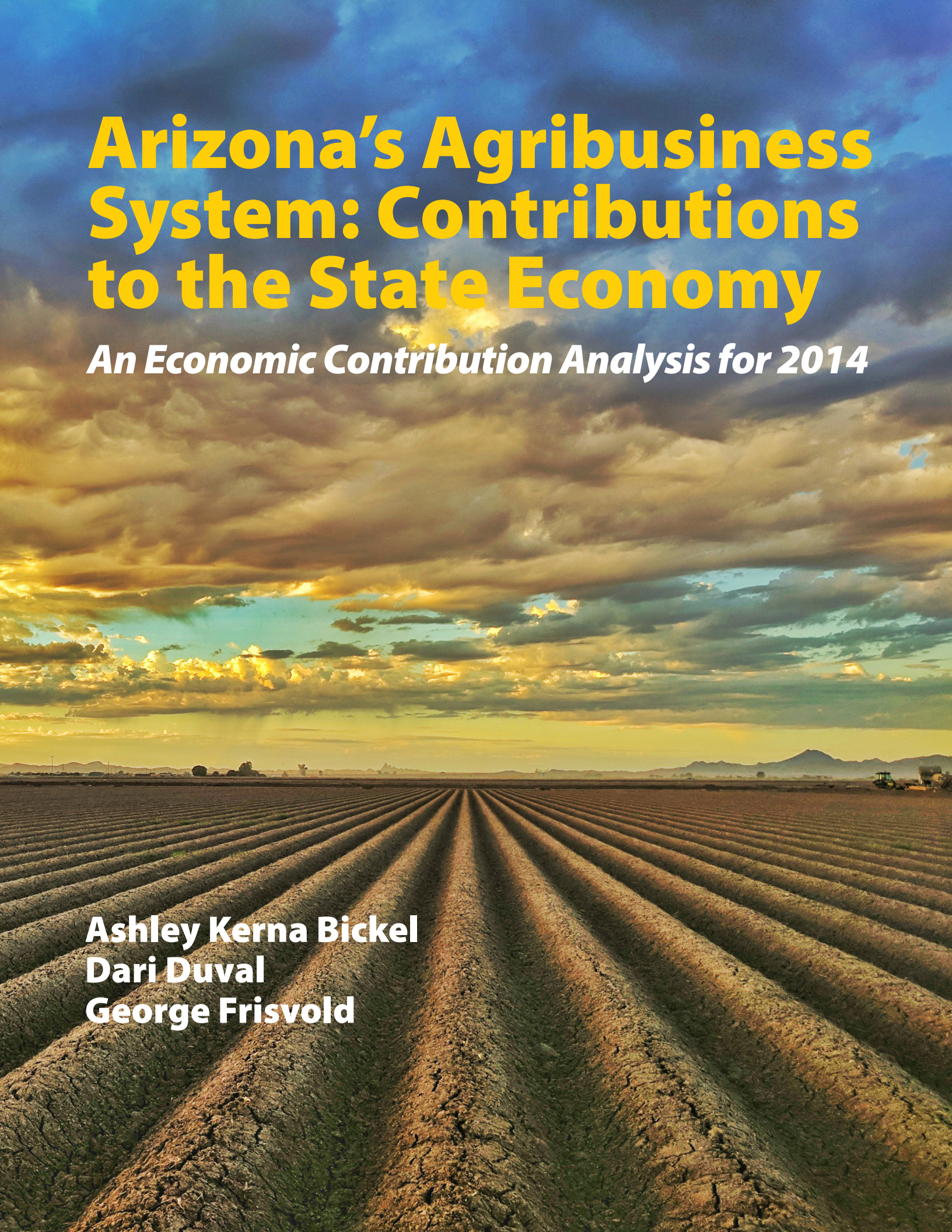

Arizona's Agribusiness System: Contributions to the State Economy

An Economic Contribution Analysis for 2014

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Executive Summary

What Is the Issue?

- The contribution of Arizona agriculture to the state economy extends beyond the commodities produced on farms and ranches across the state. On-farm production is just one part of an entire system of industries involved in and connected with agriculture in Arizona. Estimating the full contribution of agriculture to the state economy warrants an examination of the entire agribusiness system in Arizona.
- Arizona's **agribusiness system** includes crop and livestock industries, industries that supply and support on-farm production, agricultural (food and fiber) processing industries, and industries involved in the marketing and distribution of agricultural products.
- In addition to the agribusiness system's ***direct effects*** on the Arizona economy, a "ripple" of economic activity is stimulated in other industries outside of the agribusiness system to meet the demands of agricultural producers, suppliers, processors, and households that derive their income from agribusinesses. Economists call these ***indirect*** and ***induced multiplier effects***.
  - ***Indirect effects*** measure the economic activity generated by agribusiness's demand for inputs or supplies. These effects occur in other, non-agricultural industries that provide goods and services as inputs to Arizona agribusinesses, such as the transportation, telecom, or banking industries.
  - ***Induced effects*** measure the economic activity generated when households employed by Arizona agribusinesses spend their earnings on Arizona goods and services. These effects occur in industries that provide consumer goods and services to households, such as the retail, healthcare, and restaurant industries.
- This study conducts an economic contribution analysis for the 2014 calendar year and estimates the ***direct***, ***indirect***, and ***induced effects*** of Arizona's agribusiness system to the state economy. Economic contributions are reported in terms of sales, value added (contribution to gross state product [GSP]), incomes, and number of full- and part-time jobs.

What Did the Study Find?

Including direct, indirect, and induced effects, the total contribution of Arizona's agribusiness system to state sales was an estimated $23.3 billion in 2014.

- Of this $23.3 billion in total sales:
  - $5.5 billion was directly contributed by primary agriculture—crop production, livestock production, and agricultural support service industries, such as farm labor contracting.
  - $9.3 billion was directly contributed by agricultural input manufacturing, agricultural processing, and agricultural marketing and distribution.
  - $8.5 billion was generated in the Arizona economy through indirect and induced effects.

In 2014, the agribusiness system directly and indirectly supported an estimated 138,000 full- and part-time jobs and more than 162,000 unique workers.

- Of these 138,000 jobs:
  - On-farm labor in primary agriculture accounted for more than 58,000 jobs.
  - An additional 19,000 jobs were supported in agricultural input manufacturing, agricultural processing, and agricultural marketing and distribution.
  - More than 60,000 jobs were supported by spending on inputs purchased from other industries by agribusiness enterprises (***indirect effects***) and spending of agribusiness profits and wages (***induced effects***).
- The number of unique farm workers hired by Arizona farms and ranches is greater than the number of jobs. Recent research from California found an average of two unique farm workers for each year-round, full-time equivalent hired farm job. Assuming this relationship holds for Arizona—which has similar production systems—the number of unique hired workers would be 49,378, resulting in a total of 162,982 unique workers supported by the Arizona agribusiness system.

Using the standard metric for measuring the size of a state economy, gross state product (GSP), the agribusiness system directly contributed an estimated $4.3 billion to Arizona's total GSP of $281 billion in 2014.

- The state's top five agribusiness industries, in terms of their direct contribution to GSP, were agribusiness wholesale, agricultural support services (largely farm labor contracting and harvesting activities), dairy cattle and milk production, beef cattle ranching, and fluid milk manufacturing. Rounding out the top ten in value-added contribution were vegetable and melon farming, bread and bakery manufacturing, other snack food manufacturing, dog and cat food manufacturing, and hay and all other crop farming (which in Arizona is largely alfalfa and other forage).

In 2014, including multiplier effects, the agribusiness system directly and indirectly supported $5.6 billion in labor income, the wages, salaries, and benefits paid to workers and the incomes earned by business owners.

- Approximately $1.5 billion in income was earned by individuals that work on farm, whether they work in the crop, livestock, or agricultural support service industries.
- Another $1.2 billion in income was paid to individuals that work in agricultural input manufacturing, agricultural processing, or agricultural marketing and distribution.
- $2.9 billion in income was supported in other Arizona industries through indirect and induced effects.

Arizona is a national leader in the production of many agricultural commodities. In 2014…

- Arizona ranked second in the nation for the production of lettuce, spinach, broccoli, and cauliflower, providing 25%, 21%, 4%, and 11% of the nation's production, respectively.
- Arizona produced 28% of the nation's production of cantaloupe and 22% of the nation's production of honeydew.
- Arizona ranked third in the nation for the production of durum wheat (wheat used to make pasta), accounting for 16% of national production, and fourth in the nation for the production of pecans, accounting for 8% of national production.
- Arizona ranked second in the nation for production of Pima cotton and tenth for the production of upland cotton.
- Arizona ranked eleventh in the nation for cattle on feed and twelfth in the nation for milk production.

A majority of agricultural producers in Arizona are small-scale producers, both in terms of acreage and annual sales.

- According to the 2012 Census of Agriculture, approximately 60% of Arizona's agricultural operations had less than 10 acres in production and 87% of Arizona's agricultural operations had annual sales receipts of less than $25,000.

A large majority of Arizona's agricultural production comes from just a few farms.

- In 2012, 10 operations accounted for one-quarter (25%) of Arizona's agricultural sales; 46 operations accounted for 50% of all sales; and 168 operations accounted for 75% of all sales. Less than 1% of farms accounted for 75% of Arizona agricultural sales, with 99% of farms accounting for the remaining 25% of the state's agricultural sales.
- In 2012, three Arizona counties (Maricopa, Yuma, and Pinal) accounted for more than 75% of the state's agricultural production.

The types of agricultural commodities produced in Arizona vary across the state, with some regions more heavily involved in livestock production and other regions more heavily involved in crop production.

- Northern Arizona primarily consists of counties with the majority of their agricultural sales coming from livestock production and is an area that has a higher proportion (more than 50%) of principal operators that are women and/or Native Americans.
- Central Arizona is known for both livestock and dairy production, with Maricopa and Pinal counties ranked in the top 1% of U.S. counties for milk sales and cattle inventories in 2012.

- With the exception of Santa Cruz County, which is largely a livestock-producing county (with more than 85% of the county's total market value of sales coming from livestock), counties in southern Arizona are characterized by higher levels of crop production.
- Finally, western Arizona is largely a crop producing region, and is home to Yuma County, one of the leading U.S. counties in the production of leafy greens and other vegetables.

How Was the Study Conducted?

- To fully account for the wide range of agriculture-related businesses in the state, the agribusiness system includes primary agriculture (crop, livestock, and agricultural support service industries), agricultural input manufacturing, food and fiber processors, and specialized, agricultural marketing and distribution industries. In this study, the definition of the agribusiness system has been slightly expanded from previous studies to include agriculture-related economic activity taking place within the larger warehousing, wholesale, and retail industries. *The results of this analysis are not directly comparable to past years' results due to these adjustments.* A more detailed discussion of the agribusiness industries included in the economic contribution analysis is provided in the Appendix.
- The contributions of Arizona's agribusiness system to the state economy were modeled in IMPLAN 3.1. The model was customized using the best available, most recent data to more accurately reflect production practices in Arizona and economic conditions in 2014. Data and research methods used to estimate the contribution of the agribusiness system are presented in the Appendix.

Introduction

Agriculture has long been an important part of Arizona's economy. Historically, the "five Cs" were used to characterize the state's economy: cattle, citrus, climate, copper, and cotton. Today, cattle, citrus, and cotton are still important to the state's agricultural economy, while climate provides a suitable environment for the production of a variety of other agricultural commodities, including vegetables, melons, durum wheat and pecans. Production of many of these crops in Arizona is highest in the winter, when it is too cold for agricultural production in other parts of the country. This makes Arizona a strategic location for production of many agricultural commodities.

In 2014, Arizona ranked second in the nation for the production of lettuce, spinach, broccoli and cauliflower. In that year, Arizona accounted for 25% of the nation's production of lettuce, 21% of the nation's production of spinach, 4% of the nation's production of broccoli, and 11% of the nation's production of cauliflower. Arizona not only plays a significant role in the overall volume of vegetable production nationally, it also plays a critical role in providing a year-round supply of vegetables, particularly lettuce. During the winter months, from the first week of December 2014 to the first week of March 2015, 82% of the nation's lettuce was shipped from Arizona, primarily Yuma County (Kerna et al., 2017). Arizona is also an important producer of melons, accounting for 28% and 22% of the nation's production of cantaloupe and honeydew, respectively. Arizona also ranked third in the nation for the production of durum wheat (wheat used to make pasta), accounting for 16% of national production, and fourth in the nation for the production of pecans, accounting for 8% of national production (USDA, NASS, 2014).

While Arizona agriculture has diversified over the course of the twentieth century, cotton, cattle, and citrus still remain important parts of Arizona agriculture. Arizona is known for its high cotton yields, ranking second in the nation in yield per acre for Pima and upland cotton in 2014. In the same year, Arizona ranked second in the nation for production of Pima cotton and tenth for the production of upland cotton (USDA, NASS, 2014). Turning to livestock production, in 2014, Arizona ranked eleventh in the nation for cattle on feed and twelfth in the nation for milk production (USDA, NASS, 2014). Two of Arizona's counties, Maricopa and Pinal, ranked in the top 1% of U.S. counties for milk sales and cattle inventories in 2012 (USDA, NASS, 2014). Finally, as one of only four states producing citrus (Arizona, California, Florida, and Texas), Arizona accounted for 8% of the nation's production of lemons (USDA, NASS, 2014).

A national leader in the production of many agricultural commodities, it is clear that agriculture is an important economic activity in Arizona. Agriculture contributes to the state economy by growing and selling agricultural products, supporting jobs and incomes for workers, and contributing to the gross state product (GSP), the state equivalent of the gross domestic product (GDP). Yet the contribution of agriculture to the state economy extends beyond the commodities produced on farms and ranches across the state. Arizona has an entire agribusiness system composed of industries involved in agriculture-related activities, of which on-farm production is only one. Estimating the full contribution of agriculture to the state economy, therefore, warrants an examination of the entire **Arizona agribusiness system**.

Arizona's agribusiness system includes primary agriculture,[1] agricultural input manufacturers that provide supplies and equipment to producers, industries that process agricultural commodities, and industries that facilitate the distribution of agricultural products to their end users. Industries that provide inputs or supplies to agricultural production include fertilizer manufacturers and farm equipment manufacturers, among others. Agricultural processing industries are businesses that process and pack agricultural products, also known as food and fiber processing industries. These include fluid milk manufacturers, animal product processors, frozen food manufacturers, and yarn, fiber, and thread mills, among others. Finally, there are several industries involved in distributing agricultural products

1 Primary agriculture includes activities that take place on farm, such as crop production (NAICS 111), animal production (NAICS 112), and agricultural support service industries (NAICS 115) that provide on-farm support and services such as farm labor contracting, soil preparation, aerial crop dusting, or livestock breeding services. The NAICS (North American Industry Classification System) identifies businesses based on the activities in which they are primarily engaged.

(supplies and final goods) such as refrigerated warehousing, agribusiness wholesalers, and fruit and vegetable markets.[2] This study examines the contribution of this entire agribusiness system to the state economy.

In addition to the ***direct effects*** from the agribusiness system, economic activity is stimulated in other non-agribusiness industries to meet the demands of agricultural producers, suppliers, processors, and households. Economists call these ***indirect*** and ***induced multiplier effects***.

The first set of effects, ***indirect effects***, measures the economic activity generated by agribusiness's demand for inputs or supplies. These effects occur in other, non-agricultural industries that provide goods and services as inputs to Arizona agribusinesses. For example, industries that provide water, electricity, gas, and banking services supply critical inputs to agribusiness firms. Yet, these industries are not exclusively agricultural. They also provide their goods and services to other industries as well. A good example of this is the banking industry. While the ability to receive loans and manage business expenses is critically important to agricultural producers and processors, other industries also rely heavily on banking services for their operations. As such, banking is not exclusively agricultural. Nevertheless, because of the agribusiness system, there is more demand for banking (and other non-agricultural goods and services) than there otherwise would be were agribusiness not to exist in the state.

The second set of multiplier effects, ***induced effects***, measures the economic activity generated when households employed in agribusinesses spend their earnings on Arizona goods and services. These effects occur in industries that provide consumer goods and services to households, such as the retail, healthcare, and restaurant industries.

This study conducts an economic contribution analysis for the 2014 calendar year and estimates the ***direct***, ***indirect***, and ***induced effects*** of Arizona's agribusiness system to the state economy.[3] Economic contributions are reported in terms of sales, value added (contribution to gross state product [GSP]), incomes, and jobs. To provide context for these results, we begin by presenting a profile of Arizona agriculture.

2 These industries have been included under the expanded definition of Arizona's agribusiness system and were not included in previous analyses.

3 This analysis is a snapshot of economic activity in 2014. Estimating the contribution of the agribusiness system for a different year may provide significantly different results as year-to-year changes in agricultural production and prices can be quite large. The results of this analysis are not directly comparable to those of past years due to adjustment in the definition of industries included in the agribusiness system.

Profile of Arizona Agriculture

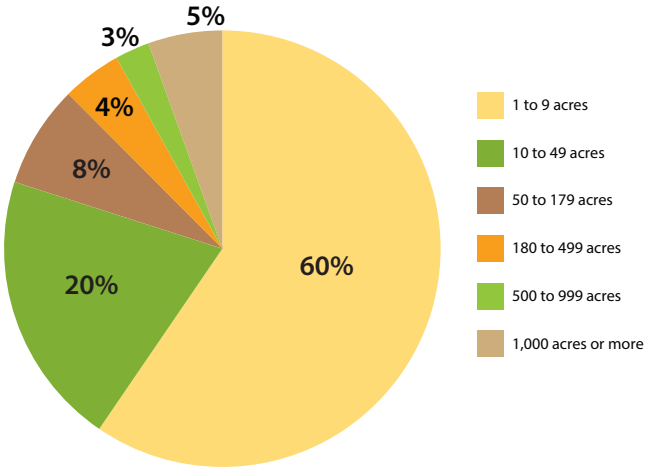
Agriculture in Arizona takes many shapes and forms, consisting of a diverse group of producers across the state, with operations varying in terms of average size, sales, and specialization. The most comprehensive picture of Arizona agriculture comes from the Census of Agriculture, conducted every five years. The latest, the 2012 Census of Agriculture, was released in 2014.

According to the 2012 Census of Agriculture, there were more than 20,000 farms and ranches in Arizona, managing more than 26 million acres of land. The average farm size in Arizona was 1,312 acres, significantly larger than the national average of 434 acres per farm. Averages, however, can be misleading. While 5% of Arizona agricultural operations have more than 1,000 acres, most operations were considered small-scale in terms of acreage, with approximately 60% of Arizona agricultural operations having less than 10 acres in production (Figure 1).

A majority of Arizona farmers and ranchers are also considered small-scale producers based on their annual sales. The 2012 Census of Agriculture reports that 87% of Arizona farms had annual sales receipts of less than $25,000. Even more surprising, 50% of Arizona farms had annual sales receipts of less than $1,000. This is in contrast to the 2% of operations that had annual sales receipts of $1 million or more (Figure 2).

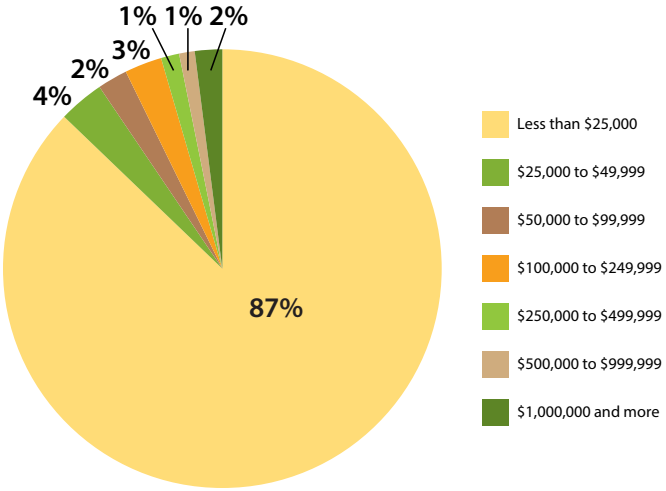
These data suggest that although most Arizona farms are small-scale producers, there are a small number of very large producers operating in the state. This is particularly evident when taking a closer look at the distribution of state agricultural sales by the number of farms producing those sales. In 2012, 10 operations accounted for one-quarter (25%) of Arizona's agricultural sales; 46 operations accounted for 50% of all sales; and 168 operations accounted for 75% of all sales (USDA, 2014; Table 44). In other words, less than 1% of farms accounted for 75% of Arizona agricultural sales, with 99% of farms accounting for the remaining 25% of the state's agricultural sales.

Figure 1. Percentage of Arizona Farms by Farm Size (Acreage), 2012



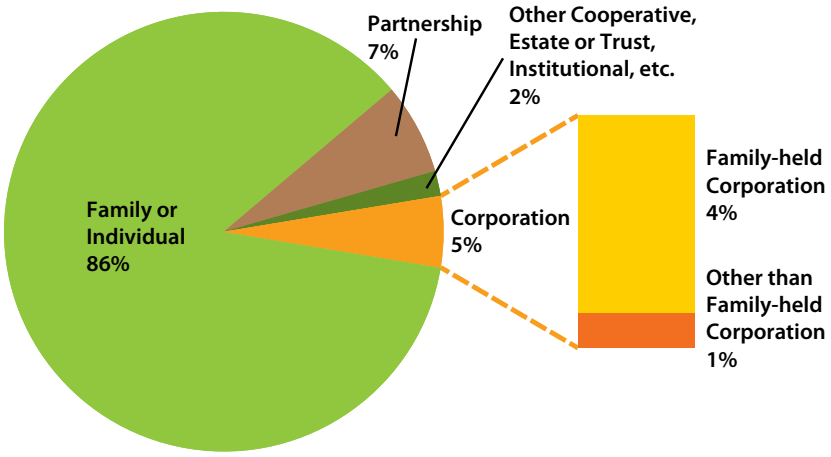
Source: USDA, 2014. 2012 Census of Agriculture—Arizona State and County Data: Table 1.

Figure 2. Percentage of Arizona Farms by Market Value of Agricultural Products Sold, 2012



Source: USDA, 2014. 2012 Census of Agriculture—Arizona State Data: Table 2.

Figure 3. Percentage of Arizona Farms by Legal Status, 2012

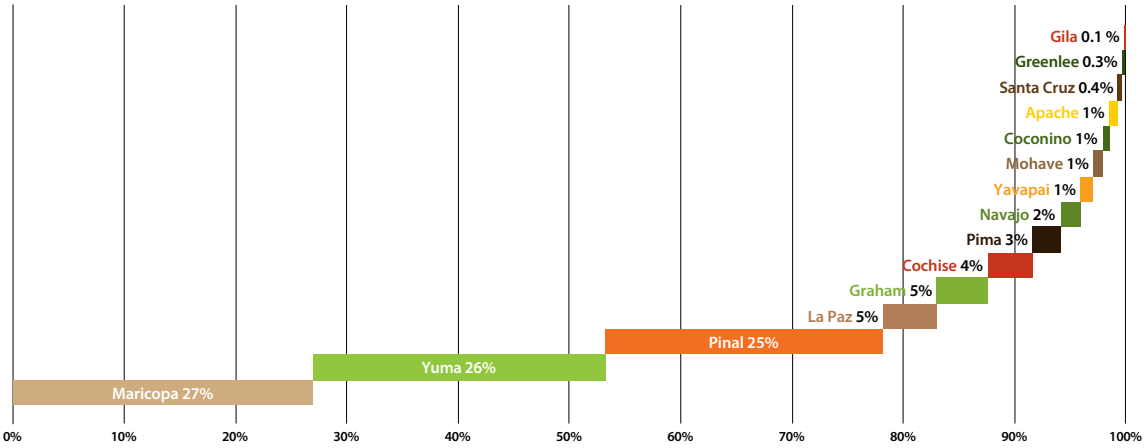


Source: USDA, 2014. 2012 Census of Agriculture—Arizona State Data: Table 67.

While a small number of farms account for a majority of the state's agricultural sales, a large majority of the farms in the state are family owned and operated. According to the 2012 Census of Agriculture, 86% of farms in Arizona were legally classified as a sole proprietorship operated by either an individual or a family (Figure 3). Approximately 7% were classified as a partnership, 4% were classified as a family-held corporation, 2% were classified as a cooperative, estate or trust, or institutional operation, and only 1% of the state's farms were classified as a corporation that was not family held. Individual or family operations, partnerships, cooperatives, and family-held corporations accounted for 90% of Arizona's state agricultural sales, while non-family held corporations accounted for 10% of total sales.

Breaking out Arizona agricultural sales geographically, three counties accounted for more than 75% of the state's sales (Figure 4). In 2012, Maricopa County accounted for 27% of the state's agricultural sales, Yuma County accounted for 26% of the state's agricultural sales, and Pinal County accounted for 25% of the state's agricultural sales.

Figure 4. Percentage of Arizona State Primary Agricultural Sales by County, 2012



Source: USDA, 2014. 2012 Census of Agriculture—Arizona State and County Data: Table 1.

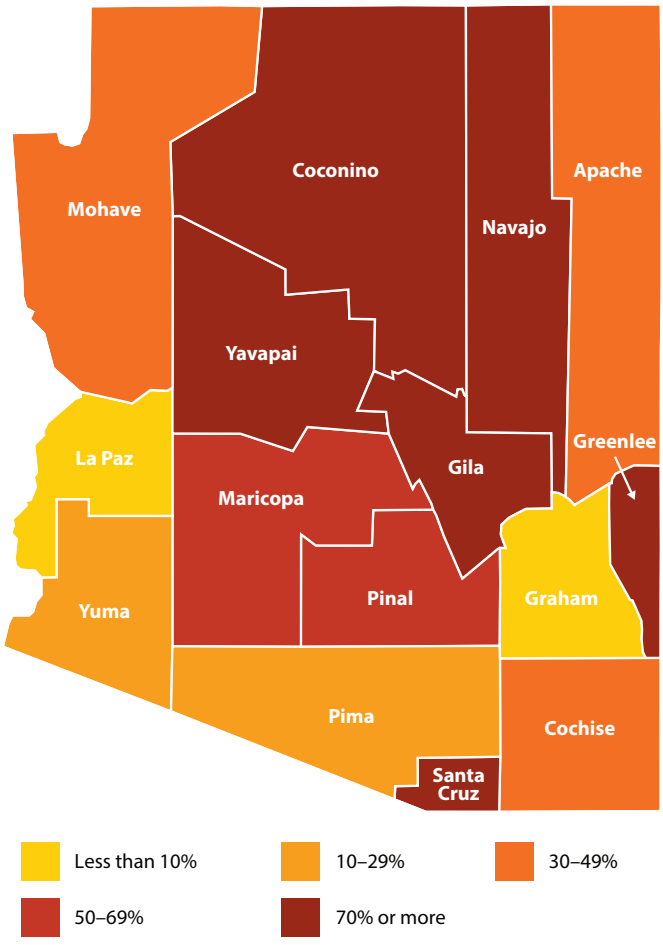
Table 1. Number of Farms, Median Acreage per Farm, and Average Market Value of Sales per Farm by Arizona County, 2012

Arizona County	Number of Farms	Median Acreage per Farm	Average Market Value of Sales per Farm
Apache	5,591	4	$4,327
Navajo	3,846	2	$16,774
Maricopa	2,479	5	$404,790
Coconino	2,239	5	$11,528
Cochise	1,093	80	$137,235
Yavapai	940	12	$44,285
Pinal	938	25	$989,058
Pima	855	9	$113,786
Yuma	562	18	$1,752,684
Graham	412	14	$414,769
Mohave	335	31	$90,103
Santa Cruz	236	41	$62,109
Gila	195	15	$19,240
Greenlee	159	36	$61,239
La Paz	125	95	$1,465,943

Source: USDA, 2014. 2012 Census of Agriculture—Arizona State and County Data: Table 1.

Apache and Navajo counties had the greatest absolute number of farms with 5,591 farms and 3,846 farms, respectively (Table 1). Though Apache and Navajo counties have the most farms in the state, the farms and ranches in these counties generally are small-scale producers, both in terms of acreage and sales (Table 1). Together with their neighbor Coconino County, the farms in this region are characterized by a large proportion of principal operators reported by USDA that are "American Indian or Alaska Native." According to the Census of Agriculture, 95% of the farms in Apache County, 90% of the farms in Navajo County, and 89% of the farms in Coconino County have a principal operator reported as an American Indian or Alaska Native (USDA, 2014, Table 50). Another distinction about the farms in this region is the fact that approximately half of all principal operators are women. In Apache and Navajo counties, 50% of principal operators are women and in Coconino County 47% of principal operators are women (USDA, 2014, Table 45). The state average for women principal operators is 39%. In the counties with the highest sales (Maricopa, Yuma, and Pinal), the proportions of women principal operators were 30%, 10%, and 22%, respectively.

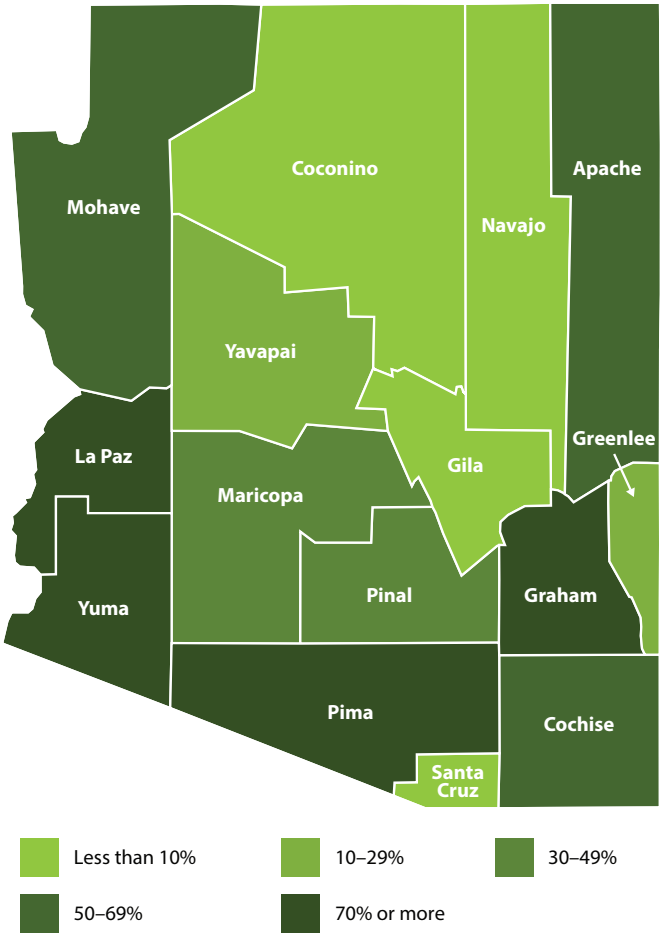
Figure 5. Value of Livestock as Percentage of Total Market Value of Primary Agricultural Products Sold by Arizona County, 2012



Source: USDA, 2014. 2012 Census of Agriculture—Arizona State and County Data: Table 2.

In terms of what is being produced in the state, in general, northern and central Arizona are primarily characterized as livestock producing counties, with these areas having a higher proportion (more than 50%) of total county agricultural sales originating from livestock. For example, in 2012, Coconino, Navajo, Gila, and Yavapai counties each had more than 70% of their total agricultural sales originating from livestock (Figure 5). Located in southeastern Arizona, Santa Cruz and Greenlee counties also had more than 70% of each county's total market value of sales coming from livestock. Pinal and Maricopa counties had 50–69% of their total agricultural sales from livestock. Central Arizona (Maricopa and Pinal counties) is known for dairy production, while other livestock counties in the state have a majority of their sales originating from the sales of cattle and calves. In Maricopa County, ***milk and other dairy products from cows*** accounted for approximately 40% of the county's total agricultural sales in 2012 and in Pinal County ***milk and other dairy products from cows*** accounted for 32% of the county's total agricultural sales. Interestingly, one of the top crops in Maricopa and Pinal counties, accounting for 12% and 10% of the county's total agricultural sales, respectively, is ***other crops and hay***, which is an important input (primarily alfalfa hay) for the ranching and dairy industries.

Figure 6. Value of Crops as Percentage of Total Market Value of Primary Agricultural Products Sold by Arizona County, 2012



Source: USDA, 2014. 2012 Census of Agriculture—Arizona State and County Data: Table 2.

Other counties in the state, such as Mohave, La Paz, Yuma, Pima, Cochise, Graham, and Apache, have a larger proportion of their county sales originating from crops (Figure 6). In 2012, Mohave, Cochise, and Apache counties had 50–69% of the county's total agricultural sales coming from crops while in La Paz, Yuma, Pima, and Graham counties, more than 70% of the county's total agricultural sales came from crops. In Mohave and La Paz counties the leading crop was ***other crops and hay***, accounting for 44% and 53% of total agricultural sales, respectively. While these two counties are technically characterized as crop-producing counties, it's interesting to note that ***other crops and hay*** is an important input for the ranching and dairy industries in the nearby counties. In Yuma and Apache counties, ***vegetables and melons*** accounted for the majority of total agricultural sales, with 59% and 47%, respectively. Cochise County had about one-fourth of total agricultural sales originate from ***grains*** and nearly one-fourth from ***fruits, tree nuts, and berries***. Finally, the leading agricultural commodities in Pima County were ***cotton and cottonseed*** and ***other crops and hay***, each accounting for about 10% of the county's total primary agricultural sales.

In summary, there are a wide variety of agricultural producers in Arizona, and state averages are not necessarily representative of their profiles. The concentration of crops versus livestock

and small versus large producers in any given area reflects its climate, topography, demography, water resource availability, and proximity to large urban areas. Generally speaking, the northern, central, and eastern parts of the state have higher levels of livestock production, as well as small-scale crop producers. The southern and western portions of the state are characterized by higher levels of crop production, and are home to the most of the state's large-scale crop producers. Regardless of these differences, however, agricultural production plays an important role in regional economies throughout the state and this contribution goes beyond on-farm production.

Economic Contributions of Arizona's Agribusiness System

The contribution of Arizona agriculture to the state economy extends beyond the commodities produced on farms and ranches across the state. Arizona has an entire system of industries involved in agriculture-related activities, of which on-farm production is only one. Arizona's agribusiness system[4] includes primary agriculture (crop and livestock production and agricultural support service industries), agricultural input manufacturing, agricultural processing industries, and industries involved in the marketing and distribution of agricultural products.

Including economic activity generated through direct, indirect, and induced multiplier effects, the total contribution of Arizona's agribusiness system to the state economy in 2014 was an estimated $23.3 billion in sales, more than 138,000 full- and part-time jobs, and $5.6 billion in labor income.[5]

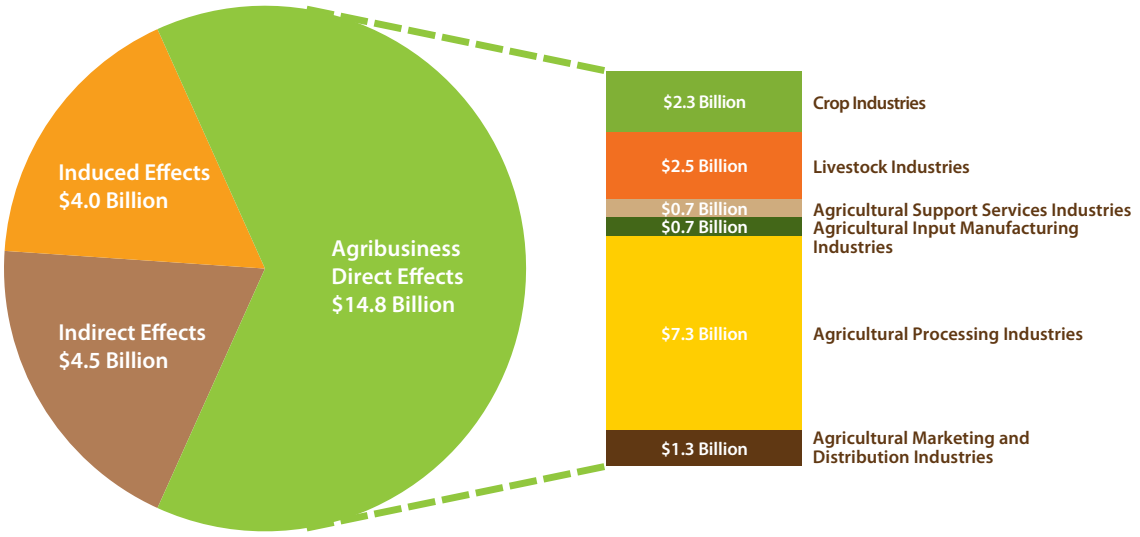
The following section presents results of the economic contribution analysis using the following economic metrics: sales, value added (synonymous to GSP), labor income, and employment.

Sales Contribution

Including direct, indirect, and induced effects, the total contribution of Arizona's agribusiness system to the state economy in 2014 was an estimated $23.3 billion in sales. Arizona's agribusiness system directly contributed $14.8 billion in sales and an additional $8.5 billion was generated in the Arizona economy through indirect and induced multiplier effects.

Of the $14.8 billion in sales directly contributed to the state economy by the agribusiness system, approximately $5.5 billion was supported by primary agriculture—the crop, livestock, and agricultural support service industries. The remaining $9.3 billion in sales was supported by the agricultural input manufacturing industry that provides supplies for on-farm production; agricultural processing industries; and industries involved in marketing and distributing agricultural products (Figure 7).

Figure 7. Economic Contribution of the Agribusiness System to Arizona State Sales, 2014



Source: Calculations by the authors. Data from IMPLAN Group, LLC, 2014; USDA, ERS, 2017; U.S. Department of Commerce, BEA, 2016.

4 A more detailed discussion of the agribusiness industries included in the economic contribution analysis is provided in the Appendix.

5 Labor income includes wages, salaries, and benefits paid to workers plus income earned by business owners.

Through indirect and induced effects, an additional $8.5 billion of sales was generated in the Arizona economy. Of this $8.5 billion, approximately $4.5 billion were indirect effects, sales generated in non-agribusiness industries that supply inputs to agribusinesses. These sales were generated in industries that sold water, electricity, gas, transportation, banking services, and other critical inputs to agribusinesses. The remaining $4.0 billion were induced effects, sales generated in industries that sell goods and services to households employed by agribusiness. These are called consumer industries and include the healthcare, retail, restaurant, and insurance industries, among others (Figure 7).

While the sales metric provides an easy-to-understand, cumulative measure of economic activity attributable to agribusiness activity, it can be misleading when talking about the contribution to the state economy. This is because the value of a product may be double counted—once as an end product and once as part of the cost of production for an intermediate input commodity. This is particularly the case within agriculture because many agricultural products are used as a production input for other agricultural operations. One of the best examples is the relationship between feed crops and livestock operations. Feed crops sold by Arizona farms may be purchased as inputs by Arizona livestock producers, leading to a double counting of the value of the feed. Therefore, economists prefer to use the value-added metric presented below.

Value-Added Contribution

In 2014, the agribusiness system directly contributed approximately $4.3 billion to state value added. Value added measures the net incremental change in the value of a good from the last stage in production and, at the state level, is synonymous with the gross state product (GSP). The state's top five agribusiness industries, in terms of value added, were agribusiness wholesale, agricultural support services (largely farm labor contracting from harvesting activities), dairy cattle and milk production, beef cattle ranching, and fluid milk manufacturing (Table 2). Rounding out the top ten in value added were vegetable and melon farming, bread and bakery manufacturing, other snack food manufacturing, dog and cat food manufacturing, and hay and all other crop farming (which in Arizona is largely alfalfa and other forage). As a measure, value added includes labor income, profits, and taxes, and therefore industries with heavy labor requirements as a

Table 2. Top 10 Agribusiness Industries in Arizona by Contribution to Value Added (Gross State Product), 2014

Rank	Agribusiness Industry	Direct Value Added ($ millions)
1	Agribusiness wholesale[6]	$710
2	Agricultural support services[7]	$640
3	Dairy cattle and milk production	$340
4	Beef cattle ranching and farming, including feedlots	$320
5	Fluid milk manufacturing	$260
6	Vegetable and melon farming	$220
7	Bread and bakery product manufacturing	$210
8	Other snack food manufacturing	$180
9	Dog and cat food manufacturing	$130
10	All other crop farming	$110

Source: Calculations by the authors. Data from IMPLAN Group, LLC, 2014.

6 This industry was constructed by the authors to capture economic activity taking place within the larger wholesale industry. NAICS codes included in this agribusiness industry are provided in the Appendix.

7 The classification for this industry is agricultural support service industries (NAICS 115; IMPLAN sector 19). In Arizona, it primarily captures economic activity from farm labor contracting.

share of total expenses will oftentimes present large value added contributions.

Employment and Income Contributions

Other metrics with which to measure the contribution of the agribusiness system to the state economy are jobs supported and incomes paid by agriculture-related businesses. In 2014, the agribusiness system directly and indirectly supported an estimated 138,293 full- and part-time jobs and 162,982 unique workers (Table 3).[8]

Department of Labor, QCEW 2014). In addition to on-farm hired labor jobs, there were, according to the USDA Census of Agriculture, 20,005 principal farm operators in 2012 (the most recent year of available data) and an additional 13,608 other, non-principal farm operators (USDA, 2014).

In addition to jobs supported through primary agriculture, there were approximately 19,000 full- and part-time jobs in other industries within the Arizona agribusiness system. These jobs were in agricultural input manufacturing, agricultural processing, and agricultural marketing and

Table 3. Estimated Number of Full- and Part-time Jobs and Unique Workers Supported by Arizona's Agribusiness System, 2014

	Jobs	Unique Workers
Total Direct Employment	77,547	102,236
Primary Agriculture	58,302	82,991
Hired Labor	24,689	49,378
Principal Farm Operators	20,005	20,005
Other Farm Operators	13,608	13,608
Agricultural Input Manufacturing	703	703
Agricultural Processing	12,265	12,265
Agricultural Marketing & Distribution	6,277	6,277
Indirect Effects on Employment	30,477	30,477
Induced Effects on Employment	30,269	30,269
Total Employment Contribution	**138,293**	**162,982**

Source: Calculations by the authors. Data from U.S. Department of Labor, BLS, QCEW, 2014; Census of Agriculture, 2014; IMPLAN Group, LLC, 2014.

First and foremost, jobs are supported on farm by primary agriculture, or industries that are involved in crop or livestock production or that provide on-farm agricultural support and services. Employment in primary agriculture consists of on-farm hired labor, self-employed principal farm operators, and other, non-principal farm operators. In 2014, the estimated number of jobs in primary agriculture was 58,302. On-farm hired labor accounted for 42% of these jobs, with 24,689 jobs. On-farm hired labor jobs include both labor directly hired by farm operators and those employed in agricultural support services industries primarily via farm labor contractors (U.S.

distribution industries. Outside of agribusiness, there were more than 60,000 additional jobs supported by spending on agribusiness inputs (***indirect effects***) and spending of agribusiness profits and wages (***induced effects***).

While these jobs estimates account for the number of full- and part-time jobs, they do not report the number of individual workers filling those jobs. This presents a problem of defining what constitutes "a job." For example, if one person works at three jobs lasting for three months each and is unemployed for three months, is this three jobs or three-quarters of a job? Research on California agricultural labor markets has found

8 Data and research methods for employment estimations are provided in the Appendix.

that there are—on average—two unique hired farm workers or Social Security numbers reported by farm employers for each year-round equivalent farm job (Hooker, et al., 2015; Martin et al., 2017). This two-to-one ratio was stable across 2007 and 2012 Census of Agriculture editions. If one assumes this two-to-one relationship also holds for Arizona—which has similar crops and production systems to California's—then the number of unique hired workers would be 49,378 workers (Table 3). This suggests that the Arizona agribusiness directly and indirectly supported employment for nearly 163,000 unique workers.

The agribusiness system also supported a total of $5.6 billion in labor income. Labor income includes the wages, salaries, and benefits paid to workers and the income earned by business owners. Approximately $1.5 billion of this income was earned by individuals that work on farm, whether they worked in the crop, livestock, or agricultural support service industries. The remaining $1.2 billion in income directly supported by the agribusiness system was paid to individuals that work in agricultural input manufacturing, agricultural processing, or agricultural marketing and distribution industries. Furthermore, through indirect and induced effects, an additional $2.9 billion in income was earned in other industries in the Arizona economy. For example, nearly $200 million was paid as income to those employed by hospitals and physician offices, $120 million was paid to workers in retail food and beverage stores, and $82 million was paid to those working in the real estate industry. These incomes were supported indirectly through the economic activity stimulated by Arizona's agribusiness system.

Appendix

Defining Arizona's Agribusiness System

Consistent with previous reports, the agribusiness system is defined as "the primary agricultural sector plus the closely related industries that depend on agricultural activity in Arizona." The definition of the agribusiness system was originally developed by Jorgen Mortensen's 2004 University of Arizona Department of Agricultural and Resource Economics publication *Economic Impact from Agricultural Production in Arizona*. The current study expands the definition of the agribusiness system to include some additional agribusiness industries that have been omitted in the past. The agricultural production, supply, processing, and marketing and distribution industries (and their respective North American Industry Classification System [NAICS] and IMPLAN codes) defined as the agribusiness system are listed in Table 4 (p. 20).

Primary agriculture includes all industries in sector 11 of the NAICS industry classification scheme with the exception of ***forestry and logging*** (NAICS subsector 113) and ***fishing, hunting, and trapping*** (NAICS subsector 114). Thus, primary agriculture includes all crop production, animal production, and agricultural support service industries (IMPLAN sectors 1–14 and 19).

Agricultural input manufacturing includes the ***fertilizer manufacturing*** sectors (IMPLAN sectors 169–171 and NAICS 325311, 325312, and 325314), the ***pesticide and other agricultural chemical manufacturing*** sector (IMPLAN sector 172 and NAICS 32532), and the ***farm machinery and equipment manufacturing*** sector (IMPLAN sector 262 and NAICS 333111).

Agricultural processing industries capture the food and fiber processing that occurs in the state. Beginning with food processing, the model includes all sectors of the ***food manufacturing*** sector (NAICS 311) with the exception of a few industries that were determined not to exist in the Arizona economy by the IMPLAN model. Only the ***winery*** subsector (NAICS 31213 and IMPLAN sector 109) is included from the ***beverage and tobacco product manufacturing*** sector (NAICS 312). To reflect fiber processing in the state, the only sectors included from ***textile mills*** (NAICS 313) are subsectors ***fiber, yarn, and thread mills*** (NAICS 3131 and IMPLAN sector 112) and ***broadwoven fabric mills*** (NAICS 31321 and IMPLAN sector 113). Many fiber processing industries are excluded from the model because the majority of textile mills do not have a direct link to cotton. Additionally, the ***leather and hide tanning and finishing*** sector (NAICS 3161 and IMPLAN sector 131) is included in the analysis.

Finally, this study includes new agriculture-related businesses that are involved in the marketing and distribution of agricultural products. For this 2014 analysis, we include agriculture-related economic activity taking place within the larger ***warehousing***, ***wholesale***, and ***retail*** industries.

- The "agribusiness warehouse" sector includes ***refrigerated warehousing and storage*** (NAICS 493120) and ***farm product warehousing and storage*** (NAICS 493130).
- The "agribusiness wholesale" sector includes ***farm and garden equipment merchant wholesalers*** (NAICS 423820), ***dairy product merchant wholesalers*** (NAICS 424430), ***fruit and vegetable merchant wholesalers*** (NAICS 424480), ***grain and field bean merchant wholesalers*** (NAICS 424510), ***livestock merchant wholesalers*** (NAICS 424520), ***other farm product raw materials merchant wholesalers*** (NAICS 424590), and ***farm supplies merchant wholesalers*** (NAICS 424910).
- Finally, the "agribusiness retail" sector includes ***fruit and vegetable markets*** (NAICS 445230).

Data Sources and Research Methods

Data from the 2014 IMPLAN Version 3.1 Arizona state model was used to estimate the economic contribution of the agribusiness system to the Arizona economy. While IMPLAN has data built into the model, modifications were made to the IMPLAN data to more accurately capture the economic activity taking place in Arizona's agribusiness industries.

First, the IMPLAN model was modified to reflect the most up-to-date estimates of commodity cash receipt data and other farm income for 2014. Data for these modifications were obtained from the USDA Economic Research Service's (ERS) Farm Income and Wealth statistics and the Bureau of Economic Analysis's (BEA) Annual State Income and Employment Statistics (USDA, ERS, 2017; U.S. Department of Commerce, BEA, 2016a). Additional modifications were made to IMPLAN's baseline data for primary agriculture industries to better reflect state-level employee

Table 4. Arizona's Agribusiness System by IMPLAN Economic Sectors and NAICS Codes

IMPLAN Code	NAICS Codes	IMPLAN Description
1	11111-2	Oilseed farming
2	11113-6, 11119	Grain farming
3	1112	Vegetable and melon farming
4	111331-2, 111331-4, 111336*, 111339	Fruit farming
5	111335, 111336*	Tree nut farming
6	1114, 1125*	Greenhouse, nursery, and floriculture production
7	11191	Tobacco farming
8	11192	Cotton farming
9	11193, 111991	Sugarcane and sugar beet farming
10	11194, 111992, 111998	All other crop farming
11	11211, 11213	Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming
12	11212	Dairy cattle and milk production
13	1123	Poultry and egg production
14	1122, 1124, 1125*, 1129	Animal production, except cattle and poultry and eggs
19	115	Support activities for agriculture and forestry
65	311111	Dog and cat food manufacturing
66	311119	Other animal food manufacturing
67	311211	Flour milling
68	311212	Rice milling
69	311213	Malt manufacturing
70	311221	Wet corn milling
71	311224	Soybean and other oilseed processing
72	311225	Fats and oils refining and blending
73	31123	Breakfast cereal manufacturing
74	311313	Beet sugar manufacturing
75	311314	Sugar cane mills and refining
76	31134	Non-chocolate confectionery manufacturing
77	311351	Chocolate and confectionery manufacturing from cacao beans
78	311352	Confectionery manufacturing from purchased chocolate
79	311411	Frozen fruits, juices and vegetables manufacturing
80	311412	Frozen specialties manufacturing
81	311421	Canned fruits and vegetables manufacturing
82	311422	Canned specialties
83	311423	Dehydrated food products manufacturing
84	311511	Fluid milk manufacturing
85	311512	Creamery butter manufacturing
86	311513	Cheese manufacturing

Table 4. Arizona's Agribusiness System by IMPLAN Economic Sectors and NAICS Codes CONTINUED

IMPLAN Code	NAICS Codes	IMPLAN Description
87	311514	Dry, condensed, and evaporated dairy product manufacturing
88	31152	Ice cream and frozen dessert manufacturing
89	311611	Animal, except poultry, slaughtering
90	311612	Meat processed from carcasses
91	311613	Rendering and meat byproduct processing
92	311615	Poultry processing
93	3117	Seafood product preparation and packaging
94	311811-2	Bread and bakery product, except frozen, manufacturing
95	311813	Frozen cakes and other pastries manufacturing
96	311821	Cookie and cracker manufacturing
97	311824	Dry pasta, mixes, and dough manufacturing
98	31183	Tortilla manufacturing
99	311911	Roasted nuts and peanut butter manufacturing
100	311919	Other snack food manufacturing
101	31192	Coffee and tea manufacturing
102	31193	Flavoring syrup and concentrate manufacturing
103	311941	Mayonnaise, dressing, and sauce manufacturing
104	311942	Spice and extract manufacturing
105	31199	All other food manufacturing
109	31213	Wineries
112	3131	Fiber, yarn, and thread mills
113	31321	Broadwoven fabric mills
131	3161	Leather and hide tanning and finishing
169	325311	Nitrogenous fertilizer manufacturing
170	325312	Phosphatic fertilizer manufacturing
171	325314	Fertilizer mixing
172	32532	Pesticide and other agricultural chemical manufacturing
262	333111	Farm machinery and equipment manufacturing
New Industry	493120, 493130	Agribusiness warehousing
New Industry	423820, 424430, 424480, 424510, 424520, 424590, 424910	Agribusiness wholesale
New Industry	445230	Agribusiness food retail (fruit and vegetable markets)

*** Indicates that the NAICS code is split amongst multiple IMPLAN industries**

Source: IMPLAN Group, LLC, 2014.

Crop Industries
Livestock Industries
Agricultural Support Services Industries
Agricultural Processing Industries
Agricultural Input Manufacturing Industries
Agricultural Marketing and Distribution Industries

compensation of hired farm labor and farm proprietor income,[9] agricultural taxes on production and imports,[10] and on-farm employment.[11]

Modifications were also made to the baseline IMPLAN industry production functions for all primary agriculture industries to more accurately represent agricultural practices in Arizona. Baseline industry production functions (also known as industry spending patterns) need to be modified because they are based on national averages. For many agricultural commodities, national averages would not accurately reflect the spending pattern of Arizona agricultural operations because the national average spending pattern may focus on non-irrigated crop production, of which there is very little (if any) in Arizona. Farm expense data from the 2012 Census of Agriculture was used to modify primary agriculture industry spending patterns.

In regard to agricultural input manufacturing and agricultural processing industries, IMPLAN baseline data were compared with data available from the U.S. Department of Labor Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages (QCEW), U.S. Department of Commerce Bureau of Economic Analysis (BEA), U.S. Census Bureau's Annual Survey of Manufactures (ASM), and U.S. Census Bureau's County Business Patterns (CBP). The only sector in which modifications were made was IMPLAN sector 94 ***bread and bakery product, except frozen, manufacturing***. Food processing estimates, the largest component of all agricultural processing, match available data from the U.S. Census Bureau's Annual Survey of Manufactures.

Finally, we estimate the agriculture-related economic activity taking place within the larger ***warehousing***, ***wholesale***, and ***retail*** industries and include them in the analysis estimating the economic contribution of the Arizona agribusiness system. Estimation is required because IMPLAN reports this data at an aggregated level. For example, IMPLAN reports economic activity for the wholesale industry in its entirety, whereas we are interested only in the subsector(s) that are related to agriculture. Employment and wage data from the U.S. Department of Labor Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages (QCEW) by 6-digit NAICS code was used to parse out agriculture-related economic activity within the ***warehousing***, ***wholesale***, and ***retail*** industries. New sectors were created in IMPLAN (using industries that do not exist in the study region) to account for agribusiness warehousing, wholesale, and food retail and original IMPLAN values for the larger industries were modified downward accordingly.

After all modifications were completed, a standard economic contribution analysis was completed, utilizing IMPLAN's multi-industry contribution analysis method. As this analysis examines primary agriculture, its backward-linked supply industries, and its forward-linked processing and distribution industries, the model was run so that each industry was not able to purchase inputs from the previous stage of production—components that were already being captured in the model. The multi-contribution analysis method ensures that there was no double counting.

There are several challenges to estimating the number of jobs supported by the agribusiness

9 Data from U.S. Department of Commerce. Bureau of Economic Analysis (BEA). 2017. Annual State Personal Income and Employment: Personal Income by Major Component and Earnings by NAICS Industry (SA5N).

10 Data from U.S. Department of Agriculture (USDA). Economic Research Service (ERS). 2017. U.S. and State-Level Farm Income and Wealth Statistics: Value Added by U.S. Agriculture.

11 Data from U.S. Department of Commerce. Bureau of Economic Analysis (BEA). 2016b. Annual State Income and Employment: Total Full-Time and Part-Time Employment by Industry (SA25N).

system, particularly for on-farm production. First, there is no one single source of data on U.S. farm labor and, of available data, discrepancies exist for how jobs are measured. For consistency, this study utilizes annual average data from the 2014 Department of Labor Quarterly Census of Employment and Wages (QCEW) for nearly all estimates. Data on jobs for hired farm labor, agricultural input manufacturing, agricultural processing, and agricultural marketing and distribution were obtained from the 2014 QCEW. This data reports state-level jobs for Arizona by industry NAICS code for all covered workers.[12] As proprietors are not included in these figures, estimates of principal operators were obtained from the 2012 Census of Agriculture. It was assumed that these numbers (from 2012) remained the same for 2014. Other data sources, such as the Bureau of Economic Analysis, suggest there was little change in farm proprietorships between 2012 and 2014. Estimates of jobs supported through indirect and induced multiplier effects were derived based on IMPLAN modeling simulations.

Second, while QCEW job estimates account for the number of full- and part-time jobs, they do not report the number of individual workers filling those jobs. This presents a problem of defining what constitutes "a job." For example, if one person works at three jobs lasting for three months each and is unemployed for three months, is this three jobs or three-quarters of a job? This is particularly challenging when estimating employment in highly seasonal agricultural industries. Research by Hooker, et al. (2015) and Martin et al. (2017) on California agricultural labor markets found there were an average of two unique farm workers or Social Security Numbers reported by farm employers for each year-round equivalent farm job. This two-to-one relationship holds stable across 2007 and 2012 Census of Agriculture editions. If one assumes this two-to-one relationship also holds for Arizona—which has similar crops and production systems as California—then the number of unique hired on-farm workers would be double the 24,689 hired farm labor jobs, or 49,378 unique workers.

The total number of hired on-farm jobs in Arizona was obtained from QCEW annual estimates summing the number of jobs from ***crop production*** (NAICS code 111), ***animal production and aquaculture*** (NAICS code 112), ***support activities for crop production*** (NAICS code 1151) and ***support activities for animal production*** (NAICS code 1152). This calculation produces 24,689 salaried on-farm hired jobs. Multiplying by two, one obtains an estimate of 49,378 unique workers. As a cross-check, this same procedure was applied to QCEW data for the same NAICS code industries in California for 2014 and compared with the unique worker estimates obtained by Martin et al., (2017). Summing annual jobs in NAICS codes 111, 112, 1151, and 1152 for California for 2014, the total number of salaried on-farm hired jobs is 410,577 jobs. Multiplying by two yields an estimate of 821,154 unique workers. This is quite close to the estimate of 829,300 unique workers obtained by Martin et al. (2017). In fact, doubling the QCEW annual jobs numbers to estimate unique workers gives a result within 1% of the Martin et al. (2017) estimates.

12 Covered workers in the private sector and in the state and local government include "most corporate officials, all executives, all supervisory personnel, all professionals, all clerical workers, many farmworkers, all wage earners, all piece workers and all part-time workers" (QCEW). It does not include proprietors, the unincorporated self-employed, unpaid family members, certain farm and domestic workers from having to report employment data, and railroad workers cover by the railroad unemployment insurance system" (QCEW).

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