# Managing Scarce Water Resources in Irrigated Drylands of Central Asia

# Two Case Studies

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# Two Case Studies

1. **<u>Uzbekistan</u>** - ET-based Irrigation Scheduling to Improve WUE and Build Resilience

2. **<u>Kazakhstan</u>** – Valuation of Ecosystem Services for Improving Agricultural Water Productivity

# Study Sites

Kyzylorda
Қызылорда
Kungirot
Nukus
Dashoguz
Urgench
Khiva
Kaplankyr Reserve
Darvaza
Khorezm
Uzbekistan
Bugunski reservoir
Turkistan
Түркістан
Shymkent
Шымкент
Taraz
Тараз
Talas
Талас
Shu
Шу
Bishkek
Бишкек
Almaty
Алматы
Naryn
Нарын
Tashkent
Kyrgyzstan
Namangan
Fergana
Khujand
Хуҷанд
Navoi
Jizzakh
Bukhara
Samarkand
Kashgar
Turkmenabat
Qarshi
Dushanbe
Душанбе
Turkmenistan
Fergana

# ET-based Irrigation Scheduling to Improve WUE in Uzbekistan

USDA ARS Agricultural Research Service

ICARDA
Science for Better Livelihoods in Dry Areas

# Hydromodule Zone (HMZ)

- Central Asian farmers use the Soviet era-developed method of irrigation which divides the irrigated areas in Hydro Module Zones (HMZ)
- Each HMZ has a set of crop-specific recommendations for irrigation based on:
  - soil characteristics (thickness of soil layers, soil texture) and
  - depth of groundwater table
- These recommendations have not been revised against changes in cultivars and fluctuations in groundwater table during past decades

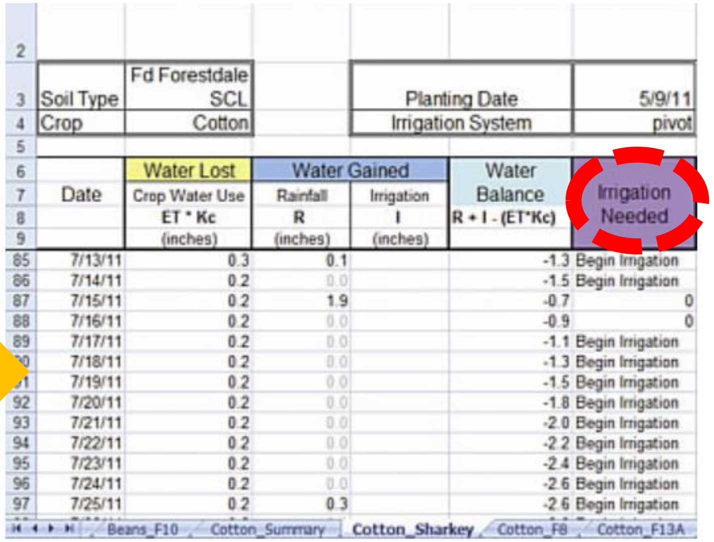
# How ET-based Irrigation Scheduling works?

ETc = Kc x Reference ET

Weather Data

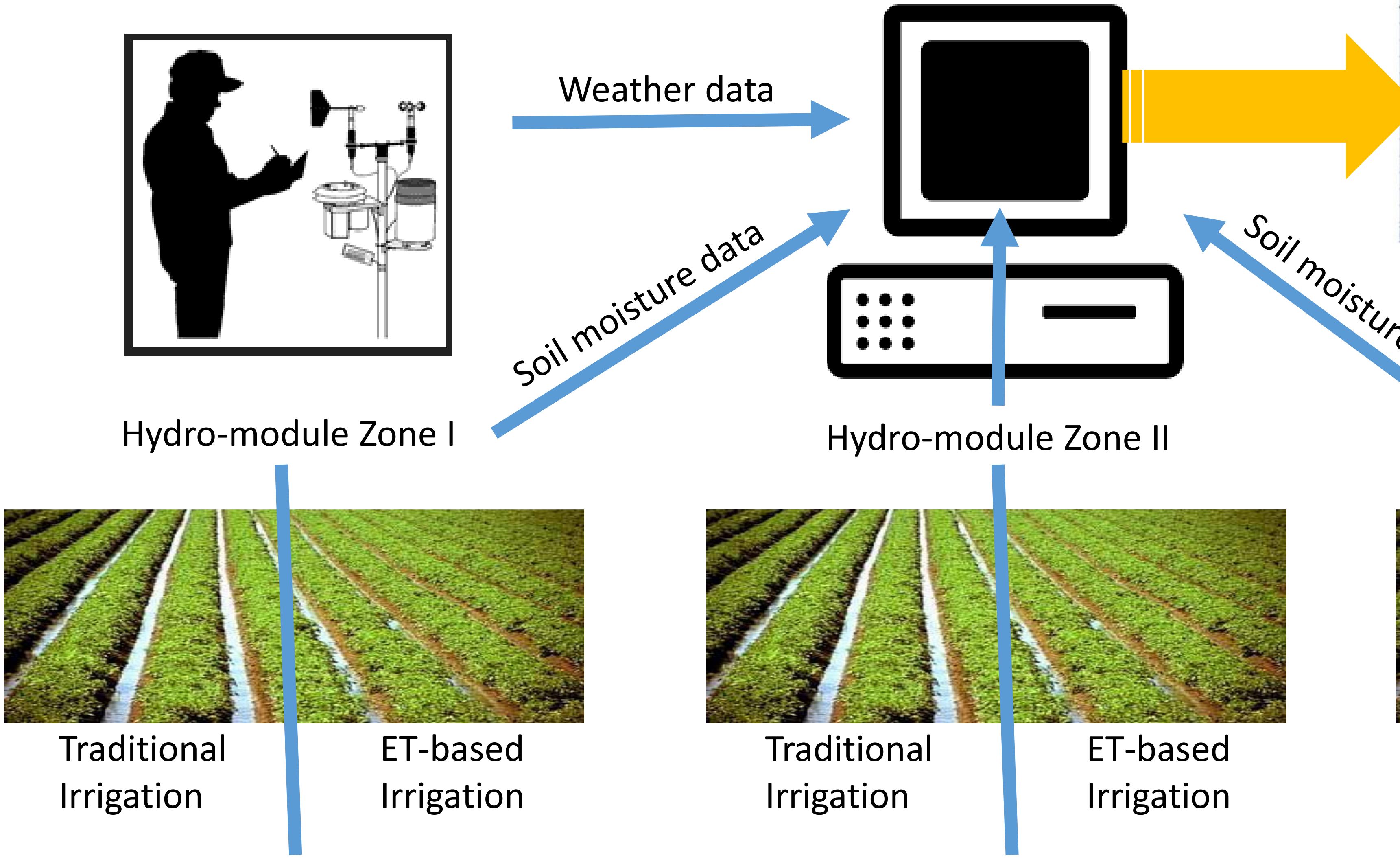
From crop modeling of historic field trial data

# Experimental Design



| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | | | | | | |
| 3 | Soil Type | Fd Forestdale SCL | | | Planting Date | 5/9/11 |
| 4 | Crop | Cotton | | | Irrigation System | pivot |
| 5 | | | | | | |
| 6 | | Water Lost | Water Gained | | Water | Irrigation |
| 7 | Date | Crop Water Use | Rainfall | Irrigation | Balance | Needed |
| 8 | | ET * Kc | R | I | R + I - (ET*Kc) | |
| 9 | | (inches) | (inches) | (inches) | | |
| 85 | 7/13/11 | 0.3 | 0.1 | | -1.3 | Begin Irrigation |
| 86 | 7/14/11 | 0.2 | 0.0 | | -1.5 | Begin Irrigation |
| 87 | 7/15/11 | 0.2 | 1.9 | | -0.7 | 0 |
| 88 | 7/16/11 | 0.2 | 0.0 | | -0.9 | 0 |
| 89 | 7/17/11 | 0.2 | 0.0 | | -1.1 | Begin Irrigation |
| 0 | 7/18/11 | 0.2 | 0.0 | | -1.3 | Begin Irrigation |
| 1 | 7/19/11 | 0.2 | 0.0 | | -1.5 | Begin Irrigation |
| 92 | 7/20/11 | 0.2 | 0.0 | | -1.8 | Begin Irrigation |
| 93 | 7/21/11 | 0.2 | 0.0 | | -2.0 | Begin Irrigation |
| 94 | 7/22/11 | 0.2 | 0.0 | | -2.2 | Begin Irrigation |
| 95 | 7/23/11 | 0.2 | 0.0 | | -2.4 | Begin Irrigation |
| 96 | 7/24/11 | 0.2 | 0.0 | | -2.6 | Begin Irrigation |
| 97 | 7/25/11 | 0.2 | 0.3 | | -2.6 | Begin Irrigation |

Beans_F10 | Cotton_Summary | Cotton_Sharkey | Cotton_F8 | Cotton_F13A

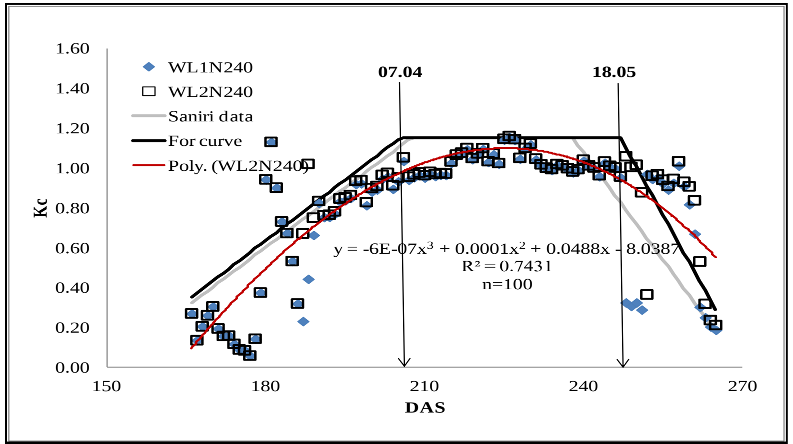


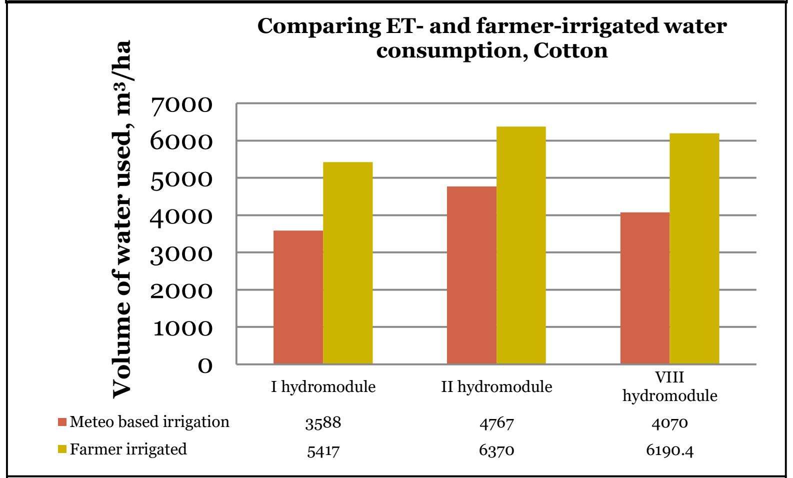
# Results

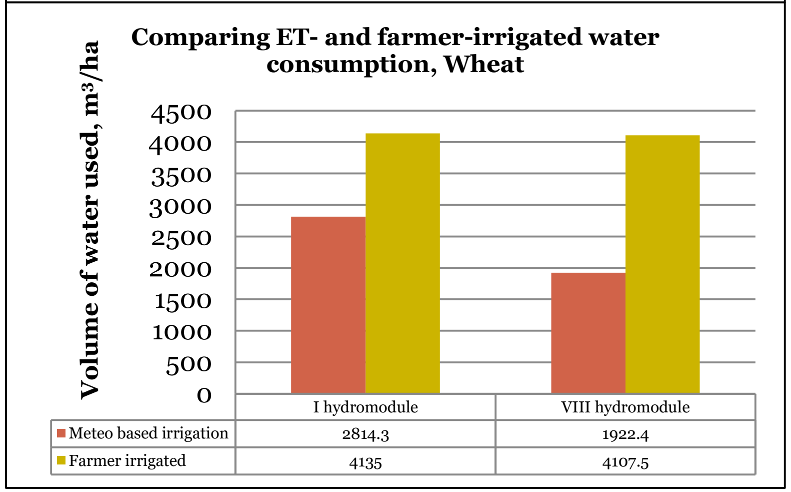
| Site (HMZ) | Water applied (mm) | | Yield (kg $ha^{-1}$) | | Water productivity (kg $m^{-3}$) | |
|---|---|---|---|---|---|---|
| | Conventional irrigation | ET-based irrigation | Conventional irrigation | ET-based irrigation | Conventional irrigation | ET-based irrigation |
| **Khorezm (VIII)** | 756 | 492 | 5700 | 5800 | 0.75 | 1.17 |
| **Fergana (I)** | 542 | 359 | 4011 | 3985 | 0.74 | 1.11 |
| **Fergana (II)** | 631 | 477 | 3975 | 4579 | 0.63 | 0.96 |
| **Fergana (VIII)** | 620 | 407 | 3968 | 3500 | 0.64 | 0.86 |

# Results

- There was on average **32% saving of irrigation** water and **50% increase in water productivity**
- The pilot area selected for research is representative of **35%** of irrigated areas in Fergana Valley (241,407 ha) and Aral Sea Basin (79,566 ha)



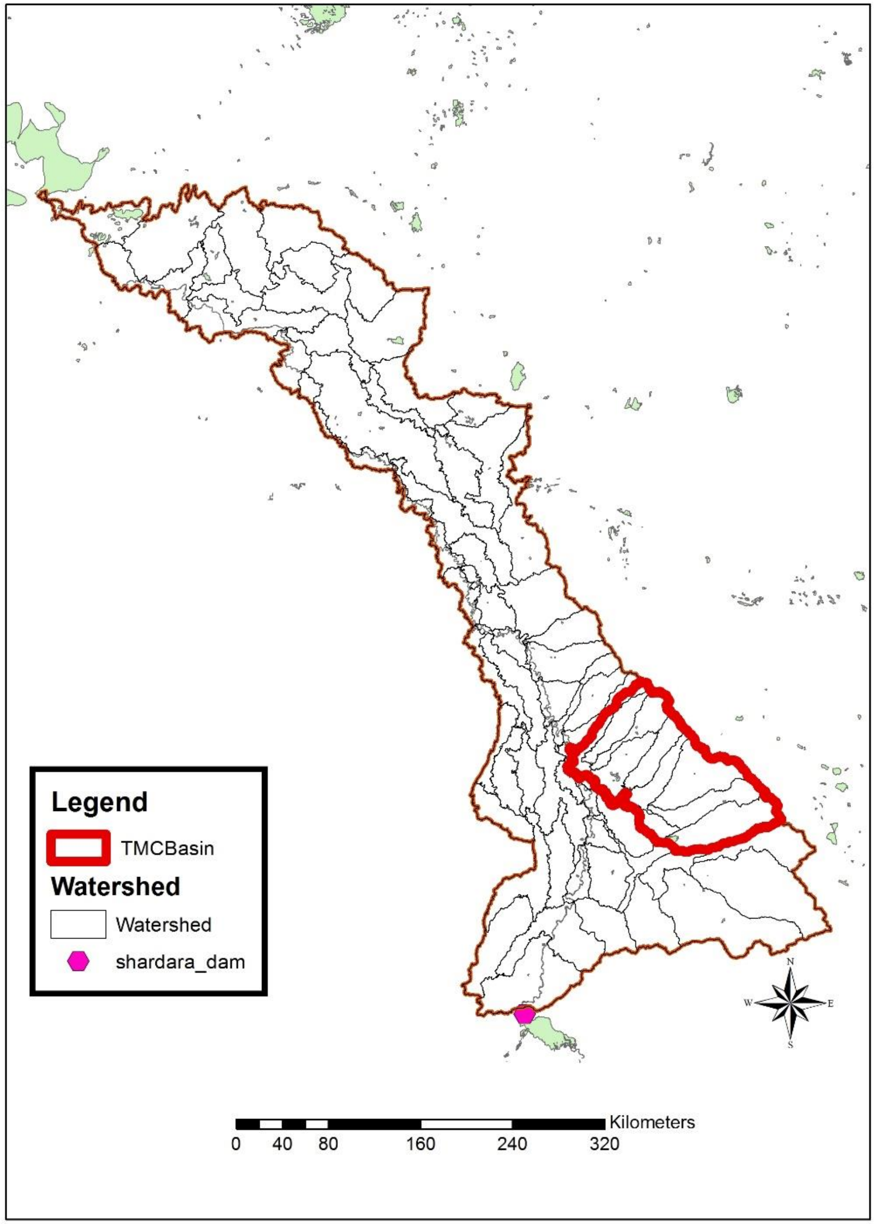



# Valuation of Ecosystem Services for Improving Agricultural Water Productivity in Aral Sea Basin, Kazakhstan

TEXAS A&M UNIVERSITY
UNIVERSITY OF MINNESOTA
ICARDA
Science for Better Livelihoods in Dry Areas

# Study Location

# Background

- Agriculture consumes large amounts of water for irrigation of cotton, corn, alfalfa, cucumber, potatoes and grapes
- Irrigation is inefficient, primarily flood irrigation is practiced - canals lose 30% of their water supply, while field level irrigation efficiency is only 50%
- Farmers over irrigate due to an unreliable supply of water

# Hypothesis of the study

- Improving agricultural water management will lead to improvement of other downstream ecosystem services sharing same water, and
- through the identification and valuation of main water-related ecosystem services, a plan can be developed for payment for improvement of agricultural water management

# Methodology –Soil Water Assessment Tool (SWAT) Modeling

- A GIS database of information about the study area includes information on elevation, land use, soil properties, agricultural management practices, reservoir inputs and outputs, water intake and supply
- These data were used with the Soil Water Assessment Tool (SWAT) to conduct detailed evaluation of water usage and other agricultural management practices and their impacts on crop yields and return flows

Soil & Water Assessment Tool | SWAT

# Methodology –Resource Investment Optimization System (RIOS)

- The objective of this component of study is to identify a suite of ecosystem services that are affected by the alternative agricultural practices modeled with SWAT, and then to evaluate changes in provision of these ecosystem services using the Resource Investment Optimization System (RIOS) model

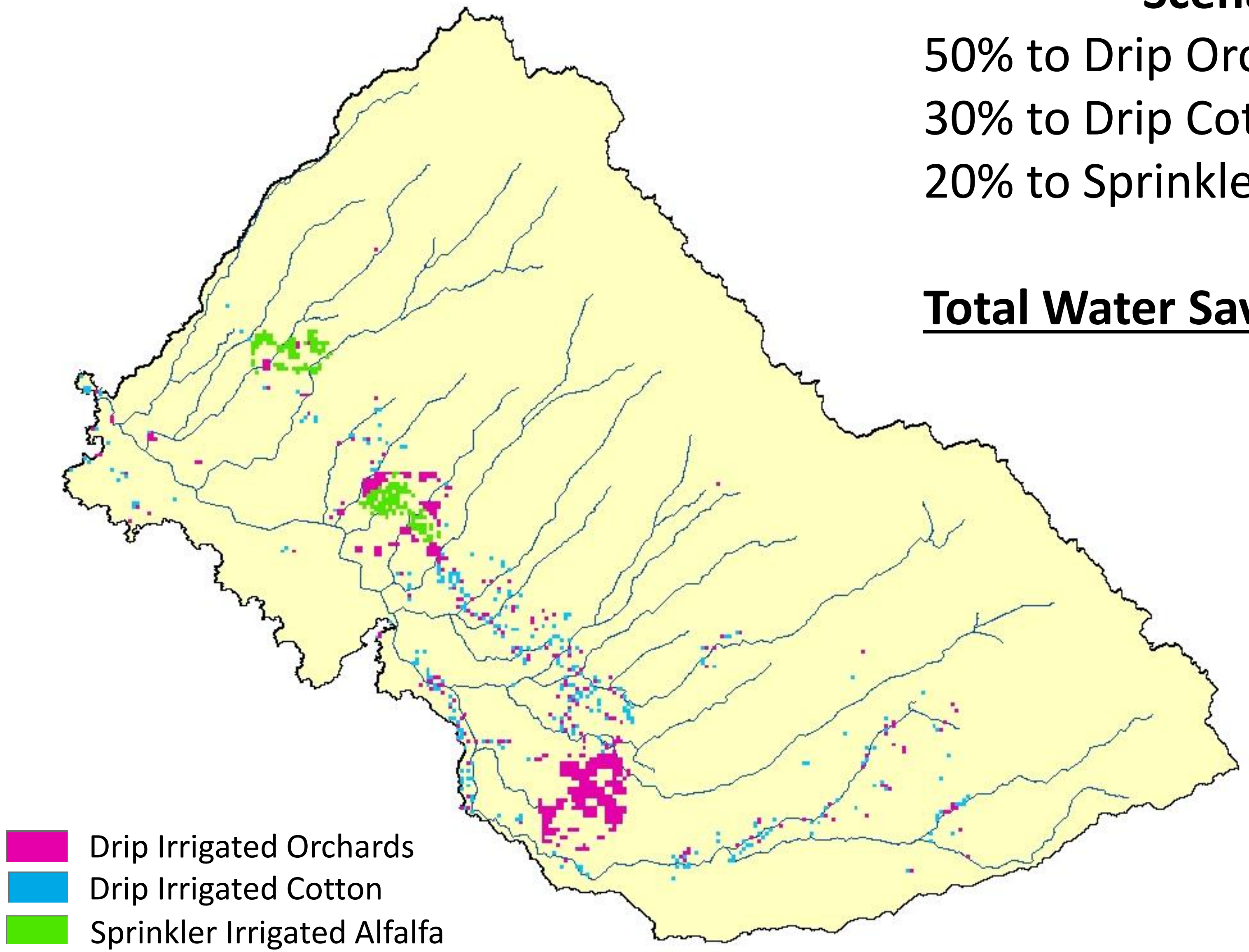
# Alternative Practices Evaluated

- Better fertilizer management
- Better irrigation water management
- Substitution of existing crops with more water efficient crops
- Retirement or alternative uses for marginal crop land
- Improved or targeted policies and subsidies

# Results - RIOS modeling

| | Net cost (Cost - Income gained) | |
|---|---|---|
| | Without Subsidies | With Subsidies |
| Cotton (flood) | | |
| Cotton (drip) | 2475.2 | 2293 |
| Alfalfa (flood) | | |
| Alfalfa (sprinkler) | 2798.4 | 2596.4 |
| Orchards (flood) | | |
| Orchards (drip) | 336 | |

# Results – RIOS modeling

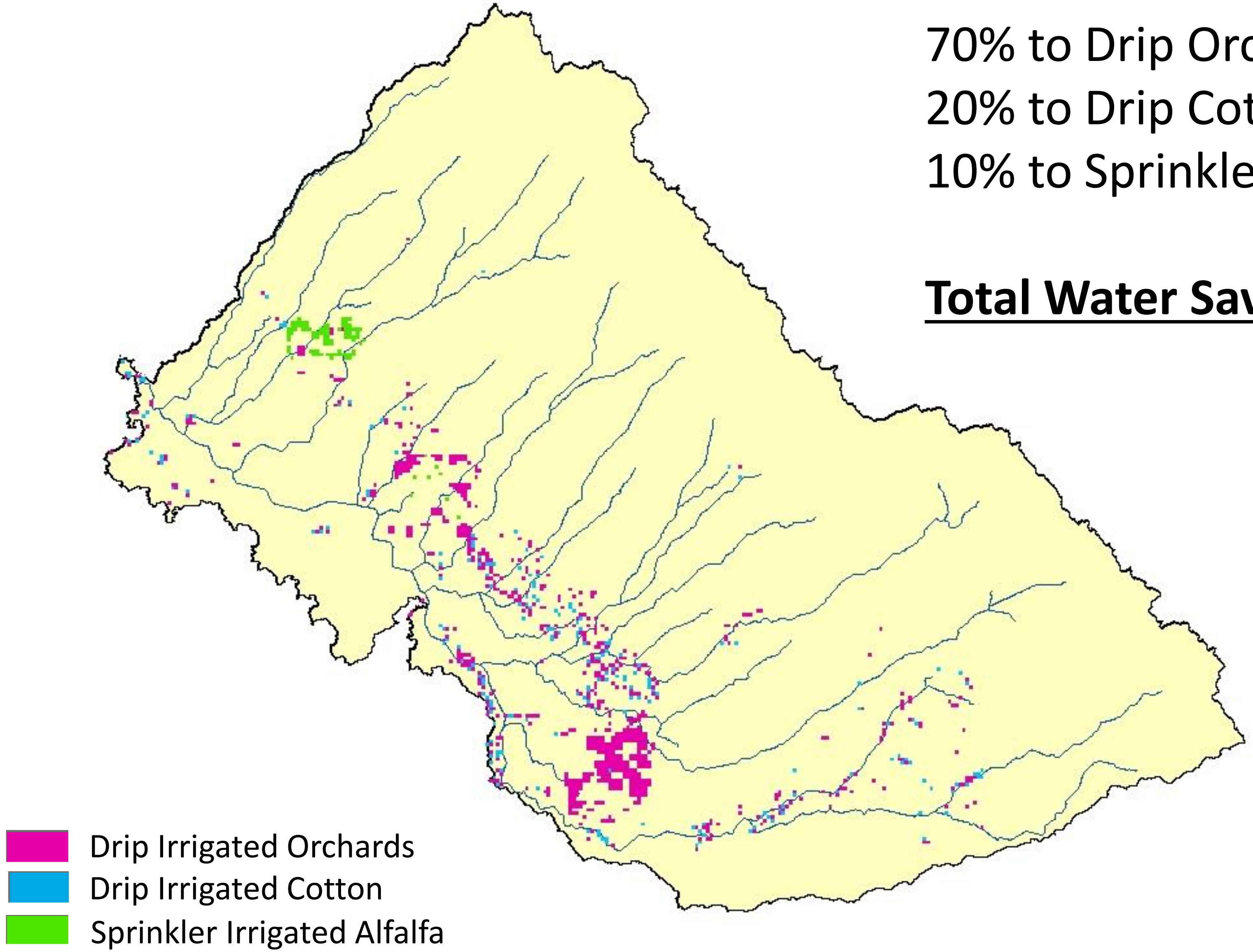



**Scenario A, $100M**

50% to Drip Orchards (20,000 ha)
30% to Drip Cotton (11,000 ha)
20% to Sprinkler Alfalfa (7,000 ha)

**Total Water Savings: 200,000,000 m$^3$**

# Results




**Scenario B, $100M**

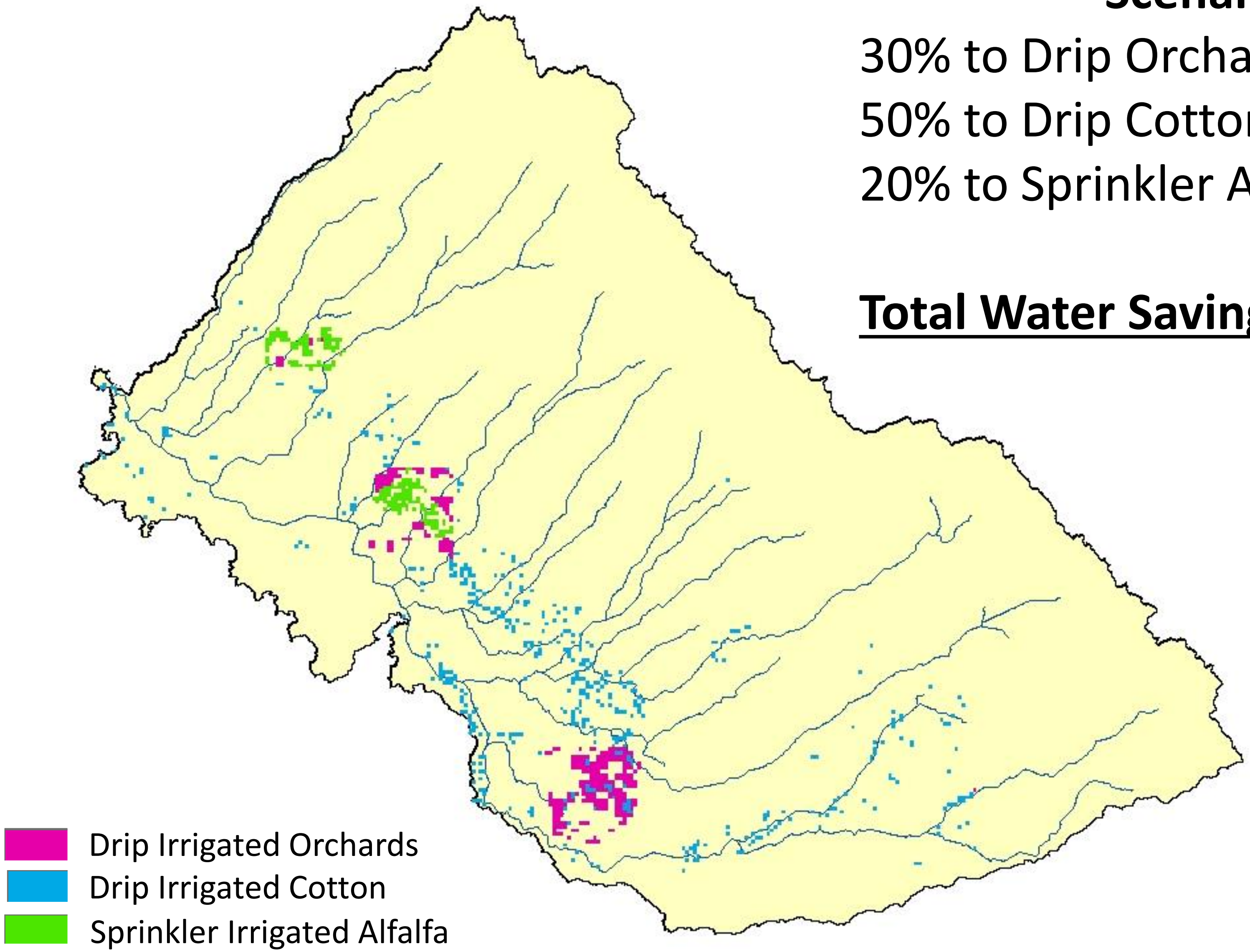
70% to Drip Orchards (28,000 ha)

20% to Drip Cotton (7,000 ha)

10% to Sprinkler Alfalfa (3,000 ha)

**Total Water Savings: 230,000,000 m$^3$**

# Results




**Scenario C, $100M**

30% to Drip Orchards (12,000 ha)

50% to Drip Cotton (18,000 ha)

20% to Sprinkler Alfalfa (7,000 ha)

**Total Water Savings: 180,000,000 $m^3$**

# Conclusion

Agriculture cannot be managed in isolation from rest of the landscape

Thank you

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