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Working Paper

Arizona State Freight Plan

(ADOT MPD 085-14)

Phase 3 Working Paper
Agriculture Sector Profile and Transportation Performance Needs

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Arizona Department of Transportation

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Working Paper

This working paper is one of 10 focusing on key Arizona economic sectors. Its purpose is to document the economic profile, outlook and transportation performance needs of Arizona's agriculture sector. This working paper will later inform system improvement needs to increase Arizona's economic competitiveness and growth. This working paper is provided for comment and discussion and should not be interpreted as final.

Acknowledgements

The CPCS team would like to thank the Arizona Department of Transportation (ADOT) for its guidance and input in developing this working paper. The team also recognizes the considerable contribution of the agriculture sector stakeholders consulted in the development of this working paper.

Opinions

Unless otherwise indicated, the opinions herein are those of the author and do not necessarily reflect the views of ADOT or the State of Arizona.

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Executive Summary

Economic and Traffic Profile

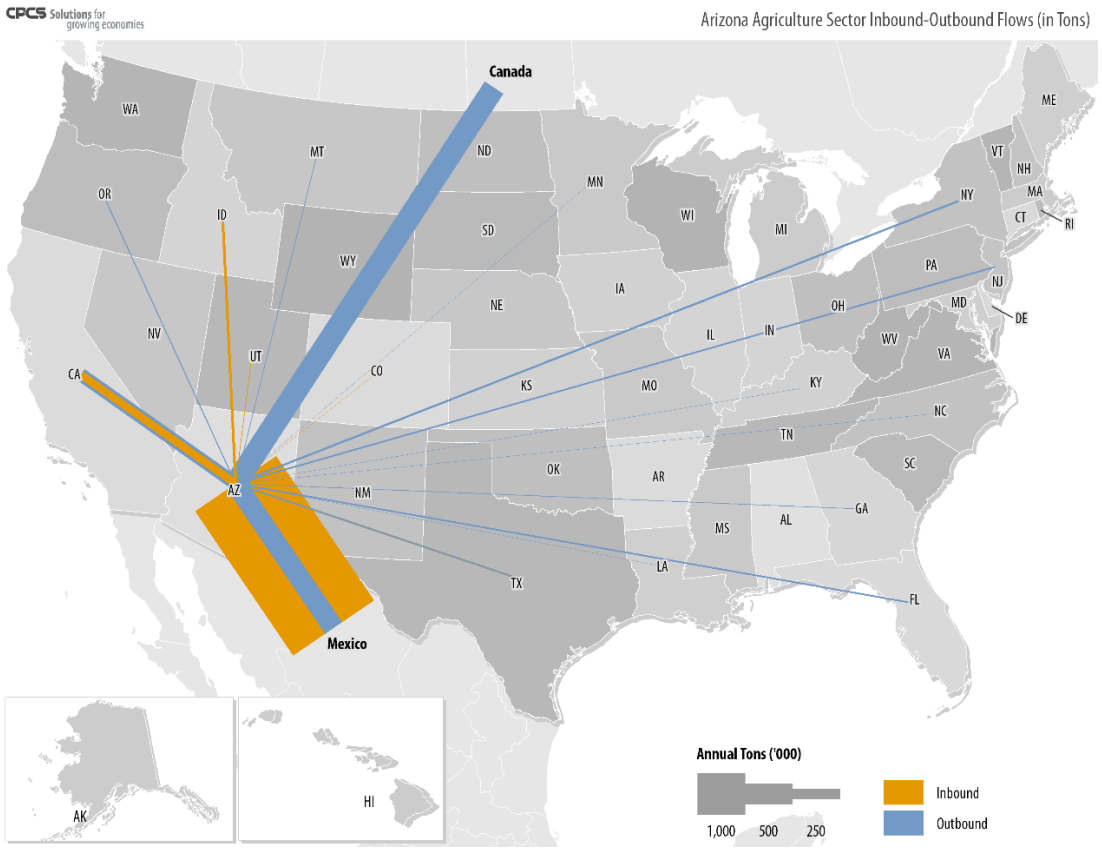
The agriculture sector in Arizona contributed $1.5 billion to the State's gross domestic product (GDP) in 2012, representing .6 percent of the State's total economic output. Since 1997, GDP in the agriculture sector has grown at a rate of 1.9 percent per annum, underperforming compared to the overall state average of 4.9 percent growth per annum.[1] In 2013, the sector employed 25,728 people[2,3], representing 1.0% of total employment in the State.[4] The total wages and salaries paid to employees in 2013 was $967 million dollars[5], making the average annual earnings per employee in 2013 approximately $38,000 for the sector. The largest commodities in the Arizonan agriculture sector are dairy, cattle, leafy greens, hay, cotton, and melons.

	Measure	Agriculture Sector	Arizona (Statewide)
Economy	GDP (2012, $ million)	$1,546	$271,503
	GDP Annualized Growth (1997-2012)	1.9%	4.9%
Jobs	Employment (2013)	25,728	2,619,055
	Compensation per Employee (2013)	$37,595	$57,393
Transportation	Total Commodity Flows (2012, Mt)	1.2	138.2
	Top Origin (2012, Mt)	Mexico (2.4 Mt)	California (9.5 Mt)
	Top Domestic Destination (2012, Mt)	Canada (.53 Mt)	Mexico (5.6 Mt)
	Intrastate Flows (2012, Mt)	.4	101.8
	% Truck (2012)	99.8%	87.2%

Source: CPCS Analysis of data from Bureau of Economic analysis and 2012 Commodity Flow Survey

Mexico, Canada and California are Arizona's largest trading partners of agricultural products. Agricultural products from Mexico account for 88 percent of all inbound traffic in the sector, while Canada and Mexico account for approximately one-third each of total outbound flows.

[1] Bureau of Economic Analysis Regional Economic Accounts, GDP by State. GDP in current dollars.
[2] Excludes self-employment.
[3] Note: Data in Section 2.2.6 from the Bureau of Economic Analysis includes data for "NAICS 115 Support Activities for Agriculture and Forestry". Some employment numbers in NAICS 115 may be attributable to the Forestry sector but are not divisible in the data available. For the sake of analysis, this employment data for NAICS 115 is included in Agriculture. Data from NAICS 115 is not included in the Forestry paper.
[4] Bureau of Economic Analysis Regional Economic Accounts, Personal Income and Employment by State. Wages and Salaries by NAICS Industry
[5] Bureau of Economic Analysis Regional Economic Accounts, Personal Income and Employment by State. SA6N Wages and Salaries by NAICS Industry



Source: CPCS analysis of Commodity Flow Survey, 2012.

Supply Chain Structure and Transportation Performance Needs

Agriculture is a diverse sector with distinct needs and supply chains depending on the product. Many agricultural products are highly perishable or temperature sensitive. Consequently, both travel time and travel reliability are critical factors affecting agricultural transportation decision. Historically, faster highway travel time is the main factor that led to the switch from rail transportation to truck transportation for most products in the sector. All agricultural products are highly dependent on freight transportation. Two notable examples include beef production and dairy processing:

- The beef industry starts with the production of feed and cow-calf operations and concludes with the processing of meats. An estimated 70 percent of all calves in Arizona go out of state for further backgrounding, finishing and feeding before they are ready for slaughter. Still, finishing and feeding businesses in Arizona are significant in the economy and in generation of truck trips. The largest actor in beef processing in Arizona is JBS which takes finished cows from Arizona and from other states and processes finished product.

- The United Dairymen of Arizona (UDA) is a milk marketing cooperative of 90 producers that represents approximately 90 percent of the milk produced in the state.[6] The UDA has a large manufacturing facility in Tempe Arizona that can process 10 million pounds of raw milk per day. The plant operates 24 hours a day and seven days a week producing milk, cream, butter, condensed milk and lactose powder. Several major dairy product processors are also located in Casa Grande, using milk marketed by the UDA.

Notable Barriers and Related Priority Improvements to Enhance Competitiveness and Growth

A number of economic issues have impacted the growth of Arizona's agricultural sector in recent years. In some regions farmers have experienced difficulty in arranging the first stage of transportation from the field to the truck. Some regions have made the transition from an agriculture based economy to one that has added value to the raw produce and created a higher priced product that supports employment with higher wages; while other regions still are heavily dependent on the raw produce and access to large numbers of low skilled workers. In both cases, a quality distribution network is critical to the success of the industry regardless of stage of value-added.

One of the top transportation issues for the agricultural sector is weight restrictions on truckloads. Stakeholders have noted that they must monitor loading of trucks to see whether a truck "weighs out" before it "cubes out" when loading product. Many in the sector would like to see weight restrictions increased to allow for better utilization of trucks, which they feel will also reduce the number of trucks on the road.

Many stakeholders have reported good performance of the transportation network in Arizona for the movement of their products. Addressing congestion on the I-10, one of the top corridors for the sector, is another key improvement to facilitate the movement of goods within the state, such as movement of cows to the JBS plant in Tolleson, and to California, the sector's top domestic trade partner.

Actions to facilitate the flow of goods across the border, such as the recent expansion of the International Border Permit to the San Luis Port of Entry (POE), as well as the expansion at the Mariposa POE are helpful in facilitating the flow of goods. Increases in border staff at Nogales, efforts to reduce Mexican Military inspections of agricultural goods destined for the United States, and repaving of the Mexican highway 15 would all be deemed as helpful for the flow of goods into Arizona and for the competitiveness of the port at Nogales. On the Arizonan side, identified improvements to the S-189 would help assist the flow of goods through to the I-19.

Other key infrastructure improvements in Arizona would be the addition of bypasses around main streets in urban areas, such as at the land POEs, and actions to increase the flow of vehicles

[6] United Dairymen of Arizona, *About the United Dairymen of Arizona*. http://www.uda.coop/About/default.asp accessed June 20, 2015.

on the I-17 to Flagstaff at the I-40, as well as pursuing the construction of the proposed Sonoran Corridor would be seen as key improvements for agricultural flows.

Acronyms and Abbreviations

ACA	ARIZONA COMMERCE AUTHORITY
ADOT	ARIZONA DEPARTMENT OF TRANSPORTATION
CFS	COMMODITY FLOW SURVEY
GDP	GROSS DOMESTIC PRODUCT
MPD	MULTIMODAL PLANNING DIVISION (OF ADOT)
Mt	MILLION TONS
NAICS	NORTH AMERICAN INDUSTRY CLASSIFICATION
POE	PORT OF ENTRY
UDA	UNITED DAIRYMEN OF ARIZONA

1 Introduction

Key Messages

The Arizona Department of Transportation, Multimodal Planning Division, retained a team lead by CPCS Transcom, Inc. to assist in the development of Arizona's State Freight Plan.

The aim of this working paper is to establish the freight transportation performance needs, outlooks, and economic contribution of Arizona's agriculture sector (defined here as NAICS Codes 111, 112, 115). This will later inform the analysis of broader transportation system based needs and priorities.

This working paper was developed in large part through stakeholder consultations and analysis of agricultural data.

1.1 Introduction: Why an Arizona State Freight Plan?

Arizona's economic potential is supported by the state's transportation infrastructure, which connects sources of production to markets.

When transportation infrastructure and related services are efficiently designed and competitively positioned, businesses benefit from lower transportation costs, faster and better transportation services, and increased reliability, which in turn contribute to their own competitiveness and growth, and that of the broader region.

Jurisdictions with access to competitive transportation infrastructure and services are at a competitive advantage in attracting investment, creating jobs and realizing economic growth. Arizona's State Freight Plan can help enable this outcome.

To this end, the ADOT's Multimodal Planning Division (MPD), is developing Arizona's State Freight Plan which will provide strategic guidance to enhance Arizona's economic competitiveness and facilitate economic growth.

1.2 Project Objectives

The State Freight Plan will define immediate and long-range investment priorities and policies that will generate the greatest return for Arizona's economy, while also advancing other key transportation system goals, including national goals outlined in MAP-21. It will identify freight transportation facilities in Arizona that are critical to the State's economic growth and give appropriate priority to investments in such facilities.

The State Freight Plan will ultimately provide Arizona with a guide for assessing and making sound investment and policy decisions that will yield outcomes consistent with the state's visions, goals, and objectives, and notably, promote regional competitiveness and economic growth.

1.3 Purpose of this Working Paper

Since it is economic activity – particularly from goods movement sectors - that drives demand for freight transportation infrastructure and services, optimization of the state's freight transportation system, and related strategies, goals and investments, must start by addressing the transportation performance needs of the sectors moving freight. Yet, the transportation performance needs of freight can differ by sector and commodity group, locations and even company.

For this reason, the team identified 10 key freight sectors in Arizona for specific focus: wholesalers and retailers, food and beverage, high-tech manufacturing, general manufacturing, transportation equipment manufacturing, transportation and logistics, mining (except oil and gas), energy (oil and gas), agriculture, and forestry.

The purpose of this working paper is to provide a focused assessment of the transportation performance needs, outlooks and economic contribution of the agricultural sector (defined here as NAICS Codes 111, 112, 115).

Specifically, it addresses the following key questions:

- At a high level, what is the profile and economic contribution of the agriculture sector to Arizona's economy?
- How do the supply chains of Arizona's agriculture sector utilize the transportation system and what are the major origins, destinations, intermediate points, and final products of these chains?
- How are the supply chains of the agriculture sector structured, managed, and what are the primary drivers of transportation decisions and related performance needs?
- What are the key trends in the agriculture sector, how are these influencing freight flows, and what are the implications, opportunities and challenges for the competitiveness of Arizona's freight system going forward?

1.4 Methodology

This working paper is informed by a combination of literature review, data collection and analysis, and extensive consultation with agriculture sector stakeholders. Documents reviewed are footnoted throughout the working paper, as appropriate. A list of individuals consulted is provided in Appendix A (unless the stakeholder has specifically requested non-attribution).

1.5 Limitations

This working paper is in many cases informed by data and input provided by third parties. CPCS has verified this information to the extent possible through analysis and cross-checking with other sources but cannot guarantee the accuracy of data received from third parties.

2 Agriculture Sector Profile

Key Messages

Agriculture has traditionally been a core element of the Arizona economy. Four of the "Five C's" (copper, cattle, cotton, citrus and climate) of Arizona relate to the agriculture sector. Today, dairy, cattle, leafy greens, melons, cotton and hay are some of the largest crops produced in the state by value.

The sector produced an estimated $1.5 billion in gross state product in 2012 and employed over 25,000 wage and salaried employees in 2013. The areas around Yuma County, and the greater Phoenix area generate significant freight flows in the agriculture sector.

Almost all international imports of agriculture commodities to Arizona originate in Mexico and a significant volume of agricultural products are destined to either Canada, Mexico or Asia.

2.1 Overview of Agriculture Sector

2.1.1 Evolution of the Sector

> **"… four of the 'five C's' of Arizona…are related to the agriculture sector."**

The agriculture industry in Arizona has traditionally been one of the strongest sectors driving the growth of the state. Four of the "Five C's" of Arizona's economy (copper, cattle, cotton, citrus and climate) are related to the agriculture sector. While today agriculture is not as central to the Arizonan economy as it once was, it is still an integral part of Arizona's increasingly diversified economy and remains a major source of economic activity and employment in the state. There are approximately 19,600 farms in Arizona operating over a total of 26 million acres.[7] In other words, approximately 35 percent of the land in the State of Arizona is used for agricultural purposes.

Cattle. Historically, ranching was very important to Arizona, with 1.8 million head of cattle in 1918.[8] Today, the number of head is approximately half of that figure at around 880,000.[9]

Figure 2-1: Olam Cottom Gin (Buckeye)

Source: CPCS

Cotton. Cotton was a major "cash crop" for Arizona starting in the 1910's with the introduction of Pima Cotton developed in Pinal County, originally cultivated by the Pima people. Most production has now shifted from Pima to Upland cotton varieties. While its relative importance to the economy has diminished, Arizona remains a leading state in the production of cotton along with Texas, Mississippi, Louisiana and California.

Citrus. Lemons, grapefruits, limes and oranges have traditionally been some of the most important citrus fruits grown in the state. Early on in the development of the state, citrus fruit were in high demand in the west by miners in order to combat scurvy. Because citrus is highly sensitive to frost, Arizona was a natural place for the production of citrus. Today Arizona is one of only four citrus-producing states in the U.S. along with Florida, Texas and California.

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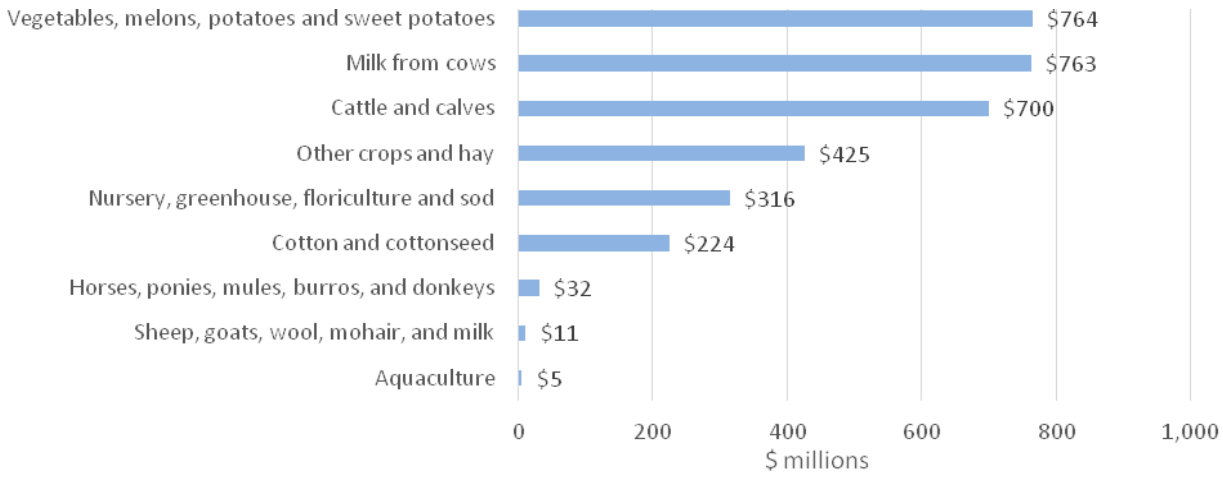
[7] United States Department of Agriculture, 2014 State Agriculture Overview (Arizona)
[8] Arizona State Library, Archives and Public Records. Arizona Almanac, Digital Arizona Library. *Accessed July 20, 2015.*
[9] United States Department of Agriculture, 2014 State Agriculture Overview (Arizona)

Climate. The climate in Arizona provides an advantage in the production of many agricultural products, most notably citrus. New industries, in particular the leafy vegetables industry, have developed in large part thanks to Arizona's favorable climate. At the center of this new industry is Yuma County, which benefits from a favorable climate and access to the Colorado River—providing ideal conditions for the cultivation of leafy vegetables. During the winter months, the Yuma area produces an estimated 90 percent of all the leafy vegetables grown in the United States from November to March, earning it the title of the nation's "winter salad bowl".[10]

Today, the vegetable, melon, potato and sweet potato industry (the largest component of this being leafy greens production), leads in sales volumes for the agriculture sector in Arizona. This is closely followed by the dairy and cattle industries, respectively. Hay, nursery and cotton production also make up very significant components of the agriculture sector.

Figure 2-2: Sales of Main Arizonan Agricultural Products (2012)



Source: CPCS Analysis of USDA Census State Profile for Arizona

2.1.2 Livestock and Dairy

Milk from cows and cattle and calves produced for beef are the second and third largest components by sales in the Arizona agriculture sector (see Figure 2-2).

[10] Julie Murphree, Arizona Farm Bureau. *Running the Numbers on Exciting Yuma, Arizona Agriculture Statistics.*

Figure 2-3: Phoenix Region Dairy Farm (Buckeye)

Source: CPCS

There were a total of 880,000 head of cattle and calves in 2014 in Arizona. By value, goats, sheep and hogs also make up smaller, yet important components of the agriculture industry in Arizona.

Figure 2-4: Livestock Inventory in Arizona

Livestock Type	Inventory (# head)
Cattle, Cows, Beef - Inventory (First of Jan. 2015)	175,000
Cattle, Cows, Milk - Inventory (First of Jan. 2015)	195,000
Cattle, Incl. Calves - Inventory (First of Jan. 2015)	880,000
Cattle, On Feed - Inventory (First of Jan. 2015)	252,000
Goats, Angora - Inventory (First of Jan. 2015)	36,000
Goats, Meat & Other - Inventory (First of Jan. 2015)	28,000
Goats, Milk - Inventory (First of Jan. 2015)	(NA)
Sheep, Incl. Lambs - Inventory (First of Jan. 2015)	150,000
Hogs - Inventory (First of Dec. 2014)	134,000

Source: United States Department of Agriculture, 2014 State Agriculture Overview (Arizona)

Of the 880,000 head of cattle and calves in Arizona, 195,000 were dedicated to milk production, producing approximately 4.7 billion pounds of milk.

Figure 2-5: Milk Production in Arizona

Milk Production	
Milk - Production, Measured in pounds / head	24,347
Milk - Production, Measured in $	1,090,168,000
Milk - Production, Measured in pounds	4,699,000,000

Source: United States Department of Agriculture, 2014 State Agriculture Overview (Arizona)

2.1.3 Crops

The total value of crop production in Arizona is estimated at over $2.3 billion in 2014. Hay, lettuce, cotton, and melons represent the largest crops in terms of value reported for 2014.

Figure 2-6: Crop Production in Arizona

Commodity	Type	Harvested Acres	Production Size	Value of Production in Dollars ($)
HAY	HAY, ALFALFA	260,000	2,210,000 TONS	477,360,000
	HAY, EXCLUDING ALFALFA	40,000	200,000 TONS	43,800,000
	HAY TOTAL			***521,160,000***
LETTUCE	LETTUCE, ROMAINE, FRESH MARKET	21,900	6,899,000 CWT	159,367,000
	LETTUCE, HEAD, FRESH MARKET	34,500	12,248,000 CWT	156,774,000
	LETTUCE, LEAF, FRESH MARKET	8,100	1,944,000 CWT	61,042,000
	LETTUCE TOTAL			**377,183,000**
COTTON	COTTON, UPLAND	149,000	490,000 480 LB BALES	145,303,000
	COTTON, COTTONSEED		172,000 TONS	45,236,000
	COTTON TOTAL			***190,539,000***
MELONS	MELONS, CANTALOUP, FRESH MARKET	16,000	3,840,000 CWT	93,312,000
	MELONS, HONEYDEW, FRESH MARKET	3,500	805,000 CWT	26,243,000
	MELONS, WATERMELON, FRESH MARKET	2,900	1,334,000 CWT	25,880,000
	MELONS TOTAL			***145,435,000***
WHEAT	WHEAT	79,000	8,692,000 BU	71,983,000
LEMONS	LEMONS	8,500		51,613,000
SPINACH	SPINACH, FRESH MARKET	8,000	1,240,000 CWT	49,476,000
PECANS	PECANS, IMPROVED, UTILIZED, IN SHELL	N/A	21,000,000 LB	44,100,000
CABBAGE	CABBAGE, FRESH MARKET	3,700	1,906,000 CWT	41,360,000
CAULIFLOWER	CAULIFLOWER	3,600	720,000 CWT	39,528,000
CORN	CORN, GRAIN	28,000	5,880,000 BU	30,870,000
BROCCOLI	BROCCOLI	6,400	800,000 CWT	29,920,000
BARLEY	BARLEY	32,000	4,000,000 BU	17,800,000
BEANS	BEANS, DRY EDIBLE	10,900	211,000 CWT	11,457,000
SORGHUM	SORGHUM, GRAIN	8,000	800,000 BU	4,234,000
APPLES	APPLES, UTILIZED	N/A	7,100,000 LB	2,991,000
PEPPERS	PEPPERS, CHILE	1,400	80,000 CWT	2,706,000
TRANGERINES	TANGERINES	2,500	8,000 TONS	(D)
POTATOES	POTATOES	3,500	1,085,000 CWT	(D)

Source: United States Department of Agriculture, 2014 State Agriculture Overview (Arizona)
(D) Withheld to avoid disclosing data for individual operations

The single highest value product is hay, and almost all hay grown in Arizona (and other southwestern states) is alfalfa. The total value of hay produced in the State almost doubled between 2005 and 2014 from $287 million to $521 million. During this same time period hay production in tons increased marginally from 2.3 million tons (Mt) to 2.4 Mt. Some of the largest impediments on further increases in hay production are the water and land requirements necessary in its production. A large portion of hay produced is dedicated to serving Arizona's dairy and cattle industry as well as for equine purposes and trade with other states.

Vegetable and melon production, largely concentrated in Yuma County, is also important in the agriculture industry for Arizona. Given its favorable winter climate, Yuma provides the U.S. with most of the lettuce and leafy green vegetables consumed during winter months.

2.2 Economic Profile and Importance to Arizona's Economy

2.2.1 GDP

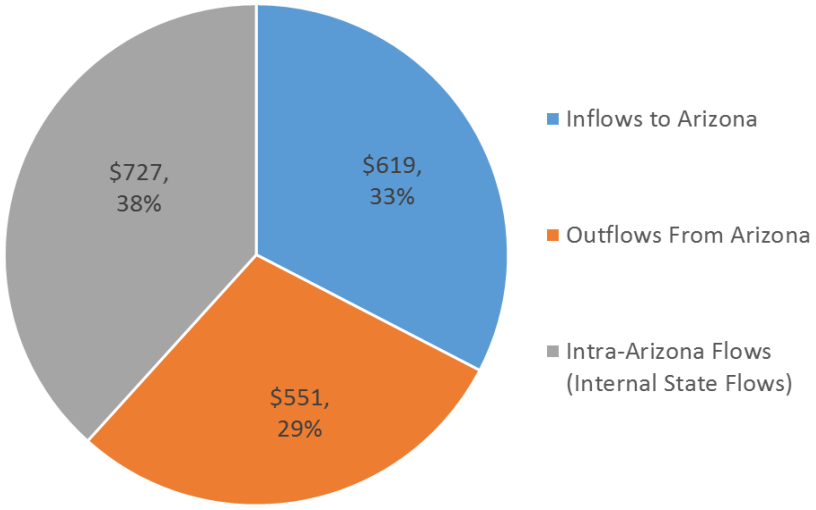
The agriculture sector in Arizona contributed $1.5 billion to the State's gross domestic product (GDP) in 2012, representing .6 percent of the State's total economic output. Since 1997, GDP in the agriculture sector has grown at a rate of 1.9 percent per annum, underperforming compared to the overall state average of 4.9 percent growth per annum.[11]

2.2.2 Commodity Flows

Overall, $2 billion of goods in the agriculture sector travelled into, out of, or within the State of Arizona in the year 2012. Of this, $726 million of goods originated in other states and were destined to Arizona, $727 million originated in Arizona and were destined for other states, and $559 million in goods travelled within the state of Arizona.

[11] Bureau of Economic Analysis Regional Economic Accounts, GDP by State. GDP in current dollars.

Figure 2-7: Value of Agricultural Flows Into, out of, and Within Arizona in 2012 ($millions)

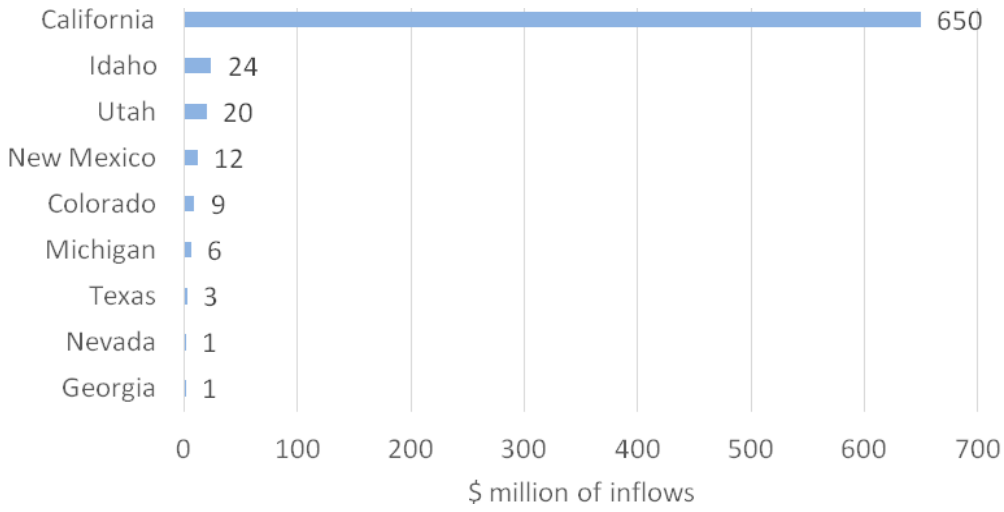


Source: CPCS analysis of Commodity Flow Survey, 2012.

2.2.3 Origins of Inflows to Arizona

The figure below summarizes the origins of agriculture sector products that were shipped to Arizona from other states. California was the largest origin of food and beverage products destined for Arizona with $650 million in products shipped to Arizona, Idaho and Utah at $24 million and $20 million respectively.

Figure 2-8: Value of Top Food and Agriculture Inflows to Arizona by State of Origin (2012)



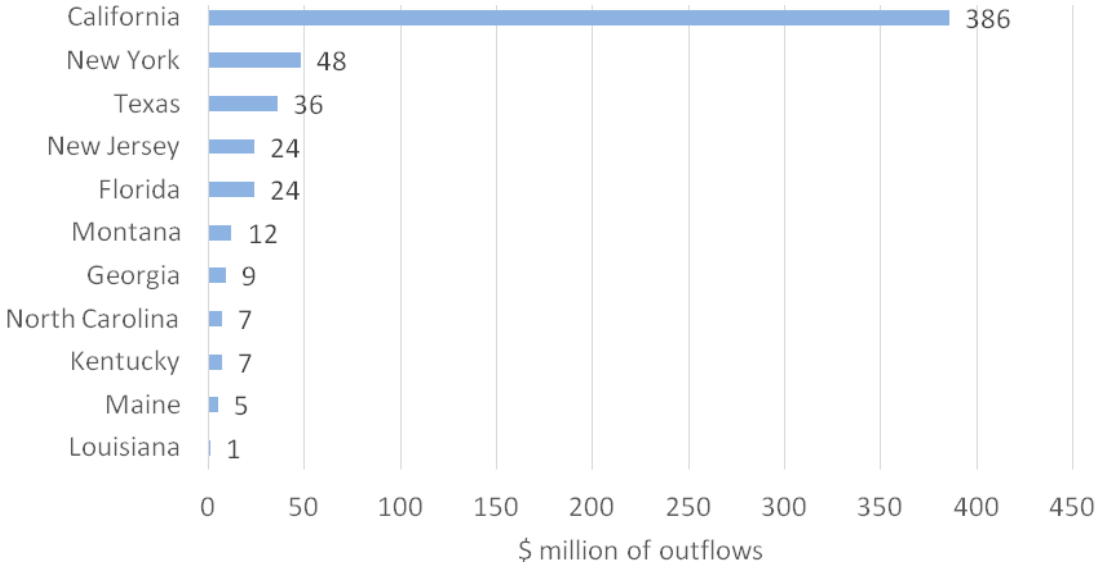
Source: CPCS analysis of Commodity Flow Survey, 2012.

2.2.4 Destinations of Outflows From Arizona to Other States

The figure below summarizes the destination of food and beverage products originating in Arizona. California was the largest domestic destination of Arizona agriculture products, where

$386 million worth of products originating in Arizona were destined. Some of these flows may have been subsequently destined for international consumption via California ports. A review of international trade flows to and from Arizona is contained in the section below.

Figure 2-9: Value of Agriculture Outflows from Arizona by State of Destination (2012)

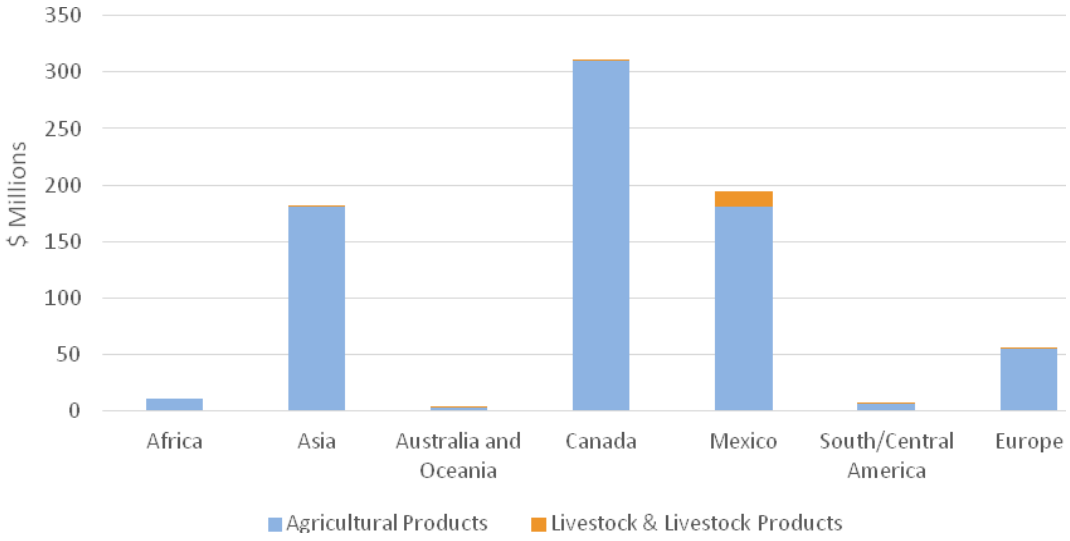


Source: CPCS analysis of Commodity Flow Survey, 2012

2.2.5 International Trade

Exports from Arizona in the agriculture sector totalled $760 million in 2014 while the state imported $2.5 billion of goods in the sector from other countries. The largest destinations for exports of goods from the agriculture sector were Canada followed by Mexico and Asia. Exports are dominated by crops, with very little livestock and livestock products being exported.

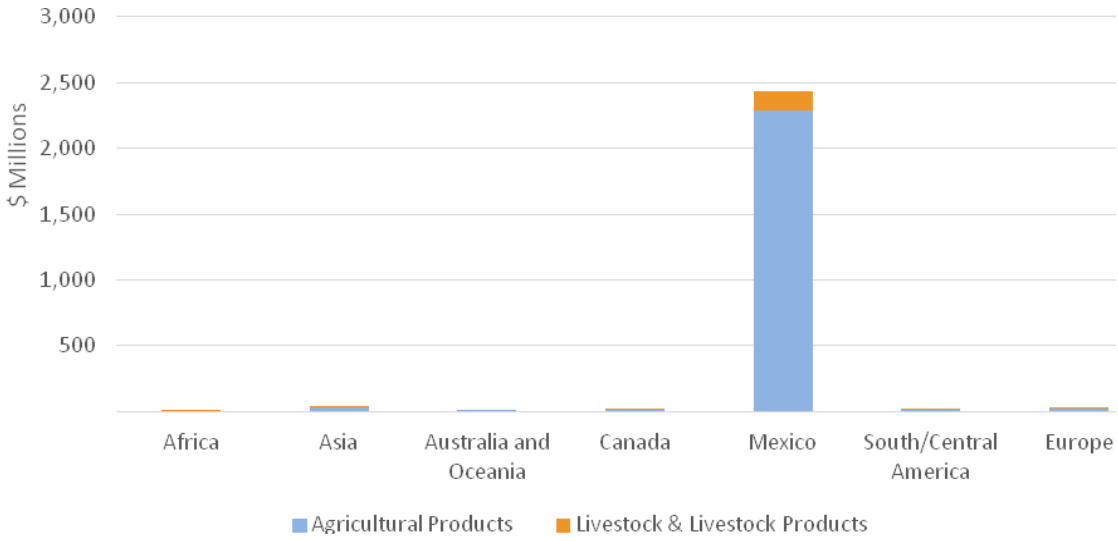
Figure 2-10: Destinations of Arizona Agricultural Exports ($ millions, 2014)



Source: CPCS analysis of United States Census Bureau Electronic Export Information. Accessed April 2015.

Arizonan imports in the agriculture sector totalled approximately $2.5 billion, $2.4 billion of which came from Mexico.

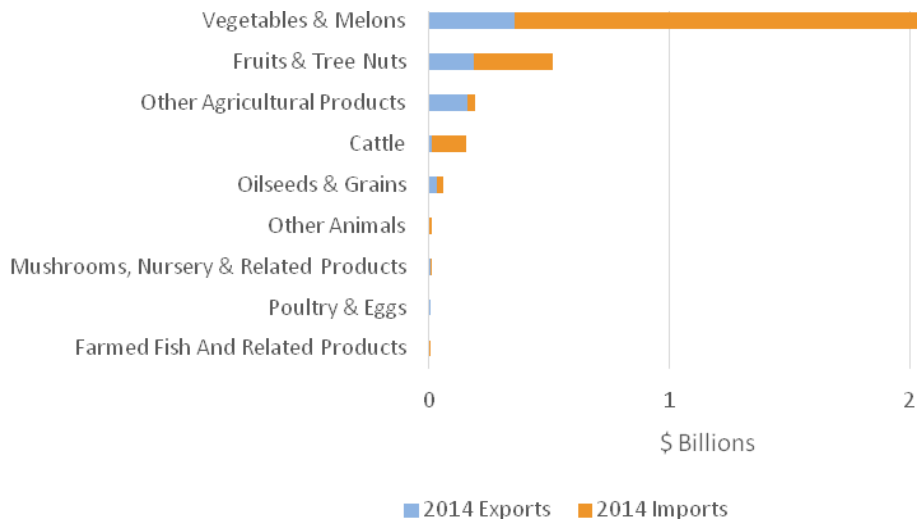
Figure 2-11: Origins of Arizona Agricultural Imports ($ millions, 2014)



Source: CPCS analysis of United States Census Bureau Electronic Export Information. Accessed April 2015.

The vegetable and melon sector is the largest sector for international trade to and from Arizona, the majority of which is imports.

Figure 2-12: Top Traded Products in the Agricultural Sector ($ billions, 2014)



Source: CPCS analysis of United States Census Bureau Electronic Export Information. Accessed April 2015.

2.2.6 Employment and Wages

In 2013, the sector employed 25,728 people[12], representing 1.0 percent of total employment in the State.[13] The total wages and salaries paid to employees in 2013 was $967 million dollars[14], with average annual earnings per employee in 2013 at approximately $38,000 for the sector.

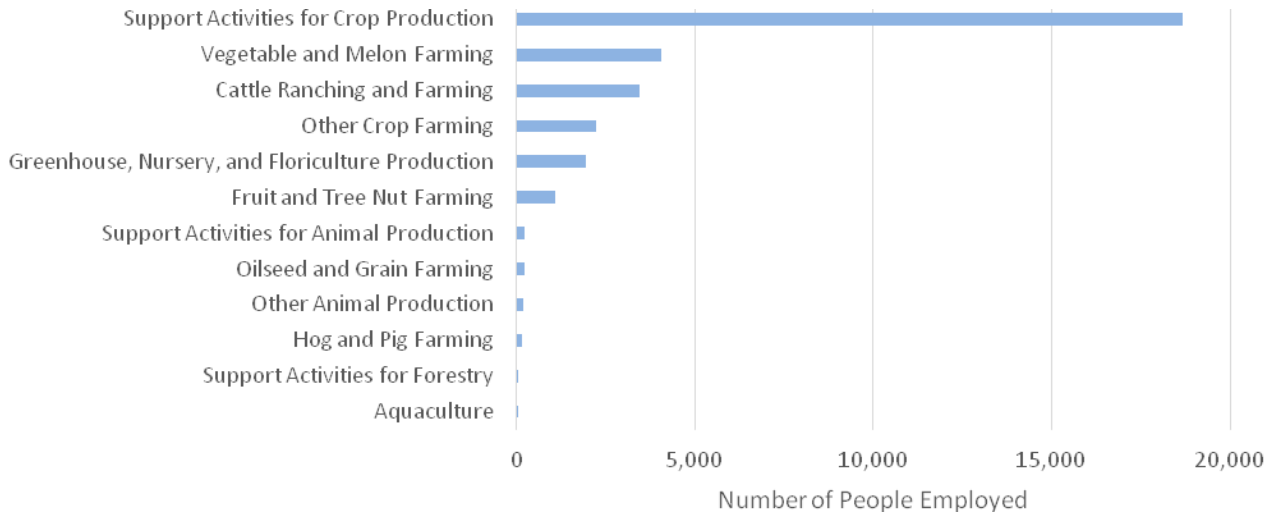
By far the largest industry generating employment in the agriculture sector is in support activities for crop production, followed by vegetable and melon farming (including lettuce farming) and cattle ranching (Figure 2-13).

[12] Note: Excludes self-employment. Data in Section 2.2.6 from the Bureau of Economic Analysis includes data for "NAICS 115 Support Activities for Agriculture and Forestry". Some employment numbers in NAICS 115 may be attributable to the Forestry sector but are not divisible in the data available. For the sake of analysis, this employment data for NAICS 115 is included in Agriculture. Data from NAICS 115 is not included in the Forestry Sector paper.

[13] Bureau of Economic Analysis Regional Economic Accounts, Personal Income and Employment by State. Wages and Salaries by NAICS Industry

[14] Bureau of Economic Analysis Regional Economic Accounts, Personal Income and Employment by State. SA6N Wages and Salaries by NAICS Industry

Figure 2-13: Breakdown of Employment in the Agriculture Sector in Arizona



Source: CPCS Analysis of Quarterly Workforce Indicators dataset, United States Census Bureau
Note: Numbers not reported for Poultry and Egg Production or Sheep and Goat Farming

2.3 Locations and Traffic Profile

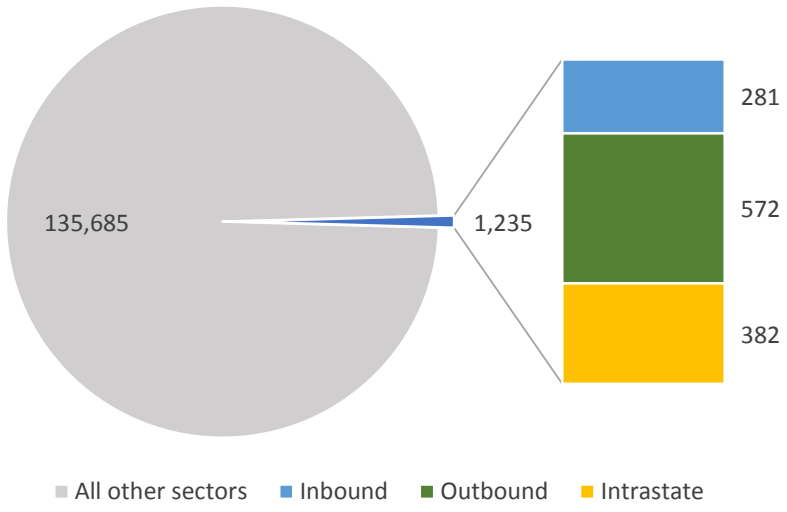
The agriculture sector in Arizona generated 1.2 Mt of freight in 2012, comprising about .9 percent of all freight tonnage in the state.[15] Approximately 46 percent of this was outbound traffic to other states, some of which is likely exported overseas. Approximately 23 percent came in from other states, some of which may be originating overseas. The remaining 31 percent represents intrastate moves.

The numbers presented below are obtained from Commodity Flow Survey (CFS), 2012. CFS accounts for only domestic movements. These include domestic shipments as well as the domestic components of international supply chains.[16]

[15] This paper defines the agriculture sector by three commodities in Commodity Flow Survey (CFS): animals and fish, cereal grains and agricultural products which represent the Standard Classification of Transported Goods (SCTG) codes 01, 02 and 03 respectively. Some of these flows are also included in two other sector papers on food and beverage and wholesale and retail.

[16] In CFS, the sum of individual state volumes is slightly lower than the national volume which is due to data suppression and rounding in individual state-to-state movements. For consistency across all the graphics (maps and charts), this paper presents the total of state level volumes.

Figure 2-14: Arizona Agriculture Sector Volume ('000 Tons)



Source: CPCS analysis of Commodity Flow Survey, 2012.

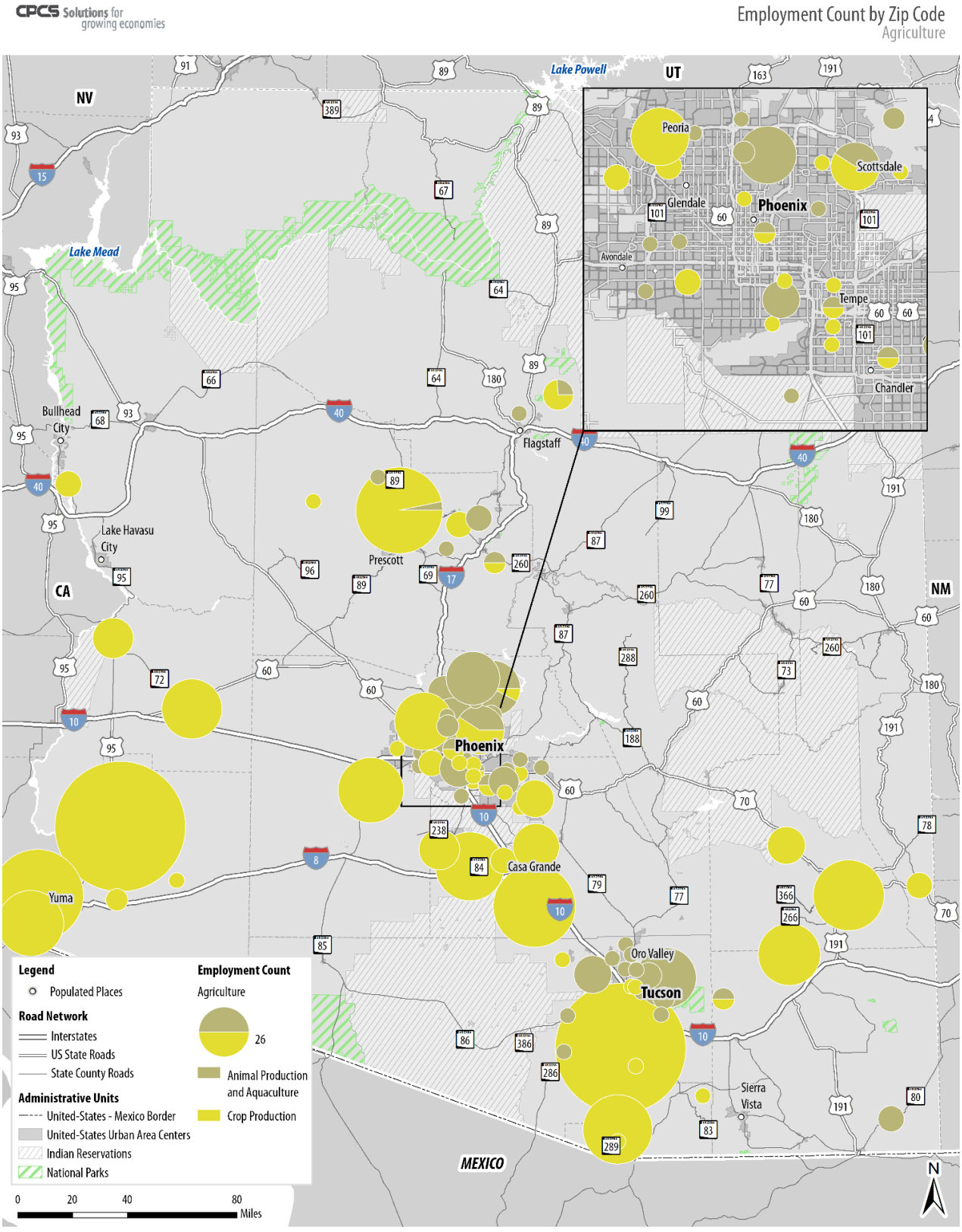
2.3.1 Activity Clusters

The activity clusters of agriculture industry are illustrated by the geographic distribution of employment in the sector.[17] Crop production is concentrated in the southern part of Arizona (igure 2-15), notably around Yuma, Green Valley – south of Tucson, Casa Grande and Fort Grant area. There are some crop production activities around Phoenix as well, mostly in Peoria, Scottsdale and Goodyear. In the northern half of the state, there is a significant cluster at Prescott and other smaller ones at Flagstaff and south of Bullhead City. Clusters of employment in animal production and aquaculture, while relatively small compared to other agricultural subsectors, are located near Oro Valley – south of Tucson and around Deer Valley – south of Phoenix.

Figure 2-16 illustrates agricultural land coverage by several crop categories and highlights the importance of lettuce, hay, cereal grains and other major crops in Arizona. As with employment, major agricultural land coverage is concentrated in southern half of the state. As illustrated in Figure 2-17, Pinal, Maricopa and Yuma Counties have the highest total acreage dedicated to agriculture. The histograms illustrate relative acreage by crop type; the U.S. Department of Agriculture's Cropscape data shows the location of the cultivated land. The data show that Yuma is the major producer of lettuce while cotton is a major product in Pinal and Pima counties. Hay is produced throughout the state.

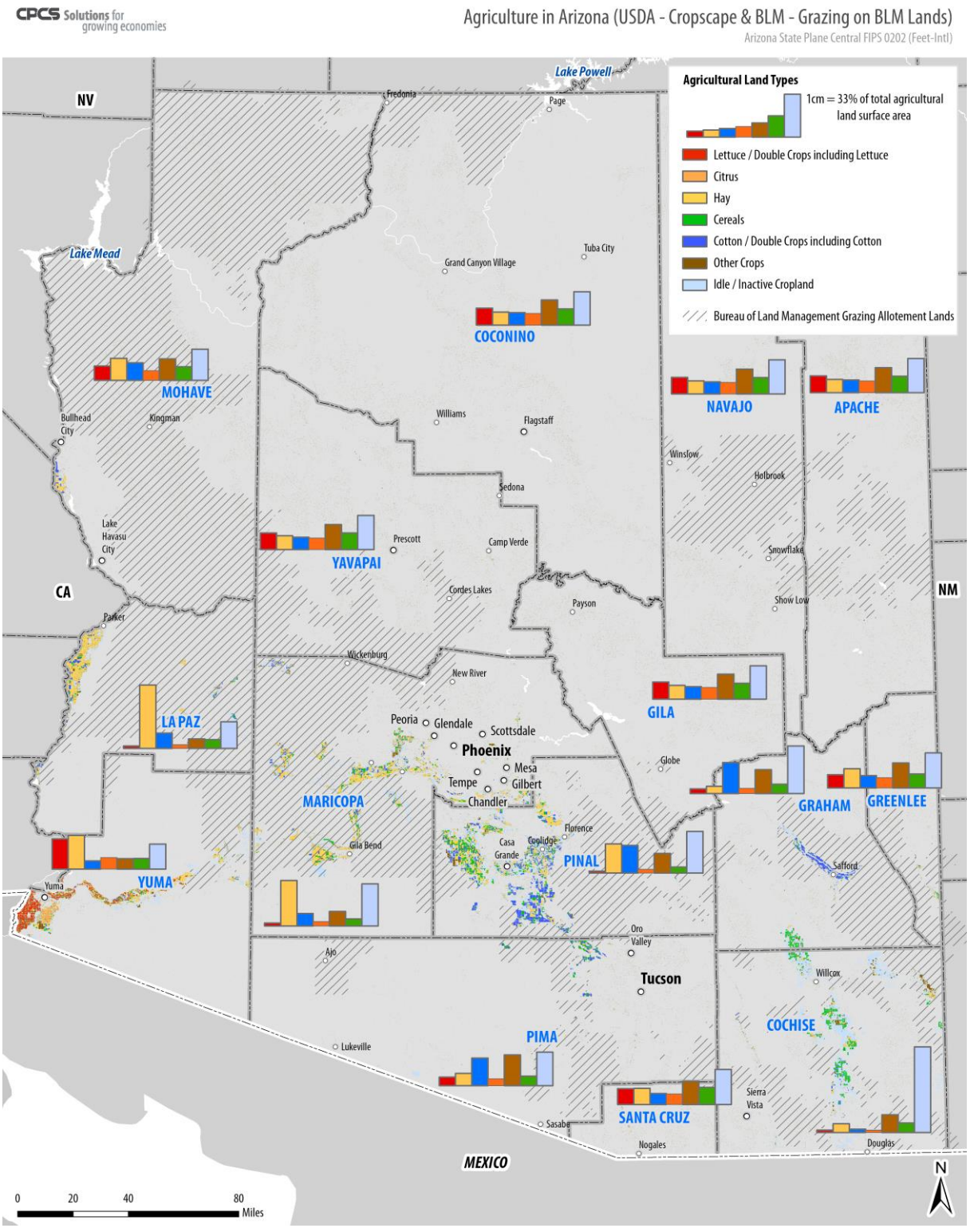
[17] Sector-specific employment was estimated at the zip-code level from County Business Pattern Data, 2013 by US Census Bureau, by multiplying the mid-point of employment range and the number of establishments.

igure 2-15: Arizona Agriculture Sector Employment Clusters



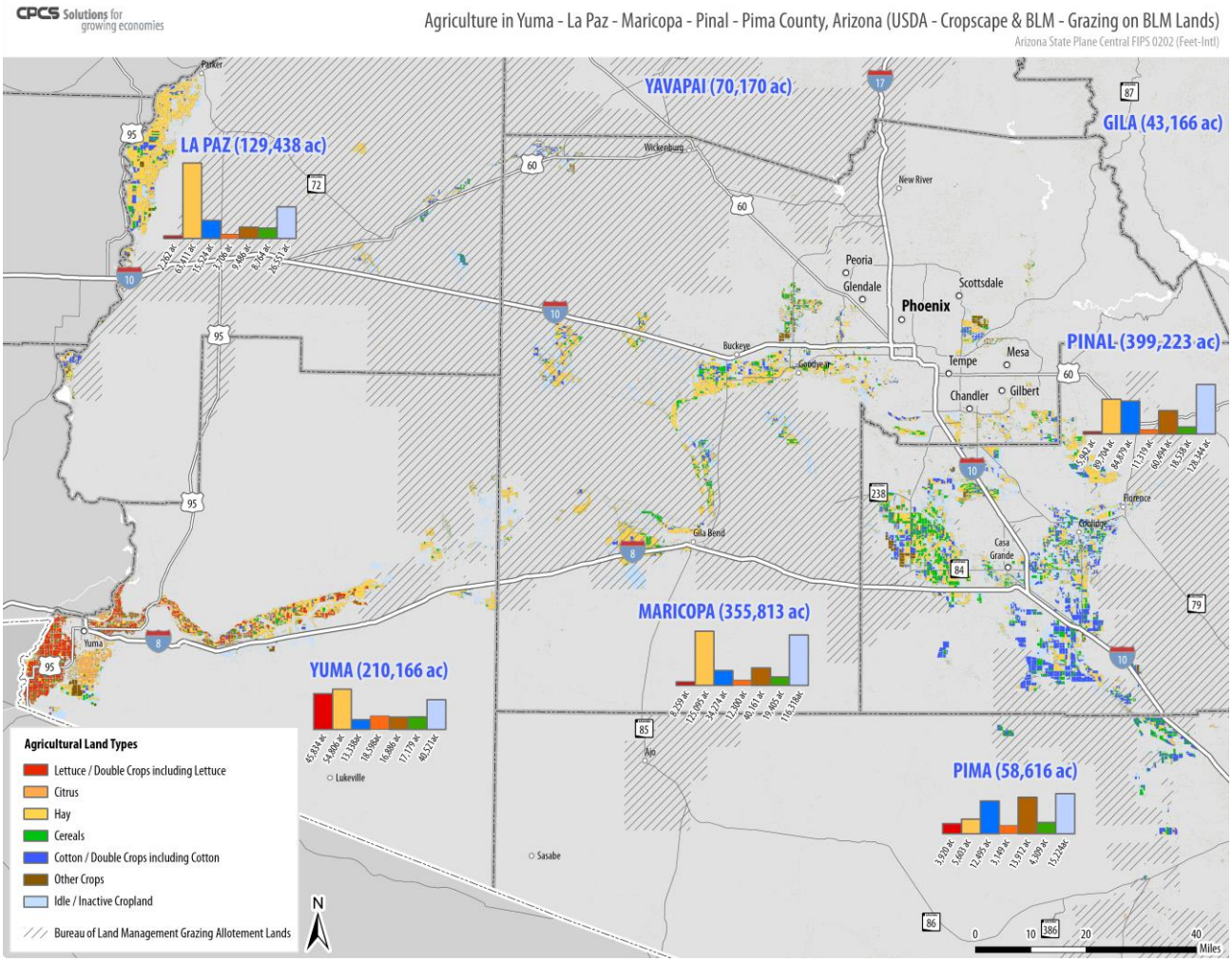
Source: CPCS analysis of County Business Pattern Data, 2013 by US Census Bureau.

Figure 2-16: Arizona Land Coverage by Crop Type



Source: CPCS analysis of U.S. Department of Agriculture, Cropscape, 2014.

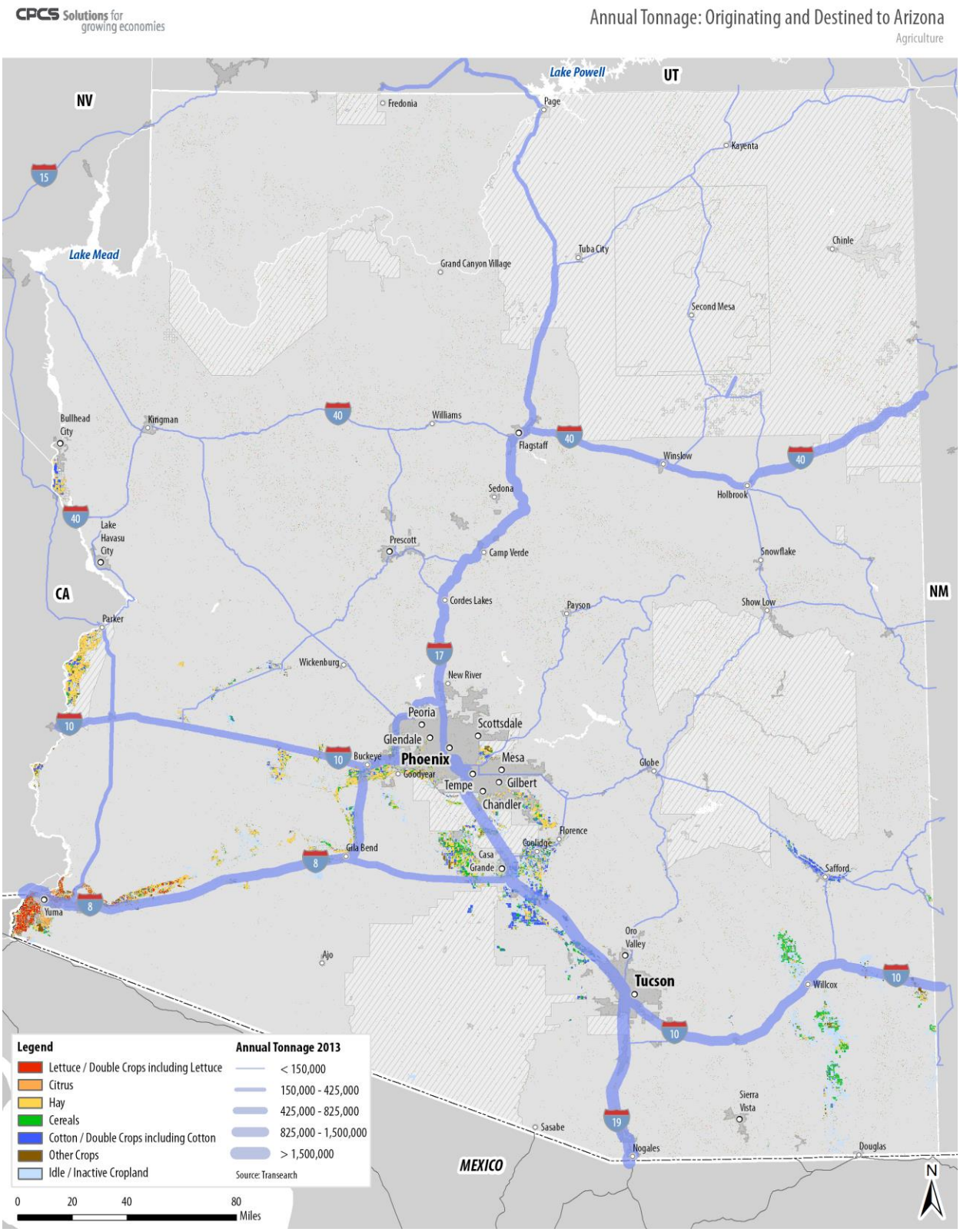
Figure 2-17: Southern Arizona Land Coverage by Crop Type



Source: CPCS analysis of U.S. Department of Agriculture, Cropscape, 2014.

Figure 2-18 below combines agricultural commodity flow on highways with their area of production. This information was extracted from Global Insight's Transearch dataset for 2013. Only Arizona-generated (originated or destined) flows are shown in the map, which excludes any through traffic. The major corridors used by the agricultural sector are I-10, I-8, I-19 and I-17 leading to I-40 eastward. The I-10 and connection with I-19 is also heavily used, an indication of Arizona's important export/import of agricultural products to/from Mexico.

Figure 2-18: Arizona Crop Production Areas and Agricultural Commodity Truck Flows

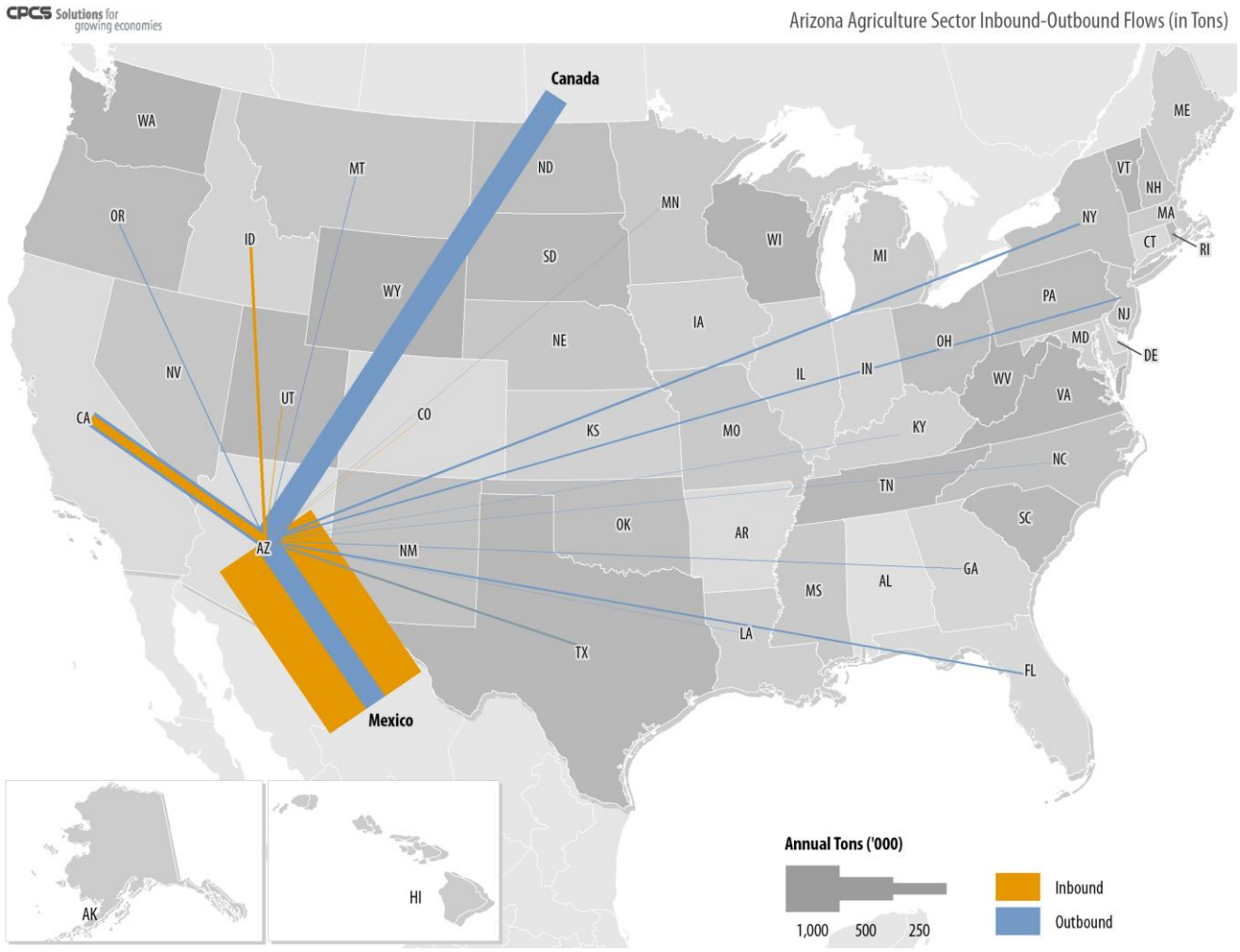


Source: CPCS analysis of U.S. Department of Agriculture, Cropscape, 2014 and Transearch 2013

2.3.2 Major Origins and Destinations

Mexico, Canada and California are the Arizona's largest agricultural trading partners. Arizona imports nearly 2.4 Mt of agricultural products from Mexico, accounting for 88 percent of all inbound traffic in the sector. California is also an important producer of products transported to the state. In terms of destination markets, of the total 1.6 Mt of outbound traffic, Canada and Mexico account for approximately one-third each. California receives more than 57 percent of the remaining domestic outbound traffic (some of which is likely exported to other parts of the world, including Asia). Other destinations include New York, New Jersey, Florida and Texas.

Figure 2-19: Arizona Agriculture Sector Inbound-Outbound Tonnages

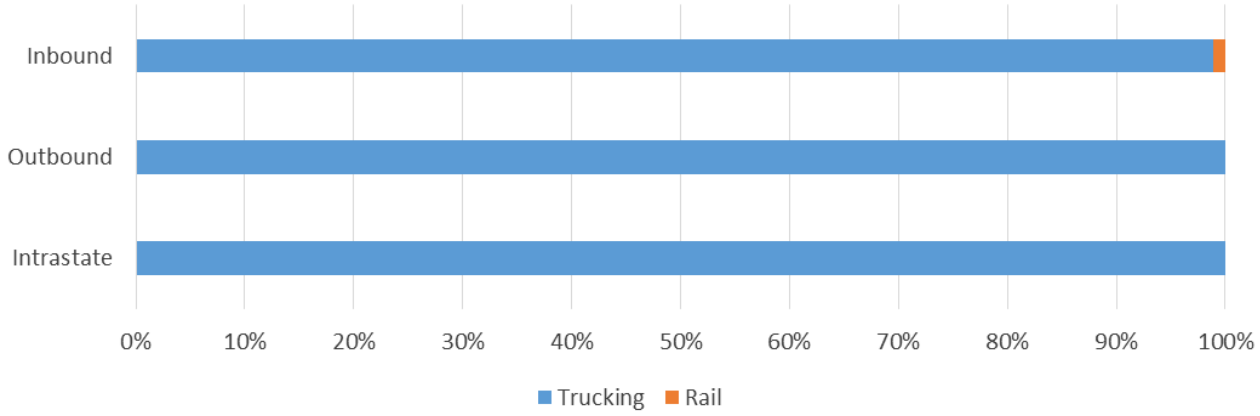


Source: CPCS analysis of Commodity Flow Survey, 2012. The import/export figures were obtained from Freight Analysis Framework 3 estimates for 2012

2.3.3 Modal Breakdown

The overwhelming majority of agriculture products are moved by truck to, from and within Arizona.[18] Apart from 2 percent inbound shipments (in tons) moved by multiple modes, all other inbound, outbound and intrastate shipments are by truck.

Figure 2-20: Arizona Agriculture Sector Volume (Tons) by Mode



Source: CPCS analysis of Commodity Flow Survey, 2012

[18] In CFS dataset, the individual mode volumes do not add up to the aggregate "All Mode" which is due to the data suppression and rounding at detailed mode level.

3 Supply Chain Structure and Transportation Performance Parameters

Key Messages

Many commodities in the agriculture sector are temperature sensitive products that require refrigeration throughout the supply chain to prevent spoilage. Given the perishable nature of products transported, almost all commodities are transported by truck owing in large part to longer transit times by rail.

Many stakeholders view weight restrictions for truckloads as being the most significant barrier to improved agricultural transportation productivity in the state. Other stakeholder cite congestion on the I-10 corridor (notably to/from Mexico) and border crossings as significant issues.

3.1 Supply Chain Structure

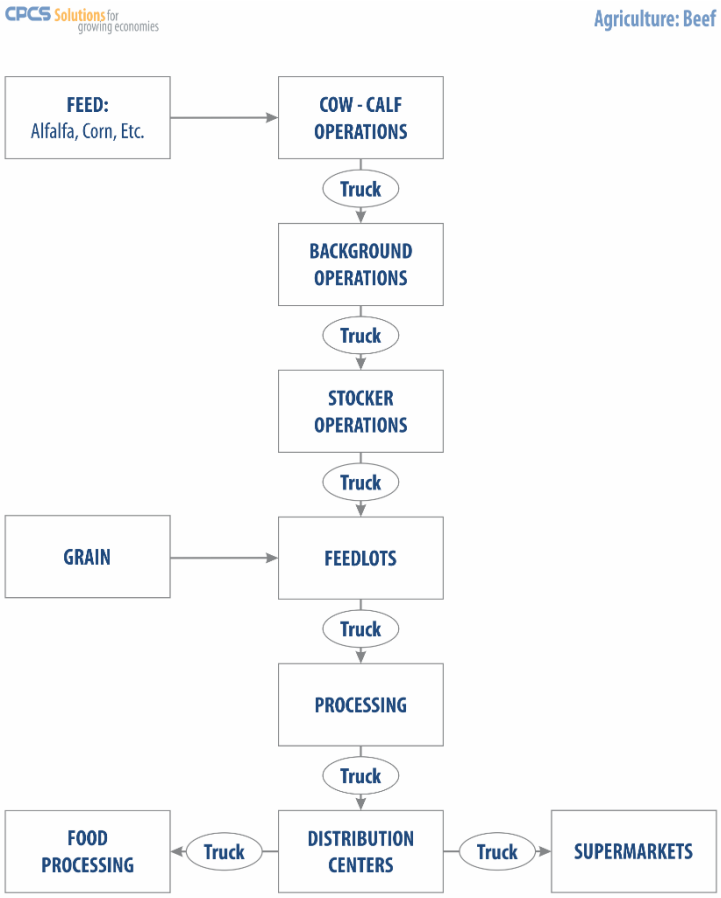
Agriculture is a diverse sector with distinct needs and supply chains which vary greatly in their structure depending on the product. In order to gain a better understanding of the key supply chains in the sector, the supply chains for beef, dairy and crops (exemplified by lettuce production) are shown in the sections below. Almost all agriculture movements are by truck. While a greater share of agricultural commodities were shipped by rail in the past, slower transit times and additional flexibility allowed by trucking have led to a move from the use of rail to truck transportation throughout the industry.

3.1.1 Beef

The beef industry is centred in Maricopa and Pinal Counties.[19] The industry utilizes trucks to move livestock, feed, and fished products as several stages of production from cow-calf operations to supermarket. In some cases, some actors manage risks in the beef supply chain through vertical integration. For example, farms may grow feed on-site in order to manage risks associated with fluctuating feed costs. An estimated 70 percent of calves from cow-calf operations are destined out of state.[20]

The largest actor in beef processing in Arizona is JBS. In 2013, JBS announced the opening of a new 16,000 square foot facility in Tolleson. The majority of cattle are processed in this facility.

Figure 3-1: Beef Industry Supply Chain



Source: CPCS

Figure 3-2: Dairy Supply Chain

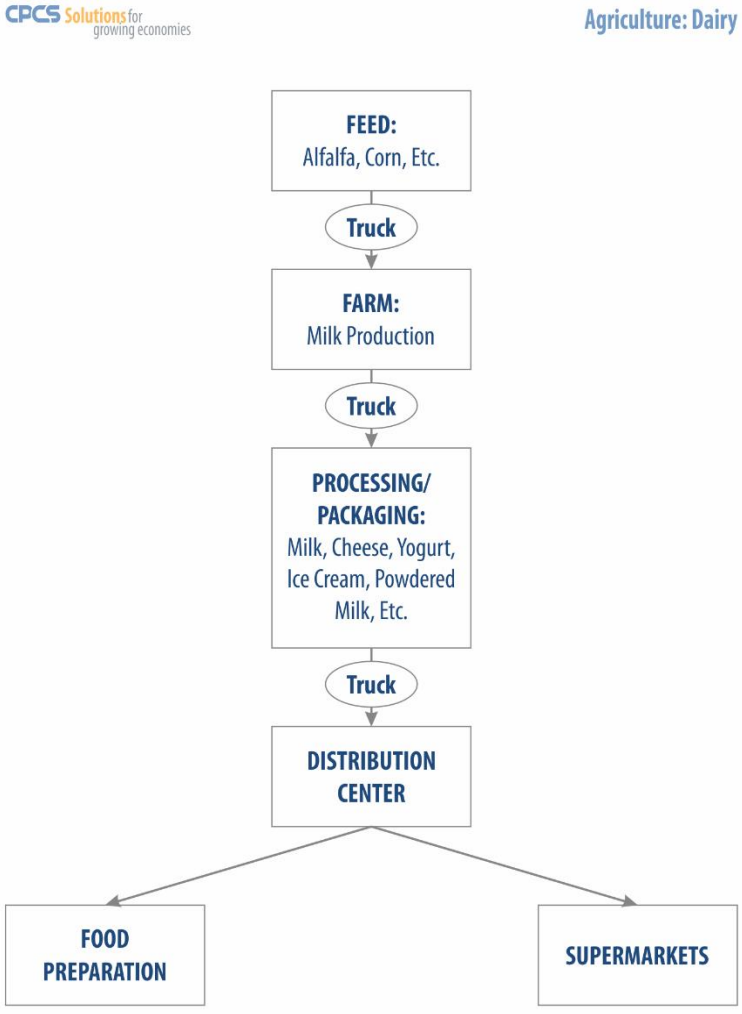
[19] Kerna, Ashley, George Frisvold, Trent Teegerstrom, Russell Tronstad, University of Arizona Department of Agricultural and Resource Economics. *The Contribution of the Beef Industry to Arizona's Economy: State and Country Profiles.*

[20] As per discussions with the Arizona Cattlemen's Association on July 29, 2015.

3.1.2 Dairy

The United Dairymen of Arizona (UDA) is a milk marketing cooperative of 90 producers that represents approximately 90 percent of the milk produced in the state.[21] UDA has a large manufacturing facility in Tempe that can process 10 million pounds of raw milk per day. The plant operates 24 hours a day and seven days a week producing milk, cream, butter, condensed milk and lactose powder.

The next largest firm in milk production in Arizona in the milk industry is Shamrock Farms, which has more than 10,000 head of dairy cows and produces cream, cottage cheese, sour cream and milk.



Source: CPCS

In terms of processing of products, Casa Grande has emerged as an important area for the production of products such as cream cheese and yogurt. For example, Franklin Foods recently opened a new plant in Casa Grande that can produce up to one million pounds of cream cheese in a week.[22] Many dairy cows are located directly in the area allowing for an efficient supply chain from farm to processor.

The dairy supply chain begins with the production of feed for cows including corn and alfalfa hay. Dairy cows are housed and milked on dairy farms where milk is transported from farm to processor. Products are processed, often in the UDA plant, before either being sent to a distribution centre for onward sale, or in some cases intermediate processed products are sold directly at the UDA plant for further processing by third parties.

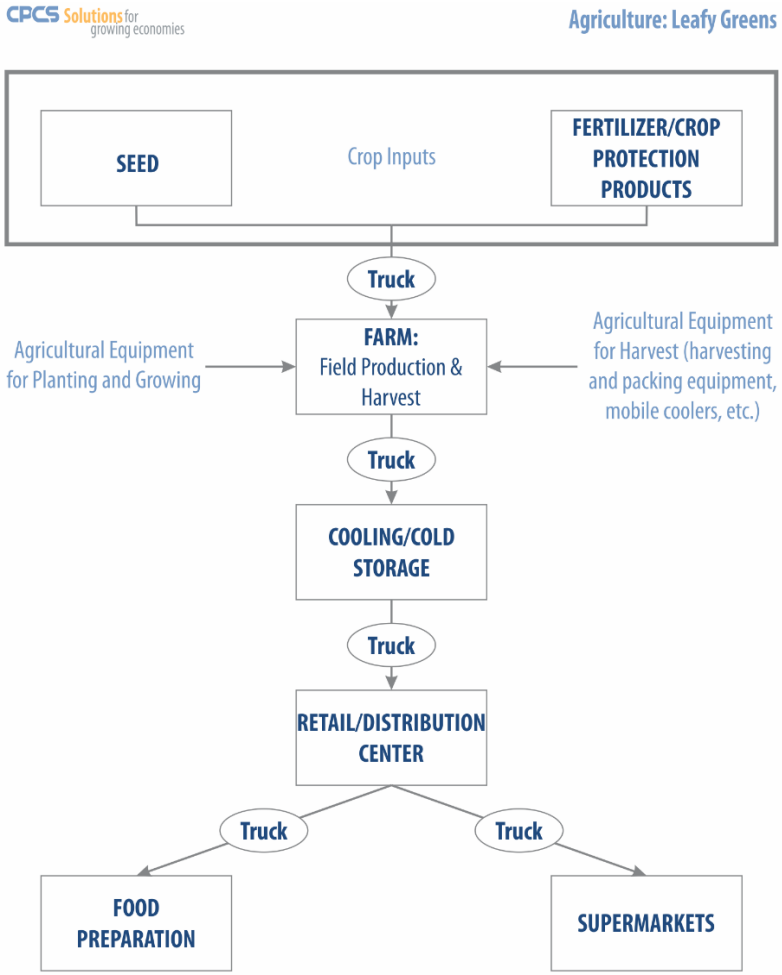
[21] United Dairymen of Arizona, *About the United Dairymen of Arizona*. http://www.uda.coop/About/default.asp accessed June 20, 2015.
[22] Merrill, Laurie. AZ Central, The Arizona Republic. *Casa Grande Cream-Cheese Plant up for Honor.* July 6, 2015.

Almost all the milk that is processed in Arizona stays within Arizona, whereas processed products may be shipped more widely throughout the country. Milk powder products are often produced for export throughout the world given their much less perishable nature.

3.1.3 Produce

The supply chains of Arizona's produce industry are varied. For the sake of analysis, this section will focus on the leafy greens industry, which is one of the largest agricultural industries in Arizona and of a more complex nature due to the perishable nature of products.

Figure 3-3: Leafy Greens Production Supply Chain



Source: CPCS

Leafy Greens

Two important nodes for the production of leafy green products in Arizona are Yuma County and the areas surrounding Phoenix. The leafy green supply chain starts with the inputs into leafy green production such as seed, fertilizer and agricultural equipment. Lettuce may be harvested either by hand or mechanically. Often, lettuce that is harvested is packed directly in the field, where it is then put on a local truck to a cooler.

Leafy greens products are highly perishable and therefore cooling after harvest is a critical component. Mobile cooling units, called pre-coolers, are often used at the time of harvest to reduce the temperature of harvested product rapidly given the particularly sensitive nature of leafy green products to temperature after harvest.

Once brought to coolers, products are generally cooled in cartons that they have been packed into at the time of harvest, put in a cold room and put on pallets. Many sales of leafy green

products are moved on a less than truckload basis, or may be included as a partial load that fills a truck already carrying a partial load originating in California.

Hay/Alfalfa

By value, hay has grown into one of the largest crops in Arizona. Generally, hay produced in the state is used as an input to feed cattle for beef or dairy operations. Sales often occur at a local level and are transported by truck. Some cuts of hay with lower protein content (there are multiple harvests per year) may serve other purposes such as feed for the equine industry.

Like other Arizona agricultural products, hay and alfalfa are typically transported by truck. Yet a small percentage of alfalfa is moving by rail, due largely to recent efforts of the Port of Tucson to load match empty westbound containers with local products. The port is looking to leverage its competitive location and access to backhaul of containers from products imported into Arizona and Texas to refill these containers with products such as alfalfa for export via rail through West Coast ports. Currently, the port has identified over 1 million tons of alfalfa that are being grown within about 100 miles of Tucson, which could translate into an estimated 40,000 container loads per year. The port expects strong growth in this and other markets in the future.

Cotton

The amount of cotton produced in Arizona has declined over the last several decades. Still, cotton remains an important component of the Arizona agricultural sector. All cotton growers in Arizona are a part of Calcot, a cooperative cotton marketing organization of 1,200 growers in the southwestern states. Peak season occurs during the autumn harvest. Most cotton produced in the state is destined to California, normally Bakersfield. Bale cotton produced is transported by truck to one of the various cotton gins throughout the state or is shipped directly to California. Once in California, an estimated 90 percent of the annual crop is exported, frequently to Pacific Rim countries but increasingly to other markets such as China, Turkey, India, Egypt and Peru.[23]

Melons

The supply chain for melons is somewhat similar to that of leafy greens. Melons are packed either in field or at a nearby packing facility where they are pre-cooled and then transported by truck to cold storage facilities. These are then transported to distribution centres for onward shipment to retail centres or food service processing locations.

3.2 Transportation Performance Parameters

Agricultural products are often highly perishable or temperature sensitive. Both travel time and travel reliability are critical factors for the agricultural sector. Travel time is the main factor that

[23] As per discussions with the Arizona Cotton Ginners Association

led to the switch from rail transportation to truck transportation for most products in the sector. For example, for the leafy greens industry, product leaving Arizona needs to arrive on the East Coast by the fifth morning after being picked. Anything beyond this time period will cut into the shelf life of the product. While leafy greens were once shipped by rail and packed with ice, they now move in temperature controlled truck units that allow for flexibility and faster travel times for shippers.

3.3 Barriers to Transportation Performance

One of the top transportation issues for the agricultural sector is **weight restrictions on truckloads**. Stakeholders have noted that they must monitor loading of trucks to see whether a truck "weighs out" before it "cubes out" when loading product. Many in the sector would like to see weight restrictions increased to allow for better utilization of trucks, which they believe will also reduce the number of trucks on the road.

For trucks coming from Mexico, there is currently a special weight limit exemption program where Mexican trucks can obtain an "International Border Permit". Previously, trucks from Mexico were arriving at border sealed and loaded with 90,000 lbs of produce (10,000 lbs over the limit). In order to meet weight restrictions for Arizona, this would require breaking the seal and dropping 10,000 lbs at the border, which led to compromising product quality as well as customs issues. Under the program, Mexican trucks weighing up to 90,000 lbs can drive up to 25 miles into Arizona. The most important route for this International Border permit is the border crossing to Nogales and its concentration of produce warehousing facilities. Trucks are unloaded and produce is

Article from Arizona City Independent- Dairy Processing in Casa Grande

Franklin Foods makes cream cheese. Making yogurt calls for milk. And that calls for cows, lots of cows.

The Casa Grande Valley has them, said Dennis Dugan, a Casa Grande dairyman and a board member of the United Dairymen of Arizona. "There's about 90,000 milk cows within 30 miles of Casa Grande and that's one reason they came here," Dugan said.

They being Commonwealth Dairy and Franklin Foods. They both selected Casa Grande for new dairy-product plants. Nearly ready for business, the plants bookend The Property Conference Center on West Gila Bend Highway, also known as Arizona 84.

They're different companies, but they have a few things in common. Both have chosen Casa Grande to make high-end dairy products for a new market — the West. In both cases, they're expanding by taking something of a transcontinental leap. Both have dairy-product plants in Vermont.

In 2011, Commonwealth Dairy opened a yogurt plant in partnership with Ehrmann in the southern Vermont city of Brattleboro. Franklin Foods has a cream cheese facility in Enosburg Falls, Vt., just miles from the Canadian border. The company's headquarters is in Delray Beach, Fla.

How Commonwealth and Franklin ended up in Casa Grande is a story of more than cows. It's a story of dairymen looking for more markets. Of city officials working to meet the infrastructure needs of the new plants — including a new sewer line. Of a business foundation that helped to create a glide path for their move to Casa Grande. Of neighbors welcoming what they saw as clean industry.

Text Source: Arizona City Independent, Published August 14, 2013

Photo Source: AZ Central, The Republic. Published November 16, 2013.

sorted and repackaged and moved onto U.S. trucks. Given the program's success, it was recently expanded to the San Luis POE commercial zone.[24]

Additionally, given the **high seasonal demand for equipment** (trucks and trailers) and the associated shortages, shippers experience significant delays in scheduling. During these times, unexpected delays throughout the supply chain can be particularly costly. To ameliorate the risks of seasonal equipment shortages that affect the cattle industry, some firms have developed in-house fleets.

Congestion on the I-10 has also been noted by some as a factor. For example, the JBS beef plant at Tolleson is located off the I-10 and congestion there impacts daily movement of cattle to the plant and outbound meat product from the plant. Additionally, increased congestion in urban areas is an ongoing concern for cities as well as trucks passing through cities. Some cities and towns were not originally developed to anticipate the level of flows that they experience today, where trucks and commercial vehicle traffic must sometimes pass through the middle of town as the most direct route to their final destination. This both impacts local stakeholders facing this increased traffic as well as trucks that are slowed passing through these areas.

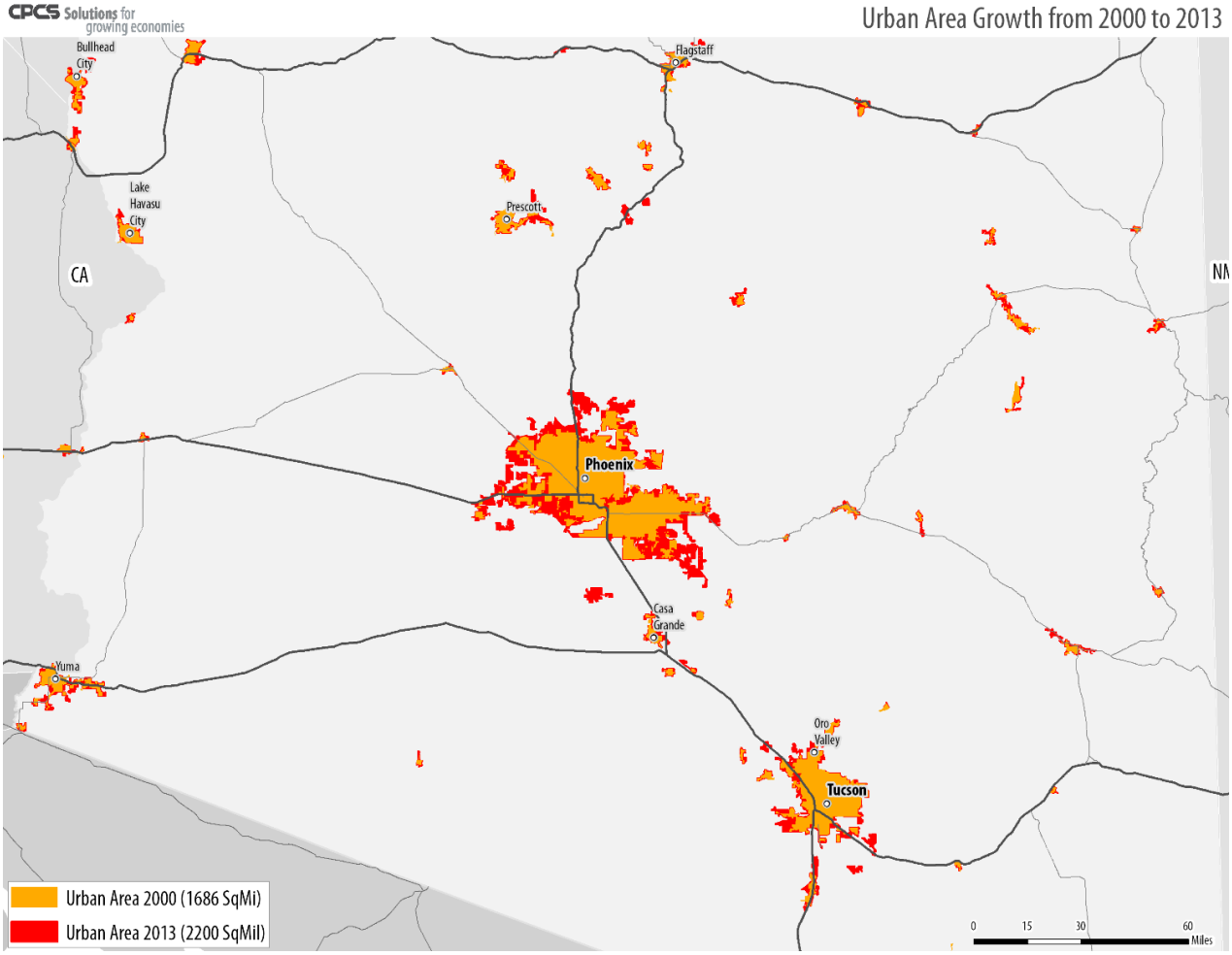
Stakeholders have also noted that **border wait times during peak produce season** can be several hours. Additionally, all agricultural flows through Nogales border are subject to inspections by the Mexican military at Benjamin Hill which cause delays. Shippers point out that shipments using competing POEs in California and Texas and not inspected and place the Nogales shipments at a disadvantage. Some have reported several hours of waits for the military inspections, which are not coordinated with border officials at the border who then may make a second inspection. Stakeholders at the border view this as a competitive disadvantage for Nogales as compared to other border checkpoints.

3.4 Trends and Implications

One of the key trends affecting Arizona's agricultural sector is the **impact of urbanization on agricultural production**. For example, a significant portion of acreage in the Phoenix metropolitan area was traditionally used for agricultural purposes but has subsequently been converted to residential and commercial development. This has reduced the amount of cultivated land for crops such as citrus. While some farms have relocated, in many cases the displaced agricultural production has not been replaced and has resulted in a net reduction in the production of crops. Figure 3-4 below summarizes the expansion of urban areas, particularly around Phoenix and Tucson between 2000 and 2013.

[24] Arizona Department of Transportation, *ADOT Expands Commercial Truck Permit Program to San Luis Port of Entry.* January 21, 2014.

Figure 3-4: Growth in size of Urban Areas in Arizona



Source: BTW TIGER Database

Another trend identified in this paper is **increase in multimodal shipments**, including a concerted effort by the Port of Tucson to increase the shipment of alfalfa and other Arizona agricultural products by rail. The port is looking to position itself to expand into this market as well as other products such as cotton, nuts, and other products. Tucson can take advantage of westbound backhaul containers from El Paso and Dallas markets in order to provide customers with containers to ship their goods to markets through the West Coast.

Border flows have been increasing, with the majority of agricultural flows moving through Nogales. The Mariposa Port of Entry expansion project has increased the potential capacity at Nogales to process 4,000 trucks a day, far above current levels. Increased capacity at the border, when coupled with sufficient resources for processing trucks at the border and infrastructure investments on both sides of the border will facilitate the continued expansion of border flows of agricultural products between Mexico and Arizona. The Port of Tucson benefits from a competitive location, serving border flows through Nogales, close to the major market in Phoenix, as well as strategically positioned between California and Texas.

4 Sector Priorities for Transportation System Performance Improvement

Key Messages

Overall, stakeholders have reported good performance of the transportation system in Arizona. Key issues identified by stakeholders include:

- Increasing weight restrictions of vehicles carrying agricultural products
- Increasing the number of customs agents at the Nogales Border
- Better coordination of inspections between border officials, and reduction of inspections of the Mexican Military for goods destined for the United States through Nogales
- Carrying out proposed improvements to the S-189
- Increasing bypass routes through urban areas where such bypasses do not yet exist (in particular at land Ports of Entry)
- Construction of the proposed Sonoran Corridor
- Addition of a truck climbing-lane on uphill segments to Flagstaff on the I-17

4.1 Priority Improvements Needs

Many agricultural transportation stakeholders believe that Arizona's freight infrastructure is performing well. Yet there are several potential improvements that agricultural stakeholders are seeking. These improvements include changes in policy, operations (including at the border), and infrastructure improvements, including:

- **Increasing weight restrictions of vehicles carrying agricultural products**. A reconsideration of weight restrictions on trucks carrying agricultural products was mentioned by many stakeholders as one of the top priority improvements that would allow them to increase performance (by fully utilizing all space in trucks and potentially reducing the number of trucks required to move commodities).

- **Actions to facilitate the flow of goods across the border**, such as the recent expansion of the International Border Permit to the San Luis POE are lauded, and further actions to facilitate the movement of goods between Arizona and Mexico would also help the overall sector. Suggested improvements include increasing the number of customs agents at the Nogales border crossing, better coordination of inspections between border officials, and reduction of inspections of the Mexican Military for goods destined for the United States through Nogales.

  At Nogales, the Mariposa POE expansions project has increased the ports potential capacity to 4,000 trucks a day. Some stakeholders have still reported that wait times during busy season can be long when not all lanes are open. Additional staff for processing commercial goods at the border from Mexico would allow for quicker processing times at the border. Some improvements on both sides of the border would also facilitate the efficient flow of agricultural goods. Additionally, stakeholders would like to see additional coordination of the inspection of goods on the south side of the border. They would ideally look to see an elimination of Mexican Military inspection of agricultural products destined for United States through Nogales (leave inspections to border officials), or a more targeted approach to inspections by the Mexican Military, along with greater coordination with border officials to reduce "double inspections".

  On the Arizonan side, planned improvements to the S-189, including key intersection improvements would allow for a much more efficient flow of goods. Currently, some stakeholders indicate the trucks often experience a bottleneck point looking to enter the I-19 from the S-189, improvements to this intersection would be beneficial to agricultural flows from Mexico.

  In Nogales, stakeholders complain of long wait times that stop traffic when trains are moving through town. The area on the I-19 between exit 12 and exit 17 is a key area for the agricultural sector, being where many agricultural products' distribution centres are located. Improvements to these exits, and roads adjacent to the area between these exits would improve the flow of agricultural goods.

Stakeholders have also indicated that a re-paving of the Mexican highway 15 on the south side of the border would greatly assist flows that are destined to move through Nogales. In the past commitments have been made to re-pave this highway and stakeholders would like to see this highway repaved.

- **Carrying out proposed improvements to the S-189** and increasing bypass routes through urban areas where such bypasses do not yet exist (in particular at land Ports of Entry).
- **Construction of the proposed Sonoran Corridor.** The Sonoran Corridor is a proposed link between the I-10 and I-19 that would result in the reduction of travel time for eastbound traffic as well as local traffic in the region. It is expected that this improvement would also drive economic development and expansion in the region.
- **Congestion projects to improve truck movement and safety.** These project include the addition of a truck climbing-lane on uphill segments to Flagstaff on the I-17 and addressing congestion on I-10. Trucks taking the I-17 to connect to the I-40 are currently slowed in steeper uphill sections, slowing overall traffic. The introduction of a truck climbing lane in some key uphill sections may allow for the quicker flow of other traffic sharing the road with trucks.

  Addressing congestion on the I-10, one of the top corridors for the sector, would also be deemed as another top improvement to facilitate the movement of goods within the state, such as cows to the JBS plant in Tolleson, and to California, the sector's top domestic trade partner.

Appendix A: List of Stakeholders Consulted

Name	Title	Organization
Ana Kennedy	Government Relations Manager	Arizona Farm Bureau
Ken Gililand	Director, International Trade and Transportation	Western Growers
Rick Lavis	Executive Director	Cotton Ginners Association
Bas Aja	Executive Vice President, Arizona Cattle Feeder's Association	Arizona Cattlemen's Association
Tom O'Carroll	Distribution Manager	United Dairymen of Arizona
Stefan Baumann	Director, Business Development	Port of Tuscon
Jamie Brown	Senior Transportation Planner	Pima Association of Governments
Kelly Anderson	Chairman/ Member of Executive Committee	State Transportation Board/ Sun Corridor Organization
Aaron White	Economic Development Specialist	City of Nogales