Congreso Aapresid | CON LA FUERZA DE Expoagro | CÓDIGO ABIERTO

Sharon B. Megdal, PhD, Director, University of Arizona Water Resources Research Center

How water supply challenges are impacting agriculture in Arizona, USA

Arizona, a state in the Southwestern United States, is home to productive agriculture. Water supply-demand imbalances are leading to changes in agricultural irrigation and cropping practices. Innovation and collaboration are key to agriculture's future.

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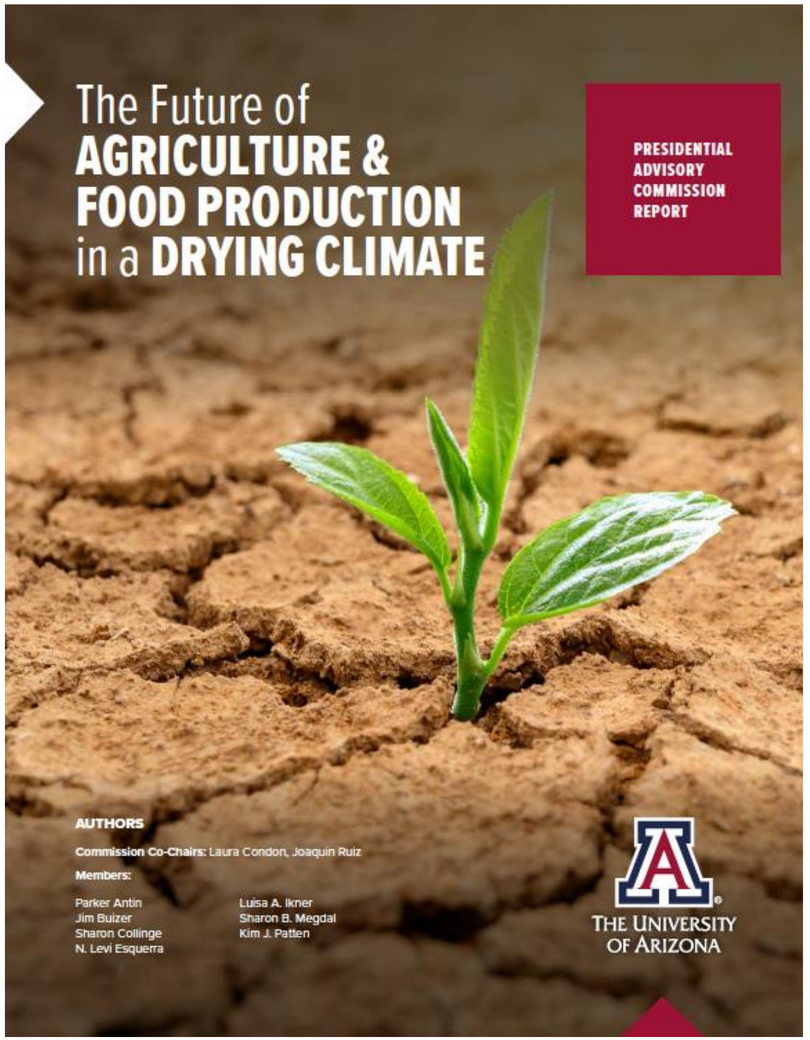
Abstract

This presentation will explain how reduced surface water and limited groundwater supplies are impacting agricultural irrigation practices and cropping patterns in Arizona, a semi-arid to arid state located in the Southwestern United States.

Irrigators in Arizona rely mainly on Colorado River water, other surface water supplies, and groundwater, with significant differences in water availability across regions of the State.

The presentation will also include discussion the findings and recommendations of the University of Arizona's Commission report, "The Future of Agriculture and Food Production in a Drying Climate". https://wrrc.arizona.edu/publication/future-agriculture-food-production-drying-climate.



WRRC bridges academia and the real-world of water management

- The University of Arizona Water Resources Research Center (WRRC) tackles key water policy and management issues, empowers informed decision-making, and enriches understanding through engagement, education, and applied research.
- Webinars, annual conference, publications, etc.
- Partnerships, engagement, and respectful dialogues are essential to our work.
- My work focuses on water policy and management at many geographic scales, including transboundary.

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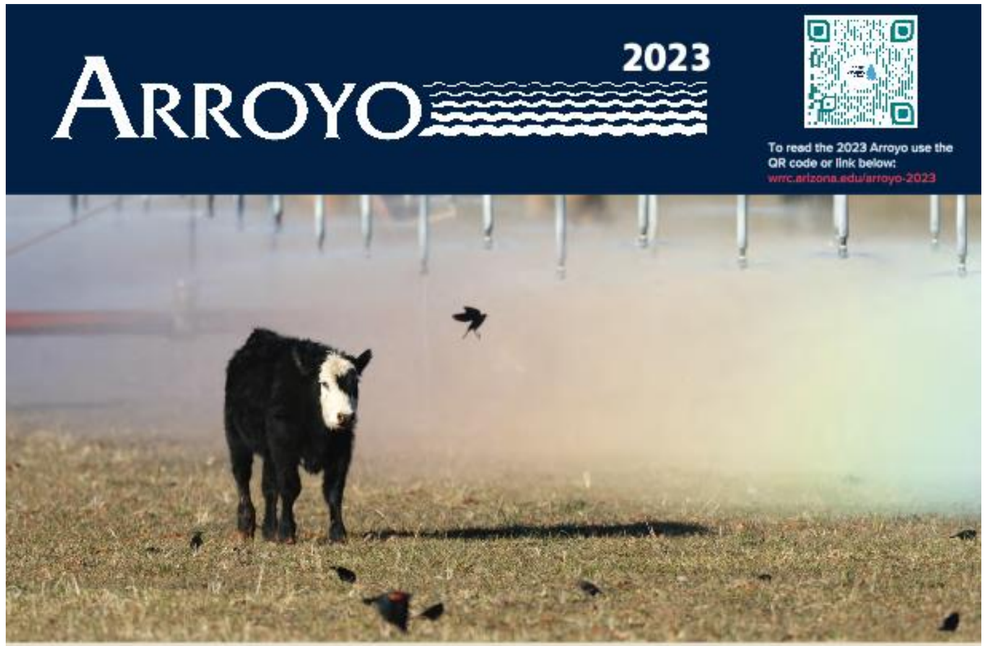

ARIZONA'S AGRICULTURAL OUTLOOK: WATER, CLIMATE, AND SUSTAINABILITY

Authors: Luke Presson and Susanna Eden
Layout: John Polle
Executive Publisher: Sharon B. Megdal
Cover Photo: David Quanrud - Chasing a Rainbow, Sulphur Springs Valley, AZ, 2010

INTRODUCTION

Arizona's development has been dominated by the five Cs—copper, cattle, cotton, citrus, and climate—three of which are products of agriculture. However, the cultural and economic contributions of the agricultural industry have declined with the increase of urbanization and economic diversification. Climate conditions and ongoing drought pose additional challenges to farmers. A megadrought has persisted in the western states for more than 20 years, resulting in a dangerous drop in available water storage. As drought forces difficult decisions on water use, food security — assured access to sufficient safe and nutritious food — is emerging as a key concern. Given these conditions and ever-increasing needs for food and fiber, what is Arizona's agricultural outlook? This *Arroyo* aims to address this question by focusing on how the state can adapt to a new climate reality and sustain the agricultural productivity and culture that has defined the character of the state for so long.

With water shortages in the Colorado River, policymakers and stakeholders are looking for every opportunity to increase water efficiency and decrease water use. Urban areas have been implementing successful conservation measures, but continued population growth still raises concerns about

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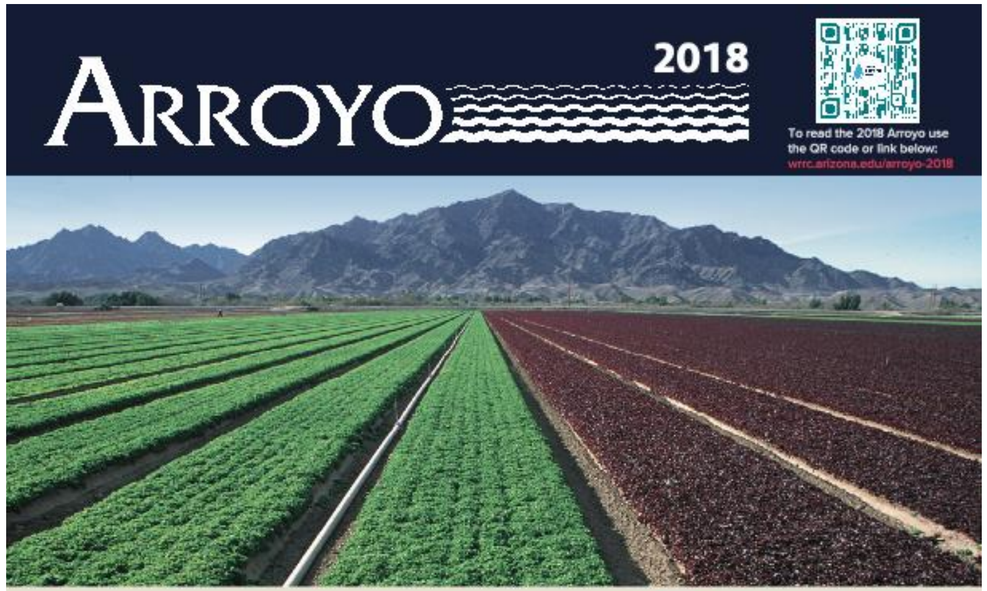

WATER AND IRRIGATED AGRICULTURE IN ARIZONA

Authors: Timothy Lahmers, Susanna Eden
Layout: John Polle
Executive Publisher: Sharon B. Megdal
Cover photo: U.S. Department of Agriculture (Jeff Vanuga)
2nd Edition June 27, 2018

Introduction

Why is so much of Arizona's water used to irrigate crops in the desert? A partial answer to this question is that Arizona provides at least two of the three prerequisites for producing crops: ample sunshine, high-quality soils, and adequate water. Although the desert lacks sufficient rainfall to grow most crops, Arizona's rivers have supported agriculture for thousands of years, and aquifers in Arizona's desert valleys hold vast quantities of groundwater. Ongoing drought, coupled with the water demands of a growing population, however, threaten those rivers and aquifers. In this context, it is useful to reexamine irrigated agriculture: its benefits, water using practices, constraints, and trends.

This *Arroyo* seeks to provide a comprehensive picture of Arizona's irrigated agriculture, presenting first a brief history of the state's desert agriculture, followed by profiles of agricultural regions in Arizona, their water sources, uses, and crops. Following sections offer background and discussion on the two major sources of water for irrigated agriculture in Arizona: groundwater and the Colorado River. A description of agricultural water use efficiency and conservation, including new crops that may reduce water application follows. Voluntary fallowing of farmland for water conservation and transfer to other uses is discussed. Collaboration opportunities with university and government agencies on conservation and water efficiency improvements are outlined. The reader will come away with a deeper understanding of how Arizona achieves sustainable food and fiber production in a desert climate.

What is Irrigated Agriculture?

Irrigated agriculture involves the controlled application of water to a crop. In semi-arid environments, such as Arizona, irrigation is essential because there

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2023 *Arryo* includes 8 factsheets

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FACTSHEET

7 Soils and Conservation Practices

Soil Texture

Soil texture is a crucial component of a soil's water holding capacity (WHC).

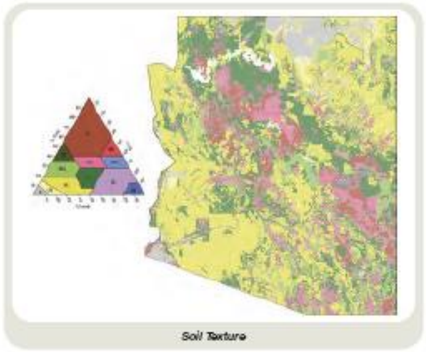
- Sandy soils have a low WHC and must be irrigated frequently.
- Clay and silt have high WHC and can be irrigated less frequently.

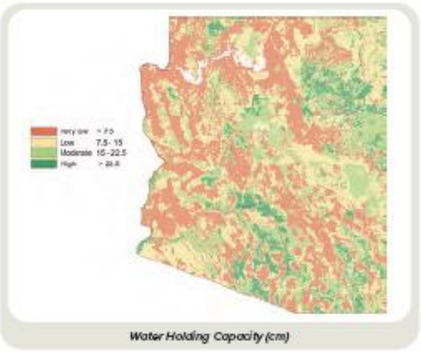
BUT the amount of water a plant can extract from the soil also depends on texture.

- Clay soils may be farmed, but clay holds water so tightly it impedes extraction by plants.
- Silty soils are great for farming as they hold a lot of water available to crops.

Soil Types

AND higher WHC is not always better. Sandy soils have low WHC but great drainage with little risk of waterlogging.


Soil Texture



Water Holding Capacity (cm)

Soil Organic Matter

- Can hold large volumes of water—much of which is available to crops.
- High SOM can also improve infiltration rates by providing structure to the soil and protecting against crusting and compaction.

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FACTSHEET

7 Soils and Conservation Practices

Soil Improvement Practices

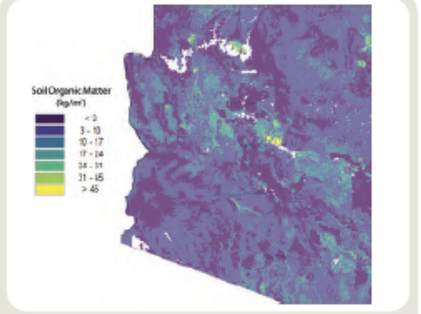
While soil texture is largely out of farmers' control, soil health can be improved.

Crop Rotation – Alternating crops seasonally or annually

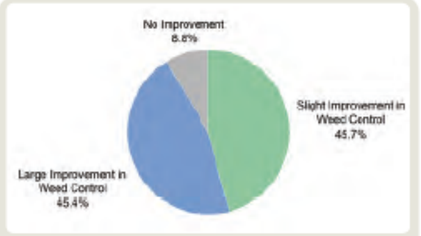
- Balances and cycles nutrients while minimizing risk from pests and disease.
- Diverse root systems improve soil structure and provide soil microbes with different food sources.

Cover Crops – Planted primarily to support soil health rather than crop production

- Used on only ~6% of Arizona's farmland because the year-round growing season encourages planting and irrigating more profitable crops.
- **BUT** cover crops add nitrogen and improve soil health.
- **AND** can control weeds, reducing the need for herbicide.



Soil Organic Matter



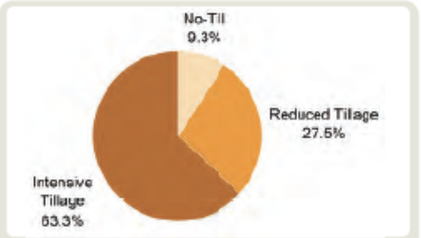
US Farmer survey responses on cover crop weed control.

Conservation tillage – Reducing or eliminating tillage on agricultural fields

Most of Arizona's farmland is operated under intensive tillage, but between 2012 and 2017, no-till practices increased while intensive tillage decreased by nearly 14%.

Decreased Tillage can:

- Save time, money, and fuel;
- Increase SOM, water retention, and drainage;
- Prevent erosion, soil compaction, and CO_2 release;
- Improve yields over the long term.



Fraction of acres under intensive, reduced, or no-till practices in Arizona. (2017)

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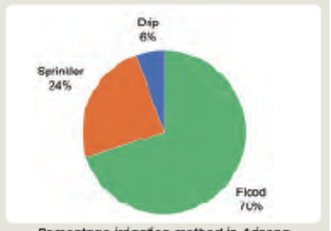
FACTSHEET

4 Irrigation Methods

The most common irrigation methods are flood, sprinkler, and drip irrigation. Each method has pros and cons, and the best choice depends on variables such as crop type, soil type, and cost.

Flood irrigation:
Water flows across a field, usually through furrows, and seeps into the soil.

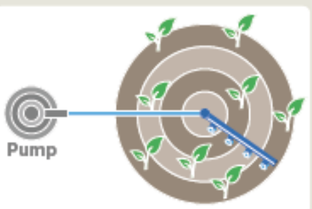
- The simplest, least costly method;
- Considered the least efficient method;
- **BUT** best for some specific uses;
- **AND** efficiency can increase to 80% or more with land leveling, automation, and reuse of runoff.



Percentage irrigation method in Arizona

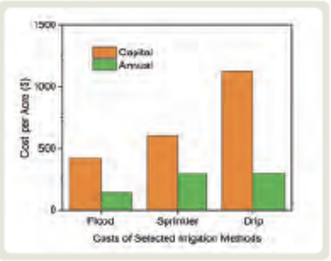
Sprinkler irrigation:
Controlled spray of pressurized water is aimed at crops, often simulating rainfall.

- Sprinkler technology is varied and includes center pivot (shown at right), linear move, traveling gun, etc;
- Relatively efficient, with little runoff or deep percolation;
- **BUT** airborne droplets may be blown away by wind and evaporate quickly;
- **HOWEVER**, some newer systems reduce losses by carrying sprinkler heads close to the soil surface.



Drip irrigation:
Distribution lines apply small volumes of water with extreme precision.

- Considered the most efficient irrigation method. Evidence suggests it can produce higher yields with less water than other methods;
- Each installation can be designed and customized;
- **BUT** Changing a field or crop is more burdensome;
- **AND** soil salinity may be a problem. Salt builds up in soil if irrigation water is high in minerals, and drip irrigation alone does not flush salts to below the root zone.



Costs of Selected Irrigation Methods

One acre-foot of Colorado River water can leave behind around one ton of salt!

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8 Native Agriculture

Several of Arizona's Native Tribes operate successful modern farms, using varieties of standard agricultural practices. However, many agricultural conservation practices have roots in native traditions and knowledge. A select few native agricultural traditions are discussed below.

Companion or Guild Planting - planting different crops together rather than in the separate fields of conventional agriculture

- Each plant benefits from the contributions of nutrients, structure, and/or shade from the others.
- The Three Sisters—beans, squash, and maize—are the primary example of companion planting.
- A diet based on the Three Sisters is nutritionally complete and healthy.
- The Three Sisters have cultural significance that connects the farmer to the land.


The Three Sisters by Anna Juchnowicz


Corn grown on Hopi land with dryland farming techniques.

Dryland Farming - farming without irrigation

- Crops grow with as little as 10 inches of yearly rainfall and often are cultivated by hand.
- Corn—perhaps the most important crop for many Native American tribes—is planted deep in carefully selected locations.
- Farming in these conditions relies on generational knowledge and familiarity with the land.

Desert-adapted Crops - the selection and cultivation of seeds adapted to local conditions

- Farmers select the seeds of successful plants from the recent harvest to use the following season.
- Successive seasons of this practice produce crops adapted to the needs of the land.
- This adaptation is critical for farm sustainability and land stewardship.


Tohono O'odham White Tepary beans (image from Nativeseeds.org)

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Slide shown in the first meeting of my spring semester graduate course

ENVS/GEOG/HWRS/LAW/PLG 596B
Water Policy in Arizona and Semi-arid Regions

Dr. Sharon B. Megdal
January 17, 2025
smegdal@arizona.edu

wrrc.arizona.edu

Water policy and management reflect many determining factors

- Resource Availability
- Location of water demands and supplies
- Economics
- Historic and Current Legal/Institutional Framework
- The nature of involvement of multiple governmental and non-governmental entities, including the extent of centralized versus decentralized decision making
- Politics of Area
- Public values and socio-cultural factors
- Historical context
- Information
- Etc…

Importance of Context

Megdal, Graduate Water Policy class, January 17, 2025

19

Wicked Water Problems Context

- Wicked Water Problems are big problems that do not have a simple pathway to resolving them.
- Two Wicked Water Problems Arizona faces:
  - Imbalance of Water Supply and Demand (Colorado River in particular)
  - Groundwater invisibility and overdraft
- Innovation and collaboration are necessary for addressing Wicked Water Problems.

Photos: SB Megdal

Arizona is in the Colorado River Basin

Arizona borders no ocean or sea. The Colorado River forms its western border.

Colorado River Basin

- About 647,000 km^2
- 7 states in the USA
  - If a nation, California's would be 5th or 6th largest economy
  - Los Angeles, California, is the 2nd largest city in the USA; Phoenix, Arizona, is the 5th
- 2 states in Mexico
- 30 Native Nations (Indigenous)
- ~ 40 million people

Hoover Dam and Lake Mead affected by megadrought

Lake Mead behind Hoover Dam

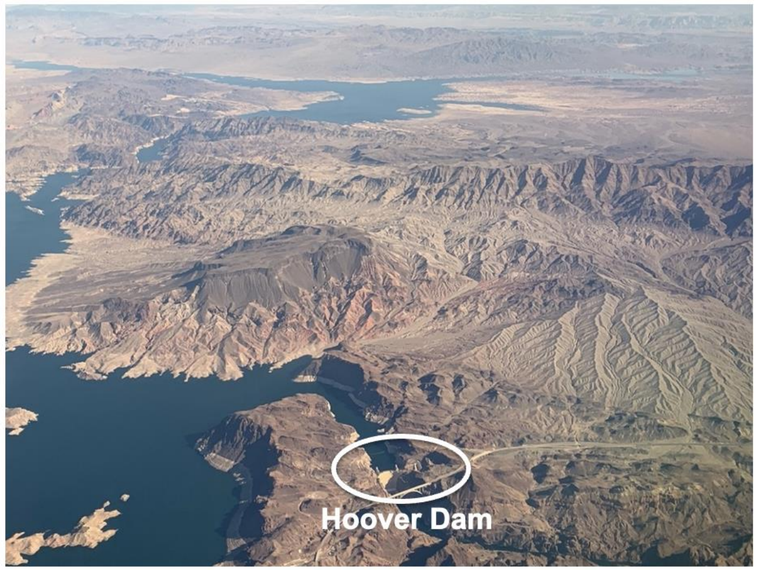


Photo: SB Megdal-Dec.2022

Snowpack vs. Runoff (% of average)		
	Snowpack	Runoff
2020	105%	61%
2021	86%	37%
2022	90%	63%
2023	161%	140%
2024	114%	83%

Figuring out how to share shortage

Family Farm ALLIANCE®

PROTECTING WATER FOR WESTERN IRRIGATED AGRICULTURE

Dated 6 August 2025

ISSUE ALERT!

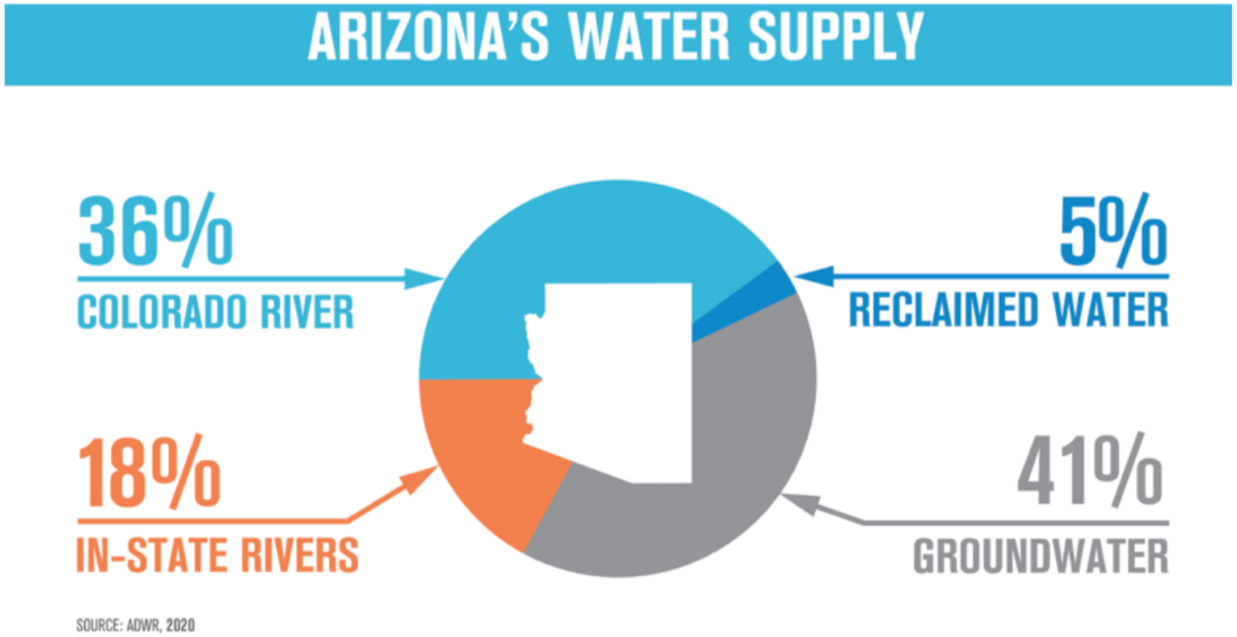
Standing Up for Colorado River Agriculture

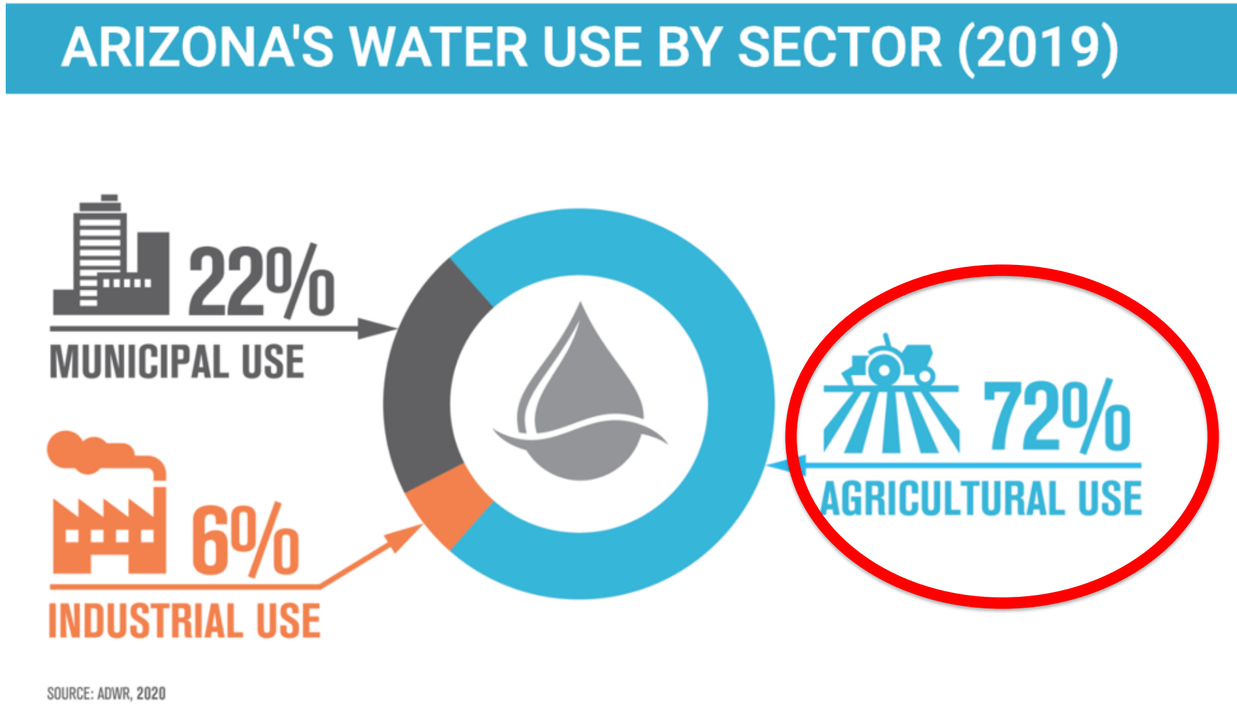
As Colorado River negotiations move toward a new era of policy, the Family Farm Alliance is working to ensure that irrigated agriculture remains a central pillar in the conversation—and in the Basin's future.

Farmers and ranchers throughout the Colorado River Basin provide far more than food. They deliver open space, wildlife habitat, groundwater recharge, and economic stability for rural communities. In regions like Yuma, Arizona—where 90% of the nation's winter leafy greens are grown—irrigated agriculture is not only efficient, it's indispensable.

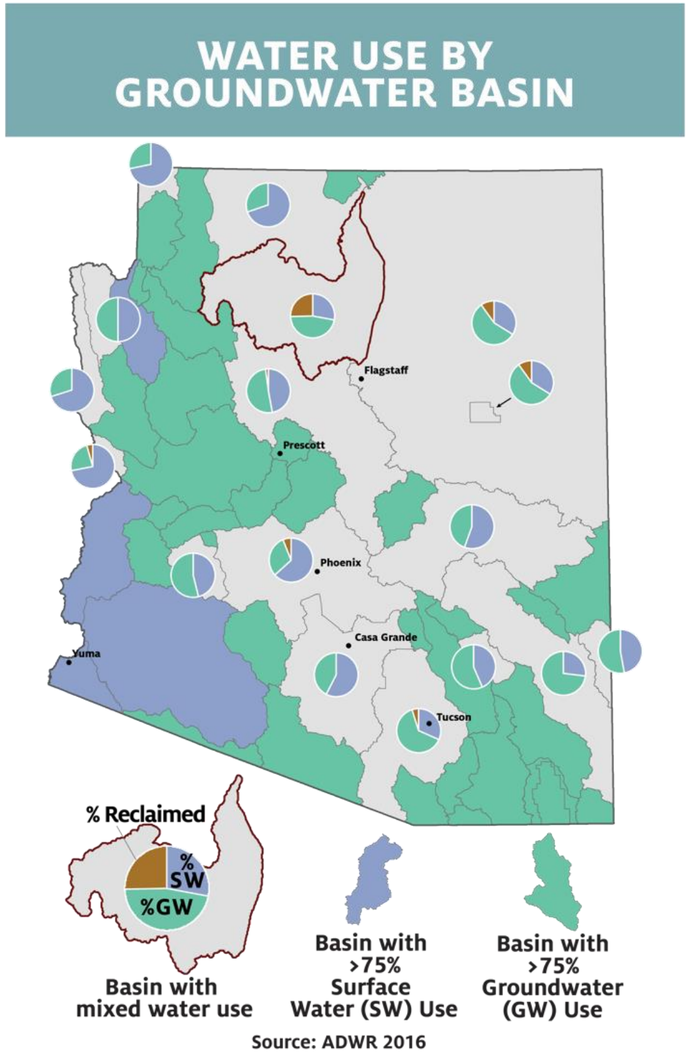
The unified message of Colorado River Basin (Basin) agriculture is simple: our food system depends on the enduring productivity of irrigated agriculture. Keeping water on farms isn't just good policy—it's a matter of national food security.

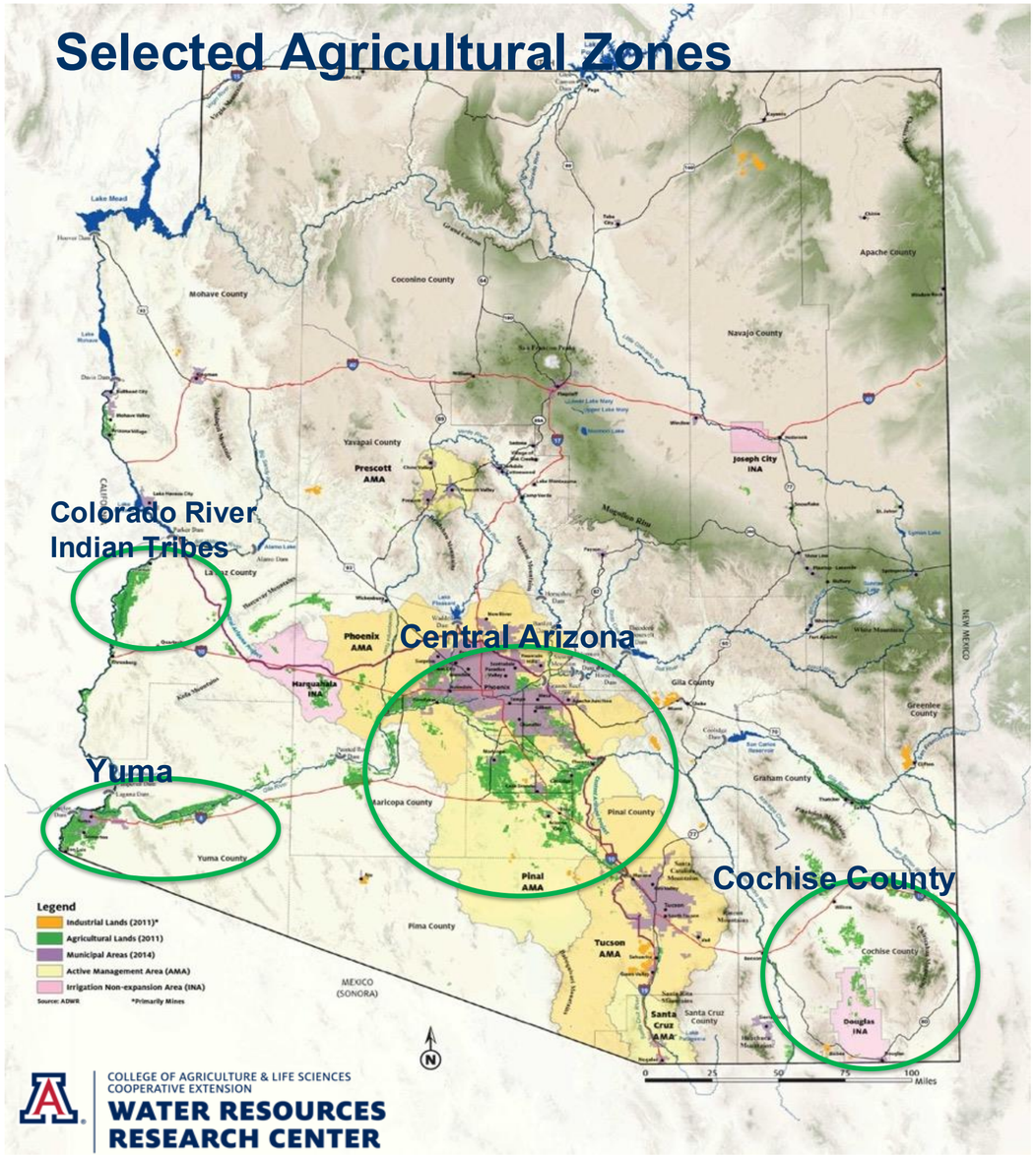
Arizona’s water sources and demand





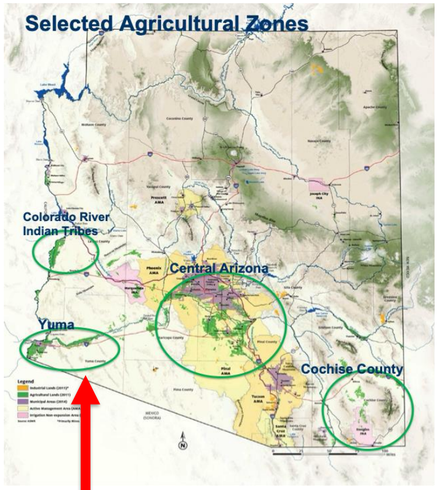
Water situations vary across Arizona





Yuma Area

- Borders the Colorado River
- Very close to Mexican border
- Very little rainfall annually
- Senior rights to Colorado River water (surface water)
- Large agri-business enterprises
- In the winter months, they grow high-value vegetables and provide much of the United States and Canada with their leafy green vegetables in the winter



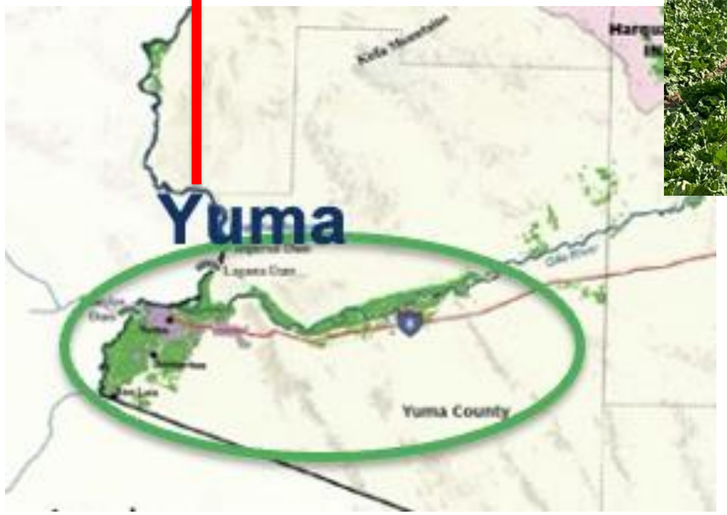
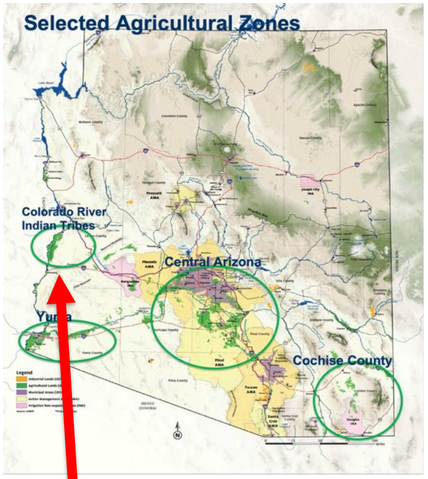


Photo: SB Megdal

Colorado River Indian Tribes (CRIT)

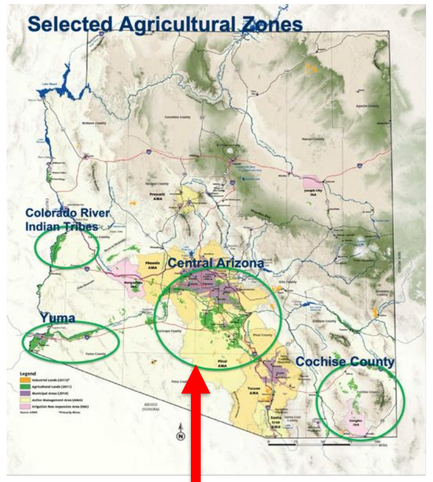
- Sovereign Tribal Nation
- Their lands span the Colorado River
- Very senior rights to Colorado River water
- Grow alfalfa, cotton, sorghum, and other crops but not leafy green vegetables grown in the Yuma region
- Have been involved in efforts to conserve water to leave in Lake Mead
- Top right photo is cotton grown with drip irrigation



Photos: Josh Moore
CRIT Farm Manager
https://wrrc.arizona.edu/sites/wrrc.cals.arizona.edu/files/2022-09/Josh-Moore-CRIT-N-Drip-Trial.pdf

Central Arizona

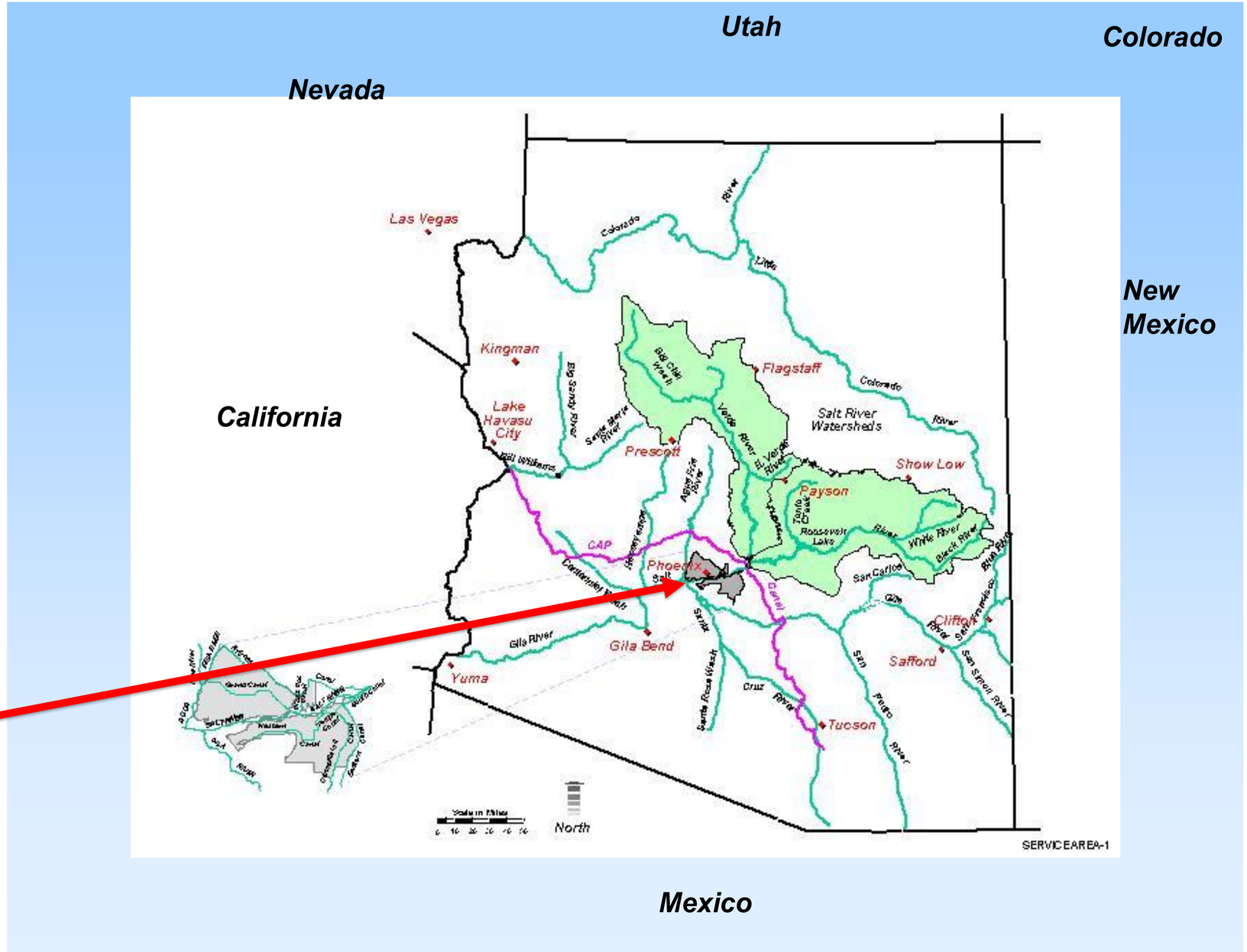
- Historical reliance on groundwater
- Then Colorado River water became a key water source
- Very little Colorado River water is now available to Central AZ ag due to reduced river flows.
- Returning to groundwater, but groundwater supplies are finite, and much land is owned by those expecting to develop it for housing and other land uses.
- Alfalfa and cotton are primary crops



Photos: SB Megdal

Salt River Project (SRP) Watershed

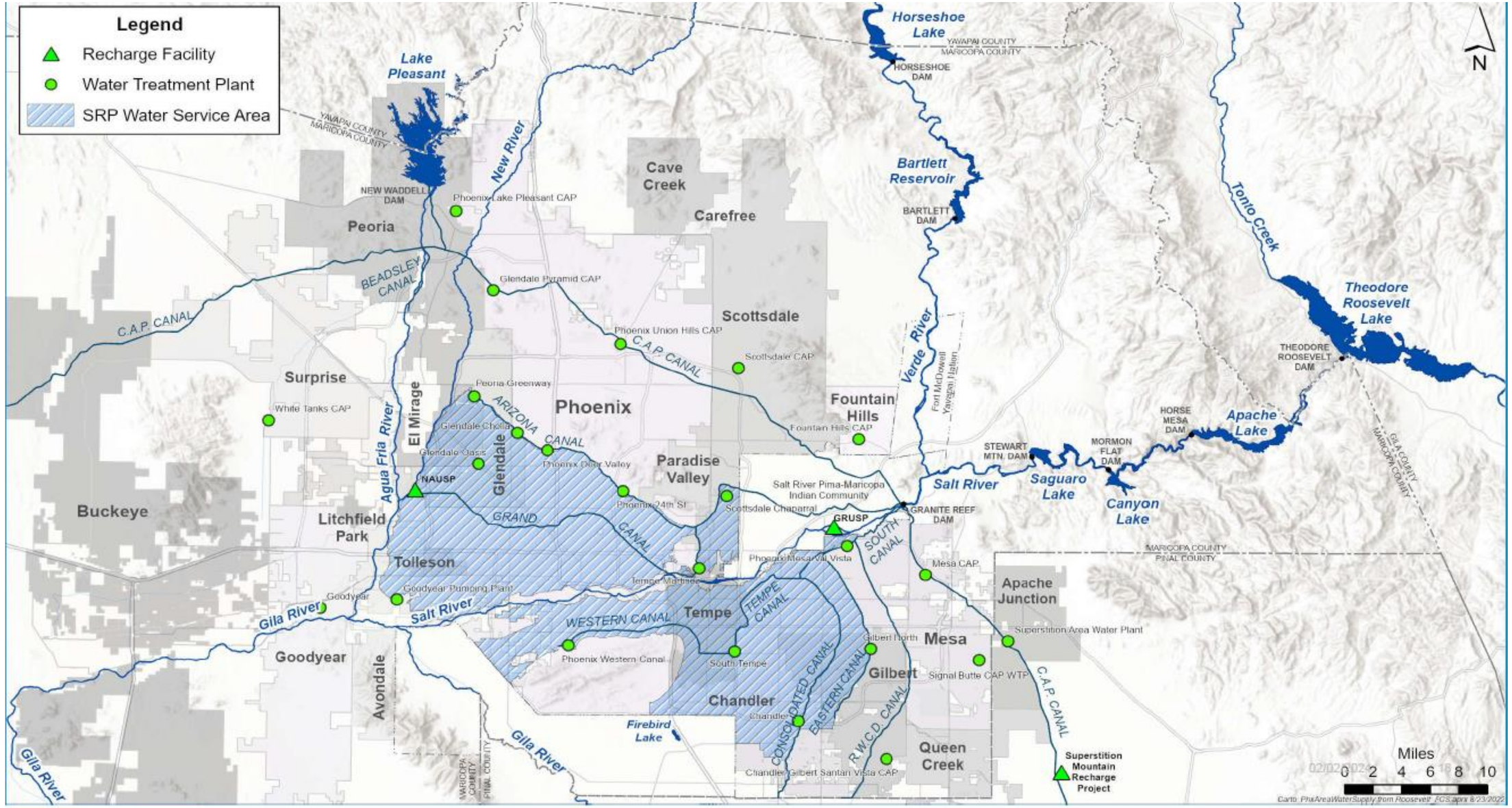
Water delivery area is gray.



Watershed is green.

Slide Source: SRP

Salt River Project Service Area (gray)

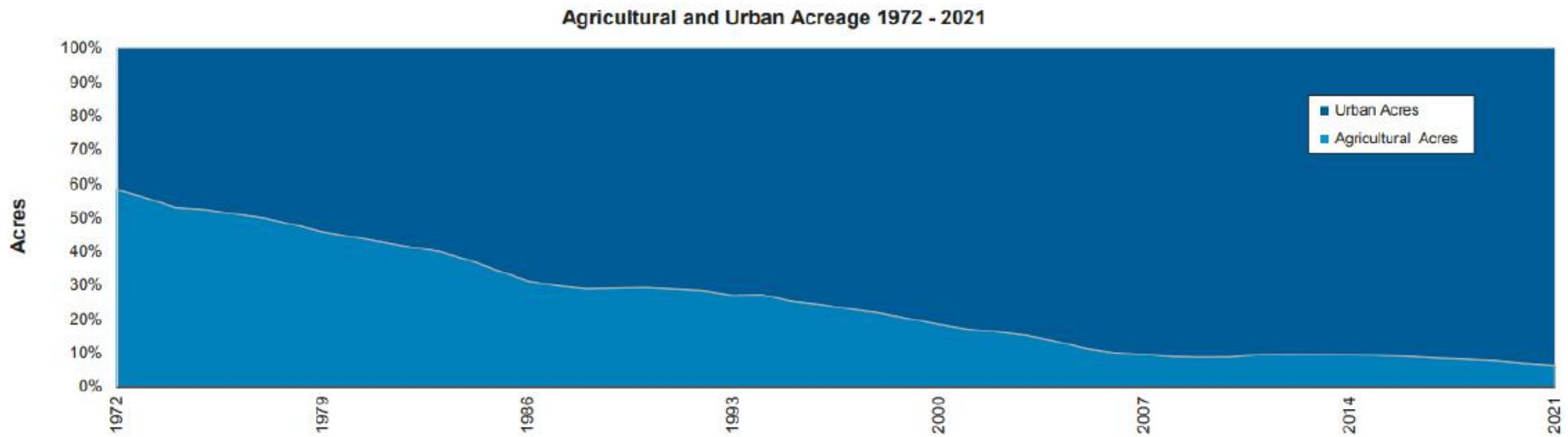


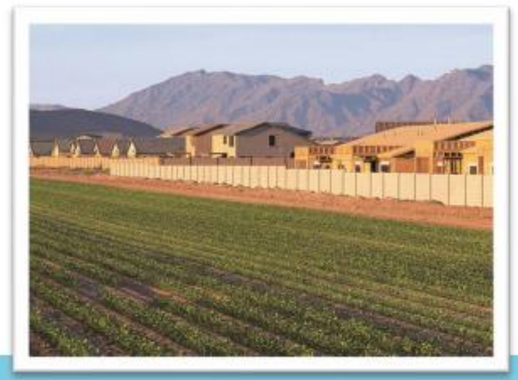
Slide Source: SRP

SRP lands are now highly urbanized

SRP Lands Are More than 90% Urban

Major transition from agricultural to urban land use from 1972 - 2021





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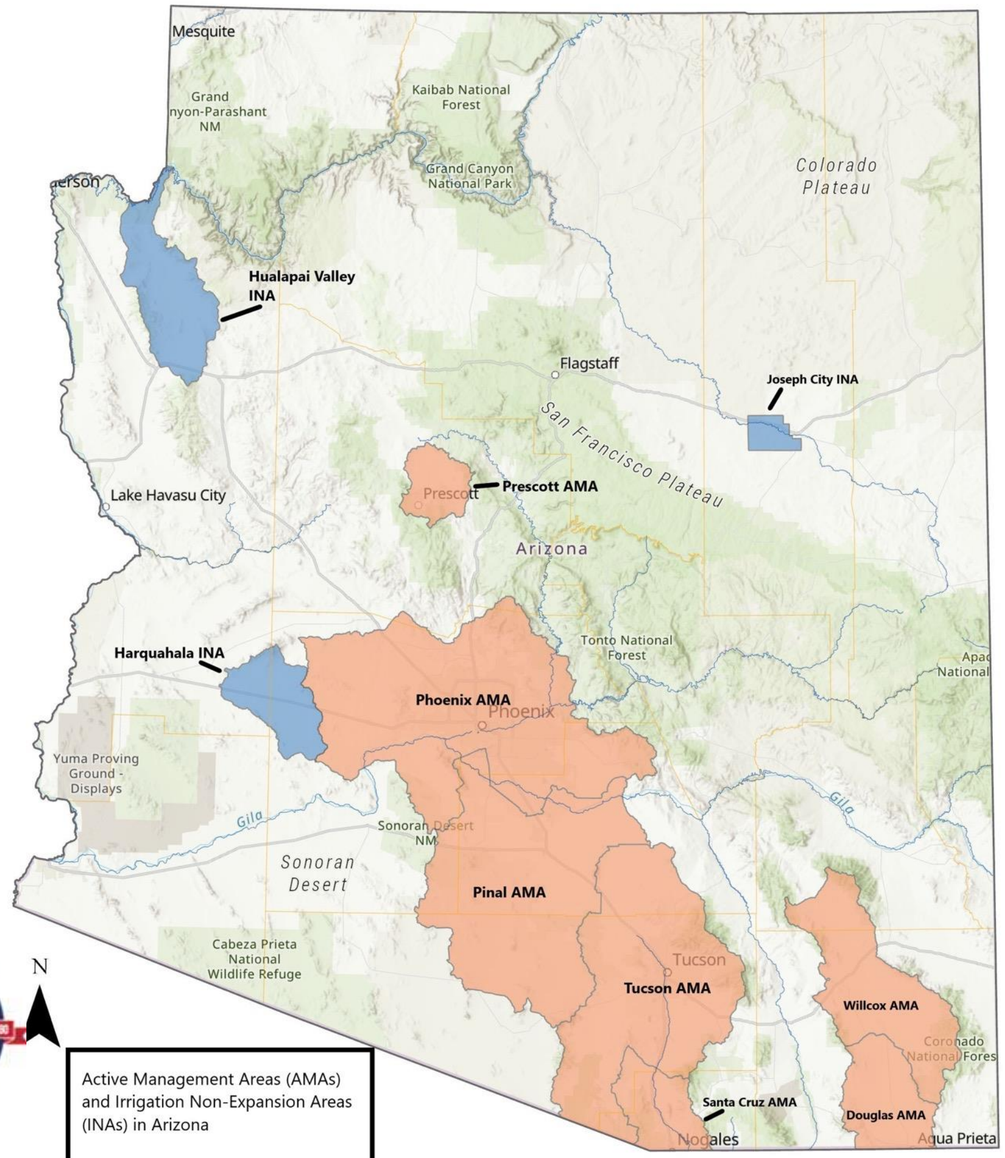
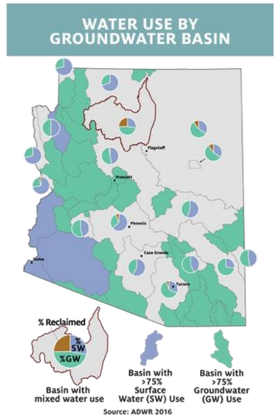
Slide Source: SRP



Active Management Areas (AMAs) and Irrigation Non-Expansion Areas (INAs) in Arizona

Groundwater is regulated in Active Management Areas (AMAs)

Agricultural footprint cannot expand in AMAs and in Irrigation Non-expansion Areas (INAs)



Cochise County

- Reliant on groundwater, which is in limited supply
- Groundwater use recently regulated in parts of the county; in other parts groundwater use is unregulated.
  - Where it is regulated, agriculture's footprint cannot increase
- A major policy issue for Arizona is what to do to manage groundwater in several rural, agriculturally dominated groundwater basins.

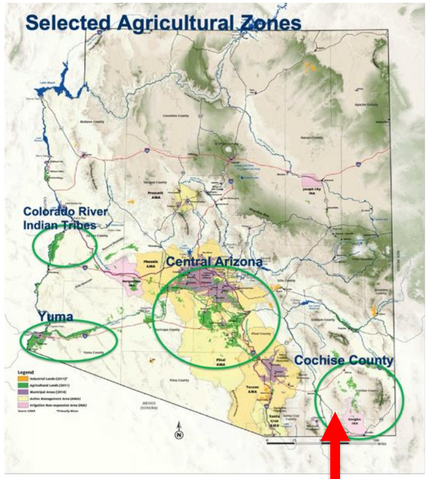
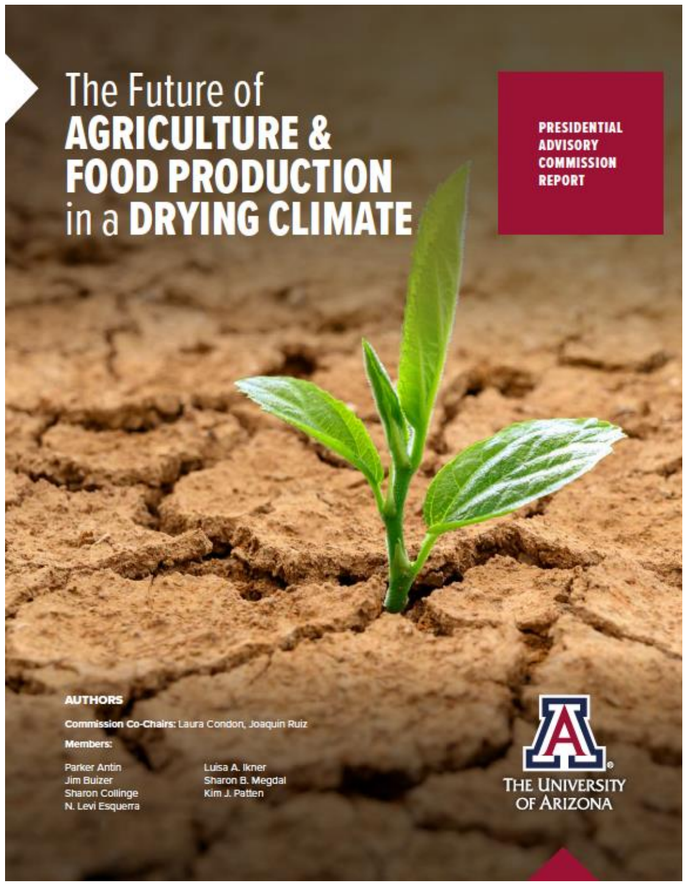


Photo: SB Megdal

Ed Curry and Sharon Megdal

Curry Seed and Chile Co.

2023 University Commission Report



https://wrrc.arizona.edu/publication/future-agriculture-food-production-drying-climate

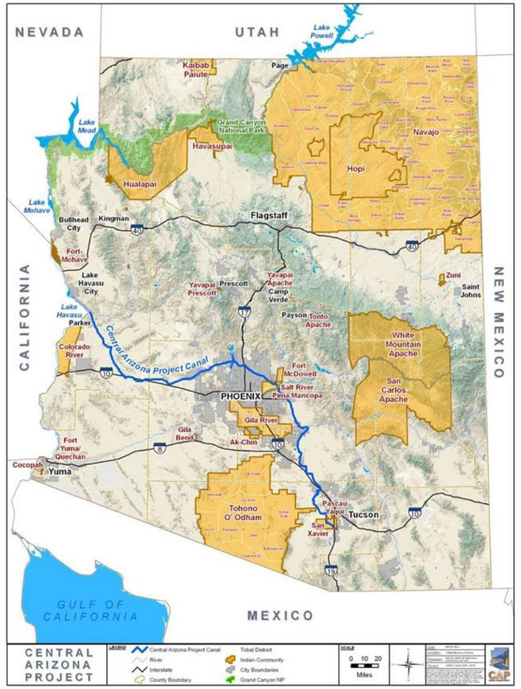
Tasked with recommending concrete steps the University of Arizona can take to position the State of Arizona as a global leader in climate-resilient sustainable agricultural and food production technology and practices.

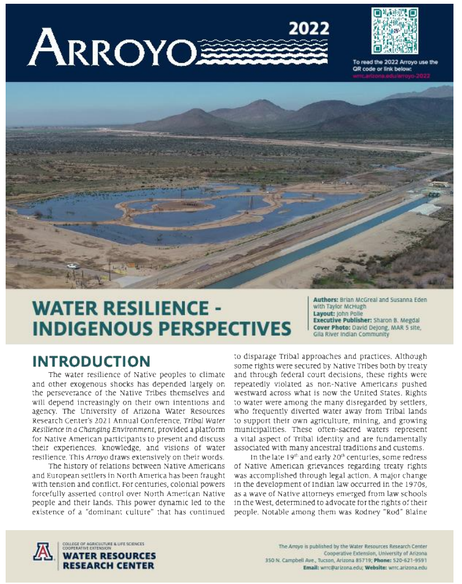
Threats

- Growing food with less water in a hotter climate
  - Reduced availability and increased competition for water
  - Decline in soil quality, biodiversity, product yield and quality
- Socioeconomic and cultural concerns
  - Loss of the agricultural land, workforce and communities
- Impediments to adaptation
  - Siloed, inflexible policies
  - Lack of systems thinking, R&D investment

Five recommendations

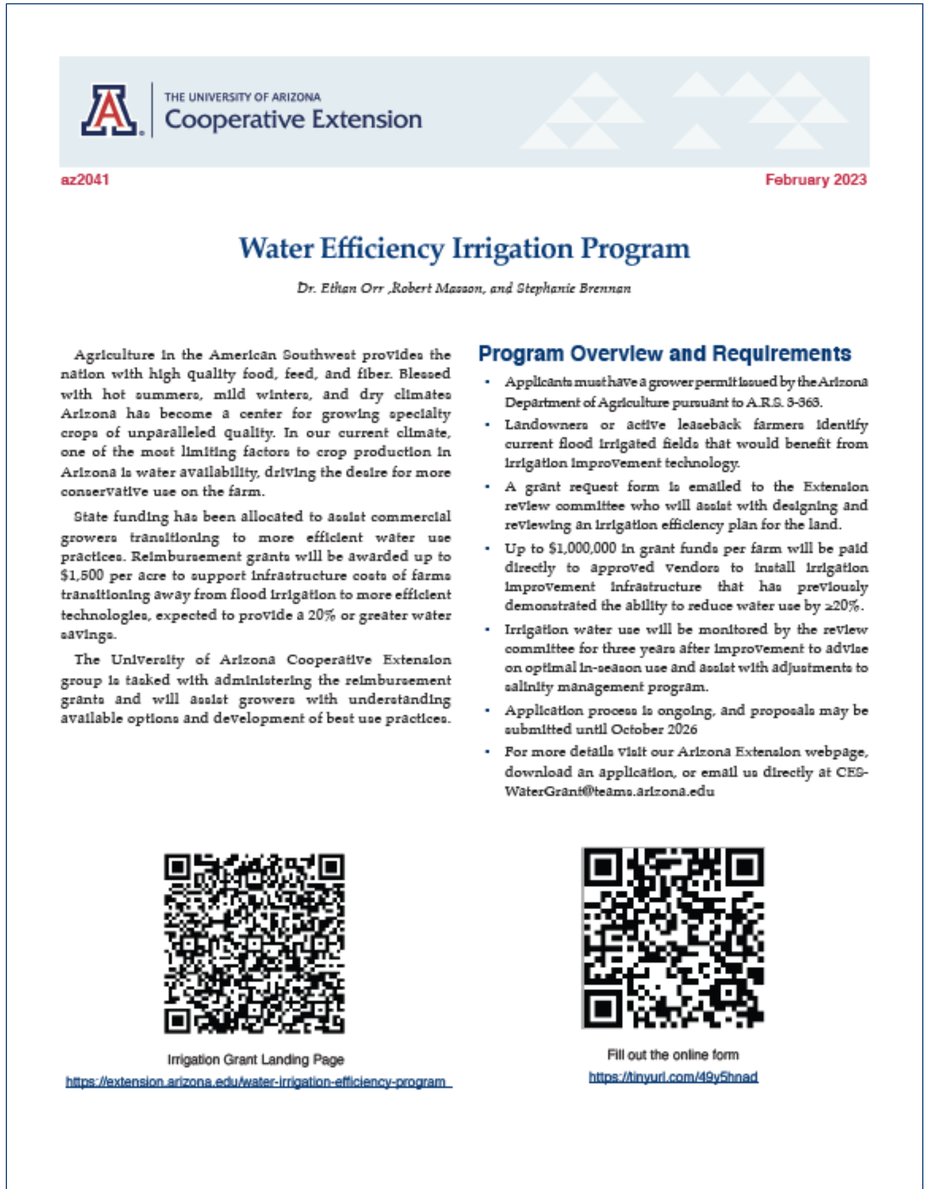
1. Create an integrated, interdisciplinary, and solutions-oriented unit that is centered at the intersection of food, water, and agriculture systems.
2. Create a Center for Soil Health to recognize the importance of maintaining and restoring soil health through regenerative practices.
3. Create/strengthen technology and innovation hubs at existing University of Arizona agricultural facilities.
   - Example: Yuma Center for Excellence in Desert Agriculture, a university-private sector partnership
4. Expand partnerships with Tribal agriculture.
5. Establish new and strengthen existing collaborations with institutions in arid regions around the world.





Water Efficiency Irrigation Program – administered by Cooperative Extension

- Reimbursement grants will be awarded up to $1,500 per acre to support infrastructure costs of farms transitioning away from flood irrigation to more efficient technologies, expected to provide a 20% or greater water savings.
- University personnel are administering the grant funds and providing analysis of results.



THE UNIVERSITY OF ARIZONA
Cooperative Extension

az2041 February 2023

Water Efficiency Irrigation Program

Dr. Ethan Orr ,Robert Masson, and Stephanie Brennan

Agriculture in the American Southwest provides the nation with high quality food, feed, and fiber. Blessed with hot summers, mild winters, and dry climates Arizona has become a center for growing specialty crops of unparalleled quality. In our current climate, one of the most limiting factors to crop production in Arizona is water availability, driving the desire for more conservative use on the farm.

State funding has been allocated to assist commercial growers transitioning to more efficient water use practices. Reimbursement grants will be awarded up to $1,500 per acre to support infrastructure costs of farms transitioning away from flood irrigation to more efficient technologies, expected to provide a 20% or greater water savings.

The University of Arizona Cooperative Extension group is tasked with administering the reimbursement grants and will assist growers with understanding available options and development of best use practices.

Program Overview and Requirements

- Applicants must have a grower permit issued by the Arizona Department of Agriculture pursuant to A.R.S. 3-365.
- Landowners or active leaseback farmers identify current flood irrigated fields that would benefit from irrigation improvement technology.
- A grant request form is emailed to the Extension review committee who will assist with designing and reviewing an irrigation efficiency plan for the land.
- Up to $1,000,000 in grant funds per farm will be paid directly to approved vendors to install irrigation improvement infrastructure that has previously demonstrated the ability to reduce water use by ≥20%.
- Irrigation water use will be monitored by the review committee for three years after improvement to advise on optimal in-season use and assist with adjustments to salinity management program.
- Application process is ongoing, and proposals may be submitted until October 2026
- For more details visit our Arizona Extension webpage, download an application, or email us directly at CES-WaterGrant@teams.arizona.edu

Irrigation Grant Landing Page
https://extension.arizona.edu/water-irrigation-efficiency-program

Fill out the online form
https://tinyurl.com/49y5hnad

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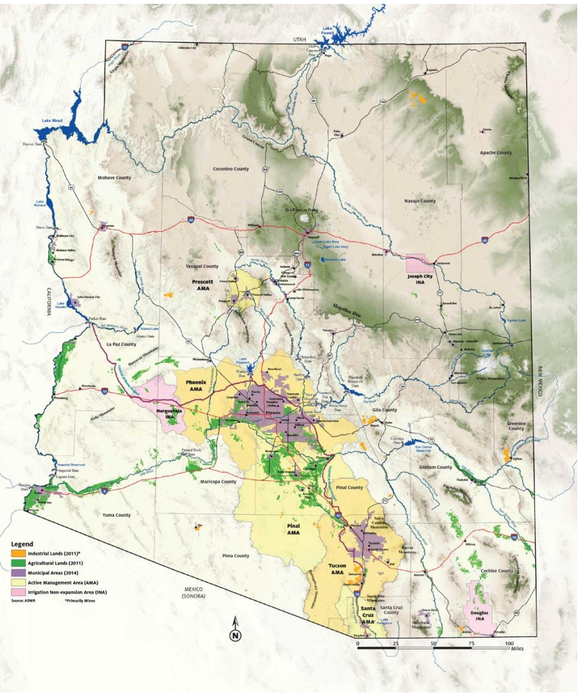
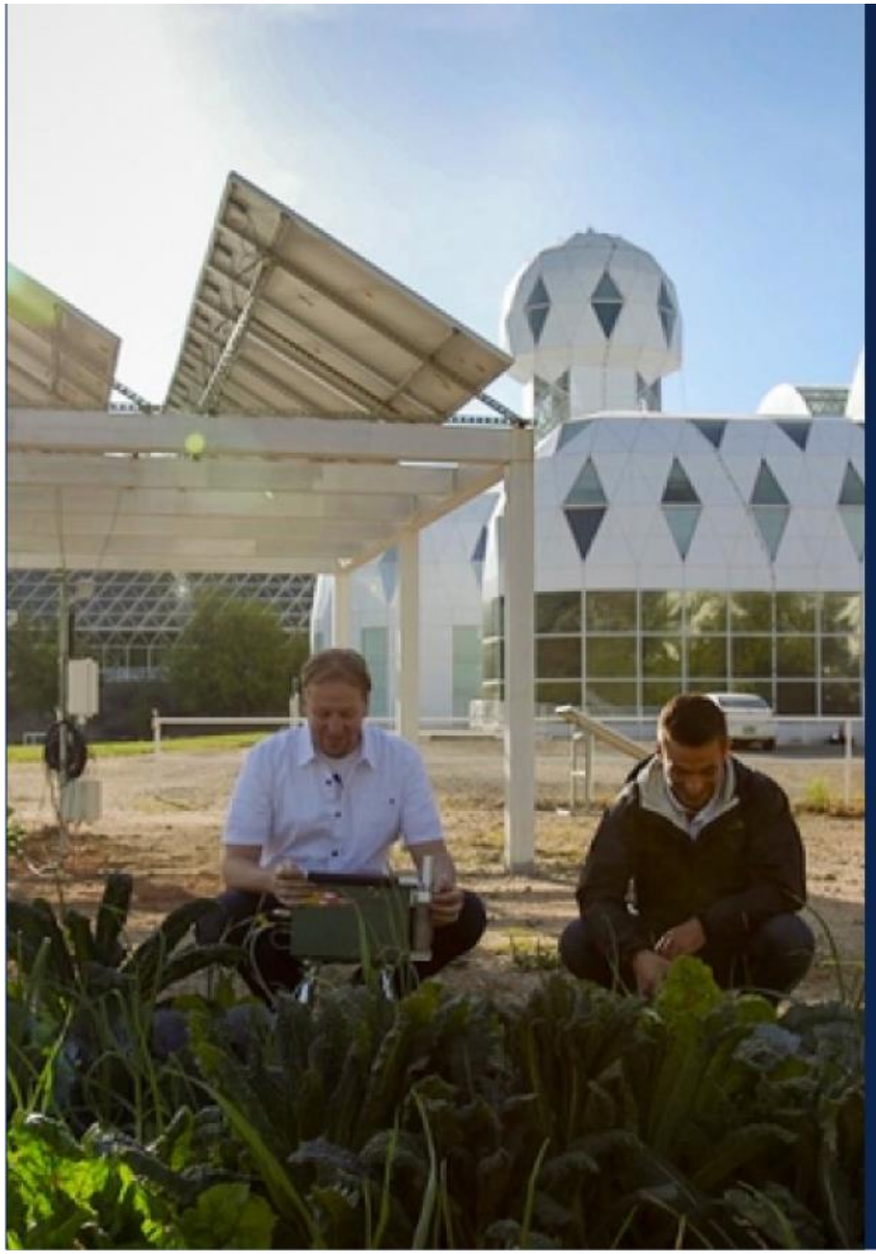
As of March 2025



On-Farm Irrigation Funding In US Dollars

- $30,000,000 American Recovery Grant
- $16,515,088 Private Sector
- $15,200,000 Arizona State Legislature
- **Total Project $61,715,088**



OPPORTUNITIES FOR GLOBAL LEADERSHIP

- Produce and provide research-based solutions
- Develop future leaders, thinkers and doers
- Engage with stakeholders to jointly arrive at implementable solutions
- Spearhead efforts to ensure Arizona's resilience to future climate, economic and policy shocks in the food and agricultural production sector

THE UNIVERSITY OF ARIZONA

Agrivoltaics

AGRIVOLTAICS

Partnerships!

Much Collaboration in all these areas, but will focus on a special one:
the Kasser Joint Institute for Food, Water, and Energy Security (KJI), a partnership of JNF-USA, the Univ of AZ and the Arava Region of Israel

https://jointinstitute.jnf.org/

AGRICULTURE IN ARID CONDITIONS

Summary of impacts to agriculture from water supply challenges

- Central Arizona farmers are having to adjust to less Colorado River water availability
  - Guayule, a rubber substitute, is being grown by some
  - Land fallowing is occurring
  - Return to groundwater, but some investment is required
  - Interest in farmlands for future urban-suburban development but pace of development is uncertain, even with some recent legislation
  - Interest in farmlands for solar development
- Yuma area agriculture is expected to continue to focus on leafy green vegetables
- Farming is expected to continue on tribal lands
- Groundwater management changes may occur in other parts of Arizona, but there are policy/political disagreements on the details
- Opportunities to implement more efficient irrigation practices

Innovation + Collaboration => Adaptation

SB Megdal case study in *Handbook of Water Diplomacy* (in press)

THE UNIVERSITY OF ARIZONA COOPERATIVE EXTENSION
WATER RESOURCES RESEARCH CENTER

Seven factors contributing to successful outcomes:

1. A functioning mechanism for cooperation, including knowledge co-production
2. Mutual respect contributing to trust
3. Involvement of interested parties (stakeholders)
4. Good communication
5. Persistence and Patience
6. Eating with your partners
7. Leadership

Additional factors:
Transparency
Sharing Lessons Learned (+ and -)

https://wrrc.arizona.edu/publication/prepublication-excerpt-factors-contribute-successful-diplomatic-outcomes-case-study

THANK YOU!

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Congreso Aapresid | CON LA FUERZA DE Expoagro

CÓDIGO ABIERTO

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