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Natural Resources Conservation Service

Irrigation Conservation and Efficiency

Arizona Water Resources Research Center Conference, March 28, 2017

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Part 1:

Arizona Irrigation in a National Perspective

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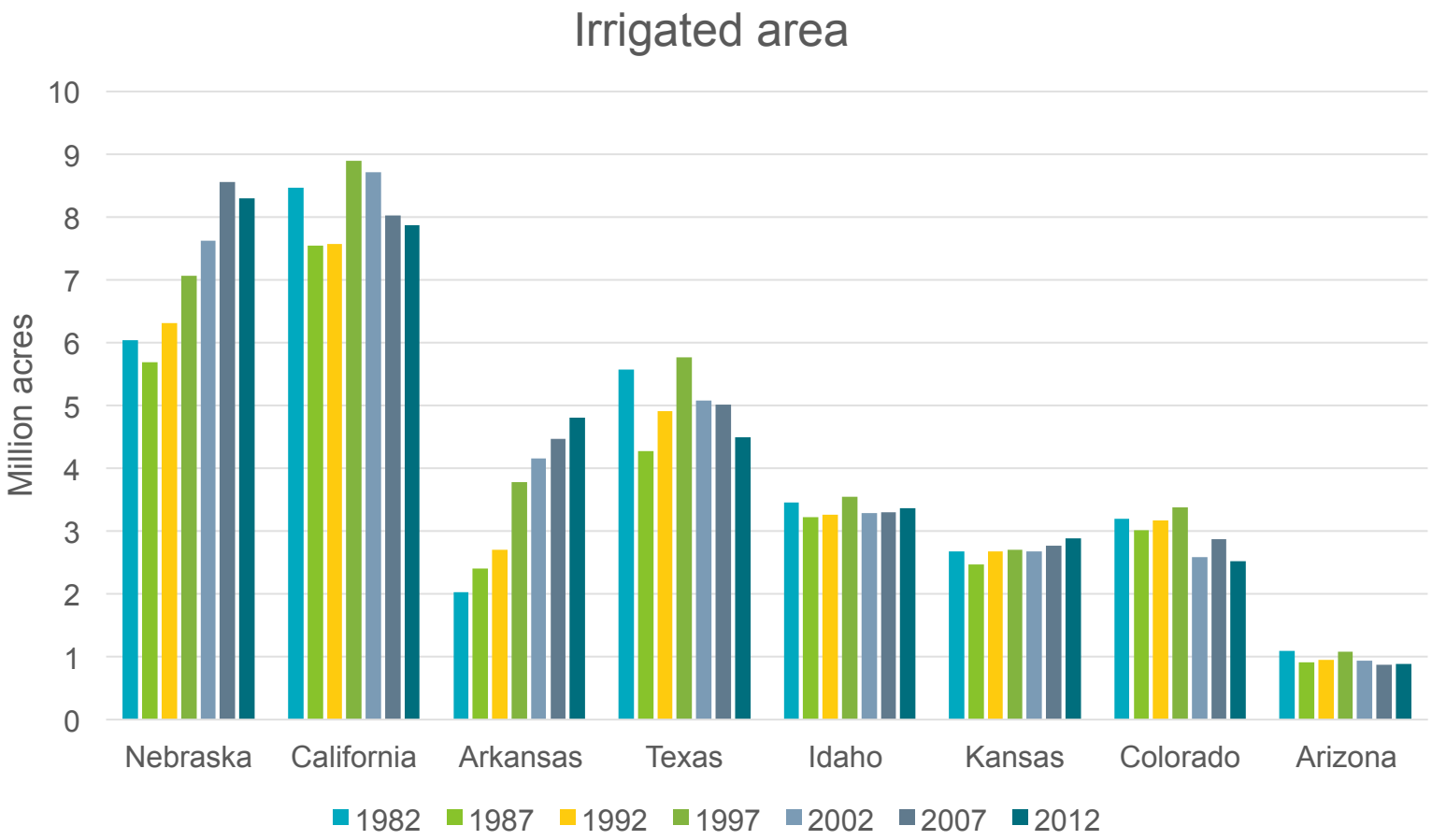
7 States account for 60% of irrigated area



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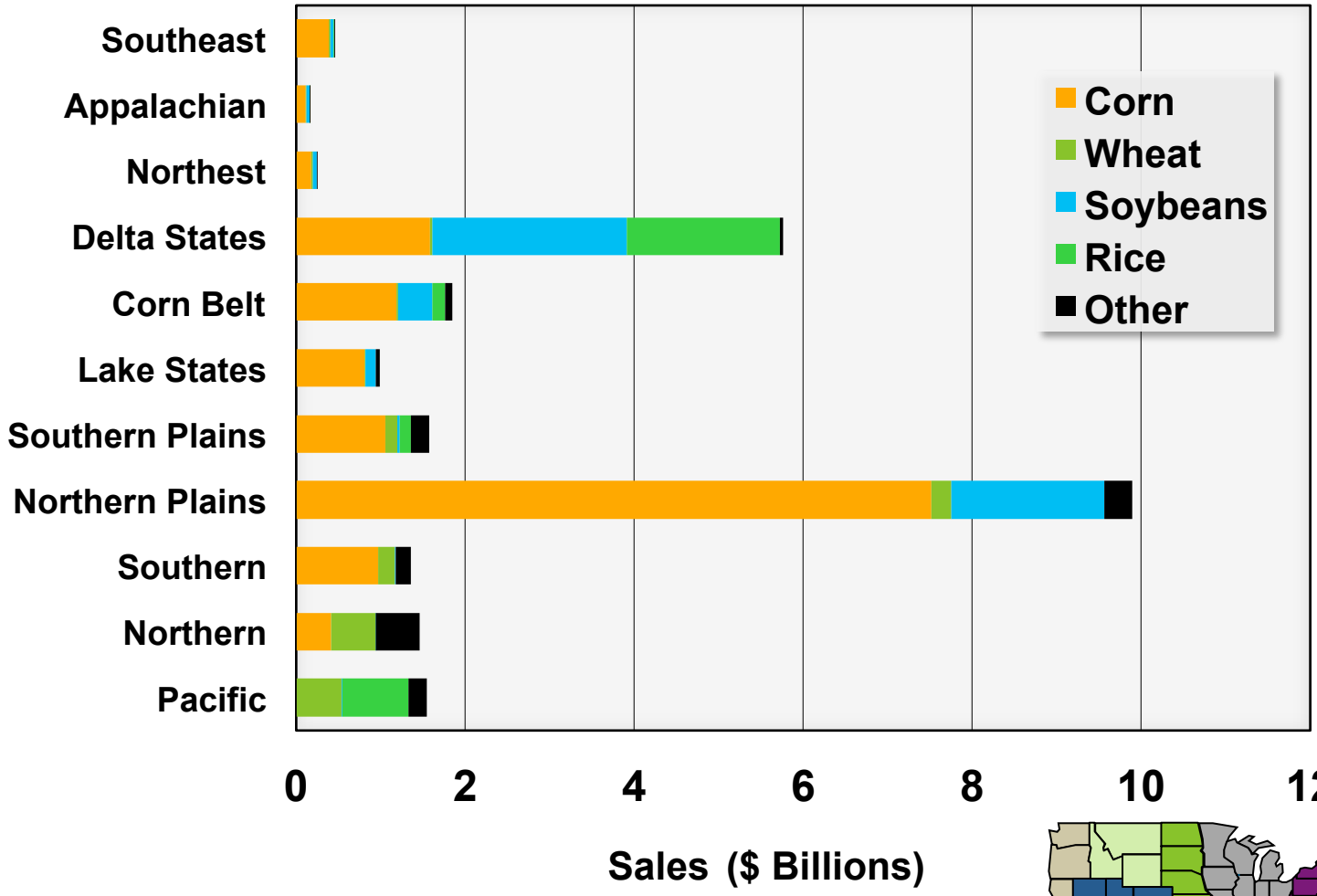
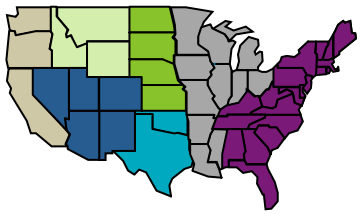
Estimated sales for irrigated grain crops, 2012





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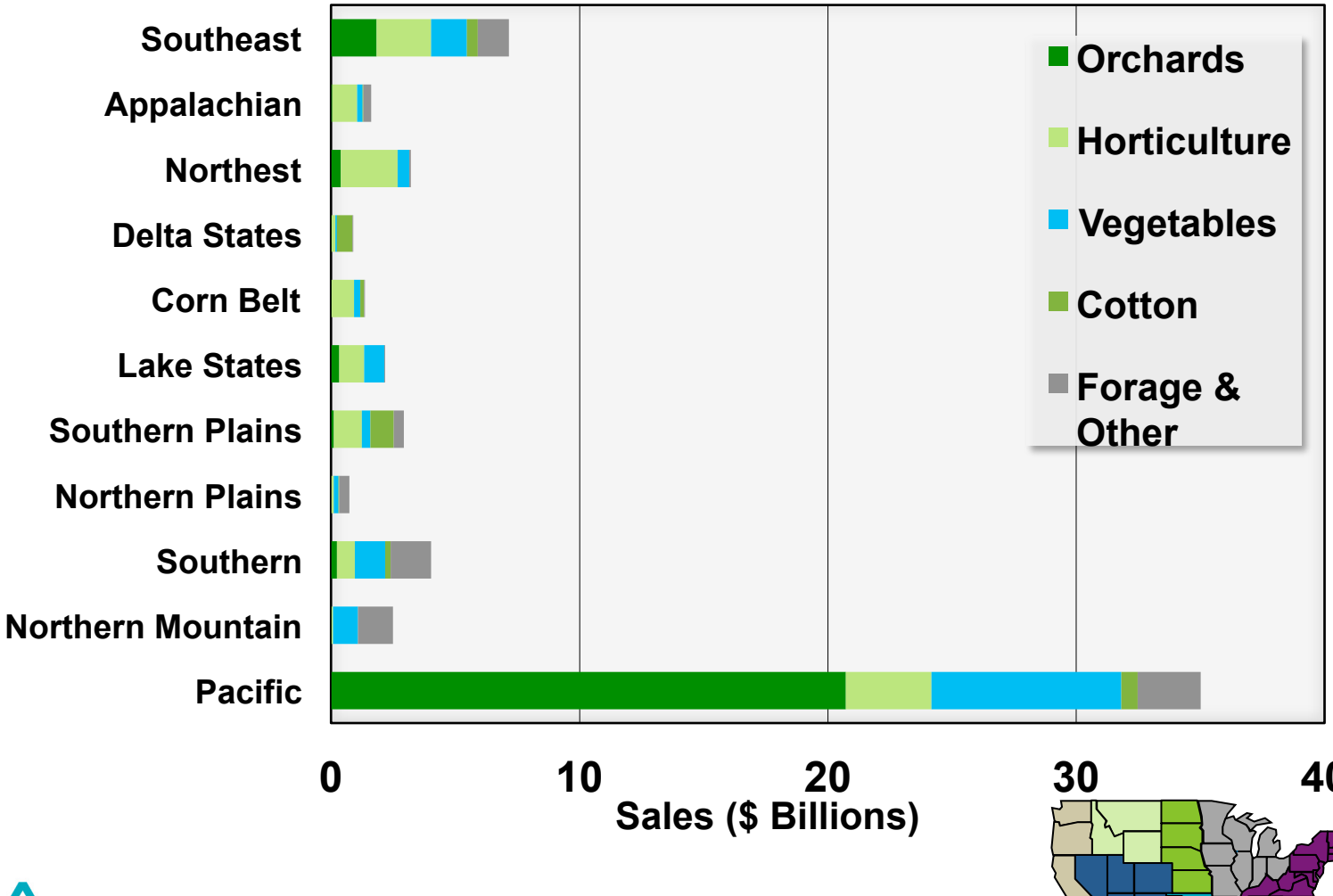
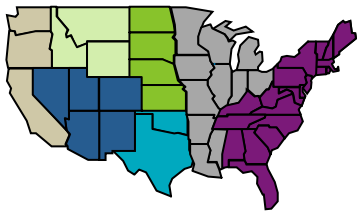
Source: NRCS analysis of NASS 2012 Census of Agriculture data

Estimated sales for irrigated non-grain crops, 2012





Source: NRCS analysis of NASS 2012 Census of Agriculture data

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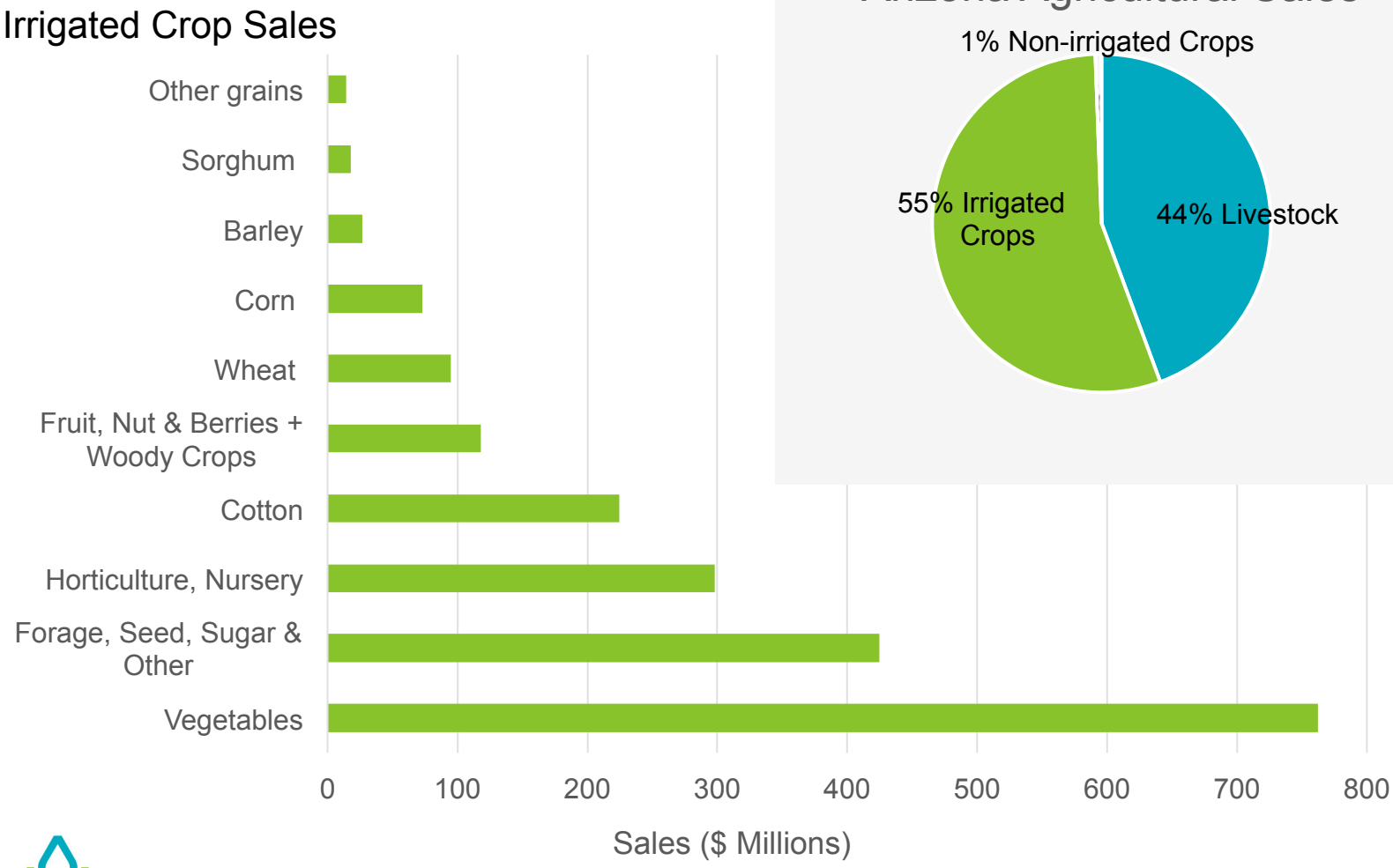
Estimated Ag sector and irrigated crop sales for Arizona, 2012



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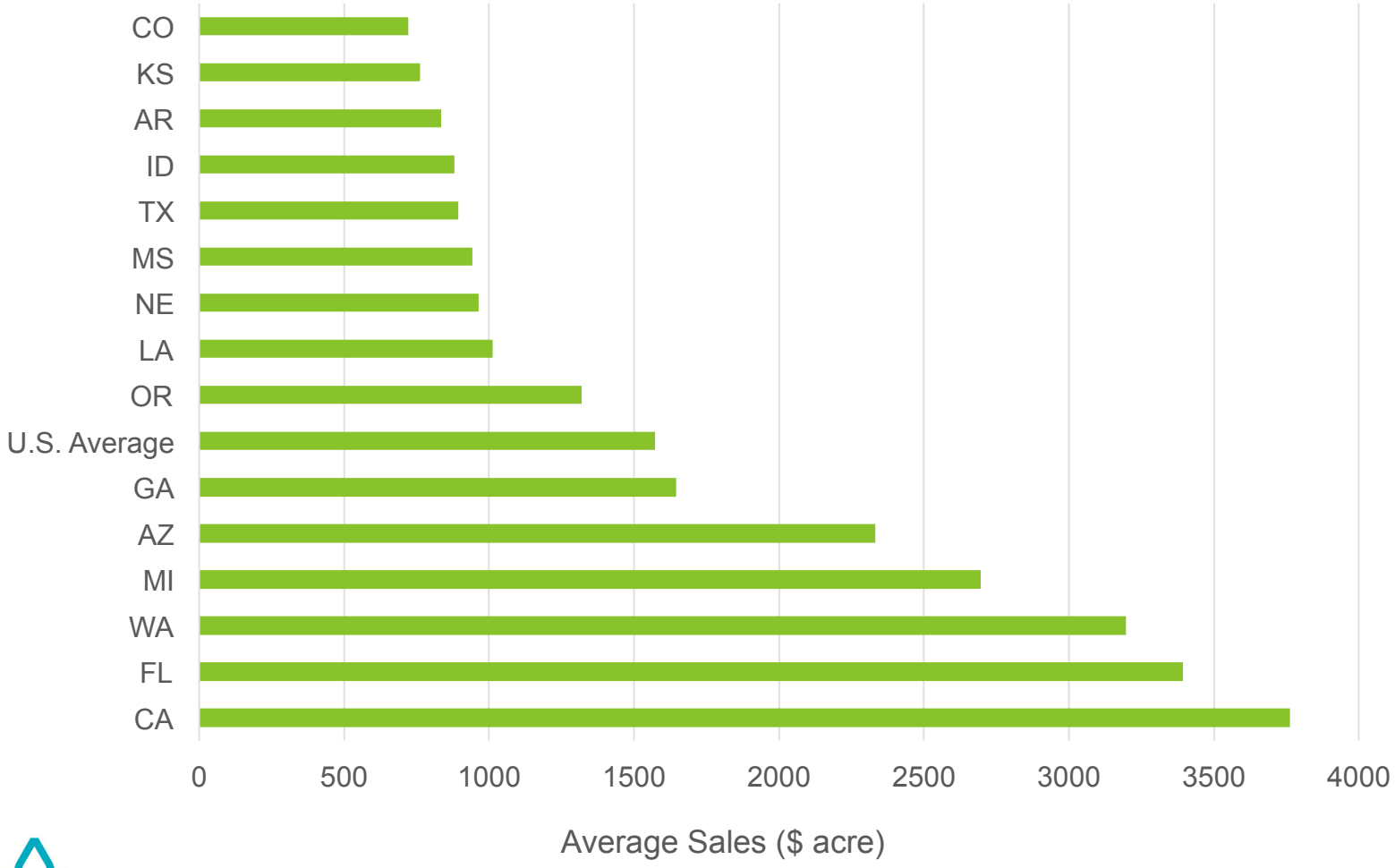
Source: NRCS analysis of NASS 2012 Census of Agriculture data

Estimated per acre irrigated crop sales, 2012

Per acre Irrigated Crop Sales for highest sales states



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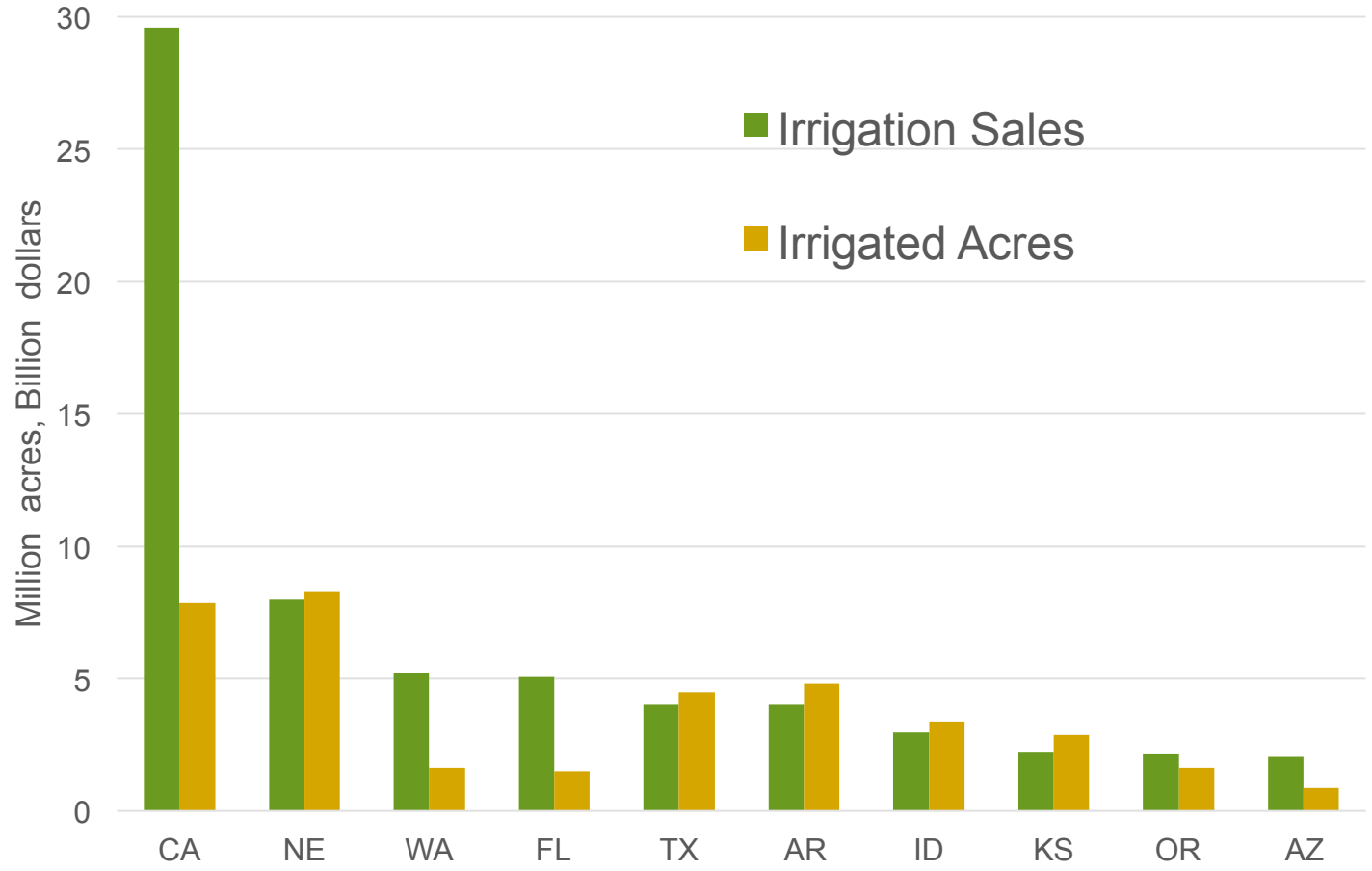
Source: NRCS analysis of NASS 2012 Census of Agriculture data

U.S. Irrigated sales with acres, leading states, 2012



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Source: NRCS analysis of NASS 2012 Census of Agriculture data

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Part 2:

Irrigation Water Conservation and Efficiency

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Irrigation conservation and efficiency

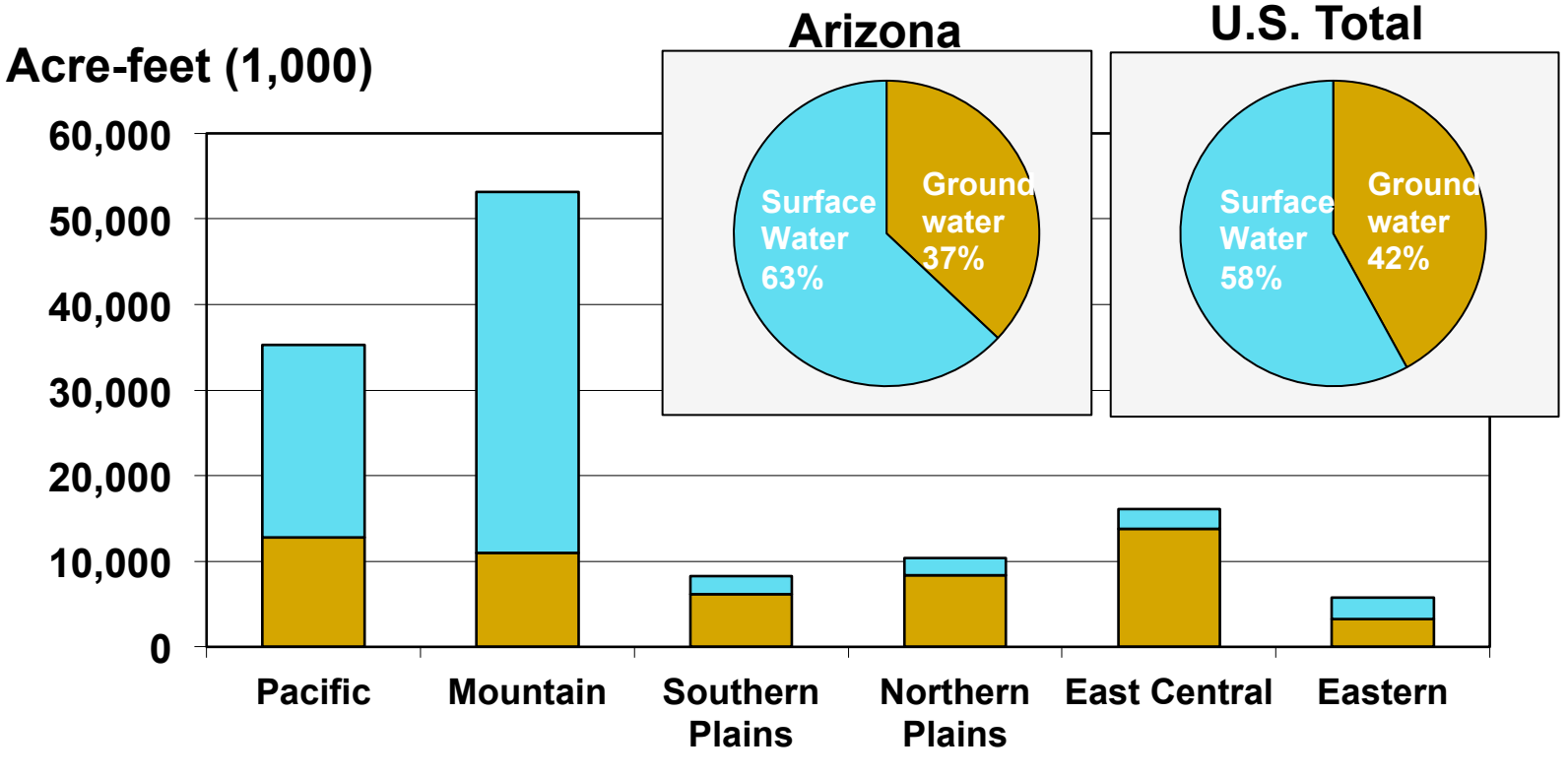
Irrigation conservation

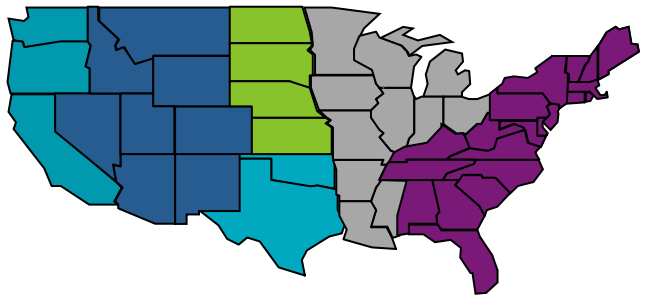
- Not a clear definition
- Is it a reduction in water diverted or applied or consumed?
- Is it producing more with the same water application (increased output with no change in water)?

Irrigation efficiency

- Engineering definition
- Improvement often with new technology or improved water management
- Improved efficiently is achievable
- “Good” thing to do

Surface water most important in west, Ground water everywhere





Source: NRCS analysis of USGS 2010 Water Use data

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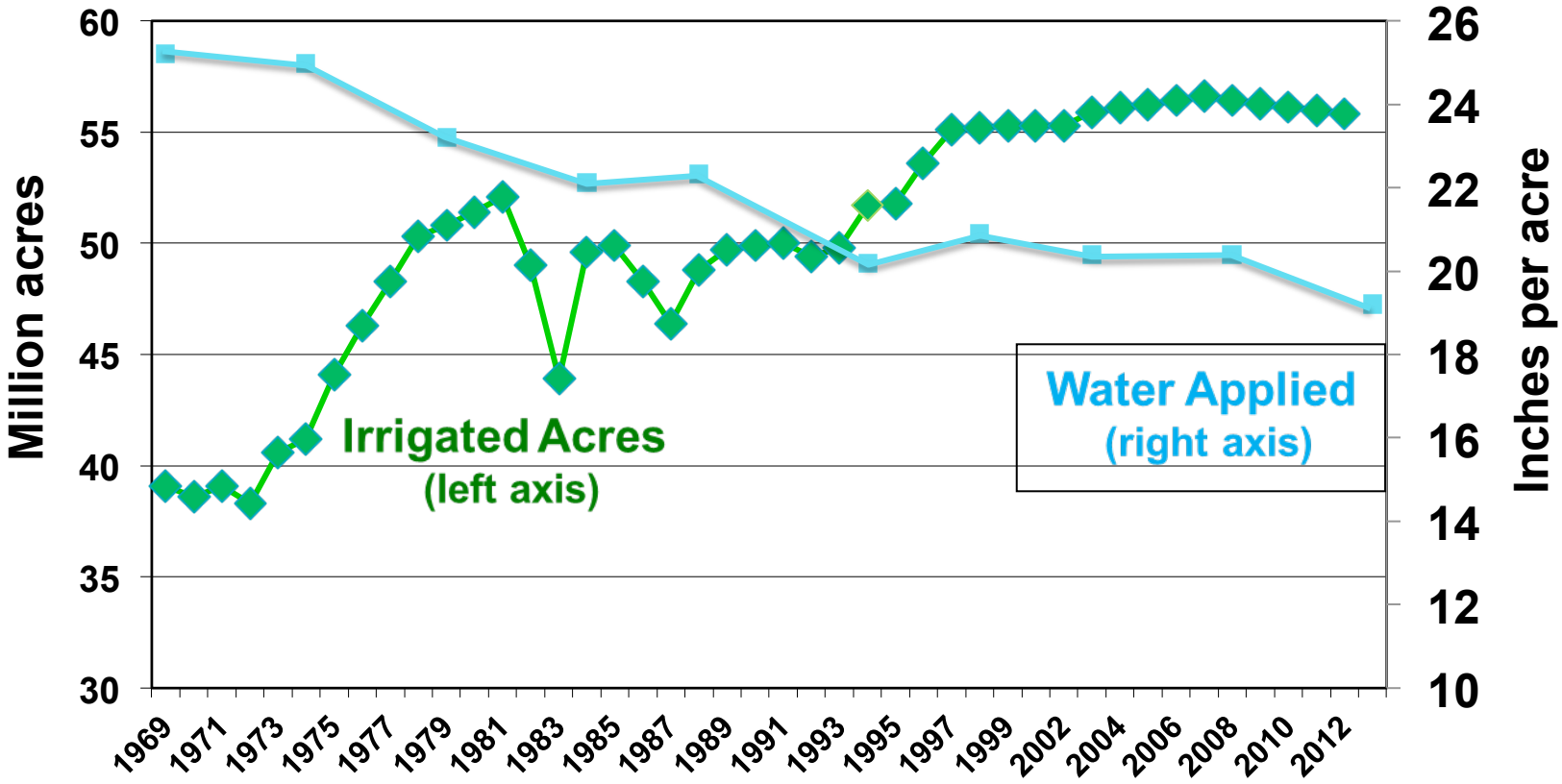
U.S. irrigated acres & water applications



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How was reduction in applied water accomplished?

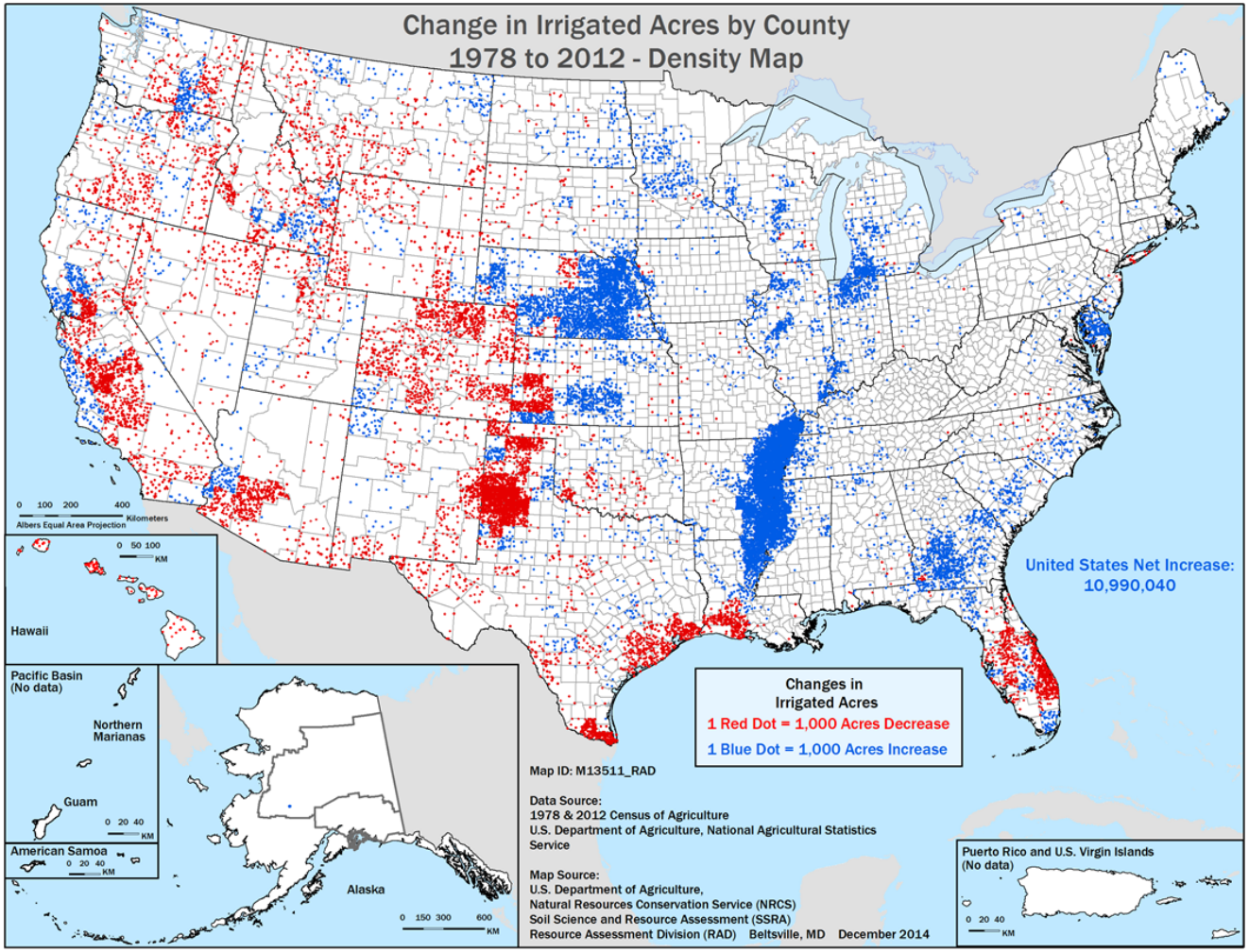
Location, location, location

- Reduced acres in higher application areas (Southwest)
- Increased acres in lower application areas (Southeast & Northern Plains)

Improved, more efficient management and technology

- Environmental Externalities
- Irrigation Externalities

Change in U.S. Irrigated Acres location 1978-2012



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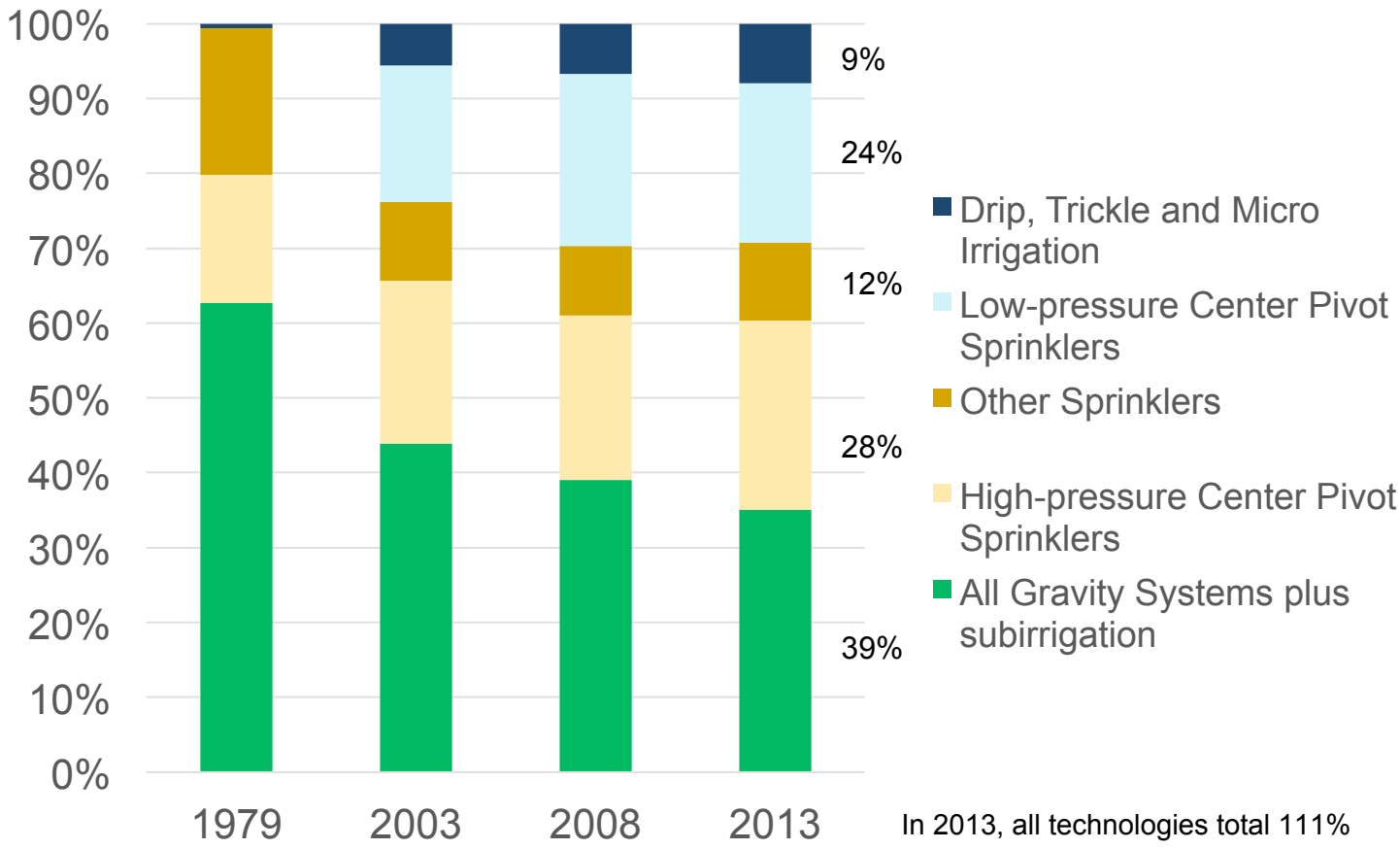
Changing Irrigation Application Technology



In 2013, all technologies total 111%

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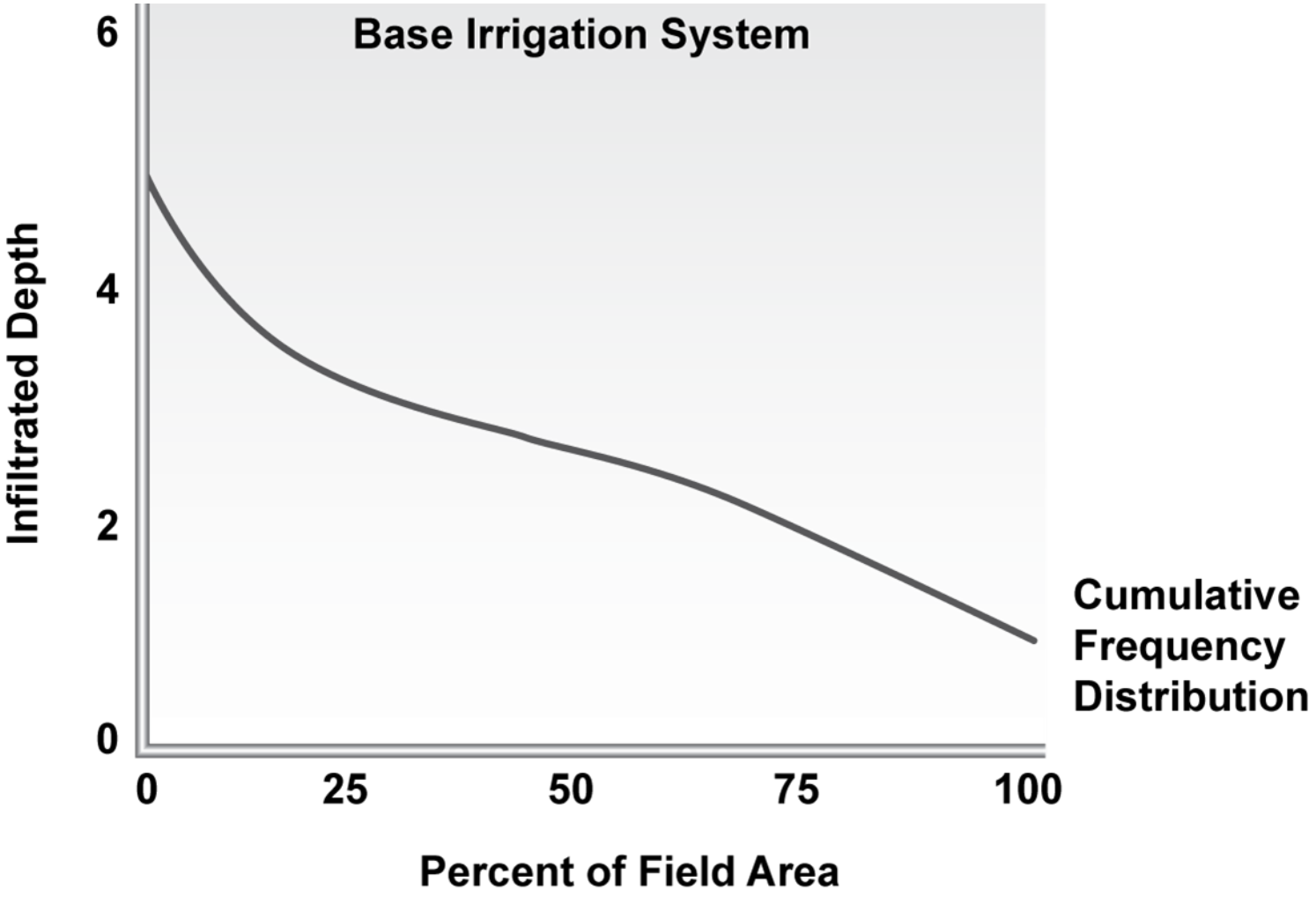
Source: USDA based on Farm and Ranch Irrigation Survey Data

Impact of Improved Efficiency: Field



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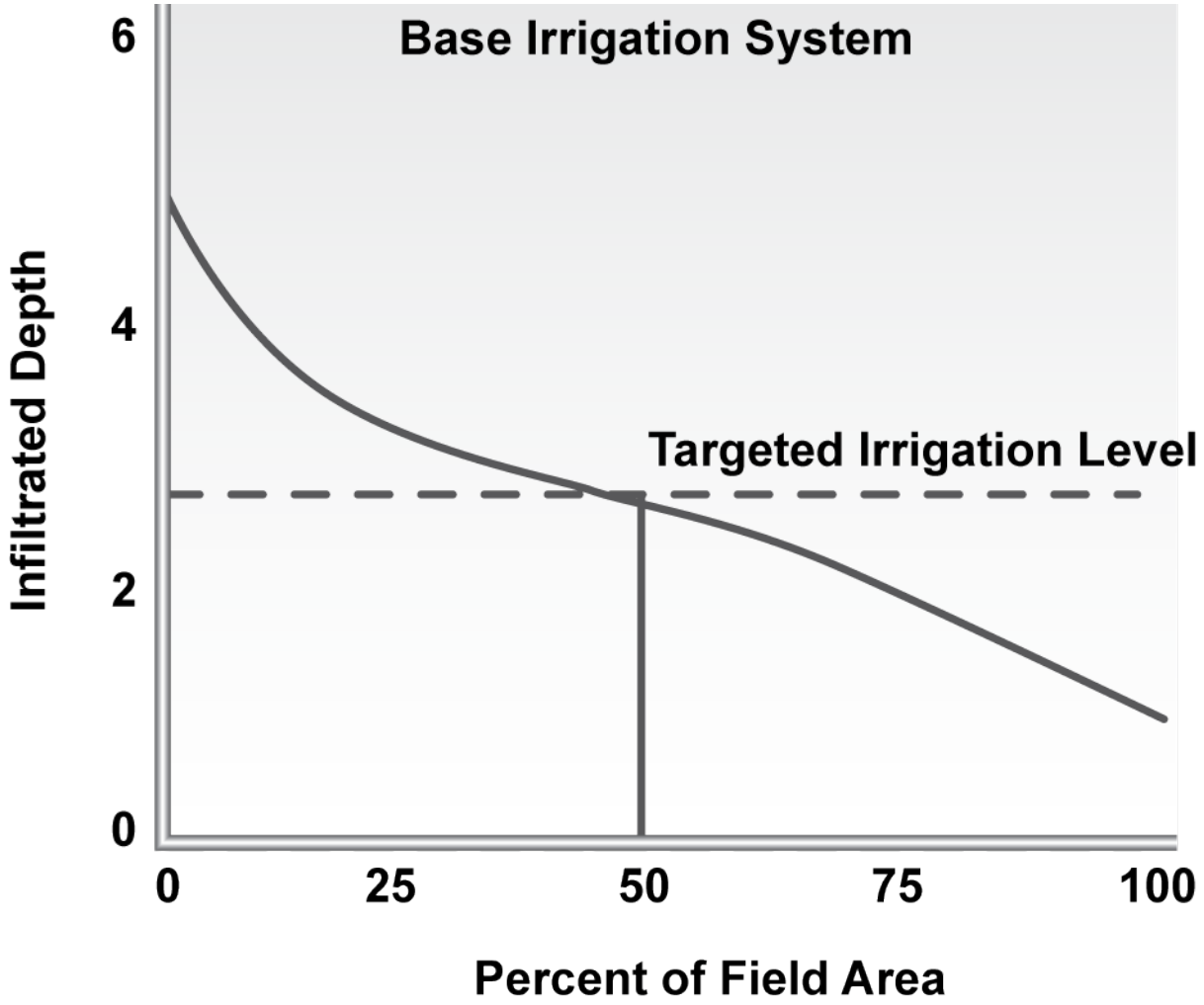

Cumulative Frequency Distribution

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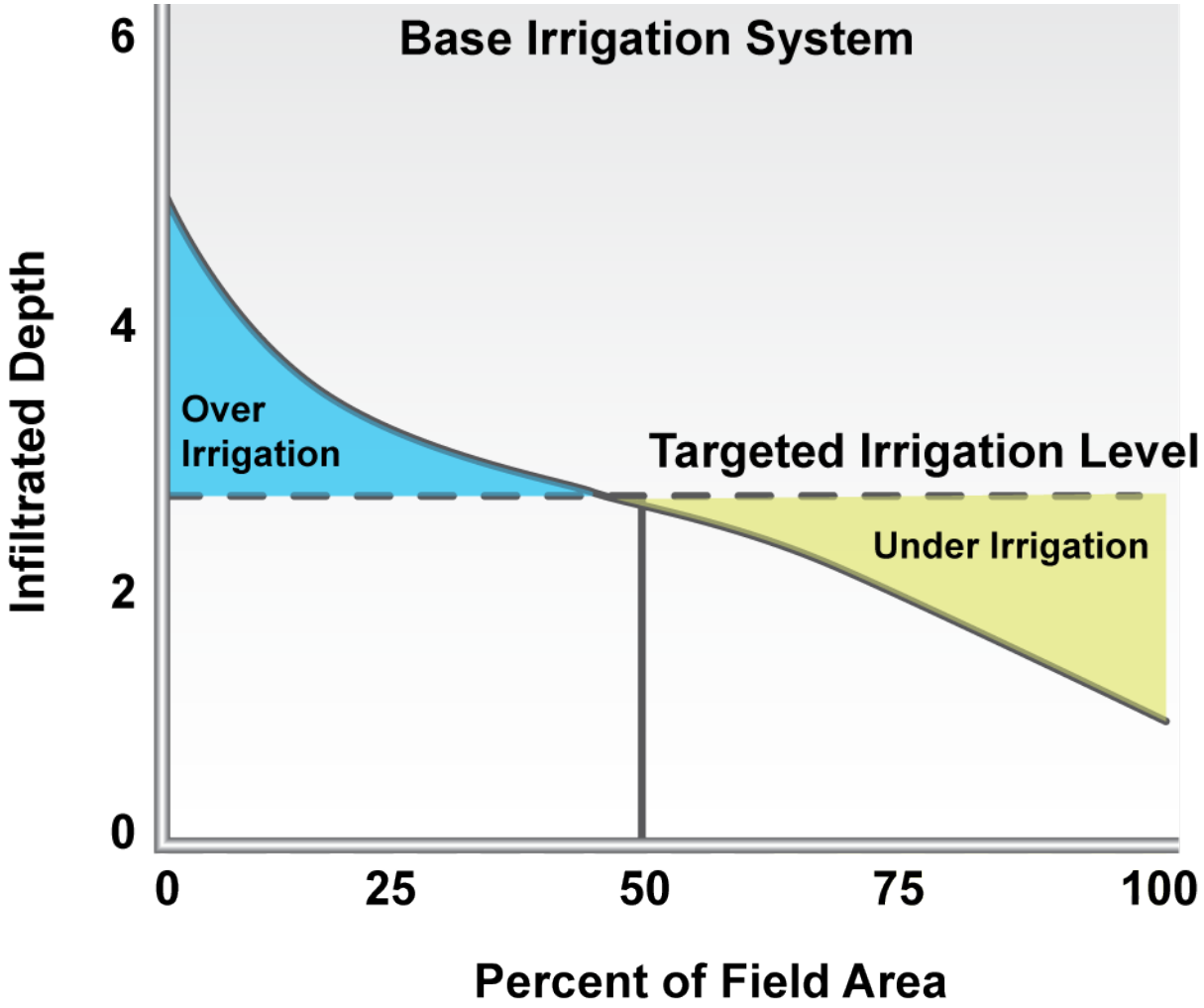
Impact of Improved Efficiency: Field



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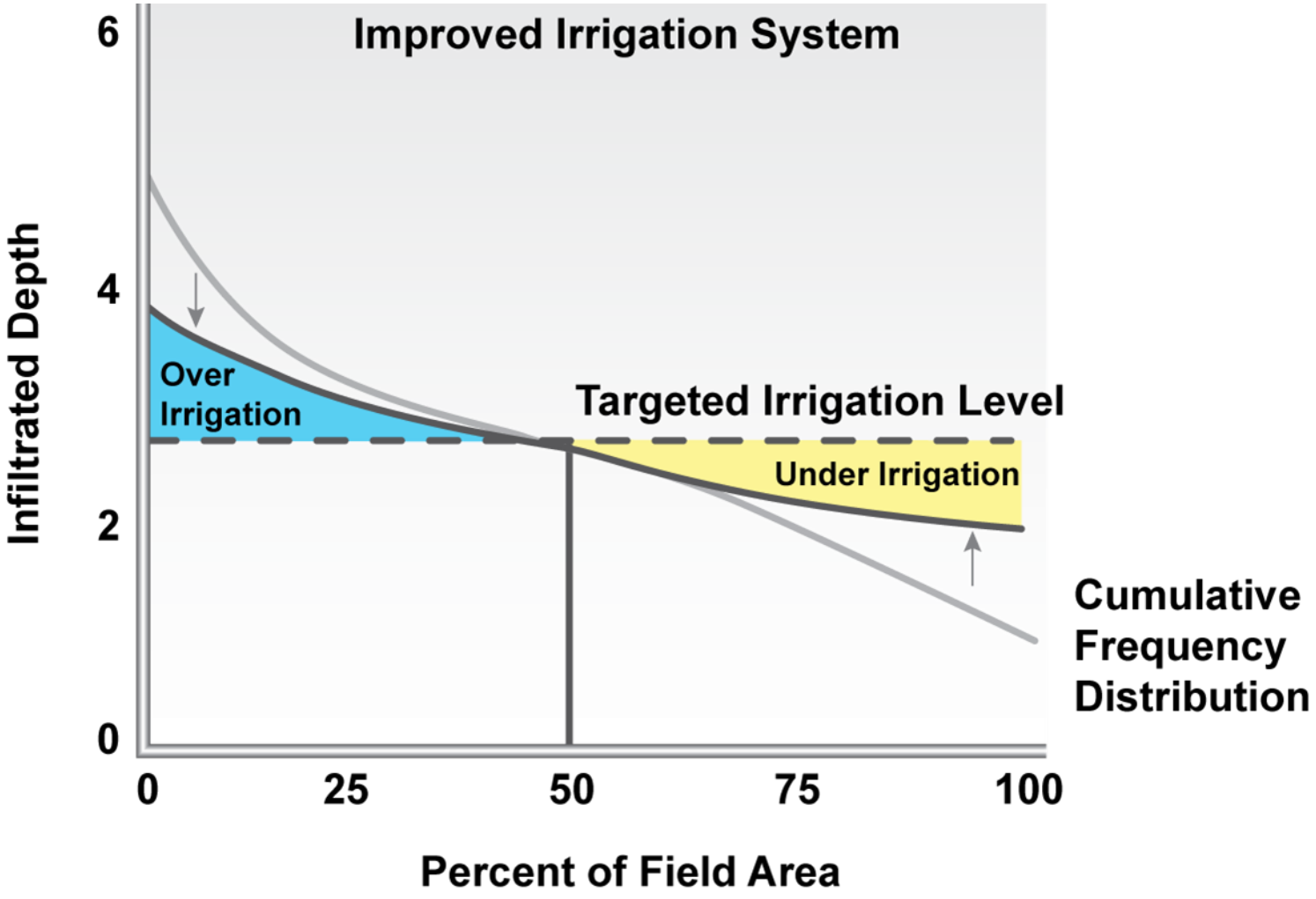

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Irrigation Efficiency (IE)

$$IE = \frac{\text{Water Beneficially Used}}{\text{Water Applied}}$$

BENEFICIAL USES

- Crop Evapotranspiration (ET_c)
- Water Harvested with Crop
- Salt Removal
- Soil Preparation
- Seed/Weed Germination
- Climate Control (frost protection, cooling)

NON-BENEFICIAL USES (*: unrecoverable)

- Evaporation* (sprinklers, wet soil)
- Deep Percolation (non-uniformity, management)
- Excess Tailwater/Runoff
- Filter Flushing
- Water required for WQ in Drains/Wetlands

IRRIGATION WATER APPLIED

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Improved Efficiency: Field View

Improved accomplishment of target irrigation

- The infiltration depth for a low-pressure, under-canopy, center pivot (or subsurface drip) approaches the target irrigation level

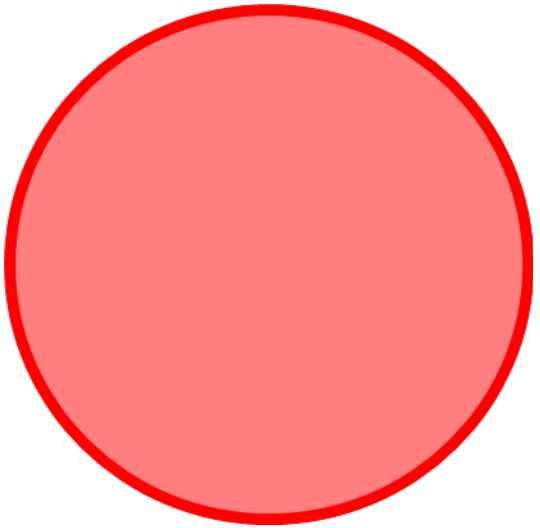
Decline in the area of field with over & under irrigation

- Increase in yield
- Increase in water consumed by crop ET because improved uniformity decreases water stress from over/under irrigation
- Reduction in runoff & deep percolation with impact on return flows and groundwater recharge

Increased water use and reduced deep percolation can create environmental & irrigation externalities because

- Institutions operate on water withdrawals (also termed diversions or water duty or allocation)
- Hydrologic system operates on consumptive use

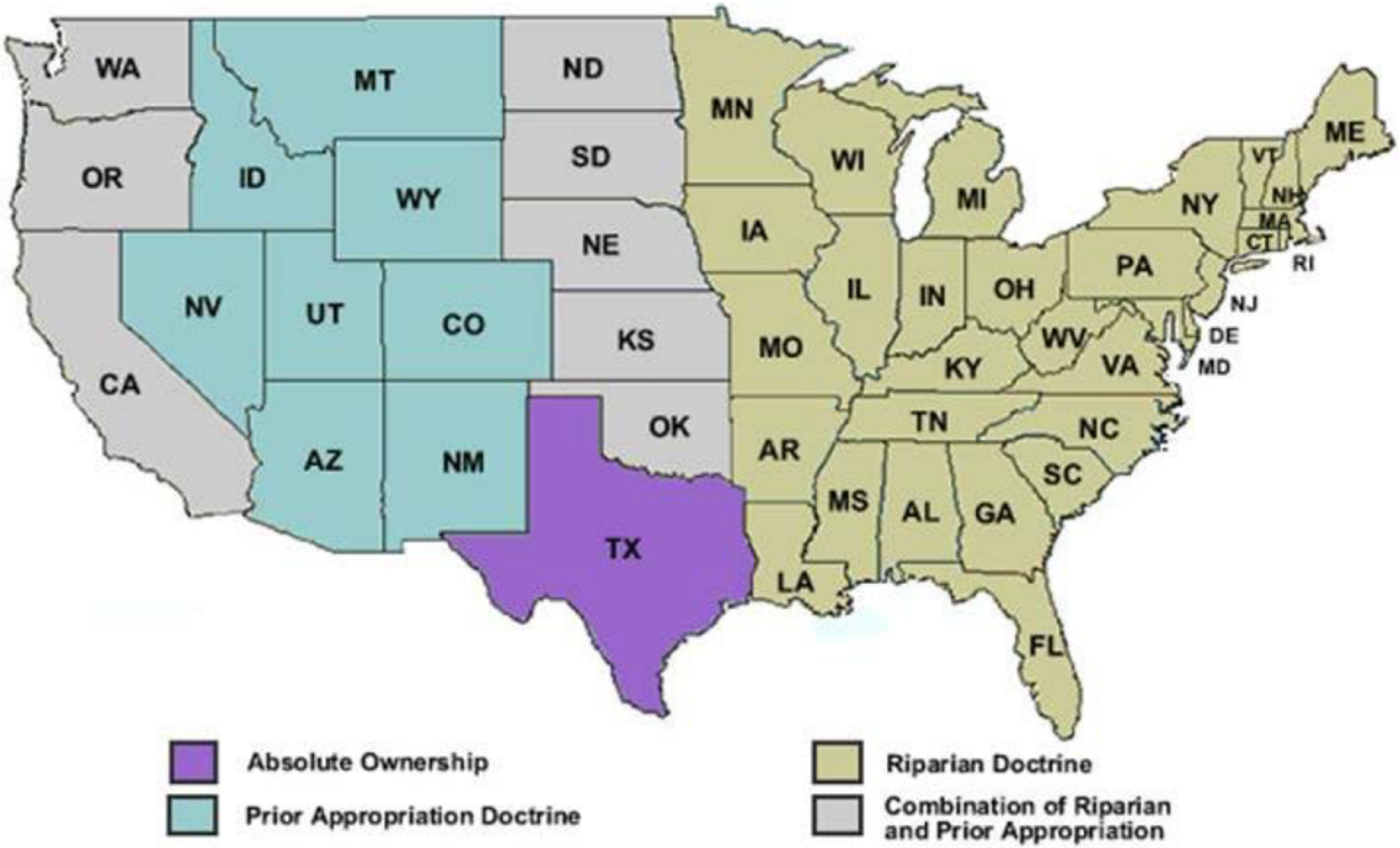
Forces in Ag Water Management



Legal/Institutional Considerations

- Water rights allocation and protection
- Transfer limits and cost
- Crop Insurance and other subsidies

Institutional Force: Water Rights



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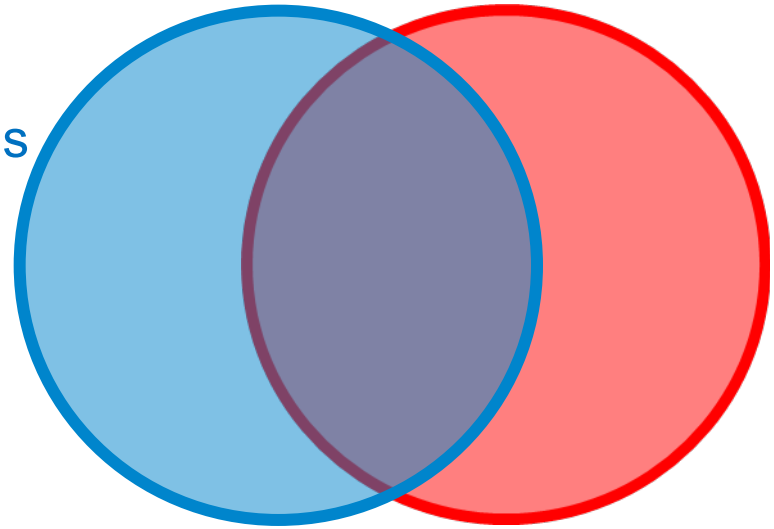
Forces in Ag Water Management

Hydrologic (physical) Considerations
- Water availability & demands
- Runoff & return flows
- Surface and ground water linkages
- Environmental flows



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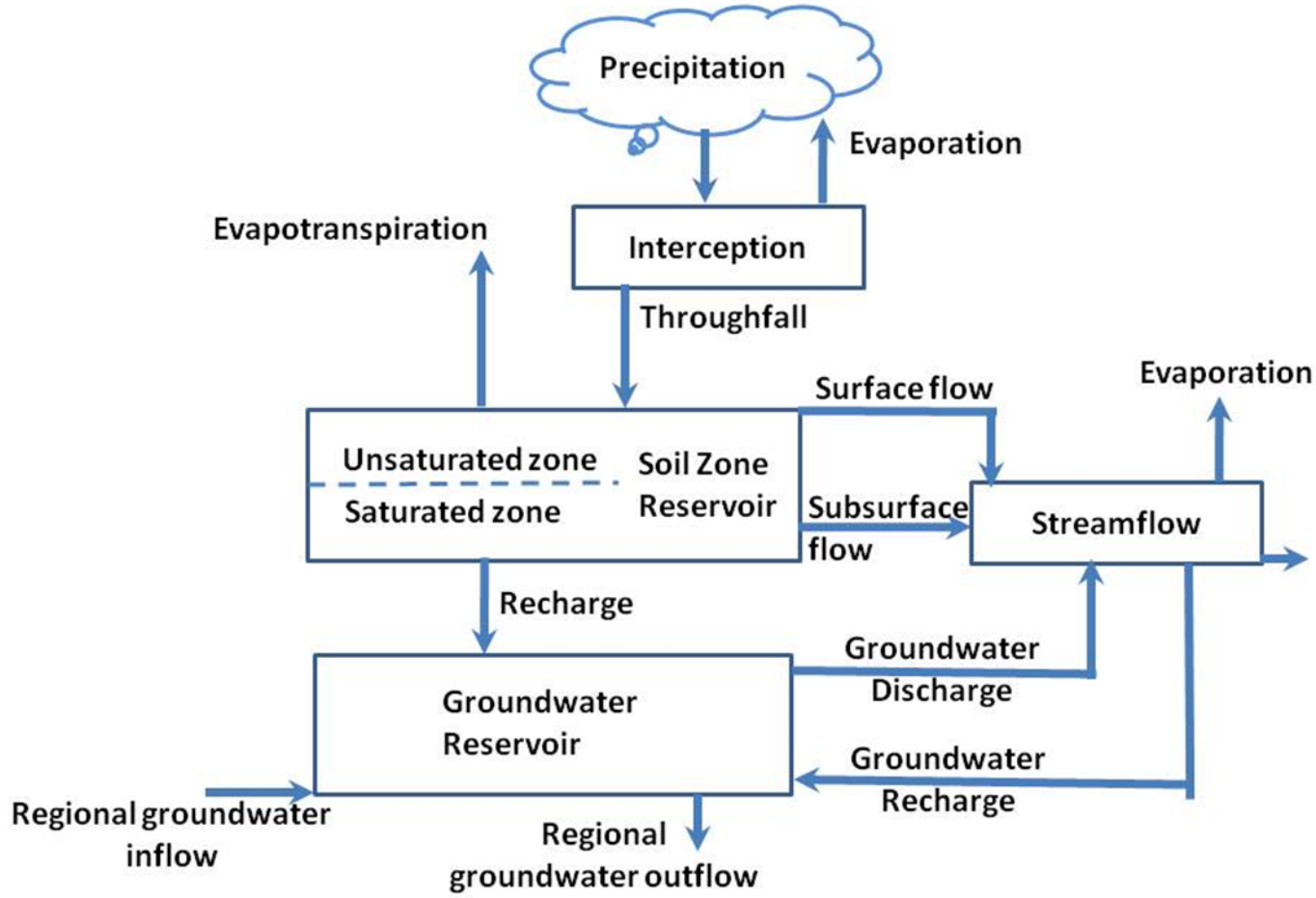
Hydrologic Force: Water Budget



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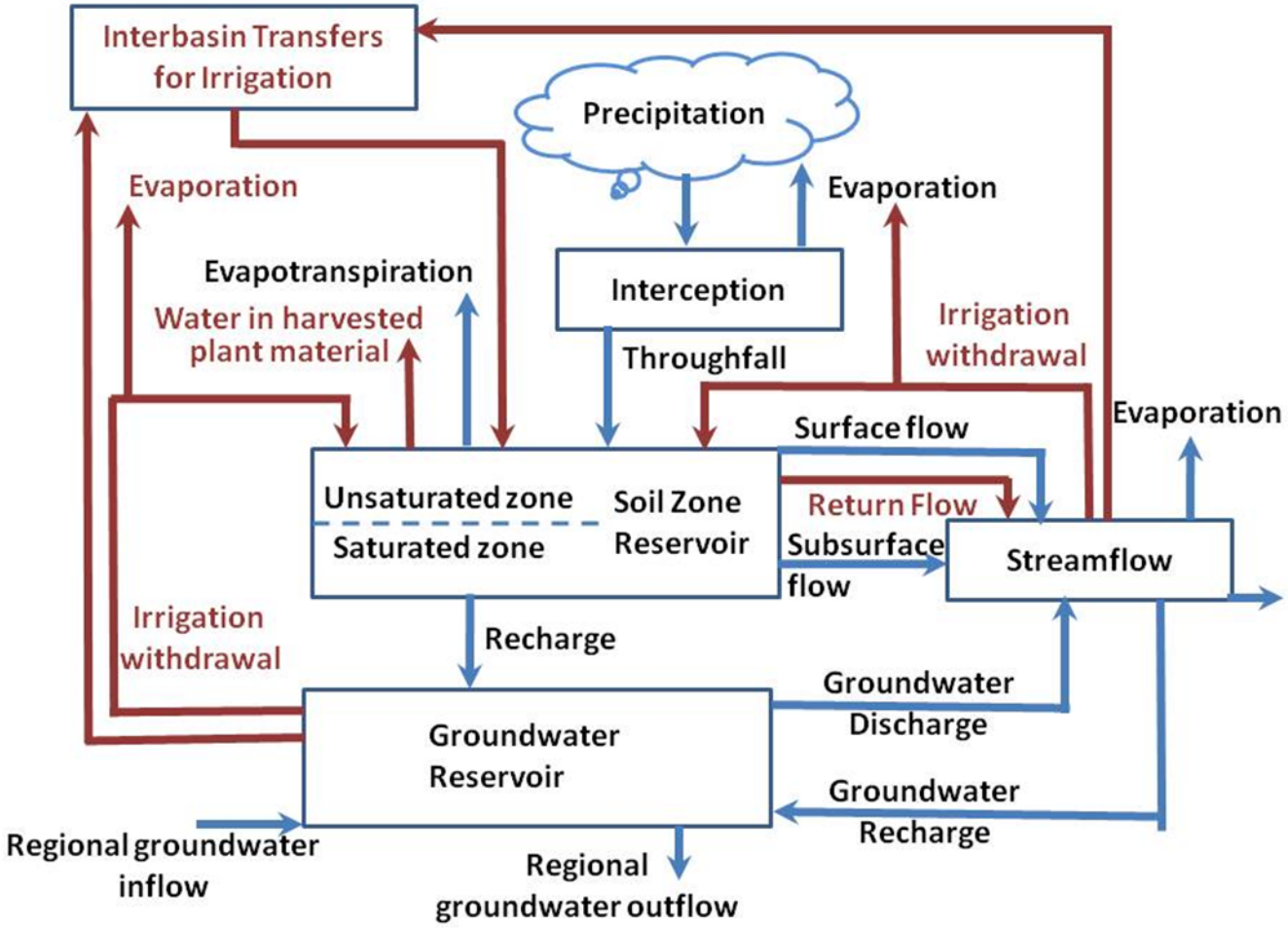
Source: Bales, Gollehon and Bernacchi, 2010

Hydrologic Force: Water Budget



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Source: Bales, Gollehon and Bernacchi, 2010

Forces in Ag Water Management

Farm Production Considerations

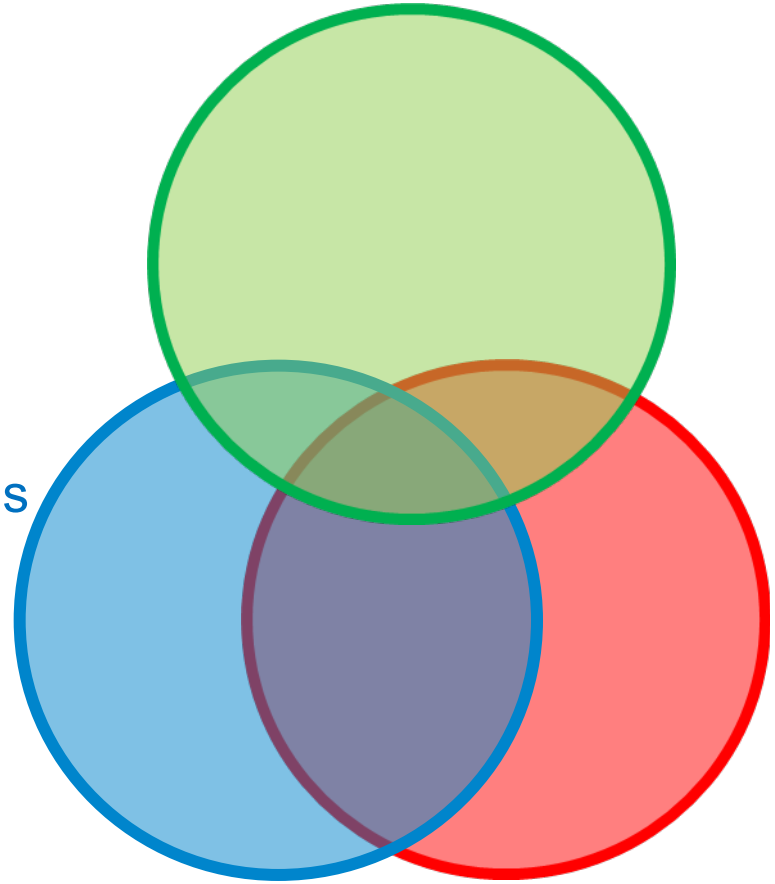
- Water as a relatively low cost input
- Yield increasing
- Minimize total input cost (water, labor & energy)
- Risk reduction
- Use, not waste

Hydrologic (physical) Considerations

- Water availability & demands
- Runoff & return flows
- Surface and ground water linkages
- Environmental flows

Legal/Institutional Considerations

- Water rights allocation and protection
- Transfer limits and cost
- Crop Insurance and other subsidies



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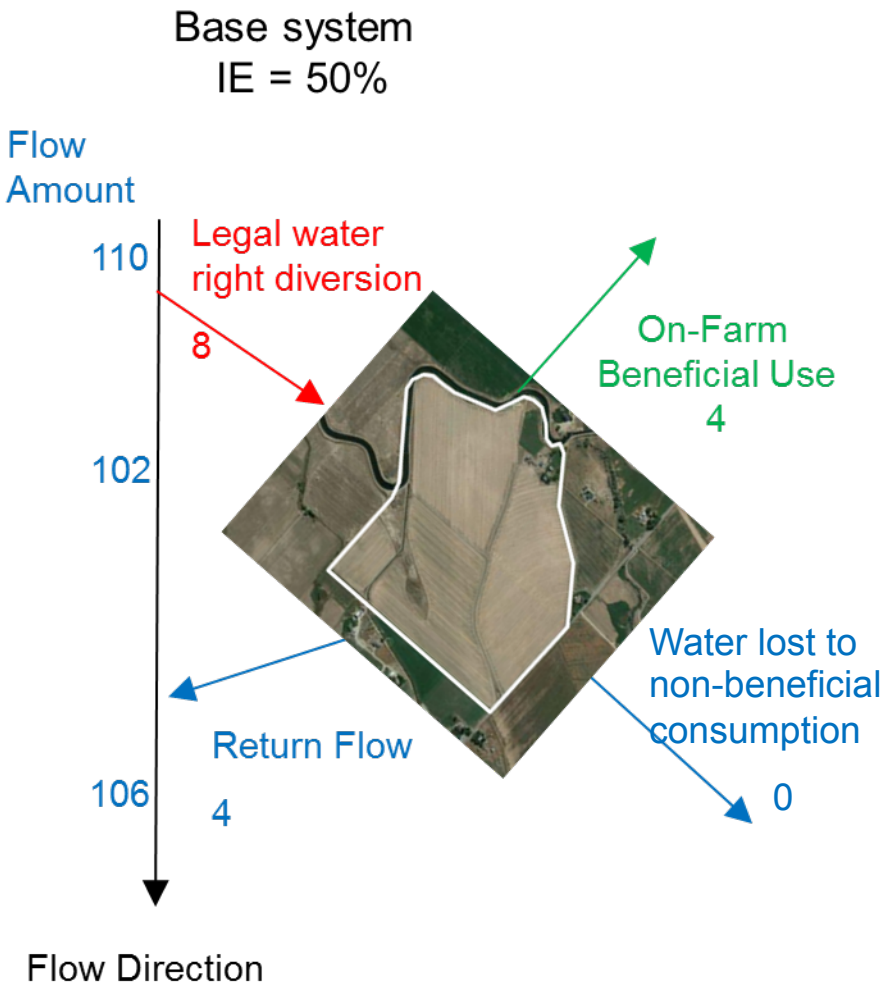
Impact of Improved Efficiency: Basin



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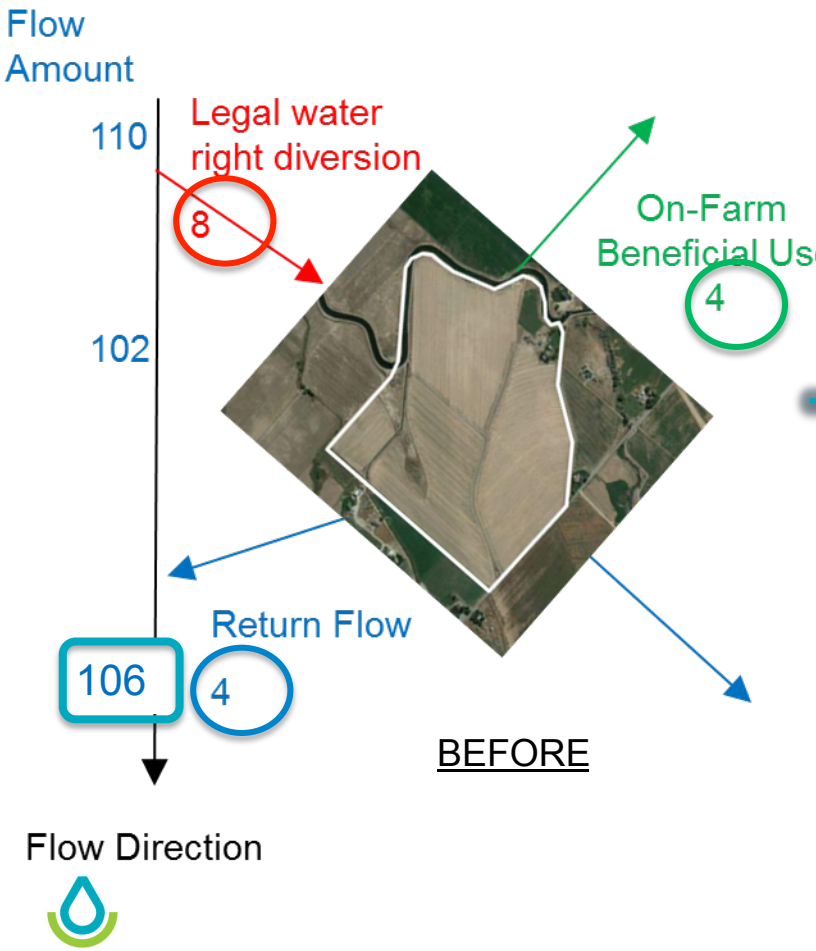
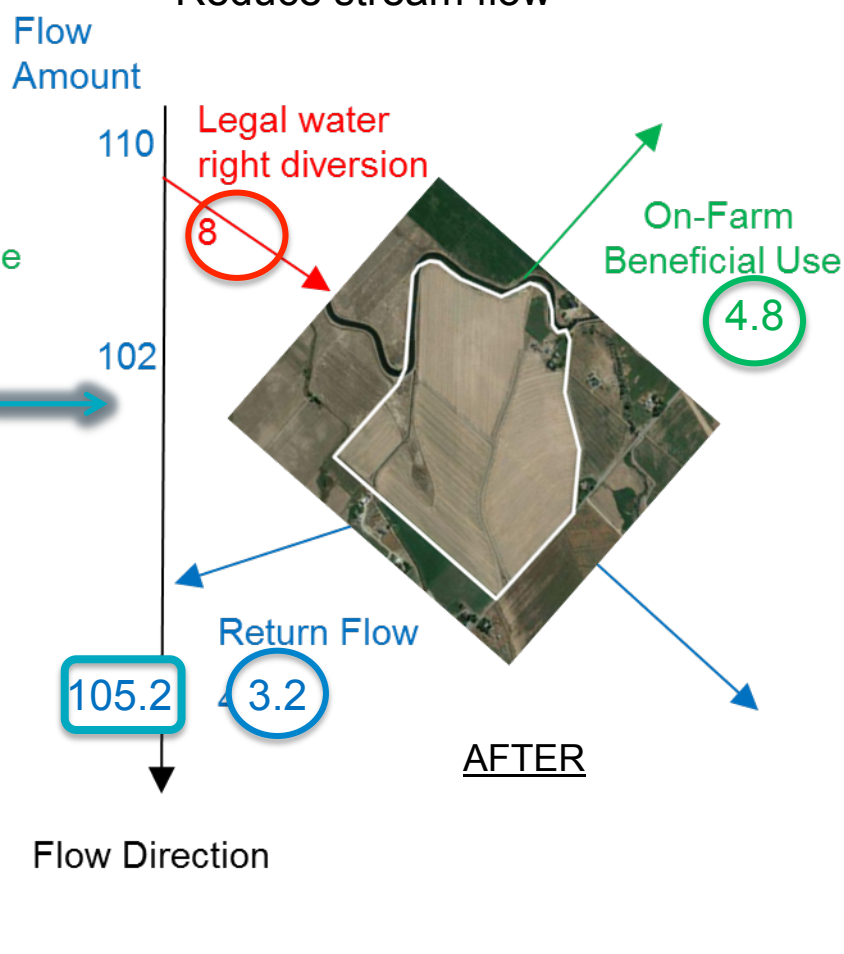
Impact of Improved Efficiency: Basin

Base system
IE = 50%



Improved system
IE = 60%
Reduce stream flow



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Improved efficiency: Basin View Summary

- **Improved irrigation efficiency does not assure an increase in downstream flow**
  - Carefully define the goal
- **Motivation to reduce withdrawals depends on the water source and institutional circumstance**
- **Reducing hydrologic water use (ET) usually reduces production**
- **Improving technology generally increases private benefits (more acres irrigated or higher yield) while increasing "hydrologic" water consumption, unless:**
  - Institutional adjustment or change,
  - Water supply constraint, or
  - Monetary reward for reducing water applications.

Conclusions

- **Provide a perspective on Arizona irrigation**
  - Acres do not equal importance
- **Improving irrigation efficiency does not automatically translate into water conservation from the agricultural sector.**
- **Conservation is complex and depends on definition**
  - Reducing hydrologic water use (ET) often reduces production
  - Depends on the area and location (field to farm to area to basin)
- **Exclusive focus on one factor determining irrigation (crop water applications) without considering the institutional factor or hydrologic consequences may not yield desired results.**

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Thank you for the opportunity to speak with you today.

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