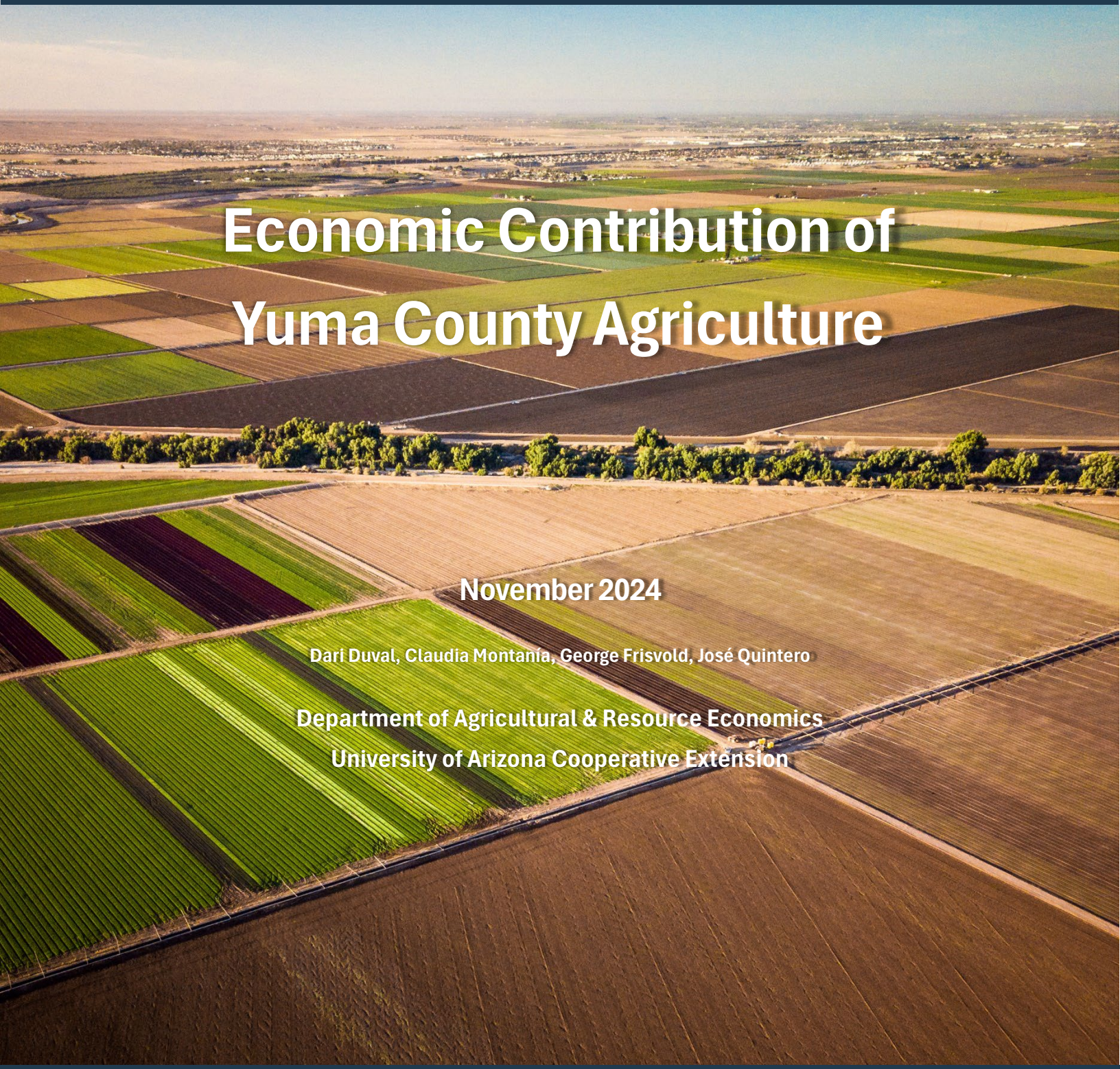

Economic Contribution of Yuma County Agriculture

November 2024

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Executive Summary

What is the study about?

This study presents an analysis of the economic importance of agriculture and agribusiness in Yuma County, Arizona. In 2015, the Yuma County Agriculture Water Coalition published *A Case Study in Efficiency – Agriculture and Water Use in the Yuma, Arizona Area* (YCAWC, 2015). The report characterized the then-current state of agricultural water use in Yuma County and detailed how the region has come to be a key agricultural area, producing high-value specialty crops meanwhile maintaining high levels of water use efficiency while operating in a desert environment. This study presents an update to portions of the 2015 study which examined the economic contributions of agriculture to the Yuma County economy. The analysis is divided into four parts:

- ***Background information*** on agriculture in Yuma County, including top crops and seasonality of production.
- ***Economic base analysis*** evaluating the extent of Yuma County's specialization in agriculture and agribusiness.
- ***Water productivity analysis*** quantifying the region's agricultural water use efficiency in comparison to other areas.
- ***Economic contribution analysis*** estimating the total economic activity supported by agriculture and agribusiness in Yuma County in 2022.

The study considers agriculture as including ***on-farm production of crops, livestock, and livestock products***; ***agricultural support services***; ***agricultural input suppliers***; and ***university-linked agricultural research and Extension***.

What did the study find?

Including multiplier effects, Yuma's agriculture and agribusiness industries generated an economic contribution of $4.4 billion in sales to the Arizona state economy in 2022. This was made up of three parts:

- On-farm agriculture, agricultural support activities, agricultural input suppliers, and university-linked research and Extension, with multiplier effects contributed $3.9 billion in sales to the Yuma County economy.
- Forward-linked industries delivering raw fresh produce and preparing fresh produce products contributed an additional $254 million in sales to the Yuma County economy.
- Yuma County's agriculture and agribusiness industry cluster created demand for goods and services in *other Arizona counties* outside of Yuma. This demand contributed $274 million in sales to other Arizona counties as well as 988 jobs. Most of this contribution occurred in Maricopa County.

The Yuma fresh produce value chain accounts for sizeable sales nationally in wholesale, retail, and foodservice industries. This includes at the national level:

- Estimated gross consumer retail spending on Yuma-grown produce of $3.2 billion.
- Wholesale industry output estimated at $715 million delivering Yuma-grown produce to retailers and foodservice establishments.
- Spending by foodservice industries, which use Yuma produce as an input, of $39 million.

Within Yuma County, direct agriculture-related sales include crops and livestock outputs as well as significant spending on inputs:

- Crop industries directly contributed $1.3 billion to county sales.
- Livestock industries directly contributed $167.3 million to county sales.
- Agricultural support service industries (which include farm labor contracting services) had sales of $411 million.
- Agricultural input suppliers in the county had sales of $944 million.
- Though not generating direct sales per se, university-linked research and Extension generated $4 million in output in the Yuma County economy.

In 2022, Yuma County accounted for roughly a third (29%) of Arizona's agricultural cash receipts. The value of crop production has increased significantly over that time, from roughly $600 million in 1969 to around $1.3 billion in 2022. Part of the growth in the value of crop production has been driven by a transition away from the production of lower-value field crops to higher-value specialty crops, particularly winter vegetables.

- In 2022, Yuma County was the third-ranked county nationally out of 2,831 counties in terms of its combined sales of vegetables, melons, potatoes, and sweet potatoes. It ranked 13th nationally out of 3,074 counties in terms of its total crop sales.
- In 2022, Yuma County had the 15th highest average cash rental rate for irrigated agricultural land in the entire country, an indicator of the land's productivity. The county ranked among counties in California and Washington known for producing high-value specialty crops, including wine grape growing regions.
- In 2022, Yuma County ranked first in cash rental rate for irrigated agricultural land among all counties in the Lower and Upper Colorado River Basin.

In terms of regional economic specialization, Yuma is to U.S. vegetable production what Silicon Valley is to computer manufacturing, Seattle is to the aerospace industry, Chicago is to commodities trading, Manhattan is to investment banking, Detroit is to auto manufacturing, and Los Angeles is to the movie and recording industries.

- In 2022, Yuma agricultural producers managed more than $2 billion in farm assets (more than $1.8 billion in land and buildings and more than $231 million in farm machinery and equipment).
- In 2022, the agricultural sector accounted for 14.5% of the county's total Gross Domestic Product (GDP). Yuma County is one of Arizona's top agricultural producers, contributing 56% of Arizona's agricultural GDP in 2022.
- For Yuma, employment in vegetable and melon farming is 58 times the national average (Location Quotient (LQ) = 58). Similarly, the LQ for Yuma post-harvest crop activities is 51.4, while for farm labor contracting it was 49.7. For crop harvesting, the LQ is 93.8.
- By way of comparison, the LQ is 66.4 for electronic computer manufacturing in Santa Clara County, California (Silicon Valley), 34.3 for aerospace manufacturing in Snohomish County, Washington (Seattle suburbs), 21.4 for securities and commodity exchanges in Cook County, Illinois (Chicago), 18.5 for motor vehicle manufacturing in Wayne County, Michigan (Detroit), and 11.4 for motion picture and sound recording industries in Los Angeles County, California (Hollywood).

Separate measures of irrigation productivity – cash rent premiums for irrigated land, economic water productivity, and blue water footprints – all provide evidence that water productivity in Yuma agriculture is high, and much higher in general than in the rest of the Colorado River Basin.

- The economic water productivity of crop production based on gross crop sales (EWP_g) for Yuma County was $1,581 / AF, meaning that $1,581 was generated in sales for every acre-foot of water used for agriculture in Yuma County. The average across all counties in the Basin was $692 / AF. The median, however, was $176 / AF, meaning half of the counties in the Basin had an EWP_g lower than this value, and half had one higher.
- Yuma accounted for 18% of crop sales in the Basin, but consumed only 8% of the irrigation water.
- A county's crop Blue Water Footprint (BWF) is the amount of water consumed to produce $1,000 worth of crop sales. Yuma's BWF is 0.63, meaning that it takes 0.63 acre-feet of water to produce $1,000 in crop sales. The average BWF for the entire basin is 1.44. So, Yuma's BWF is less than half of the Basin average. The median BWF is 5.67, meaning that half of the Basin counties have a BWF lower than 5.67 and half have a BWF greater than 5.67.

How was the study done?

This study conducts three economic contribution analyses: one for on-farm agriculture (crop, livestock, and agricultural support service industries), agricultural input suppliers, and university research and Extension; one for forward linked economic activity in Yuma County, and a final analysis of the contribution of the same sectors to other Arizona counties using a multi-regional input-output (MRIO) model. The economic contribution analyses were modeled using the IMPLAN Pro 2022 model for Yuma County, Arizona. The model was customized using the best available, most recent data to more accurately reflect the production and economic context in Yuma County. The methods used to estimate economic contributions are presented in the Appendix. The study relies on a number of data sources, first and foremost the 2022 Census of Agriculture (USDA, 2024).

Introduction

This study presents an analysis of the economic importance of agriculture and agribusiness in Yuma County, Arizona. In 2015, the Yuma County Agriculture Water Coalition published *A Case Study in Efficiency – Agriculture and Water Use in the Yuma, Arizona Area* (YCAWC, 2015). The report characterized the then-current state of agricultural water use in Yuma County and detailed how the region has come to be a key agricultural area, producing high-value specialty crops meanwhile maintaining high levels of water use efficiency while operating in a desert environment. This study presents an update to portions of the 2015 study that examined the economic contributions of agriculture to the Yuma County economy. The analysis is divided into four parts:

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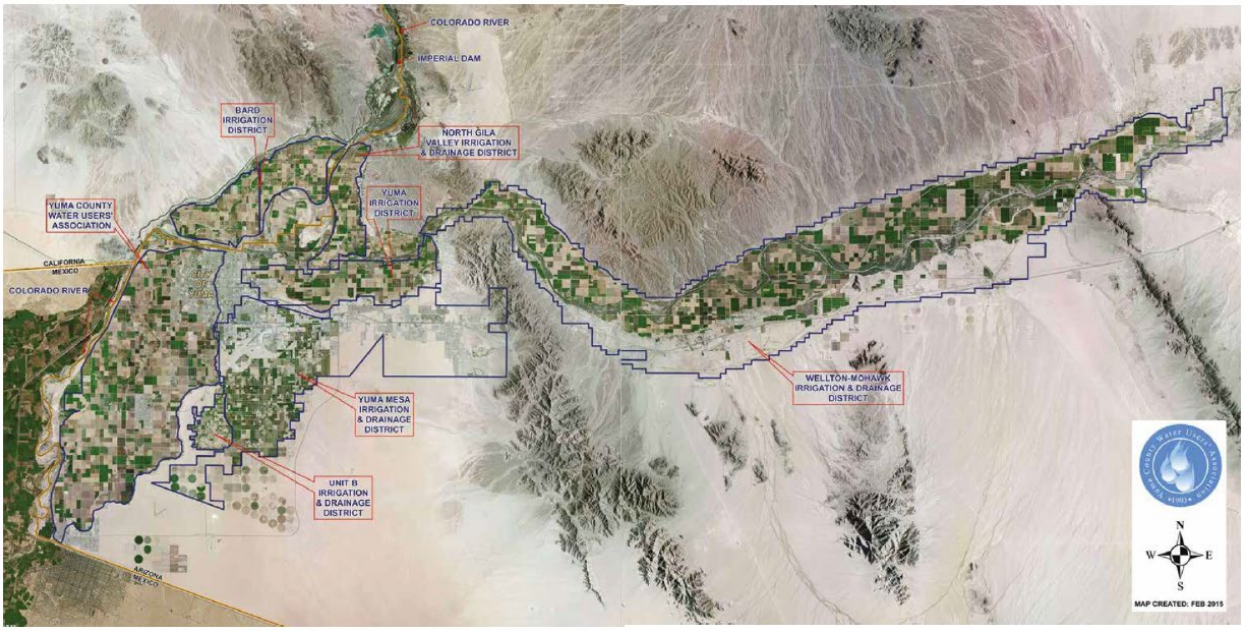
- ***Water productivity analysis*** quantifying the region's agricultural water use efficiency in comparison to other areas.
- ***Economic contribution analysis*** estimating the total economic activity supported by agriculture and agribusiness in Yuma County in 2022, as well as quantifying additional forward-linked economic activity associated with agricultural production in the county.

The study considers agriculture as including on-farm production of crops, livestock, and livestock products; agricultural support services; agricultural input suppliers; and university-linked agricultural research and Extension. It also considers aspects of the post-harvest supply chain. This includes forward-linked industries delivering raw fresh produce and preparing fresh produce products. The study also considers national level consumer retail spending, wholesale industry spending, and foodservice industry spending on Yuma produce. We begin with an overview of Yuma County's agricultural production and how it has evolved over time.

Background

Yuma County is located at the fertile confluence of the Gila and Colorado Rivers in Southwestern Arizona. The Cocopah and Quechan tribes inhabited the area upon the arrival of Spanish explorers and missionaries (Visit Yuma, 2024). The Yuma area was deemed a strategic location due to a narrowing of the flood-prone Colorado River at that location, enabling safe passage across the river to California. In the 1900s, dams were constructed along the Colorado River to divert and regulate its flows, and canals were built to deliver water to the Yuma area, enabling the growth of the area's agricultural industry (Visit Yuma, 2024). Today, the area is a highly concentrated center of agricultural production due to its geography and natural resources and is a key producer of winter vegetables, notably leafy greens. Crop production occurs primarily along the Colorado and Gila Rivers, supported by the infrastructure of the region's many irrigation districts (Figure 1).

Figure 1. Yuma Area Irrigation Districts

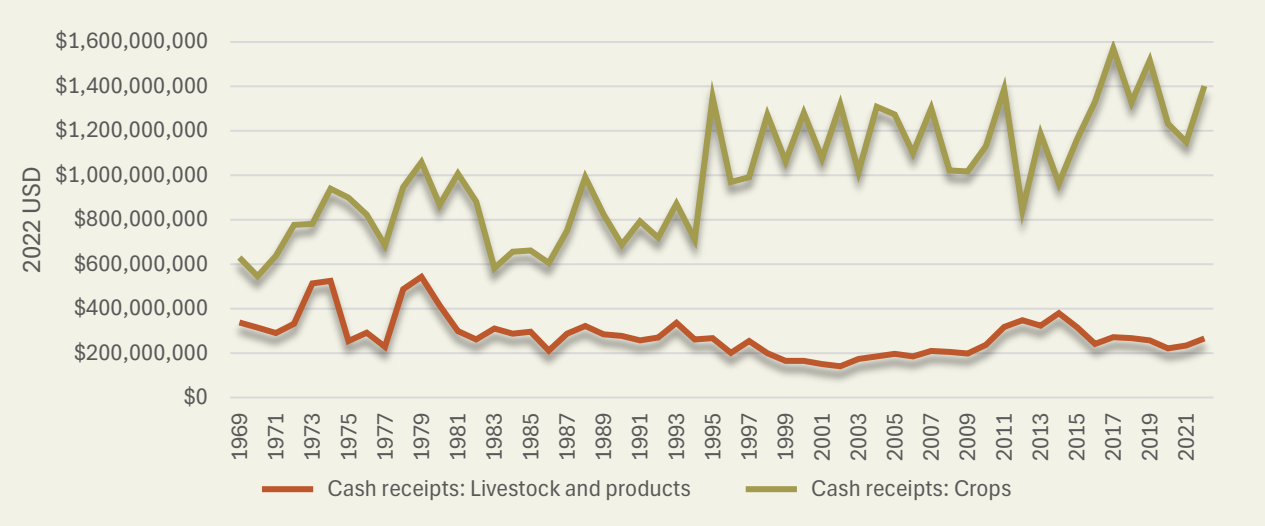


Source: Yuma County Water Users Association

Agricultural Production & Cash Receipts

In 2022, the year of the most recent USDA Census of Agriculture, Yuma County accounted for roughly a third (29%) of Arizona's agricultural cash receipts. The inflation-adjusted value of production of livestock and livestock products in Yuma County has fluctuated between $200 and $400 million in 2022 dollars (Figure 2). Meanwhile, the value of crop production has increased significantly over that time, from roughly $600 million in 1969 to around $1.3 billion in 2022, more than doubling when adjusted for inflation. Part of the growth in the value of crop production has been driven by a transition away from production of lower-value field crops to higher-value specialty crops, particularly winter vegetables.

*Figure 2. Yuma County Cash Receipts - Crops & Livestock, 2022 USD, 1969-2022**



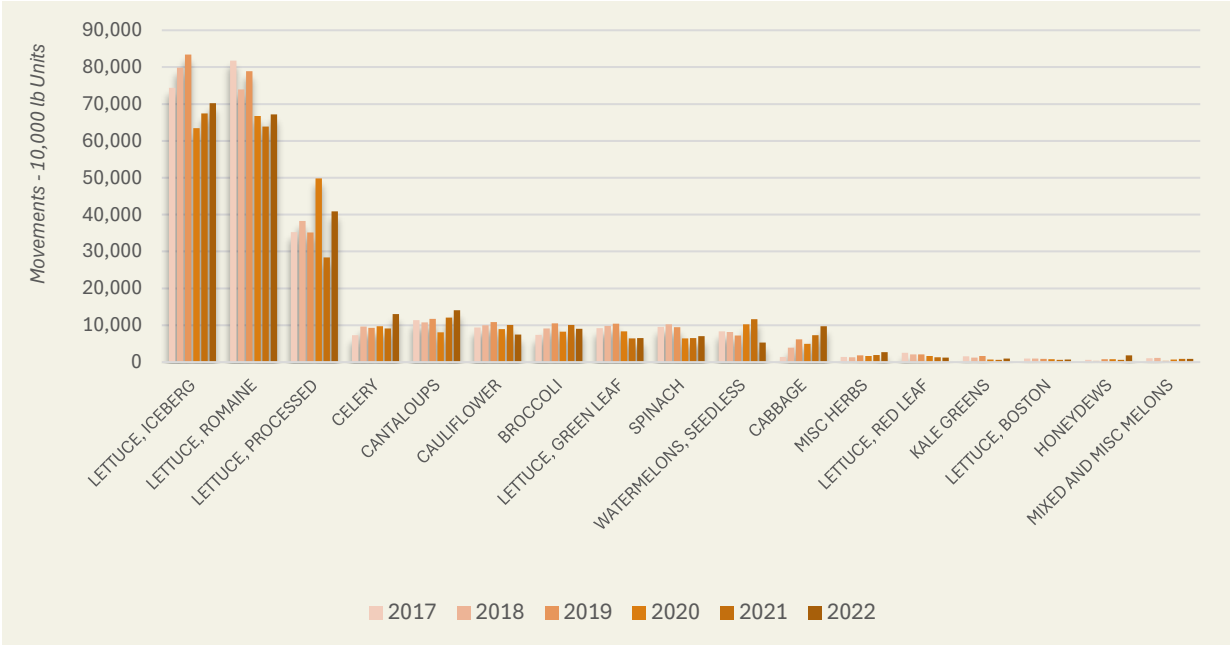
Source: Bureau of Economic Analysis, 2024

* La Paz County, Arizona separated from Yuma County in 1983, at which time it had roughly $150 million (2022 USD) in agricultural cash receipts, primarily from sales of crops. A corresponding decline in Yuma County crop cash receipts can be detected in Yuma County's crop cash receipts. Data prior to 1983 reflect production in areas that today constitute both Yuma and La Paz counties.

Crop Production

Yuma County is a major producer of winter vegetables, providing a large share of the national supply of a number of commodities during winter months, including Romaine lettuce, iceberg lettuce, processed lettuce, spinach, and other commodities (Duval, 2023).

Figure 3. Western Arizona – Top Specialty Crops by Annual Weight of Movements, 2017-2022

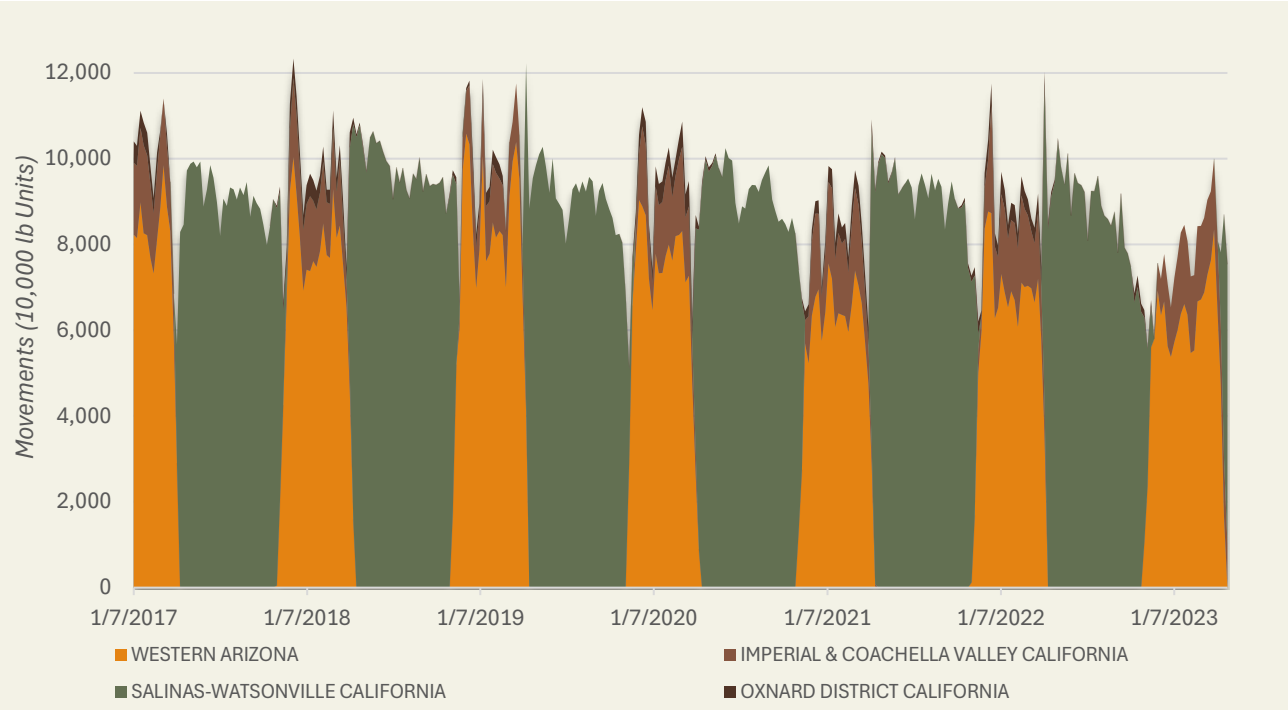


Source: USDA AMS, 2023

Top winter vegetable crops grown in Yuma County include iceberg, Romaine, and other lettuces, celery, cauliflower, broccoli, spinach, and cabbage, among others. Additionally, in summer months the area produces melons, including cantaloupes, watermelons, honeydews, and other melons (Figure 3).

Yuma County is part of a seasonal rotation of leafy greens production that supplies most of the nation's leafy greens, including iceberg lettuce, Romaine lettuce, green leaf lettuce, red leaf lettuce, and Boston lettuce. Production rotates seasonally between California's Central Valley (Salinas, Watsonville, and other areas) during summer months and Western Arizona and Imperial Valley during winter months. Combined, a relatively stable supply of leafy greens is produced across the year by shifting production seasonally to where growing conditions are optimal. Figure 4 illustrates the rotating production of lettuce between Arizona and California by area of origin.

Figure 4. Weekly Lettuce Shipping Movements (All Types) by Origin in 10,000 Lb. Units, 2017-2023



Source: USDA AMS (2023). Includes iceberg lettuce, Romaine lettuce, green leaf lettuce, Boston lettuce, & red leaf lettuce

Table 1. Harvested Acreage of Selected Field Crops in Yuma County, 2022

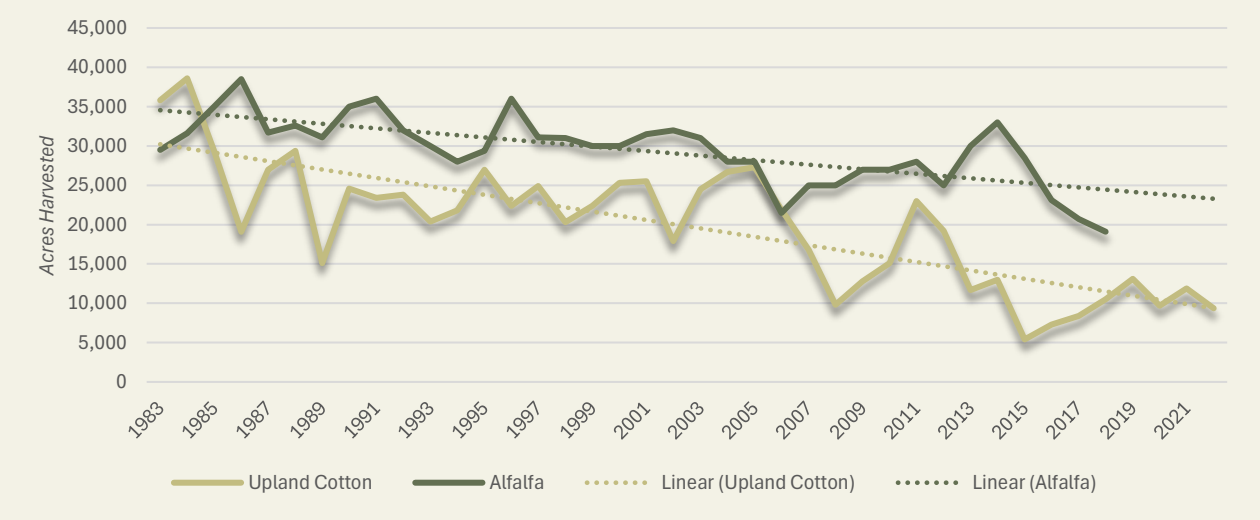
Crop	Acres Harvested (2022)
Wheat	42,968
Alfalfa hay	28,593
Hay, excluding alfalfa	23,496
Cotton	10,306
Sudangrass, Seed	5,154
Barley	1,397
Corn, Silage	1,345

Source: Census of Agriculture (2022)

In 2022, Yuma County vegetable and melon sales totaled $1.1 billion, representing 75% of the county's total agricultural commodity sales. Beyond vegetables and melons, Yuma County is also a producer of field crops, some of which are grown in rotation with winter vegetables (Table 1).

Yuma County's emergence as a producer of high-value specialty crops has been enabled through a shift from field crops such as cotton and alfalfa to seasonal rotation between winter vegetables and grains such as durum wheat. Since the 1980s, acreage of upland cotton and alfalfa hay harvested in Yuma County has declined considerably (Figure 5).

Figure 5. Upland Cotton and Alfalfa Hay Acres Harvested, Yuma County, 1983-2022



Source: USDA NASS, 2023

Meanwhile, both acreage in vegetables and acreage in wheat, grown in rotation with vegetables, have increased (Figure 6).

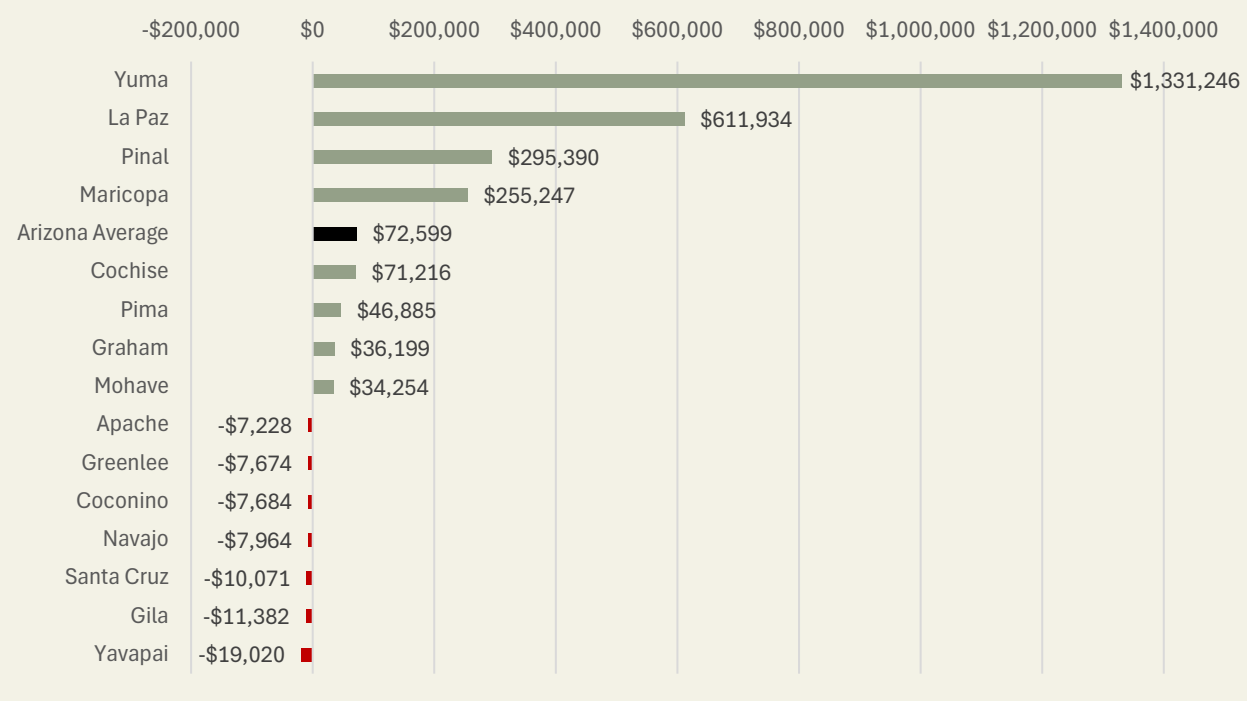
Figure 6. Total Vegetable Acres & Wheat Acres Harvested, Yuma County, 1997-2022

Source: Census of Agriculture, 1997-2022

In 2022, Yuma County was the third-ranked county nationally out of 2,831 counties in terms of its combined sales of vegetables, melons, potatoes, and sweet potatoes. It ranked 13th nationally out of 3,074 counties in terms of its total crop sales. The county ranks highly among counties nationally in terms of its production of many winter vegetable commodities, in particular production of different varieties of leafy greens.

Yuma County has a high concentration of large, profitable farms with significant investments in facilities and equipment. In 2022, Yuma agricultural producers managed more than $2 billion in farm assets (more than $1.8 billion in land and buildings and more than $231 million in farm machinery and equipment). The average value of agricultural land and buildings per farm in Yuma County was $4,628,708 in 2022, significantly above the state average of $1,348,526.

Figure 7. Net Cash Farm Income, Average per Farm, 2022

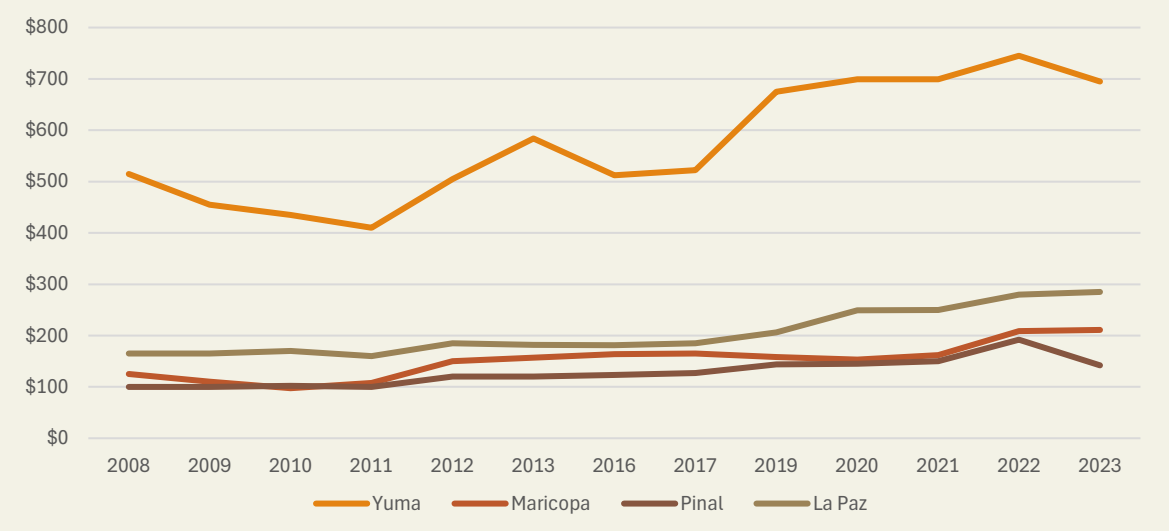


Source: 2022 USDA Census of Agriculture

The profitability of Yuma County farms can be demonstrated through a comparison of the average net cash farm income per farm among Arizona counties (Figure 7). Yuma County has the highest average net farm income per farm of Arizona counties, surpassing the next highest county, La Paz County, by more than a factor of two. Of the farms that report net positive income (the majority of farms in Yuma County), the average net farm income per farm is $2.6 million.

Further evidence of the productivity of Yuma County crop production can be found in prevailing cash rents for agricultural land. Of Arizona counties, Yuma County has the highest average cash rents for irrigated land in the state (Figure 8).

Figure 8. Cash Rental Rate per Acre for Irrigated Cropland in Arizona, 2008-2023



Source: USDA NASS, 2023

Figure 9. Top U.S. Counties by Cash Rental Rate per Acre for Irrigated Agricultural Land

Source: USDA NASS County Cash Rental Rates, 2023

In fact, in 2023, Yuma County had the 15th highest average cash rent rate for irrigated agricultural land in the entire country, an indicator of the land's productivity. The county ranked among counties in California and Washington known for producing high-value specialty crops, including wine grape growing regions (Figure 9).

Livestock Production

Livestock production in Yuma County is dominated by a small number of large producers. In 2022, the county had one large cattle feedlot and one dairy (USDA, 2024). The county ranked second in Arizona in 2022 in terms of the value of its production of cattle and calves, and fifth in the state by the value of its

production of milk from cows. The county's single feedlot, which self-reports a capacity of 115,000 head (Five Rivers Cattle Feeding, 2024), purchases Holsteins from the U.S. and Mexico for finishing.

Because of the limited number of livestock producers in Yuma County, data on production, sales, inventory, and other measures are typically not disclosed for producer confidentiality. For this analysis, we present estimates of sales, value-added, employment, and other measures for livestock production. These estimates, detailed in Appendix A, do not represent official figures for the county but are derived to conduct an economic contribution analysis for all agriculture in the county. According to these estimates, the economic output of Yuma County's livestock sector was roughly $167 million in 2022.

Agricultural Support Services

Agricultural support services include activities that serve crop production, livestock production, and forestry. In Yuma County, most agricultural support service establishments support crop production. In particular, farm labor contractors play a critical role in the seasonal harvest of fresh fruits and vegetables in the region. Though technically providing an input to production for Yuma County farms, this study examines agricultural support service providers as a direct component of the agricultural economy. Table 2 details the number of establishments and average 2022 employment of firms providing agricultural support services in the county. In total, over 7,300 jobs were directly supported in agricultural support services in 2022 by 135 firms. Data for cotton ginning and other agricultural support services are not disclosed. Combined, agricultural support service establishments were estimated to generate $411 million in annual sales in the county.

Table 2. Agricultural Support Services Establishments & Employment, Yuma County, 2022

Industry	Establishments	Employment
NAICS 115 Support activities for agriculture and forestry	135	7,328
NAICS 115112 Soil preparation, planting, and cultivating	20	314
NAICS 115113 Crop harvesting, primarily by machine	13	512
NAICS 115114 Postharvest crop activities (except cotton ginning)	24	2,078
NAICS 115115 Farm labor contractors and crew leaders	67	4,331

Source: QCEW, 2022

Agricultural Input Suppliers

Agricultural input suppliers are a critical part of Yuma County's agriculture and agribusiness industry cluster. Not only do they serve local on-farm production, they also supply agricultural producers domestically and internationally. Some large agribusiness companies are headquartered in Yuma, evidence of the region's importance as an agriculture and agribusiness industry cluster. As industry sales figures are not available at the county level, we develop estimates of sales for specific categories of agricultural input suppliers. For agricultural chemicals and fertilizers, lime, and soil conditioners, industry output was estimated proportional to wages as reported by the QCEW (BLS, 2024), adjusted to reflect total employee compensation using ratios from IMPLAN (IMPLAN, LLC, 2024) and output to employee compensation ratios, again, from IMPLAN. In the case of agricultural machinery rental and veterinary services used by the agricultural industry, outputs were estimated based on industry input spending from the 2022 Census of Agriculture (USDA, 2024). In total, agricultural input suppliers were estimated to generate $944 million in annual sales in the county.

University Agricultural Extension & Research

Continued gains in irrigation water use efficiency in the Yuma area have been made possible through grower adoption of new production and irrigation technologies (YCAWC, 2015; Frisvold et al., 2018). Collaboration with university research and Extension personnel is a critical component enabling the diffusion of new technologies. Among other university resources in the community, three University of Arizona affiliated programs have operations in the Yuma area which directly support agriculture and agribusiness: Yuma County Cooperative Extension, the Yuma Agricultural Center, and the Yuma Center of Excellence for Desert Agriculture. These three programs directly support roughly 60 jobs in the Yuma area and over $3 million in labor income.

Economic Base Analysis

The production of agricultural commodities plays a significant role in Yuma County's economy. In 2022, the agricultural sector accounted for 14.5% of the county's total Gross Domestic Product (GDP). Yuma County is one of Arizona's top agricultural producers, contributing 56% of Arizona's agricultural GDP in 2022 (BEA, 2022). To fully understand the strategic importance of this sector within the Yuma economy, it is necessary to analyze the role it plays in comparison to other industries, not only in terms of production, but also in terms of sectoral specialization and employment generation.

In regional economics, there are two main types of sectors in a local economy: basic and non-basic sectors. Basic sectors are characterized by their primary markets being located outside the county. The county produces more goods or services than required for local consumption, and a substantial portion is "exported" to other regions. For example, winter vegetables from Yuma are shipped all across the United States. In this context, exports denote sales to regions beyond the county, not necessarily international exports. Basic sectors play an important role in the county economy because they generate sales that bring money into the county economy from outside. These sales draw new income and purchasing power into a county. For this reason, expanding basic sectors is considered crucial for the region's economic development (Thulin, 2015).

The demand of the non-basic sectors relies on the local population. These sectors often provide goods and services to individuals working in basic sectors and other non-basic sectors. Examples include grocery stores, pharmacies, restaurants, and auto repair shops that primarily provide services and commodities to the local population.

A common method for assessing a sector's contribution to a county's economic base is through the application of location quotients (LQ), originally developed by Florence (1929). Mathematically, an LQ is a local sector's share of local employment divided by that same sector's national share of total national employment. The formula for the location quotient for a sector i is:

$$LQ_i = \frac{e_i/E}{n_i/N}$$

where
i = The economic sector under study
LQ_i= Location quotient for economic sector i
e_i = County employment in economic sector i
E = Total county employment
n_i = National employment in economic sector i
N = Total national employment.

The LQ is often based on employment values because employment data is collected for local areas in great sector detail. LQs are regularly reported at the state and county level by the U.S. Department of Labor, Quarterly Census of Employment and Wages (QCEW). Sectors that employ roughly the same share of employees as the national average will have location quotients near one. This implies they are employing people and producing output to fulfill their local needs. If a sector has a location quotient greater than 1.25, this often indicates it is producing more than enough output to satisfy local demands and the sector is exporting goods or services outside the area (Crawley et al., 2013; Goetz et al., 2009; Morrissey, 2016). In other words, an LQ of 1.25 or higher usually indicates that the sector is a basic sector—a sector that is bringing in money to the county from outside. The more specialized a region is in a particular industry, the higher its LQ.

One can also use LQs to identify national centers of economic activity. The more specialized a region is in a particular industry, the higher the LQ for that industry. Table 4 shows LQs for Yuma agricultural activities compared to LQs for major areas of economic specialization across the United States. For example, for Yuma, the LQ for vegetable and melon farming is 58. This means that the share of total county employment in this industry in Yuma is 58 times the national average. Similarly, the LQ for Yuma post-harvest crop activities is 51.4, while for farm labor contracting it was 49.7. For crop harvesting, the LQ is 93.8

By way of comparison, the LQ is 66.4 for electronic computer manufacturing in Santa Clara County, California (Silicon Valley), 34.3 for aerospace manufacturing in Snohomish County, Washington (Seattle suburbs), 21.4 for securities and commodity exchanges in Cook County, Illinois (Chicago), 18.5 for motor vehicle manufacturing in Wayne County, Michigan (Detroit), 17.8 for oil and gas manufacturing in Harris County, Texas (Houston), 14.1 for investment banking and securities intermediation in New York County, New York (Manhattan), and 11.4 for motion picture and sound recording industries in Los Angeles County, California (Hollywood) (Table 3).

Table 3. Location Quotients for Selected Yuma Agricultural Activities Compared to Major Areas of US Economic Specialization. 2022

County, State	Metro Area	Economic Activity	Location Quotient
Yuma, AZ		Crop harvesting, primarily by machine	93.8
Santa Clara, CA	Silicon Valley	Electronic computer manufacturing	67.7
Yuma, AZ		Vegetable & melon farming	58.0
Yuma, AZ		Postharvest crop activities	51.4
Yuma, AZ		Farm labor contractors & crew leaders	49.7
Snohomish, WA	Seattle Suburbs	Aerospace product & parts manufacturing	34.3
Cook, IL	Chicago	Securities & commodity exchanges	21.4
Wayne, MI	Detroit	Motor vehicle manufacturing	18.5
Harris, TX	Houston	Crude petroleum extraction	17.8
New York, NY	Manhattan	Investment banking & securities intermediation	14.1
Los Angeles, CA	Hollywood	Motion picture & sound recording industries	11.4

Source: U.S. Department of Labor, BLS, 2022

In sum, in terms of regional economic specialization, Yuma is to U.S. vegetable production what Silicon Valley is to computer manufacturing, Seattle is to the aerospace industry, Chicago is to commodities trading, Manhattan is to investment banking, Detroit is to auto manufacturing, and Los Angeles is to the movie and recording industries. The high LQs for vegetable production (and related economic activities) are indicators of both Yuma County's national importance in vegetable production as well as the role of these activities in bringing income into the local economy.

It is clear that Yuma has a high specialization in agricultural activities, especially related to crop harvesting and vegetables and melon farming. But how much does this sector contribute to employment and wages in Yuma? When looking at the overall industry contributions made by the main agricultural-related activities at 2-digits NAICS code in Table 4, we can highlight that over 20% of wages and jobs in Yuma County are related to these activities, generating more than 12,000 jobs and more than $530 million dollars in total wages (without considering and accounting for animal production and aquaculture-related activities). Within these sectors, Agriculture, forestry, fishing, and hunting had the greater contribution to Yuma's employment in 2022.

Table 4. Agriculture Contributions to Employment and Wages across Industries at 2-Digit NAICS Code in Yuma County, 2022

Industry	Businesses	Jobs	Total Wages ($ millions)	Annual Wages per Employee	Share of Jobs	Share of Wages
Yuma total, all industries	3,595	56,335	$2,638	$46,83	100%	100%
NAICS 11 Agriculture, forestry, fishing & hunting*						
NAICS 111 Crop production & NAICS 115 Support activities for agriculture and forestry	248	10,228	$421	$41,128	18%	16%
NAICS 31-33 Manufacturing						
NAICS 311 Food manufacturing & NAICS 321 Wood product manufacturing	15	627	$30	$48,287	1%	1%
NAICS 42 Wholesale Trade						
NAICS 4245 Farm Product Raw Materials & NAICS 42491 Farm Supplies	37	411	$39	$95,424	1%	1%
NAICS 48-49 Transportation & warehousing						
NAICS 48-49 Transportation & warehousing	139	887	$44	$50,059	2%	2%
All Ag & Food Industries*	439	12,153	$535	$43,986	22%	20%

* NAICS 112-Animal production and aquaculture numbers not included (ND)
Source: U.S. Department of Labor, BLS, 2022

After identifying the main agricultural-related sectors operating in Yuma, Table 5 further analyzes the economic contribution of these sectors. Within the agriculture, forestry, fishing and hunting sector, we can see that in 2022, 67% of these jobs and wages were generated by support activities for agriculture and forestry, while the remaining 33% were associated directly with crop production. Table 5 also reports that food manufacturing accounted for 17% of all manufacturing jobs and 23% of all manufacturing wages in 2022. In the same way, farm supplies represented 20% of all wholesale trade jobs and 29% of all wholesale trade wages. Transportation and warehousing were also a key player in the food value chain, and 44% of the jobs in this sector were generated by truck transportation. Given the strategic importance of agriculture in Yuma's economy, we can assume that most of these numbers were related to its associated activities.

In summary, the contribution of the agricultural-related activities is key to understanding Yuma's economy. This county is not only specialized in crop production and support activities for agriculture as the LQ results suggest, but also these sectors contributed significantly to jobs and wages across major industries.

Table 5. Employment Contributions Related to Agriculture in Yuma County, 2022

Industry	Businesses	Jobs	Total Wages ($ millions)	Annual Wages per Employee	Share of Jobs	Share of Wages
NAICS 11 Agriculture, forestry, fishing & hunting*	248	10,228	$420.7	$41,128	100%	100%
NAICS 111 Crop production	113	2,900	$138.8	$47,868	28%	33%
NAICS 115 Support activities for agriculture & forestry	135	7,328	$281.8	$38,461	72%	67%
NAICS 31-33 Manufacturing	102	3,190	$177.9	$55,769	100%	100%
NAICS 311 Food manufacturing	8	554	$26.7	$48,267	17%	23%
NAICS 321 Wood product manufacturing	7	73	$3.5	$48,440	2%	3%
NAICS 42 Wholesale Trade	182	1,684	$114.5	$67,990	100%	100%
NAICS 4245 Farm Product Raw Materials	5	74	$5.5	$73,800	4%	5%
NAICS 42491 Farm Supplies	32	337	$33.8	$100,173	20%	29%
NAICS 48-49 Transportation & warehousing	179	1,684	$86.2	$51,159	100%	100%
NAICS 484 Truck transportation	127	741	$37.3	$50,371	44%	33%
NAICS 493 Warehousing & storage	12	146	$7.1	$48,475	9%	6%

*NAICS 11 values were estimated based on BLS data. Numbers do not account for NAICS 112-Animal production and aquaculture.
Source: U.S. Department of Labor, BLS, 2022

Water Productivity of Yuma Agriculture

Yuma area growers have achieved important gains in water use efficiency and economic productivity of irrigation water use in recent decades (YCAWC, 2015; Frisvold, et al., 2018). This section examines the productivity of Yuma County's agricultural water use relative to other Colorado River Basin counties.

Cash Rents as a Measure of the Value of Irrigated Crop Production

One method economists use to estimate the value of water use in agriculture is to compare cash rents for irrigated versus non-irrigated land in the same area (Supalla et al., 2006; Henderson and Akers, 2008). Cash rental rates reflect lessee willingness to pay to lease land, which in turn reflects their expected net returns of operating the land. Cash rental rates also reflect the opportunity cost to the lessor (i.e. what they are giving up by not operating the acreage directly). Farmland sales values are often not a good metric for this purpose. This is because sales values can reflect the speculative value of converting agricultural land to residential or commercial real estate. Cash rents, in contrast, are more closely tied to the value of land in current agricultural production.

The difference between the irrigated cropland rental rate and the rental rate for non-irrigated land reflects the value that producers place on being able to irrigate that land. Some analysts further adjust the irrigated–non-irrigated rent differential by differences in property taxes or by certain additional costs associated with irrigated agriculture (Thompson and Supalla, 2023; Pritchett et al., 2008). However, in efficient agricultural land rental markets, cash rents may already reflect these additional cost differences (Rimsaite, et al., 2021). If agricultural rental markets are active, this price premium for irrigated land should reflect assessments by knowledgeable growers in the area, which would account for tax and other cost differences.

The value of water for irrigation in a particular area (the rent premium for irrigated land) can be estimated in (at least) two different ways that we will call Premium A and Premium B:

> ***Premium A*** = [Cash rental rate for irrigated cropland] – [Cash rental rate for pastureland]
>
> ***Premium B*** = [Cash rental rate for irrigated cropland] – [Greater of {Cash rental rate for non-irrigated cropland}, {Cash rental rate for pastureland}]

In many parts of the arid, western United States, non-irrigated crop production is not economically viable. Here, the only non-irrigated agricultural land use may be for (non-irrigated) pastureland.

Table 6 reports cash rental rates for irrigated land for counties in the Colorado River Basin using USDA, National Agricultural Statistical Service (NASS) data for 2023. It also reports per acre premiums for irrigated cropland using Premium A and Premium B definitions above. NASS does not report individual estimates of cash rental rates for some counties. This may be to avoid disclosing information about individual producers or where the number of transactions is not large enough to provide statistically accurate estimates. For groups of such unreported counties, NASS combines estimates in an “Other Counties” estimate. Estimates in Table 6 are reported in nominal (non-inflation adjusted) 2023 values.

Cash rent premiums for irrigated cropland were much greater in Yuma County than in any other county in the Colorado River Basin, $692.10 / acre under each method. No other counties had premiums even above $400 / acre. Only one county had premiums exceeding $300 / acre.

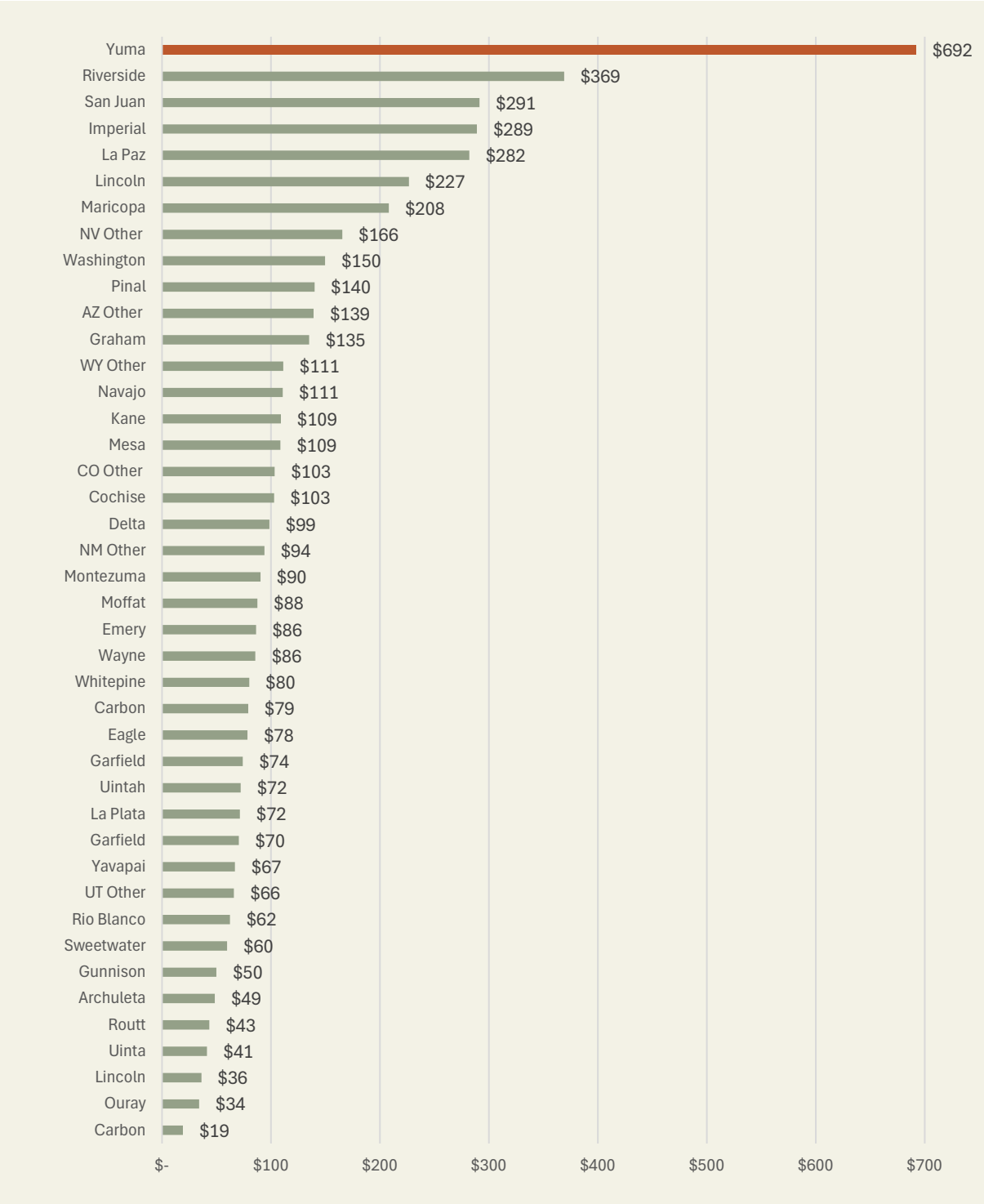
Table 6. Estimated Irrigated Cropland Rental Rate Premiums for Colorado River Basin Counties, 2023

State / Agricultural District	County	Irrigated Cropland Rental Rate	Non-Irrigated Cropland Rental Rate	Pasture Rental Rate	Irrigation Rent Premium A	Irrigation Rent Premium B
Arizona						
Northern	Apache	NR*				
Northern	Coconino	NR*				
Southern	Cochise	$ 105.00		$ 2.20	$ 102.80	$ 102.80
Southern	Graham	$ 138.00		$ 2.90	$ 135.10	$ 135.10
Northern	Gila	NR*				
Southern	Greenlee	NR*				
Southern	La Paz	$ 285.00		$ 2.90	$ 282.10	$ 282.10
Southern	Maricopa	$ 211.00		$ 2.90	$ 208.10	$ 208.10
Northern	Mohave	NR*				
Northern	Navajo	$ 113.00		$ 2.30	$ 110.70	$ 110.70
	Other Counties	$ 142.00		$ 2.90	$ 139.10	$ 139.10
Southern	Pima	NR*				
Southern	Pinal	$ 142.00		$ 2.00	$ 140.00	$ 140.00
Southern	Santa Cruz	NR*				
Northern	Yavapai	$ 70.00		$ 3.00	$ 67.00	$ 67.00
Southern	**Yuma**	**$ 695.00**		**$ 2.90**	**$ 692.10**	**$ 692.10**
California						
So California	Imperial	$ 300.00		$11.00	$ 289.00	$ 289.00
So California	Riverside	$ 380.00	$ 20.00	$11.00	$ 369.00	$ 360.00
Colorado						
Southwest	Archuleta	$ 52.00	$ 20.50	$ 3.50	$ 48.50	$ 31.50
Southwest	Delta	$ 105.00		$ 6.50	$ 98.50	$ 98.50
NE & Mountain	Eagle	$ 84.00		$ 5.60	$ 78.40	$ 78.40
Southwest	Garfield	$ 73.50		$ 3.10	$ 70.40	$ 70.40
NE & Mountain	Grand	NR*				
NE & Mountain	Gunnison	$ 55.50		$ 5.60	$ 49.90	$ 49.90
Southwest	Hinsdale	NR*				
Southwest	La Plata	$ 83.50	$ 14.50	$12.00	$ 71.50	$ 69.00
Southwest	Mesa	$ 113.00		$ 4.40	$ 108.60	$ 108.60
NE & Mountain	Moffat	$ 90.50	$ 17.50	$ 3.00	$ 87.50	$ 73.00
Southwest	Montezuma	$ 94.50	$ 14.50	$ 4.20	$ 90.30	$ 80.00
	Other Counties	$ 109.00	$ 19.50	$ 5.60	$ 103.40	$ 89.50
Southwest	Ouray	$ 40.00		$ 5.90	$ 34.10	$ 34.10
NE & Mountain	Pitkin	NR*				
NE & Mountain	Rio Blanco	$ 68.00		$ 5.60	$ 62.40	$ 62.40
NE & Mountain	Routt	$ 49.00	$ 22.00	$ 5.60	$ 43.40	$ 27.00
Southwest	San Miguel	NR*				
NE & Mountain	Summit	NR*				
New Mexico						
Southwest	Catron	NR*				
Southwest	Grant	NR*				
Southwest	Hidalgo	NR*				
Northwest	McKinley	NR*				
	Other Counties	$ 95.50	$ 25.00	$ 1.60	$ 93.90	$ 70.50
Northwest	San Juan	$ 293.00		$ 1.60	$ 291.40	$ 291.40

State / Agricultural District	County	Irrigated Cropland Rental Rate	Non-Irrigated Cropland Rental Rate	Pasture Rental Rate	Irrigation Rent Premium A	Irrigation Rent Premium B
Nevada						
South	Clark	NR*				
South	Lincoln	$ 237.00		$10.50	$ 226.50	$ 226.50
	Other Counties	$ 176.00		$10.50	$ 165.50	$ 165.50
Northeast	White Pine	$ 95.50		$15.50	$ 80.00	$ 80.00
Utah						
Eastern	Carbon	$ 81.00		$ 2.00	$ 79.00	$ 79.00
Eastern	Daggett	NR*				
Eastern	Duchesne	NR*				
Eastern	Emery	$ 93.00		$ 6.80	$ 86.20	$ 86.20
Southern	Garfield	$ 76.50		$ 2.30	$ 74.20	$ 74.20
Eastern	Grand	NR*				
Southern	Kane	$ 113.00		$ 4.00	$ 109.00	$ 109.00
	Other Counties	$ 82.00	$ 31.00	$16.00	$ 66.00	$ 51.00
Eastern	Uintah	$ 81.50		$ 9.30	$ 72.20	$ 72.20
Southern	Washington	$ 156.00		$ 6.40	$ 149.60	$ 149.60
Southern	Wayne	$ 91.50		$ 5.80	$ 85.70	$ 85.70
Wyoming						
South Central	Carbon	$ 24.00		$ 4.80	$ 19.20	$ 19.20
West	Lincoln	$ 41.50	$ 25.00	$ 5.40	$ 36.10	$ 16.50
	Other Counties	$ 119.00	$ 20.00	$ 7.70	$ 111.30	$ 99.00
West	Sublette	NR*				
South Central	Sweetwater	$ 68.00		$ 8.20	$ 59.80	$ 59.80
West	Uinta	$ 49.00		$ 7.70	$ 41.30	$ 41.30

* NR: Not Reported. Cash rents not reported for individual counties are included in a state's Other Counties cash rents.

Figure 10. Irrigated Cropland Rental Rate Premium 'A' for Colorado River Basin Counties, 2023



Source: USDA NASS and Author calculations

Riverside County, California premiums were second at $360-$369 / acre, followed by San Juan County, New Mexico ($291.40 / acre), Imperial County, California ($289 / acre) and La Paz County, Arizona ($282.10 / acre). Notably, four of the counties ranked in the top five for irrigated land premiums (Yuma, Riverside, Imperial, and La Paz) all use water from the Lower Colorado River mainstem. The choice of alternative Premium A or B does

not affect the overall results much. Figure 10 graphically presents the irrigation rental rate premium (A) estimates from Table 6. It illustrates the high expected return to irrigation in Yuma relative to other Colorado Basin counties.

Economic Water Productivity and Blue Water Footprints Definitions

One method of assessing the efficiency of agricultural water use is *water productivity* – the amount of crop output produced per unit of water consumed. For example, this might be measured as bushels of crop produced per acre foot of water applied. Water productivity is often referred to as "crop per drop." A drawback of this physical productivity measure is it is difficult to compare productivity across different crops. How does one compare the productivity of producing bushels of wheat, bales of cotton, or tons of alfalfa?

Another approach is to examine *economic water productivity*, which the UN FAO (2015) defines as the monetary value generated from each unit of water consumed. In other words, it estimates the dollar amount of crop produced per ace-foot of water consumed. In this way, output across crops can be compared on a dollar-to-dollar basis. Economic water productivity also allows for measurement on a whole-farm basis (where farms produce multiple crops) and on a broader regional basis, such as counties, where different regions have different crop mixes.

Related to economic water productivity is the notion of a water footprint of production. Practitioners of water footprint assessment divide water use into three kinds: green water, blue water, and grey water (Mekonnen and Hoekstra, 2011). Green water represents the consumptive use of rainwater stored in the soil. Green water use is the minimum value between the effective rainfall and the crop water requirement. Effective rainfall is the percentage of rainfall available to plants and crops, subtracting losses from runoff, evaporation, and deep percolation. Blue water is the consumptive use of ground and surface water applied to crops through irrigation. Grey water is the amount of freshwater required to assimilate the load of pollutants based on existing ambient water quality standards. Grey water footprint analyses have focused on nitrogen from fertilizer applications entering water bodies.

The blue water footprint (BWF) (acre-feet of water consumed per physical unit or dollar value of output) is just the reciprocal of water productivity. While economic water productivity measures the dollar value per acre foot of water consumed, the blue water footprint measures the amount of water consumed to produce a dollar of output.

Calculating Economic Water Productivity and Blue Water Footprints at the County Level

In principle, one could obtain estimates of county-level crop production and water consumptive use for crop production to develop county-level economic water productivity and blue water footprint measures for crop production in the Colorado Basin. To do this in practice requires matching economic and water use data. This is more difficult than one might imagine. USDA reports overall crop sales at the county level only in Agricultural Census years, every five years, including 2012 and 2017. USDA reports state-level water use data for the subsequent years 2013 and 2018, but does not report county-level water use data. The Department of Commerce, Bureau of Economic Analysis (BEA) reports county crop cash receipts annually. The US Geological Survey (USGS) reports estimates of irrigation water withdrawals for crops and estimates of crop consumptive use of water at five-year intervals. The most recent year of reported data is 2015 (Dieter et al., 2018). So, it is possible to combine BEA and USGS data from 2015 to estimate economic water productivity and blue water footprints for crop production in Colorado Basin counties for that year.

In conducting this analysis, we encountered some data anomalies and made some adjustments, which we describe next. These are summarized in Frisvold and Duval (2024). We considered data from 55 counties in the Colorado River Basin that account for 99.9% of water consumed for crop irrigation. We did not consider data from six counties that, combined, accounted for 0.1% (one-tenth of one percent) of irrigation water use. For these counties, there was limited data on irrigation water use. In such cases, USGS must make indirect inferences about water use. Comparing USDA data from 2012 and 2017 Agricultural Censuses (closest Census years to 2015) and USGS 2015 estimates, these counties often have large differences in reported irrigated acres from USGS estimates. The USGS estimates of irrigation water use are likely significantly undercounted, which greatly inflates estimates of economic water productivity. For example, it is not reasonable to expect a county's farmers to earn $16,000 per acre foot of water. Values for the counties that account for 99.9% of Basin water use do not suffer from such inconsistencies.

For this current analysis, we also supplemented USGS data from the US Bureau of Reclamation's (USBR) Lower Colorado Accounting System (LCRAS) (USBR, 2015) and data from the Arizona Department of Water Resources (ADWR, 2024a, 2024b). LCRAS estimates are made annually instead of every five years, as the USGS estimates are made. LCRAS reports disaggregated estimates for irrigation districts, cities, Indian reservations, and other entities along the Colorado River mainstem. Also, LCRAS estimates receive significant scrutiny from stakeholders in the region.

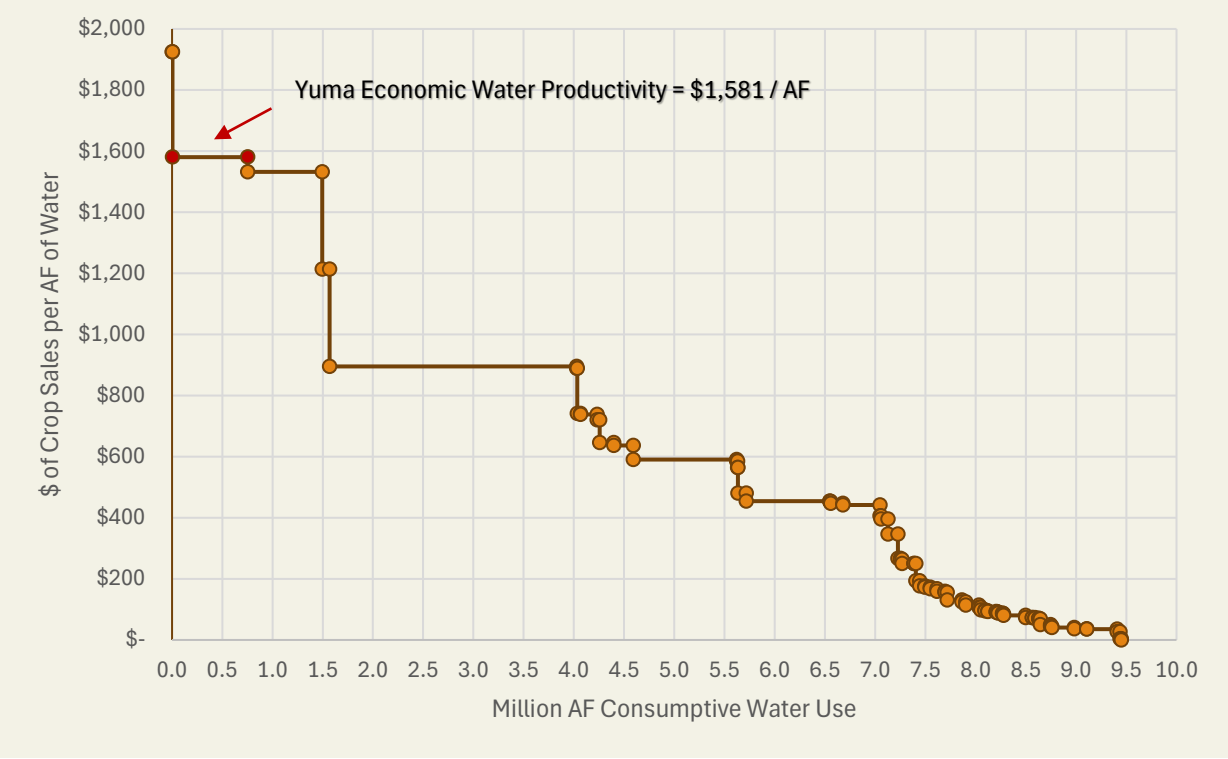
There are significant differences between water use estimates from USGS and LCRAS for Mohave, La Paz, and Yuma Counties in Arizona and for Riverside and Imperial Counties in California. For example, estimates of system irrigation efficiencies (consumptive use divided by withdrawals) from LCRAS were 64% for Yuma, 54% for Mohave County, and 51% for La Paz County for Colorado River surface water withdrawals (the bulk of water use in these counties). USGS estimates of efficiency for all three counties were a uniform 80% applied to all three counties. Separate data from USGS (Knight et al., 2021) and ADWR (ADWR, 2024a, 2024b) support an 80% efficiency assumption for groundwater use in Mohave and La Paz Counties. These efficiencies do not seem accurate for surface water withdrawals along the Colorado mainstem.

While USGS reported 1.5 million acre-feet (maf) of consumptive use for Imperial County, the LCRAS estimates for the Imperial Irrigation District (IID) were more than 2.5 maf. According to the IID website, agriculture accounts for 97% of district water use. Accounting for this would adjust agricultural consumptive use downward, but only to 2.46 maf. Indeed, IID's own reports of its consumptive water use match figures from LCRAS (IID, 2024). Similarly, USGS consumptive use estimates for Riverside County were 0.61 maf, while LCRAS estimates for the Palo Verde Irrigation District and the Coachella Valley Water District combine for a consumptive use total of 0.74 maf.

Considering that LCRAS estimates are done annually instead of every five years, that they rely more on direct estimates based on both measured and simulated return flows, and that they receive regular scrutiny from local water users, we have adjusted estimates of consumptive use for Mohave, La Paz, and Yuma Counties in Arizona and for Riverside and Imperial Counties in California. For Arizona counties, this involved relying on USGS groundwater withdrawal and groundwater use efficiency assumptions, but using LCRAS surface water withdrawal and consumptive use estimates to calculate county totals. This reduced estimates of consumptive use for the three Arizona counties by more than 0.4 maf. Procedures used are provided in more detail in Appendix D. For California counties, we used LCRAS consumptive use estimates for Riverside and Imperial Counties, which exceeded USGS estimates by 1 maf. The estimated consumptive use of water for irrigated crop production for the entire Colorado Basin was nearly 9.5 maf.

Based on these calculations, the economic water productivity of crop production based on gross crop sales (EWP_g,) for Yuma County was $1,581 / AF (Figure 11). The average across the entire Colorado River Basin was $692 / AF. The median value, however, was $176 / AF, meaning half of the counties in the Basin had an EWP_g lower than this value, and half had one higher. Yuma accounted for 18% of crop sales in the Basin, but consumed 8% of the irrigation water. Counties with an EWP_g below $200 / AF consumed 2 maf (22% of the Basin total). Counties with an EWP_g below $750 / AF consumed more than 5.4 maf (57% of the Basin total). Santa Cruz County, Arizona had the highest estimated EWPg in the Basin. USGS estimates of irrigated acres in the county were consistent with USDA NASS estimates, so estimates do not appear to result from data problems with irrigated acreage estimates. The county has wineries as well as greenhouse operations (with relatively higher sales values and low water use), so this may explain the relatively high EWP_g.

Figure 11. Economic Water Productivity (EWP_g) of Colorado River Basin Counties and Cumulative Basin Water Consumption for Irrigation (EWP_g = crop sales per acre foot of irrigation water consumed)



Blue Water Footprint

For this study, we define a county's crop Blue Water Footprint (BWF) as the amount of water consumed to produce $1,000 of crop sales. This is just

$$\boldsymbol{BWF} = 1{,}000 / EWP_g$$

Yuma's BWF is 0.63, meaning that it takes 0.63 acre-feet of water to produce $1,000 in crop sales. The average for the entire basin is 1.44. So, Yuma's BWF is less than half of the Basin average. The median BWF is 5.67, meaning that half the Basin counties consume more than 5.67 acre-feet of water to produce one thousand dollars' worth of crops, while half of the counties use less than 5.67 acre-feet to produce one thousand dollars' worth of crops. Counties with a BWF greater than 10 consumed 1.4 maf (15% of the Basin total, but accounted for just 1% of crop sales). Counties with a BWF greater than 5 consumed 2 maf (22% of the Basin total), but accounted for just 3% of crop sales.

Summary

Separate measures of irrigation productivity – cash rent premiums for irrigated land, economic water productivity, and blue water footprints – all provide evidence that water productivity in Yuma agriculture is high, and much higher in general than in the rest of the Colorado River Basin.

Economic Contribution Analysis

The contribution of agriculture and agribusiness industries to Yuma County's economy goes beyond on-farm production to generate subsequent rounds of economic activity in other industries. This activity is generated when farmers, livestock producers, and agricultural input suppliers purchase inputs for production from other local businesses, as well as when people employed by agricultural producers spend their earnings in the local economy. These effects are known as ***indirect*** and ***induced multiplier effects***.

Indirect effects measure economic activity generated by agriculture and agribusiness operations' demand for inputs or supplies. These effects represent business-to-business transactions that occur in other local non-agricultural industries that provide goods and services as inputs to production and can include expenditures on things such as utilities, insurance, banking, or marketing. Additional rounds of indirect effects occur when these companies purchase inputs from other businesses located in Yuma for their own operations.

Induced effects measure the economic activity generated when households employed by Yuma County farms and agribusiness companies spend their earnings on local goods and services. These effects are the household-to-business transactions that occur in local industries that provide consumer goods and services to households, such as the retail, healthcare, and restaurant industries.

This study uses the IMPLAN input-output model (IMPLAN Group, LLC, 2022) to estimate the total (direct, indirect, and induced effects) contribution of on-farm agriculture, agricultural input suppliers, and university research and Extension to the Yuma County economy in 2022. On-farm agriculture is the production of raw, unprocessed agricultural commodities and agricultural support services related to on-farm production, such as planting and harvesting.[1] Agricultural inputs suppliers include pesticides and fertilizer suppliers, machinery rental and leasing, and veterinary services and supplies.[2] University research and Extension includes activities conducted by the Yuma Agricultural Center (YAC), the Yuma Center of Excellence for Desert Agriculture (YCEDA), and Yuma County Cooperative Extension. We also estimate forward-linked economic activity in Yuma County attributable to agriculture and agribusiness in warehousing and food processing. Finally, we provide estimates of economic activity supported in other Arizona counties attributable to Yuma agricultural industry cluster.

Economic contributions are limited by a phenomenon known as leakage. Leakage occurs when a business purchases inputs or a household purchases consumer goods and services from outside the region, in this case from outside Yuma County. When this occurs, that spending has "leaked" out of the local economy and the circulation of those dollars ceases, resulting in a dampening effect.

Economic contributions can be measured using a series of interrelated metrics. **Sales (or gross output)** is an intuitive measure analogous to the way we transact money in our day-to-day lives. While sales provide an easy-to-understand, cumulative measure of economic activity, it can double count certain transactions that involve local use of locally sourced supplies. This is particularly the case within agriculture because many agricultural products are used as production inputs for other agricultural operations. One of the best examples is the use of locally produced feed crops by the dairy industry. One business' revenues are another's expenditures,

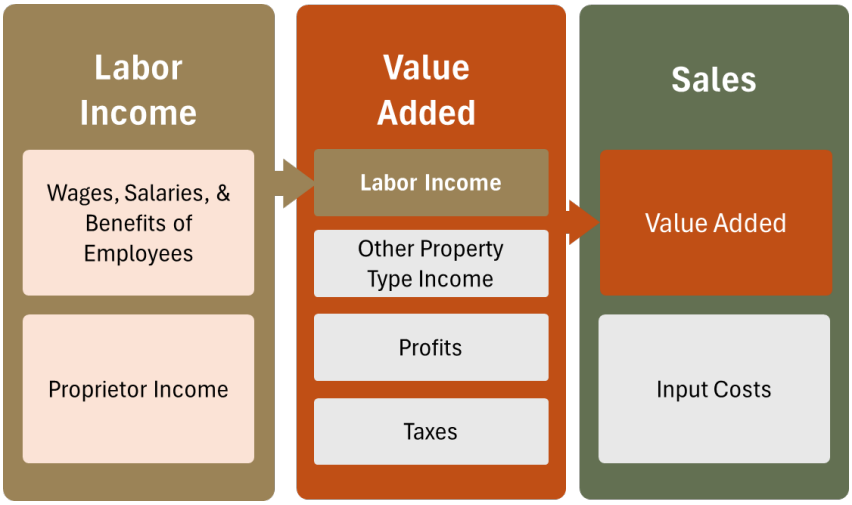
[1] On-farm agriculture in this analysis is defined as NAICS codes 111 (crop production), 112 (animal production and aquaculture), and 115 (support activity for agriculture and forestry).

[2] Agricultural inputs suppliers are defined as NAICS codes 32532 (Pesticide and other agricultural chemical manufacturing), 424910 (Farm Supplies Merchant Wholesalers), 423940 (Veterinarians' equipment and supplies merchant wholesalers), 424210 (Veterinarians' medicines merchant wholesalers), 532490 (Agricultural machinery and equipment rental or leasing), and 541940 (Veterinary Services).

leading to a double counting of the value of the feed when using sales or output as a measure of economic activity.

An alternative measure is **value added** which measures the value created by an industry over and above the cost of inputs to production. It is analogous to gross domestic product (GDP) and only counts the net new value of production that occurs in an economy. Value added includes labor income, other property type income, profits, and taxes. Labor income can further be broken down into wages, salaries, and benefits paid to hired employees, as well as income to proprietors who own businesses. Figure 12 illustrates the relationship between sales, value added, and labor income. Because these measures are interrelated, they are not additive.

Figure 12. Components of Economic Output (Sales)



Direct Contribution of On-Farm Agriculture and Agricultural Input Suppliers

In 2022, the output generated by on-farm agriculture and its suppliers in Yuma County was roughly $2.8 billion, directly contributing $1.2 billion to Yuma County's GDP. On-farm agriculture and agricultural input suppliers directly supported 11,800 jobs. Crop industries[3] contributed approximately $1.3 billion to county output and livestock industries[4] contributed an estimated $167.3 million. Industry sales include the value of agricultural cash receipts and any additional industry sales that are generated by other farm activities. The agricultural support service industry in Yuma County had estimated sales of $411 million in 2022, while the agricultural input suppliers in the county had sales of $943.8 million (Table 7).

[3] Crop industries include grain farming, vegetables and melon farming, fruit farming, cotton farming, and all other crop farming. See Appendix B for more information.
[4] Livestock and poultry industries include beef and cattle ranching, dairy, and other animal production (including poultry and eggs). See Appendix B for more information.

Table 7. Direct Contribution of On-Farm Agriculture and Agricultural Input Suppliers in Yuma County, AZ by Component, 2022

Agricultural Activity	Output (Sales)
Crop Production	$1,339,779,000
Livestock Production	$167,287,000
Agricultural Support Services	$411,057,000
Agricultural Input Industries	$943,835,000
University Research & Extension	$3,809,000
Total	**$2,865,767,000**

Multiplier Effects of On-Farm Agriculture and Agricultural Input Suppliers

Direct sales of crops, livestock, and agricultural inputs only represent a part of agriculture's total contribution to Yuma County's economy. Agricultural sales support indirect and induced multiplier effects, generating additional rounds of business-to-business and household-to-business transactions in the local economy. These transactions support additional sales, value added, income, and jobs in other Yuma County industries. Direct sales of $2.8 billion in 2022 supported an additional $418.8 million in indirect effects and $636 million in induced effects, for a total sales contribution of $3.9 billion (Table 8).

The contribution of on-farm activities and agricultural input suppliers to Yuma County's gross regional product was $1.8 billion including multiplier effects. An estimated 11,800 jobs were directly supported by agricultural industries, whether the jobs were in crop production, livestock production, agricultural support services, or agricultural input supplier industries, providing direct combined labor income of $1 billion. Including direct, indirect, and induced multiplier effects, on-farm agriculture and agricultural input suppliers in Yuma County supported a total of 17,834 jobs in the county and $1.37 billion in labor income in 2022.

Table 8. Economic Contribution of On-Farm Agriculture and Agricultural Input Suppliers to Yuma County Economy, 2022

Effect	Employment	Labor Income	Value Added	Output (Sales)
Direct Effect	11,800	$1,053,105,700	$1,226,163,200	$2,861,957,800
Indirect Effect	2,300	$129,068,800	$206,907,400	$418,808,100
Induced Effect	3,700	$189,610,000	$377,226,800	$636,384,300
Total Effect	17,800	$1,371,784,500	$1,810,297,400	$3,917,150,200

University Agricultural Extension & Research

We estimate the county economic contribution of University of Arizona Cooperative Extension and research activities taking place in Yuma County. Expenditure and employment data provided by the Yuma Agricultural Center (YAC), Yuma Center of Excellence for Desert Agriculture (YCEDA), and Yuma County Cooperative Extension were used to model the economic contribution of operational expenditures, research expenditures, and employee payroll. Table 9 details the estimated economic contribution of these three programs, combined. This economic contribution only relates to the operational and payroll spending of the three University of Arizona programs examined in this report and does not reflect an analysis of the economic effects of any productivity gains (such as higher crop yields) attributable to university research and Extension.

Table 9. Economic Contribution of Yuma County Cooperative Extension, YAC, & YCEDA

Impact	Employment	Labor Income	Value Added	Output
Direct Effect	57	$3,140,200	$3,547,700	$3,809,000
Indirect Effect	1	$26,800	$53,300	$111,700
Induced Effect	9	$446,200	$895,800	$1,496,900
TOTAL	67	$3,613,200	$4,496,800	$5,417,600

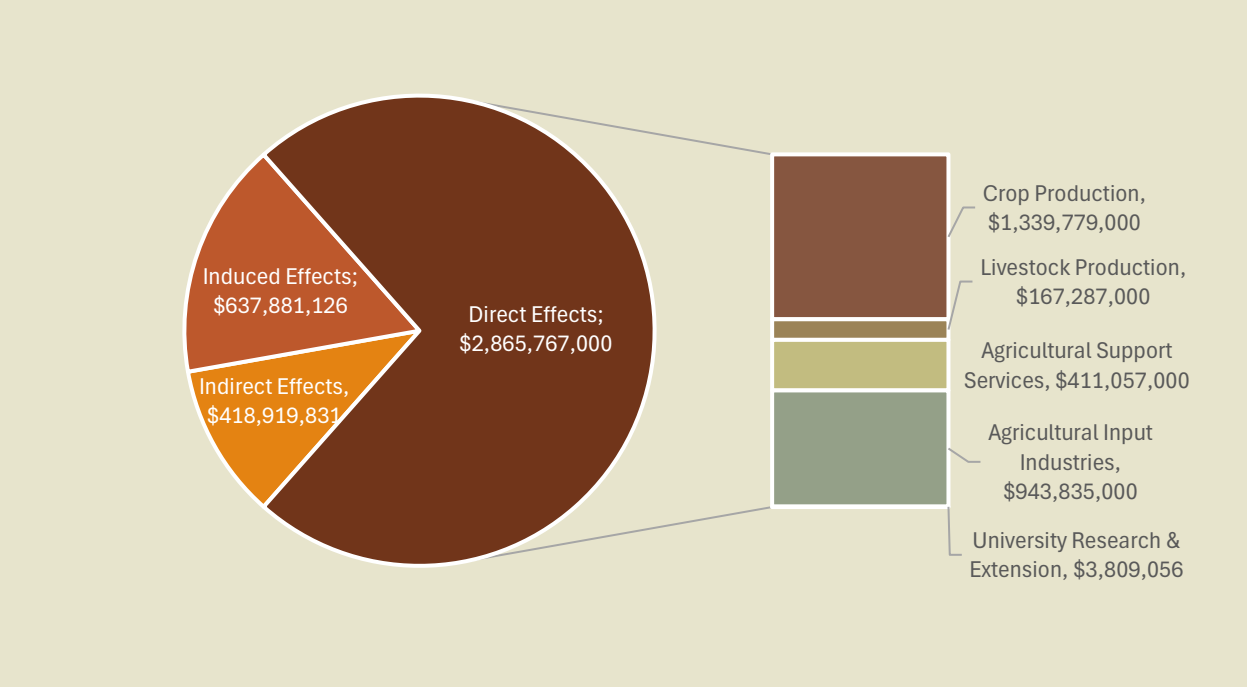
Total Contribution of Yuma County Agricultural & Agribusiness Industry Cluster

Combined, on-farm agriculture, agribusiness, and university research and Extension in Yuma County support $3.9 billion in sales, which represents $1.8 billion in county GDP. This economic activity supports an estimated total of roughly 17,900 jobs in the county economy earning $1.38 billion in labor income (Table 10). Figure 13 presents graphically the relative magnitude of these effects, in terms of sales (output).

Table 10. Total Contribution of Yuma County Agricultural & Agribusiness Industry Cluster to Yuma County Economy

Impact	Employment	Labor Income	Value Added	Output
Direct Effect	11,870	$1,056,245,900	$1,229,711,000	$2,865,766,900
Indirect Effect	2,284	$129,095,600	$206,960,700	$418,917,800
Induced Effect	3,747	$190,056,200	$378,122,500	$637,881,100
TOTAL	17,901	$1,375,397,700	$1,814,794,200	$3,922,565,800

Figure 13. Economic Contribution of On-Farm Agriculture and Agricultural Input Suppliers to Yuma County Sales, 2022



Contribution of Yuma County Agriculture to Other Arizona County Economies

Arizona's agricultural value chains are interconnected across different counties in the state, as well as to other states and foreign countries. The economic contribution of Yuma County agriculture and agribusiness therefore extends beyond the county and supports economic activity in other areas of the state. In this section, we estimate the contribution of Yuma County agriculture to other Arizona counties using a Multi-Regional Input-Output (MRIO) analysis. This method allows us to track how on-farm activities and agricultural input suppliers in Yuma County affect the economies of other counties in Arizona. The revised Yuma County IMPLAN model was used in conjunction with unmodified county models for Arizona's 14 other remaining counties.

In 2022, the economic contribution of Yuma County's agricultural industry to other Arizona counties was estimated at $273.8 million in output (sales), $142.9 million in value added (equivalent to GDP), $74.2 million in labor income, and 988 jobs (Table 11).

Table 11. Economic Contribution of Yuma County Agriculture to Other Arizona Counties, 2022

	Employment	Labor Income	Value Added	Output/Sales
Direct Effect	0	$0	$0	$0
Indirect Effect	553	$48,198,900	$93,756,900	$191,526,500
Induced Effect	435	$26,048,100	$49,234,400	$82,357,900
Total Effect	988	$74,247,000	$142,991,300	$273,884,400

Figure 14. Sales Generated by Yuma Agricultural Activities in Other Arizona Counties, 2022

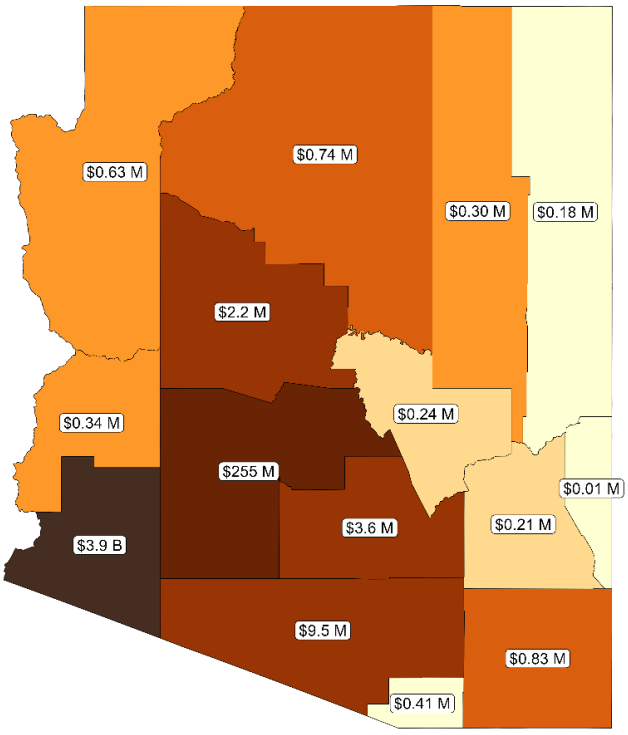
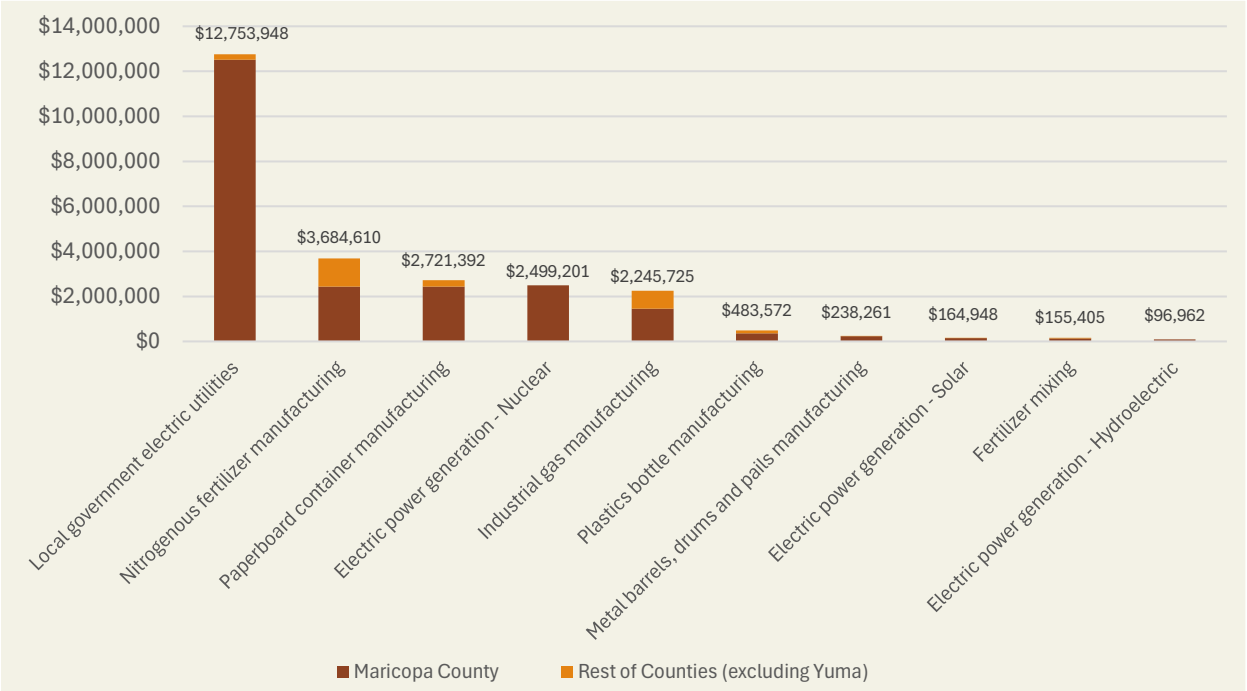


Figure 14 presents the output (sales) impact of Yuma County agriculture to other Arizona counties, including multiplier effects. More than 90% of this activity occurs in Maricopa County, the state leader in population and gross regional product. In 2022, agricultural activity in Yuma County contributed $255 million in sales in Maricopa County.

Counties throughout the state, but particularly Maricopa County, provide key inputs to agricultural production in Yuma County. This includes local government electric utilities[5], fertilizers, paperboard containers, industrial gas, and agricultural chemicals, among other industries (Figure 15).

Figure 15. Top 10 Industries Supported in Arizona but Outside Yuma County by Yuma County Agricultural Production, 2022



In summary, on-farm agriculture and agricultural input suppliers in Yuma County generate a statewide economic contribution of $4.2 billion in sales, $2.0 billion in gross regional product, and support 18,822 jobs generating more than $1.4 billion in labor income (Table 12).

Table 12. Economic Contribution of Yuma Agriculture to Arizona Economy (Including All Counties), 2022

	Employment	Labor Income	Value Added	Output (Sales)
Direct Effect	11,813	$1,053,105,700	$1,226,163,200	$2,861,957,800
Indirect Effect	2,836	$177,267,700	$300,664,300	$610,334,600
Induced Effect	4,173	$215,658,100	$426,461,300	$718,742,200
Total Effect	18,822	$1,446,031,500	$1,953,288,800	$4,191,034,600

Forward-Linked Economic Activity

In addition to on-farm agriculture, a sophisticated cluster of businesses helps bring agricultural commodities produced in Yuma County to the market. The highly perishable nature of leafy greens and certain other fresh vegetable commodities grown in Yuma County requires an uninterrupted cold chain post-

[5] *Local government utilities* is one of the sectors in other areas other state most connected with Yuma County agriculture, particularly in Maricopa County. This is explained by the configuration of utility service areas in the state. Irrigated agriculture requires pumping water which can be energy intensive. Yuma falls within the service area of Arizona Public Service (APS), a publicly-traded electric utility headquartered in Phoenix (in Maricopa County).

harvest. This involves businesses engaged in post-harvest activities such as pre-cooling, processing, packing, cold storage, and refrigerated transportation (Kerna, et al., 2017). The presence of these forward-linked industries in the county is attributable in part to agriculture, and they constitute a part of the county's fresh produce industry cluster. For purposes of this analysis, we consider refrigerated warehousing and storage (NAICS 493120) and perishable prepared food manufacturing (NAICS 311991) as forward-linked industries in Yuma County's agricultural cluster (Table 13). Refrigerated warehousing includes operations involved in cold storage of perishable agricultural commodities such as leafy greens. Perishable prepared food manufacturing involves processing commodities such as lettuce into value-added bagged salads, shredded lettuce, and other preparations for retail, wholesale, and foodservice customers. While transportation is a critical component of the value chain, due to the mobile nature of operations, it is difficult to determine where operations and employment are based and therefore transportation is not included in this analysis.

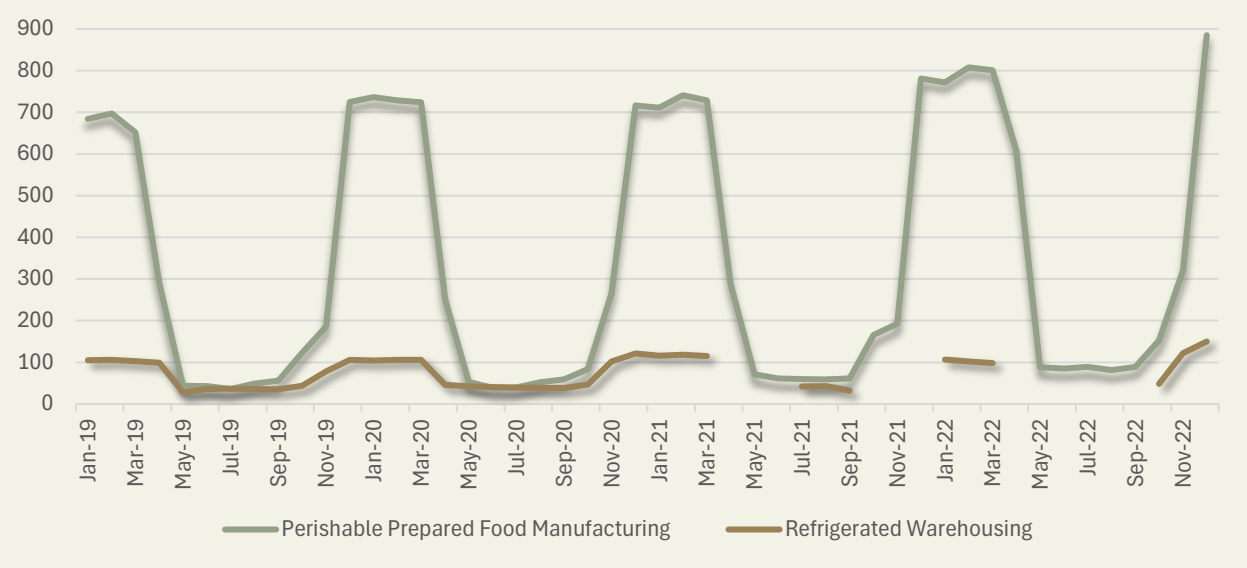
Table 13. Forward-Linked Industries in Yuma County, 2022

Industry	Establishments	Employment
NAICS 493120 Refrigerated warehousing and storage	7	75
NAICS 311991 Perishable prepared food manufacturing	4	398

Source: BLS QCEW (2023)

Employment in both refrigerated warehousing and perishable prepared food manufacturing in Yuma County exhibit strong seasonal trends mirroring the production and harvest of winter vegetables in Yuma County (Figure 16). In fact, sophisticated production lines for processing leafy greens are assembled for the winter

Figure 16. Monthly Employment, Refrigerated Warehousing & Storage and Perishable Prepared Food Manufacturing, 2019-2023, Yuma County, AZ



Source: BLS QCEW (2023)

production season in Yuma County, then disassembled, transported, and reassembled in California's central valley for the summer production season (Kerna et al., 2017).

Forward-Linked Economic Activity in Yuma County

The economic contribution of forward-linked industries, which includes refrigerated warehousing and perishable prepared food manufacturing, was modeled using wage data from the QCEW (BLS, 2024). Wages and salaries were converted to labor income using IMPLAN's Wage and Salary / Employee Compensation Conversion reference (IMPLAN Group, LLC, 2024) and then modeled as industry output changes in 'Warehousing and storage' and 'All other food manufacturing', setting local purchase percentages to zero for all agricultural industries and for both respective industries. The economic contribution of these forward-linked industries is presented in Table 14.

Table 14. Economic Contribution of Forward-Linked Industries in Yuma County

Impact	Employment	Labor Income	Value Added	Output
Direct Effect	529	$28,675,200	$37,791,100	$188,489,500
Indirect Effect	220	$12,807,400	$20,318,600	$43,146,500
Induced Effect	133	$6,832,100	$13,500,300	$22,824,900
Total	882	$48,314,700	$71,610,000	$254,460,900

Transportation services are involved throughout the fresh produce value chain. Some are captured in backward-linked industries supplying services as inputs to on-farm production and agricultural support services. Others are captured through the subsequent analysis of the value of wholesale, retail, and foodservice services supported in the U.S. economy by produce originating in Yuma. While captured indirectly, the contribution of transportation services is not explicitly estimated in this analysis due to the difficulty of determining where individual operators are based and where the corresponding economic activity would be registered.

National Forward-Linked Economic Activity

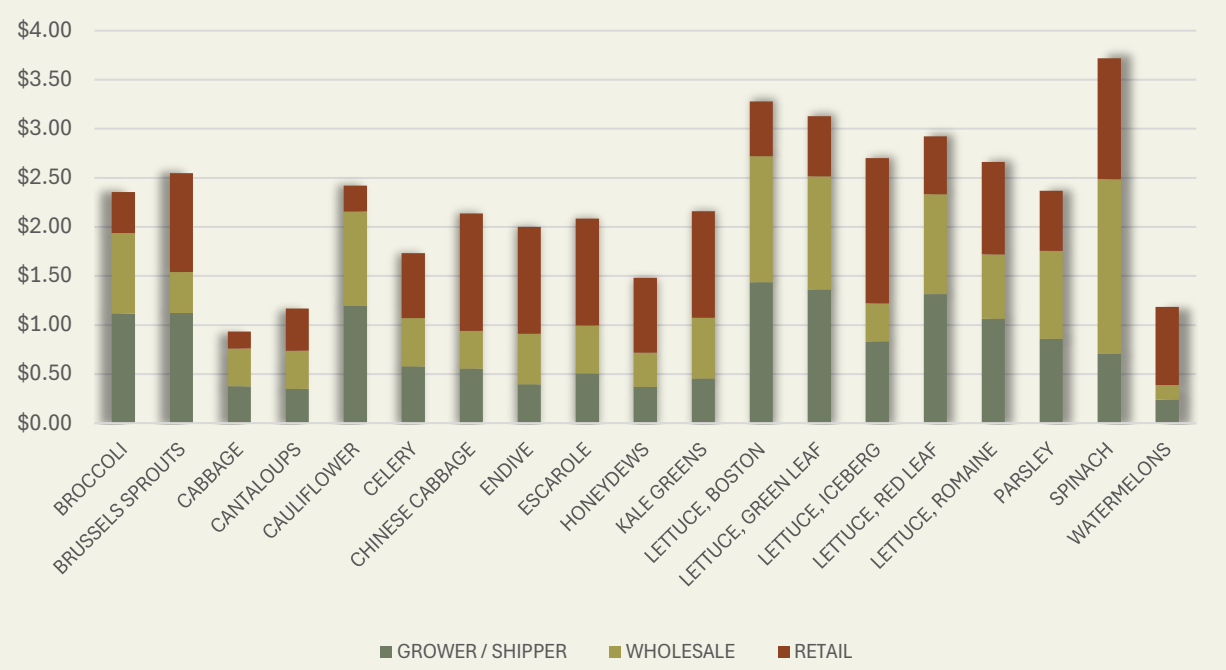
Agricultural commodities produced in Yuma County, particularly fresh produce commodities, go on to be distributed throughout the United States and beyond. These commodities are brought to market by wholesalers, retailers, and foodservice establishments as produce, value-added products, or as ingredients to transformed final products. For example, lettuce may be sold as-is, as part of a bagged salad mix, or as part of a prepared meal. To deliver these products from the farm to customers requires the services of wholesalers, retailers, and foodservice establishments. In providing their services, these establishments incur expenses and add value. The economic activity that occurs delivering Yuma County produce to end customers can be estimated using a price margin approach.

Weekly shipping point, terminal market, and retail prices were retrieved for top specialty crops produced in Yuma County (Table 15). To estimate the price margin between each step in the value chain, the set of weekly prices were converted to a per-pound basis and differenced, yielding a farm to wholesale price margin and a wholesale to retail price margin per pound of produce for each week of the year (Figure 17).

Table 15. Specialty Crops Examined in Wholesale, Retail, & Foodservice Analysis

BROCCOLI	ESCAROLE	LETTUCE, ROMAINE
BRUSSELS SPROUTS	FRISEE	LETTUCE, OTHER
CABBAGE	HONEYDEWS	MIXED AND MISC MELONS
CANTALOUPS	KALE GREENS	PARSLEY
CAULIFLOWER	LETTUCE, BOSTON	RADICCHIO
CELERY	LETTUCE, GREEN LEAF	SPINACH
CHINESE CABBAGE	LETTUCE, ICEBERG	SWISS CHARD
ENDIVE	LETTUCE, RED LEAF	WATERMELONS, SEEDLESS

Figure 17. Estimated Price per Pound (Conventional / Non-Organic) for Selected Yuma County Specialty Crops by Grower/Shipper, Wholesale, & Retail Components, 2022

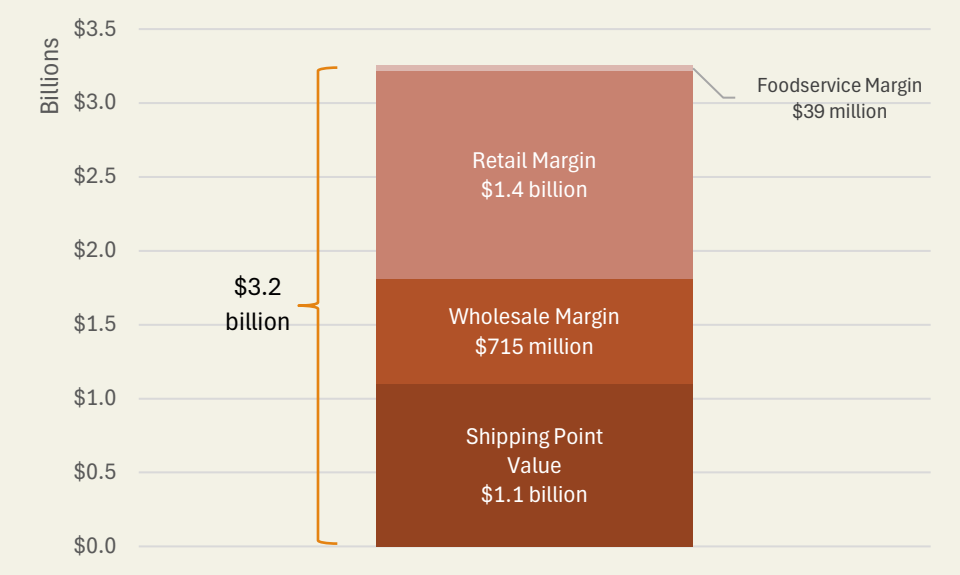


Source: USDA AMS, Author Calculations

To estimate the total economic activity occurring bringing these commodities to market, estimated price margins were applied to volume of movements from Western Arizona (USDA AMS, 2024), while applying a downward adjustment to volume of movements to account for losses, shrinkage, and spoilage (USDA ERS, 2024). Price margins were calculated separately for both organic and conventional produce when sufficient data were available. As feasible, the separate margins were applied to organic produce originating in Yuma County. When organic price margins were not feasible to calculate, conventional (non-organic) margins were used for organic produce. Based on input from growers, it is estimated that 100% of produce originating in Yuma goes through wholesale, and from there 80% goes on to retail while the remaining 20% is destined for foodservice. To estimate the economic activity generated by produce at foodservice establishments, a gross profit margin of 11.6% for *Food services and drinking places* (NAICS 722) (BEA, 2022) in 2019 was applied to the estimated share of produce going to foodservice. This is based on the assumption that lettuce, for example, is not sold as-is at foodservice, but rather as part of a transformed

final product, therefore the profit margin is applied to the value of the produce purchased as inputs by foodservice establishments. Figure 18 presents estimated economic activity occurring within the wholesale, retail, and foodservice industries as a result of taking Yuma County-produced specialty crops to market. An estimated $715 million is supported in wholesale industries nationally, $1.4 billion in retail industries, and $39 million in foodservice. These estimates implicitly reflect transportation services expenditures incurred in transporting produce to market through these three market channels.

Figure 18. Forward-Linked Retail, Wholesale, & Foodservice Output from Top Yuma County Specialty Crops, 2022



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Appendices

Appendix A. Estimating Agricultural Industry Sales in Yuma County

Agricultural production in Yuma County includes a number of large operations that exclusively operate in certain industries, therefore for purposes of maintaining the confidentiality of individual operations, government statistics do not disclose certain data points for the county. It was therefore necessary to estimate the output or sales of certain components of Yuma County's agricultural industry. This was achieved using data from the Census of Agriculture and the Bureau of Economic analysis, as well as publicly disclosed information on individual operations. Table A1 presents published data and the estimates modeled in this analysis.

Table A1: Agricultural Sales Statistics & Estimates

2022 Census of Agriculture Sectors	IMPLAN Sectors	Yuma County Sales (2022 Census)	Estimated / Modeled
Grains, oilseeds, dry beans, & dry peas	Grain farming	$55,094,000	$55,094,000
Vegetables, melons, potatoes, & sweet potatoes	Vegetable & melon farming	$1,129,444,000	$1,129,444,000
Fruits, tree nuts, & berries	Fruit farming	$56,649,000	$56,649,000
Cotton & cottonseed	Cotton farming	$14,109,000	$14,109,000
Other crops & hay	All other crop farming	$84,483,000	$84,483,000
Cattle & calves / Milk from cows	Beef cattle ranching & farming, including feedlots & dual-purpose ranching & farming / Dairy cattle & milk production	(D)	$166,458,000
Poultry & egg production	Other animal production, (including & poultry and eggs)	$58,000	$829,000
Hogs & pigs		$28,000	
Sheep & goats		$64,000	
Horses		(D)	
Aquaculture		--	
Other animals & other animal products		$679,000	
Other Sectors	**IMPLAN Sectors**		**Estimated / Modeled**
Ag Support Services	Ag Support Services		$411,056,722
Chemicals	Pesticide and other agricultural chemical manufacturing	--	$743,651,050
Fertilizer, lime, & soil conditioners	Wholesale - Other nondurable goods merchant wholesalers	--	$162,412,690
Rent and lease expenses for machinery, equipment, & farm share of vehicles	Commercial and industrial machinery and equipment rental and leasing	--	$27,876,000
Medical supplies, veterinary, & custom services for livestock	Veterinary services	--	$1,811,153
	Wholesale - Professional & commercial equipment & supplies (Veterinarians' equipment & supplies merchant wholesalers)	--	$2,852,264
	Wholesale - Drugs & druggists' sundries (Veterinarians' medicines merchant wholesalers)	--	$5,231,948

Appendix B. IMPLAN Model Customizations

Data from the IMPLAN Pro 2022 model for Yuma County were used to estimate the contribution of agriculture to the Yuma County economy. However, modifications were made to the model to more accurately capture the economic activity taking place on Yuma County farms.

First, agricultural output figures were updated in the model to reflect data from the 2022 Census of Agriculture, as detailed in Appendix A. Sales for agricultural support services and agricultural input suppliers were estimated using the ratio of employee compensation to output from IMPLAN and industry-specific employee compensation from the Bureau of Labor Statistics Quarterly Census of Employment and Wages and the Bureau of Economic Analysis. Employment numbers by industry were modified in the model to better reflect publicly available data as detailed in Appendix C. Intermediate expenditure and value-added shares were modified to reflect 2022 Census of Agriculture shares, with intermediate expenditures calculated using state-level production expenses by industry as follows:

$$IE = Total\ Expenses - (Hired\ Farm\ Labor + Contract\ labor + Customwork\ and\ custom\ hauling + Property\ Taxes + All\ other\ production\ expenses)$$

Default industry spending patterns in IMPLAN were modified to better reflect production practices in Arizona. Default production functions in IMPLAN are based on national average production practices which include a combination of irrigated and dryland farming. Meanwhile, virtually all crop production in Yuma County is irrigated. Data on farm production expenses were not available at the county level, so state-level production expenses from the Census of Agriculture were used. Due to the significant share of state production represented by Yuma County, particularly in the vegetable and melon industry, state-level production functions should be representative of cultivation practices in Yuma.

IMPLAN's model does not count corporate profits as part of the 'Proprietor Income' category. Instead, it includes it within the 'Other Property Income' category, which by default has higher levels of leakage to other regions compared with Proprietor Income. However, in the case of Yuma, many of the farms are family-held corporations, and consequently, there is a high probability that the income generated by these family-held corporations will be spent within Yuma County. This might cause an underestimation of induced effects in the region. To account for this within the IMPLAN model, we used data on the legal status of farms provided by the 2022 Census of Agriculture. Specifically, we calculated the ratio of acreage in non-family held corporations to total farm acreage in Yuma, understanding that only non-family held corporations should be accounted in the "Other Property Income" category. This ratio was used to redistribute the default values of Proprietor Income (90%) and Other Property Income (10%) categories across agricultural industries (all crop and livestock producing industries) in IMPLAN.

Finally, local purchase percentages were set to zero for all the agricultural industries listed in Table A1 to keep total output in each industry at its reported level. The model with modified regional data and industry production functions was run as a series of industry contribution events.

Appendix C. Employment Estimates

Employment in the agricultural industry cluster includes farm proprietors, directly hired farm labor, agricultural support service workers, and farm input suppliers' employees. The Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW) reports data on monthly jobs and quarterly salaries paid out to workers by six-digit NAICS code. The annual average number of hired workers in agriculture in Yuma County in 2022 was 10,261. However, this does not include data on farm proprietors. To account for farm proprietors in our estimates, we assume that each farm operation represents a single proprietor. The Census of Agriculture reported 378 farms in Yuma County. Thus, 378 proprietors were added to the 10,261 hired workers within their respective industries, totaling 10,795 on-farm employees. Data on agriculture input suppliers' employment were retrieved from QCEW and complemented with IMPLAN data. Including on-farm activities and agricultural input suppliers, total estimated employment within the agricultural industry cluster in Yuma County was 11,813 in 2022. Table C1 reports estimated employment by sector.

Table C1. Estimated Yuma County Agricultural Industry Cluster Employment, Including Proprietors

IMPLAN Code	IMPLAN Description	Employment Estimates (2022)
	Total agricultural employment	***11,813***
	Crop production	***3,198***
2	Grain farming	108
3	Vegetable and melon farming	2,318
4	Fruit farming	315
8	Cotton farming	66
10	All other crop farming	391
	Livestock production	***269***
11-12	Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming/ Dairy cattle and milk production	198
13	Poultry and egg production	0
14	Animal production, except cattle (including poultry and eggs)	71
19	***Support activities for agriculture and forestry***	***7,328***
	Agricultural Input Suppliers	***1,018***
170	Pesticide and other agricultural chemical manufacturing	563
400	Fertilizer, lime, and soil conditioners	342
453	Agricultural machinery and equipment rental or leasing	72
467	Veterinary services	22
393	Veterinarians' equipment and supplies merchant wholesalers	11
397	Veterinarians' medicines merchant wholesalers	8

Source: Author's calculations based on data from U.S. Department of Labor, BLS, 2022 (on-farm employment), Census of Agriculture, 2022 (number of farms as a proxy for number of proprietors). Non-disclosed data were estimated.

Appendix D. Calculating Agricultural Consumptive Use of Water along the Colorado River Mainstem

For Imperial and Riverside Counties, estimates of consumptive use were based on 2015 LCRAS data (LCRAS, 2015). For Riverside County, total consumption was calculated as the sum of consumptive use by the Palo Verde Irrigation District (399,031 AF) and the Coachella Valley Water District (342,068 AF), for a total of 741,099 AF. For Imperial County, consumptive use estimates for the Imperial Irrigation District (IID) were added to consumptive use estimates of Yuma Project Reservation Division (Bard Units and Indian Units) (47,621 AF) and other Imperial County users below Imperial Dam (5,812 AF). As IID reports that 3% of its water deliveries are for non-agricultural uses, IID agricultural consumptive use was estimated to be 2,480,933 × 0.97 = 2,406,505 AF. This places total Imperial County agricultural consumptive use at 2,459,938 AF.

In Yuma County, entities withdrawing water, based on LCRAS data, included Gila Monster Farms, Wellton-Mohawk Irrigation and Drainage District (IDD), the University of Arizona, North Gila Valley Irrigation District, Yuma Irrigation District, Yuma Mesa IDD, Unit "B" IDD, Fort Yuma Indian Reservation, Yuma County Water Users' Association, Cocopah Indian Reservation, and other small-scale users below Imperial Dam. Total consumptive use was estimated to be (from these sources combined) 663,381 AF. USGS estimated that Yuma County had 120,282 AF of groundwater withdrawals in 2015. LCRAS reports on water pumped from shallow wells adjacent to the Colorado River (and treated as Colorado River water for accounting purposes). This total, 14,106 AF, was deducted from the USGS 120,282 AF groundwater withdrawals estimate. USGS assumed an irrigation efficiency of 0.80 for all water withdrawals from Yuma County. This 80% was applied to off-river groundwater withdrawals in the county for an estimated groundwater consumptive use of 0.8 × (120,282–14,106) = 84,941 AF. Combined on-river and off-river consumptive use was estimated to be a total of 748,322 AF for Yuma County.

For Mohave County, USGS total county withdrawals were estimated to be 122,367 AF, while LCRAS on-river withdrawals were 98,714 AF. The difference, 23,653 AF, matches almost exactly groundwater withdrawals from Mohave County's Hualapai Valley groundwater basin. For Mohave County, LCRAS consumptive use estimates of 52,945 AF were combined with consumptive use estimates for the Hualapai Valley. Here the USGS-assumed (Dieter et al., 2018) 0.8 efficiency estimate was applied to the 23,653 AF for a groundwater consumptive use of 18,923 AF.

For La Paz County, on-river consumptive use was estimated from use by the Colorado River Indian Reservation, Cibola Valley IDD, the Hopi Tribe, GSC Farm, LLC, Rayner Ranch, and some minor users between Parker and Imperial dams. This consumptive use totaled 316,842 AF. USGS estimates of total county water withdrawals exceeded LCRAS estimates of on-river withdrawals by 67,959 AF. This closely matches separate estimates of off-river groundwater withdrawals in the county's Butler Valley and McMullen Valley (ADWR 2024a, 2024b). The USGS estimates of 0.8 irrigation efficiency for these basins match almost identically with ADWR estimates. Applying 0.8 × 67,959 = 54,367 AF. Combined La Paz County consumptive use on-river and in the Butler and McMullen Valleys is estimated to be 371,209 AF.

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