Is Irrigation Water Use Efficiency Important – Evidence from the Testing Ag Performance Solutions Project

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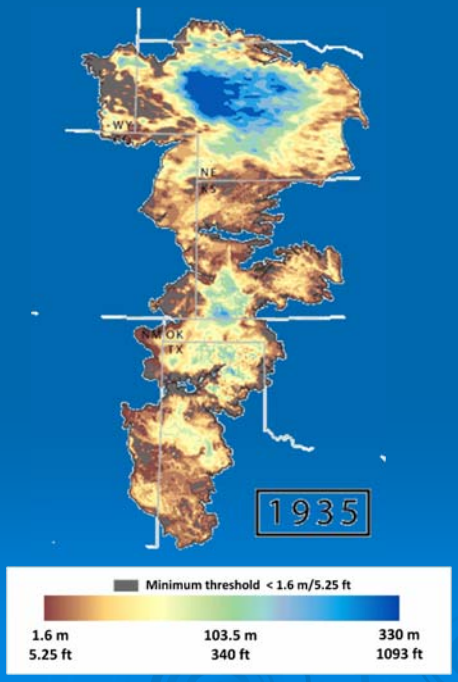
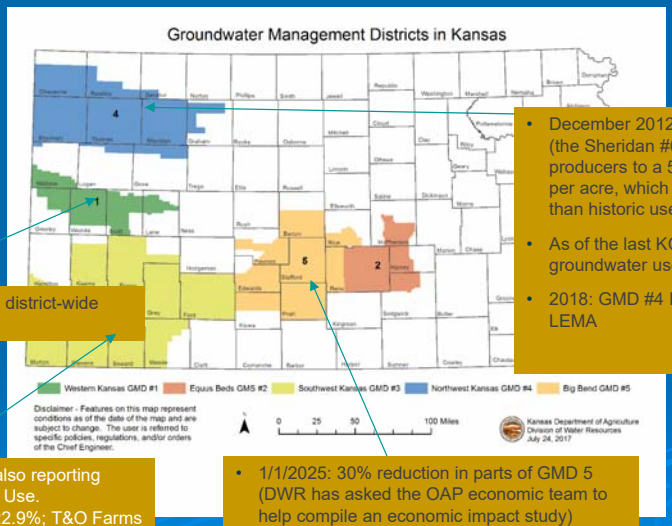
The Problem



The Solution

- An absolute reduction in groundwater use
- Improving Irrigation efficiency, by itself, does not work.

What is Kansas doing about it



- December 2012: The first approved LEMA (the Sheridan #6 high priority area) restricted producers to a 5-year allocation of 55 inches per acre, which is approximately 20% less than historic use.
- As of the last KGS report they have reduced groundwater use by 34%.
- 2018: GMD #4 Implemented a district-wide LEMA

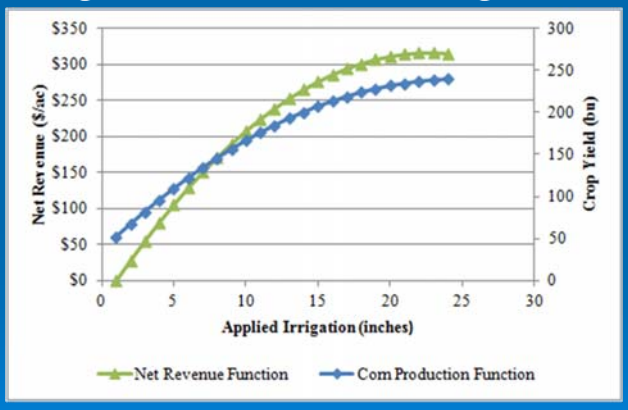
- 2022: GMD #1 Implemented a district-wide LEMA

Water Conservation Areas are also reporting large reductions in groundwater Use.
Garden City Company 22.9%; T&O Farms 42.6%

- 1/1/2025: 30% reduction in parts of GMD 5 (DWR has asked the OAP economic team to help compile an economic impact study)

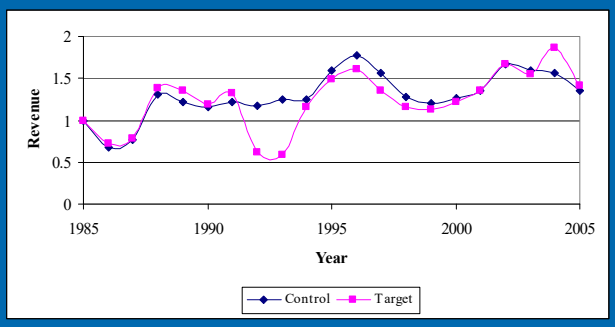
Big Question

- What happens to producer income as we reduce groundwater usage?



- But – are we as efficient as we think we are?

What We Have Observed: Wet Walnut Creek IGUCA



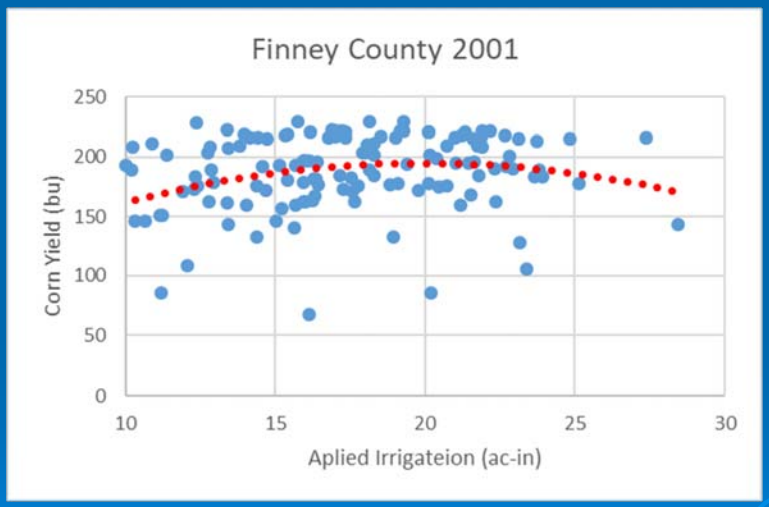
- Statistically significant short-run and a statistically <u>insignificant long-run reduction</u> in annual irrigated crop revenue.

What We Have Observed: Sheridan #6 LEMA

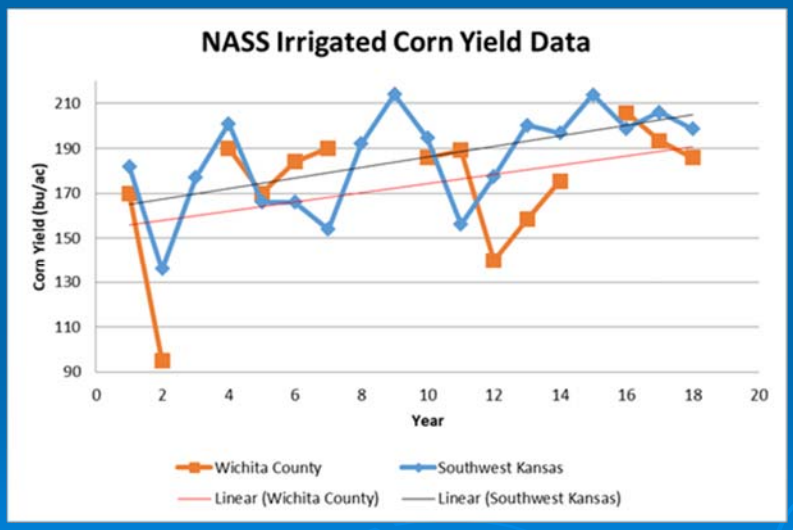
Item	Observations	Water Use (in/ac)	Yield (bu/ac)	Cash Flow ($/ac)	Cash Flow ($/in)
Corn Weighted Average - Inside LEMA	20	10.3	218.0	$375	$36
Corn Weighted Average - Outside LEMA	11	13.4	220.6	$360	$27

- Cash Flow = Revenue less variable expenses less land rent
- This is not a statistically valid sample

What We Have Observed: RMA- WRIS Analysis



What We Have Observed: Wichita County LEMA Study



What Data Do We Need to Determine Efficiency

- Crop yield (only RMA has this data)
- Change in soil moisture (???)
- Crop evapotranspiration (???)
- Groundwater Use (WRIS data is available)
- Rainfall (Prism data is available)
- Soil type (NRCS data is available)

- Generally not enough data to estimate at the field level

Testing Ag Performance Solutions Project

- A national platform used to evaluate outcomes from producers' management decisions in a competitive framework
- Producers compete to maximize profit & yield, and limit input usage through their decisions
- Kansas State University Northwest Research-Extension Center in Colby, Kansas; 12 acres; keith silt loam; Valley variable rate center pivot
- 35 teams that grew 20 different corn hybrid varieties
- The following are the preliminary results

Estimating Water Use Efficiency (WUE) and Water Productivity (WP)

$$WUE = \frac{ET}{Irr + ER + \Delta SM} = \frac{ET}{TW}$$

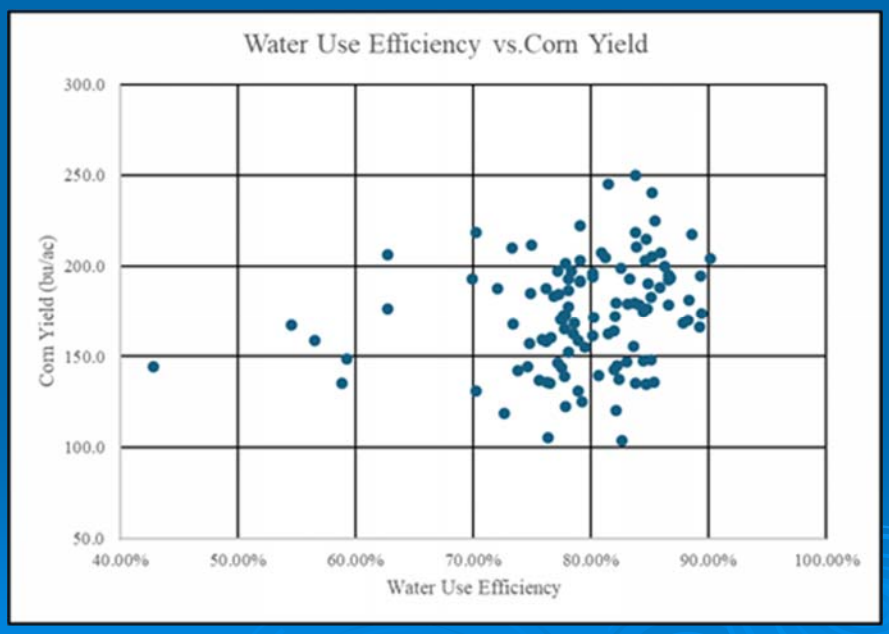
$$WP = \frac{Yield}{Irr + ER + \Delta SM} = \frac{Yield}{TW}$$

ET is the seasonal crop evapotranspiration, Irr is the applied irrigation, ER is the seasonal effective rainfall, ΔSM is the seasonal change in soil moisture and TW is the total water available for crop production

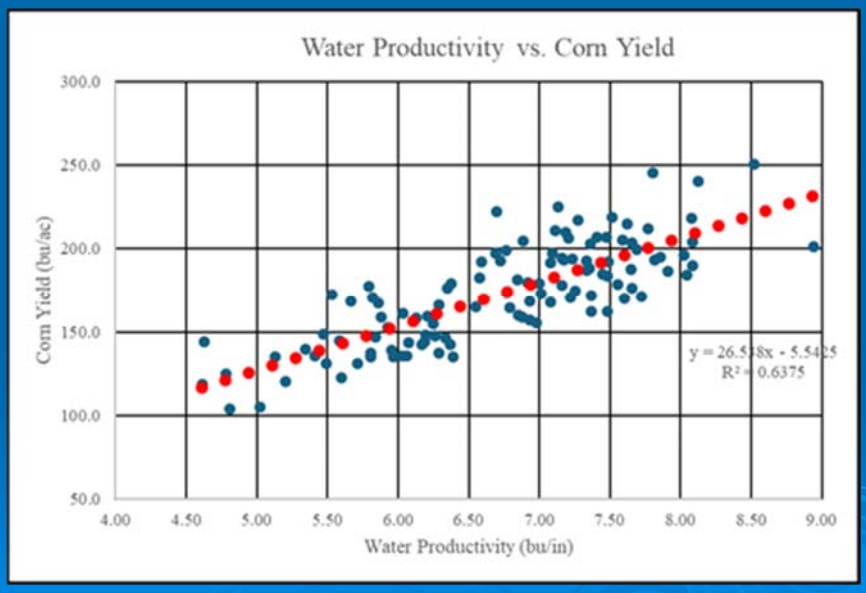
Summary Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Evapotranspiration (*ET*)	112	20.34	2.83	13.31	26.92
Precipitation (*ER*)	112	7.59	0.33	6.62	7.73
Change in Soil Moisture (ΔSM)	112	9.30	1.71	5.36	16.49
Irrigation (*IRR*)	112	8.81	2.14	5.45	15.25
Yield (*Y*)	112	173.26	30.16	103.83	250.34
Total Water (*TW*)	112	25.70	2.71	20.95	33.21
Water Use Efficiency (*WUE*)	112	0.79	0.08	0.43	0.90
Water Productivity (*WP*)	112	6.74	0.91	4.61	8.94

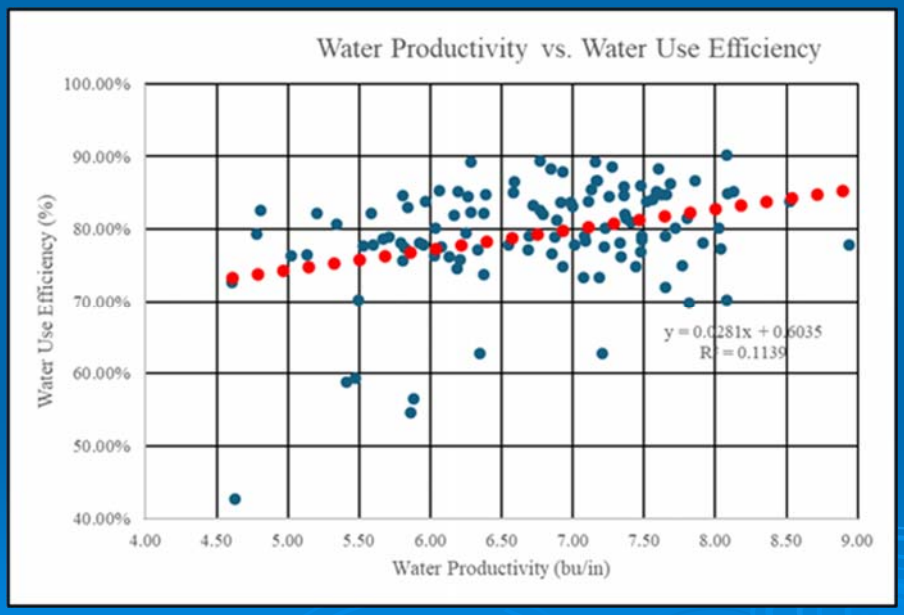
Water Use Efficiency vs Yield



Water Productivity vs Yield



WUE vs WP



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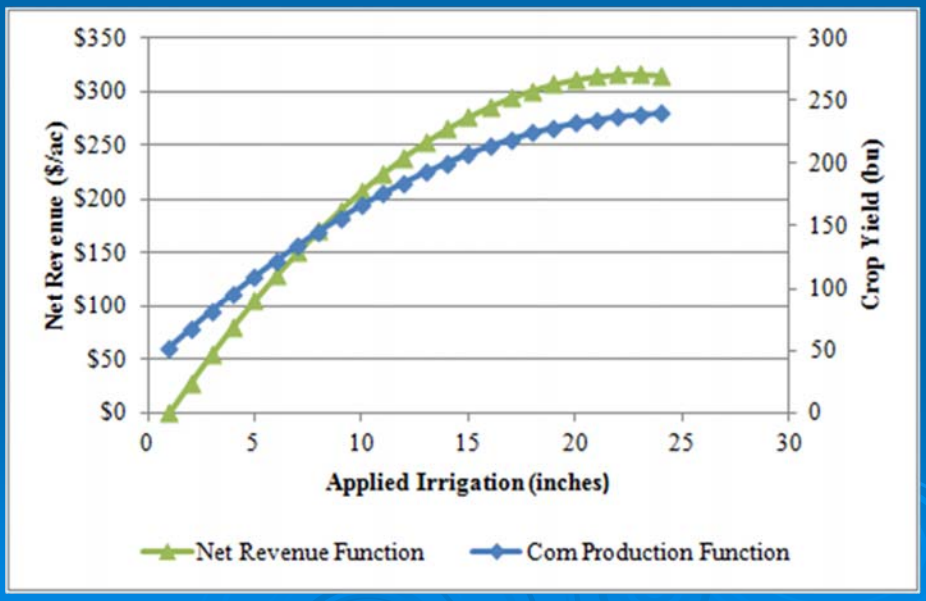
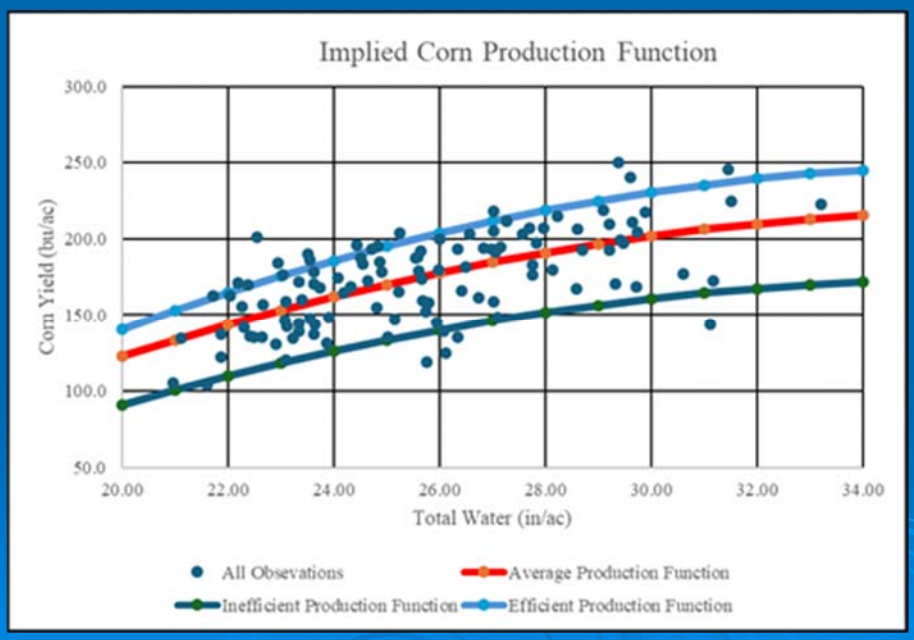


Implied Production Functions



Big Question

- What happens to producer income as we reduce groundwater usage?
- It depends on their current level of water use efficiency and water productivity

Where Do We Go From Here

- Analyze the relationship between profitability and WUE & WP
- The research suggested that there are certain hybrids that gave higher WUE and WP.
- Analyze the relationship between fertilizer usage and WUE & WP
- Evaluate the relationship between the change in soil moisture and WUE and WP

Where Do We Go From Here

- Current USDA SAS Grant titled “Sustainable Irrigation and Climate Adaptation in Southern High Plains: A Satellite-Enabled and Peer-Led Model”
- Current Memorandum of Understanding between KSU and USDA RMA
- Current FFAR proposal titled “Leveraging the Testing Agricultural Performance Solutions (TAPS) platform to understand producers’ decision-making and selected stacked practice outcomes” which will give access to Nebraska, Colorado, and Oklahoma TAPs data

Questions