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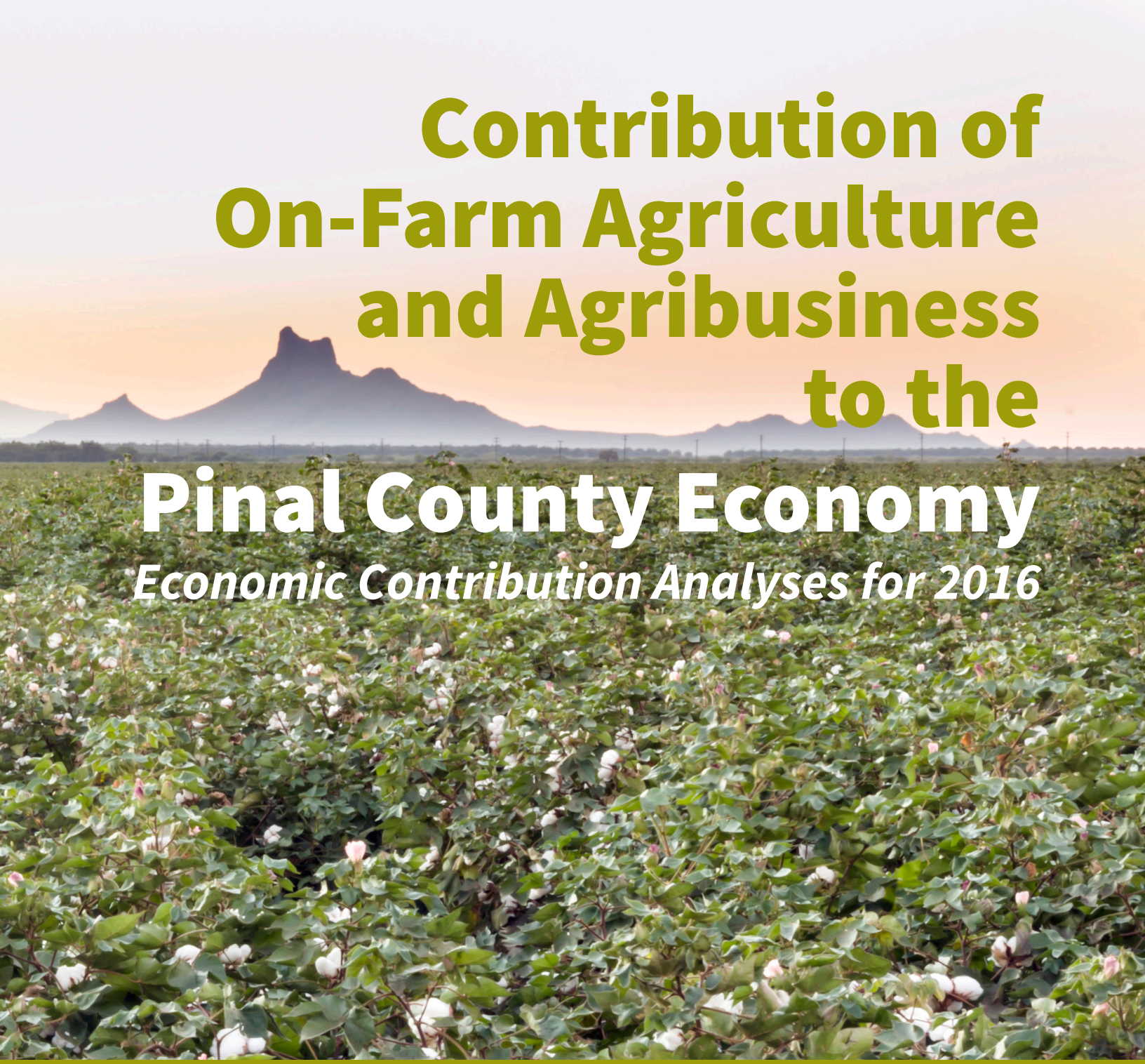
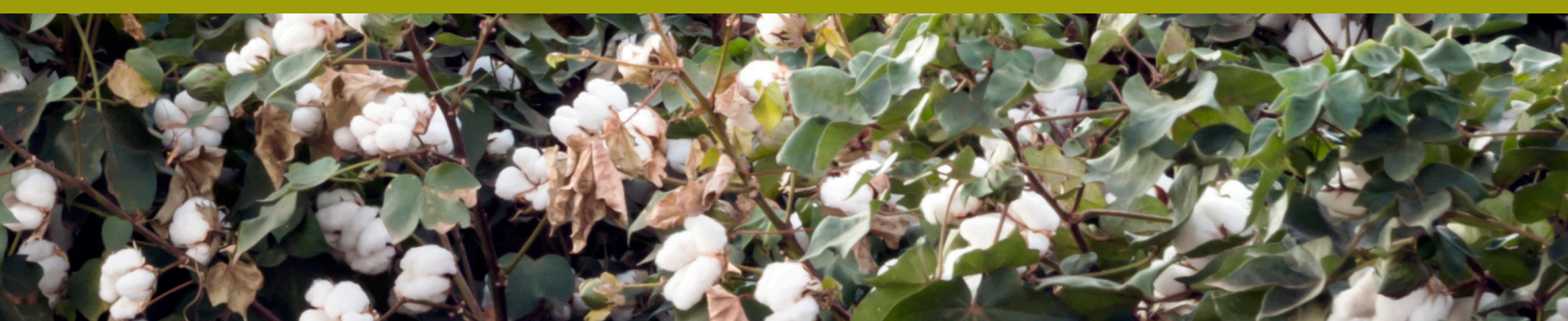
*Economic Contribution Analyses for 2016*



**Ashley Kerna Bickel**
**Dari Duval**
**George Frisvold**



# Contribution of On-Farm Agriculture and Agribusiness to the Pinal County Economy

## *Economic Contribution Analyses for 2016*

**Ashley Kerna Bickel**
*Economic Impact Analyst*

**Dari Duval**
*Economic Impact Analyst*

**George Frisvold**
*Professor and Extension Specialist*

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# Acknowledgments

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# Executive Summary

## What Is the Issue?

- Pinal County ranks in the top 2% of all U.S. counties in the total value of agricultural sales and the top 1% in cotton and cottonseed sales, milk sales, and inventories of cattle and calves. Supporting large dairy and beef industries, Pinal County ranks in the top 4% of all counties in barley acreage, corn acreage, and forage crop acreage.
- The contribution of agriculture to the Pinal County economy goes beyond the direct sales value of crops and livestock produced in the region. In addition to the direct contribution of farm gate sales, or agricultural cash receipts, a "ripple" of economic activity is stimulated in other industries outside of agriculture to meet the demands of farmers and ranchers and households that derive their income from agriculture. Economists call these ***indirect*** and ***induced multiplier effects***.
  - ***Indirect effects*** measure economic activity generated by farmers and ranchers' demand for inputs or supplies. These effects are the business-to-business transactions that occur in other agricultural and non-agricultural industries that provide goods and services as inputs to Pinal County farmers and ranchers, such as the insurance, utility, or banking industries.
  - ***Induced effects*** measure the economic activity generated when households employed by Pinal County farms spend their earnings on local goods and services. These effects are the household-to-business transactions that 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 2016 calendar year, estimating the total (direct, indirect, and induced multiplier effects) contribution of on-farm agriculture to the Pinal County economy.
- On-farm production is just one part of an entire system of industries connected with agriculture. In Pinal County, a large and important industry intimately connected with on-farm production is the dairy processing and dairy product manufacturing industry. With this in mind, the study also conducts an economic contribution analysis of on-farm agriculture plus related agribusiness industries involved in input manufacturing and food and fiber processing, estimating the total (direct, indirect, and induced multiplier effects) contribution of agriculture and agribusiness to the Pinal County economy in 2016.
- Finally, as the availability of irrigation water is of utmost importance to crop production in the region, this study considers the economic consequences of a hypothetical water cutback and estimates the reduction in acreage, on-farm sales, and the resulting economic multiplier effects from reduced purchases of local inputs, reduced farm income, and reduced farm employment and wages.

## What Did the Study Find?

### Profile of Pinal County Agriculture

#### Pinal County ranks high among U.S. counties in the production of many agricultural commodities.

- Pinal County ranks in the top 2% of U.S. counties for total value of agricultural sales.
  - The county ranks in the top 1% of all U.S. counties for total animal product sales, also ranking in the top 1% for milk sales and in the top 2% for cattle and calf sales.
  - The county ranks in the top 3% of all U.S. counties for total crop sales, also ranking in the top 1% for cotton and cottonseed and in the top 1% for "other crops and hay" sales, where alfalfa sales dominate in Pinal County.
  - Despite its specialization in feed, forage, and cotton crops, Pinal County also ranks in the top 7% of all counties for vegetable production and fruit and nut production.

#### Pinal County is predominately a livestock-producing county.

- Between 2012 and 2016, approximately two-thirds (2/3) to three-quarters (3/4) of the county's total annual agricultural sales were derived from livestock and their products.
- The top livestock commodities produced are beef and milk, with roughly a 50/50 split between cattle and calf sales and milk sales.

#### Pinal County is an important contributor to Arizona milk supplies.

- In 2012, Pinal County accounted for just 6% of the state's total population but accounted for 39% of the state's milk sales, supplying milk to the large urban centers of Phoenix (Maricopa County) and Tucson (Pima County). These two urban counties accounted for 75% of Arizona's population but generated only 52% of Arizona's milk sales.

#### Most farms in Pinal County are family- or individually-owned and are considered small scale, both in terms of acreage and sales.

- Of the 938 farms in Pinal County in 2012, most farms (602 or 64%) were family- or individually-owned.
- Most Pinal County farms are small scale in terms of acreage, with more than 50% (530 farms) having less than 50 acres, and 37% (348 farms) having less than 10 acres.
- About half of Pinal County farms had sales less than $10,000 in 2012. The highest proportion of Pinal County farms (256 or 27%) had annual sales of less than $1,000. That said, the second highest proportion (145 or 15%) had annual sales of $500,000 or more. Operations with $250,000 or more in sales made up 21% of farms but 98% of sales.

## Contribution Analyses of Pinal County Agriculture and Agribusiness

### Including direct, indirect, and induced multiplier effects, the total contribution of on-farm agriculture to Pinal County sales was an estimated $1.1 billion in 2016.

- Of this $1.1 billion in total sales,
  - $908.1 million in sales was directly contributed by on-farm agriculture, with approximately $599.3 million in sales from livestock production, $275.8 million in sales from crop production, and $33 million in sales from agricultural support service industries, such as cotton ginning and farm labor contracting; and
  - $213.7 million in sales was generated in the Pinal County economy through indirect and induced multiplier effects.

### Agriculture and agribusiness are part of Pinal County's economic base and Pinal County has a high concentration of employment in several agricultural industries.

- Of the top 20 industries in Pinal County ranked by concentration of employment (location quotient), nine are agricultural or agriculture-related industries.
- The employment location quotient for cotton farming in 2017 was 47.8, meaning that the share of employment in cotton production in Pinal County is 47.8 times the national average.
- Not only is the location quotient for cotton farming quite high, but so too are the location quotients (LQs) for hay farming (18.5), cotton ginning (23.0), and milk production (25.7). To put these numbers in perspective, the LQ for automobile manufacturing is 24.8 in Wayne County, Michigan (which includes the city of Detroit). In terms of labor specialization, cotton farming and dairies are to Pinal County what auto manufacturing is to Detroit.

### Agribusiness industries involved in agricultural input manufacturing, food and fiber processing, and agricultural product wholesaling make significant contributions to Pinal County's economy.

- Direct sales of $908.1 million from on-farm agriculture in 2016 were supplemented with $979 million in direct sales from agricultural input manufacturing and agricultural (food and fiber) processing in Pinal County.
- Nearly two-thirds of these additional agribusiness sales came from Pinal County businesses involved in fluid milk manufacturing; dry, condensed, and evaporated dairy product manufacturing; and snack food manufacturing.
- Food manufacturing is the largest manufacturing sector in the county, providing more than 25% of all manufacturing jobs.
- Agriculture-related wholesale trade accounts for 23% of county wholesale trade jobs.

### Including direct, indirect, and induced effects, the total contribution of on-farm agriculture and agribusiness to Pinal County's output was nearly $2.3 billion in total sales in 2016.

- Nearly $1.9 billion of this total was from direct agricultural and agribusiness sales.
- The remainder was sales in other industries stimulated by agricultural activities.

*Including direct, indirect, and induced effects, the total contribution of agriculture and agribusiness to Pinal County's gross regional product (GRP) was an estimated $611.1 million in 2016.*

- The contribution to gross regional product, or value added, is the most accurate metric to use when talking about the contribution of an industry to a regional economy. Value added measures the net incremental change in the value of the good from the last stage in production and is synonymous with gross domestic product (GDP) at the national level.
- Value added combines net farm income, profits in other industries, county employee compensation, and tax revenues.
- Of the total $611.1 million supported by on-farm agriculture and agribusiness and the resulting indirect and induced multiplier effects, $433.5 million originated directly from on-farm agriculture and agribusiness industries, with $273.0 million directly from on-farm agriculture.

*Agriculture and agribusiness support jobs and incomes in Pinal County.*

- Including indirect and induced effects, Pinal County agriculture and agribusiness supported 7,516 full- and part-time jobs in the county and incomes of $356.8 million in 2016.
- Pinal County agriculture and agribusiness directly supported an estimated 5,150 full- and part-time jobs, with nearly three-fourths of these jobs occurring on-farm.

### Analysis of Fallowing Impacts

*A hypothetical cutback of 300,000 acre-feet of irrigation water, and a corresponding reduction in the wheat, alfalfa, and cotton acreage grown and harvested in Pinal County, would affect farmers and the regional economy, but in different ways.*

- With fewer acres in production, farmers would have decreased sales as well as decreased costs of production (because they are no longer purchasing inputs needed for growing and harvesting). Direct effects to farmers, therefore, would be lower net revenues for their individual operations.
- A reduction in agricultural production could have negative effects on the regional economy resulting from lower spending on inputs and labor.
- Given hypothetical, simplified scenarios and reductions in acreage (and resulting changes in economic activity from production), the total value-added (GRP) impacts to the Pinal County economy from large-scale land fallowing range from $31.7 million to $35 million. About half of these losses are directly borne by agricultural producers and their employees in Pinal County. The remaining reductions in value added come from multiplier effects, where non-agricultural industries have reduced employee compensation, taxes, and profits because of fewer inputs purchased and fewer farmworkers spending on household goods and services. Approximately 1% of county value-added reductions would occur through reduced county sales tax revenue.
- Large-scale land fallowing reduces employment in Pinal County by 270 to 480 full- and part-time jobs, depending on economic modeling assumptions.

## How Was the Study Conducted?

- This study conducts two economic contribution analyses: one for on-farm agriculture (crop, livestock, and agricultural support service industries) and one for agriculture and agribusiness combined (on-farm agriculture, agricultural input manufacturing, and food and fiber processing industries).
- The economic contribution analyses were modeled using the IMPLAN 3.1 input-output software and data. The model was customized using the best available, most recent data to more accurately reflect the production practices and economic conditions in Pinal County in 2016. Data and research methods used to estimate the contribution are presented in Appendix A.
- Results of the economic contribution analyses are presented by value of sales, value added (contribution to gross regional product [GRP]), labor income, and number of full- and part-time jobs.
- Using the same input-output model, IMPLAN 3.1, this study estimates the decreases in economic activity associated with hypothetical reductions in agricultural production in Pinal County. Reductions in the value of agricultural production are assumed to occur as a result of fewer acres in production due to fallowing resulting from a hypothetical irrigation water cutback of 300,000 acre-feet (AF). Water application rates, yield, and price data were used to estimate reductions in acreage and the value of production for six hypothetical, simplified fallowing scenarios comprised of various wheat, alfalfa, and cotton crop-fallowing mixes. Reductions in agricultural sales were then modeled in IMPLAN to estimate the resulting decreases in regional economic activity.

# 1 Introduction

Agriculture and agribusiness industries are highly concentrated in Pinal County. Pinal County ranks among the top three agricultural-producing counties in Arizona and also ranks highly at the national level for the production of many agricultural commodities. The contribution of agriculture to the Pinal County economy goes beyond the direct sales value of crops and livestock produced in the region. In addition to the direct contributions of agricultural cash receipts and on-farm jobs, a "ripple" of economic activity is stimulated in other industries outside of agriculture to meet the demands of farmers, ranchers, and households that derive their income from agriculture. Economists call these ***indirect*** and ***induced multiplier effects***.

***Indirect effects*** measure economic activity generated by farmers and ranchers' demand for inputs or supplies. These effects are the business-to-business transactions that occur in other agricultural and non-agricultural industries that provide goods and services as inputs to Pinal County farmers, such as the insurance, utility, or banking industries. ***Induced effects*** measure the economic activity generated when households employed by Pinal County farms spend their earnings on local goods and services. These effects are the household-to-business transactions that occur in industries that provide consumer goods and services to households, such as the retail, healthcare, and restaurant industries. Because of these ***indirect*** and ***induced multiplier effects***, the total economic contribution of agriculture in Pinal County is considerably greater than indicated by farm gate sales. This study conducts an economic contribution analysis for the 2016 calendar year and estimates the total (direct, indirect, and induced multiplier effects) contribution of on-farm agriculture to the Pinal County economy.

On-farm production, however, is just one part of an entire system of industries involved in and connected with agriculture. In Pinal County, a large and important industry connected with livestock production is the dairy processing and dairy product manufacturing industry. With this in mind, this analysis builds upon the results of the economic contribution analysis of on-farm agriculture to include agriculture-related industries, or industries that supply inputs and provide services that support on-farm production as well as industries that process or manufacture agricultural products (food and fiber processing). This study estimates the total 2016 contribution, including direct, indirect, and induced multiplier effects, of agriculture and agribusiness to the Pinal County economy.

This study begins with a brief history of agriculture in Pinal County and then provides a comprehensive overview of current agricultural production in the county, relying primarily on data from the 2012 Census of Agriculture.[1] The study then presents the results of the economic contribution analyses, presenting them separately. The contribution of on-farm agriculture can be found in Section 6.1 and the contribution of agriculture and agribusiness combined can be found in Section 6.2. Contributions are reported by value of sales, value added (contribution to gross regional product [GRP]), labor income, and number of full- and part-time jobs supported. Finally, this study examines potential economic impacts of reduced crop production. Reductions in crop production could result from a number of factors including unfavorable market prices or lower yields, but here the study examines reductions in crop production resulting from a hypothetical reduction of 300,000 acre-feet of irrigation water for Pinal County agriculture. Changes in agricultural acreage, agricultural production, and broader impacts to the Pinal County economy were estimated under several different fallowing scenarios.

**1** The Census of Agriculture is the most comprehensive data available for agriculture production at the county-level. The latest Census data are from 2012.

# 2 Background

Pinal County and Central Arizona have a long history of agricultural production. Archeological evidence suggests that agriculture, specifically irrigated agriculture, started as early as A.D. 600 when the native population, the Hohokam, began construction of a network of large canals near the Salt and Gila Rivers to irrigate their crops (Howard, no date; Lahmers and Eden, 2018). The Akimel O'odham (Pima) and Xalychidom Piipash (Maricopa) tribes continued agricultural production on these lands and, by the mid- to late- 1800s, they were cultivating nearly 15,000 acres, producing wheat, corn, beans, and squash (Lahmers and Eden, 2018).

Around the same time, American settlers came to the region, attracted by the prospects of mining and farming. Agricultural research and production at this time was centered around developing a long-staple, Egyptian variety of cotton used in the production of tires. Other desirable traits were its ease of use and strength for spinning thread (Saffell, 2007). Pinal County played an important role in the development of the new long-staple variety of cotton, Pima cotton, as it was first grown in Sacaton, Arizona. The cotton industry in Arizona grew rapidly in the early 1900s as Goodyear Tire & Rubber Company, who manufactured tires for World War I, purchased or leased more than 20,000 acres in the area now known as Goodyear in nearby Maricopa County (Saffell, 2007; Cornelius, 2017). By 1920, cotton acreage in Arizona had increased from 6,800 acres in 1918 to more than 180,000 acres, with much of this produced in Central Arizona. By 1950, farmers were growing cotton on "nearly every farm in Pinal County" (Saffell, 2007), cementing cotton as one of Arizona's five Cs: copper, cattle, cotton, citrus, and climate.

***Figure 1.*** *Map of Pinal County*


The agricultural industry in Central Arizona continued to grow in the region as wells were installed, dams were constructed, and other irrigation projects were pursued. Arguably the most important water infrastructure project in Arizona was the Central Arizona Project (CAP), authorized by President Lyndon B. Johnson in 1968. This canal system would divert water from the Colorado River and provide a means of delivering Arizona's share of the Colorado River (1.5 million acre-feet) to the farms and cities of Central Arizona (Central Arizona Project, 2016). The construction of the CAP canal was imperative to Central Arizona as the region's population continued to grow, irrigated agriculture expanded, and improvements in groundwater pumping technology contributed to over-pumping and groundwater overdraft. To manage its shrinking groundwater supplies and effectively ensure federal funding for CAP, the Arizona legislature passed the Groundwater Management Act in 1980 (Lahmers and Eden, 2018). The Groundwater Management Act, "was and likely still is, the most far-reaching groundwater management regulatory framework in the United States" (Megdal, 2012). It created five Active Management Areas (AMAs) and limited the expansion of agriculture by "restricting use of water for irrigation to lands that had been irrigated at some time during 1975 through 1979" in the AMAs and other areas designated as Irrigation Non-Expansion Areas (INAs) (Megdal, 2012). Most of Pinal County, primarily western Pinal County, falls within an Active Management Area, either in the Pinal, Phoenix, or Tucson AMA (Figure 1). Approximately forty-two percent (42%) of Pinal County falls within the Pinal AMA, 15% of Pinal County falls within the Phoenix AMA, and another 13% falls within the Tucson AMA. The remaining 29% of land in Pinal County acreage does not fall within an AMA.

The CAP started delivering water to Central Arizona in the late 1980s, providing critical water resources to the growing agricultural industry and Central Arizona communities. Major communities in Pinal County include Casa Grande, Coolidge, Eloy, Florence, and Maricopa. Pinal County is also home to the Ak-Chin Indian Community and portions of the Gila River Indian Community and Tohono O'odham Nation. CAP water is divided into priority pools, with high priority pools being allocated to Municipal and Industrial (M & I) water users and Indian water users, and lower priority pools for non-Indian agricultural users, and the "Ag Pool."[2] The Ag Pool supplies a large portion of irrigated agriculture in Central Arizona, most of which was used by non-Indian agriculture (Lahmers and Eden, 2018; CAP, 2016). Today, combined with pumped groundwater, CAP still represents an important source of irrigation water. That said, with low priority water rights, the Ag Pool CAP allocation would be the first to be cut in the event of a shortage on the Colorado River (Lahmers and Eden, 2018).

While the Pinal County economy has grown and diversified over the past century, agriculture is still an important contributor to the county economy. In fact, Pinal County ranks in the top 1% of all U.S. counties in terms of animal product sales, cotton and cottonseed sales, and cow milk sales. It also ranks in the top 1% for cattle and calf inventories (Table 1). The county ranks in the top 2% of counties for total agricultural sales, for cattle and calf sales, and in the top 3% for crop sales. The importance of livestock and dairy production is also reflected in feed and forage crop production. The county ranks in the top 4% nationwide for forage land, barley, and corn silage acreage. It also ranks in the top 1% for "other crops and hay" acreage, where alfalfa sales dominate in Pinal County. Note that Pinal County ranks in the top 3% in cotton acreage, but in the top 1% for cotton and cottonseed sales. This occurs because upland cotton yields are more than 60% higher in Pinal County than the national average. Yields in Pinal County regularly exceed 1,400 pounds per acre, while the national average is regularly less than 900 pounds per acre. Despite its specialization in feed, forage, and cotton crops, Pinal also ranks in the top 7% of all counties in vegetable production and fruit and nut production.

***Table 1.** Pinal County's Rankings in Sales and Acreage Among other U.S. Producing Counties, 2012*

| Item | Top % |
|---|---|
| **Market Value of Agricultural Products Sold ($1,000)** | |
| Total Value of Agricultural Products Sold | 2 |
| Value of Crops Including Nursery and Greenhouse | 3 |
| Value of Livestock, Poultry, and Their Products | 1 |
| **Value Of Sales by Commodity Group ($1,000)** | |
| Grains, Oilseeds, Dry Beans, and Dry Peas | 25 |
| Cotton and Cottonseed | 1 |
| Vegetables, Melons, Potatoes, and Sweet Potatoes | 7 |
| Fruits, Tree Nuts, and Berries | 6 |
| Other Crops and Hay | 1 |
| Cattle and Calves | 2 |
| Milk from Cows | 1 |
| **Top Crop Items (Acres)** | |
| Cotton, All | 3 |
| Forage-Land Used for All Hay and Haylage, Grass Silage, and Greenchop | 4 |
| Barley for Grain | 4 |
| Corn For Silage | 4 |
| **Top Livestock Inventory Items (Number)** | |
| Cattle and Calves | 1 |
| Colonies of Bees | 7 |

*Source: Author's calculations, U.S. Department of Agriculture, NASS Quickstats, 2014.*

**2** The "Ag Pool", or Agricultural Settlement Pool, was created in 2004 and offered a pool of excess CAP water, subject to availability, to agricultural users in Central Arizona at energy-only rates through 2030 (Central Arizona Project, 2016).

# 3 Pinal County Agriculture Overview

According to the 2012 Census of Agriculture, the most recent, comprehensive data available on county agricultural production, there were 938 farms in Pinal County, covering nearly 1.2 million acres of land, with approximately 223,626 irrigated acres (U.S. Department of Agriculture, 2014b). The average farm size in Pinal County was 1,252 acres, slightly smaller than the Arizona average of 1,312 acres, but significantly larger than the national average of 434 acres (U.S. Department of Agriculture, 2014d).

Included in these statistics is agricultural production and activity taking place on American Indian reservations in Pinal County. In the Ak-Chin Indian Community, located fully within Pinal County, there were a reported 4 farms with undisclosed acreage to prevent identification of individual farmers (U.S. Department of Agriculture, 2014a). While data is not disclosed by the Census of Agriculture, other data suggests that the Ak-Chin Indian Community has 16,000 acres of farmland, principally producing cotton, but also cultivating barley, potatoes, alfalfa and corn (Ak-Chin Tribal Enterprises, no date). The Gila River Indian Community, spanning both Pinal County and Maricopa County, had 41 farms in 2012 with more than 345,000 acres, with approximately 27,000 of those acres irrigated (U.S. Department of Agriculture, 2014a). Agricultural production in the Gila River Indian Community is heavily dominated by crops, with the most common type of agricultural operation cultivating forage crops and hay and cotton (Duval et.al, 2018). Finally, the Tohono O'odham Nation, located in Pinal, Pima, and Maricopa counties, had 64 farms in 2012 with undisclosed total acreage, but approximately 8,400 irrigated acres (U.S. Department of Agriculture, 2014a).

Pinal County, overall, is predominately a livestock-producing region, with about two-thirds of the total market value of agricultural products sold in 2012 coming from the sale of livestock and livestock products. The total market value of agricultural products sold in 2012 was nearly $928 million, with $612 million from the sale of livestock and livestock products and $316 million from the sale of crops (U.S. Department of Agriculture, 2014b). The following section takes a closer look at the commodities produced in Pinal County, as provided by the 2012 Census of Agriculture.

***Table 2.** Market Value of Livestock Sales in Pinal County and Share of Total County Animal Product Sales, 2012*

| Livestock Commodities | Farms | Sales ($2012) | Percentage of Pinal County Total Animal Product Sales |
|---|---|---|---|
| Cattle and Calves | 160 | $314,683,000 | 51.4% |
| Milk from Cows | 24 | $294,886,000 | 48.2% |
| Horses, Ponies, Mules, Burros, and Donkeys | 127 | $1,661,000 | 0.3% |
| Sheep, Goats, Wool, Mohair, and Milk | 74 | $457,000 | 0.1% |
| Other Animals and Products | 41 | $317,000 | 0.1% |
| Hogs and Pigs | 21 | $6,000 | 0.0% |
| Poultry and Eggs | 70 | (D) | (D) |
| Aquaculture | 7 | (D) | (D) |
| **Total Livestock Sales** | **378** | **$612,160,000** | |

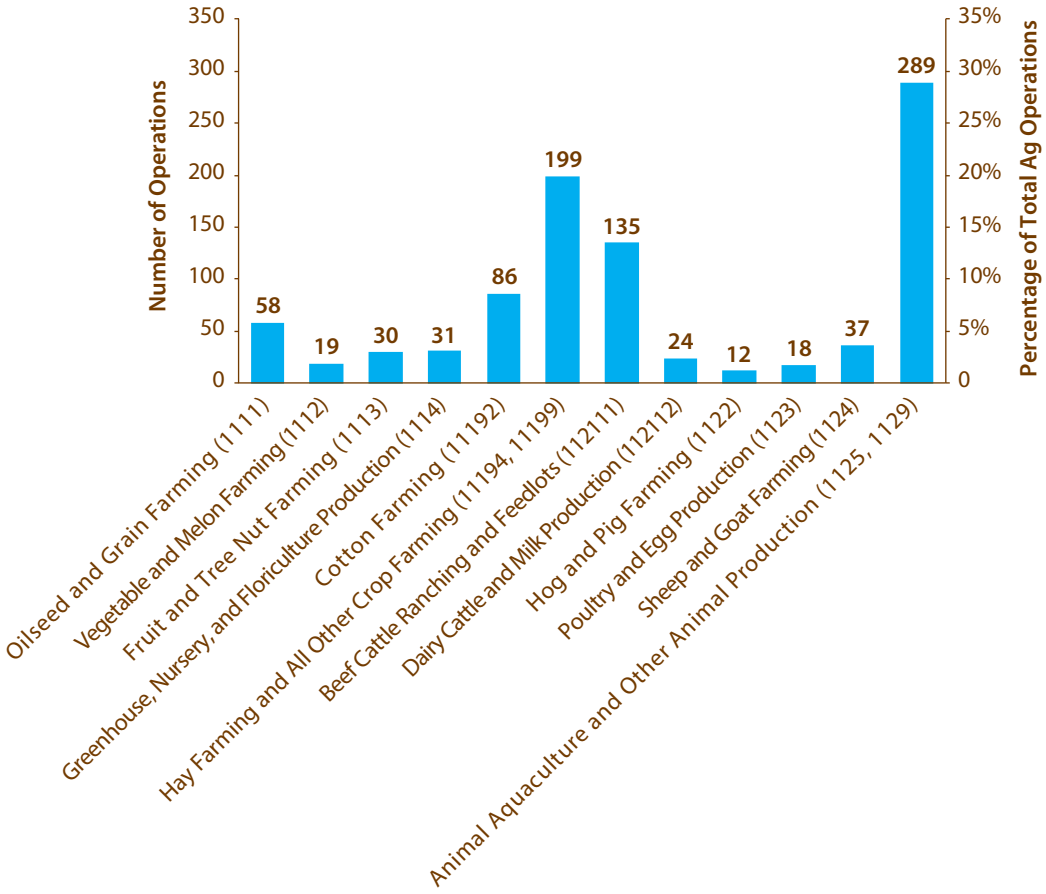
*Source: U.S. Department of Agriculture, 2014b.*

## 3.1 Livestock Production

As of 2012, nearly all livestock cash receipts in Pinal County were from the sale of cattle and calves and milk from cows, with sales split down the middle between the beef industry and the dairy industry (U.S. Department of Agriculture, 2014b). Cattle and calves accounted for approximately 51.4% of Pinal County livestock cash receipts and milk from cows accounted for approximately 48.2% of the county's livestock cash receipts (Table 2). Other livestock commodities, combined, made up less than 1% of livestock cash receipts. Sales data for poultry and eggs and aquaculture were not disclosed to prevent identification of individual farmers.

At the state level and even at the national level, as shown in Table 1, Pinal County is a leading producer of cattle and calves and milk from cows. In 2012, Pinal County ranked first among Arizona counties and 36th in the nation for cattle and calf sales (top 2%) and 15th in the nation for inventory (top 1%). Pinal County ranked second among Arizona counties and 17th among U.S. counties for milk sales (top 1%).

***Figure 2.*** *Pinal County Farms by NAICS Code Specialization, 2012*




*Source: U.S. Department of Agriculture, 2014b.*

### *3.1.1 Cattle and Calves*

With sales of nearly $315 million in 2012, Pinal County accounted for about 45% of Arizona's sales of cattle and calves. Sales originated from 160 Pinal County farms with 273,139 cattle and calves sold. Approximately 98% of the cattle and calves sold originated from 34 farms that have more than 500 head. This reflects the presence of a number of large feedlots in the county (Arizona Department of Agriculture, 2018). Of the 216 total farms in Pinal County that have an inventory of cattle, 135 farms are specialized in beef production, meaning that more than 50% of their agricultural cash receipts come from the sale of cattle and calves (Figure 2).

***Table 3.** Pinal County's Share of Arizona's Population and Milk Sales Compared to Other Arizona Counties*

| | Population | Milk Sales | State Share of Population | State Share of Milk Sales |
|---|---|---|---|---|
| **Arizona Total** | 6,498,569 | $762,957,000 | 100% | 100% |
| **Maricopa County** | 3,884,705 | $398,256,000 | 60% | 52% |
| **Pima County** | 990,380 | 0 | 15% | 0% |
| **Pinal County** | 389,192 | $294,886,000 | 6% | 39% |
| **All Other Counties** | 1,234,292 | 69,815,000 | 19% | 9% |

*Source: U.S. Department of Agriculture, 2014b; University of Arizona EBRC, 2018.*

### *3.1.2 Milk from Cows*

Pinal County is an important contributor to Arizona's milk supplies (Table 3). In 2012, Pinal County accounted for just 6% of the state's total population but accounted for 39% of the state's milk sales, with nearly $295 million in sales (Table 3). Neighboring Maricopa County ranked first in the state with milk sales of $398 million. Pinal County is an especially important source of milk for the large urban centers of Phoenix (Maricopa County) and Tucson (Pima County). These two urban counties accounted for 75% of Arizona's population but produced only 52% of the state's milk. Milk sales in Pinal County originated from 24 farms, all of which are specialized in dairy production (Figure 2).

### *3.1.3 Other Livestock Production*

Other livestock production in Pinal County is small relative to the beef and dairy industries. That said, Pinal County ranked 4th among Arizona counties and 130th in the nation for the sale of horses and ponies. In 2012, there were 127 farms that sold 308 horses and ponies valued at $1.6 million and Pinal County accounted for approximately 5% of Arizona's horse and pony sales, falling behind Maricopa County (43%) and Yavapai County (13%). While a small proportion of sales comes from these other livestock products, approximately 30% of farms in Pinal County would be considered specialized in other animal production (Figure 2).

*Table 4. Market Value of Crop Sales in Pinal County and Share of Total County Crop Sales, 2012*

| Crop Commodities | Farms | Sales ($2012) | Percentage of Pinal County Total Crop Sales |
|---|---|---|---|
| Cotton and Cottonseed | 148 | $94,008,000 | 29.8% |
| Other Crops and Hay[3] | 241 | $91,840,000 | 29.1% |
| Corn | 57 | $21,445,000 | 6.8% |
| Wheat | 59 | $19,810,000 | 6.3% |
| Barley | 82 | $13,224,000 | 4.2% |
| Fruits, Tree Nuts, and Berries | 34 | $7,781,000 | 2.5% |
| Sorghum | 35 | $7,136,000 | 2.3% |
| Other Grains, Oilseeds, Dry Beans, and Dry Peas | 8 | $185,000 | 0.1% |
| Vegetables, Melons, Potatoes, and Sweet Potatoes | 30 | (D) | (D) |
| Nursery, Greenhouse, Floriculture, and Sod | 37 | (D) | (D) |
| **Total Crop Sales** | **423** | **$315,577,000** | |

*Source: U.S. Department of Agriculture, 2014b.*

## 3.2 Crop Production

The importance of livestock and dairy production in Pinal County is also reflected in its feed and forage crop production. The top crop commodities by value produced in Pinal County, according to the 2012 Census of Agriculture, include cotton and cottonseed (29.8% of Pinal County crop sales), other crops and hay, including alfalfa (29.1% of Pinal County crop sales), and grains such as corn, wheat, barley, and sorghum (19.5% of Pinal County crop sales) (Table 4). Fruits, tree nuts, and berries account for 2.5% of county crop sales and the remainder of sales are either for vegetables, melons, potatoes, and sweet potatoes, or nursery products (data is not disclosed for these products to maintain confidentiality of producers).

Of all Arizona counties, Pinal County had the most cropland in the state, with 302,591 acres of total cropland in 2012. Maricopa County had the second highest with 222,469 acres of total cropland. Irrigated, harvested cropland in Pinal County in 2012 was 221,997 acres (U.S. Department of Agriculture, 2014b).

### *3.2.1 Cotton*

Pinal County's top crop by acreage and value of sales is cotton. In 2012, 148 farms in Pinal County produced 239,643 bales of cotton on 85,225 acres of farmland, contributing more than $94 million to county agricultural sales (U.S. Department of Agriculture, 2014b). The most common type of cotton produced in Pinal County is upland cotton. All 148 cotton farms reported producing upland cotton while only 1 farm reported producing Pima cotton. In Pinal County, there were 86 farms specialized in cotton farming (Figure 2).

**3** The USDA category of Other Crops and Hay includes crops such as hay, grass silage, haylage, greenchop, hops, maple syrup, mint for oil, peanuts, sugarcane, sugarbeets, etc. For Pinal County, this is comprised almost exclusively of forage crops.

***Table 5.** Farms, Acreage, and Forage Production (Dry Tons) of the Top 4 Arizona Forage Producing Counties, 2012*

| County | Farms | Acres | Percentage of AZ Acres | Forage Production in Tons (Dry) | Percentage of AZ Production in Dry Tons |
|---|---|---|---|---|---|
| La Paz | 70 | 66,968 | 21% | 523,162 | 23% |
| Maricopa | 293 | 88,682 | 27% | 641,942 | 28% |
| Pinal | 243 | 67,831 | 21% | 507,611 | 22% |
| Yuma | 180 | 45,238 | 14% | 326,270 | 14% |
| | | | | | |
| Top 4 Counties | 786 | 268,719 | 83% | 1,998,985 | 87% |
| | | | | | |
| Arizona | 1,390 | 324,562 | 100% | 2,288,772 | 100% |

*Source: U.S. Department of Agriculture, 2014b.*

Pinal County ranked first in Arizona for both cotton sales and acreage, producing 42% of the state's cotton sales. Similarly, 43% of Arizona's cotton acreage is located within Pinal County with 85,225 of Arizona's 197,455 cotton acres (U.S. Department of Agriculture, 2014b). Pinal County ranks 5th in the nation overall for cotton and cottonseed sales.

### 3.2.2 Hay and Other Crops

The second most valuable crop in 2012 by sales was hay and other crops.[4] Pinal County ranked third in Arizona for the value of hay and other crops sold, valued at $91.8 million. Maricopa County ($119.3 million) and La Paz County ($97.7 million) are first and second in the state.

Pinal County accounted for approximately 21% of acreage and 22% of the production of forage in dry tons in the state, including hay, grass silage, haylage, and greenchop. The majority of forage land for the production of feed crops in the state is located in Central Arizona (in Pinal and Maricopa counties) and in Western Arizona (La Paz and Yuma counties). These top 4 feed-producing counties accounted for 87% of the state's production of dry forage tonnage (Table 5). Nationally, Pinal County is ranked 17th for other crop and hay sales (top 4%). Forage markets tend to be localized due to transportation costs. The high concentration of dairies and feedlots accounts for this localized concentration of feed production in Central Arizona.

### 3.2.3 Corn

In 2012, Pinal County produced more than $21 million of corn (Table 4). The majority of corn produced in Pinal County is corn for silage or greenchop, with 48 farms producing 555,499 tons on 17,795 acres of land. Pinal County ranked first in the state for acreage and tonnage of corn for silage, followed by Maricopa County with 13,674 acres and 365,200 tons produced (U.S. Department of Agriculture, 2014b).

Alone, Pinal County accounted for approximately 55% of the tonnage of corn silage produced in the state, but including Maricopa County's production, these two counties accounted for approximately 91% of the corn silage tonnage produced in the state. Corn silage is an important component of feed for the county's livestock industry. Again, production tends to occur near livestock operations due to transportation costs. An additional 12 farms in Pinal County produced 541,649 bushels of corn for grain on 2,983 acres.

**4** This statistic, as defined by the 2012 Census of Agriculture, includes the value of sales from hay, grass silage, haylage, greenchop, hops, maple syrup, mint for oil, peanuts, sugarcane, sugarbeets, etc. Sales are almost exclusively forage crops.

Pinal County accounted for approximately one-tenth of the state's acreage and production of corn for grain.

### 3.2.4 Small Grains (Wheat and Barley)

In 2012, Pinal County had 59 farms with wheat sales, valued at $19.8 million (Table 4). Most wheat produced in Pinal County is durum wheat. In 2012, 56 farms in Pinal County harvested 16,436 acres of Durum wheat, producing more than 1.5 million bushels. Durum wheat is a market class of wheat utilized around the world for pasta making (Duval et al., 2016). An additional nine farms produced winter wheat, farming 1,400 acres and producing nearly 100,000 bushels.

In 2012, Pinal County produced nearly 2.5 million bushels of barley, valued at $13.2 million (Table 4). Barley was produced on 82 farms and 21,400 acres. Pinal County ranked first in the state and accounted for nearly 50% of Arizona's statewide production of barley. Together with Maricopa County, the second largest barley-producing county in Arizona, these two counties accounted for 85% of the state's barley acreage and 84% of the bushels produced (U.S. Department of Agriculture, 2014b). Most barley grown in Arizona is grown for animal feed.

In Arizona, small grains are grown in rotation with cotton, vegetables, or hay. In fact, previous research by Duval et al. (2016) demonstrated that most wheat and other small grain production occurs on farms that specialize in the production of other commodities. For example, 36% and 29% of small grain sales originate from operations specializing in hay farming and vegetable and melon farming, respectively.

### 3.2.5 Fruits, Tree Nuts, and Berries

In 2012, Pinal County had 59 farms with land in orchards and 34 farms with sales of fruit, tree nuts, and berries, valued at nearly $8 million (Table 4). Not all farms with land in orchards had sales in 2012, due to non-bearing acreage.

While only 18 of these 59 farms grow tree nuts, approximately 48% of the orchard acreage in Pinal County was for the production of nuts (1,798 of 3,744 acres). Nuts produced in Pinal County include almonds (6 farms), pecans (10 farms), and pistachios (2 farms).

Orchard acreage for much of the fruit production in Pinal County is not disclosed, but farms in Pinal County grew citrus fruits such as oranges (30 farms) and lemons (26 farms), and non-citrus fruits such as peaches (17 farms), grapes (14 farms), apples (13 farms), avocados (12 farms), and pomegranates (8 farms), among others (U.S. Department of Agriculture, 2014b).

### 3.2.6 Sorghum

In 2012, Pinal County had 35 farms with sales of sorghum, valued at $7.1 million (Table 4). Sorghum is widely used as livestock feed and can either be grown as sorghum for grain or sorghum for silage or greenchop. In Pinal County, more acreage is devoted to sorghum for silage or greenchop (6,611 acres) than sorghum for grain (4,005 acres). That said, Pinal County is the largest producer of sorghum for grain in the state, accounting for 38% of the state's acreage and 43% of the bushels produced (U.S. Department of Agriculture, 2014b).

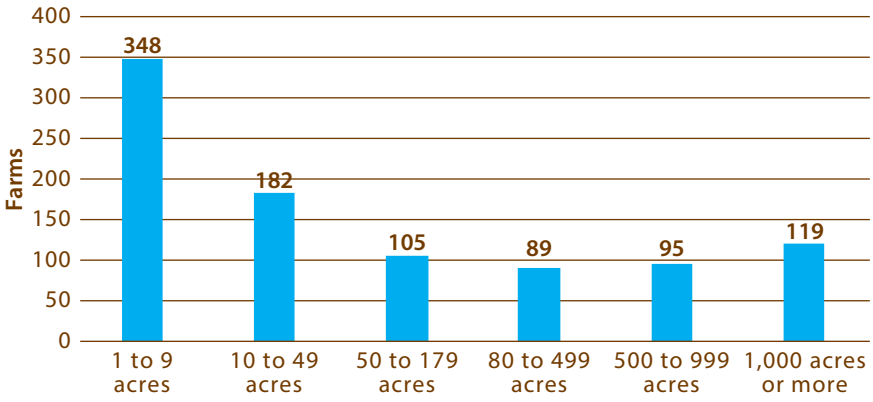
### *3.2.7 Vegetables, Melons, Potatoes, and Sweet Potatoes*

Although sales data is not disclosed for vegetables, melons, potatoes, and sweet potatoes in Pinal County (Table 4), the county ranked third in the state for vegetable and melon sales, behind Yuma and Maricopa counties.

In 2012, Pinal County had 30 farms producing vegetables harvested for sale on 8,593 acres. Acreage is not disclosed for many individual vegetable commodities, but farms in Pinal County grew lettuce (14 farms), tomatoes (12 farms), sweet corn (7 farms), asparagus (6 farms), snap beans (6 farms), beets (6 farms), green onions (6 farms), pumpkins (4 farms), and watermelons (4 farms), among other vegetables and melons (U.S. Department of Agriculture, 2014b).

Compared to vegetable production in Yuma and Maricopa counties, acreage in Pinal County is closer to Maricopa County. While Yuma County had over 100,000 acres of vegetables harvested for sale, Maricopa County had just above 12,600 acres, about 4,000 acres more than Pinal County (U.S. Department of Agriculture, 2014b).

***Figure 3.** Pinal County Farms by Size (Acreage), 2012*




*Source: U.S. Department of Agriculture, 2014b.*

## 3.3 Farm Characteristics

As mentioned previously, farms can be classified based on the commodity that they "specialize" in. Specialization is determined by NAICS code[5] and identifies farms by their top agricultural commodity. Of the 938 farms in Pinal County, the majority are specialized in hay and other crop farming (199 farms) and animal aquaculture and other animal production (289 farms) (Figure 2). The latter category includes operations where "no one animal or family of animals [accounts] for one-half of the establishment's agricultural production" (U.S. Department of Agriculture, 2014b). Considering that Pinal County is considered part of the Phoenix metropolitan statistical area, the other animal production statistic is likely capturing many domestic animal breeding operations, particularly horse breeding. This is supported by the fact that the third most valuable livestock product in Pinal County in 2012 was sales of horses and ponies. Other farms specializing in animal aquaculture or other animal production could be involved in apiculture (beekeeping) or raising other animals.

As mentioned previously, nearly 1.2 million acres of land were in Pinal County farms. In terms of land in farms by types of use, 70.1% was dedicated to pastureland, 25.8% to cropland, and 4.1% to other uses. In terms of acreage, most farms in Pinal County would be considered small scale. In 2012, 37% of Pinal County farms had less than 10 acres and 19% had acreage between 10 and 49 acres (Figure 3).

**5** The North American Industry Classification System (NAICS) is a system of codes used in the United States, Mexico, and Canada to categorize enterprises (as well as their sales, value added, employment, etc.) for statistical purposes based upon the economic activity or activities in which they are engaged.

***Table 6.** Pinal County Farms by Size (Value of Sales), 2012*

| Farms by Value of Sales | Farms | Percentage | Sales | Percentage |
|---|---|---|---|---|
| Less than $1,000 | 256 | 27% | $23,000 | 0.002% |
| $1,000 to $2,499 | 65 | 7% | $103,000 | 0.011% |
| $2,500 to $4,999 | 52 | 6% | $180,000 | 0.019% |
| $5,000 to $9,999 | 99 | 11% | $644,000 | 0.1% |
| $10,000 to $24,999 | 100 | 11% | $1,466,000 | 0.2% |
| $25,000 to $49,999 | 54 | 6% | $1,798,000 | 0.2% |
| $50,000 to $99,999 | 31 | 3% | $1,917,000 | 0.2% |
| $100,000 to $249,999 | 78 | 8% | $13,461,000 | 1.5% |
| $250,000 to $499,999 | 58 | 6% | $21,482,000 | 2.3% |
| $500,000 or more | 145 | 15% | $886,662,000 | 95.6% |
| **Total** | **938** | **100%** | **$927,736,000** | **100.0%** |

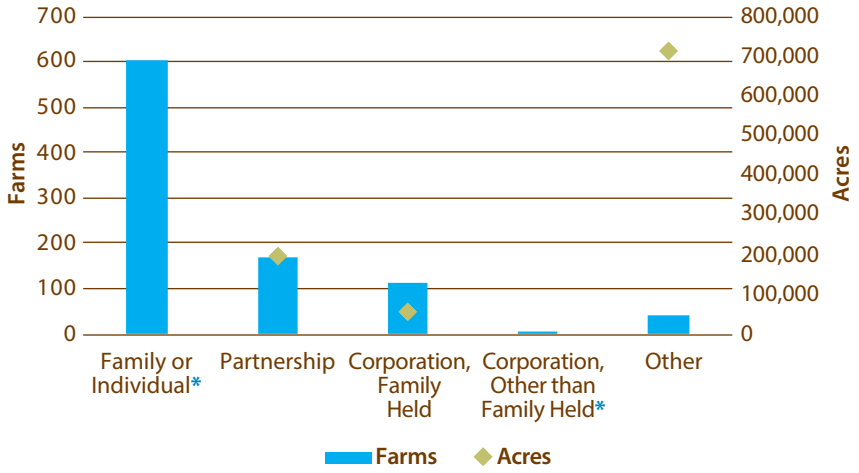
*Source: U.S. Department of Agriculture, 2014b.*

Similarly, most farms in Pinal County would be considered small scale in terms of sales, with approximately 50% of farms with sales less than $10,000 (Table 6). In fact, the highest proportion of Pinal County farms (256 or 27%) have less than $1,000 in annual sales. The 203 operations with sales of $250,000 or more accounted for 21% of farms, but 98% of Pinal County's agricultural sales (Table 6).

Pinal County farmers have one of the highest average net cash farm incomes in the state ($181,133), only falling behind farmers in Yuma County ($590,209) and La Paz County ($293,889) (U.S. Department of Agriculture, 2014b).

Pinal County farm operators managed more than $3 billion in assets. This includes roughly $2.8 billion in land and buildings and $177 million in farm machinery. USDA does not report dollar values of animal inventories, but Pinal County farm operators held more than 300,000 animals in 2012 (U.S. Department of Agriculture, 2014b). Pinal County farm operators made $10.4 million in interest payments to the finance and banking system and reported paying $6.1 million in property taxes (U.S. Department of Agriculture, 2014b).

***Figure 4.** Pinal County Farms and Associated Acreage by Legal Status for Tax Purposes, 2012*




*Source: U.S. Department of Agriculture, 2014b.*
**Acreage data not disclosed to protect confidentiality of individual farm data.*

Averages, however, can be misleading. A closer look at county net cash farm income statistics reveals that 373 farms in Pinal County had net gains and 565 farms had net losses. The average net cash farm income among farms with net gains was $540,351, while the average net cash farm income among farms with net losses was -$56,014 (U.S. Department of Agriculture, 2014b).

Most farms (64% or 602 of 938) in Pinal County were family or individual owned farms. This was followed by partnerships and family-held corporations. By acreage, most acreage within the county falls under the "other" category, representing cooperatives, estates, or trusts, with more than 720,000 acres (Figure 4).

***Table 7.** Pinal County Farms, Operators, and Land in Farms for All Operators and Principal Operators by Race, 2012*

| | All Operators | | | Principal Operators | |
|---|---|---|---|---|---|
| | Farms | Operators | Land in Farms (Acres) | Farms | Land in Farms (Acres) |
| American Indian or Alaska Native Operators | 74 | 84 | (D) | 63 | (D) |
| Asian Operators | 6 | 7 | 78 | 6 | 78 |
| Black or African American Operators | 5 | 5 | 100 | 5 | 100 |
| Native Hawaiian or Other Pacific Islander Operators | 9 | 9 | 480 | — | — |
| Spanish, Hispanic, or Latino Origin Operators | 132 | 165 | 57,938 | 81 | 32,820 |
| White Operators | 863 | 1,380 | (D) | 857 | (D) |
| Operators Reporting More than One Race | 9 | 16 | 6,598 | 7 | 6,040 |
| **Total** | **938** | **1,531** | **1,174,727** | **236** | **1,174,727** |

*Source: U.S. Department of Agriculture, 2014b.*

Of the 1,531 operators of Pinal County's 938 farms, 90% reported their race as white, 11% as Spanish, Hispanic, or Latino origin, and 5% as American Indian or Alaska Native (Table 7). Less than 1% reported their race as Native Hawaiian or Other Pacific Islander, Black or African American, Asian, or more than one race.

Approximately one-third of farm operators in Pinal County were women, with 512 women operators on 480 farms and accounting for more than 250,000 acres (Table 8). There were 208 farms (just over 20% of farms) in Pinal County with female principal operators, accounting for nearly 45,000 acres.

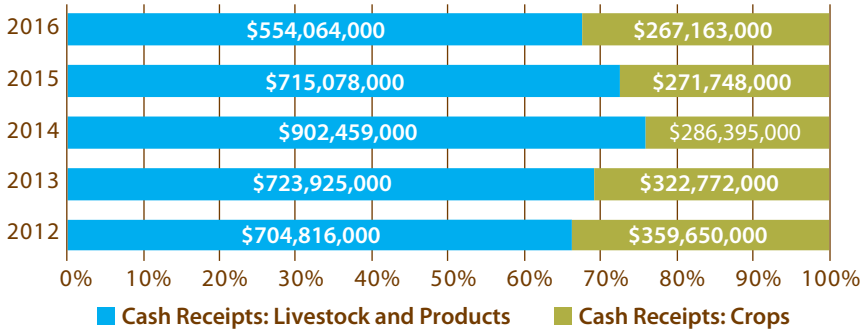
In 2012, approximately 63% of principal operators (589) in Pinal County considered farming as their principal occupation. In fact, more than half of the Pinal County principal operators (516) reported that they did not have any days where they worked off farm. In contrast, about 30% of Pinal County principal operators reported working 200 days or more off farm. In 2012, the average age of principal operators in Pinal County was 56 years, up from 53.3 years in 2007 (U.S. Department of Agriculture, 2014b).

***Table 8.** Pinal County Farms, Operators, and Land in Farms for All Women Operators and Principal Women Operators, 2012*

| | All Operators | | | Principal Operators | |
|---|---|---|---|---|---|
| | Farms | Operators | Land in Farms (Acres) | Farms | Land in Farms (Acres) |
| Female Operators | 480 | 512 | 254,193 | 208 | 44,504 |
| Male Operators | 458 | 1,019 | 920,531 | 730 | 1,130,220 |
| **Total** | **938** | **1,531** | **1,174,724** | **938** | **1,174,724** |

*Source: U.S. Department of Agriculture, 2014b and authors' calculations.*

***Figure 5.** Pinal County Agricultural Cash Receipts, 2012–2016 (Nominal Dollars)*



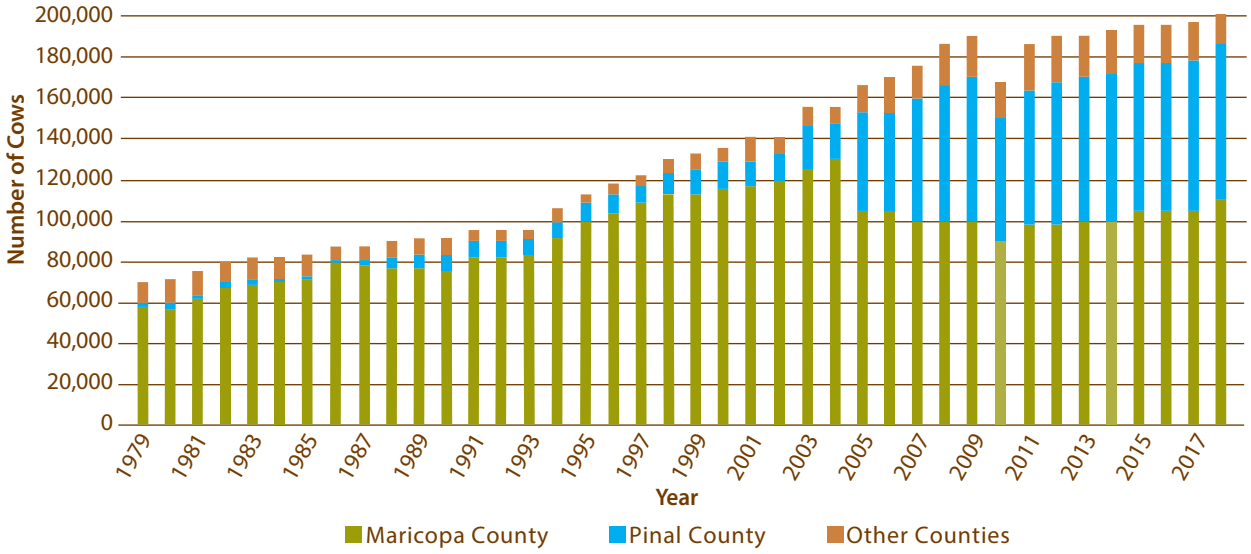

*Source: U.S. Department of Commerce, BEA, 2016.*

## 3.4 Recent Trends in Agricultural Production

As detailed in previous sections, Pinal County is largely a livestock producing county, with approximately two-thirds (2/3) to three-quarters (3/4) of the county's total annual agricultural sales derived from livestock and their products (BEA, 2012–2016) (Figure 5). In 2014, high cattle prices drove livestock cash receipts to more than $900 million, in nominal prices.

Consistent with state-level trends, the dairy industry has been growing in Pinal County, in part due to the demand for milk and other dairy products in the growing urban areas of Central Arizona. Between 1979 and 2017, Arizona's milk cow inventory increased from about 70,000 cows to more than 200,000 cows, with Pinal County playing a major role in raising milk cows since around 2005 (Figure 6).

***Figure 6.** Arizona Milk Cow Inventory by County, 1979–2017*




*Source: U.S. Department of Agriculture, NASS Quickstats, multiple years.*

***Table 9.** Pinal County Livestock Inventory, 2002–2007–2012*

| | Inventory | | | |
|---|---|---|---|---|
| **Livestock Inventory in Pinal County** | **2002** | **2007** | **2012** | **Percentage Change (2002 to 2012)** |
| Cattle and Calf Inventory | 241,360 | 397,517 | 306,517 | 27.0% |
| Beef Cows | 8,515 | 18,219 | 10,220 | 20.0% |
| Milk Cows | 21,302 | 66,892 | 71,139 | 234.0% |
| Hogs and Pig Inventory | 495 | 328 | 68 | -86.3% |
| Sheep and Lamb Inventory | 9,841 | (D) | 3,318 | -66.3% |
| Poultry—Layers 20 Weeks Old and Older Inventory | 530 | 1,958 | 3,019 | 469.6% |

*Source: U.S. Department of Agriculture, NASS Quickstats, multiple years.*

Taking a closer look at livestock inventory trends for Pinal County, the growth in the dairy industry becomes even more apparent. Between 2002 and 2012, inventory of milk cows in Pinal County grew more than 200% from around 20,000 milk cows to more than 70,000 milk cows (Table 9). Some of this growth is due to dairies moving from urban Maricopa County into Pinal County. In contrast, over the same timeframe, the beef cow inventory has experienced both growth and contraction, increasing significantly from 2002 to 2007, but decreasing between 2007 and 2012, for a net increase of 20%.

As the dairy and beef industries have continued to grow in Pinal County, crop production has largely shifted towards agricultural products that are used as feed crops for these industries. There has been a shift in acreage towards forage land, growing hay (including alfalfa hay), grass silage, haylage, and greenchop and corn for silage. This has been accompanied by a reduction in acreage for both wheat and cotton (Table 10).

***Table 10.** Pinal County Selected Crops Harvested, 2002–2007–2012*

| | Acres Harvested | | | |
|---|---|---|---|---|
| **Selected Crops Harvested in Pinal County** | **2002** | **2007** | **2012** | **Percentage Change (2002 to 2012)** |
| Barley for Grain | 17,476 | 11,718 | 21,436 | 22.7% |
| Corn for Grain, Silage or Greenchop | 8,265 | 15,925 | 20,958 | 153.6% |
| Cotton | 94,075 | 73,718 | 85,225 | -9.4% |
| Dry Edible Beans, Excluding Limas | (D) | (D) | 533 | NC |
| Sorghum for Grain, Silage or Greenchop | (D) | 18,477 | 10,616 | NC |
| Wheat for Grain | 27,508 | 19,316 | 17,869 | -35.0% |
| Forage-Land Used for All Hay and All Haylage, Grass Silage, and Greenchop | 46,211 | 63,811 | 67,831 | 46.8% |
| Vegetables Harvested for Sale | 7,593 | 9,811 | 8,593 | 13.2% |
| Land in Orchards | (D) | (D) | 3,744 | NC |
| All Harvested Cropland | 207,635 | 209,076 | 226,962 | 9.3% |

*Source: U.S. Department of Agriculture, NASS Quickstats, multiple years.*

Another trend emerges examining the water use for Pinal County's top crops, cotton and other crops and hay. Research by Frisvold (2016) found that irrigation application intensity (the amount of water applied per unit of land area) for cotton decreased in Arizona from 4.9 acre-feet (per acre)[6] in 1984 to 4.5 acre-feet (per acre) in 2013. Despite the decrease in water applied, cotton crop productivity, as measured by pounds of cotton produced per acre-foot, increased from 272 pounds per acre-foot to 335 pounds per acre-foot. In the case of alfalfa hay, water applications increased slightly from 5.2 acre-feet (per acre) in 1983 to 5.4 acre-feet (per acre) in 2013, but crop water productivity increased from 1.35 tons to 1.54 tons per acre-foot of water applied (U.S. Department of Agriculture, 2014d).

**6** An acre-foot is the volume of water needed to cover one acre of land to a depth of one foot (Maupin et al., 2014).

# 4 Economic Base Analysis

While it's clear that Pinal County plays a significant role in the state's production of many agricultural commodities, what is the role of agriculture to the Pinal County economy relative to other industries?

In regional economics, economic base theory divides sectors of a local economy (for these purposes, a county economy) into basic and non-basic sectors. In basic sectors, the primary markets for locally produced goods and services lay outside of that county. The county produces more goods or services than are needed to meet local demands and much of what is produced locally is "exported" to other areas. Here, exports refer to sales to parties outside the county and not necessarily international exports. For example, in this context, sales from Pinal County to California, Phoenix, or Tucson would be exports. Basic sectors play an important role in the county economy because the sales they generate bring money into the county economy from outside. Because exports draw new income and purchasing power into a county, expanding basic sectors is considered crucial for the region's economic development (Thulen, 2015).

Non-basic sectors are those that depend on the local population as their main source of demand. Many non-basic sectors are those that provide goods and services to proprietors and workers employed in basic sectors as well as proprietors and workers in other non-basic sectors. These sectors might include grocery stores, pharmacies, barbershops, auto repair shops, etc., that primarily serve the local population.

A common way to evaluate a sector's contribution to a county's economic base is the application of location quotients (LQ), originally developed by Florence (1929). Mathematically, a LQ is measured as a local sector's share of total 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 particular economic sector
$LQ_i$ = 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. 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 is often taken to indicate that 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, a 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.

***Table 11.** Pinal County Industries Ranked by Employment Location Quotient, 2017*

| Rank | Industry | Annual Average Employment Location Quotient |
|---|---|---|
| 1 | NAICS 212230 Copper, Nickel, Lead, and Zinc Mining | 148.1 |
| **2** | **NAICS 111920 Cotton Farming** | **47.8** |
| 3 | NAICS 561210 Facilities Support Services | 47.7 |
| **4** | **NAICS 112120 Dairy Cattle and Milk Production** | **25.7** |
| **5** | **NAICS 115111 Cotton Ginning** | **23.0** |
| **6** | **NAICS 111940 Hay Farming** | **18.5** |
| **7** | **NAICS 111998 All Other Miscellaneous Crop Farming** | **7.6** |
| **8** | **NAICS 115112 Soil Preparation, Planting, and Cultivating** | **6.1** |
| **9** | **NAICS 111140 Wheat Farming** | **5.9** |
| 10 | NAICS 531190 Lessors of Other Real Estate Property | 5.4 |
| **11** | **NAICS 115113 Crop Harvesting, Primarily by Machine** | **5.2** |
| 12 | NAICS 447190 Other Gasoline Stations | 5.0 |
| 13 | NAICS 327320 Ready-Mix Concrete Manufacturing | 4.8 |
| 14 | NAICS 813990 Other Similar Organizations | 4.4 |
| 15 | NAICS 237110 Water and Sewer System Construction | 3.4 |
| 16 | NAICS 811412 Appliance Repair and Maintenance | 2.9 |
| **17** | **NAICS 424910 Farm Supplies Merchant Wholesalers** | **2.6** |
| 18 | NAICS 811192 Car Washes | 2.5 |
| 19 | NAICS 453910 Pet and Pet Supplies Stores | 2.4 |
| 20 | NAICS 621330 Offices of Mental Health Practitioners | 2.3 |

*Source: U.S. Department of Labor, BLS, 2017.*

Table 11 reports the top 20 Pinal County 6-digit NAICS code[7] industries by employment location quotient. The more specialized a region is in a particular industry, the higher its location quotient (LQ). For Pinal County, the location quotient for cotton farming was 47.8 in 2017. This means that the share of employment in cotton production in Pinal County is 47.8 times the national average (Table 11). Of the top 20 industries in Pinal County ranked by location quotient, 9 are agricultural or agriculture-related industries (bolded in Table 11). The location quotients also reflect the importance of mining and private prisons (a major component of Facilities Support Services) in Pinal County.

If one were to calculate the employment LQs by 3-digit NAICS, Pinal County is considered specialized in all aspects of on-farm production. In 2017, the Pinal County employment LQs for crop production (111), livestock production (112), and agriculture and forestry support activities (115) were 2.8, 11.3, and 2.0, respectively.

One can also use LQs to identify national centers of production. Not only is the location quotient for cotton farming quite high, but so too are the LQs for hay farming, cotton ginning, and milk production. To put these numbers in perspective, the LQ for automobile manufacturing is 24.8 in Wayne County, Michigan (which includes the city of Detroit). So, in terms of labor specialization, cotton farming and dairies are to Pinal County what auto manufacturing is to Detroit.

**7** The North American Industry Classification System (NAICS) is a system of codes used in the United States, Mexico, and Canada to categorize enterprises (as well as their sales, value added, employment, etc.) for statistical purposes based upon the economic activity or activities in which they are engaged). NAICS codes range from 3-digit codes to 6-digits codes. Each additional digit signifies greater industry detail. For example, the 3-digit NAICS code for Crop Production is 111. Within Crop Production is Oilseed and Grain Crop Production (NAICS Code 1111); while within that category is Wheat Farming (NAICS Code 11114).

# 5 Role of Off-Farm Agribusiness in Pinal County

In Pinal County, agriculture and agribusiness (hired labor for on-farm production, food and fiber manufacturing, and farm input manufacturing) account for about 9% of all private sector jobs and 10% of all private sector annual wages. Yet, agriculture and agribusiness accounts for a larger share of basic industry employment. Among all sectors with a location quotient of 1.25 or higher, agriculture and agribusiness account for 15% of jobs and 18% of county wages.

Food manufacturing is Pinal County's single largest manufacturing sector aggregated at the 3-digit NAICS code level. Food manufacturing businesses account for 28% of all manufacturing jobs in Pinal County but account for a higher share (33%) of manufacturing wages (Table 12). This is because wages in food manufacturing are higher than average manufacturing wages in the county. The largest industry within food manufacturing is dairy product manufacturing. Dairy product manufacturing accounts for 18% of county manufacturing jobs while all other food manufacturing production accounts for another 10% of county manufacturing jobs. Annual wages per employee are $13,754 per year higher in the dairy manufacturing sector ($66,830 per employee per year) compared to the county average for all manufacturing jobs ($53,076). Agriculture-related manufacturing is also present as part of other manufacturing sectors. For example, three of the nine chemical manufacturing businesses in the county are fertilizer manufacturers, while one of the eight machinery manufacturing businesses is a farm machinery business (Table 12).

***Table 12.** Food and Agricultural Manufacturing in Relation to All Manufacturing in Pinal County, 2017*

| Type of Manufacturing | Businesses | Jobs | Total Wages | Annual Wages per Employee | Share of Jobs | Share of Wages |
|---|---|---|---|---|---|---|
| NAICS 31-33 All Manufacturing | 109 | 3,592 | $190,638,838 | $53,076 | 100% | 100% |
| **NAICS 311 Food** | **13** | **1,021** | **$62,753,122** | **$61,467** | **28%** | **33%** |
| **NAICS 3115 Dairy Product** | **5** | **644** | **$43,066,193** | **$66,830** | **18%** | **23%** |
| **All Other Food (Calculated)** | **8** | **377** | **$19,686,929** | **$52,220** | **10%** | **10%** |
| NAICS 327 Nonmetallic Mineral Product | 19 | 440 | $23,315,446 | $53,010 | 12% | 12% |
| **NAICS 325 Chemical** | **9** | **421** | **$17,332,132** | **$41,193** | **12%** | **9%** |
| **NAICS 32531 Fertilizer** | **3** | **(ND)** | **(ND)** | **(ND)** | **0%** | **0%** |
| NAICS 326 Plastics & Rubber Products | 6 | 281 | $13,799,391 | $49,050 | 8% | 7% |
| NAICS 332 Fabricated Metal Product | 14 | 254 | $11,536,643 | $45,390 | 7% | 6% |
| NAICS 331 Primary Metal | 6 | 139 | $6,755,822 | $48,545 | 4% | 4% |
| NAICS 336 Transportation Equipment | 5 | 72 | $3,701,043 | $51,582 | 2% | 2% |
| **NAICS 333 Machinery** | **8** | **54** | **$2,353,075** | **$43,508** | **2%** | **1%** |
| **NAICS 333111 Farm Machinery** | **1** | **(ND)** | **(ND)** | **(ND)** | **0%** | **0%** |
| NAICS 339 Miscellaneous | 7 | 41 | $1,999,265 | $48,862 | 1% | 1% |
| NAICS 323 Printing | 10 | 29 | $839,658 | $28,871 | 1% | 0% |
| All Unreported Industries Combined | 8 | 840 | $46,253,241 | $55,063 | 23% | 24% |

*Source: U.S. Department of Labor, BLS, 2017.*
*(ND): Not disclosed.*

***Table 13.** Agriculture-Related Wholesale Trade in Pinal County, 2017*

| Industry | Businesses | Jobs | Total Annual Wages | Annual Wages per Employee | Share of Jobs | Share of Wages |
|---|---|---|---|---|---|---|
| NAICS 42 Wholesale Trade | 158 | 1,053 | $84,249,517 | $80,003 | 100% | 100% |
| NAICS 4245 Farm Product Raw Materials | 6 | 121 | $6,652,159 | $55,205 | 11% | 8% |
| NAICS 42491 Farm Supplies | 10 | 128 | $9,311,058 | $72,601 | 12% | 11% |

*Source: U.S. Department of Labor, BLS, 2017.*

There are also agriculture-related businesses involved in wholesale trade. In Pinal County, agriculture-related wholesale trade accounts for 23% of all wholesale trade jobs and 19% of all wholesale trade wages (Table 13).

These data suggest that Pinal County is specialized in the production of many agricultural commodities and that agriculture and agribusiness, as a whole, plays an important role in the county's economic base. The following section will examine the total contribution of on-farm agriculture and agribusiness to the Pinal County economy, including the direct, indirect, and induced multiplier effects.

# 6 Economic Contribution Analysis Results

The contribution of agriculture to the Pinal County economy extends beyond the value of on-farm production. In addition to the direct contribution of agriculture through the value of farm-gate sales, or agricultural cash receipts, a "ripple" of economic activity is stimulated in other industries to meet the demands of farmers and ranchers and households that derive their income from agriculture. Economists call these ***indirect*** and ***induced multiplier effects***.

***Indirect effects*** measure economic activity generated by farmers and ranchers' demand for inputs or supplies. These effects are the business-to-business transactions that occur in other local agricultural and non-agricultural industries that provide goods and services as inputs to Pinal County farmers, such as the insurance, utility, or banking industries. Additional rounds of indirect effects occur when these farm input suppliers purchase inputs from other Pinal County businesses for their own operations.

***Induced effects*** measure the economic activity generated when households employed by Pinal County farms 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 to estimate the total (direct, indirect, and induced effects) contribution of on-farm agriculture to the Pinal County economy in 2016 (IMPLAN Group, LLC, 2016). 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.[8]

On-farm production is just one part of an entire system of industries involved in and connected with agriculture. In Pinal County, a prime example of an industry connected with on-farm production is the dairy product manufacturing industry. As demonstrated previously, dairy product manufacturing plays a significant role in county employment and income.

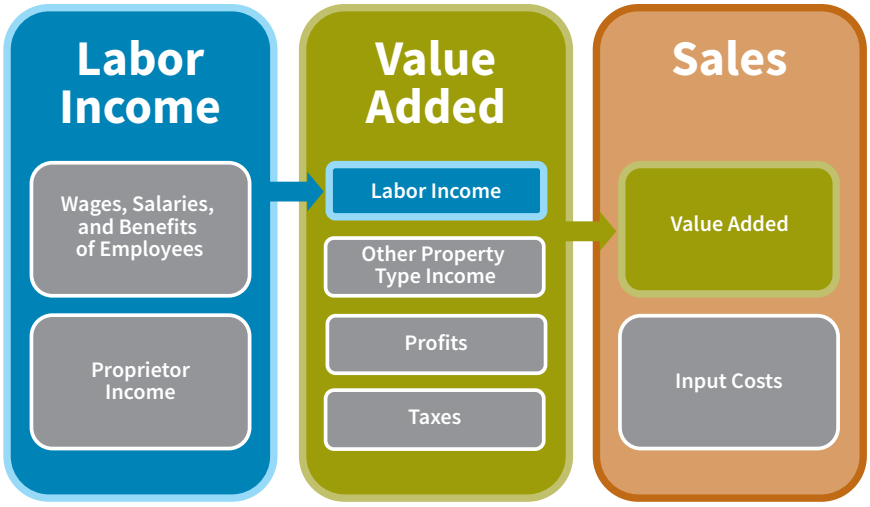
With this in mind, this analysis builds upon the results of the economic contribution analysis of on-farm agriculture to include agriculture-related industries, or industries that supply inputs and provide services that support on-farm production as well as industries that process or manufacture agricultural products (food and fiber processing).[9] This study estimates the total 2016 contribution (direct, indirect, and induced multiplier effects) of agriculture and agribusiness to the Pinal County economy.

The contribution of agriculture and agribusiness to the Pinal County economy is 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 Pinal County. When this occurs, that spending has "leaked" out of the Pinal County economy and the circulation of those dollars, and the resulting indirect and induced multiplier effects, cease. Nevertheless, because of these multiplier effects, the economic contribution of on-farm agriculture and its related industries is considerably greater than indicated by farm-gate sales figures.

8 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).

9 Agriculture and agribusiness includes on-farm agriculture (NAICS codes 111, 112, and 115), agricultural input manufacturing industries (NAICS codes 325311, 325312, 32532, and 333111), and a selection of food and fiber processing/manufacturing industries (NAICS codes 311, 31213, 3131, 31321, and 3161). A more thorough discussion of the industries included in the analysis is provided in Appendix C.

*Figure 7. Components of Economic Sales (Output)*




This study presents economic contributions in several different ways. **Sales (or gross output)** is an intuitive way to measure and understand economic activity because it's the way we measure individual transactions in our daily lives. While the sales metric provides an easy-to-understand, cumulative measure of economic activity, it can be misleading when talking about local economic contributions. 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 another commodity. 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 relationship between feed crops and livestock operations. Feed crops sold by Pinal County farms may be purchased as inputs by Pinal County livestock producers. One business' revenues are another's expenditures, leading to a double counting of the value of the feed.

Therefore, economists prefer to use the value-added metric. **Value added** measures the value created by an industry over and above the costs of inputs, like gross domestic product (GDP), or in the case of Pinal County, the gross regional product (GRP). 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 7 demonstrates the relationship between sales, value added, and labor income.

The following sections present the results of the Pinal County 2016 economic contribution analyses for: (1) on-farm agriculture and (2) on-farm agriculture and agribusiness combined. Model simulations were conducted using the IMPLAN Version 3.1 input-output data and software (IMPLAN Group, LLC, 2016). Results are presented for the 2016 production year, the latest data available from IMPLAN.

## 6.1 Contribution of On-Farm Agriculture to Pinal County Economy

### 6.1.1 Direct Contribution of On-Farm Agriculture

In 2016, the crop and livestock industries directly contributed an estimated $875.1 million in sales to the Pinal County economy. Of that total, crop industries contributed approximately $275.8 million and livestock industries contributed approximately $599.3 million. These industry sales include the value of agricultural cash receipts plus any additional industry sales that are generated by other farm activities.[10] For example, some operators boost farm sales by providing farm tours (agritourism) or selling agricultural support services to other farmers. The agricultural support service industry in Pinal County had estimated sales of $33 million in 2016 (IMPLAN Group, 2016). Combined, on-farm agriculture represented $908.1 million in direct sales in 2016 and directly contributed $273 million to Pinal County's gross regional product (Table 14).

***Table 14.** Economic Contribution of On-Farm Agriculture to Pinal County Economy, 2016*

| Impact Type | Direct Effect | Indirect Effect | Induced Effect | Total Effect |
|---|---|---|---|---|
| Sales (Output) | $908,100,000 | $134,100,000 | $79,600,000 | $1,121,800,000 |
| *Value Added* | $273,000,000 | $58,500,000 | $41,300,000 | $372,800,000 |
| *Labor Income* | $190,500,000 | $31,700,000 | $17,000,000 | $239,200,000 |
| Employment | 3,804 | 732 | 611 | 5,147 |

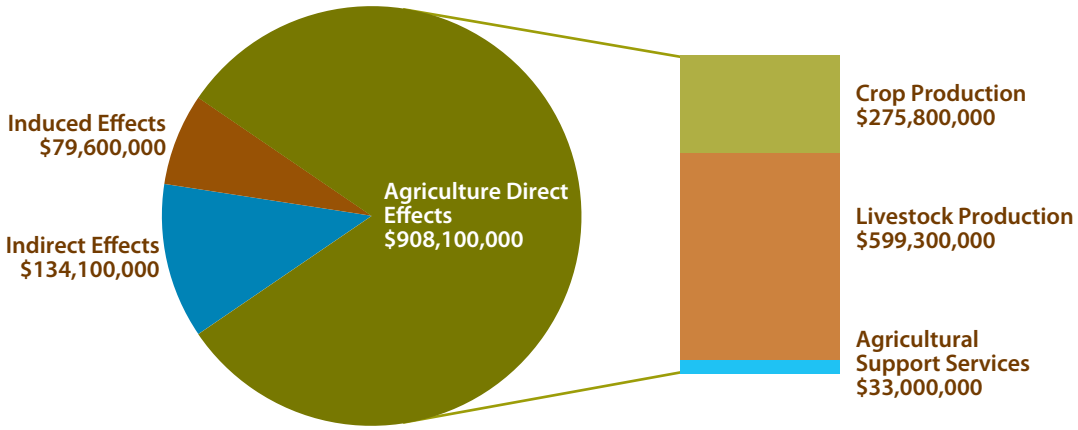
*Source: Authors' calculations; IMPLAN Group, LLC, 2016; U.S. Department of Commerce, BEA, 2016a.*

### 6.1.2 Multiplier Effects of On-Farm Agriculture

Direct sales of crop and livestock products, however, only represent a share of agriculture's total contribution to Pinal County's economy. Those agricultural sales support indirect and induced multiplier effects, generating additional rounds of business-to-business and household-to-business transactions. These transactions support additional sales, value added, income, and jobs in other Pinal County industries. Direct sales effects of roughly $908.1 million supported an additional $134.1 million in indirect effects and $79.6 million in induced effects, for a total sales contribution of $1.1 billion (Figure 8).

**10** Sales generated through other farm activities are reported by the Bureau of Economic Analysis (BEA) as other farm-related income. Total industry sales are, therefore, agricultural crop receipts plus other farm-related income.

***Figure 8.** Economic Contribution of On-Farm Agriculture to Pinal County Sales, 2016*




*Source: Authors' calculations; IMPLAN Group, LLC, 2016; U.S. Department of Commerce, BEA, 2016a.*

The total value-added contribution, or the contribution to Pinal County's gross regional product (GRP), from on-farm agriculture was $372.8 million including multiplier effects, with $273 million originating directly from on-farm agriculture (Table 14). An estimated 3,804 full- and part-time jobs[11] were directly supported on-farm, in the crop, livestock, or agricultural support service industries, providing a labor income of nearly $191 million. Including direct, indirect, and induced multiplier effects, on-farm agriculture in 2016 supported a total of 5,147 full- and part-time jobs in the county and $239.2 million income.

Combined, the estimated direct, indirect, and induced contribution of on-farm agriculture to the Pinal County economy in 2016 was approximately $1.1 billion in sales, $372.8 million in value added, and nearly 5,200 jobs generating $239.2 million in labor income.

## 6.2 Contribution of On-Farm Agriculture and Agribusiness to Pinal County Economy

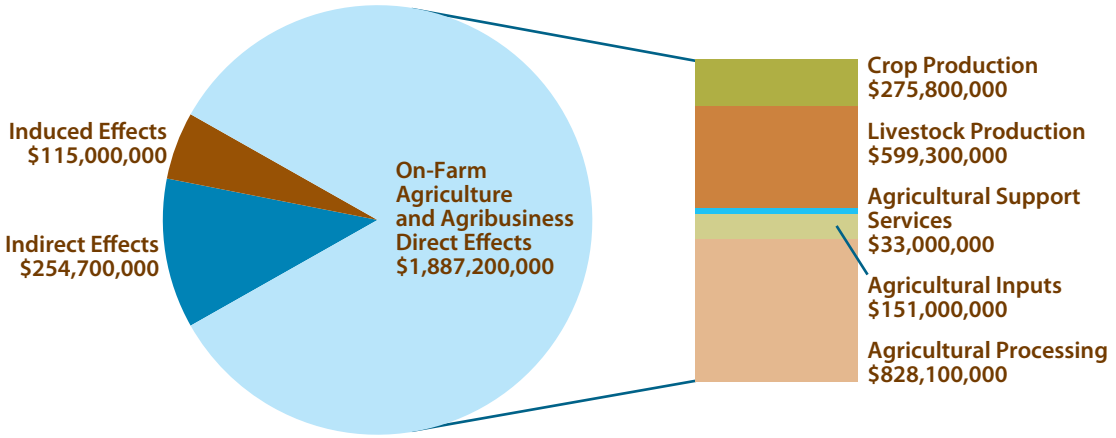
As mentioned previously, on-farm production is just one part of an entire system of industries involved in and connected with agriculture. This analysis builds upon the results of the economic contribution analysis of on-farm agriculture to include agriculture-related industries, or industries that supply inputs and provide services that support on-farm production and industries that process or manufacture agricultural products (food and fiber processing).

### *6.2.1 Direct Contribution of On-Farm Agriculture and Agribusiness*

In 2016, direct sales of $908.1 million from on-farm agriculture were supplemented with $979 million in sales from agricultural input manufacturing and agricultural (food and fiber) processing in Pinal County (Figure 9). As demonstrated by these sales figures, off-farm agriculture-related industries contribute more than half of the agriculture and agribusiness direct sales contribution, signifying the importance of industries that provide inputs to farms (such as fertilizer manufacturers) and downstream industries that transform agricultural commodities into food products. Nearly two-thirds of these additional agribusiness sales came from Pinal County businesses involved in fluid milk manufacturing, dry, condensed, and evaporated dairy product manufacturing, and snack food manufacturing (IMPLAN Group, LLC, 2016).

**11** A more thorough discussion of how on-farm employment was estimated is provided in Appendix B.

***Figure 9.*** *Economic Contribution of On-Farm Agriculture and Agribusiness to Pinal County Sales, 2016*




*Source: Authors' calculations; IMPLAN Group, LLC, 2016; U.S. Department of Commerce, BEA, 2016a.*

***Table 15.** Economic Contribution of On-Farm Agriculture and Agribusiness to Pinal County Economy, 2016*

| Impact Type | Direct Effect | Indirect Effect | Induced Effect | Total Effect |
|---|---|---|---|---|
| Sales (Output) | $1,887,200,000 | $254,700,000 | $115,000,000 | $2,256,900,000 |
| *Value Added* | $433,500,000 | $117,200,000 | $60,400,000 | $611,100,000 |
| *Labor Income* | $266,400,000 | $65,600,000 | $24,800,000 | $356,800,000 |
| Employment | 5,150 | 1,472 | 895 | 7,516 |

*Source: Authors' calculations; IMPLAN Group, LLC, 2016; U.S. Department of Commerce, BEA, 2016a.*

### *6.2.2 Multiplier Effects of On-Farm Agriculture and Agribusiness*

The direct contribution of the Pinal County agriculture and agribusiness to county sales was nearly $1.9 billion (Figure 9). Including the indirect and induced effects generated through Pinal County farmers and agribusinesses purchasing inputs from other local businesses and agribusiness employees spending their earnings on local goods and services, the total contribution of agriculture and agribusiness to county sales was nearly $2.3 billion.

The total value-added contribution, or the contribution to Pinal County's gross regional product (GRP), from agriculture and agribusiness was $611.1 million, with $433.5 million originating directly from on-farm agriculture and agribusiness industries (Table 15). Of this $433.5 million, on-farm agriculture contributed approximately $273 million. An estimated 5,150 full- and part-time jobs were directly supported by Pinal County agriculture and agribusiness, with nearly three-fourths of these jobs occurring on-farm. The direct labor income supported by agriculture and agribusiness in Pinal County was an estimated $266.4 million in 2016. Including direct, indirect, and induced effects, agriculture and agribusiness supported a total of 7,516 full- and part-time jobs in the county and $356.8 million of income in 2016.

***Table 16.** Top 10 IMPLAN Industries by Employment Supported by Off-Farm Agribusiness Indirect and Induced Effects, 2016*

| Rank | IMPLAN Industry | Indirect & Induced Effects | |
|---|---|---|---|
| | | Employment | Labor Income |
| 1 | Wholesale Trade | 259 | $15,600,000 |
| 2 | Real Estate | 209 | $2,400,000 |
| 3 | Truck Transportation | 170 | $13,200,000 |
| 4 | Other Local Government Enterprises | 100 | $6,500,000 |
| 5 | Marketing Research and All Other Miscellaneous Professional,Scientific, and Technical Services | 73 | $1,000,000 |
| 6 | Services to Buildings | 69 | $800,000 |
| 7 | Limited-Service Restaurants | 67 | $1,100,000 |
| 8 | Maintenance and Repair Construction of Nonresidential Structures | 60 | $3,600,000 |
| 9 | Retail—General Merchandise Stores | 58 | $1,900,000 |
| 10 | Accounting, Tax Preparation, Bookkeeping, and Payroll Services | 45 | $900,000 |

*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

To provide an example of the jobs and incomes supported in other, seemingly unrelated industries, Table 16 shows the top 10 industries (by employment) that are supported by off-farm agribusiness through indirect and induced effects (IMPLAN Group, LLC, 2016). The majority of full- and part-time jobs supported by agribusiness indirect and induced multiplier effects were in the wholesale trade industry, with 259 jobs and approximately $15.6 million in income. This reflects businesses involved in agriculture-related wholesale trade, as demonstrated in Table 13. While most of these wholesale jobs are related to indirect effects (business-to-business transactions), some jobs in wholesale are related to induced effects (household-to-business transaction) as many household products pass through wholesale as part of the supply chain. Jobs and incomes are also supported in the restaurant and retail industries, largely driven by induced effects.

# 7 Potential Effects of Reduced Crop Production

The final section of this study examines the potential effects of reduced crop production on the Pinal County economy. Using the same input-output model, IMPLAN Version 3.1, this analysis estimates the economic impact associated with hypothetical reductions in crop production in Pinal County. Reductions in the value of agricultural production could be a result of many factors including unfavorable market prices or lower yields, but this analysis examines reductions in crop production due to fallowing (taking acreage out of production) in response to a hypothetical irrigation water cutback of 300,000 acre-feet (AF).

Because it is difficult to predict how individual farmers and irrigation districts would respond to water cutbacks, this study makes several simplifying assumptions to examine the impacts to farmers and the overall regional economy. First, the study follows a similar approach to the one taken by the U.S. Bureau of Reclamation (BOR) (2007) in its report, *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead: Final Environmental Impact Statement.* The BOR economic analysis of the impacts of a Lower Colorado Basin shortage declaration assumed that Central Arizona agriculture would respond to reductions in CAP water supplies by fallowing land (i.e., taking land out of production). BOR assumed that the three field crops most likely to have acreage fallowed would be wheat, alfalfa, and cotton due to their relatively low earnings per acre-foot of water applied (U.S. Bureau of Reclamation, 2007).

The analysis presented here also examines large-scale land fallowing as a response to water cutbacks, and similarly focuses on fallowing wheat, alfalfa, and cotton.[12] We do not consider other potential grower responses, such as switching to groundwater to irrigate crops. Here, growers forego production and profits on fallowed acres. They also do not apply inputs (including labor) to those acres, so (if purchased locally) there is a decrease in economic activity in other sectors of the local economy.

**12** Based on Pinal County production, the focus of this analysis is spring durum wheat, alfalfa hay, and upland cotton.

*Table 17. Water Application, Yield, and Price Assumptions*

| | Wheat | Alfalfa | Cotton |
|---|---|---|---|
| AZ Water Application Rate, Gravity (2015) | 3.3 acre-feet/acre | 5.5 acre-feet/acre | 4.6 acre-feet/acre |
| Pinal County Average Yield (2016) | 95.3 bushels/acre | 8.05 tons/acre | 1,499 lbs./acre |
| AZ Average Price (2016) | $6.70/bushels | $152/ton | $0.66/lb. |

*Source: U.S. Department of Agriculture, 2014c; U.S. Department of Agriculture, NASS Quickstats, 2016.*

We assume that fallowed wheat, alfalfa, and cotton acreage was irrigated through gravity or flood irrigation and that these acres have gravity-flow water-application rates equal to the state averages for these crops, as reported in the USDA Farm and Ranch Irrigation Survey (Table 17). Furthermore, this study assumes that all wheat, alfalfa, and cotton acreage fallowed have Pinal County average 2016 yields, as reported by USDA. Thus, production losses are constant per acre fallowed. In reality, less productive and less profitable lands would be fallowed first. Finally, this study assumes that all production is of average quality and sells for the average price. Table 17 reports the baseline assumptions about water application rates, yields, and prices.

This analysis estimates changes in wheat, alfalfa, and cotton acreage (and resulting economic activity) resulting from a hypothetical reduction of 300,000 acre-feet of irrigation water supply for Pinal County agriculture. The study considers six scenarios (Table 18). The first scenario, following previous research done by the U.S. Bureau of Reclamation, assumes that wheat would be the first crop to be fallowed in Pinal County. However, considering that more than 90,000 acres of wheat would need to be fallowed to produce 300,000 AF of water and, in 2016, only 20,800 acres of wheat were planted and harvested in Pinal County, additional cropland would need to be fallowed. This study considers three separate combinations of wheat fallowed with alfalfa and cotton. The first scenario assumes that 100% of Pinal County wheat acreage is fallowed, while the remainder fallowed is alfalfa acreage.[13]

*Table 18. Fallowing Scenarios Based on 2016 Acreage*

| Fallowing Scenarios | Total Acreage Fallowed | 2016 Acreage | Percentage of 2016 Crop Acreage | Estimated Percentage Total Irrigated Harvested Cropland[14] |
|---|---|---|---|---|
| **1:** 100% Wheat, Remaining Alfalfa | 62,865 | 83,800 | 100% Wheat; 67% Alfalfa | 28% |
| **2:** 100% Wheat, Remaining Cotton | 71,096 | 88,700 | 100% Wheat; 74% Cotton | 32% |
| **3:** 100% Wheat, Remaining 50% Alfalfa and 50% Cotton | 66,981 | 151,700 | 100% Wheat; 33% Alfalfa; 37% Cotton | 30% |
| **4:** Alfalfa Only | 54,545 | 63,000 | 87% Alfalfa | 25% |
| **5:** Cotton Only | 65,217 | 67,900 | 96% Cotton | 29% |
| **6:** 50% Cotton, 50% Alfalfa | 59,881 | 130,900 | 48% Cotton 43% Alfalfa; | 27% |

*Source: Authors' calculations; U.S. Department of Agriculture, NASS Quick Stats, 2016; U.S Department of Agriculture, 2014b.*

**13** In the U.S. Bureau of Reclamation's study on the effects of shortages on crop acres and production, the first crop projected to drop out of production is wheat followed by alfalfa and then cotton.

**14** Data on irrigated harvested cropland (221,997 acres) comes from the 2012 Census of Agriculture, the most recent data available.

The second scenario assumes that all wheat acreage is taken out of production, but instead of alfalfa, the remainder is taken out of cotton acreage. The third scenario assumes that in addition to the wheat acreage taken out of production, half of the remaining water reduction comes from fallowing alfalfa acres and the other half comes from fallowing cotton acres.

The study also considers the acreage (and resulting economic activity) that would be taken out of production if only alfalfa acreage was fallowed or only cotton acreage was fallowed. The fourth scenario assumes that alfalfa is the only crop fallowed in response to a hypothetical 300,000 AF water cutback, a reduction of approximately 54,545 acres of alfalfa. In 2016, Pinal County harvested 63,000 acres of alfalfa, so a reduction of this magnitude would account for approximately 87% of the alfalfa acreage and production in the county. The fifth scenario assumes that cotton is the only crop with acreage fallowed in Pinal County, a reduction of approximately 65,217 acres. In 2016, Pinal County planted 67,900 acres of cotton, so a reduction of this magnitude would represent nearly all of the cotton acreage and production in the county. Given the water rights structure of farmers in Pinal County, with some agricultural production occurring on tribal land with higher priority water rights, it is unlikely that 100% of alfalfa or 100% of cotton would be fallowed. Therefore, the sixth and final scenario considers a water cutback that is split equally between alfalfa and cotton, requiring 27,273 acres of alfalfa to be fallowed and 32,609 acres of cotton to be fallowed. Reduced crop acreage of these magnitudes would decrease Pinal County's total irrigated harvested cropland by an estimated 25% to 32%.

A reduction in the acreage grown and harvested in Pinal County would affect both farmers and the regional economy, but in different ways. With fewer acres in production, the farmer would have decreased sales as well as decreased costs of production (because they are no longer purchasing inputs needed for growing and harvesting). Effects to the farmer, therefore, would be lower net revenues for their individual operations. A reduction in agricultural production could also have negative effects on the regional economy resulting from lower spending on local inputs and labor. This analysis examines the impacts of reduced crop production on backward-linked industries. This means that the analysis captures potential reductions in economic activity in industries that provide inputs to farms (fewer inputs purchased) and the reductions in consumer industries. Reductions in production and reduction in inputs are in fixed proportion to one another, so if production is reduced by 20%, demand for inputs is also reduced by 20%. If farmers purchase 100% of their inputs from within Pinal County, a reduction in agricultural production and the resulting decreased spending on inputs would have a significant effect on other Pinal County businesses that provide those inputs. If Pinal County farmers were purchasing inputs from outside the region, however, the effects on other industries would not be as severe. This analysis relies on IMPLAN local purchase coefficients to estimate the proportion of inputs that Pinal County farmers purchase from within the county.

While this study captures the backward linkages and multiplier effects of reduced agricultural production, it does not examine potential impacts in the forward-linked agriculture-related businesses included in the analysis. IMPLAN assumes firms are "price-takers" where the market price that producers receive is determined by national (and world) markets. As such, it does not assume that the price of crops changes in response to localized production changes. More specifically, the baseline model assumes that livestock and dairy producers in Pinal County can obtain feed and forage crops from outside the county at the same, constant, regional price. To the extent that local production shocks increase local prices, the model will understate negative impacts on county feed and forage purchasers.

## 7.1 Reduction in Wheat and Alfalfa Acreage

Based on Pinal County's average yield per acre and the Arizona average price per bushel in 2016, fallowing all wheat acreage in Pinal County (20,800 acres) would result in nearly 2 billion fewer bushels of wheat produced and $13.3 million in reduced wheat sales. As stated previously, fallowing all wheat acreage in Pinal County would result in a reduction of water applications by only 68,650 acre-feet. In order to reduce water applications by the remaining 231,360 acre-feet, approximately 42,065 acres of alfalfa would need to be fallowed. Based on Pinal County's average yield per acre and the Arizona average price per ton in 2016, fallowing 42,065 acres of alfalfa would result in nearly 340,000 fewer tons of alfalfa produced and $51.4 million in reduced alfalfa sales.

Given reduced wheat and alfalfa sales of $64.7 million and indirect and induced multiplier effects, the total estimated reduction to Pinal County sales in 2016 would be $98.6 million. Reductions of this magnitude correspond to $31.7 million less in value added, $21 million less in labor income, and approximately 273 fewer jobs (Table 19).

***Table 19.** Estimated Pinal County Economic Impacts from Reductions in Wheat and Alfalfa Acreage, 2016*

| Impact Type | Direct Effect | Indirect Effect | Induced Effect | Total Effect |
|---|---|---|---|---|
| Sales (Output) | -$64,700,000 | -$26,900,000 | -$7,000,000 | -$98,600,000 |
| *Value Added* | -$15,700,000 | -$12,400,000 | -$3,600,000 | -$31,700,000 |
| *Labor Income* | -$11,800,000 | -$7,700,000 | -$1,500,000 | -$21,000,000 |
| Employment | -47 | -174 | -53 | -273 |

*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

## 7.2 Reduction in Wheat and Cotton Acreage

This scenario assumes that all wheat acreage is fallowed, but instead of fallowing alfalfa, cotton is fallowed in order to reduce water applications by the remaining 231,360 acre-feet. In order to do this, nearly 50,300 acres of cotton would need to be fallowed. Based on Pinal County's average yield per acre and Arizona's average price per pound in 2016, fallowing 50,300 acres of cotton would result in nearly 157,000 fewer bales of cotton produced and $50.2 million in reduced cotton sales.

Given reduced wheat and cotton sales of $63.5 million and indirect and induced multiplier effects, the total estimated reduction to Pinal County sales in 2016 would be $94.1 million. Reductions of this magnitude correspond to $32.9 million less in value added, $23.3 million less in labor income, and approximately 406 fewer jobs (Table 20).

***Table 20.** Estimated Pinal County Economic Impacts from Reductions in Wheat and Cotton Acreage, 2016*

| Impact Type | Direct Effect | Indirect Effect | Induced Effect | Total Effect |
|---|---|---|---|---|
| Sales (Output) | -$63,500,000 | -$22,800,000 | -$7,800,000 | -$94,100,000 |
| *Value Added* | -$18,300,000 | -$10,600,000 | -$4,000,000 | -$32,900,000 |
| *Labor Income* | -$14,300,000 | -$7,300,000 | -$1,700,000 | -$23,300,000 |
| Employment | -191 | -156 | -59 | -406 |

*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

## 7.3 Reduction in Wheat, Alfalfa, and Cotton Acreage

The third scenario assumes that all wheat acreage in Pinal County is fallowed, and both alfalfa and cotton acreage are fallowed in order to reduce water applications by the remaining 231,360 acre-feet. This study assumes that these water cutbacks would be split equally between alfalfa and cotton, resulting in 21,032 fewer acres of alfalfa and 25,147 fewer acres of cotton. In total, reductions of 300,000 acre-feet would result in $13.3 million in reduced wheat sales, $25.7 million in reduced alfalfa sales, and $25.1 million in reduced cotton sales.

Given reduced wheat, alfalfa, and cotton sales of $64.1 million and indirect and induced multiplier effects, the total estimated reduction to Pinal County sales in 2016 would be $96.3 million. Reductions of this magnitude correspond to $32.3 million less in value added, $22.2 million less in labor income, and approximately 340 fewer jobs (Table 21).

***Table 21.** Estimated Pinal County Economic Impacts from Reductions in Wheat, Alfalfa, and Cotton Acreage, 2016*

| Impact Type | Direct Effect | Indirect Effect | Induced Effect | Total Effect |
|---|---|---|---|---|
| Sales (Output) | -$64,100,000 | -$24,800,000 | -$7,400,000 | -$96,300,000 |
| *Value Added* | -$17,000,000 | -$11,500,000 | -$3,800,000 | -$32,300,000 |
| *Labor Income* | -$13,100,000 | -$7,500,000 | -$1,600,000 | -$22,200,000 |
| Employment | -119 | -165 | -56 | -340 |

*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

## 7.4 Reduction in Cotton Acreage

The fourth scenario assumes that in response to a water cutback of 300,000 acre-feet, cotton is the only crop fallowed in Pinal County. In order to reduce water use by 300,000 acre-feet, approximately 65,200 acres of cotton would need to be fallowed. Based on Pinal County's average yield per acre and Arizona's average price per pound in 2016, fallowing 65,200 acres of cotton would result in 203,700 fewer bales of cotton produced and $65.1 million in reduced cotton sales. In 2016, Pinal County planted 67,900 acres of cotton, so a reduction of this magnitude would represent nearly all of the cotton acreage and production in the county.

Including direct, indirect, and induced multiplier effects, the total estimated reduction to Pinal County sales in 2016 would be $98.3 million. A reduction of this magnitude corresponds to $35.0 million less in value added, $25.8 million less in labor income, and approximately 484 fewer jobs (Table 22).

***Table 22.** Estimated Pinal County Economic Impacts from Reductions in Cotton Acreage, 2016*

| Impact Type | Direct Effect | Indirect Effect | Induced Effect | Total Effect |
|---|---|---|---|---|
| Sales (Output) | -$65,100,000 | -$24,700,000 | -$8,500,000 | -$98,300,000 |
| *Value Added* | -$18,800,000 | -$11,800,000 | -$4,400,000 | -$35,000,000 |
| *Labor Income* | -$15,600,000 | -$8,400,000 | -$1,800,000 | -$25,800,000 |
| Employment | -244 | -174 | -65 | -484 |

*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

## 7.5 Reduction in Alfalfa Acreage

The next scenario assumes that alfalfa is the only crop fallowed in response to a 300,000 AF water cutback. In order to reduce water use by 300,000 acre-feet, approximately 54,545 acres of alfalfa would need to be fallowed. Based on Pinal County's average yield per acre and price per pound in 2016, fallowing 54,545 acres of alfalfa would result in nearly 440,000 fewer tons of alfalfa produced and a $66.7 million reduction in alfalfa sales. In 2016, Pinal County harvested 63,000 acres of alfalfa, so a reduction of this magnitude would account for approximately 87% of the alfalfa acreage and production in the county.

Including direct, indirect, and induced multiplier effects, the total estimated reduction to Pinal County sales in 2016 would be $104.2 million. A reduction of this magnitude corresponds to $33.5 million less in value added, $22.8 million less in labor income, and approximately 311 fewer jobs (Table 23).

Comparing Tables 22 and 23, one can see that the direct employment losses are greater when fallowing cotton than fallowing alfalfa in response to the same water supply reduction. In 2016, acreage harvested of each crop was comparable—63,000 acres for alfalfa and 67,900 acres (less than an 8% difference). Yet according to the Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW), annual average hired labor employment in cotton farming was 287 jobs in Pinal County, while hired labor employment in alfalfa farming was only 69 jobs.

***Table 23.** Estimated Pinal County Economic Impacts from Reductions in Alfalfa Acreage, 2016*

| Impact Type | Direct Effect | Indirect Effect | Induced Effect | Total Effect |
|---|---|---|---|---|
| Sales (Output) | -$66,700,000 | -$29,900,000 | -$7,600,000 | -$104,200,000 |
| *Value Added* | -$15,400,000 | -$14,200,000 | -$3,900,000 | -$33,500,000 |
| *Labor Income* | -$12,300,000 | -$8,900,000 | -$1,600,000 | -$22,800,000 |
| Employment | -56 | -198 | -58 | -311 |

*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

## 7.6 Reduction in Cotton and Alfalfa Acreage

The final scenario assumes that both cotton and alfalfa acres are fallowed in a response to a 300,000 acre-feet cutback. This analysis assumes that 50% of the reduction in water use would come from fallowing cotton acreage and the remaining 50% would come from fallowing alfalfa. Using the same water application rates, yield, and price received information from previous scenarios, the estimated cotton acreage fallowed would be 32,609 acres and the estimated alfalfa acreage fallowed would be 27,273 acres. The fallowing of this acreage would result in approximately 102,000 fewer bales of cotton and nearly 220,000 fewer tons of alfalfa produced, valued at $65.9 million in sales.

Including direct, indirect, and induced multiplier effects, the total estimated reduction to Pinal County sales in 2016 would be $101.3 million. Reductions of this magnitude correspond to of $34.3 million less in value added, $24.3 million less in labor income, and an estimated 397 fewer jobs (Table 24).

***Table 24.** Estimated Pinal County Economic Impacts from Reductions in Cotton and Alfalfa Acreage, 2016*

| Impact Type | Direct Effect | Indirect Effect | Induced Effect | Total Effect |
|---|---|---|---|---|
| Sales (Output) | -$65,900,000 | -$27,300,000 | -$8,100,000 | -$101,300,000 |
| *Value Added* | -$17,100,000 | -$13,000,000 | -$4,200,000 | -$34,300,000 |
| *Labor Income* | -$13,900,000 | -$8,700,000 | -$1,700,000 | -$24,300,000 |
| Employment | -150 | -186 | -61 | -397 |

*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

***Table 25.** Summary of Acreage Fallowed and Direct Change in On-Farm Sales by Fallowing Scenario*

| Fallowing Scenarios | Total Acreage Fallowed | Direct Change in On-Farm Sales (2016) |
|---|---|---|
| **1:** 100% Wheat, Remaining Alfalfa | 62,865 | -$64,700,000 |
| **2:** 100% Wheat, Remaining Cotton | 71,096 | -$63,500,000 |
| **3:** 100% Wheat, Remaining 50% Alfalfa and 50% Cotton | 66,981 | -$64,100,000 |
| **4:** Alfalfa Only | 54,545 | -$66,700,000 |
| **5:** Cotton Only | 65,217 | -$65,100,000 |
| **6:** 50% Cotton, 50% Alfalfa | 59,881 | -$65,900,000 |

*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

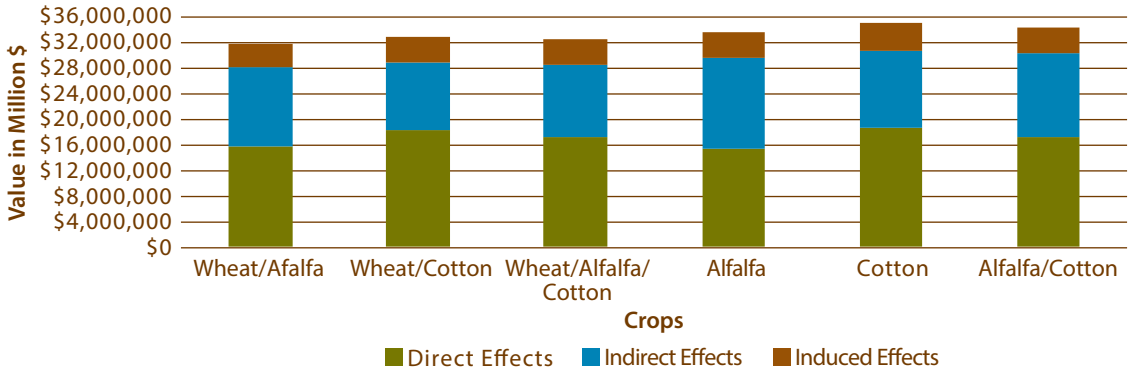
## 7.7 Summary of Economic Impacts from Reduced Crop Production

A hypothetical cutback of 300,000 AF of irrigation water under these six simplified scenarios would result in anywhere from 54,500 acres of cropland to 71,100 acres of cropland fallowed in Pinal County. As alfalfa has the highest water application rate per acre, scenarios that fallow alfalfa acreage would have lower total acreage fallowed. That said, in 2016, gross sales per acre were higher for alfalfa than for cotton and wheat, therefore scenarios with fallowed alfalfa acreage have larger reductions in sales. Reduced farm-gate sales for the six scenarios modeled range from a reduction of $63.5 million to $66.7 million, a reduction of approximately 7% of 2016 Pinal County on-farm agricultural sales (Table 25).

Given these reductions in acreage (and resulting economic activity from production), the losses in county sales (including direct, indirect and induced multiplier effects) range from $94 million to $104 million. The total value-added losses to the Pinal County economy range from $31.7 million to $35 million, with about half of these effects directly affecting farms in Pinal County (Figure 10). The remaining reductions in value added are derived from multiplier effects, where other non-agricultural industries have reduced labor income, taxes, and profits as a result of fewer inputs purchased and fewer farm workers purchasing household goods and services. Approximately 1% of county value-added reductions would occur through reduced county sales tax revenue.[15]

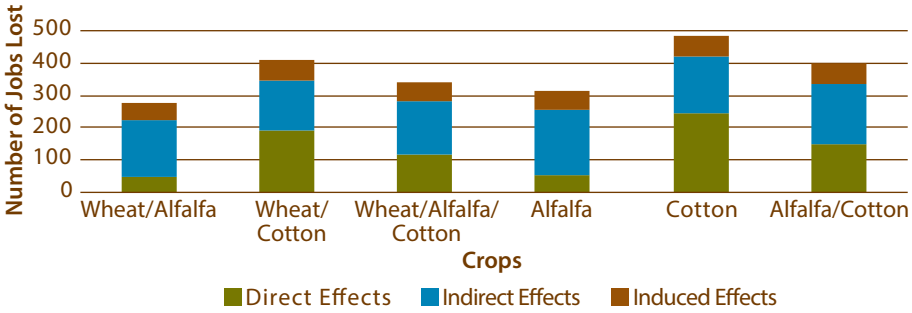
**15** County sales tax is estimated using the county sales tax rate of 1.6% and estimates of taxable sales (not including sales of services) that are generated through indirect and induced effects.

***Figure 10.** Reduced Pinal County Value Added from Reduced Crop Production*




*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

***Figure 11.** Pinal County Job Losses from Reduced Crop Production*




*Source: Authors' calculations; IMPLAN Group, LLC, 2016.*

Reductions in total full- and part-time jobs in Pinal County related to reduced crop production from these six scenarios range from 270 jobs to 480 jobs (Figure 11). As mentioned previously, employment data for hired on-farm labor is much higher for cotton than alfalfa production. Scenarios that fallow cotton acreage have larger direct on-farm job losses.

# 8 Summary

While the Pinal County economy has grown and diversified over the past century, agriculture and its related agribusiness industries are still important contributors the regional economy. Predominately a livestock producing region, Pinal County is an important contributor to Arizona's production of beef and milk, however, it is also a major producer of livestock feed crops (primarily alfalfa) as well as cotton.

The contribution of agriculture to the Pinal County economy extends beyond the value of on-farm production. In addition to the direct contribution of agriculture through the value of farm-gate sales, or agricultural cash receipts, a "ripple" of economic activity is stimulated in other industries to meet the demands of farmers and ranchers (***indirect multiplier effects***) and households that derive their income from agriculture (***induced multiplier effects***). The total contribution, including indirect and induced effects, of on-farm agriculture to the Pinal County economy in 2016 was approximately $1.1 billion in sales, $372.8 million in value added, and nearly 5,200 jobs generating $239.2 million in labor income.

On-farm production is just one part of an entire system of industries involved in and connected with agriculture. In Pinal County, food manufacturing is the largest manufacturing sector in the county, accounting for more than one-quarter of county manufacturing jobs and one-third of county manufacturing wages. The largest of these food manufacturing industries is the dairy product manufacturing industry, accounting for 18% of county manufacturing jobs. Other agribusinesses such as farm merchant wholesalers and fertilizer manufacturers also support jobs and incomes in the county. In fact, agriculture and agriculture-related industries make up 9 of the top 20 industries in Pinal County by concentration of employment.

Including off-farm agriculture-related industries, on-farm agriculture and agribusiness directly contributed nearly $1.9 billion to Pinal County sales. Including indirect and induced effects generated through Pinal County farmers and agribusinesses purchasing inputs from other local businesses and agribusiness employees spending their earnings on local goods and services, the total contribution of agriculture and agribusiness to county sales was nearly $2.3 billion. The total contribution of agriculture and agribusiness to the Pinal County economy in 2016, including indirect and induced effects, was approximately $611.1 million in gross regional product (GRP) and more than 7,500 jobs generating $356.8 million in labor income.

These economic contribution analysis results provide a snapshot of the Pinal County economy in 2016 and demonstrate agriculture's contribution to sales, value added (gross regional product), labor income, and jobs. While it is difficult to predict with certainty how agriculture's contribution would change given water cutbacks, this study estimates the economic impacts of changes in wheat, alfalfa, and cotton acreage resulting from a hypothetical reduction of 300,000 acre-feet of irrigation water for Pinal County agriculture in 2016. Changes in acreage and the value of agricultural production, and the range of potential impacts to the Pinal County economy, were estimated using six simplified scenarios. Each scenario assumes land is fallowed (taken out of production) and producers do not switch to groundwater to irrigate crops, which could potentially mitigate the economic impacts of water cutbacks.

A hypothetical cutback of 300,000 AF of irrigation water in 2016, under these six simplified scenarios, would result in anywhere from 54,500 to 71,100 acres fallowed in Pinal County. Based on 2012 Census of Agriculture estimates, this would represent 25% to 32% of Pinal County harvested irrigated

cropland. As alfalfa has the highest water application rate per acre, scenarios that fallow alfalfa acreage have lower total acreage fallowed. That said, in 2016, gross sales per acre were higher for alfalfa than for cotton and wheat, therefore scenarios with alfalfa acreage fallowed have larger reductions in sales. Based on the six simplified scenarios, farm-gate sales would be reduced between $63.5 million and $66.7 million, approximately 7% of the total Pinal County on-farm agricultural sales.

Given these reductions in acreage (and resulting economic activity from on-farm production), the total value-added impacts to the Pinal County economy range from $31.7 million to $35 million, with about half of these effects directly affecting farms in Pinal County. The remaining reductions in value added are derived from multiplier effects, where other non-agricultural industries generate less labor income, taxes, and profits as a result of fewer inputs purchased and fewer farmworkers purchasing household goods and services. Given these six scenarios of reduced agricultural acreage, reductions in Pinal County employment range from 270 to 480 total full- and part-time jobs.

While it is difficult to make precise predictions about the economic impacts of water cutbacks to Pinal County agriculture and the county economy overall, this study provides some insight into agriculture's role in the county economy. By estimating the current contribution of agriculture to the county economy, we can better understand the economic linkages between agriculture and other industries within the Pinal County economy and determine where impacts might be experienced in the event of changes in agricultural production. The study also provides some insight into the magnitude of potential economic impacts, considering a hypothetical water cutback and estimating reductions in acreage and on-farm sales, and the resulting multiplier effects from reduced purchases of inputs, reduced farm income, and reduced farm employment and wages. It is unclear the extent to which reductions in agricultural acreage would result in less economic activity (if any) in forward-linked agribusinesses such as food and fiber processing, therefore the hypothetical water cutback scenario is applied in the context of on-farm agriculture, not on-farm agriculture and agribusiness combined.

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# Appendices

## Appendix A: Data and Research Methods

Data from the 2016 IMPLAN Version 3.1 Pinal County model were used to estimate the contribution of agriculture and agriculture and agribusiness combined to the Pinal County 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 on Pinal County farms.

First and foremost, the IMPLAN model was updated to reflect the most up-to-date estimates of crop and livestock cash receipts and other farm income. This data comes from the Bureau of Economic Analysis (BEA) Farm Income and Expenses data series. In 2016, BEA reported total cash receipts plus other farm income in Pinal County of $875.1 million. Individual crop and livestock commodity cash receipts were estimated based upon shares reported by the 2012 Census of Agriculture. Sales for the agricultural support service industry were obtained from IMPLAN data. However, BEA wage and salary data for the industry was used to corroborate the IMPLAN estimate. The IMPLAN value for agricultural support service sales was within 5% of the estimate based on data from wages and salary data. In total, on-farm agricultural sales were an estimated $908.1 million.

Additional modifications were made to IMPLAN's baseline data for crop and livestock industries to better reflect county-level employee compensation and farm proprietor income[16] as well as on-farm employment.[17] Intermediate expenditure and value-added shares were informed by 2012 Census of Agriculture data.

Finally, modifications were also made to the baseline IMPLAN industry production functions for all on-farm agriculture industries to more accurately represent agricultural practices in Pinal County. 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 Pinal County agricultural operations because nearly all harvested cropland in Pinal County is irrigated, in contrast with production in other states. For all crops, except cotton and hay and other crops, farm expense data from the 2012 Census of Agriculture were used to modify the industry spending patterns. For cotton and hay, farm expense data were obtained from unpublished Pinal County cost and return budgets.

For the economic contribution analysis, the IMPLAN multi-industry contribution analysis method was used to ensure that county-level economic output was not overstated and that there was no double counting.

**16** Data from U.S. Department of Commerce. Bureau of Economic Analysis (BEA). 2016. Personal Income by Major Component and Earnings by NAICS Industry (CAINC5N).

**17** Data from U.S. Department of Commerce. Bureau of Economic Analysis (BEA). 2016. Total Full-Time and Part-Time Employment by NAICS Industry (CAEMP25N).

## Appendix B: Estimating On-Farm and Agricultural Support Services Employment

There are several challenges to measuring on-farm employment. While several data sources provide information on on-farm employment, they often measure employment in different ways, resulting in significant differences in employment estimates. On-farm employment includes farm proprietor jobs, directly hired farm labor, and agricultural support service workers. The following section outlines the data sources available and their estimates for on-farm employment in Pinal County.

The USDA Census of Agriculture reports the number of directly hired farm labor and principal operators every five years, most recently for 2012. In Pinal County, 2012 Census of Agriculture estimates suggest that there were 3,316 workers hired for on-farm labor on 364 farms. The majority of these workers (74%) were reported working on the 74 farms in Pinal County that employed 10 workers or more. Additionally, more than three-quarters of the 3,316 hired workers (2,544 workers) worked on-farm 150 days or more that year (U.S. Department of Agriculture, 2014b). According to the 2012 Census of Agriculture, the total number of operators on Pinal County farms was 1,531. As farms can have multiple operators, this is more than the number of farms in Pinal County. That said, each farm can only have one principal operator. In 2012, there were 938 principal operators. Of these, only 63% (589 principal operators) considered farming their primary occupation (U.S. Department of Agriculture, 2014b). Unfortunately, the Census of Agriculture does not report the number of workers doing custom work as part of the agricultural support services industry. Given this data, we can estimate that, conservatively, there were at least 3,905 individuals employed by on-farm agriculture in Pinal County and an undetermined number of jobs in the agricultural support services industry.

***Table 26.** Pinal County On-Farm Employment Reported by BLS*

| Pinal County Employment in Agriculture by NAICS Code (BLS) | Annual Average Employment (2016) |
|---|---|
| **NAICS 11 Agriculture and Agricultural Support** | **2,345** |
| **NAICS 111 Crop Production** | **651** |
| NAICS 1111 Oilseed and Grain Farming | (ND) |
| NAICS 1112 Vegetable and Melon Farming | 103 |
| NAICS 1113 Fruit and Tree Nut Farming | (ND) |
| NAICS 1114 Greenhouse and Nursery Production | 73 |
| NAICS 1119 Other Crop Farming | 452 |
| *NAICS 11192 Cotton Farming* | 287 |
| *NAICS 11194 Hay Farming* | 69 |
| *NAICS 11199 All Other Crop Farming* | 95 |
| **NAICS 112 Livestock Production** | **1,318** |
| NAICS 1121 Cattle Ranching and Farming | 1,302 |
| *NAICS 11211 Beef Cattle Ranching, Farming, and Feedlots* | 90 |
| *NAICS 11212 Dairy Cattle and Milk Production* | 1,212 |
| NAICS 1122 Hog and Pig Farming | (ND) |
| NAICS 1123 Poultry and Egg Production | (ND) |
| NAICS 1124 Sheep and Goat Farming | (ND) |
| NAICS 1125 Aquaculture | (ND) |
| NAICS 1129 Other Animal Farming | (ND) |
| **NAICS 115 Agricultural Support Activities** | **377** |
| NAICS 1151 Support Activities for Crop Production | 361 |
| NAICS 1152 Support Activities for Animal Production | 16 |

*Source: U.S. Department of Labor, BLS, 2017.*
*(ND): Not disclosed.*

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 four-digit NAICS code. However, QCEW only includes data for operations large enough to pay into the unemployment system and does not include data on farm proprietors. Therefore, not including proprietors, the estimated employment for on-farm hired workers and agricultural support services was 2,345 (Table 26).

***Table 27.*** *Pinal County On-Farm Employment Reported by BEA*

| Pinal County Employment in Agriculture (BEA) | Total Full-Time and Part-Time Employment (2016) |
|---|---|
| **Estimated Total Agriculture and Agricultural Support** | **3,804** |
| Farm Employment | 3,167 |
| *Farm Proprietor Employment* | 817 |
| *On-Farm Employment* | 2,350 |
| Agricultural Support Employment | 637 |

*Source: U.S. Department of Commerce, BEA, 2016b.*

The Bureau of Economic Analysis reports total full-time and part-time employment for farm employment in Pinal County. In 2016, total farm employment was estimated at 3,167 workers, where approximately 817 were farm proprietors. The BEA also estimates an additional 637 full- and part-time jobs in the agricultural support services industry. Together, the estimated employment in Pinal County for on-farm agriculture was 3,804 jobs (Table 27). Given that this is the most comprehensive estimate available, the analysis uses this data for employment estimates presented in Table 14.

## Appendix C: Pinal County Agriculture and Agribusiness Industries

Consistent with previous reports, agriculture and agribusiness is defined as "the primary agricultural sector plus the closely related industries that depend on agricultural activity in Arizona." One commonly used term used to describe these industries is the "agribusiness system," 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 latest research on Arizona's agribusiness system (Bickel, et al. (2017)) expands the definition of the agribusiness system to include some additional agribusiness industries that have been omitted in the past. As much as possible, this study adheres to the definition of agribusiness presented in Bickel, et al. (2017).

Table 28 reports the agricultural production, supply, processing, and marketing and distribution industries (and their respective North American Industry Classification System (NAICS) and IMPLAN codes) that were included in the definition of agribusiness. Industries shaded in Table 28 indicate industries that exist in Pinal County and were therefore included in the analysis.

Primary, on-farm 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, on-farm agriculture includes all crop production, animal production, and the agricultural support industry (IMPLAN sectors 1-14 and 19). Section 6.1 presents the results of the economic contribution analysis for on-farm agriculture in Pinal County.

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 county. Beginning with food processing, the model includes all sectors of the food manufacturing sector (NAICS 311) that exist in the Pinal County economy, as determined 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, if it were to exist in Pinal County, the leather and hide tanning and finishing sector (NAICS 3161 and IMPLAN sector 131) would have been included in the analysis. Section 6.2 presents the results of the economic contribution analysis for on-farm agriculture and agribusiness combined.

This study does not ***directly*** include agriculture-related businesses involved in the marketing and distribution of agricultural products due to lack of data. Data is not available for many of the agriculture-related economic activities taking place within the larger *warehousing, wholesale* and *retail* industries. Although this economic activity is not included in the direct effects of agribusiness, it is included by modeling the indirect effects. This is evident from the results presented in Table 16, where nearly 260 jobs are supported in the larger *wholesale* industry.

***Table 28.** Pinal County Agriculture and Agribusiness 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 |
| 87 | 311514 | Dry, Condensed, and Evaporated Dairy Product Manufacturing |
| 88 | 31152 | Ice Cream and Frozen Dessert Manufacturing |

***Table 28.** Pinal County Agriculture and Agribusiness by IMPLAN Economic Sectors and NAICS Codes (Continued)*

| IMPLAN Code | NAICS Codes | Implan Description |
|---|---|---|
| 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 |

** indicates that the NAICS code is split amongst multiple IMPLAN industries.*
*Source: IMPLAN Group, LLC, 2016 for Pinal County, AZ.*

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