The Importance of Regional Analysis in Evaluating Agricultural Water Conservation Strategies

Bridget Guerrero, Shyam Nair, and Steve Amosson

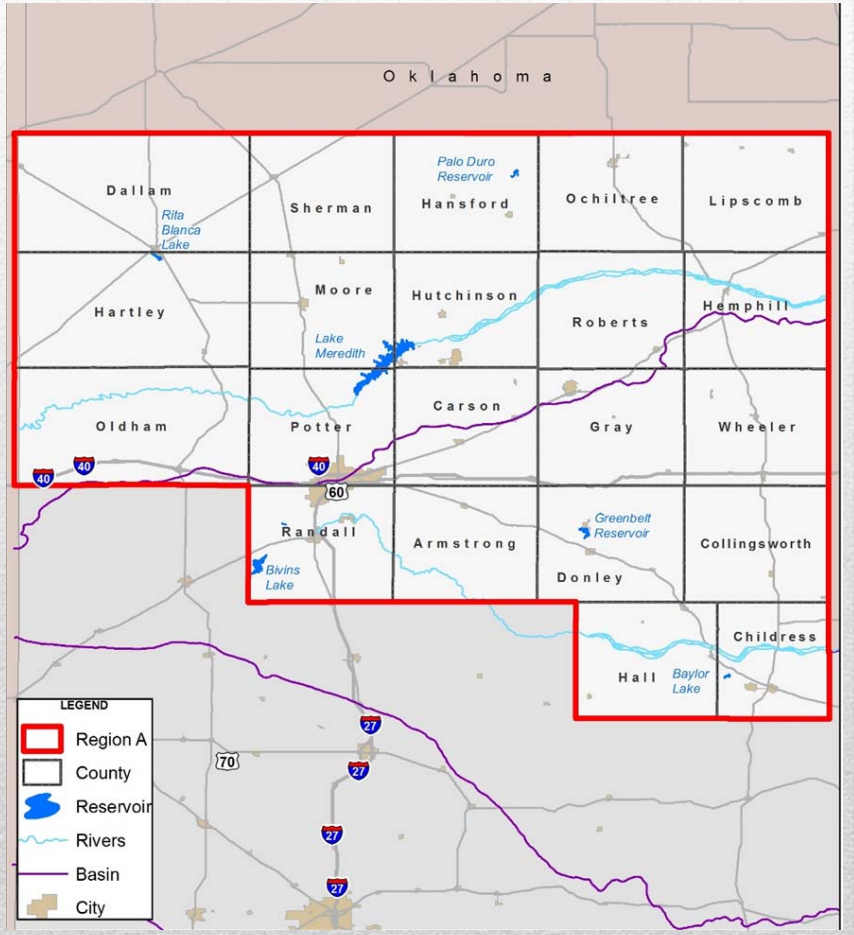
Mid-Continent Regional Science Association Annual Conference
St. Louis, Missouri

Introduction

- Panhandle Water Planning Area
  - Formed pursuant to Senate Bills 1 and 2 of the 75th Legislature of the State of Texas, which require all areas of the state of Texas to conduct a comprehensive water planning program.
- Agriculture is the primary water user – 92%
  - Estimates of water demand by county for crops and livestock
  - **Examined 8 water management strategies for reducing irrigation demands from the Ogallala Aquifer**

Planning Area Description

- 21 Counties
- Canadian and Red River Basins
  - 3 major reservoirs
- 2 major and 3 minor aquifers
- Economic Drivers
  - Agribusiness
  - Manufacturing
  - Energy
  - Tourism

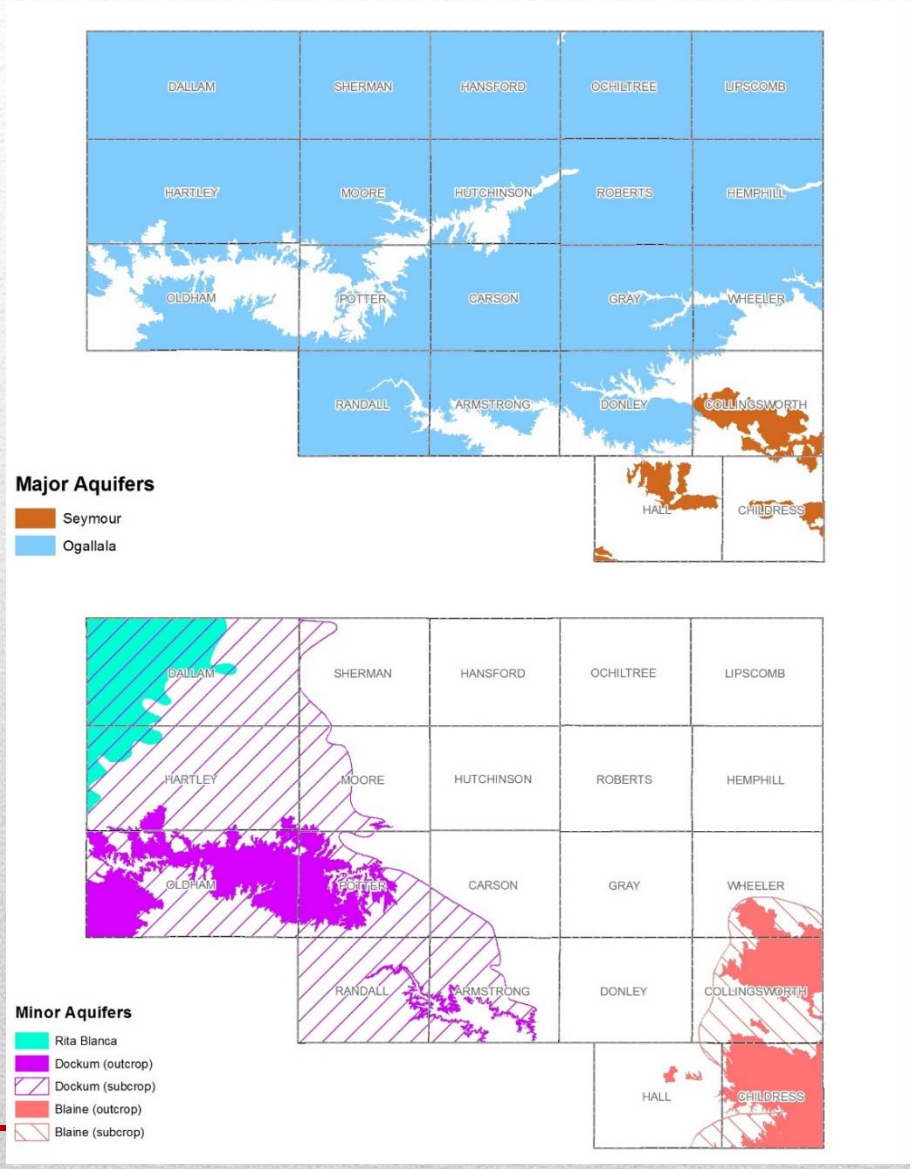


2 Major Aquifers:

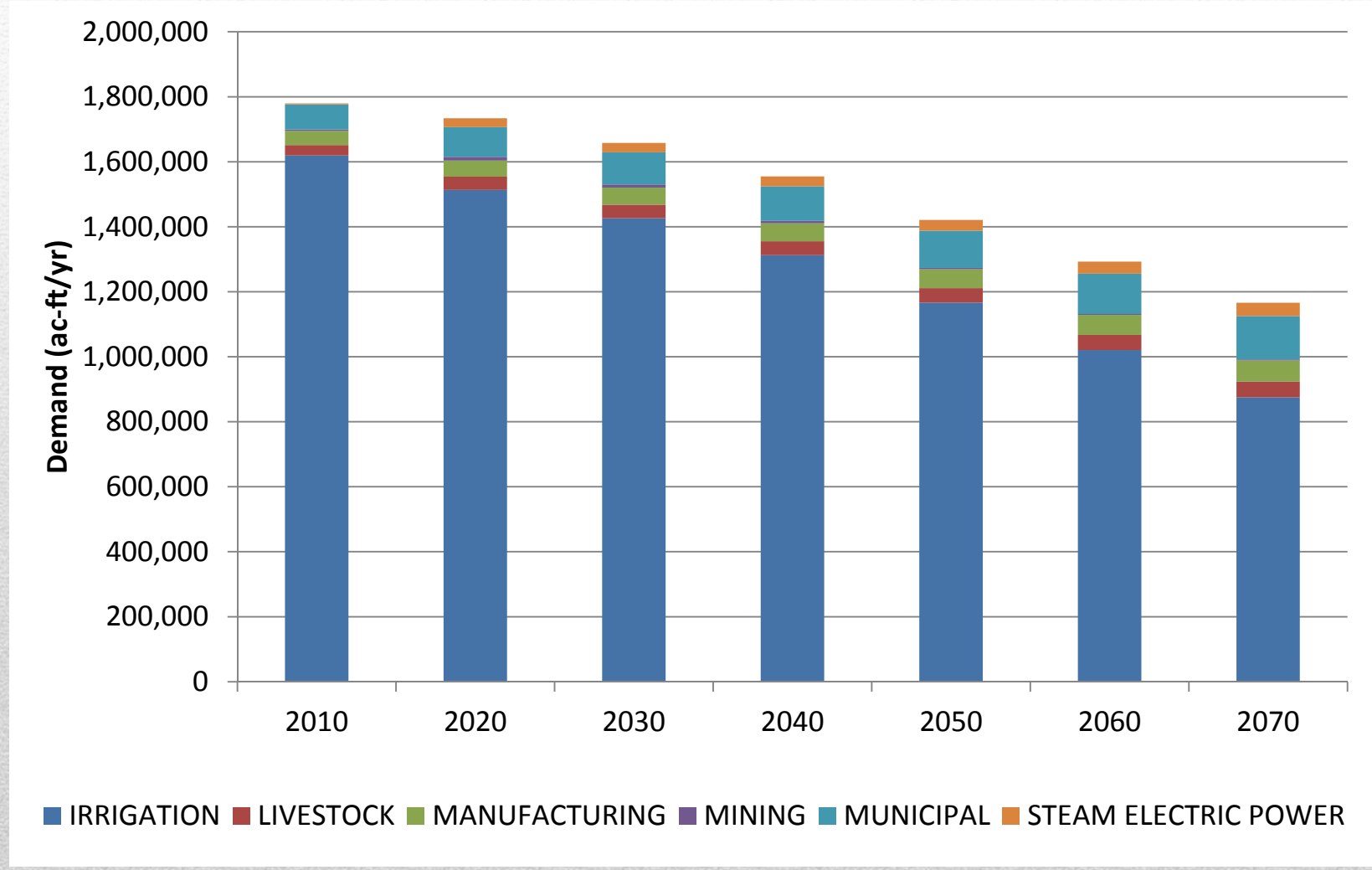
- Ogallala
- Seymour

3 Minor Aquifers:

- Rita Blanca
- Dockum
- Blaine



Water Demands



Descriptions of Agricultural Conservation Strategies

Description: 1. Irrigation Scheduling

The process of allocating irrigation water according to crop requirements based on meteorological demands and field conditions with the intent to conserve water, control disease infestations, and maximize farm profit.

- Methods: soil water measurement, plant stress sensing, and weather-based.
- Water savings: 2 to 3 acre-inches of irrigation per year for corn. Assumed to be 10% of the water applied for each crop.
- Implementation cost: $5.00 per acre

Description: 2. Irrigation Equipment Changes

Current irrigation methods practiced in the Texas Panhandle include conventional furrow irrigation (CF), center pivot irrigation (MESA: Mid-Elevation Spray Application, LESA: Low Elevation Spray Application, and LEPA: Low Elevation Precision Application), and subsurface drip irrigation (SDI).

- Water savings: 3.5 and 1.3 acre-inches per acre for conversion of furrow to MESA/LESA and MESA/LESA to LEPA, respectively.
- Implementation cost: difference in total cost of each irrigation system

Description: 3. Change in Crop Type

Considerable amounts of irrigation water can be saved by shifting from high water use crops like corn to lower water use crops like cotton, wheat or grain sorghum.

- Water savings: 7.8-8.6 acre-inches per acre depending on the crop
- Costs: change in land values; loss in producer gross receipts

Description: 4. Change in Crop Variety

Short season varieties of corn and grain sorghum use less water than the conventional longer season varieties.

- Water savings: 4.1 and 3.0 acre-inches per acre for corn and sorghum, respectively.
- Costs: decrease in producer net income and gross receipts

Description: 5. Conversion to Dryland

Converting from an irrigated to dryland cropping system may be a viable economic alternative for some producers in the Panhandle.

- Water savings: 13.9 acre-inches per acre
- Costs: change in land values; loss of producer gross receipts

Description: 6. Soil Management

Effective soil management practices can increase the efficiency of both irrigation and rainfall events, increase soil infiltration, reduce runoff, reduce evaporative loss, and conserve moisture available within the soil profile.

- Water savings: 1.75 acre-inches per acre
- Costs: savings from field operations

Description: 7. Advances in Plant Breeding

Plant breeding has played a major role in increasing crop productivity and enhancing the efficiency of inputs such as irrigation.

- Water savings: corn, cotton and soybean varieties will reduce water use by 15% followed by an additional 15%; wheat and grain sorghum varieties will reduce the water use by 12%
- Costs: $1.00 per acre for every 1% reduction in water use for additional seed expense.

Description: 8. Precipitation Enhancement

Precipitation enhancement, commonly known as cloud seeding or weather modification, is a process in which clouds are inoculated with condensation agents (such as silver iodide) to enhance rainfall formation.

- Water savings: one acre-inch per acre
- Costs: $8.11 per acre-foot saved

Cost Savings from reduced pumping

Many of the strategies result in reduced pumping of water from the Ogallala. Thus, producers realize cost savings from not pumping as much water.

- Cost savings: $9.10 per acre-inch

Adoption Schedule

Water Management Strategy	Annual Regional Water Savings (% of irrigation or ac-inch/ac/yr.)	Assumed Baseline Use 2013	Goal for Adoption 2020	Goal for Adoption 2030	Goal for Adoption 2040	Goal for Adoption 2050	Goal for Adoption 2060	Goal for Adoption 2070
Irrigation Scheduling	10%	20%	35%	50%	75%	85%	90%	95%
Irrigation Equipment Changes	Furrow to MESA or LESA 3.5	87%	90%	91.5%	93%	94.5%	96%	98%
	MESA or LESA to LEPA or SDI 1.3	75%	80%	85%	90%	95%	100%	100%
Change in crop type	7.8-8.6	10%	15%	20%	25%	30%	35%	40%
Change in crop variety	4.10 (corn) 3(sorghum)	40%	50%	60%	70%	70%	70%	70%
Conversion to Dryland	13.9	0%	2.5%	5%	5%	5%	5%	5%
Soil Management	1.75	70%	75%	80%	85%	90%	95%	95%
Advances in Plant Breeding for Drought Tolerance	Corn, cotton, and soybean 15% (2020-2030) 30% starting in 2040	0%	50%	75%	85%	95%	95%	95%
	Wheat and sorghum 12% starting in 2030	0%	0%	50%	75%	85%	95%	95%
Precipitation Enhancement	1.0	38%	38%	38%	38%	38%	38%	38%

Cumulative Region A estimated water savings, 2020-2070

Conservation Strategy	Water Savings (acre-feet)
Irrigation Scheduling	4,685,325
Irrigation Equipment Changes	3,643,928
Change in crop type	6,394,663
Change in crop variety	3,064,326
Conversion to Dryland	4,156,337
Soil Management	1,970,123
Advances in Plant Breeding for Drought Tolerance	13,821,966
Precipitation Enhancement	813,923

Water Savings and Costs

Water Management Strategy	Cumulative Water Savings (WS)	Implementation Cost (IC)	IC/WS	Cost Savings	Net Cost/WS	Loss in Gross Receipts
	ac-ft.	$1,000	$/ac-ft.	$1,000	$/ac-ft.	$1,000
Irrigation Scheduling	4,685,325	$209,396	$45	$511,637	($65)	-
Change in Crop Variety	3,064,326	$602,294	$197		$197	$1,204,587
Irrigation Equipment Changes	3,643,928	$55,638	$15	$397,917	($94)	-
Change in Crop Type	6,394,663	$199,934	$31		$31	$3,006,360
Soil Management	1,970,123	($34,989)	($18)	$215,137	($127)	-
Precipitation Enhancement	813,923	$6,601	$8	$88,880	($101)	-
Irrigated to Dryland Farming	4,156,337	$145,226	$35		$35	$2,805,477
Advances in Plant Breeding	13,821,966	$113,322	$8	$1,509,359	($101)	-

IMPLAN Methodology

Water Management Strategy	IMPLAN Sectors					
	19	115	203	417	6001	GR
Irrigation Scheduling	$209,396	($306,982)		($204,655)	$302,241	
Change in Crop Variety						$1,204,587
Irrigation Equipment Changes			$55,638		($55,638)	
Change in Crop Type						$3,006,360
Soil Management	($34,989)	($129,082)		($86,055)	$250,126	
Precipitation Enhancement	$6,601	($53,328)		($35,552)	$82,279	
Irrigated to Dryland Farming						$2,805,477
Advances in Plant Breeding	$113,322	($905,615)		($603,743)	$1,396,037	

Water Savings and Costs

Water Management Strategy	IC/WS	Net Cost/WS	Regional Output	Regional Output Cost/WS	Annual Employment Impact
	$/ac-ft.	$/ac-ft.	$1,000	$/ac-ft	jobs
Irrigation Scheduling	$45	($65)	$60,689	$13	106
Change in Crop Variety	$197	$197	$1,498,366	$320	-199
Irrigation Equipment Changes	$15	($94)	($35,847)	($8)	-
Change in Crop Type	$31	$31	$3,747,287	$800	-490
Soil Management	($18)	($127)	$153,948	$33	-11
Precipitation Enhancement	$8	($101)	$41,568	$9	5
Irrigated to Dryland Farming	$35	$35	$3,546,404	$757	-478
Advances in Plant Breeding	$8	($101)	$873,470	$186	35

Summary

- Strategies which result in a major loss of producer gross receipts will result in the largest loss to the regional economy
- Irrigation Equipment Changes was the only strategy that resulted in a positive regional economic impact
- Reduced pumping costs had a major effect on regional output.

Implications

- The “costs” of water conservation strategies can vary depending on the view:
  - Groundwater management district
  - Producer
  - Regional economy
- All views must be considered when evaluating policies/strategies


Questions?