



Economic Contributions of Imperial County Agriculture





Agricultural Commissioner's Mission Statement



To promote and protect our agricultural industry by providing clear direction and appropriate regulatory oversight while protecting our residents and the environment through the enforcement of pesticide laws, weight and measurement standards, the detection and eradication of pests harmful to our agricultural industry, human health, and other plant resources.

Office of the Agricultural
Commissioner and Sealer of
Weights & Measures
852 Broadway
El Centro, CA 92243
Phone: 442.265.1500
Fax: 760.353.9420
agcom@co.imperial.ca.us
<https://agcom.imperialcounty.org/>

Commissioner's Letter



I am pleased to share the **Economic Contributions of Imperial County Agriculture**. This report takes a significant step beyond the Agricultural Crop and Livestock Report our department publishes each year. Instead of stopping at crop production values and acreage, it quantifies agriculture's total economic contributions through production, local

processing, employment, and economic multiplier effects. In short, this report uses twenty-first-century economic tools to document agriculture's broader role in sustaining a thriving local economy.

The new study shows that in 2019, agriculture contributed a total of \$4.364 billion to the county economy. In addition, this report documents exceptional economic diversification within agriculture, which has implications for countywide economic resiliency.

Agriculture has a long tradition in Imperial County. For more than a century, it has been a pillar of our economy and culture. With this report, we renew our understanding of the importance of the commitment to sustaining that tradition well into the future.

Sincerely,

Carlos Ortiz
Agricultural Commissioner/Sealer of Weights & Measures

Supervisor's Letter

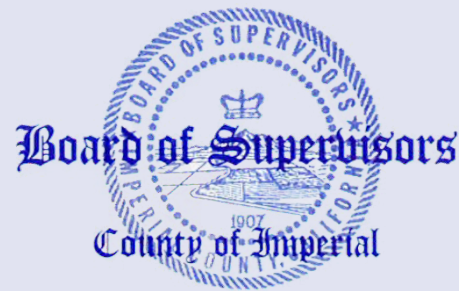


Agriculture is the backbone of Imperial County's rich history and bright future. Agricultural production, innovations to improve on-farm efficiencies and supportive businesses contribute billions of dollars into our local economy each year. Farm dollars provide tax revenue used to improve our roads, build parks and create jobs. Our farmers and ranchers produce fruits, vegetables, forage and beef for the nation

and world's population consistently ranking Imperial in the top ten agricultural producing counties in California. With an abundance of open space and reliable water supply, agriculture in Imperial County will remain strong for generations to come.

Sincerely,

Michael W. Kelley
Chairman, Supervisor District 3



Board of Supervisors, County of Imperial



Jesús E. Escobar
District 1

Luis A. Plancarte
District 2

Michael W. Kelley
District 3 (Chairman)

Ryan E. Kelley
District 4

Raymond R. Castillo
District 5

Tony Rouhotas, Jr.
County Executive Officer

County Administration Center
940 W. Main St., Suite 209
El Centro, CA 92243
Phone: 442.265.1020
Fax: 442.265.1027
michaelkelley@co.imperial.ca.us
<https://imperialcounty.org>

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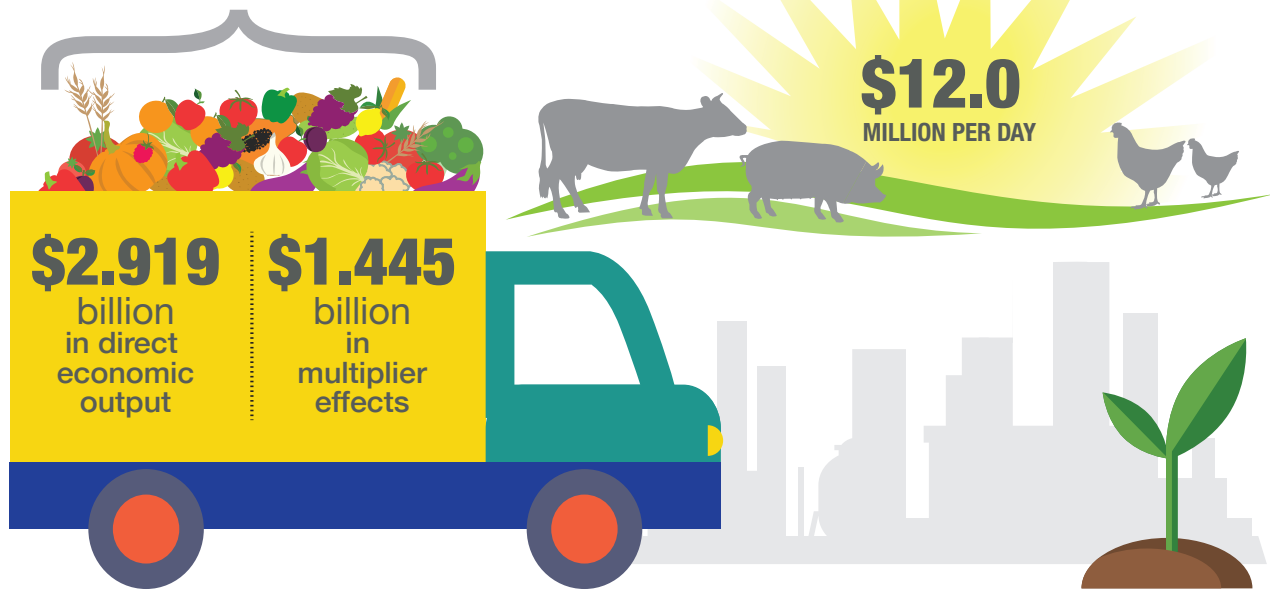
Imperial County Agriculture By the Numbers

Economic Contributions

of the Agricultural Industry for 2019

\$4.364 billion

Imperial County Agriculture's total contribution to the local economy



Employment Effects

of the Agricultural Industry



13,472
direct employees

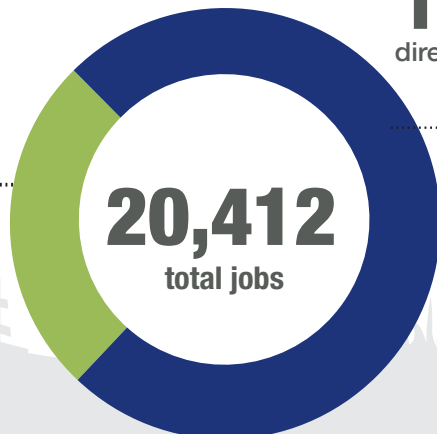


ONE in six

jobs in Imperial County directly attributable to the agricultural industry

6,940

additional jobs attributable to multiplier effects: expenditures by agricultural companies and their employees





Introduction

In December 2017, we published a research report that examined crop production values and wider economic contributions such as local food processing, employment, and multiplier effects. That document generated a tremendously positive response, providing detailed assessments of agriculture's role in sustaining a healthy local economy. This document updates and expands upon that original report.

Like before, we used multiple data sources and advanced economic modeling techniques to analyze agriculture's total contribution to the Imperial County economy. As with the 2017 report, this one also measures economic diversification within agriculture, which has implications for economic resilience. Overall, the findings offer important information for policymakers, the public, and anyone who values a vibrant and resilient local economy.

Our Approach

A *basic industry* sells most of its products beyond the local area and thus brings outside money into local communities. Agriculture easily qualifies as a basic industry in Imperial County. Calculating a reasonable range of economic contributions by a basic industry entails quantifying three economic areas: 1) *direct* economic effects; 2) *indirect* economic effects; and 3) *induced* economic effects. This report covers all three.

Direct economic effects include farm production, local processing, and their related employment. *Indirect* effects consist of local inter-industry, business-to-business supplier purchases. *Induced* effects reflect local consumption spending by employees. The **Multiplier Effects** section on page 8 explains this further.

To understand the furthest economic impacts of agriculture, one would also need to assess agricultural-related costs to society, such as net impacts on water and other natural resources. While important, these impacts lie beyond the scope of this study.

Our calculations draw from local and national data sources. The local sources include industry experts and the annual Imperial County Agricultural Crop and Livestock Report produced by the Agricultural Commissioner and Sealer of Weights and Measures. The main national data source is IMPLAN, a widely used economic modeling program (see www.implan.com).

Originally created for the U.S. Department of Agriculture (USDA), IMPLAN uses econometric modeling to convert data from more than a dozen federal government sources into local values for every U.S. county and zip code, across 546 industry sectors. Because IMPLAN draws from multiple sources, including the latest USDA Census of Agriculture, its employment and economic output numbers often differ from those reported by individual state and federal agencies.

Except where otherwise noted, all figures are from 2019, the most recent IMPLAN dataset available. Where appropriate, we adjusted sector names for clarity and applied coefficients to IMPLAN values to reflect unique Imperial County conditions. Please contact the authors for additional details on the methods used.



Direct Effects of Imperial County Farm Production

This section focuses on the simplest measures of economic activity: production and employment. It describes total farm production and the number of agricultural jobs.

PRODUCTION

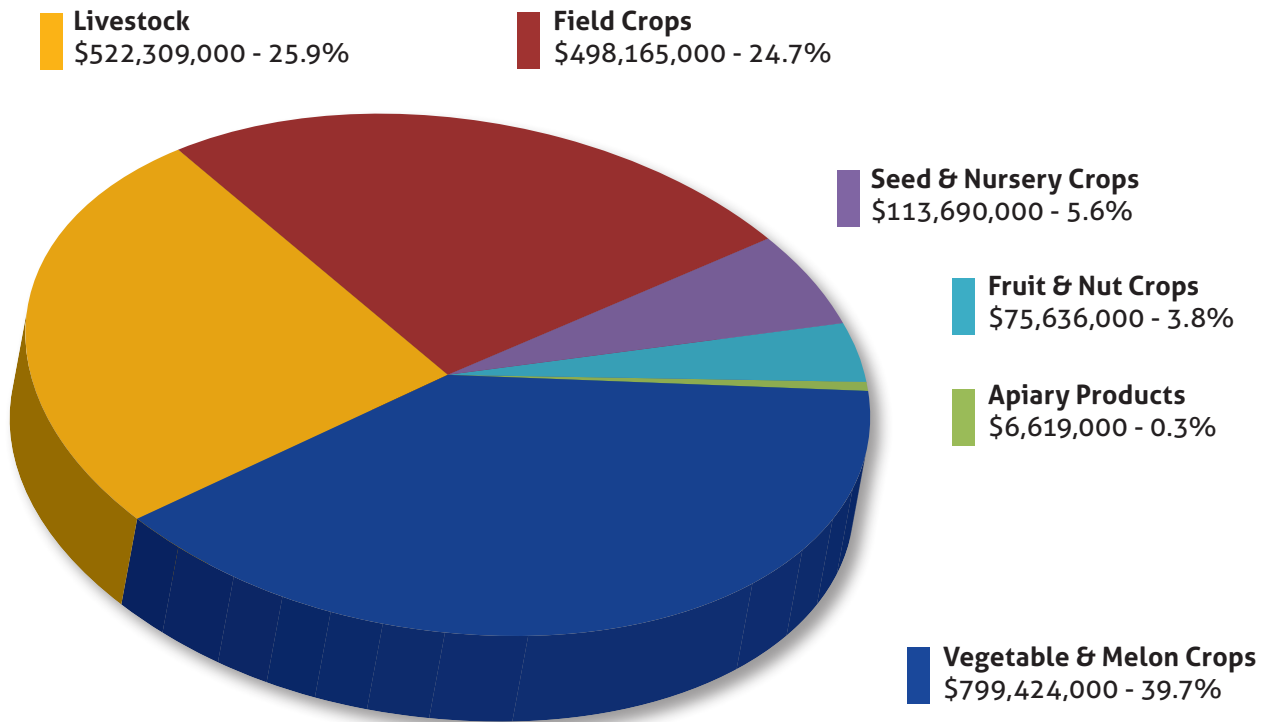
Figure 1 shows the various categories that made up Imperial County farm production value. At \$799.4 million, Vegetable & Melon Crops was the single largest production category by dollar value, comprising 39.7% of the county total. Three products dominated this category: leaf lettuce (\$109.5 million), broccoli (\$105.5 million), and head lettuce (\$103.0 million).

At 25.9%, Livestock represented the second-largest category (\$522.3 million) and consisted mainly of feedlot cattle (\$449.0 million). Field Crops ranked a close third with \$498.2 million and 24.7%. Together, these three categories accounted for 90.3% of the county's direct farm production values.

The combined total dollar value for all products rose \$417.3 million (26.1%) over the previous decade, from \$1.599 billion in 2009 to \$2.016 billion in 2019. Total values do not reflect net profit or loss experienced by individual growers or by the industry as a whole. Interested readers are encouraged to consult the Office of the Agricultural Commissioner's 2019 Agricultural Crop and Livestock Report for additional details on specific products and their value.

Figure 1. Distribution of Imperial County Farm Production

Source: 2019 Agricultural Crop and Livestock Report, Office of the Imperial County Agricultural Commissioner/Sealer.



EMPLOYMENT

How many people work in agricultural production? For 2019, IMPLAN data indicate that agricultural production directly employed 7,794 people in Imperial County. This figure encompassed a wide range of production-related jobs, including not just growing and harvesting, but also sales, marketing, and many other roles. It did not include 5,679 food processing jobs, which are discussed on page 12. Nor did it include Imperial County's many public sector jobs in agriculture, across a wide range of local, state, and federal agencies.



Multiplier Effects of Imperial County Farm Production

This section quantifies the economic ripples that farm production creates in the local economy. These ripples take two forms: *indirect effects* and *induced effects*. The first consists of business-to-business supplier purchases. For example, when a grower buys farm equipment, fertilizer, pesticides, seed, insurance, banking services, and other inputs, the grower creates *indirect effects*.

The second ripple type, *induced effects*, consists of consumption spending by owners and employees of agricultural businesses and their suppliers. They buy groceries, housing, healthcare, leisure activities, and other things for their households. All this spending creates ripples in the local economy.

Figure 2. Economic Effects of Imperial County Farm Production

Dollar values are in \$ millions. Figures are for 2019 and come from IMPLAN and U.S. Bureau of Economic Analysis, with adjustments for local conditions. Not all columns and rows add exactly due to rounding.

FARM PRODUCTION SECTOR	Output Effects (\$ Millions)			TOTAL
	Direct	Indirect	Induced	
Grain & Oilseed Farming	\$23.9	\$6.8	\$7.4	\$38.1
Vegetable & Melon Farming	\$800.1	\$234.7	\$144.1	\$1,178.9
Fruit & Tree Nut Farming	\$74.3	\$16.9	\$15.2	\$106.4
Greenhouse, Nursery & Floriculture Production	\$8.0	\$1.9	\$1.2	\$11.1
Cotton Farming	\$4.5	\$0.9	\$1.4	\$6.8
Sugarcane & Sugar Beet Farming	\$63.8	\$15.3	\$15.8	\$94.9
All Other Crop Farming	\$514.8	\$148.3	\$120.1	\$783.1
Beef Cattle Ranching & Farming	\$476.5	\$155.6	\$108.2	\$740.2
Support Activities for Agriculture	\$94.8	\$6.2	\$30.0	\$131.0
Other Animals & Animal Products	\$45.9	\$5.3	\$12.0	\$63.1
TOTAL ECONOMIC OUTPUT	\$2,106.5	\$591.8	\$455.3	\$3,153.7
	Employment Effects (# Jobs)			TOTAL
	Direct	Indirect	Induced	
TOTAL EMPLOYMENT	7,794	3,250	2,912	13,956

Although agricultural companies and their employees certainly spend money in other counties, this study only reflects those expenditures within Imperial County. Quantifying expenditures outside the county would be a complex effort that lies well beyond the scope of this report.

Figure 2 shows agriculture's *direct*, *indirect*, and *induced* economic effects within the county for major production sectors. The numbers use IMPLAN multipliers for each sector, which are rooted in the most recent U.S. Bureau of Economic Analysis input-output models.

Note that sector names and production values in **Figure 2** differ from the county's annual report. They closely follow a standard classification system used nationwide called the North American Industrial Classification System (NAICS), as adapted by IMPLAN. Each NAICS/IMPLAN category has an explicit definition.



NAICS/IMPLAN also combines familiar products in unfamiliar ways. For example, Imperial County's \$12.2 million wheat crop fits into "Grain & Oilseed Farming" in **Figure 2**, whereas hay and other Field Crops occur under "All Other Crop Farming." Cotton and sugar beets each have a separate category with distinct multipliers. The county's \$106.8 million in seed production (including cotton) occurs across multiple sectors, depending on the type of seed.

Each sector has distinct multipliers. Imperial County "Vegetable & Melon Farming," for example, had a 2019 *indirect effects* multiplier of 0.2933 and an *induced effects* multiplier of 0.1801. This means that each dollar's worth of direct output generated an extra 29 cents in supplier purchases, plus 18 cents more in consumption spending by owners and employees of agricultural businesses and their suppliers.

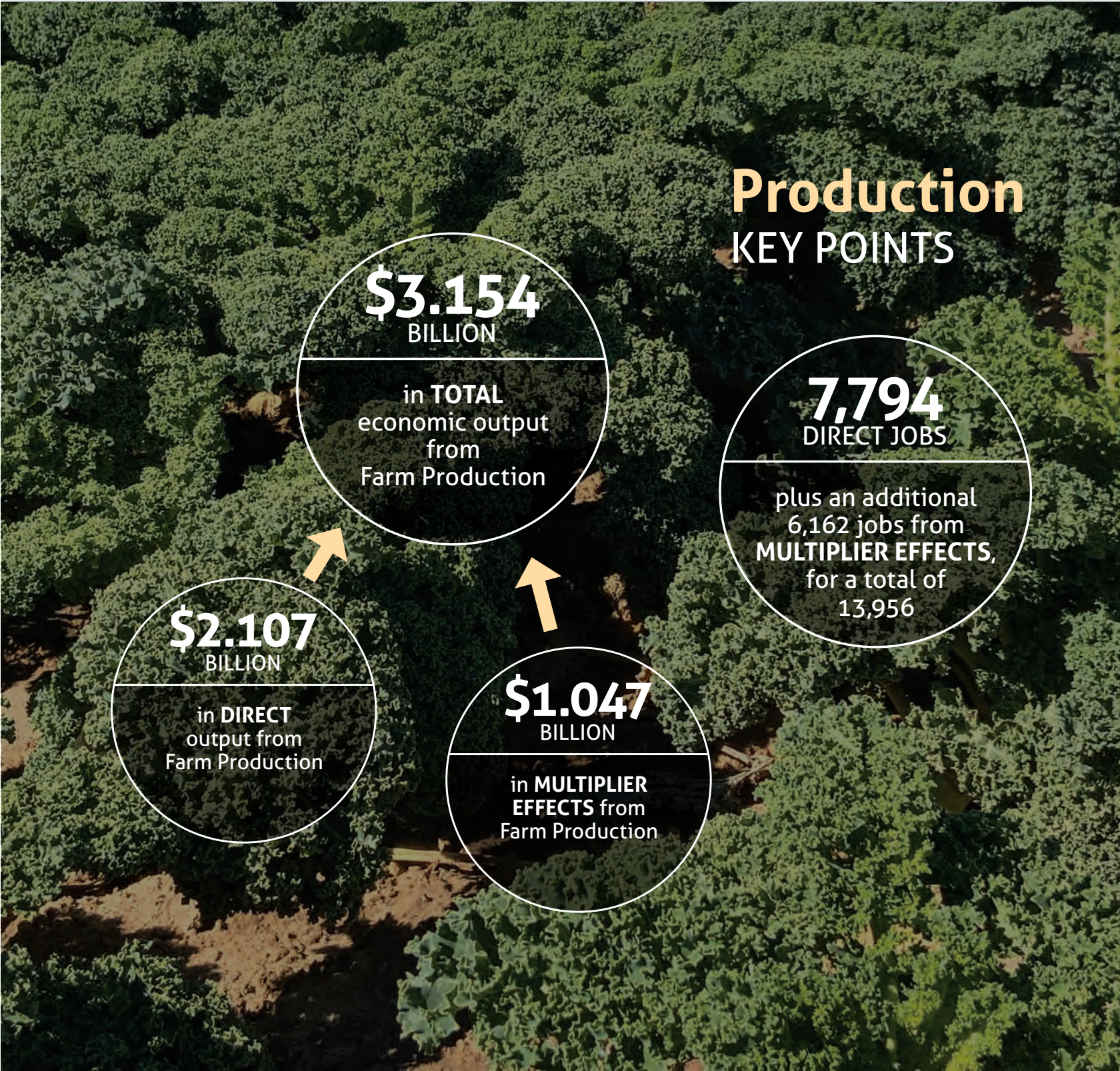
Multipliers change every year for each sector and county in the entire nation to reflect where companies and employees spent their money. The induced effects multiplier for Beef Cattle Ranching & Farming, for example, was 0.1256 in 2016 but rose to 0.2270 for 2019.

Sectors have unique multipliers not just for economic output but also for employment. Imperial County "All Other Crop Farming," for example, supported 2,847 direct jobs plus an additional 260 *indirect effects* jobs and 148 more from *induced effects*. The bottom row of **Figure 2** shows combined employment figures across sectors.

The following list helps bridge NAICS and IMPLAN sectors in **Figure 2** with familiar Imperial County commodities listed in the annual Agricultural Crop and Livestock Report:

- **Grain & Oilseed Farming:** Barley, Field Corn, Oats, Rape, Safflower, Sorghum, Wheat, and Relevant Seeds;
- **Vegetable & Melon Farming:** Broccoli (Market), Cabbage (Market), Carrots, Cauliflower (Market), Head Lettuce, Leaf Lettuce, Salad Products, Spring Mix, Onions, Potatoes, Spinach, Sweet Corn, Romaine Lettuce, Misc. Vegetables, Cantaloupes, Honeydew & Misc. Melons, Watermelons and Various Seeds (e.g., Broccoli, Carrot, Cauliflower, Celery, Chinese Cabbage, Coriander, Lettuce, Mizuna, Watermelon); Vegetable Transplants;
- **Fruit & Tree Nut Farming:** Dates, Grapefruit, Lemons, Oranges (Valencia), Tangelos, Tangerines, Misc. Crops, Citrus By-Products, Pecans;
- **Greenhouse, Nursery & Floriculture Production:** Aloe Vera, Chrysanthemum Seed, Cut Flowers, Nursery Plants, Palm Trees;
- **Cotton Farming:** Cotton (Lint), Cotton (Seed);
- **Sugarcane & Sugar Beet Farming:** Sugar Beets, Sugar Cane;
- **All Other Crop Farming:** Alfalfa Hay & Seed, Bermuda Grass Hay & Seed, Klein Grass Hay, Onion Seed, Misc. Non-Certified Seed, Misc. Certified Seed, Pastured Crops, Straw (Baled), Sudan Grass Hay, and Misc. Field Crops;
- **Beef Cattle Ranching & Farming:** Beef Cattle (Feedlot), Misc. Livestock (e.g., Calves, Replacement Cattle, Dairy Animals);
- **Other Animals & Animal Products:** Aquatic Products, Milk, Manure/Compost, Sheep, Wool, California Mid-Winter Fair & Fiesta Show Animals
- **Support Activities for Agriculture:** Pollination, Soil Preparation, Planting, Cultivating, Misc. Other Farm Management Services (see text for additional details);

Because IMPLAN's methodology differs from that of the county's annual agriculture survey, the total 2019 direct production value in **Figure 2** (\$2.108 billion) differs slightly from the \$2.016 billion reported in the 2019 Imperial County Agricultural Crop and Livestock Report. The total also differs from the figure reported in our 2017 study. The latter difference stems mostly from the reclassification of many "Support Activities for Agriculture" into a new category, "Light Processing of Fruits & Vegetables," as described in **Figure 3** and its associated text.





Locally Sourced, Value-Added Food Processing

Farm production tells only part of the story. Imperial County is home to several food processors that play a key role in the local economy. This section estimates the economic value of local food processing. It is neither an exact science nor a full assessment but rather gives the reader a basic overview of the topic.

Like the previous study, we avoid overstating the numbers by only including food manufacturers and sectors that fit two strict criteria: 1) they use mostly local agricultural inputs; and 2) they are unlikely to exist here without the presence of the associated agricultural sector. Many processing facilities would not operate in Imperial County were it not for the abundant supply of fruits, vegetables, meat, and other raw agricultural products.

We also took precautions to avoid double-counting. For example, we did not factor sugar beet production into this section because the Farm Production section already captured the dollar value of sugar beets (\$62.1 million). We only calculated the value created by converting sugar beets into sugar, pulp, and molasses. The same applies to leafy greens and other vegetables that undergo light processing into value-added products.

Based on these strict criteria, we excluded several IMPLAN food and beverage sectors that other studies often include.¹ Adding these sectors could overstate the value of local agriculture, including its employment and multiplier effects.

For example, we did not include Imperial County's \$16.9 million in bread and bakery products because most raw ingredients such as flour and yeast came from outside the county. The county does produce wheat (\$12.2 million), but it goes to Texas, Missouri, and Illinois for milling into wheat flour. Other examples include the county's manufacturing of frozen cakes and other pastries (\$7.5 million), roasted nuts and peanut butter (\$5.0 million), and various other snack foods (4.7 million).

Of note, the county's nascent beer brewing sector nearly quintupled since our previous study, from \$2.3 million to \$11.4 million. Although brewers sometimes flavor beer with local lemons, melons, honey, and carrots, they still depend on outside grains such as hops grown in the Pacific Northwest or Germany.

Figure 3 shows the economic effects of locally sourced, value-added food processing. Like the previous section, sector names generally follow the NAICS and IMPLAN classification system with adjustments for Imperial County context.

The largest sector, "Meat & Other Animal Products," consists mostly of one facility that handles about 30% of the county's cattle production. Most cattle go to other counties for processing (e.g., Los Angeles, Fresno) or to Arizona. Sheep only spend the winter in Imperial County, then go elsewhere for processing.

Several smaller examples exist. Boutique-scale processing of goats, rabbits, poultry, swine, and lambs occurs in conjunction with the California Mid-Winter Fair & Fiesta, with show animals sold by auction or barn sales. Imperial County has a few remaining dairies for dairy products and was home to California's last remaining producer of Swiss and Muenster cheeses until it closed in late 2013. The county is a major fish supplier to California and Asia but only sells live fish. Other examples include compost and wool.

¹ See, for example: 1) Sexton *et al.* 2015, "The Economic Impact of Food and Beverage Processing in California and Its Cities and Counties"; and 2) "The Measure of California Agriculture, Chapter 5" by the U.C. Davis Agricultural Issues Center (2009).



Figure 3. Economic Effects of Locally Sourced, Value-added Food Processing

Sources: IMPLAN and U.S. Bureau of Economic Analysis data, with input by local industry experts. Columns and rows may not compute exactly due to rounding.

FOOD PROCESSING	Output Effects (\$ Millions)			TOTAL
	Direct	Indirect	Induced	
Meat & Other Animal Products	\$327.5	\$188.6	\$39.4	\$555.5
Light Processing of Fresh Fruits & Vegetables	\$284.5	\$18.5	\$90.1	\$393.1
Compressed Hay & Other Animal Feed	\$150.1	\$27.6	\$6.9	\$184.6
Miscellaneous Other Food Manufacturing	\$50.1	\$21.4	\$5.6	\$77.2
TOTAL ECONOMIC OUTPUT	\$812.1	\$256.2	\$142.1	\$1,210.3
	Employment Effects (# Jobs)			TOTAL
	Direct	Indirect	Induced	
TOTAL EMPLOYMENT	5,679	519	258	6,457

“Light Processing of Fresh Fruits & Vegetables” in **Figure 3** reflects post-harvest value added to the county’s abundant produce. New for this report, this sector captures portions of IMPLAN’s “Support Activities for Agriculture” sector that involve the sorting, grading, cleaning, and packing of fresh produce, including when those activities occur in the field during harvest. This partial reclassification of economic output and employment from farm production to local processing increases the level of precision. But it also makes comparisons to the past study problematic, at least for categories such as production and processing. We can still compare their combined overall totals across time.

Vegetables go mostly to the fresh market or other counties for processing. For example, 40% to 50% of the county’s \$45.3 million onion crop was processed, but it occurred outside the county. Similarly, 68% of the county’s \$65.8 million carrot crop went to processing (\$45.1 million), nearly all of it in Kern County. Leafy greens, too, mainly go elsewhere for processing, often into ready-to-eat and ready-to-use products. Estimated percentages of key crops that get processed range from 30% of leaf lettuce, 40% of cabbage, and 50% of Romaine and head lettuce, to 99% of spinach and 100% for Arugula, Mizuna, and Romaine hearts.

Most citrus goes to the fresh market. Depending on the quality of the fruit, an estimated 25% to 40% of tangerines, tangelos, oranges, lemons, and grapefruit are processed into juices and related products. All of this processing occurs outside the county.

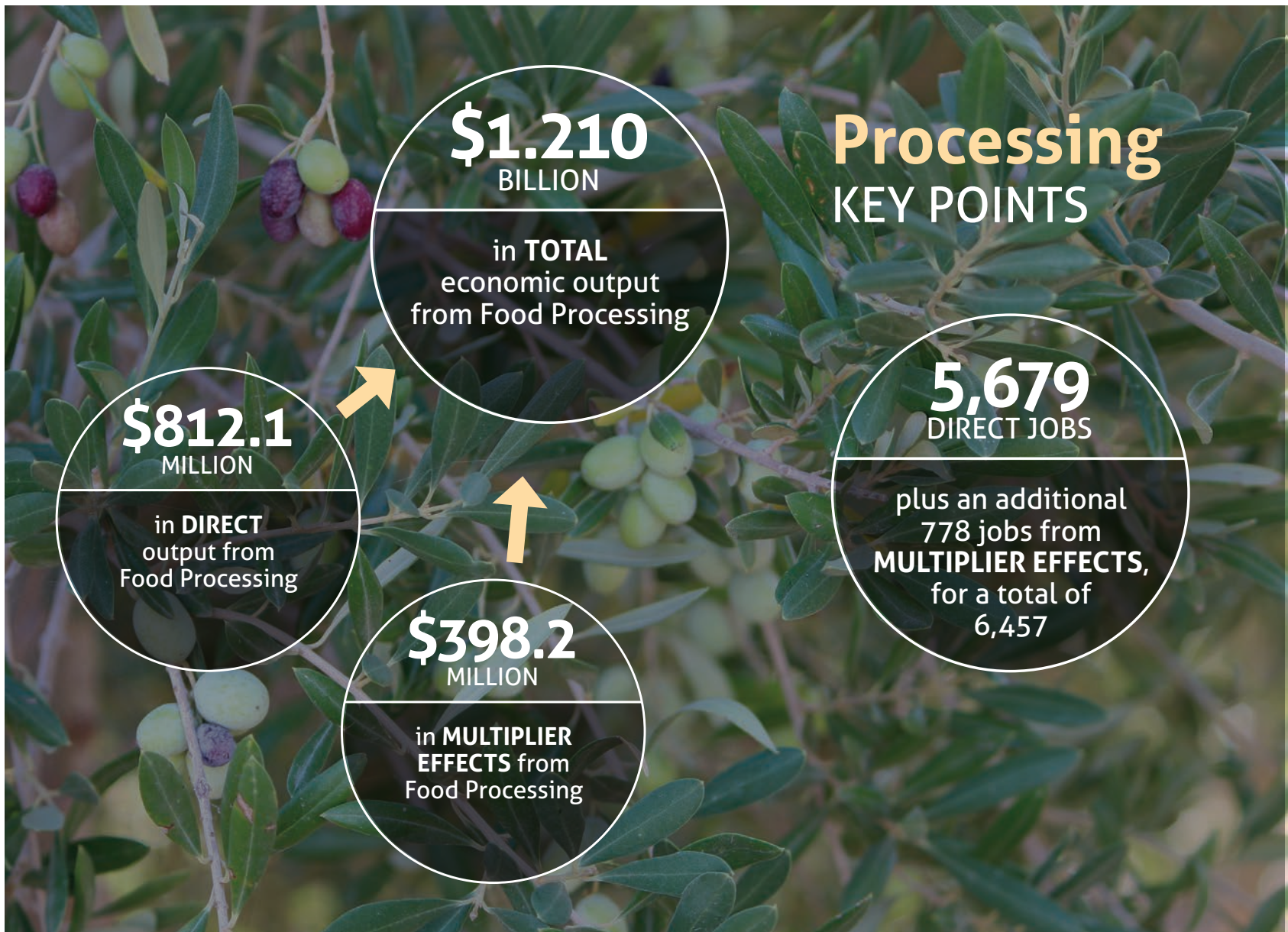
Economic Contributions of Imperial County Agriculture

Various kinds of small-scale fruit processing occur. For example, a portion of the county's \$22.7 million date crop was processed into date nut bread, date butter, and related products. Five percent of the olive crop was processed into olive oil locally, rather than at olive mills in Arizona. At least one producer used local figs to make jams.

"Compressed Hay & Other Animal Food Manufacturing" in **Figure 3** captures the estimated 30% to 40% of the county's \$217.4 million alfalfa hay production that growers compress into small, double compressed bales, rather than sell for direct consumption in feedlots. Several alfalfa compressing facilities operate within the county. In 2019, these facilities exported most of their products to Japan, Korea, Saudi Arabia, China and ten other Asian countries.

An estimated 50% of the county's \$83.6 million Bermuda Grass production also gets compressed, as does 80% to 90% of the \$30.5 million Klein Grass crop and 80% to 95% of the \$39.9 million in Sudan Grass. These, too, go mostly to Asia.

The catch-all category "Miscellaneous Other Food Manufacturing" reflects various niche products. For example, the county has become the world's largest manufacturer of spirulina and spirulina-based products, with exports to more than 20 countries. Beet sugar manufacturing also occurs here. Of the eleven beet processing facilities built in California since 1870, the only remaining one is in Imperial County. That operation uses local beets to produce beet sugar and co-products such as dried beet pulp and beet molasses.



Total Economic Contributions of Imperial County Agriculture

The previous sections have provided key pieces to an economic puzzle. This section combines those puzzle pieces into a final picture showing the overall economic effect of Imperial County agriculture.

As **Figure 4** shows, the total 2019 economic contribution of Imperial County agriculture was \$4.364 billion. This consisted of \$2.919 billion in combined, direct output from production and processing, plus \$1.445 billion in multiplier effects (rounded).

The \$4.364 billion in total 2019 output marked a 3.0% decrease from the \$4.498 billion figure in our 2017 report, which was based on 2016 data. Of note, this slight drop approximates the 2.3% drop in production values during that time, as documented in the relevant Agricultural Crop and Livestock Reports.

For perspective, agriculture pumped *twelve million dollars per day* into the county economy during 2019 (\$11,956,259 to be exact). That equated to \$498,177 per hour and \$8,303 per minute.

Total agricultural employment covered in the scope of this study was 20,412. This included 13,472 jobs directly in agriculture and another another 6,940 attributable to multiplier effects (rounded). The 13,472 direct agricultural jobs represented a 4.2% rise over the 2016 level of 12,916. It also represented 16.8% of Imperial County's total employment of 80,026, or about one out of every six jobs (5.9 to be exact).



Figure 4. Overall Economic Effects of Imperial County Agriculture

Columns and rows may not compute exactly due to rounding.

Type of Effect	Direct	Indirect	Induced	TOTAL
FARM PRODUCTION				
Output Effects (\$ Millions)	\$2,106.5	\$591.8	\$455.3	\$3,153.7
Employment Effects (# Jobs)	7,794	3,250	2,912	13,956
LOCALLY SOURCED, VALUE-ADDED FOOD PROCESSING				
Output Effects (\$ Millions)	\$812.1	\$256.2	\$142.1	\$1,210.3
Employment Effects (# Jobs)	5,679	519	258	6,457
TOTAL VALUE OF AGRICULTURAL INDUSTRY				
Output Effects (\$ Millions)	\$2,918.6	\$848.0	\$597.4	\$4,364.0
Employment Effects (# Jobs)	13,472	3,769	3,171	20,412




Agriculture In The Larger Economy

Agriculture’s \$2.920 billion in direct output represented 23.9% of the county’s total economic output of \$12.202 billion, about one out of every 4.2 dollars. This made agriculture the largest economic sector in Imperial County, as shown in **Figure 5**.

Consistent with our previous study, which was based on 2016 data, government once again ranked second (\$2.709 billion). Among other things, government included public safety, public education, military, social services, and even agricultural agencies. As **Figure 5** shows, real estate & rentals ranked third again, this time at \$1.18 billion

Figure 5. Imperial County Industries Ranked by Direct Economic Output


Note: The sizable change in “Manufacturing” is attributable to reclassification of certain food manufacturing activities into “Agriculture (production & processing).”

CATEGORY NAME	OUTPUT	RANK 2016 Data	RANK 2019 Data
 Agriculture (production & processing)	\$2,918,611,876	1	1
Government (all levels & types)	\$2,708,585,124	2	2
Real Estate & Rentals	\$1,183,230,811	3	3
Wholesale Trade	\$770,395,108	5	4
Retail Trade	\$609,148,423	4	5
Health & Social Services	\$531,280,497	6	6
Transportation & Warehousing	\$442,938,507	7	7
Finance & Insurance	\$413,608,014	11	8
Accommodation & Food Services	\$413,476,192	9	9
Construction	\$383,476,050	10	10
Utilities	\$337,135,335	12	11
Other Services	\$336,714,104	14	12
Professional, Scientific & Technical Services	\$324,856,786	13	13
Administrative & Waste Services	\$250,852,021	15	14
Mining	\$182,481,426	16	15
Manufacturing	\$163,868,711	8	16
Information	\$149,088,453	17	17
Management of Companies	\$28,489,470	18	18
Arts, Entertainment & Recreation	\$27,506,007	19	19
Educational Services	\$26,243,738	20	20

For employment, agriculture once again ranked second in the county, behind government (**Figure 6**). Health & social services ranked third again with 9,194 jobs and included, for example, doctors, dentists, hospitals, and day care services.

As we have seen with other California counties, local employment attributable to agriculture’s multiplier effects has declined over time. A combination of factors likely drives this phenomenon, led by century-long trends toward increased globalization and mechanization.

Figure 6. Imperial County Industries Ranked by Employment

CATEGORY NAME	EMPLOYMENT	RANK 2016 Data	RANK 2019 Data
Government (all levels & types)	18,532	1	1
 Agriculture (production & processing)	13,472	2	2
Health & Social Services	9,194	3	3
Retail Trade	7,977	4	4
Accommodation & Food Services	5,311	5	5
Other Services	5,063	7	6
Transportation & Warehousing	3,763	8	7
Administrative & Waste Services	3,099	6	8
Construction	2,729	10	9
Professional, Scientific & Technical Services	2,320	11	10
Real Estate & Rentals	2,034	12	11
Finance & Insurance	1,865	13	12
Wholesale Trade	1,472	9	13
Manufacturing	814	14	14
Educational Services	582	18	15
Arts, Entertainment & Recreation	467	16	16
Mining	435	15	17
Utilities	409	17	18
Information	314	19	19
Management of Companies	174	20	20

How Resilient is Agriculture to Economic Shocks?

Like growers and ranchers everywhere, Imperial County agricultural producers face a long list of risks. Prominent examples include droughts, floods, crop pests and diseases, food safety-related outbreaks, new regulations, new competitors, labor availability and cost, price drops, rising costs for fuel, equipment and other inputs, and even a global pandemic. Any one of these risks can deal a damaging blow. When combined, they can undermine not just an individual operation but an entire industry.

What’s the best way to lower these risks? Opinions vary, but most emphasize *product diversification*. From the old adage, “don’t keep all your eggs in one basket” to the advice that modern financial planners give, diversity tends to create stability.

A growing body of research supports this conventional wisdom. The more diversified a local economy is, the better it protects economic growth and employment during economic shocks. It’s a complex topic, though, with many factors in play and much research yet to be done.

This raises the question: How economically diversified is Imperial County agriculture? Does the county have low agricultural diversity, likely increasing its risk to economic shocks? Or is agriculture highly diversified, implying a stronger economic buffer?

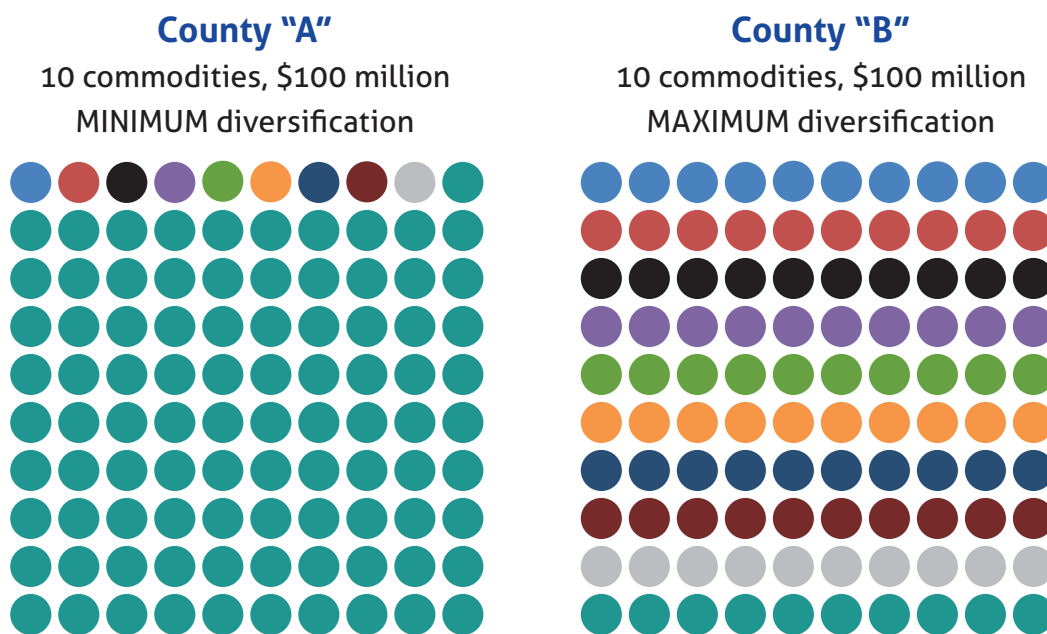
To answer this question, we calculated the Shannon-Weaver Index for Imperial County agriculture. Created in 1949 for military code breaking, the Shannon-Weaver index is widely used by economists, ecologists, and others interested in quantifying diversity. Different versions of the basic Shannon-Weaver formula exist. What they all have in common, though, is that they quantify not just the number of different items—such as characters in a coded message, species in a rainforest, ethnicities on a university campus, or crops grown in a county—but also their relative *evenness* or *abundance*.

Figure 7 portrays this relationship. County “A” and County “B” both grow the same number of commodities and have the same total value of that production. But County “A” has a low index, near zero, because 91% of production concentrates in a single commodity. Any shock to that commodity could devastate the agricultural economy.

County “B” depicts the opposite. Production perfectly balances across all commodity categories. Each commodity type contributes 10% of the total. This gives County “B” a strong buffer against economic shocks.

Figure 7. Agricultural Diversification is More Than Just the Number of Commodities

The two fictitious counties have identical agricultural commodities and total revenues, but diversification gives County “B” a stronger buffer against economic shocks



SHANNON-WEAVER INDEX

How exactly does one calculate the Shannon-Weaver Index for agriculture? The main steps were: 1) created a comprehensive list of agricultural products and their production values; 2) removed fourteen minor, outlier products that had production values less than 0.25% of the county total, in particular: citrus by-products, cotton (lint & seed), grapefruit, honey, onion seed, pastured crops, sheep (feeders & wool), spring mix, straw (baled), tangelos, tangerines, and wax; 3) entered the data into the Shannon-Weaver formula; and 4) converted to a 1.0 scale, which has become popular over recent years. The 1.0 scale is more intuitive for audiences to understand. It also makes comparisons easier than the unlimited scale we used in our previous study, which resulted in Imperial County index of 3.23. For additional details, please contact the authors.

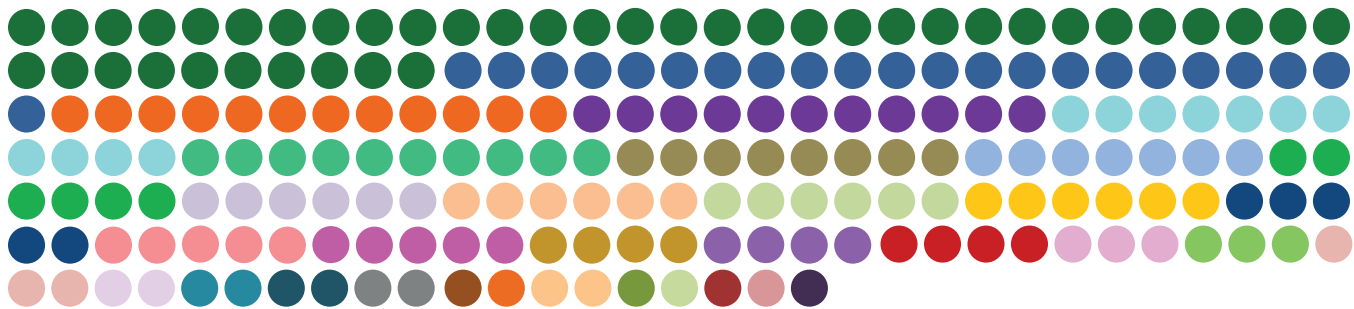
For 2019, the Shannon-Weaver Index for Imperial County's agricultural industry was **0.69**.

What exactly does this number mean? For starters, getting the highest index, a perfect 1.00 on a scale from 0.00 to 1.00, would require the impossible: produce all seventy-two of California's major commodities and have farm gate values equally distributed across them. In such a case, the hypothetical county in **Figure 7** would show seventy-two rows instead of ten, each row a different color and identical length. No single county could accomplish this.

Over the past decade, Imperial County has consistently produced thirty-four major commodities. The relative contribution of individual commodities varied during this period from 0.25% of the county's total farm gate value (the minimum threshold for this analysis) to 25.6% of the county total (feedlot cattle in 2013). **Figure 8** depicts their most recent relative contributions.

Figure 8. Relative Distribution of Imperial County Agricultural Commodities

Colored circles represent approximately \$10 million each and depict major agricultural commodities' relative contributions to Imperial County's total 2019 farm gate value. Commodities less than \$10 million in value are depicted with a single dot. The figure does not include minor outlier commodities that contributed less than 0.25% of the county total (Source: 2019 Imperial County Agricultural Crop and Livestock Report)



The Shannon-Weaver formula includes a logarithmic function, which complicates interpretation. The logarithm makes the scale exponential, like the Richter Scale that measures earthquakes. Many Californians understand that a 7.4 earthquake releases twice the energy of a 7.2 earthquake even though the numbers are not far apart. The same principle applies here.

The 0.69 index is the highest one we have seen among twenty California counties analyzed thus far. This likely suggests exceptional protection from economic shocks. Validating the extent of that protection would require stress testing, i.e. modeling specific shocks to see how they affect the industry.

How has the Shannon-Weaver Index changed over time? Has agriculture become more diversified in Imperial County, or less so? **Figure 9** shows the Shannon-Weaver Index for the past decade. The graph closely parallels a similar one from our previous study, but uses the new 1.0 scale and includes data from recent years.

Economic Contributions of Imperial County Agriculture

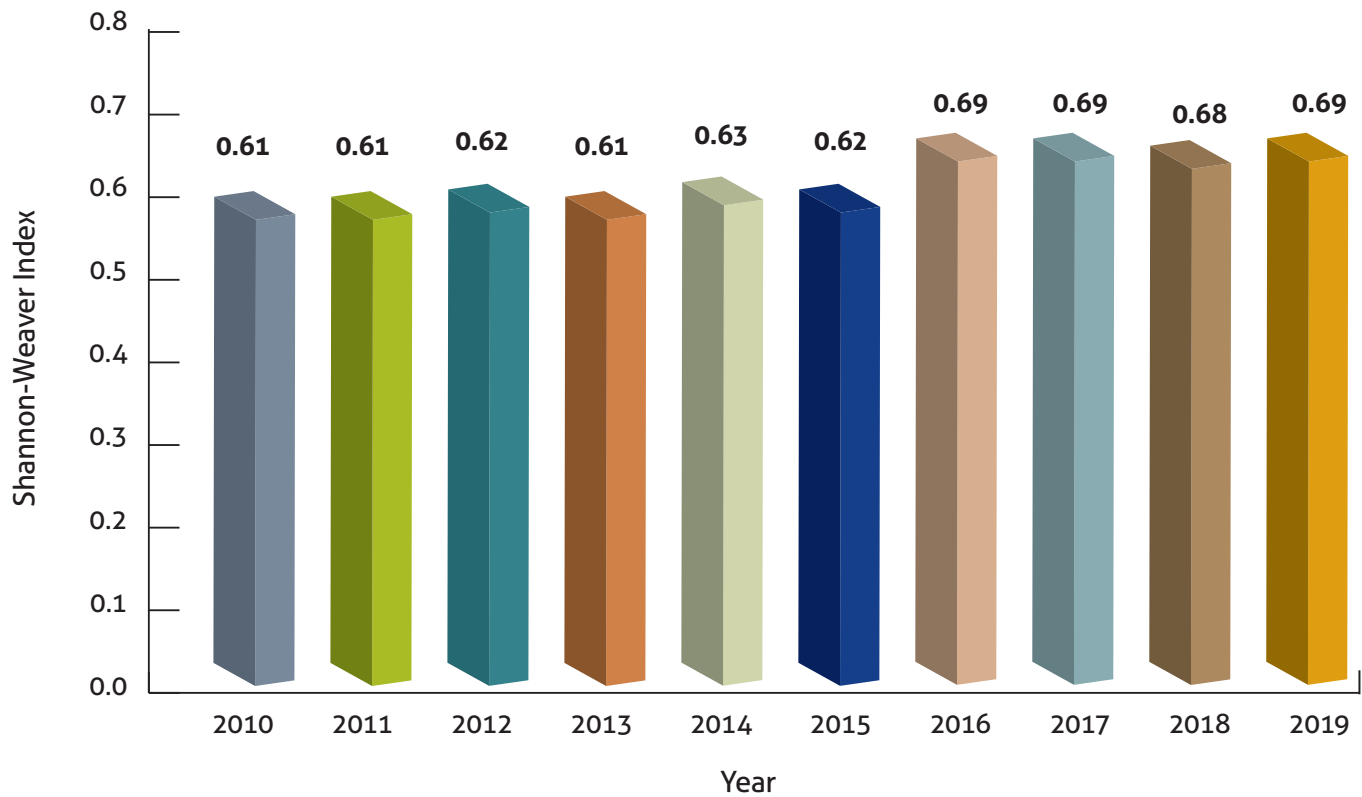
The main thing to note is consistent, high diversification across years. In fact, the index has risen over time, and recently matched its all-time high. This suggests a high level of economic resiliency within agriculture. It also contrasts with the downward trend occurring in many California counties that have become dependent on one or two major products.

Changes over time underscore the importance of a strong, diversified production base. From 2015 to 2016, for example, several of the county’s largest product categories experienced notable declines. The top-ranked commodity, cattle, dropped 10.0%. Second-ranked alfalfa declined by 11.7%. The fourth-biggest commodity, onions, dropped 11.4%. Seventeen other commodities also declined, including wheat, which plummeted 49.0%.

But the county’s strong diversification buffered the negative effects. Alfalfa seed, broccoli, carrots, cauliflower, head lettuce, leaf lettuce, and other commodities increased for 2016. Romaine lettuce more than doubled to \$70.2 million. Spinach tripled to \$96.5 million. Thus, what could have been a double-digit drop for the county’s total agricultural production transformed into a 7.1% increase for 2016. Meanwhile, the county’s diversification index spiked to a new high (Figure 9).

Figure 9. Ten-Year Trend in Imperial County Agriculture’s Economic Diversification

An indicator of economic resilience, the *Shannon-Weaver Index* quantifies diversification by combining the number of different commodities produced and their relative economic value.



Toward the Future

This report has documented the role that Imperial County agriculture plays in the county economy. The key points for 2019 are:

- Including local food production, processing, and multiplier effects, agriculture contributed \$4.364 billion to the county economy – about twelve million dollars per day – and retained its #1 ranking as the county's largest industry.
- As the County's second-largest employer behind government, agriculture directly supported 13,472 jobs – about one out of every six jobs in Imperial County – plus another 6,940 attributable to multiplier effects.
- With a Shannon-Weaver Index of 0.69, agricultural production had an exceptionally high level of economic diversification, providing important economic resilience to the industry and to the larger county economy.



Agriculture is an essential pillar of the Imperial County economy and represents a vital link to the County's cultural past and competitive future. Although this report has presented many facts and figures, it has barely begun to fill key information gaps about agriculture's role. Several additional questions that lie beyond the scope of this report may warrant future research (see below). In the meantime, the findings herein provide the clearest picture yet of Imperial County agriculture's powerful economic role.



Additional Questions

- **ADDING VALUE LOCALLY.** As this report has shown, much processing of Imperial County's raw agricultural products occurs outside the county. What new policies, programs, and other initiatives, if implemented, could expand locally sourced, value-added food processing within the county?
- **REGIONAL ANALYSIS.** What economic impacts, dependencies, and synergies occur across Imperial County and its key agricultural neighbors such as Yuma County, Riverside County, San Diego County, and Mexicali? What opportunities exist to strengthen agriculture across the greater region?
- **ECONOMIC SHOCKS.** How would potential shocks affect agriculture's economic output, for example significant new regulations, pests, labor policies, water issues, technology breakthroughs, or changes in the price of key inputs?
- **INDUSTRIAL HEMP AND CANNABIS.** Imperial County has few commercial industrial hemp and cannabis production activities, including those now in the registration process. What challenges and opportunities would expanded cultivation of these crops create for local agriculture? For the County?
- **WATER.** Imperial County's abundant food production depends on Colorado River water delivered via the All-American Canal. What challenges does this water supply face? What measures, if implemented, could best safeguard this vital resource well into the future?

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