Agriculture in Arizona's Economy: An Economic Contribution Analysis

Ashley Kerna and George Frisvold

Department of Agricultural and Resource Economics
Cooperative Extension
The University of Arizona

October 2014

ARIZONA
College of Agriculture & Life Sciences
Agricultural and Resource Economics

ARIZONA
College of Agriculture & Life Sciences
Cooperative Extension

Acknowledgements

The authors thank the Arizona Farm Bureau for their support during the production and release of this report. Funds for acquisition of economic modeling software were provided by U.S. Department of Commerce Economic Development Administration (EDA) Grant 07-66-06410-02. Thanks also go to Nancy Bannister for editing, designing, and formatting this report. The final contents of this report are the responsibility of the authors.

© 2014
The Department of Agricultural and Resource Economics
The University of Arizona

The University of Arizona is an equal opportunity, affirmative action institution. The University does not discriminate on the basis of race, color, religion, sex, national origin, age, disability, veteran status, or sexual orientation in its programs and activities.
Any products, services, or organizations that are mentioned, shown, or indirectly implied in this publication do not imply endorsement by The University of Arizona.

Table of Contents

5 Executive Summary
- **5** What Is the Issue?
- **5** What Did the Study Find?
- **5** How Was the Study Conducted?

6 Introduction
7 Profile of Arizona Agriculture
9 Economic Contributions of Arizona's Agribusiness System
- **10** Summary of Contributions

13 Appendix
- **13** Defining Arizona's Agribusiness System
- **14** Data Sources and Methodology

15 References

List of Tables

7 **Table 1.** Number of Farms in Arizona by Farm Type, 2012
10 **Table 2.** Economic and Employment Contributions of the Agribusiness System to Arizona's Economy, 2011
13 **Table 3.** Arizona's Agribusiness System by IMPLAN Economic Sector

List of Figures

8 **Figure 1.** Percentage of Arizona Farms by Farm Size (Acreage), 2012
8 **Figure 2.** Percentage of Arizona Farms by Farm Size (Annual Sales), 2012
11 **Figure 3.** Economic Contribution of the Agribusiness System to Arizona's State Output, 2011

Executive Summary

What Is the Issue?

- Agriculture's contribution to the Arizona economy is more than just the economic activity generated by farms and ranches across the state. Many industries in the state depend on agriculture as a basis for their economic activity. Estimating agriculture's contribution to the state economy warrants an examination of the entire agribusiness system in Arizona.
- Arizona's agribusiness system includes primary agriculture (crop and livestock production) and its supporting input-supply and food and fiber processing industries.
- In addition to the agribusiness system's *direct effects* on the Arizona economy, a "ripple" of economic activity is stimulated in other sectors of the Arizona economy to meet the demands of agricultural producers, processors, and households. Economists call these the *indirect and induced multiplier effects*.
  - *Indirect effects* measure the economic activity that is generated by agribusiness's demand for inputs. These effects occur in other, non-agricultural sectors of the economy that provide goods and services as inputs to agricultural production and processing, such as the warehousing, transportation, and banking industries.
  - *Induced effects* measure the economic activity that is generated when households employed in agribusiness industries spend their earnings (profits and wages) on Arizona goods and services. These effects occur in industries that provide goods and services to households, such as the retail, healthcare, and restaurant industries.
- This report takes a comprehensive look at the role of agriculture in the Arizona economy, conducting an economic contribution analysis that considers the direct, indirect, and induced effects of the agribusiness system.

What Did the Study Find?

- There are more than 20,000 farms and ranches in Arizona that manage roughly three-quarters of the state's total land area.
- **Arizona farmers and ranchers manage capital assets** (land, buildings, and machinery) **valued at $18.1 billion.**
- Based on data from the 2011 production year, **the contribution of Arizona's agribusiness system to state output (sales) was $17.1 billion (valued in today's 2014 dollars).** This figure includes direct effects as well as the indirect and induced multiplier effects.
- **Agribusiness's total contribution to Arizona's state gross domestic product (GDP) was $7.3 billion (valued in today's 2014 dollars)**.
- **More than 88,000 full- and part-time jobs were supported by Arizona's agribusiness system.** While nearly 50,000 of these were jobs within agriculture and its supporting industries, an estimated 38,000 additional jobs were supported in non-agricultural sectors.
- **Every 100 jobs in the agribusiness system support an additional 78 jobs in other industries in Arizona.**

How Was the Study Conducted?

- The economic contribution analysis was conducted using input-output modeling and the premiere software for this type of analysis, IMPLAN Version 3.1. IMPLAN is a modeling system of a regional economy that is based on national averages of production conditions. This model was refined based on the best available, recent data to more accurately reflect production conditions in Arizona.
- The contributions of agriculture and its supporting industries to the state economy were measured through the following metrics: total output (sales), value added (GDP), labor income, and employment.
- The results are broken down to demonstrate the economic contributions from primary agriculture (on-farm production), agricultural support industries (input-supply and food and fiber processing industries), and the agribusiness system as a whole. Additional detail reveals whether the contributions were a result of direct, indirect, or induced effects.

Introduction

As a leader in the production of many agricultural commodities, it is clear that agriculture is an important activity in Arizona. Arizona ranks second in the country (only to California) in the production of lettuce (head, leaf, and romaine), cauliflower, broccoli, spinach, cantaloupes, honeydews, and lemons (USDA, NASS, 2011). It also ranks in the top ten in the production of pima cotton, upland cotton, cottonseed, durum wheat, barley, tangerines, pecans, cabbage, chile peppers, watermelons, and principal vegetables (USDA, NASS, 2011). Turning to livestock production, Arizona ranks 10th in the nation in the number of cattle on feed (USDA, NASS, 2011). Clearly, Arizona is a prominent player in national agricultural production. But, closer to home, how does agriculture contribute to Arizona's economy?

The contribution of Arizona agriculture to the state economy extends beyond the commodities directly produced on farms and ranches. Several industries provide critical support for agricultural production, basing their own economic activity on Arizona agriculture. First, there are industries in Arizona that almost exclusively provide goods and services as inputs to agricultural production. These agricultural service and input-supply industries, such as pest management consultants, fertilizer manufacturers, and farm equipment manufacturers, provide jobs and wages for local residents and contribute to the overall economic activity of the state. Secondly, industries that process and pack agricultural products, or agricultural processing industries, also contribute to the economic activity of the state. Both of these agricultural support industries depend on Arizona agricultural production, thus increasing agriculture's role in the state economy.

This analysis examines the contribution of the entire agribusiness system to the state economy. It includes primary commodity agriculture (crop and livestock production) as well as the closely related input-supply and processing industries that depend on agricultural activity in Arizona.[1]

In addition to the *direct effects* from the agribusiness system, these industries stimulate further demand for goods and services in other, non-agricultural industries. For example, industries that provide water, electricity, gas, warehousing, transportation, and banking services, among others supply critical inputs to agribusiness firms. Yet, these industries are not exclusively agricultural. They also provide their goods and services to other industries. A good example of this is the warehousing industry. While warehousing services are critically important to agricultural producers and processors, non-agricultural retail sectors and wholesale sectors also rely heavily on warehousing services. So, warehousing is not exclusively agricultural. Nevertheless, because of agriculture, there is more demand for warehousing (and other non-agricultural goods and services), than there otherwise would be.

Economists call these increases in demand for inputs outside the direct industry *indirect effects*. Indirect effects also account for the fact that non-agricultural suppliers of inputs to agriculture must themselves purchase more inputs to deliver goods and services. Thus, demands for agricultural inputs have additional backward linkages to other sectors of Arizona's economy. This "ripple" of economic activity is one part of the multiplier effect of agricultural activity. *Induced effects* are another important economic multiplier. Induced effects measure the economic activity resulting from proprietors and workers in agribusiness firms—as well as employees at input-supply firms—spending their earnings on consumer goods and services within the state. These households take the paychecks they earn and spend them at the grocery store, doctor, and restaurants and movie theaters, thus generating economic activity in sectors completely unrelated to agriculture. These indirect and induced multiplier effects are combined with the direct effects to measure the total contribution of the agribusiness system to Arizona's economy.

The first section of this report provides a basic profile of Arizona agriculture, compiling data from the 2012 Census of Agriculture, the most recent and comprehensive report on agriculture available. Next, we present estimates of the total economic contribution of Arizona's agribusiness system, including the indirect effects from non-agribusiness suppliers and the induced effects from household spending of proprietors and workers in the agribusiness sectors. The contributions of the agribusiness system to the state economy are discussed in terms of output (sales), value added (GDP), labor income, and employment.

1 The Appendix contains an in-depth description of the agribusiness industries included in the economic contribution analysis.

Profile of Arizona Agriculture

According to the 2012 Census of Agriculture, Arizona has more than 20,000 farms and ranches spanning across the state (Table 1). In fact, farmers and ranchers are the primary managers of Arizona's lands, with cropland and grazing land representing roughly three-quarters of the state's land area (USDA, ERS, 2014). Table 1 shows the number of farms in Arizona by farm type, as defined by the North American Industry Classification System (NAICS). The NAICS classification identifies farms by the commodity that they "specialize" in, in other words, by the commodity that constitutes the majority (greater than 50%) of the total sales of the operation.[2]

The most prevalent type of agricultural operation in Arizona is operations specialized in *Animal aquaculture and other animal production.* There are 5,506 of these operations followed by *Sheep and goat farming* (4,593), *Beef cattle ranching and feedlots* (4,215), and *Vegetable and melon* farming (1,625). While the NAICS definition is useful in identifying the number of operations specialized in the production of a particular commodity, it may not provide a completely accurate description of Arizona agriculture. A great example is the *Animal aquaculture and other animal production* category. According to USDA, this category includes "establishments primarily engaged in raising a combination of animals with no one animal or family of animals accounting for one-half of the establishment's agricultural production" (USDA, NASS, Appendix B B-9). This means that an operation with beef cattle accounting for 49 percent (or less) of its production would be counted in the *Animal aquaculture and other animal production* category. Nevertheless, these statistics demonstrate that although Arizona is known for its contribution to national production of many specialty crops, livestock production is an important component of Arizona agriculture. Nearly 75% of operations specialize in some form of livestock production.

2 Personal communication, Steve Manheimer, USDA, NASS, Nov. 26, 2013.

3 North American Industry Classification System.

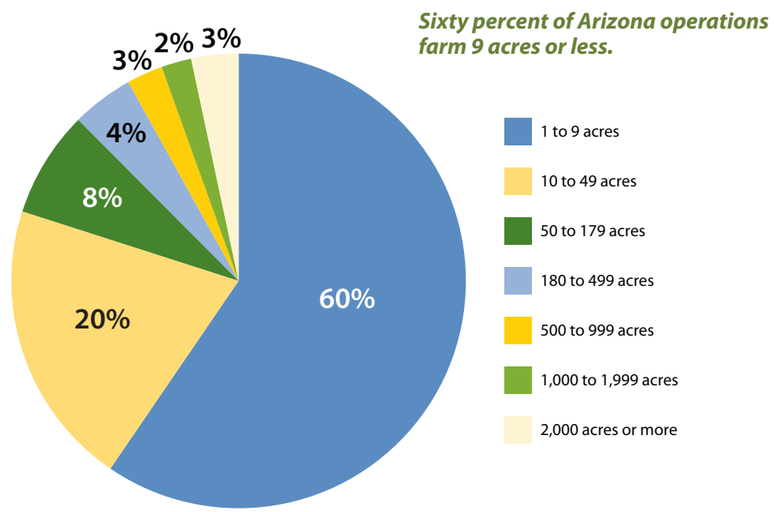
4 Farms are defined by the Census of Agriculture as any agricultural operation with the potential for sales of $1,000 or more, or farms that would normally be expected to sell agricultural products of $1,000 or more.

Table 1. Number of Farms in Arizona by Farm Type, 2012.

Type of Farm by NAICS[3]	Number of Farms[4]
Oilseed and Grain Farming	718
Vegetable and Melon Farming	1,625
Fruit and Tree Nut Farming	877
Greenhouse, Nursery, and Floriculture Production	400
Cotton	195
Hay and Other Crops	1,294
All Crop Farms	***5,109***
Beef Cattle Ranching & Farming and Feedlots	4,215
Dairy Cattle and Milk Production	102
Hog and Pig Farming	213
Poultry and Egg Production	267
Sheep and Goat Farming	4,593
Animal Aquaculture and Other Animal Production	5,506
All Livestock Farms	***14,896***
All Farms	**20,005**

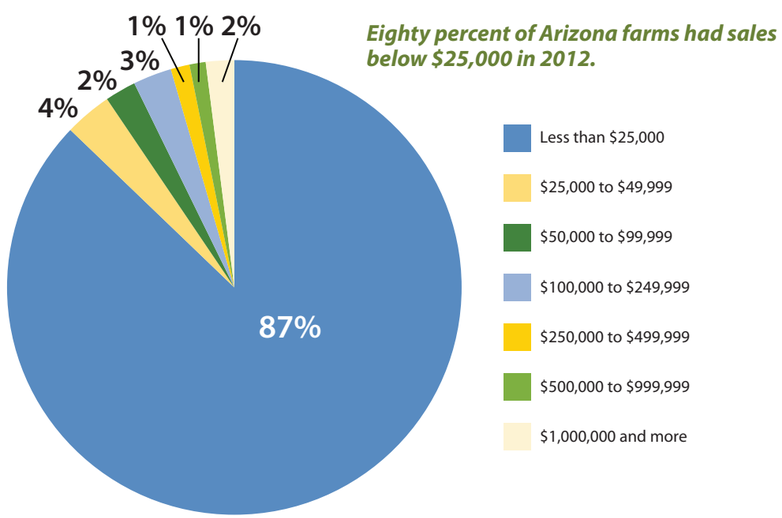
Source: USDA, 2014. 2012 Census of Agriculture–Arizona State and County Data: Table 68.

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



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

Figure 2. Percentage of Arizona Farms by Farm Size (Annual Sales), 2012.



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

Capital assets (land, buildings, and machinery) managed by Arizona farmers and ranchers are valued at $18.1 billion (USDA, 2014: Tables 46 and 47). Land and buildings account for $16.8 billion of this total, with an average value of nearly $850,000 per farm.

Specialization and market value of capital assets are just two of the ways to characterize the profile of Arizona agriculture. Another would be to look at the distribution of farm size by land area. As seen in Figure 1, a large majority of farms operate on a small area of land. More than one-half of Arizona agricultural operations have less than 10 acres in production and approximately 80% of farms have less than 50 acres in production. On the other side of the spectrum, only three percent of Arizona farms have acreage of 2,000 acres or more.

Finally, one cannot talk about Arizona agriculture without recognizing that, consistent with national trends, a majority of farmers and ranchers are small-scale producers. As seen in Figure 2, more than 85% of Arizona farms have annual sales receipts of less than $25,000. In fact, taking a closer look at small-scale operations, over 50% of farms in Arizona have sales of less than $1,000. This is in contrast to the 2% of Arizona operations that have annual sales receipts of $1 million or more.

Even more staggering, ninety-three percent of all agricultural sales in Arizona originate from agricultural producers with sales of more than $500,000, further demonstrating that a relatively small number of operations account for the bulk of the agricultural sales in Arizona. To put this in perspective, just 10 farms account for 25% of all agricultural sales revenues; 46 farms account for 50% of sales and 168 farms account for 75% of total agricultural sales in the state (USDA, 2014: Table 44). In other words, less than 1% of farms account for 75% of Arizona agricultural sales with the remaining 99% of farms accounting for 25% of total agricultural sales.

Economic Contributions of Arizona's Agribusiness System

The contribution of Arizona agriculture to the state economy extends beyond the commodities produced on farms and ranches across the state. Industries that rely on Arizona agriculture for their own production, such as agricultural input-supply and processing industries, would not have the same level of activity without Arizona agriculture. Furthermore, economic activity is stimulated in other industries in the Arizona economy to meet the demands of agricultural producers and processors (indirect effects) and households (induced effects). An economic contribution analysis was conducted using the input-output modeling software IMPLAN Version 3.1 to estimate the total economic contribution of Arizona's agribusiness system.

The IMPLAN (IMpact analysis for PLANning) modeling software provides a detailed account of the Arizona economy, demonstrates how each sector in the economy is linked to one another, and essentially tracks the flow of all goods and services in the economy. In this analysis, it is used to assess the economic contribution of the agribusiness system by "removing" it from the model and examining how the removal affects economic activity in other sectors of the economy. The analysis estimates the total contribution (direct, indirect, and induced effects) of the agribusiness system on output (sales), value added (GDP), labor income, and employment.

Before running the model, several modifications were made to the IMPLAN baseline data to reflect conditions in Arizona. First, the data was modified to reflect state-level employee compensation of hired farm labor,[5] farm proprietor income,[6] agricultural taxes on production and imports,[7] and on-farm employment.[8] Secondly, as the modeling system is based on national average conditions, the production functions (the mix of

5 Data from U.S. Department of Agriculture (USDA), Economic Research Service (ERS), *U.S. and State-Level Farm Income and Wealth Statistics.*

6 Data from Department of Commerce, Bureau of Economic Analysis (BEA), *Annual State Income and Employment.*

7 Data from U.S. Department of Agriculture (USDA), Economic Research Service (ERS), *U.S. and State-Level Farm Income and Wealth Statistics.*

8 Data from Department of Labor, Bureau of Labor Statistics (BLS), *Quarterly Census of Employment and Wages* and Department of Commerce, Bureau of Economic Analysis (BEA), *Annual State Income and Employment.*

Table 2. Economic and Employment Contributions of the Agribusiness System to Arizona's Economy, 2011.

	Direct Effects	Indirect Effects	Induced Effects	Total
Total Output ($ billion)[9]				
All Agribusiness	*$11.5*	*$2.8*	*$2.8*	*$17.1*
Primary Agriculture	$5.8	$1.1	$1.7	$8.6
Supply and Processing	$5.7	$1.7	$1.1	$8.5
Value Added ($ billion)[10]				
All Agribusiness	*$4.0*	*$1.6*	*$1.7*	*$7.3*
Primary Agriculture	$3.1	$0.7	$1.0	$4.8
Supply and Processing	$0.9	$0.9	$0.7	$2.5
Labor Income ($ billion)[11]				
All Agribusiness	*$2.2*	*$0.9*	*$0.9*	*$4.0*
Primary Agriculture	$1.6	$0.3	$0.6	$2.5
Supply and Processing	$0.6	$0.6	$0.3	$1.5
Employment[12]				
All Agribusiness	*49,981*	*17,155*	*21,635*	*88,771*
Primary Agriculture	39,312	6,788	13,404	59,504
Supply and Processing	10,669	10,368	8,231	29,267

Source: Calculations by the authors, data from IMPLAN Group, LLC, 2011a; USDA ERS Farm and Wealth Statistics, 2011; Department of Commerce BEA State Income and Employment Summary, 2011; Department of Labor BLS, Quarterly Census of Employment and Wages, 2011.

NOTE: Presented in 2014 (inflation-adjusted) dollars.

inputs used in primary agricultural sectors) were modified to reflect agricultural conditions and practices in Arizona, particularly regarding the use of irrigation. Finally, the model was redefined to ensure that there was no double counting in the agribusiness system. A more detailed discussion of the model specifications is presented in the Appendix.

Table 2 presents the results of the economic contribution analysis. The contributions were estimated for primary agriculture, its supply and processing industries, and for the agribusiness system as a whole. State-level IMPLAN output (sales) data for the 2011 production year for Arizona were used to calculate all contributions. All dollar figures presented have been inflation-adjusted to today's (2014) dollars.

Summary of Contributions

In the 2011 production year, the agribusiness system directly and indirectly contributed to approximately $17.1 billion in economic output to the Arizona economy (valued in today's 2014 dollars). This total is composed of a variety of effects as illustrated in Figure 3. The total contribution of $17.1 billion is the result of $5.7 billion in sales generated in agricultural supply and processing industries, $5.6 billion in sales generated in non-agribusiness supply industries and other industries affected by household spending, and $5.8 billion in sales generated by on-farm production in primary agriculture. A closer look at primary agriculture demonstrates

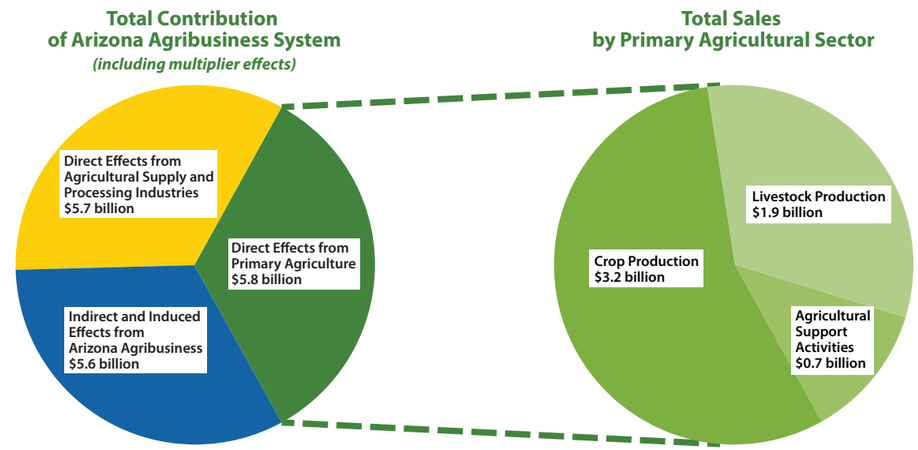
9 Output is the value of industry production, or gross sales (IMPLAN Group LLC).

10 Value Added is the difference between an industry's total output and the cost of its intermediate inputs. It is comprised of wages and salaries paid to workers, profits to the industry, and taxes on production and imports (IMPLAN Group LLC).

11 Labor Income is all forms of employment income, including employee compensation (wages and salaries including benefits) and proprietor income (IMPLAN Group LLC).

12 Employment is the number of annual average monthly jobs in the industry. It includes self-employed, wage and salary employees, and all full-time, part-time, and seasonal jobs (Day, 2014).

Figure 3. Total Economic Contribution of Arizona's Agribusiness System to State Output by Industry, 2011



Source: Calculations by the authors, data from IMPLAN Group, LLC, 2011a.

NOTE: Presented in 2014 (inflation-adjusted) dollars.

that crop production accounted for a majority of these sales with a market value of $3.2 billion. Livestock production accounted for an additional $1.9 billion and agricultural support services, largely farm labor contracting and other on-farm agricultural support services, accounted for an additional $0.7 billion.

While this measure provides a cumulative view of sales attributable to agribusiness activity, measuring the economic contribution or importance of the system using the output metric can be misleading. This is because the value of a product may be double counted—once as an end-product and once as an input in the production of another commodity. This is particularly the case with agriculture as many agricultural products are used as a production input in other agricultural operations. A great example is the relationship between feed crops and livestock operations. Feed crops sold by Arizona farms may be purchased as inputs by other Arizona farms and ranches, leading to a double counting of the value of the feed. Value added alleviates this problem because it measures the net incremental change in value from the last stage of production. In other words, value added does not include the value of the inputs used in producing the final good. It measures the *additional* gain in economic activity and is comprised of the wages and salaries paid to its workers, the profits of the industry, and the taxes paid to the government (IMPLAN Group, LLC).

Economists prefer to use the value added metric to describe the contributions to the economy because it prevents double counting, but also because it is consistent with the official measure of gross domestic product (GDP), the measure used most often to measure the size of the economy. As shown in the second section of Table 2, primary agriculture and agricultural supply and processing industries combined to generate $4.0 billion in direct value added. This level of activity supported an additional $3.3 billion in indirect and induced effects to bring agribusiness's total contribution to state GDP to $7.3 billion.

The estimate of $2.2 billion of direct labor income to agricultural producers, suppliers, and processors is comprised of wages and salaries paid to employees as well as proprietor income. Primary agriculture accounted for a majority of this, with $1.6 billion: $460 million in hired farm worker income, $730 million in farm proprietor income, and $420 million in farm

contract-worker income. Accounting for indirect and induced effects, the total labor income contribution from the agribusiness system was approximately $4.0 billion.

Finally, according to model estimates, the agribusiness system directly supported nearly 50,000 part- and full-time jobs in Arizona, 79 percent of those in primary agriculture. The purchase of production inputs from non-agribusiness firms supported an estimated 17,000 additional jobs in the state while household spending from agribusiness and non-agribusiness workers accounted for an additional 21,600 jobs. In total, the estimated employment contribution of agribusiness was more than 88,000 jobs. This means that every 100 jobs in the agribusiness system support an additional 78 jobs in other economic sectors the state.

Appendix

Defining Arizona's Agribusiness System

The agribusiness system is defined as "the primary agricultural sector plus the closely related industries that depend on agricultural activity in Arizona." This definition was originally developed by Jorgen Mortensen's 2004 University of Arizona Department of Agricultural and Resource Economics publication *Economic Impacts from Agricultural Production in Arizona*. The agricultural production, supply, and processing industries (and their respective IMPLAN sector codes) defined as the agribusiness system are listed in Table 3.

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

Agricultural supply and service industries included in the model are the *fertilizer manufacturing* sector (NAICS 32531 and IMPLAN sector 130), the *pesticide and other agricultural chemical manufacturing* sector (NAICS 35320 and IMPLAN sector 131), and the *farm machinery and equipment manufacturing* sector (NAICS 333111 and IMPLAN sector 203).

Agricultural processing industries included all sectors of the *food manufacturing* sector (NAICS 311), with the exception of a few industries that were determined not to exist in the Arizona economy by the IMPLAN model. Only the *winery* subsector (NAICS 31213 and IMPLAN sector 72) is included from the *beverage and tobacco product manufacturing* sector (NAICS 312). Many fiber processing industries were excluded from the model because a majority of textile mills did not have a direct link to cotton. The only sectors included from *textile mills* (NAICS 313) were subsectors *fiber, yarn, and thread mills* (NAICS 3131 and IMPLAN sector 75) and *broadwoven fabric mills* (NAICS 31321 and IMPLAN sector 76). Finally, we included the *leather and hide tanning and finishing* sector (NAICS 3161 and IMPLAN sector 92).

Table 3. Arizona's Agribusiness System by IMPLAN Economic Sector

IMPLAN Industry Number and Description	
1	Oilseed farming
2	Grain farming
3	Vegetable and melon farming
4	Fruit farming
5	Tree nut farming
6	Greenhouse, nursery, and floriculture production
7	Tobacco farming
8	Cotton farming
9	Sugarcane and sugar beet farming
10	All other crop farming
11	Cattle ranching and farming
12	Dairy cattle and milk production
13	Poultry and egg production
14	Animal production, except cattle and poultry and eggs
19	Support activities for agriculture and forestry
41	Dog and cat food manufacturing
42	Animal food manufacturing
43	Flour milling and malt manufacturing
45	Soybean and oilseed processing
46	Fats and oils refining and blending
51	Chocolate confectionary manufacturing from purchased chocolate
52	Nonchocolate confectionary manufacturing
53	Frozen food manufacturing
54	Fruit and veggie canning, picking, drying
55	Fluid milk and butter manufacturing
56	Cheese manufacturing
57	Dry, condensed, and evaporated dairy product manufacturing
58	Ice cream and frozen dessert manufacturing
59	Animal (except poultry) slaughter, rendering, and processing
62	Bread and bakery manufacturing
63	Cookie, cracker, pasta manufacturing
64	Tortilla manufacturing
65	Snack food manufacturing
66	Coffee and tea manufacturing
67	Flavoring and concentrate manufacturing
68	Seasoning and dressing manufacturing
69	All other food manufacturing
72	Wineries
75	Fiber, yarn, thread mills
76	Broadwoven fabric mills
92	Leather and hide tanning and finishing
130	Fertilizer manufacturing
131	Pesticide and other agricultural chemical manufacturing
203	Farm machinery and equipment manufacturing

Data Sources and Methodology

Data from the 2011 IMPLAN model for the state of Arizona was used to estimate the economic contribution of agricultural production. Due to IMPLAN's ability to provide estimates for non-disclosed data and reconcile multiple data sources, we elected to use IMPLAN industry output data as the basis of this analysis. However, primary agricultural industry sales were compared to commodity cash receipt data obtained from NASS's Annual Statistical Bulletin and USDA Economic Research Service's (ERS) Farm Income and Wealth Statistics to identify inconsistencies. IMPLAN estimates for total primary agricultural output were within 2% of USDA ERS figures.

Modifications were made, however, to IMPLAN baseline data to reflect state-level employee compensation of hired farm labor,[13] farm proprietor income,[14] agricultural taxes on production and imports,[15] and on-farm employment.[16] This 2011 state-level data was distributed among primary agricultural industries based upon the shares reported by the 2012 Census of Agriculture.

Additional modifications of the IMPLAN data were required to accurately represent agricultural practices in Arizona. The baseline production functions (also known as industry spending patterns) for each agricultural sector in IMPLAN are based on national averages. This means that for some commodities, the spending pattern for Arizona can vary drastically from the same commodity in another region. The primary reason for this is irrigated agriculture (IMPLAN Group, LLC). The national average spending pattern may represent non-irrigated crop production, which is certainly not the case for semi-arid Arizona. Farm expense data was obtained from the 2012 Census of Agriculture and primary agriculture industry spending patterns were modified to reflect the shares of input expenditures.

Finally, as this analysis examines agriculture and its backward-linked supply industries and its forward-linked processing industries, the model must be redefined to ensure that there is no double counting. The model was modified so that each industry was not able to purchase inputs from the previous stage of production—components that were already being captured in the model. IMPLAN's procedures for a multi-contribution analysis were followed to eliminate double counting in the estimates of indirect effects (IMPLAN Group, LLC, 2011b).

13 Data from U.S. Department of Agriculture (USDA), Economic Research Service (ERS), *U.S. and State-Level Farm Income and Wealth Statistics.*

14 Data from Department of Commerce, Bureau of Economic Analysis (BEA), *Annual State Income and Employment.*

15 Data from U.S. Department of Agriculture (USDA), Economic Research Service (ERS), *U.S. and State-Level Farm Income and Wealth Statistics.*

16 Data from Department of Labor, Bureau of Labor Statistics (BLS), *Quarterly Census of Employment and Wages* and Department of Commerce, Bureau of Economic Analysis (BEA), *Annual State Income and Employment.*

Note:

The purpose of this report is to provide an up-to-date estimate of agriculture's role in the Arizona economy. The Department of Agricultural and Resource Economics (AREC) at the University of Arizona has produced several reports in the past, the latest of which describes how agriculture's contribution to the state economy has changed from 1990 to 2007 (Mortensen, 2010). Value added impacts ranged from $2.7 billion in 1990 (Leones and Conklin, 1993) to $3.0 billion in 2000 (Mortensen, 2004) to $4.0 billion in 2007 (Mortensen, 2009). Total contribution to state output also exhibited growth, rising from $6.6 billion in 2000 (Mortensen, 2004) to $10.3 billion in 2007 (Mortensen, 2009). Estimated total employment had been trending downward with approximately 94,339 jobs in 1990 (Leones and Conklin, 1993), 72,920 jobs in 2000 (Mortensen, 2004), and 59,066 jobs in 2007 (Mortensen, 2009).

While efforts were made to keep this analysis consistent with previous AREC reports, a review of similar studies (English, Pop, and Miller, 2014; Ward, Jakus, and Coulibaly, 2013) influenced this report to include all food processing and manufacturing sectors (NAICS 311) as part of the Arizona agribusiness system, some of which were not included in previous AREC reports. Due to these few discrepancies in the definition of the agribusiness system, direct comparisons from previous reports cannot be made with this report. Future analyses by the AREC Department will follow the methodology outlined in this report.

References

Day, Frances. 2014. *Principles of Impact Analysis and IMPLAN Applications*. IMPLAN Group, LLC. 16740 Birkdale Commons Parkway, Suite 206. Huntersville, NC 28078, www. IMPLAN.com.

English, Leah, Jennie Popp, and Wayne Miller. 2014. *Economic Contribution of the Agricultural Sector to the Arkansas Economy in 2012*. Arkansas Agricultural Experiment Station, University of Arkansas System, Division of Agriculture, Fayetteville. Research Report 994. Available at http://arkansasagnews.uark.edu/994.pdf.

IMPLAN Group, LLC. 2011a. IMPLAN System (Version 3.1 data and software). 16740 Birkdale Commons Parkway, Suite 206. Huntersville, NC 28078, www. IMPLAN.com.

IMPLAN Group, LLC. 2011b. Estimating the Contribution of a Current Industry. Available at http://implan.com/index.php?option=com_content&view=article&id=660:660&-catid=253&Itemid=508.

Leones, Julie P. and Neilson C. Conklin. 1993. *Agriculture in the Arizona Economy.* Arizona Department of Agriculture, Arizona State University and The University of Arizona.

Mortensen, Jorgen R. 2004. *Economic Impacts from Agricultural Production in Arizona*. Department of Agricultural and Resource Economics, The University of Arizona. Available at http://ag.arizona.edu/arec/pubs/econimpacts/economicimpactsforweb.pdf.

Mortensen, Jorgen R. 2009. *Impacts from Agricultural Production and from Specialty Crops on the Arizona Economy 2007*. Department of Agricultural and Resource Economics, The University of Arizona. Available at http://ag.arizona.edu/arec/pubs/impactsfromagproduction2007.pdf.

Mortensen, Jorgen R. 2010. *Impacts of Agricultural Production and Specialty Crops on Arizona's Economy in 2007: Addendum Report*. Department of Agricultural and Resource Economics, The University of Arizona. Available at http://ag.arizona.edu/arec/pubs/impactsfromagproduction2007addendum2010.pdf.

U.S. Department of Agriculture (USDA). 2014. *2012 Census of Agriculture: Arizona State and County Data*, Volume 1, Geographic Area Series, Part 3 AC 12-A-3. Issued May 2014. Available at http://www.agcensus.usda.gov/Publications/2012/.

U.S. Department of Agriculture (USDA). Economic Research Service (ERS). 2011. *U.S. and State-Level Farm Income and Wealth Statistics*. Available at http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/value-added-years-by-state.aspx#.VE2_dRbp_fY.

U.S. Department of Agriculture (USDA). Economic Research Services (ERS). 2014. *Data Products: Major Land Uses.* Available at http://www.ers.usda.gov/data-products/major-land-uses.aspx#UvLE0z1dWi4.

U.S. Department of Agriculture (USDA). National Agricultural Statistics Service (NASS). 2011. *Arizona Agricultural Statistics Bulletin*. Available at http://www.nass.usda.gov/Statistics_by_State/Arizona/index.asp.

U.S. Department of Commerce. Bureau of Economic Analysis (BEA). 2011. *Annual State Income and Employment*. Farm income and expenses (SA45). Available at http://www.bea.gov/iTable/iTable.cfm?reqid=70&step=1&isuri=1&acrdn=1#reqid=70&step=1&isuri=1.

U.S. Department of Labor. Bureau of Labor Statistics (BLS). 2011. *Quarterly Census of Employment and Wages.* Available at http://www.bls.gov/cew/data.htm.

Ward, Ruby A., Paul M. Jakus, and Lassina Coulibaly. 2013. *The Economic Contribution of Agriculture to the Economy of Utah in 2011.* Department of Applied Economics, Utah State University, Center for Society, Economy, and the Environment Paper #2013-01. Available at http://www.ag.utah.gov/documents/EconomicContributionOfAgriculture2011.pdf.