (Table 16). These results suggest an overall benefit from the re-allocation of harvested land from high water use crops to crops with lower water requirements.

However; the demand for agricultural products are generally known to be inelastic thus a larger percentage change in price can be expected than the percentage changes in quantity produced. Suppose demand elasticity for alfalfa is -0.11 and for fresh tomatoes is -0.25[5] (Table 17). This implies a 5 percent decline in alfalfa production will lead to 45 percent increases in alfalfa price thus alfalfa producers might increase their revenue; however alfalfa is used as inputs to livestock/dairy industries. Thus increases in alfalfa prices lead to increases in the cost of production for these industries which may lead to decline in their net returns. For the fresh tomatoes, 136 percent increases in production implies a decline of 544 percent in price, hence the value of production of fresh tomatoes would be expected to be reduced dramatically. Significant downward pressure for the price of fresh tomatoes will create decline in net return for the producers of fresh tomatoes (see box for more information). Thus the overall effect of reallocation of harvested land from alfalfa production to fresh tomato production might lead to negative effects to the economy.

| Table 16: Economic Impact of Reallocation of Harvested Land from Alfalfa Production to Fresh Tomatoes Production for California, 2009 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Direct and Total Effects | | | | | | |
| | Direct Effects | | | | Total Effects | | |
| | Industry output (sales) | Employment | Labor Income | Value Added | Employment | Labor Income | Value Added |
| | ($ million) | (jobs) | ($ million) | | (jobs) | ($ million) | |
| Agricultural Production and Processing | 150,894 | 594,666 | 30,270 | 43,228 | 1,363,315 | 70,231 | 110,718 |
| Agricultural Processing | 98,273 | 197,561 | 12,003 | 20,450 | 634,929 | 36,610 | 62,708 |
| Agricultural Production | 52,621 | 397,105 | 18,267 | 22,778 | 728,386 | 33,621 | 48,011 |
| Forestry, Fishing, Hunting | 1,266 | 10,375 | 351 | 563 | 19,865 | 769 | 1,161 |
| Ag-support Activities | 10,002 | 190,376 | 6,178 | 5,593 | 243,331 | 9,025 | 10,643 |
| Farming | 41,353 | 196,354 | 11,738 | 16,622 | 465,191 | 23,828 | 36,207 |
| Dairy/Poultry Production | 5,814 | 22,250 | 335 | 1,219 | 41,663 | 1,297 | 2,928 |
| Livestock | 1,988 | 13,706 | 137 | 391 | 22,678 | 527 | 1,135 |
| Cotton | 304 | 997 | 51 | 124 | 2,623 | 124 | 251 |
| Grain | 1,289 | 15,752 | 122 | 474 | 21,938 | 393 | 973 |
| Fruit | 11,777 | 48,387 | 4,531 | 5,455 | 146,344 | 8,793 | 11,938 |
| Vegetables | 8,496 | 30,789 | 2,661 | 3,867 | 89,030 | 5,238 | 8,104 |
| Tree Nuts | 3,651 | 29,166 | 1,469 | 1,891 | 57,440 | 2,708 | 3,799 |
| Sugar | 40 | 684 | 6 | 16 | 890 | 15 | 32 |
| All Other Crop | 3,928 | 12,994 | 576 | 1,148 | 37,270 | 1,674 | 3,027 |
| Green House, Nursery | 4,011 | 21,180 | 1,844 | 2,010 | 44,640 | 3,043 | 3,976 |
| Oilseed | 56 | 449 | 5 | 27 | 676 | 15 | 46 |
| | | | | | | | |
| Source: Center for Agricultural Business, CSUFresno, using IMPLAN v3 software package and 2009 dataset. | | | | | | | |
| Notes: Direct and total effects in Nominal dollars. Total effects include direct, indirect and induced effects of the industry named a left. | | | | | | | |
| For Total Effects, vlues that utilize multiplier effects cannot be aggregated to get totals. | | | | | | | |
| Industry ourput: value of production (i.e. total sales) by the froup of industries named at the left. | | | | | | | |
| Employment: number of jobs directly employed by the corresponding industry. | | | | | | | |
| Labor income: value of wages and salaries and other proprietary income paid by industry. | | | | | | | |
| Value added equals sum of labor income (employee compensation and proprietor income), property income and indirect business taxes. This is the same as total sales (industry output) less purchased inputs and services. | | | | | | | |
| Agricultural processing: this group includes animal feed, food and beverage industries. | | | | | | | |
| Agricultural support activities includes fertilizer and pesticides manufacturing, soil preparation and harvesting services, packing and cooling and cotton ginning. | | | | | | | |

| Table 17: Estimated Supply and Demand Elasticities for Alfalfa and Fresh Tomatoes | | | | |
|---|---|---|---|---|
| Commodities | Supply Response (own-Price) | | Domestic Demand | |
| | Short-Run | Long-Run | Own-Price | Income |
| Alfalfa | 0.35-0.66 | 1.06 | -0.11 | 1.74 |
| Fresh Tomatoes | 0.27 | 0.4 | -0.25 | 0.89 |
| Note: Short-run supply response for alfalfa varied between 0.35 and 0.66 based on different specifications. The demand for alfalfa hay is a derived demand. The figure reported is the elasticity based on the number of cows in the dairy industry. | | | | |
| Source: "Estimation of Supply and Demand Elasticities of California Commodities", C. Russo, R. Green, and R. Howitt, Working Paper No. 08-001, June 2008, Department of Agricultural and Resource Economics, University of California, Davis | | | | |

Water is an essential input required for agricultural production; however, to evaluate the potential returns for the economy from changes in water use patterns, water use needs to be considered in the context of other factors, including the other factors of production, cross commodity linkages, and domestic and global market characteristics.

*Water Conservation through Shifting*

*Cropping Choices: Alfalfa vs. Fresh Tomatoes*

Replacing crops that are associated with high rates of applied water per unit area with those that use less water has been suggested as an alternative that can result in substantial water savings.[6] This idea has been based on the fact that because plant water requirements in much of California are met by irrigation, water saved from crop shifting can reduce water withdrawals as well as consumptive uses. This idea is also linked to the assumption that crop shifting may also provide economic advantages to the region. Field crops are generally more water-intensive and generate lower value per acre compared with other crop types thus; well-planned crop shifting could reduce water use while increasing revenue.

Scenarios for change that are designed to result in water conservation need to be subjected to a thorough examination. In the absence of such analyses, assumptions regarding the outcome of such change can miss key factors that may result in a different magnitude and/or direction of change in those outcomes.

In their 2008 study Pacific Institute authors present the results of a scenario that assumes a 25 percent shift from irrigated field crops to irrigated vegetable crop acreage. Their calculations result in a savings of 1.2 MAF in agricultural water use and an increase in production value of $5.1 billion – an apparent win/win outcome.

The authors suggest that, the fact that crop shifting is already occurring indicates it is cost effective for many farmers; and that future assessments should evaluate how shifting crop type affects the net production value.

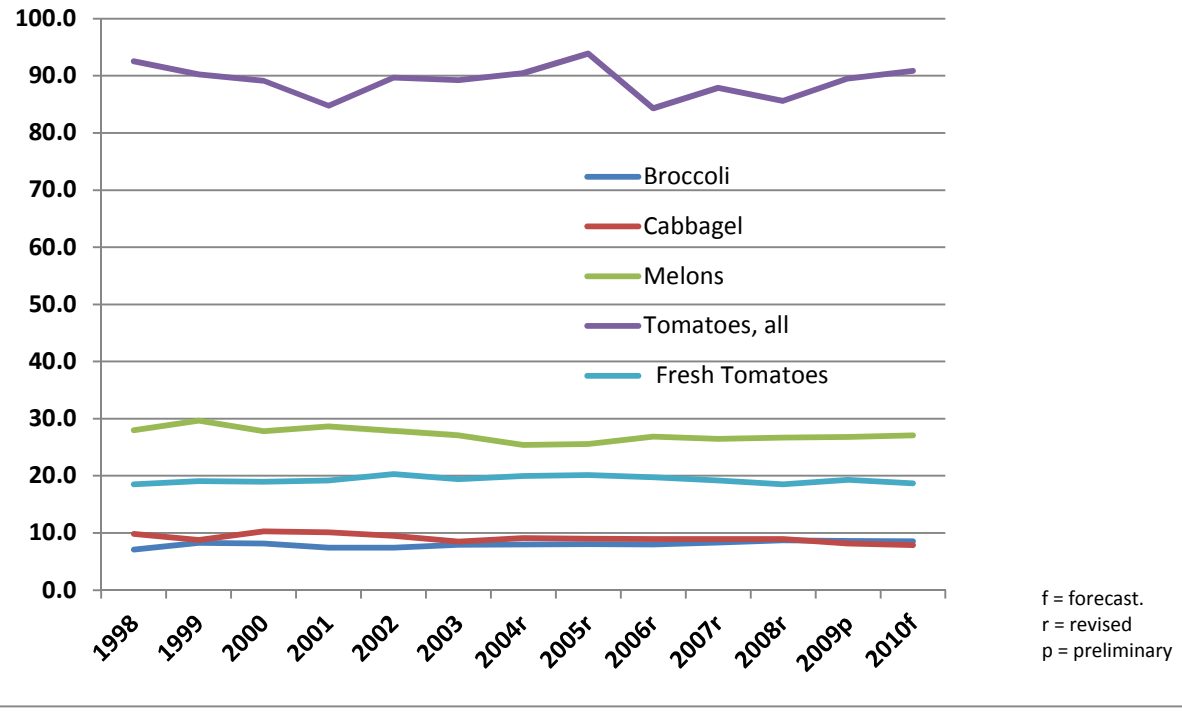
In a contrasting example we compare the potential water savings and economic effects of a change in acreage devoted to production of alfalfa, a high use, low per unit value, water use field crop to fresh tomato production, a low use, high per unit value crop. In this case we will assume a modest 1.5 percent shift in irrigated alfalfa acreage.

Demand and supply for agricultural products are generally known to be inelastic thus a percentage change in price is greater than percentage changes in quantity. Estimates of the demand elasticity for alfalfa are around -0.11 and for fresh tomatoes is -0.25.[7] This implies that a 1.5 percent decline in alfalfa production (14,700 acres, 2009) will lead to around a 14 percent increase in alfalfa price; thus, alfalfa producer revenue increases with all else being equal; however alfalfa is used as a primary input in the dairy industry. Thus increases in

alfalfa prices lead to increases in cost of production for dairies which leads to decline in net returns to this sector of the industry. For the fresh tomatoes, an additional 14,700 acres would be equivalent to about a 41 percent increase in production from the 2009 base and would imply a decline of 163 percent in the price for this commodity; hence the value of production of fresh tomatoes would be reduced dramatically.

Based on historic per capita consumption patterns for vegetables, little significant increases in the quantity demanded can be expected (Figure 4). Accordingly, although some shift in acreages of various commodities has occurred throughout the SJV, even small increases in additional shifts would appear to face strong headwinds in an attempt to increase producer revenues. While potential water use savings are possible, the economic viability of such cropping patterns at current acreage levels would be challenging.

**Figure 4. U.S. Vegetable Consumption Per Capita (lbs. , farm weight)**




[1] This paper was commissioned as part of the Center for Irrigation Technology (CIT) report ***Agricultural Water Use in California: A 2011 Update***. This report may be downloaded at www.californiawater.org.

[2] Taylor, P. (1949). Central Valley Project: Water and Land. The Western Political Quarterly, Vol. 2, No. 2. June, 1949.

[3] http://www.usbr.gov/projects/Project.jsp?proj_Name=Central%20Valley%20Project&pageType=ProjectPage

[4] 2007 Census of Agriculture; Farm and Ranch Irrigation Survey (2008), Volume 3, Special Studies, Part 1, AC-07-SS-1, Updated July 2010, USDA.
[5] Carlo Russo, R. Green, and R. Howitt. "Estimation of Supply and Demand Elasticities of California Commodities", Working Paper No. 08-001, Department of Agricultural and Resource Economics, University of California, Davis, June 2008.
[6] Cooley, Heather, Juliet Christian-Smith and Peter H. Gleick. "More with Less: Agricultural Water Conservation and Efficiency in California: A Special Focus on the Delta". Pacific Institute, September, 2008.
[7] Carlo Russo, R. Green, and R. Howitt. "Estimation of Supply and Demand Elasticities of California Commodities", Working Paper No. 08-001, Department of Agricultural and Resource Economics, University of California, Davis, June 2008.