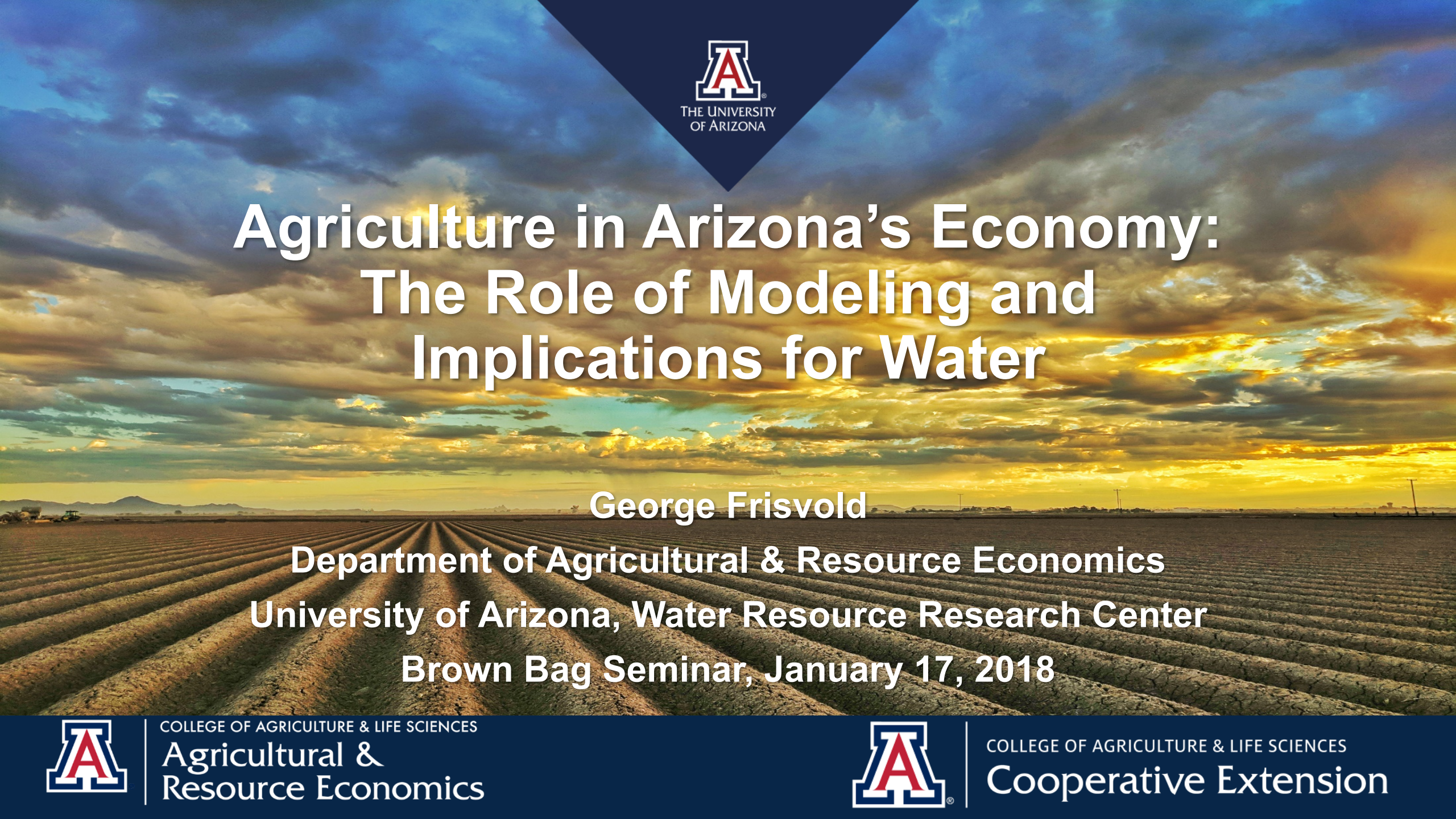

THE UNIVERSITY OF ARIZONA

Agriculture in Arizona's Economy: The Role of Modeling and Implications for Water

George Frisvold

Department of Agricultural & Resource Economics

University of Arizona, Water Resource Research Center

Brown Bag Seminar, January 17, 2018

COLLEGE OF AGRICULTURE & LIFE SCIENCES
Agricultural & Resource Economics

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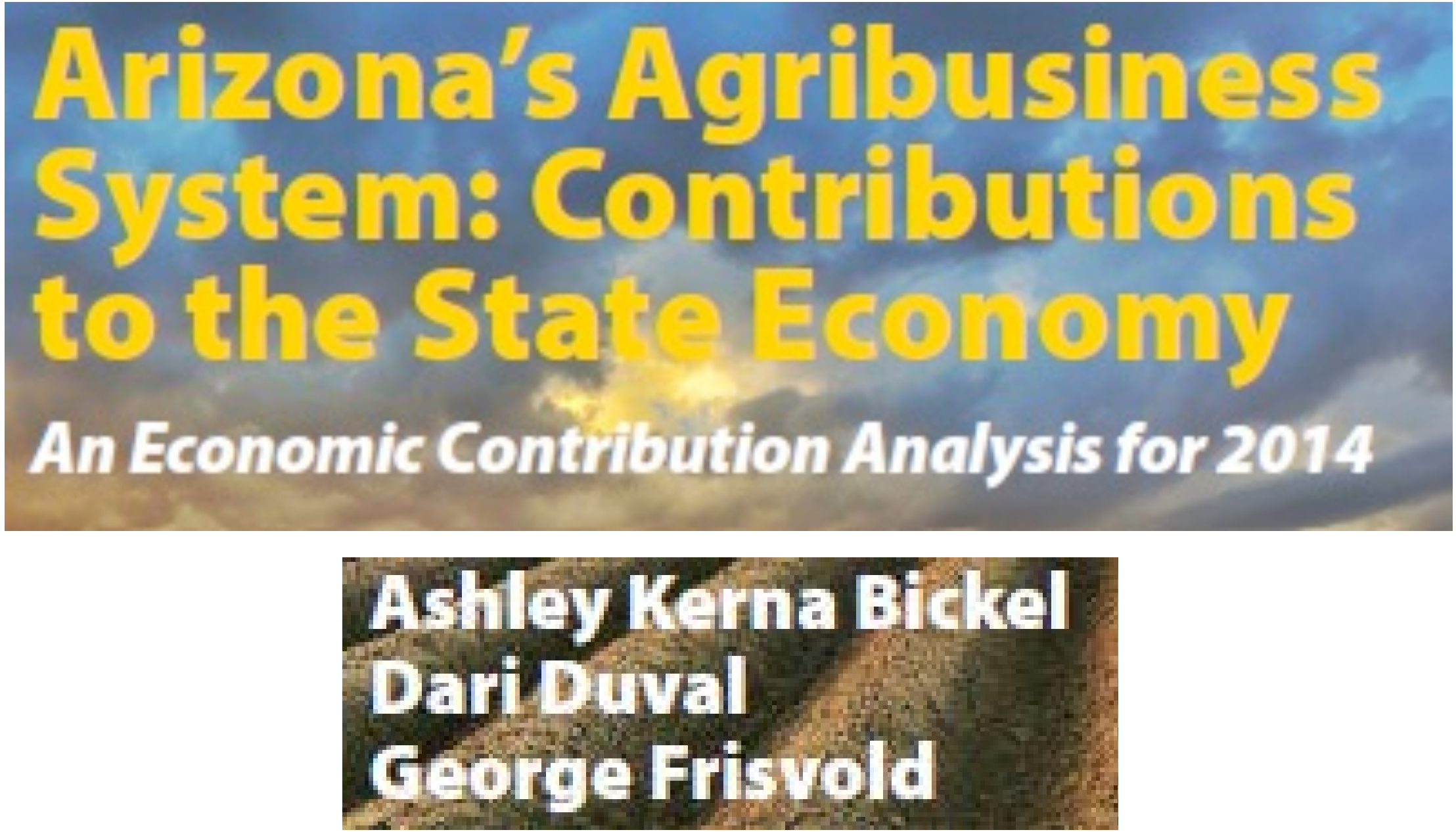
Plan for Today

- Results from Bickel, Duval, and Frisvold study https://cals.arizona.edu/arec/publication/arizonas-agribusiness-system-contributions-state-economy
- Brief discussion of Input-Output (IO) models
- How IO models have been and can be (and should not be) applied to measure economic impacts of water shortages
- Discuss new NOAA-funded research project I am beginning to assess economics effects on Arizona of a shortage declaration for the Colorado River


Arizona's Agribusiness System: Contributions to the State Economy
An Economic Contribution Analysis for 2014
Ashley Kerna Bickel
Dari Duval
George Frisvold

Profile of Arizona Agriculture

Arizona is a national leader in the production of many agricultural commodities

- In 2014, Arizona…
  - Ranked **2nd** in the nation for the production (cwt) of **lettuce** (head, leaf, Romaine), **spinach**, **broccoli**, and **cauliflower**
  - Produced **28%** of the nation's production of **cantaloupe** and **22%** of the nation's production of **honeydew**
  - Ranked **4th** in the nation for the production of **pecans**, accounting for **8%** of national production

Arizona Agriculture by the Numbers

20,005	Number of farms and ranches in Arizona
26 million	Acres of land managed by Arizona farms and ranches
75%	Share of Arizona's agricultural sales from Maricopa, Pinal, and Yuma counties

A majority of the Arizona's agricultural sales come from a few large producers

- 10 operations account for 25% of sales
- 46 operations account for 50% of sales
- 168 operations farms account for 75% of sales

Less than 1% of farms account for 75% of Arizona's agricultural sales, and the remaining 99% of farms account for 25% of sales.

Arizona Agriculture by the Numbers

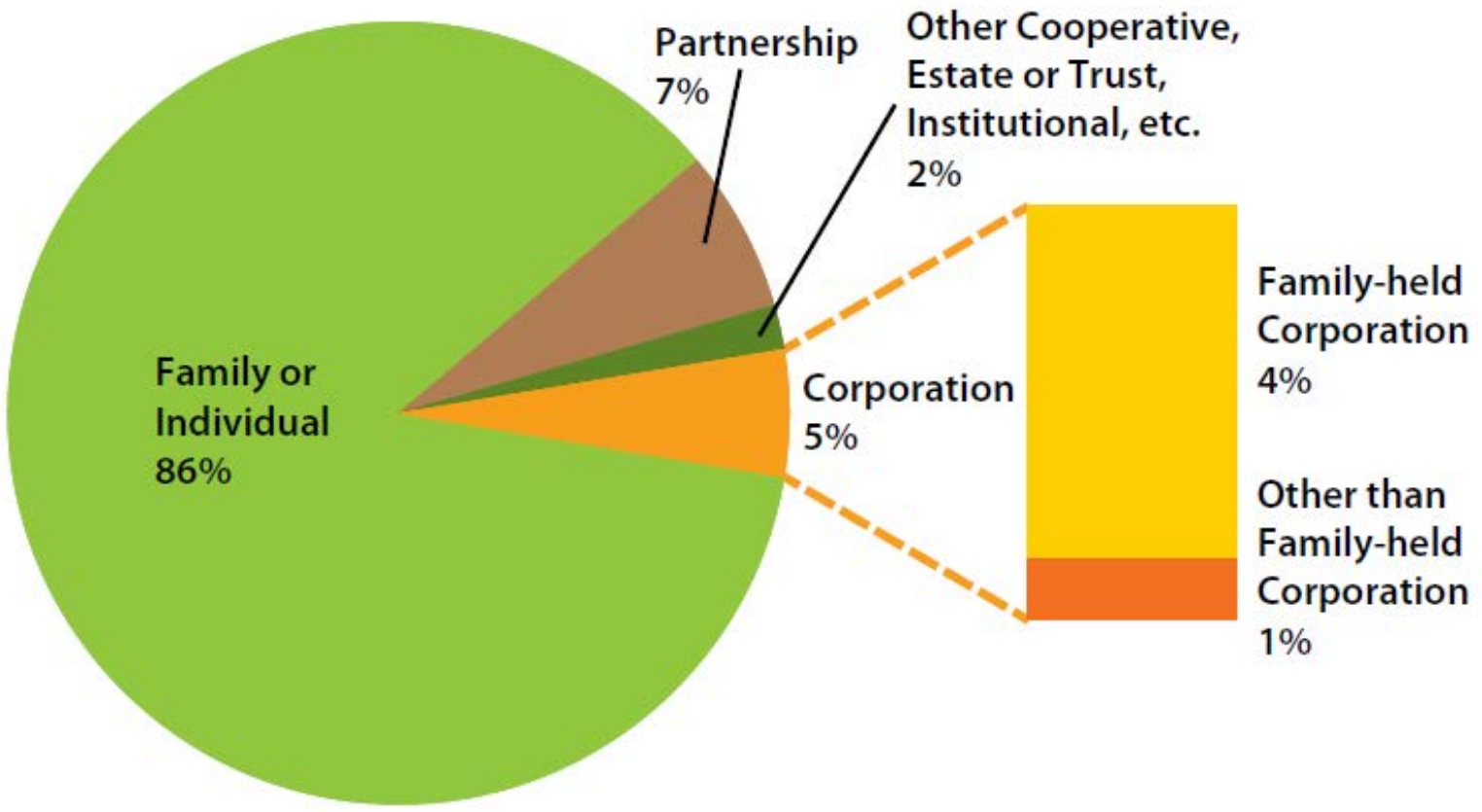
87% Share of Arizona farms and ranches with sales of less than $25,000

97% Arizona farm and ranch operations that are family-run or partnerships

Most Arizona farms are operated by an individual or family

Sales from corporations that are not family-held only accounted for 10% of Arizona's state agricultural sales

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



Arizona's Agribusiness System

Input Manufacturing

Businesses that provide inputs or supplies to agricultural production

Examples:

- Fertilizer manufacturers
- Farm equipment manufacturers
- Irrigation supplies

Primary Agriculture

Businesses, farms, and ranches involved in on-farm production

Examples:

- Crop production
- Livestock production
- Support activities for agriculture (farm labor contracting)

Agricultural Processing

Businesses that process & pack agricultural products

Examples:

- Fluid milk manufacturers
- Animal product processors
- Frozen food manufacturers
- Yarn, fiber, & thread mills

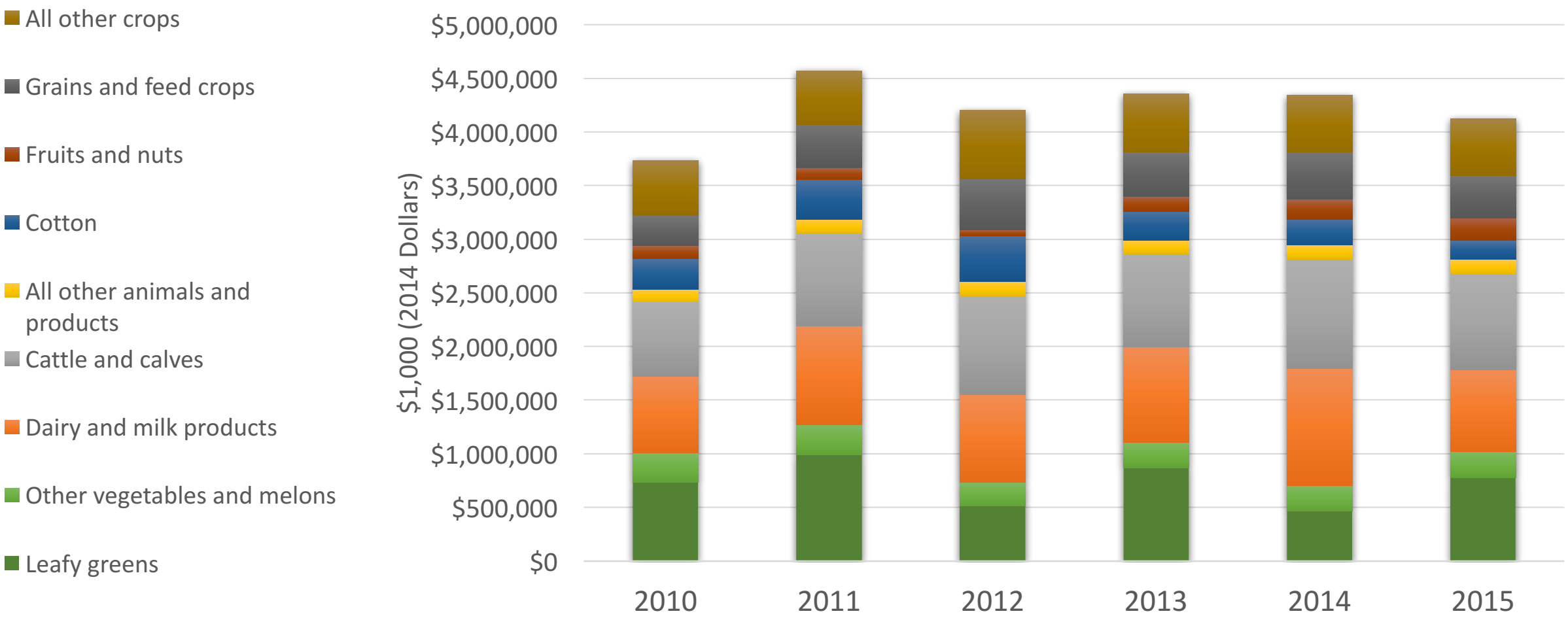
Ag Marketing & Distribution

Businesses involved in supplying final food and fiber products to end users and consumers

Examples:

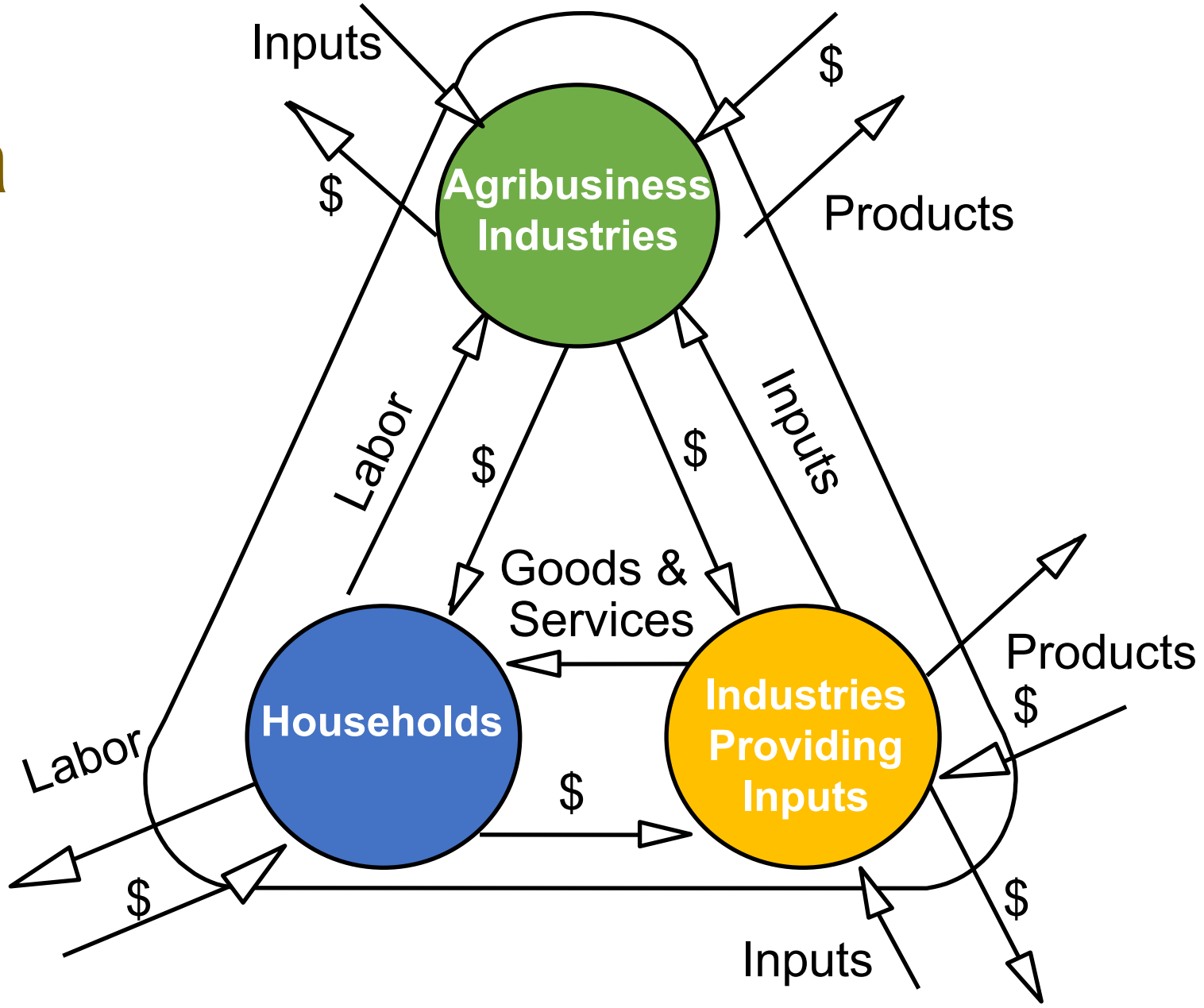
- Refrigerated warehousing
- Agribusiness wholesalers
- Fruit & vegetable markets

Arizona Cash Receipts 2010-2015

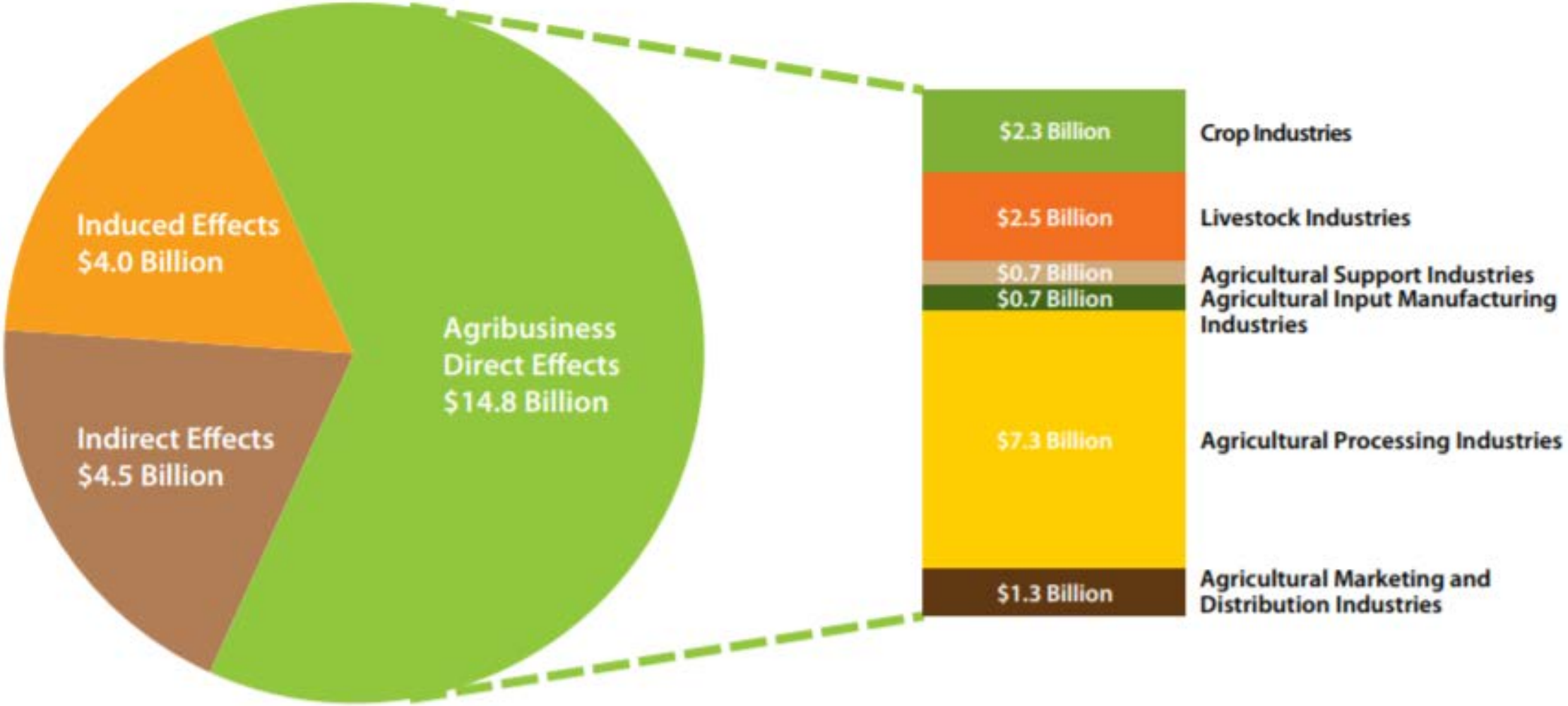


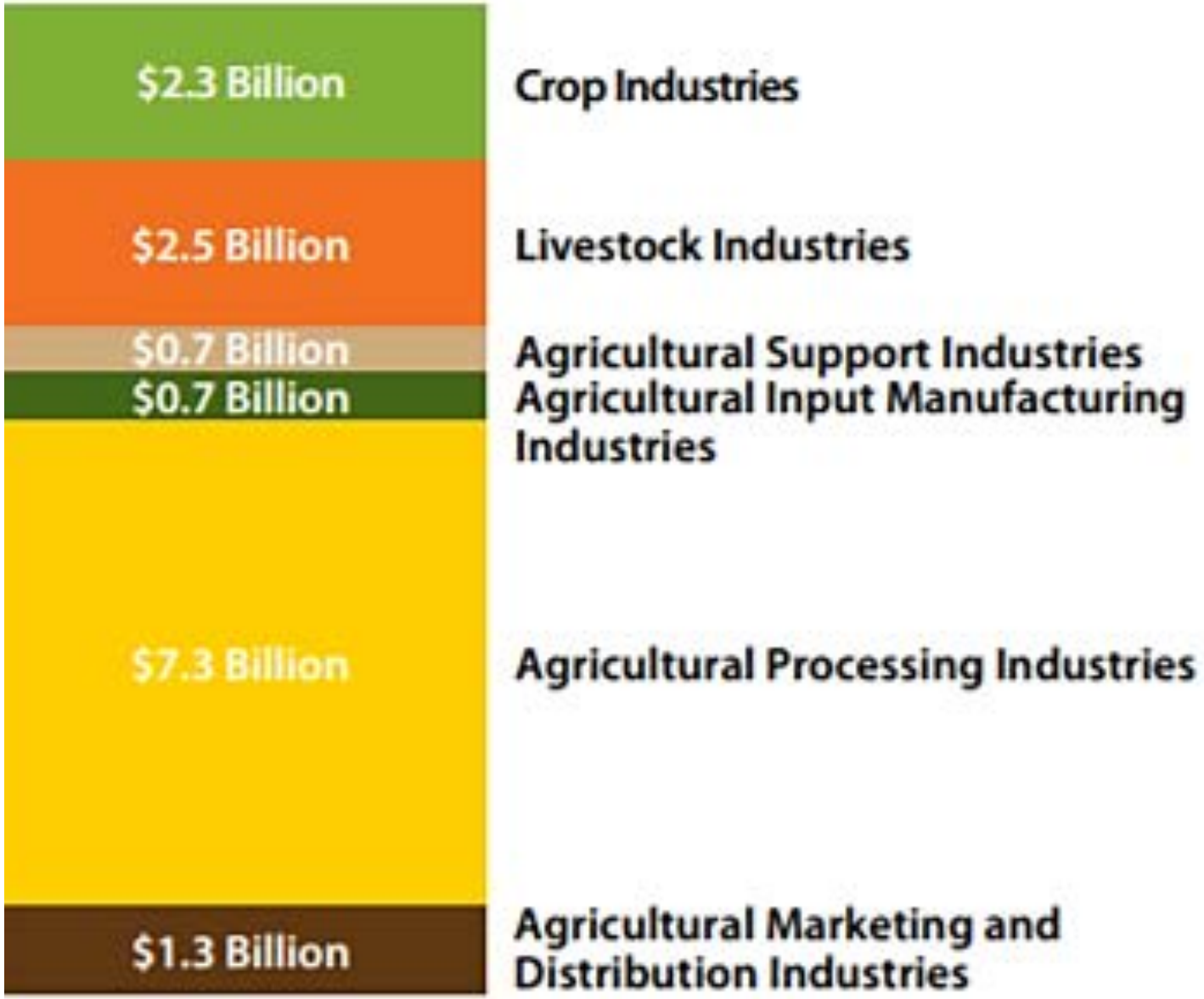
Industry Connections in a State Economy

- Agribusinesses employ households & purchase supplies for their business
- Agribusiness demands for inputs/supplies (**indirect effects**)
- Employees & business owners purchase household goods and services (**induced effects**)



$23.3 Billion Contribution to State Sales

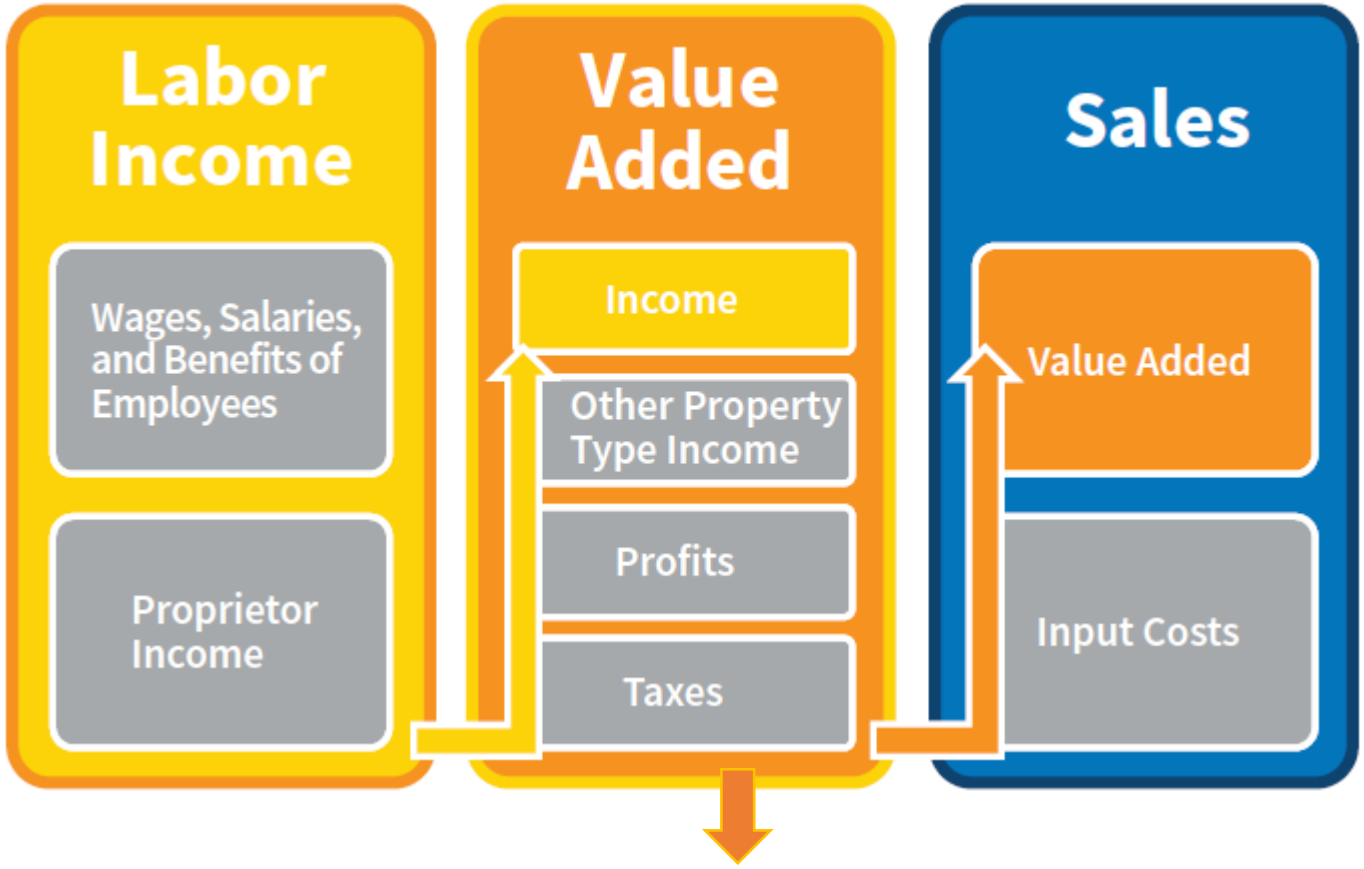




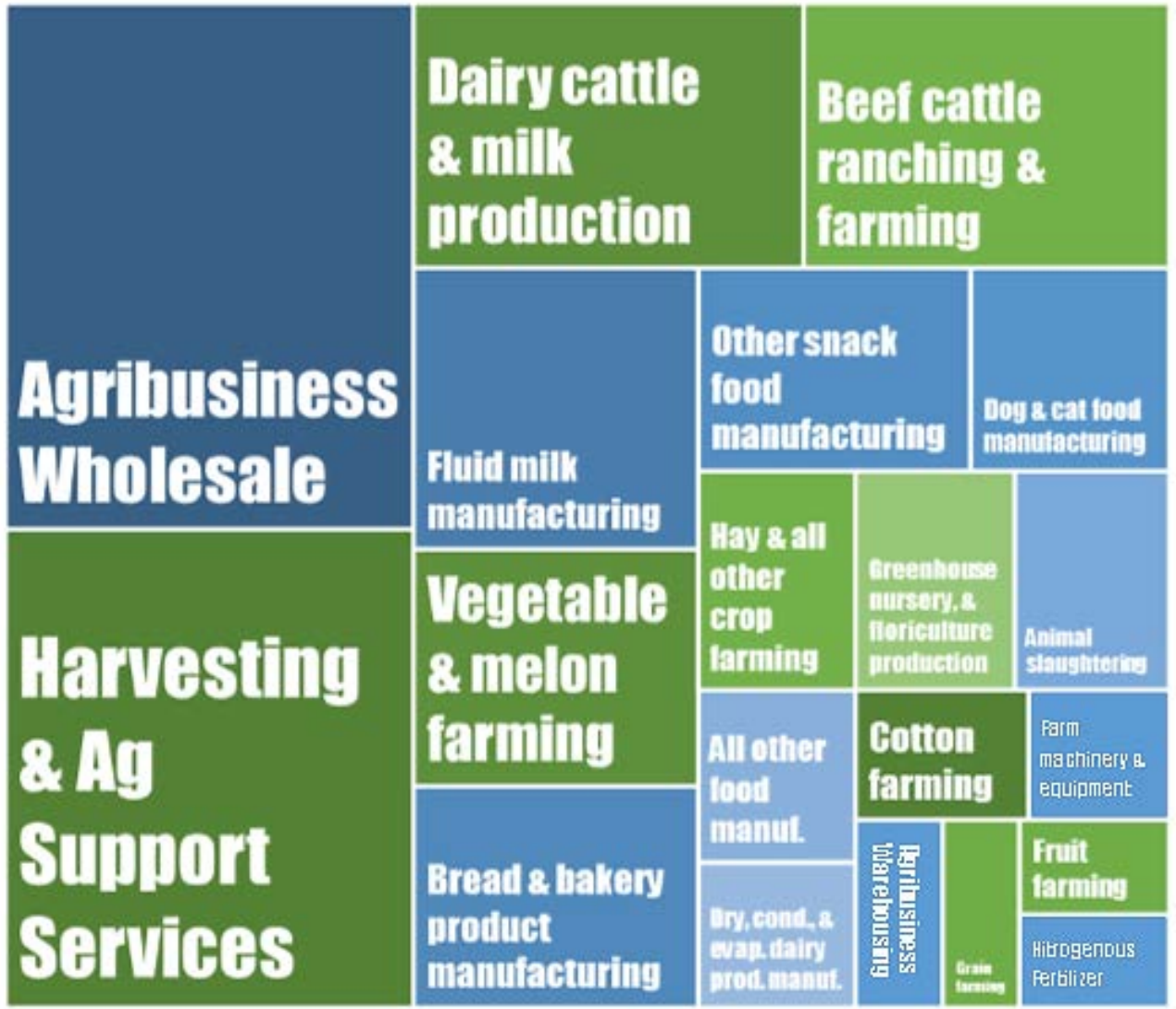
Looking Closer at Direct Effects

Measuring the Total Contribution of Arizona's Agribusiness System

- Total contribution includes:
  - Direct effects
  - Indirect effects
  - Induced effects
- Metrics used to measure the contribution
  - Sales
  - Value Added
  - Labor Income
  - Jobs



Value Added is synonymous with Gross State Product (GSP)



$4.3 billion direct contribution to Arizona Gross State Product (GSP)

Top 5 industries:

1. Agribusiness wholesale
2. Agricultural support services
3. Dairy cattle & milk production
4. Beef cattle ranching
5. Fluid milk manufacturing

Job estimates don't capture…

- Research from California found that there are – on average – 2 unique hired farmworkers for each year-round equivalent farm job
- 162,982 unique workers supported by Arizona's agribusiness system
- Sharp swings in labor demand (Leafy greens)

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

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

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

More than 135,000 full- and part-time jobs

- 138,293 full- and part-time jobs supported by Arizona's agribusiness system in 2014
  - More than 77,000 jobs directly in agribusiness (58,000 in primary agriculture)
  - More than 60,000 ***non-agribusiness*** jobs supported by
    - spending on agribusiness inputs (*indirect effects)*
    - spending of agribusiness profits and wages (*induced effects*)

Summing Up Impacts

In 2014, the Arizona agribusiness system directly contributed:

$4.3 billion to Arizona's Gross State Product (GSP)

Including direct & multiplier effects, the TOTAL CONTRIBUTION of Arizona's agribusiness system was:

$23.3 billion in sales

138,293 full- and part-time jobs

$5.6 billion in income

162,982 unique workers

Input-Output Modeling

- Wassily Leontief received 1973 Nobel Prize in Economic Sciences for development of the input-output method

- Sir Richard Stone received 1984 Nobel Prize in Economic Sciences for pioneering work in developing national income accounts

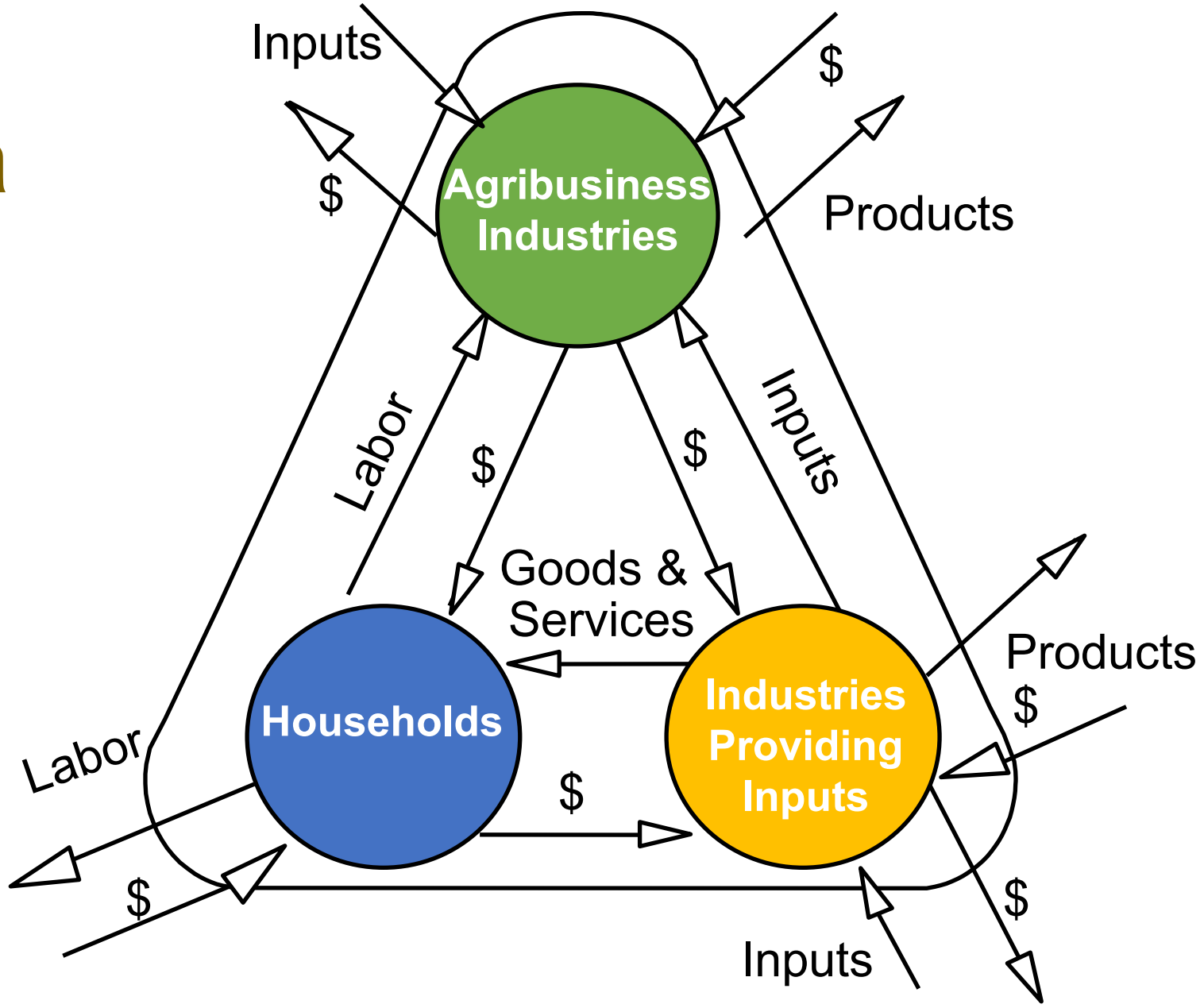
Input-Output Modeling Using IMPLAN

- IMPLAN (**IM**pact analysis for **PLAN**ning) software
  - maintains a database of the 440-sectors in the US economy at various geographic scales (such as US, state, county)
  - handles complex matrix mathematical operations to estimate economic impacts

- IMPLAN models
  - flows of all spending of goods & services between sectors
  - flows of spending & sales inside & outside the region of analysis

Industry Connections in a State Economy

- Agribusinesses employ households & purchase supplies for their business
- Agribusiness demands for inputs/supplies (**indirect effects**)
- Employees & business owners purchase household goods and services (**induced effects**)



Question: Why might you want to use an IO model to examine effects of changes in water supplies?

- Agricultural sector models usually only consider output markets (production, sales, farm income)

- We may be interested in
  - Effect on number of jobs
  - Effects on sales, income, and jobs in other industries

- Example: Effects of Land Fallowing Agreements
  - Reduces demand for agricultural inputs and labor
  - How does that affect the overall local economies of “water exporting” areas?
  - What level of compensation might be needed for “winners” to compensate those who lose?

Continuing with Land Fallowing Example

- Negative effects of taking land out of production
  - Direct loss of agricultural production
  - Less demand for agricultural inputs
  - Less consumer spending (from profits and wages) in local economy

- But if fallowing is done voluntarily in exchange for payments ... how and where are those payments spent?
  - On consumer goods largely “imported” from outside region?
  - Re-invested in other local industries
  - Invested in agriculture in other regions?
  - Answer critical to how a local economy is affected

Question: How might you use an IO model to examine effects of changes in water supplies?

- IO models are demand-driven: no resource constraints built into the model
- Water supply shocks must be modeled as changes in spending on inputs and revenues from production
- Need to determine which sectors (industries) will be affected and by how much?

Modeling Colorado River Shortage

- Two applications:
  - One reasonable
  - One … not
- All economic models simplify and abstract from reality in key ways
- With large complex economic models the important thing is not the model result, but rather understanding ***why*** the model gives you that result

Study 1: “The Economic Importance of the Colorado River to the Basin Region”

- Report for *Protect the Flows*

- Assumes each sector of the economy requires a certain amount of water (OK, reasonable so far)

- Assumes each and every sector of the economy reduces their water use by the same percentages with an overall cut in water supplies (this doesn’t make sense)

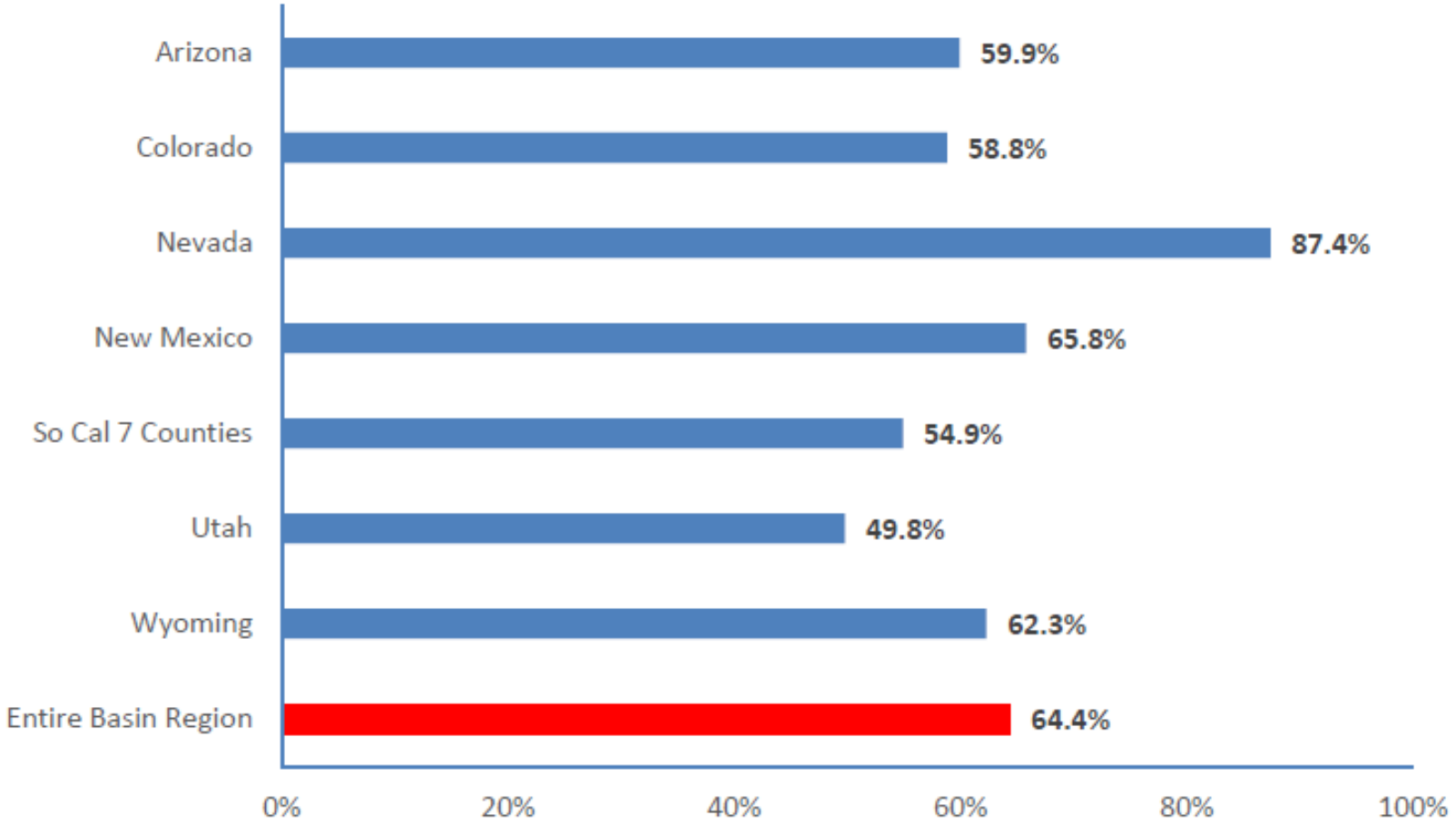
Why is assuming an equiproportional cutback a “bad” assumption

- Doesn’t match water rights and laws
- Not consistent with actions of rationale economic actors
- If water supplies get cut 25%
  - 25% less alfalfa
  - 25% fewer Hollywood movies
  - 25% fewer appendectomies and baby deliveries in hospitals
  - 25% fewer NFL, MLB, and NBA games

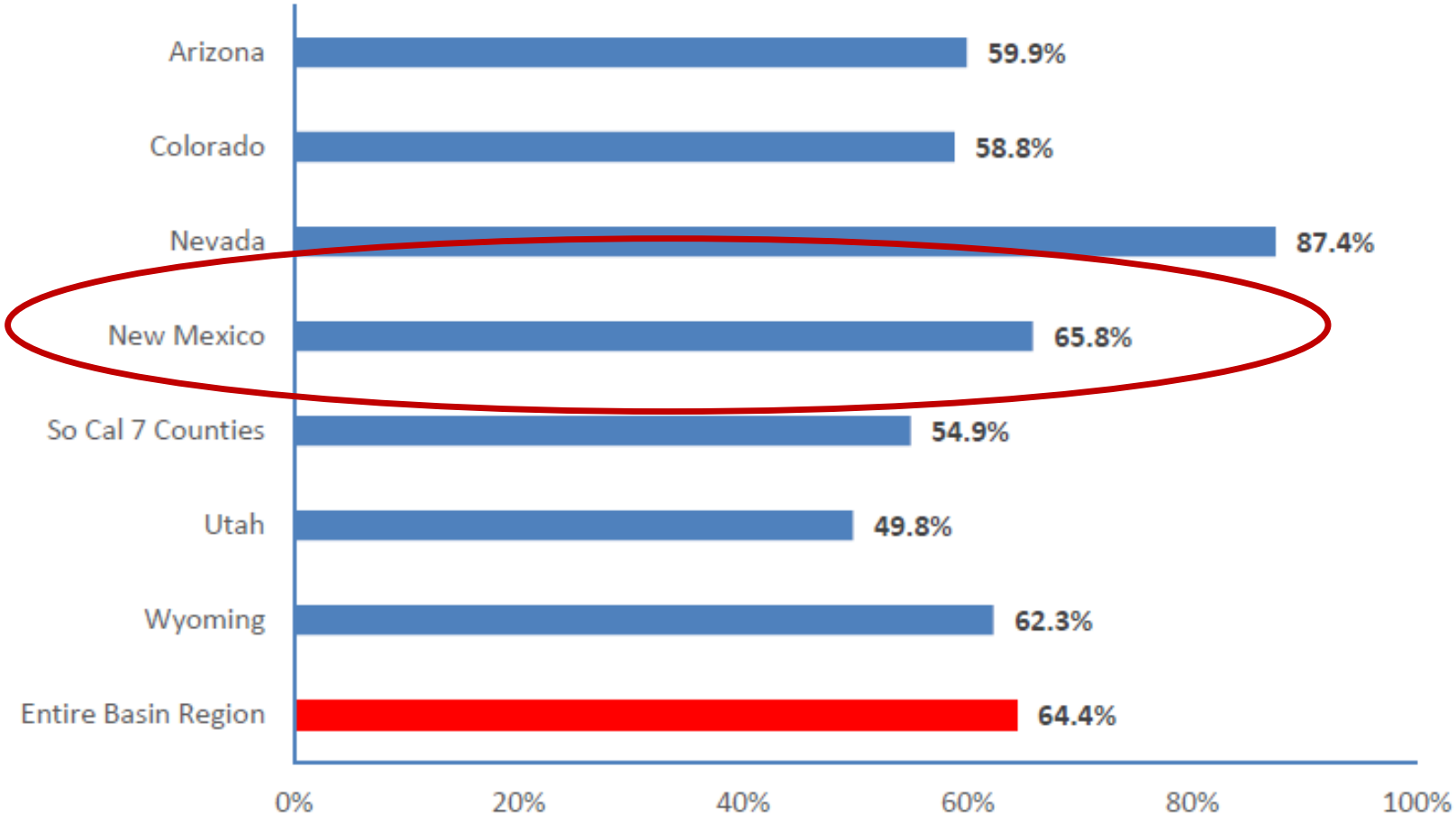
Top 5 Sectors affected

- Real Estate and Rental (e.g. any establishment engaged in renting, leasing or allowing the use of property, motor vehicles, consumer goods, and nonfinancial intangible assets) - $174.3 billion.
- Healthcare and Social Services (e.g. ambulatory healthcare; child day care; hospitals; nursing; residential care; and vocational rehabilitation) - $148.6 billion.
- Finance and Insurance (e.g. banking; credit intermediation; insurance; securities, commodities and trusts) - $137.1 billion.
- Professional, Scientific and Technical Services (e.g. accounting and bookkeeping; advertising; architectural and engineering; computer services; consulting; legal; photography; research; translation services; veterinary services) - $130.6 billion.
- Retail Trade (e.g. any establishment engaged in retailing merchandise) - $96.2 billion.

Estimated % losses in State Gross State Project



Estimated % losses in State Gross State Project



Limitation of IMPLAN model on large regional scale

- No input substitution or change in practices
  - No adoption of water conservation
  - No switch to new technologies
  - No switch to groundwater
- Not telling economically consistent story
  - Huge changes in production and employment
  - More than $1 trillion in lost Gross State Product
  - **16 million jobs lost**
  - But model assumes no changes at all in prices or wages

Colorado River Interim Guidelines for Lower Basin Shortages & Coordinated Operations for Lake Powell & Lake Mead

- Final EIS: Appendix H (Socioeconomic Data)

- Example of (IMHO) a well done analysis

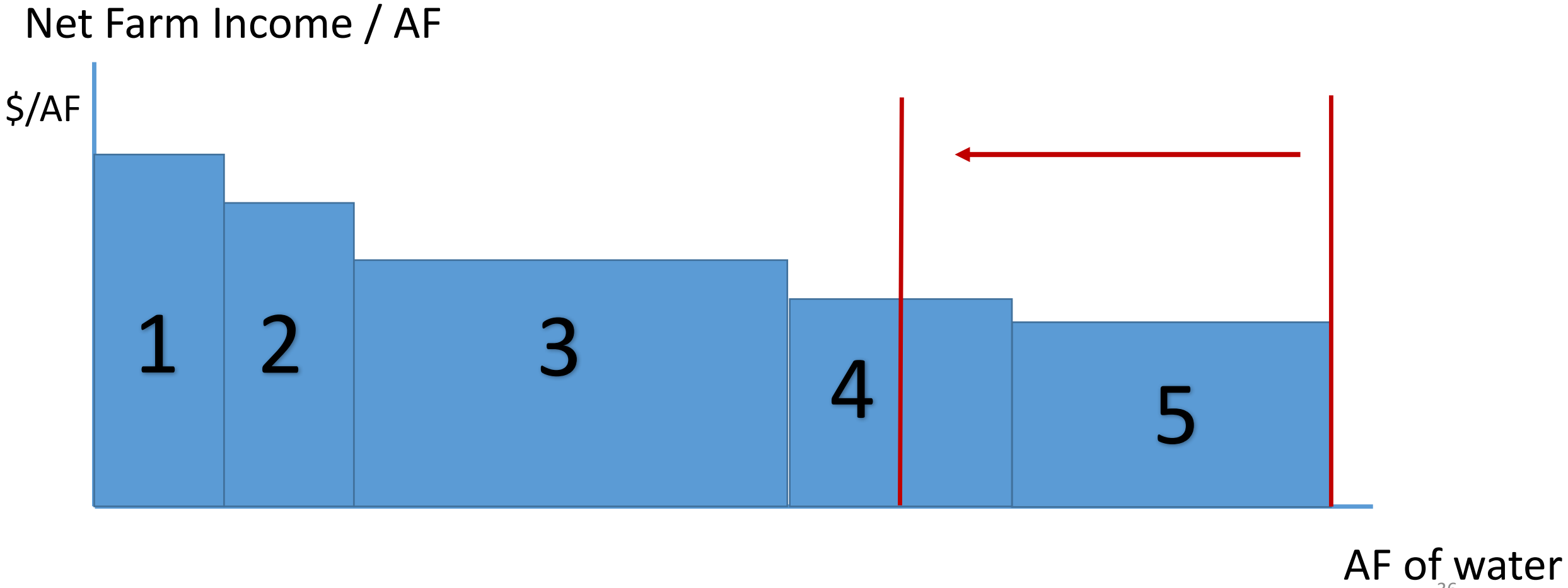
Interim Guidelines Economic Analysis

- Assumptions about water supply shock
  - Water reductions (primarily) to Central AZ agriculture
  - Growers respond by fallowing land
    - One could quibble about whether this would be the only response, but …
    - An interesting, realistic and reasonable thing to look at
  - Assume growers fallow least profitable acres
    - Growers make fallowing choices to minimize their losses
    - Seems reasonable

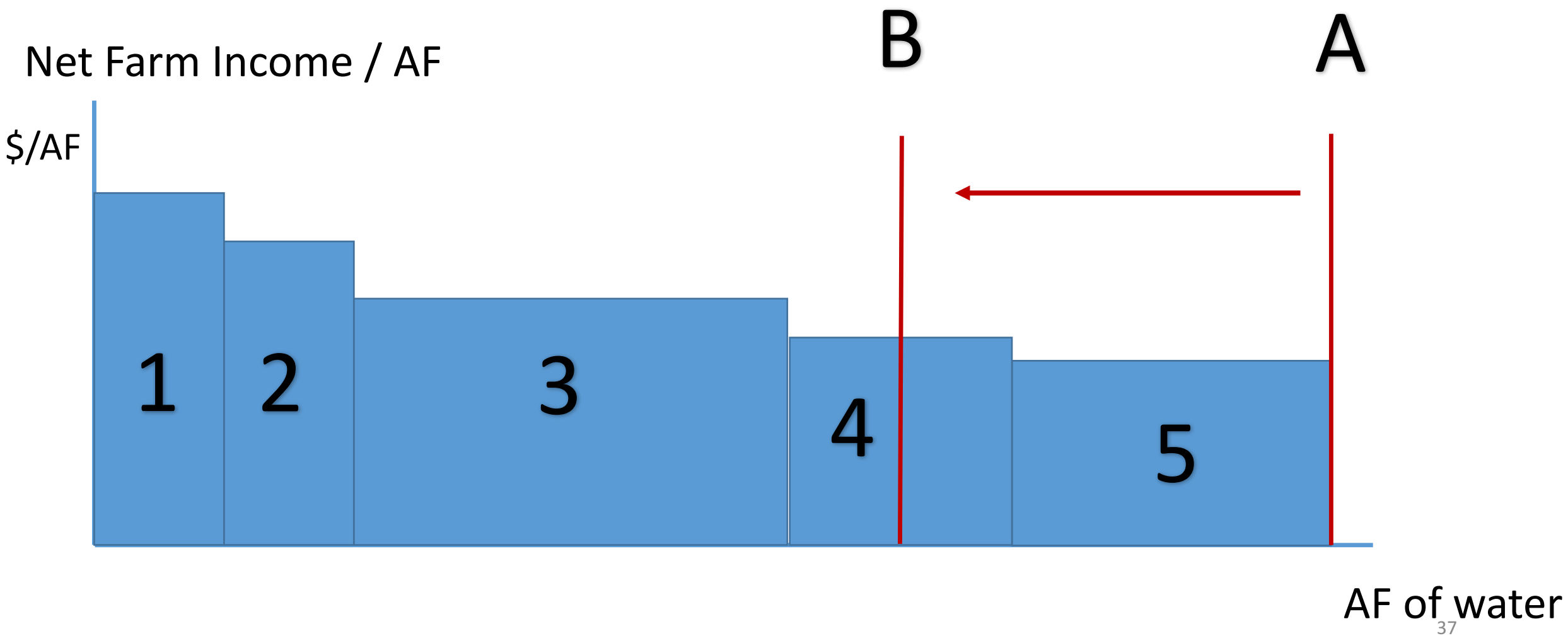
Assumed Grower Behavior

- Based on the amount of shortage realized in each county, the model estimates the amount of land that would be fallowed using the relative profitability of each crop.
- The model assumes that the least profitable crops are fallowed first.
- Once all of the irrigated land associated with the least profitable crop is fallowed, the model assumes that fallowing of the next-least profitable crop would commence.

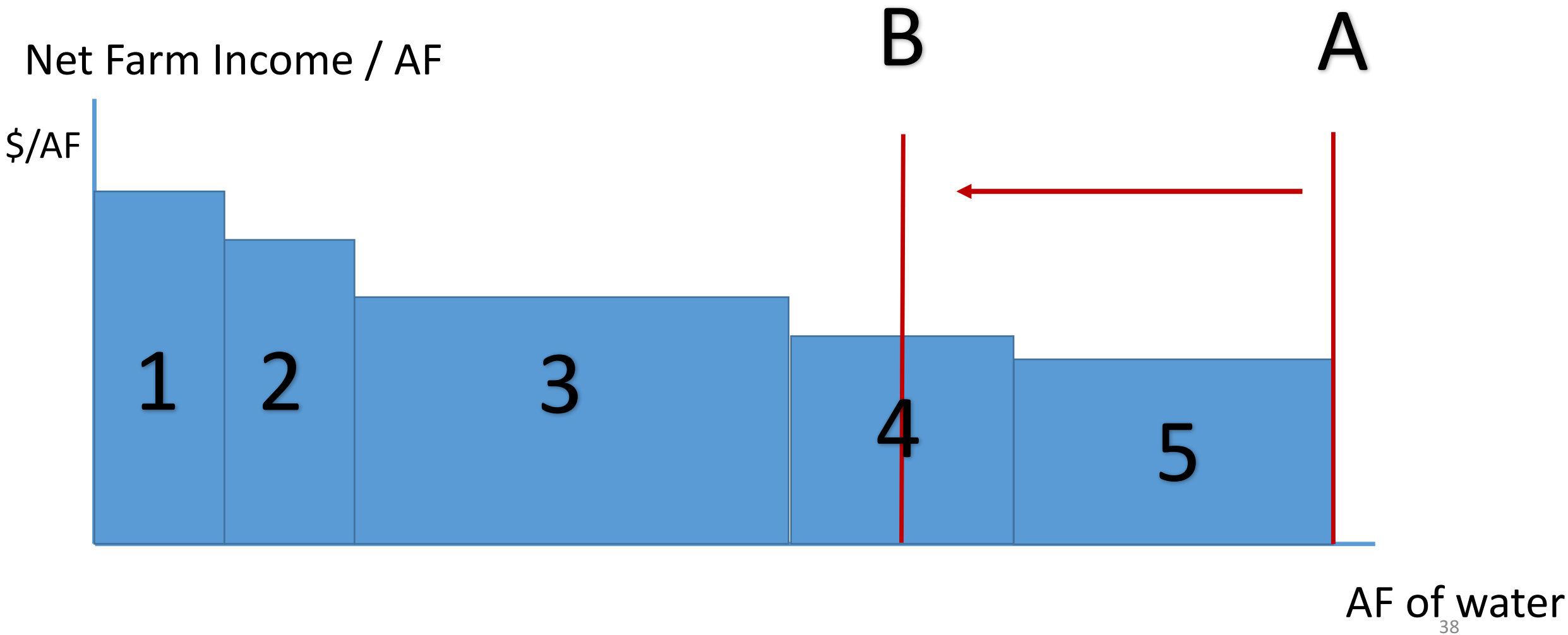
In this irrigation district, crops ranked by their profitability per acre foot (AF) of water



Irrigation District's water allocation falls from A to B



Irrigation District adapts by fallowing all acres of crop 5 and half the acres of crop 4



Simulated acreage reductions

- Lowest value crops vary in amount across sub-regions

- “For the 500 kaf shortage evaluated in this discussion, approximately 86,000 acres would be removed from crop production consisting of
  - 25,000 acres of cotton,
  - 48,000 acres of grain, and
  - 13,000 acres of forage crops.”

Table H-27
Estimated Change In Employment and Income as a Result of a
500,000 af shortage to Non-Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	**Direct**	**Indirect + Induced**	**Total**		**Direct**	**Indirect + Induced**	**Total**
Maricopa	(108.6)	(50.5)	(159.2)		(3,144.695)	(1,807,440)	(4,952,135)
Pinal	(179)	(186.5)	(365.6)		(10,598,009)	(5,939,280)	(16,537,289)
Mohave	(7.7)	(3.5)	(11.2		(289,494)	(102,518)	(69,941)
La Paz	(4.6)	(2.4)	(7.0)		(142,568)	(54,195	(196,764)
Yuma	(8.5)	(6.4)	(15.0)		(215,957)	(168,664)	(384,621)
Total	**(308.4)**	**(249.3)**	**(558.0)**		**(14,390,723)**	**(8,072,097)**	**(22,462,821)**

Table H-35
Estimated Change In Employment and Income as a Result of a 500,000 af Shortage to Indian Agricultural Lands in Arizona—2017

	Employment				Income		
County	**Direct**	**Indirect + Induced**	**Total**		**Direct**	**Indirect + Induced**	**Total**
Maricopa	(21.4)	(5.8)	(27.2)		(383,787)	(210,898)	(594,685)
Pinal	–	–	–		–	–	–
Pima	(32.9)	(6.3)	(32.9)		(487,150)	(214,065)	(515,647)
Mohave	–	–	–		–	–	–
La Paz	(1.9)	(1.0	2.9		(76,175)	(22,679)	(82,340)
Yuma	–	–	–		–	–	–
Total	**(56.2)**	**(13.2)**	**(56.2)**		**(930,598)**	**(447,642)**	**(1,378,239)**

Estimated Impacts of 500 KAF reduction to AZ economy

- About 1/3 of income losses are outside of direct farm income
- About 40% of job losses are outside direct farm job losses
- Total personal income losses <$50 / AF
- Total Losses: $24 **million**
  - AZ total personal income >$250 **billion**
  - Maricopa & Pinal County personal Income >$175 **billion**

Modeling differences in for a 1.8 MAF reduction in AZ water supplies

- Protect the Flows Report: >$108 **Billion** in Income Losses
- Interim Guidelines EIS: <$50 **Million** in Income Losses
- That’s a pretty big discrepancy!

How Big a Discrepancy?: Bigger proportionally than the difference in the distance from ….
… the WRRC to Tempe
… and from the WRRC to the Moon?

How can such wildly different estimates be in the public domain without comment?

- This happens when economics is **not** being used to inform policy

- Economic impact numbers quoted in $ millions and $ billions are presented without any context

A Colorado River Shortage Declaration: Planning, Responses, and Consequences
CLIMAS Lead: George Frisvold

- How well are current public and private information sources helping Arizona farmers prepare for a Colorado River shortage?
- What preparations are farmers and water suppliers currently making?
- **How would a shortage declaration affect production, income and jobs?**

Updating and expanding on BOR analysis

- Sensitivity analysis
  - Returns per acre foot of water can vary a lot from year to year
  - Which crops would be fallowed most could shift a lot
  - Costs of fallowing higher in “high price” years, lower in low price years

- Shifting from surface water to groundwater
  - Crop sales would fall by less
  - Expenses (for groundwater pumping would go up)

Updating and expanding on BOR analysis

- Effects of a voluntary conservation program
  - BOR Interim Guidelines discussed this, but did not do formal quantitative analysis
  - Results would depend on size and form of compensation payments
    - Some payments could go to Irrigation Districts
    - Other payments could go to agricultural input suppliers and farm labor
  - Compensating community (beyond growers) is tricky to model and even trickier to implement in real life
    - Losses hard to document
    - Labor force highly mobile


THE UNIVERSITY OF ARIZONA
Questions?
George Frisvold
frisvold@ag.Arizona.edu
(520) 621-6269
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Agricultural & Resource Economics
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Cooperative Extension