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Economic Impact of California's Citrus Industry in 2020

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Key findings

- The value of California citrus production in the 2020-21 marketing year was $3.63 billion.
- The total economic impact of the industry on California's economy in 2020-21 was $7.6 billion.
- The California citrus industry added $1.9 billion to California's state GDP in 2020.
- Estimated full time equivalent jobs in the California citrus industry in 2020-21 totaled 24,247.
- Estimated wages paid by the California citrus industry income in 2020-21 totaled $759 million.
- A 20% reduction in California citrus acreage would cause a loss of 8,213 jobs, $214 million in employee income, and reduce state GDP by $569 million.

Economic Impact of California's Citrus Industry

Introduction

A key factor explaining why California continues to be an economic success story is the flexibility that comes with the great diversity of economic activities that take place in the state. From manufacturing to information technology, education, aerospace and health care, California's leads or is among the leaders among states in a large number of industries. This diversity means that the state's economy is not especially vulnerable to downturns in any one single industry.

One often-overlooked contributor to the diversity of California's economy is agriculture. California's farmers produced about $53 billion worth of agricultural commodities in 2020. These commodities in turn are the reason why California has such a large food and beverage processing industry. Together agriculture and closely-related industries account for about 500 thousand jobs in California which represents about 2% of total employment.

California citrus is a major contributor to the economic value of the agricultural sector. Oranges, mandarins, lemons, and grapefruit, accounted for 2.3% of total crop acres in the state and generated 6.7% of total crop revenue in 2020. However, the contribution of California's citrus industry to California's economy is much larger than just the value of its sales. The application of management skills and capital equipment to efficiently utilize land and water to produce high quality citrus generates upstream and downstream jobs and income that magnify the importance of citrus production beyond its farm value.

Citrus production costs have increased in recent years in part increased demands from the government in the form of new regulations. The pace of new regulations has not slackened with new food safety and labor rules to be phased in over the next few years. California's citrus industry also faces increased costs associated with efforts designed to prevent HLB from spreading into commercial groves. If the ongoing prevention efforts are not successful, then the industry faces the difficult task of trying to determine how it will operate in the presence of this devastating disease.

The purpose of this paper is to provide estimates of the contribution of the citrus industry to California's economy. Attempts to forecast future events are, of course, speculative by their nature. But given that new regulations have already been passed and are currently being phased in we can make informed estimates of their likely impact on the citrus industry. In addition, wherever HLB has infested a region, it has not been eliminated or controlled so we know that costs associated with HLB are likely not going to decrease in the next few years. And finally, we know California water supplies will likely be reduced in the future due to reduced availability of groundwater supplies. The results of this paper can give guidance as to the impact on California's economy if these factors cumulatively reduced citrus production in California.

Measures of Economic Contribution

The economic contribution of California's citrus industry to the state can be measured in different ways. A brief exploration of the different measures is helpful to fully understand the importance of the citrus industry to California. I begin this discussion using data on California agriculture rather than just citrus.

The size of California's economy is most often measured by state gross domestic product. In 2020, California's state GDP totaled $3 trillion. This means that $3 trillion was either earned by workers as wage income or earned by individuals or businesses as business profits before depreciation or paid as a business tax. The contribution to state GDP of goods-producing industries like agriculture is measured using value-added data from the Department of

Agriculture and the Census Bureau.[1] Agricultural value-added is calculated using data on farm receipts and expenditures. USDA estimates that the value-added of California agriculture was $26.9 billion in 2020.[2]

Using agriculture's direct contribution to California's GDP understates its economic importance to the state because it ignores the dependence of other sectors of the economy on farm output. For example, California's large food and beverage manufacturing industry is in the state largely because California's farms produce so much raw product. The industry employs more than 231,000 people and generates $21.5 billion in personal income. This compares to farm employment of 231,000 individuals and personal income of $16.4 billion.[3] Other industries are also dependent on agriculture, including those that provide agricultural inputs and that transport farm production and food products made from California farm production.

The dependence of other California industries on agricultural production means that any change in agricultural production has both direct and indirect impacts on the state's economy. Analysts typically use various economic multipliers to capture the broad economic impact of an industry to a state. The output multiplier captures the impact of a change in the value of agricultural output on the change in total economic activity in the state. An output multiplier of 0.7 means that $700,000 worth of economic output outside agriculture is created per $1 million change in agricultural activity. The labor income multiplier captures the impact on total labor income from a change in labor income in agriculture. A labor income multiplier of 0.6 means that if $1 million more in labor income is paid in agriculture then an additional $600 thousand in

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[1] See "Gross Domestic Product by State Estimation Methodology" US Department of Commerce, Bureau of Economic Analysis. 2006.

[2] See USDA-ERS tables available at https://data.ers.usda.gov/reports.aspx?ID=17830#P18185a947f584db5a405671ce25f340f_5_109iT0R0x5

[3] Employment and earnings data obtained from US Bureau of Economic Affairs, state income and employment database.

labor income is generated in related industries. A value-added multiplier of 1.3 means that $1.30 of value-added is created in related industries per dollar of value-added increased in agriculture.

The various multipliers are used to estimate the economic effects of a change in the value of agricultural output and employment. The direct effects are simply the effects in agriculture itself, whether it be value of output, employment, labor income, or value-added. The indirect effects are the impact that a change in agriculture has on related industries that supply agriculture or that depend on agricultural output. The induced effects are those effects that are caused by California households spending the money that they earn in agriculture or related industries. Adding together the direct effects, the indirect effects, and the induced effects thus provides the total impact that agriculture has on California's economy.

Data on output, value-added, employment, and labor income along with estimates of the various multipliers are needed to determine the total economic impact of an industry in California. What also is needed is the particular policy scenario to be analyzed. Two types of policy scenarios are most typically analyzed using multipliers. The first is to estimate the impact of a new industry or investment that is proposed in a region. The economic impact of the new industry is measured relative to the economic situation that currently exists. The second type of policy scenario is to measure the economic contribution of an existing industry relative to the economic situation that would exist if the industry did not exist.

One issue that arises with using multipliers to estimate the economic impact of either gaining a new industry or losing an industry is that the multipliers used in the analysis represent existing inter-industry dependencies. In the case of a wholly new industry locating in a region, these dependencies do not exist so existing estimates of multipliers do not exist. In the case of losing an industry, any new inter-industry connections that form will potentially offset a portion of the negative impacts from the lost industry.

Data

California citrus data are collected by the California Department of Agriculture (CDFA) in collaboration with the National Agricultural Statistics Service (NASS) of the U.S. Department of Agriculture (USDA). An annual citrus summary report is released by NASS in August or September of each year.[4] This report contains data from the most recent production year. For example, the September 2021 report contains data from the 2020/21 production year. transported to the packer. The difference in these two values is the value of FOB. I attempt a reconciliation of these two data sources in this report. Private sector data about the citrus industry are also available. One report published by Rabobank was used here to estimate the value of packinghouse services for mandarins.[5]

Destination of California Citrus

The value of citrus grown in California changes as fruit moves along its supply chain. Value is added when fruit on the tree is harvested and delivered to a packinghouse. More value is added when it is processed by the packinghouse and made ready for shipment. At the packing house fruit is either packed for the fresh market or it is aggregated and sent to the processing market. The proportion of California citrus that is packed for the fresh market is shown in Figure 1 for the three most recent years for which data are available. Across the three years an average of 80% of oranges, 74% of lemons, 75% of grapefruit and 71% of mandarins have gone to the fresh

[4] Citrus Fruits 2021 Summary. USDA-NASS. ISSN: 1948-9048, September, 2021.
[5] Rabo AgFocus – November 2015. Available to subscribers only at https://research.rabobank.com/far/en/sectors/regional-food-agri/us-citrus.html

market. These data verify that California growers send a high proportion of their citrus to the fresh market.

Fresh market fruit has a higher value than fruit that is processed. More care needs to be taken with fresh fruit so there are higher costs associated with its handling. Processing fruit typically is fruit that does not meet fresh market quality standards. Its sales price is therefore lower than fresh market fruit. In addition, processing fruit is typically identified early in the packing process so a portion of the costs associated with packing fresh fruit are not incurred with processing fruit.[6]

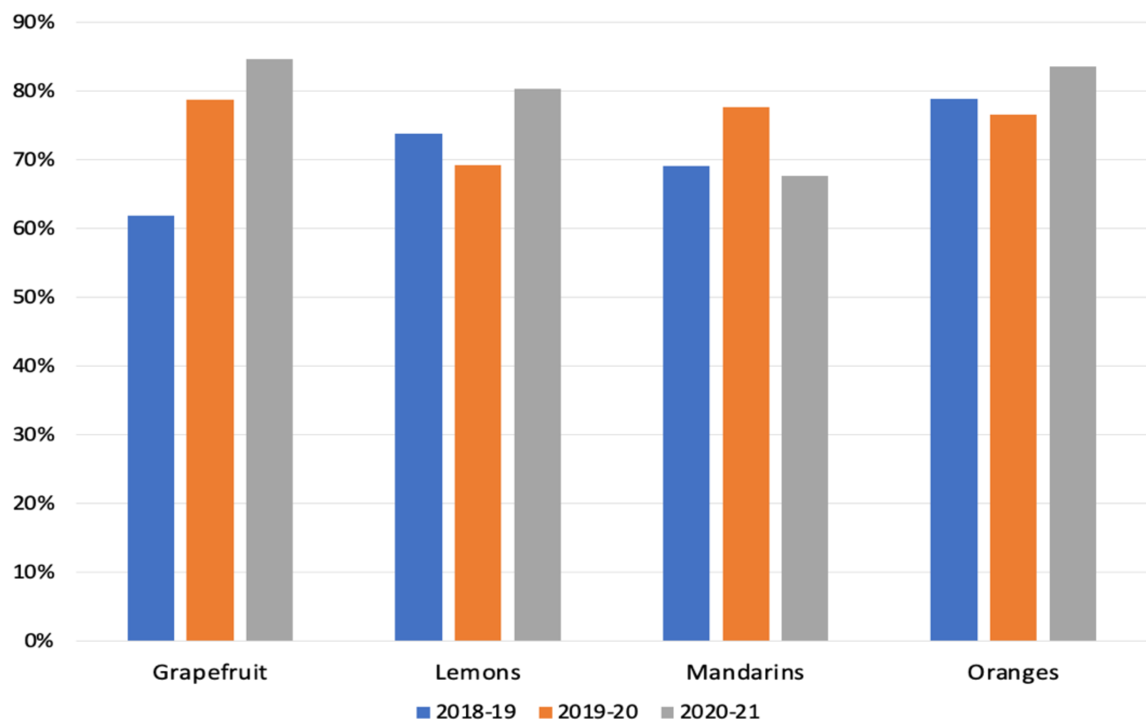

Figure 1. Proportion of California Citrus Packed for Fresh Market

Source: Citrus Fruits 2021 Summary. USDA-NASS. ISSN: 1948-9048, September 2021.

[6] See Berk, Z., chapter 7 in *Citrus Fruit Processing* Academic Press, Elsevier, London. 2016.

Value of California Citrus

The objective of this report is to determine the impact of a change in citrus production on the economic contribution of the California citrus industry. A key determinant of this value is revenue generated from citrus sales. The appropriate point in the supply chain at which to calculate revenue from fruit destined for the fresh market is after it has been packed and sold. Because a large proportion of California citrus is consumed outside of the state, it would not be appropriate to measure revenue at the retail level. The most appropriate value of fruit destined for the processing market is the price of fruit delivered to processing plants. Any cost incurred at the packinghouse and transportation costs from the packinghouse to the processing plant would be included in this price.

Ideally then, the value of California citrus harvested in a year would be the value of citrus packed and sold for delivery to the fresh market plus the value of citrus purchased by processing plants. As shown in Figure 1, NASS reports quantities of each type of citrus that is destined for fresh and processing markets. However, NASS does not report the average prices received for California fresh citrus vs. California citrus that is processed because of confidentiality concerns. NASS does not even report average prices received and reports only total state value for California lemons and mandarins. Thus, we need to calculate the value of citrus packinghouses from available data.

The difference in the value of citrus sold by packers and the value of citrus delivered to packers is used to estimate the value of packinghouse services. NASS reports monthly prices for both FOB and packinghouse door fresh citrus for California oranges and lemons, and for U.S. grapefruit. NASS bases their estimates of monthly prices on surveys of packinghouses. NASS does not report FOB mandarin prices. The difference between the NASS FOB price and the

NASS price for fruit delivered to the packinghouse door is a measure of the value added by packinghouses.

The average difference in the FOB price and the packinghouse door price of California oranges in 2018-19 as reported by NASS is $10.12 per box, or 12.7 cents per pound. The average difference in the price of California lemons in 2018-19 as reported by NASS is $10.22 per box, or 12.8 cents per pound. And the average difference in the price of U.S. grapefruit in 2018-19 is $10.23 per box or 12.8 cents per pound. In November of 2015 Rabobank released a market report on U.S. citrus and estimated the cost of moving delivered citrus (oranges, mandarins, and lemons) through the packinghouse and getting it sold and ready to deliver. The cost per carton of mandarins as estimated by Rabobank is $6.10 per 38 pound carton for lemons. On a cents per pound basis this translates to 30.6 cents per pound for mandarins.

The next step in estimating total packinghouse value is to adjust these fresh-market values to account for the proportion of fruit that is not packed for the fresh market. Fruit that goes to the processing market is washed and sorted and then sent to processors. Lacking a better estimate, I assume that the packinghouse value added to processing fruit is 30% of the value added to fresh fruit. The method I use to calculate the packinghouse value of California citrus is to multiply the resulting per-box estimates of packinghouse value for oranges, lemons, grapefruit and mandarins by the total number of boxes produced as reported by NASS. Table 1 shows citrus quantities in 2020-21 and Table 2 presents the final estimate of California citrus value produced in the 2020-21 marketing year.

Table 1. Fresh and Processed California Citrus Production in 2020-21

	Fresh	Processed	Total
	80 pound boxes ('000's)		
Oranges	38,400	13,800	52,200
Lemons	17,500	6,200	23,700
Mandarins	18,300	8,200	26,500
Grapefruit	2,600	1,600	4,200

Source: Citrus Fruits 2020 Summary. USDA-NASS. ISSN: 1948-9045, August 2020.

Table 2. Value of California Citrus in the 2020-21 Marketing Year

	NASS Value* ($'000)	Number of Boxes Produced ('000)	Value Added of Packinghouse ($/box)	Total Packinghouse Value ($'000)	Total Value ($'000)
Oranges	901,281	52,200	8.02	418,669	1,319,950
Lemons	638,250	23,700	7.92	187,718	825,968
Mandarins	815,089	26,500	20.07	531,950	1,347,039
Grapefruit	101,805	4,200	8.48	35,600	137,405
Total	2,456,425	106,600		1,173,937	3,630,362

*Value of citrus delivered to packinghouse.

Impact of Citrus on California's Economy

The Table 2 total value of California citrus represents the revenue generated by citrus sales from the packinghouse shipping point. This revenue is generated by sales to buyers of fresh-packed citrus and by citrus processors. A relatively small portion of the purchased citrus is destined for California consumers because of exports and the fact that California has only about 12% of U.S. population. This means that the packinghouse sales point in the citrus supply chain is most appropriate for calculating the contribution of citrus to California's economy. The direct contribution of California citrus production on California's economy is $3.630 billion.

The $3.630 billion in citrus sales is distributed to all participants in the citrus supply chain up to and including the packinghouse. After paying citrus growers for the fruit, packinghouse employee costs, and other costs, packinghouse owners receive the remainder as pre-tax profits. Citrus growers use their payments from the packinghouse to cover their own payments to harvest labor, fuel, nutrient and chemicals suppliers, water suppliers, pre-harvest employees, machinery suppliers, and owners of land that is rented. Pre-tax grower profit is what remains after these costs are paid.

The citrus dollars that flow to the suppliers of goods and services used by citrus growers and packinghouses in turn generate their own economic activity. This second-round of economic activity is the indirect effect of California citrus production. The induced effect of California citrus production is the economic activity generated by households that spend the money paid to them for work in the citrus industry and for owning assets (land, buildings, machinery) used in the citrus industry. The total contribution of California citrus production equals the sum of the direct effect, the indirect effect, and the induced effect.

Indirect and Induced Economic Impact of California Citrus

IMPLAN multipliers measure the indirect effects of changes in the value of output in an industry. No IMPLAN multipliers are separately available for California citrus production. For fruit farming in California, the IMPLAN indirect multiplier is 0.445, which means that for every $1.00 change in the value of fruit, an additional 44.5 cents in economic activity is generated. Hodges, et al in their study of the Florida citrus industry use an indirect multiplier of 0.25.[7] But California growers manage their citrus more intensively than do Florida growers because so

[7] Hodges, A.W., M. Rahmani, T.J. Stevens, and T.H. Spreen. "Economic Impacts of the Florida Citrus Industry in 2012-13." Food and Resource Economics Department, University of Florida. December 19, 2014.

much of the California crop is destined for the fresh market. Therefore, purchased inputs account for a greater share of the value of citrus production in California. It is more appropriate to use the California fruit farming multiplier of 0.445 than the multiplier from the Hodges et al report. The IMPLAN induced effect multiplier for California fruit production is 0.568. To be consistent, I use this value for the induced effect multiplier used.

No IMPLAN multipliers specific to the California citrus packinghouse industry are published. Hodges et al estimate that the indirect multiplier of the Florida fresh citrus packinghouse industry is 0.2 and the induced effect multiplier is 1.133. The Hodges et al multiplier values for the processed fruit industry are 0.332 for the indirect multiplier and the 0.719 for the induced multiplier. In the 2020-21 marketing year, 74% of California's citrus was packed for the fresh market and 26% was processed. I take a weighted average of the Hodges et al multipliers and use them here. The weighted average results in an average indirect multiplier of 0.261 and an average induced multiplier of 1.023 for California's packinghouse industry.

Table 3 reports the direct, indirect and induced economic contributions of California's citrus industry. Total direct value of California citrus production was $3.63 billion in 2020-21 from Table 2. This value generated an additional $1.4 billion in economic activity from related businesses supplying material and services to the California citrus industry. An additional $2.596 billion in economic activity was generated by households spending income that they received from California's industry, making the total economic impact equal to $7.626 billion.

Table 3. Economic Impact of California's Citrus Industry

	Citrus Production	Packinghouse	Total
		$ million	
Direct Effect	2,456.4	1,173.9	3,630.4
Indirect Effect	1,093.1	306.5	1,399.6
Induced Effect	1,395.2	1,201.0	2,596.2
Total Effect	4,944.8	2,681.4	7,626.2

Source: Calculated by author.

Impact of a Reduction in California Citrus Production

Increased cost of meeting regulations, increased cost of Asian citrus psyllid (ACP) control, and the possible spread of HLB from backyard citrus trees to commercial groves could lead California growers to decide to plant another crop leading to decreased acreage and production. The multipliers reported here can be used to determine the impact of reduced production on California's economy. Here I report the economic impacts of a 20% reduction in California citrus production to illustrate how a change in production from any source will impact California's economy. The economic variables that I use to measure the impact are value of output, employment, employment income, and value added. There are no published estimates of citrus employment data that I am aware of so I make my own estimates and show the assumptions I had to use in the estimation.

A 20% reduction in production could come about either from reduced yield, reduced acreage, or a combination of the two. To facilitate calculation of the impact on employment, I assume that reduced production would come about from a 20% decrease in citrus bearing acreage. UC Extension budgets estimate that it takes approximately 23 hours of labor per acre per year to grow oranges and 20 hours per acre to grow lemons. Harvest costs (picking and hauling to packinghouse) for the two crops are estimated to be $926/acre for oranges and $2,699 per acre for lemons. These harvest costs are based on a per acre yield of 24.5 bins (900 pounds per bin) for oranges and 47.5 bins per acre for lemons. Recent average yields (2016-17) in California were 28.8 bins per acre for oranges, 38.8 bins per are for lemons, 37.4 bins per acre for grapefruit, and 37.3 bins per acre for mandarins[8]. Adjusting the UC Extension harvest costs to reflect actual yields in 2016-17 increases orange harvest costs to $1,095 per acre and lowers lemon harvest costs to $2,205 per acre. Lacking data on harvest costs for grapefruit I set per-acre grapefruit harvest costs equal to oranges. Grapefruit have higher yields than oranges but are larger. The only available UC Extension budget for mandarins was a 2011 budget with mandarin harvest costs of $2,385 per acre with a yield of 26.6 bins, which suggests that mandarin harvest costs exceed lemon harvest costs. To be conservative, and to reflect the lack of current estimates, I set mandarin harvest costs equal to lemon harvest costs.

The reason why I need to estimate harvest costs is to determine how many hours it takes to pick and haul fruit to the packinghouse. Table 4 shows the calculations and my estimate of the number of hours per acre for each citrus fruit type.

The total number of hours to grow, harvest and haul California citrus is found by multiplying the Table 4 results by the number of acres for each type of fruit. Dividing the result by the number of hours of work per year (2,087 in an average year) gives the number of full-time equivalent jobs involved in producing California citrus and delivering it to the packinghouse. The results are shown in Table 5. My method of estimating employment in producing, picking and hauling fruit results in 15,096 full time equivalent jobs. The number of people employed by the citrus industry is larger than this number to the extent that some of the jobs are not full time,

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[8] Mandarins are not picked into 900-pound field bins, but I express yield in bins to facilitate comparison with orange, lemon, and grapefruit yields.

which is the case for most harvest labor, for example. The next step is to determine the number of jobs in the packinghouse industry.

Table 4. Data and Assumptions Used to Calculate Total Hours to Produce California Citrus

	Production Labor	Pick and Haul Cost		Labor Cost	Harvest Hours	Total Hours
	hours/acre	$/acre	% Labor	$/hour	hours/acre	hours/acre
Oranges	23	1,095	90%	15	66	89
Lemons	20	2,205	90%	15	132	152
Grapefruit	20	1,095	90%	15	66	86
Mandarins	25	2,205	90%	15	132	157

Source: See text for calculations of pick and haul cost. Wage rate is total wage rate including taxes. Harvest hours calculated by multiplying pick and haul cost by %Labor and dividing the result by the wage rate.

Table 5. Estimation of Citrus Jobs Producing, Picking, and Hauling to Packinghouse

	Hours Per Acre	Bearing Acres	Total Annual Hours	FTE Jobs
Oranges	89	142,000	12,638,000	6,055
Lemons	152	50,000	7,600,000	3,642
Grapefruit	86	8,700	748,200	358
Mandarins	157	67,000	10,519,000	5,040
Total	114	268,500	31,505,200	15,096

Source: Calculated by author. Total hours per acre is the acreage-weighted average for each citrus type.

There exists no published data showing employment in citrus packing houses. In lieu of a survey of all California packinghouses I base my estimate in this report on published data from the Hodges et al study of the Florida citrus industry. Hodges et al estimate that the fresh fruit packinghouse operations employed 831 people in 2012-13. NASS reports that about six million 80-pound boxes of fresh oranges were packed in that year.[9] Assuming that California

9 Citrus Fruits 2013 Summary. NASS, United States Dept. of Agriculture. September 2013.

packinghouses have the same ratio of jobs per thousand boxes packed as assumed by Hodges et al, then this ratio—138.5 jobs per million boxes packed—can be used to estimate the number of citrus packinghouse jobs in California. According to NASS, California packinghouses packed 103.4 million 80-pound boxes of citrus in 2020-21. Applying the Florida ratio to the California pack results in 14,238 citrus packinghouse jobs in California.

This estimate does not imply that there are 14,238 full time equivalent jobs in California citrus packinghouses however, because the Florida report does not differentiate between part-time and full-time jobs. Due to the seasonal nature of citrus production, most jobs in the packinghouse industry are likely less than full time. If 2/3rds of the jobs are half time and 1/3 of the jobs are full time, then this translates into 9,545 full time equivalent jobs. Adding 9,545 jobs in the packinghouse industry to the 14,702 jobs in the citrus industry that are needed to produce the fruit and get it to the packinghouse results in a total of 24,247 full time equivalent citrus industry jobs in California. If the average wage in the citrus industry is $15 per hour then this amounts to a total income of $759 million in wage income.

As for employment data, there are no published data on value-added of California citrus. USDA publishes value added estimates by broad crop category. In 2020 California agriculture sold about $52.3 billion worth of product and generated about $27.7 billion in value added, which means that value-added equaled about 53% of total sales. If we apply this ratio to the citrus industry then from Table 4, $3.63 billion in sales generated about $1.9 billion in value added. A report put together by Dr. Timothy Richards in 2008 used a value-added to value of output ratio for California citrus of 57%, but he did not explicitly document where he obtained this ratio. Presumably that estimate was provided by IMPLAN. My estimate of $1.9 billion is the direct contribution that the citrus industry made to California's GDP.

I can determine the impact of a 20% reduction in citrus acreage caused by either increased cost of regulations or increased costs of ACP control. My calculations are reported in Table 6. A 20% reduction in citrus acreage would decrease the value of California citrus production by $726 million. This estimate assumes that imported fruit would fill the production gap so that California farmers would not benefit from higher prices caused by this production shortfall. After adding in the indirect and induced impacts of this reduction, the total value of goods produced in California would be reduced by $1.525 billion. Employment in the citrus industry would decrease by 4,849 jobs. Total California employment would decrease by 8,223 jobs after accounting for the indirect and induce impacts. Associated employment income would be reduced by $214 million. State GDP would decrease by about $569 million after the indirect and induced impacts are added to the direct impacts.

Table 6. Annual Economic Impact of a 20% Reduction in California Citrus Acreage

	Output Value	Employment	Employment Income	Value Added
	$ million	jobs	$ million	$ million
Direct	726	4,849	152	385
Indirect	280	1,845	32	109
Induced	519	1,529	30	75
Total	1,525	8,223	214	569

Source: Calculated by author using IMPLAN multipliers.