Virtual workshop series:
Water Resource Management and Irrigation in Kansas

Natural Resources PFT

Kansas Center for Agricultural Resources and the Environment (KCARE)

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Theme 3: Water Resource Management and Irrigation in Kansas

- Offered as a Professional Development Event in PEARS for county extension agents
- 5 sessions in March and April, 8:30 am to 9:30 am
  - The next session is *March 30, 2021*
- **Zoom Meeting ID: 952 6066 1935, passcode: water OR livestream on YouTube**

Today's format

- Please **mute** your microphones. Use the chat to sign in.
- Speakers will present for 30-40 minutes
- Panelists will join the discussion at the end
- Please ask questions through the **chat** function (located at the lower part of your screen).
- Although our "end time" is posted for 9:30 a.m., participants are welcome to remain longer if they want to discuss the topic further.

Water Resource Management and Irrigation in Kansas

Understanding irrigation systems and new technologies

Thursday, March 25, 2021

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Speakers

Jonathan Aguilar
Associate Professor, Biological and Agricultural Engineering, Kansas State University

Matthew Sanderson
Randall C. Hill Distinguished Professor of Sociology, Anthropology, and Social Work, Kansas State University

Bill Golden
Research Assistant Professor, Department of Agricultural Economics, Kansas State University

Moderator

Aleksey Sheshukov, Associate Professor, Department of Biological and Agricultural Engineering, Kansas State University

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Attitudes toward water in the High Plains-Ogallala Region

Matthew R. Sanderson, Ph.D.
Randall C. Hill Distinguished
Professor of Sociology
& Professor of Geography and
Geospatial Sciences
Kansas State University

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Motivation?

- Time is running out
  - and it's been a long time…
- Do not know much about:
  - how people view water
  - how/why they value it (or not)
- Where are shared values? Where are tensions?
- Then, can help build capacity… ***if*** this is a goal…
- ***Is*** there a problem?
- Whether people subject to this 'problem' actually believe there is a problem
- Conservation efforts lack legitimacy
- …if people that must face consequences of depletion do not believe there is a problem

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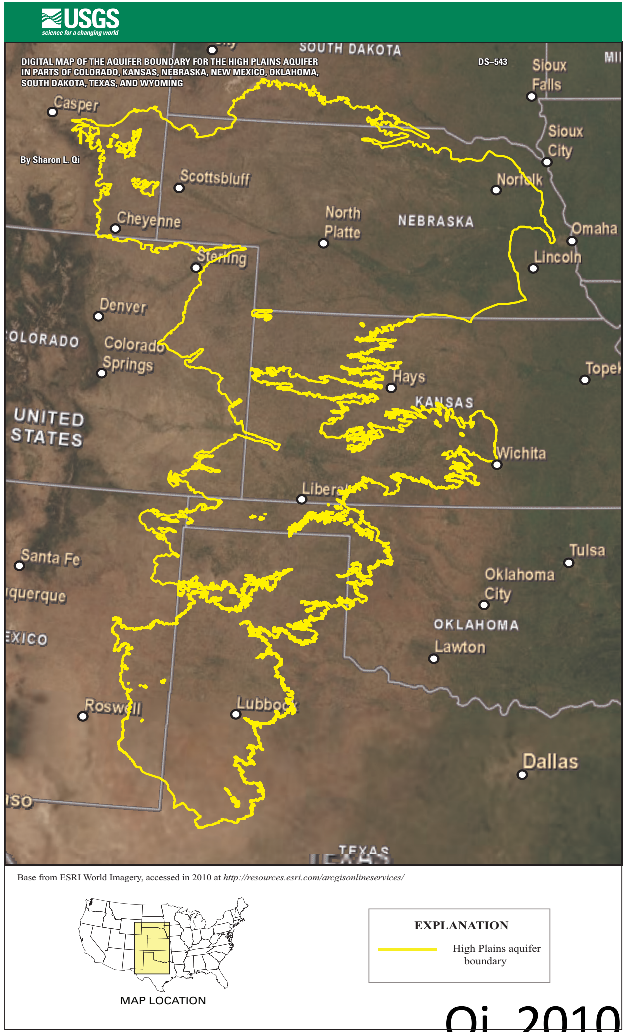
Data and Methods

- January – July 2018
- 1,226 responses
- Represents target population [USDA Ag Census]
  - Age, Education, Income, Farm ops
- Good variation
  - 52% did not irrigate [n = 625]
  - 48% did irrigate [n = 578]



Qi, 2010

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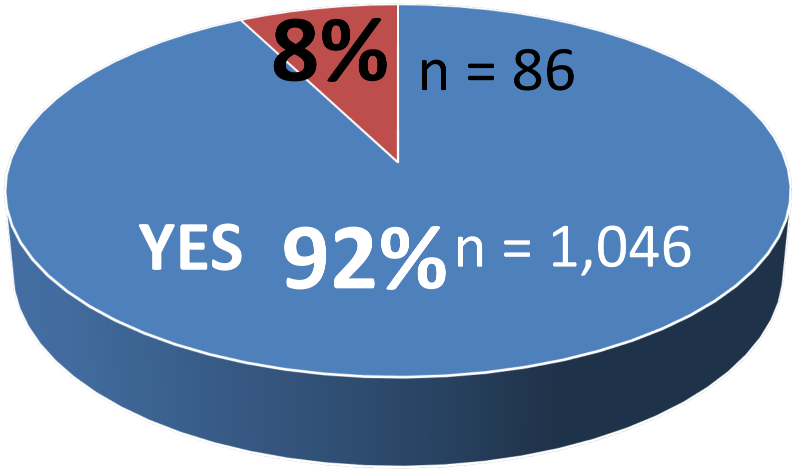
Should groundwater be saved or conserved?



- Yes or No
  - 94 no-response [7.7%]
- **Overall ~ 9/10 say "yes"**
  - 85% with non-responses
- By state, no fewer than 8/10 say "yes" [with non-responses]
- CO = 81%
- NE = 83%
- TX = 84%
- **KS = 90%**
- OK = 92%
- NM = 94%

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Have views of the problem changed over 34 years?

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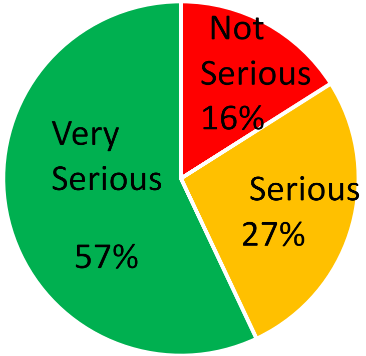
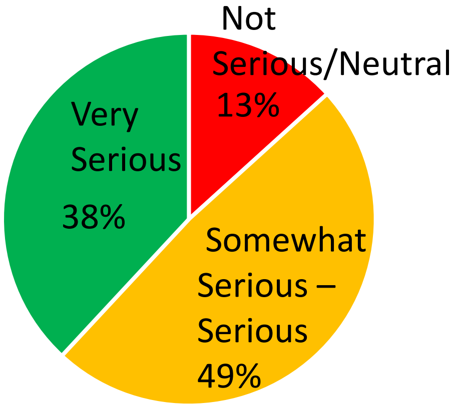
How serious is the problem?

- Kromm and White:
- Mean **3.74** [n = 956]: **Serious to Very serious**
- **84%: Serious problem**



- Our study: Same question

1. In 14 K&W counties, mean is unchanged = **3.74** [n=294]: **Serious**
2. **87%?: Serious problem**
3. Percentage viewing as a "Very Serious" problem **declined ~20%**
   - Note: K&W had more general public included



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Does view of problem severity vary by state?

- Kromm and White did not seem to disaggregate

- **Clear difference between Nebraska and all other states [North to South]**
- Nebraska = 42% [27% Serious + 15% Very Serious]

- In 5/6 states: ***"super-majority" (2/3) "serious or very serious"***
- In TX and NM: ***nearly ½ "very serious"***

- Colorado = 67% [27% Serious + 40% Very Serious]
- **Kansas = 74% [37% Serious + 37% Very Serious]**
- Oklahoma = 80% [45% Serious + 35% Very Serious]
- Texas = 83% [33% Serious + 50% Very Serious]
- New Mexico = 85% [38% Serious + 47% Very Serious]

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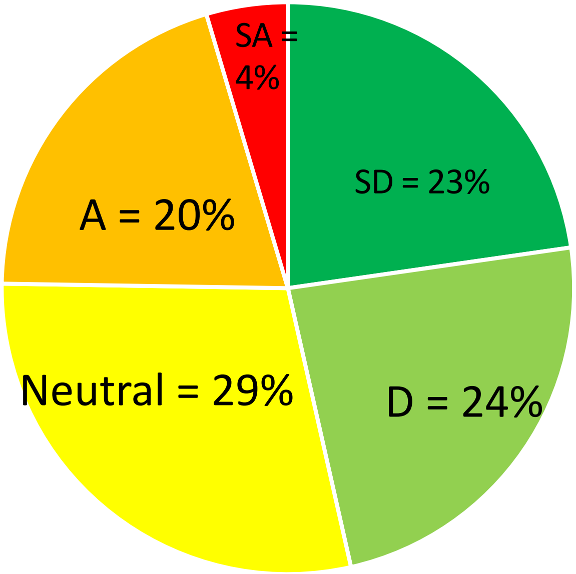
"Groundwater should be used. Groundwater does no good in the ground."

- **"Use ethic/value"**
  - **1 = strongly disagree; 5 = strongly agree**

- Only ~1/4 ***agree*** to some extent (24%)
- Of note:
  - ~ 1/3 are neutral [29%]
  - ~ 1/2 disagree to some extent [47%]

- Some difference across states…



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“Groundwater should be used. Groundwater does no good in the ground.”

- **Overall, 24% agree**

- By state, no more than 1/3 agree or strongly agree:
  - CO = 33%
  - TX = 29%
  - NE = 27%
  - NM = 24%
  - OK = 19%
  - **KS = 14%**

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"Groundwater levels are problem for my community"

- **Overall, 47% agree**

- Strong perception of community exposure **across the region**
  - Only in NE do <55% agree; in NE [only 29% agree]

- In ***all*** states, perception of **community problem is >** perception of personal problem
- **In *Kansas*, the gap in perception (personal/community problem) *is largest***

- TX: 80% [73% perceive it as a personal problem]
- NM: 76% [61%]
- CO: 67% [56%]
- **KS: 61% [37%] +24% difference**
- OK: 55% [47%]
- NE: 29% [23%]

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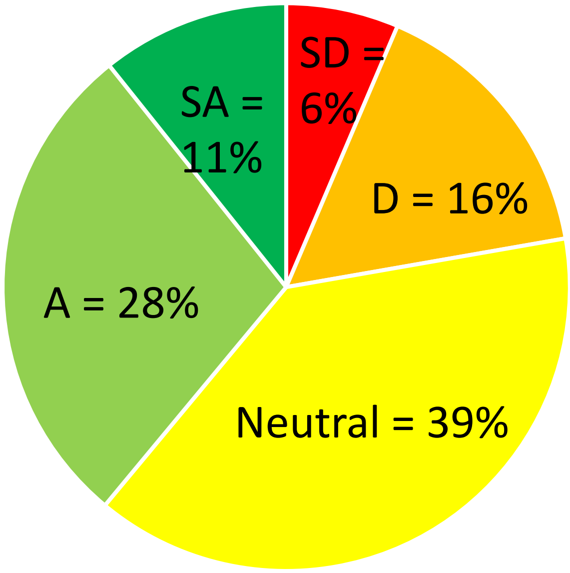
Groundwater should be conserved today so that…

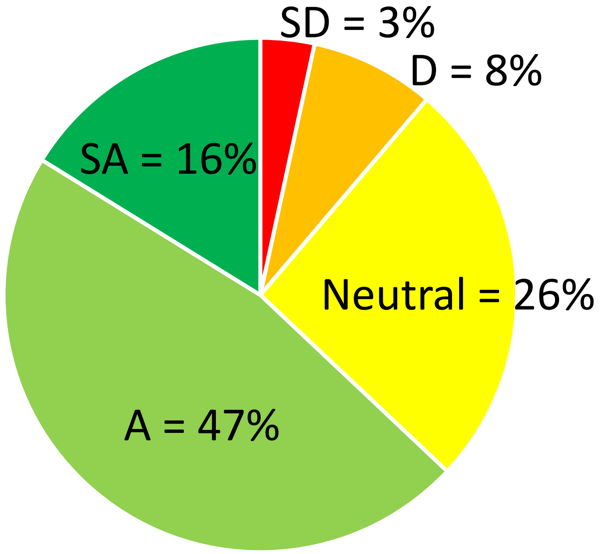
…it is available to producers if **<u>commodity prices</u>** are higher in the future.

39% Agree



…it is available to producers if **<u>drought</u>** becomes more frequent in the future.

73% Agree



Strongest agreement on altruistic measures…

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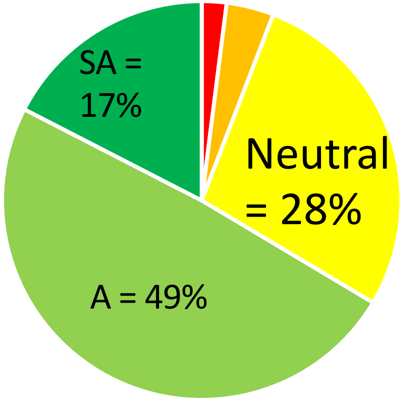
Groundwater should be conserved today so that…

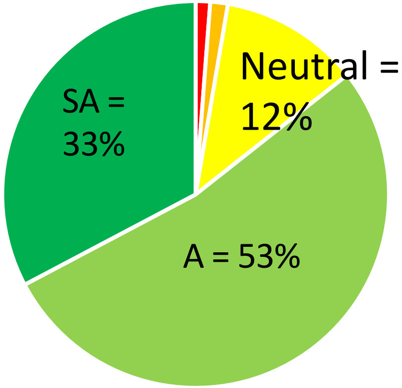
"…**jobs and business** opportunities continue to be available in my **community** in the future."

66% Agree



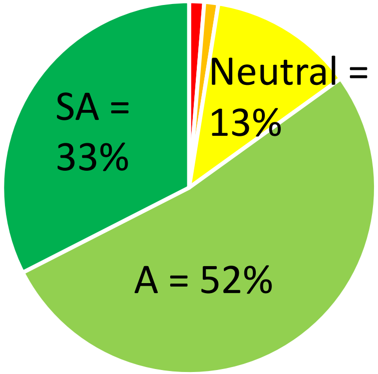
"….**future generations in my area** can enjoy the benefits I have experienced."

86% Agree



"…**my children and grandchildren** can enjoy the benefits I have experienced."

85% Agree



So, then what is groundwater "worth"?...

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Summary & Implications

1. Nebraska is different

2. **Yes,** there is a legitimate problem, and it is perceived to be ***about as severe as it was in 1984***
   - In near term (5 years), perceived stability in living standards

3. **Drought** is a major **personal** reason to conserve
   - Considerable perceived dependence with variation in **personal** exposure/vulnerability

- But…

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Summary & Implications

5. A key aspect of the challenge is **social/community-based**
   - Pushing tech adoption further can still play role; many doing what they can
   - Will be more about ***extending*** technologies, broadening uptake
   - May be more limited, but could be means of building networks, capacities, culture of conservation…

6. Despite variation in personal exposure/vulnerability, perception of **community dependence is stronger and less variable**
   - Likely even higher among public

7. Good news: seems to be sufficient **altruism**
   - Strong majorities see a future for others in the region as most important reason to conserve
   - E.g., jobs, businesses, future generations, my kids and grandkids

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Funding Agencies and Partners

USDA
United States Department of Agriculture
National Institute of Food and Agriculture

OgallalaWater.org
OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

KANSAS STATE UNIVERSITY

IRRIGATION TRENDS AND MANAGEMENT TOOLS

Jonathan Aguilar, PhD, PE

Assoc. Professor/ Water Resource Engineer
K-State Southwest Research –Extension Center
Garden City, KS

KEY ITEMS

- Irrigators are doing something, but…
- Irrigation water is important, but…
- How to navigate through the tools/tech

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Why Irrigate?

- Improve Yield
  - Narrow Yield Gap
  - Increase Net Return
- Stabilize Yield
- Improve Product Quality
- Improve Local Economy
- Reduce Risks (rainfall timing)

Kansas Precipitation

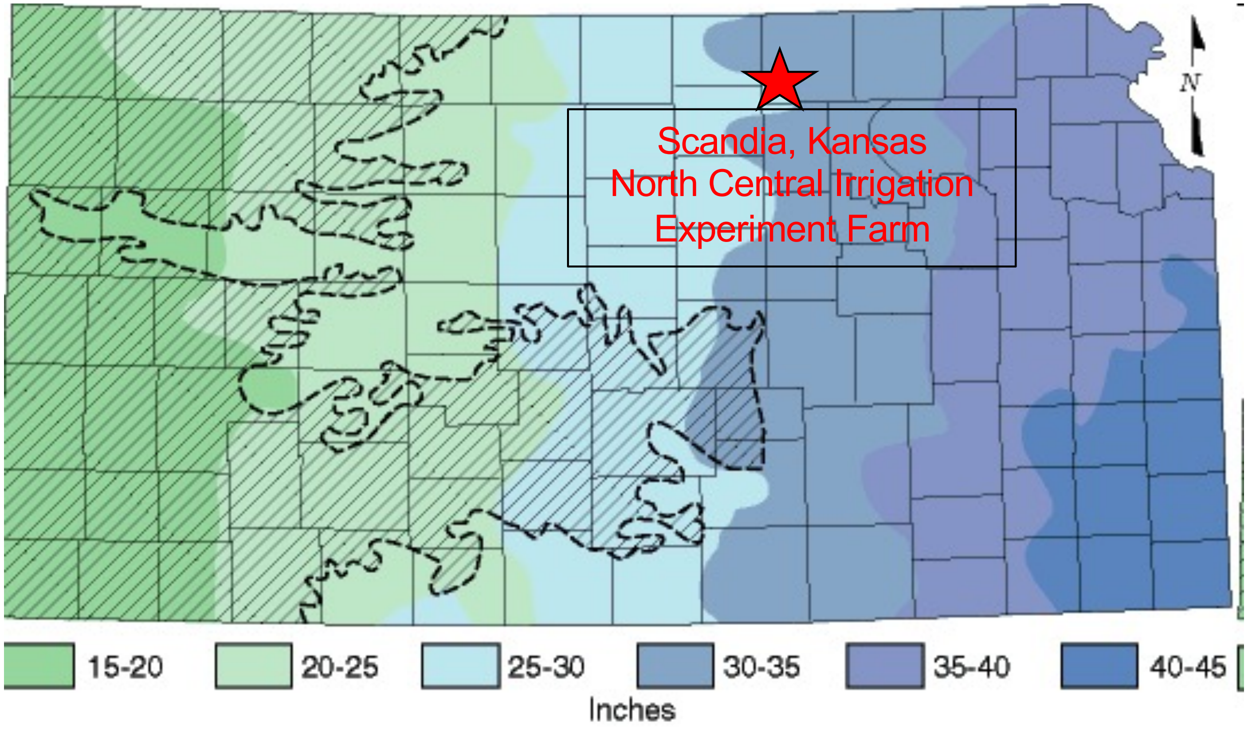

Figure 3. Normal annual precipitation (1961 - 1990) in Kansas. The area west of the dashed line shows the extent of the High Plains aquifer in Kansas (from Goodin et al., 1995).

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Improve Yield

Time of Irrigation Study at Scandia Exp. Farm	1991 Yield Bu/Ac	1980-1991 Bu/Ac	1991 Irrigation Date
No Irrigation	**3**	**56**	None
1X (Tassel)	**124**	**141**	7/8
2X (Tassel + 1 week)	148	159	7/8, 7/15
3X (Tassel + 1 wk + 2 wks)	155	164	7/8, 7/15, 7/25
2X (65% depletion)	159	172	7/1, 7/23

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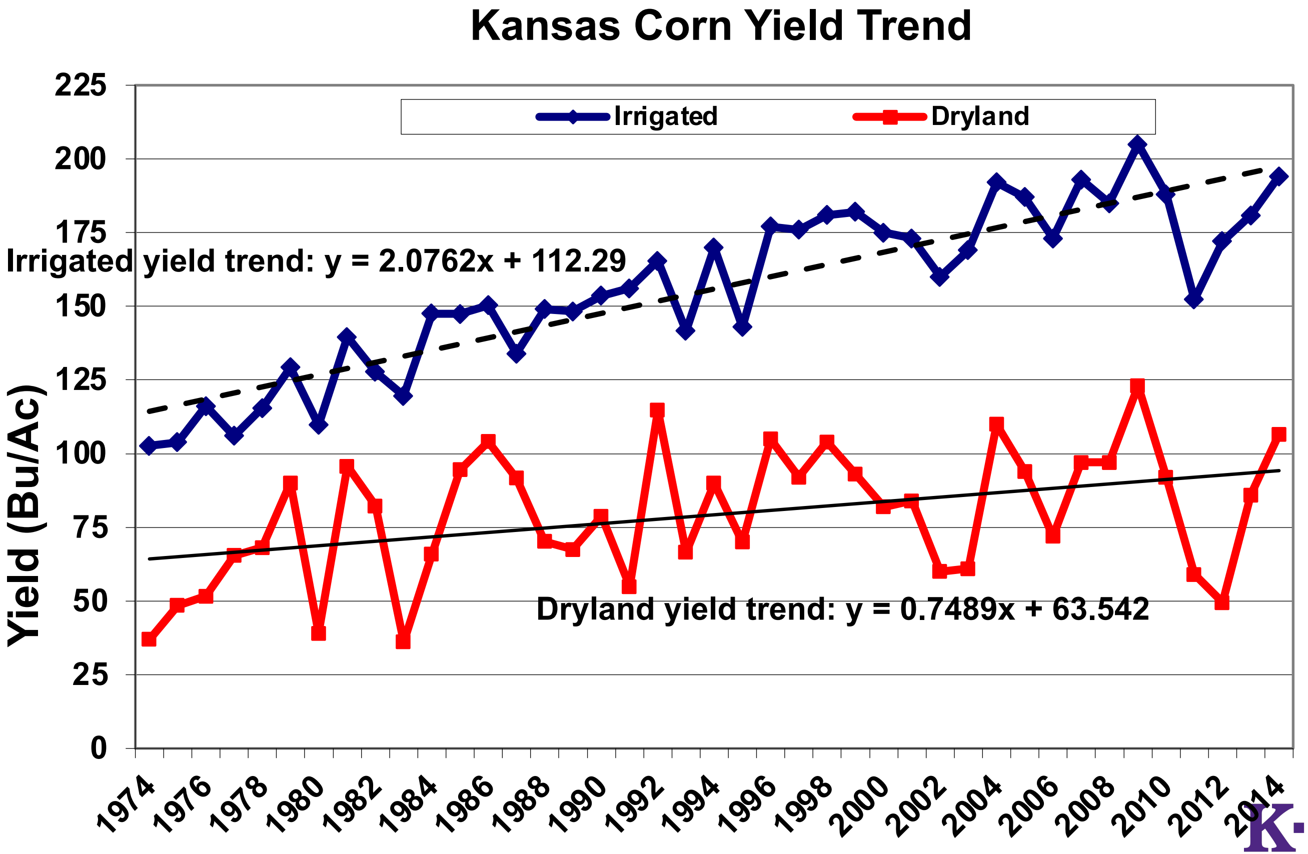
Stabilize yield



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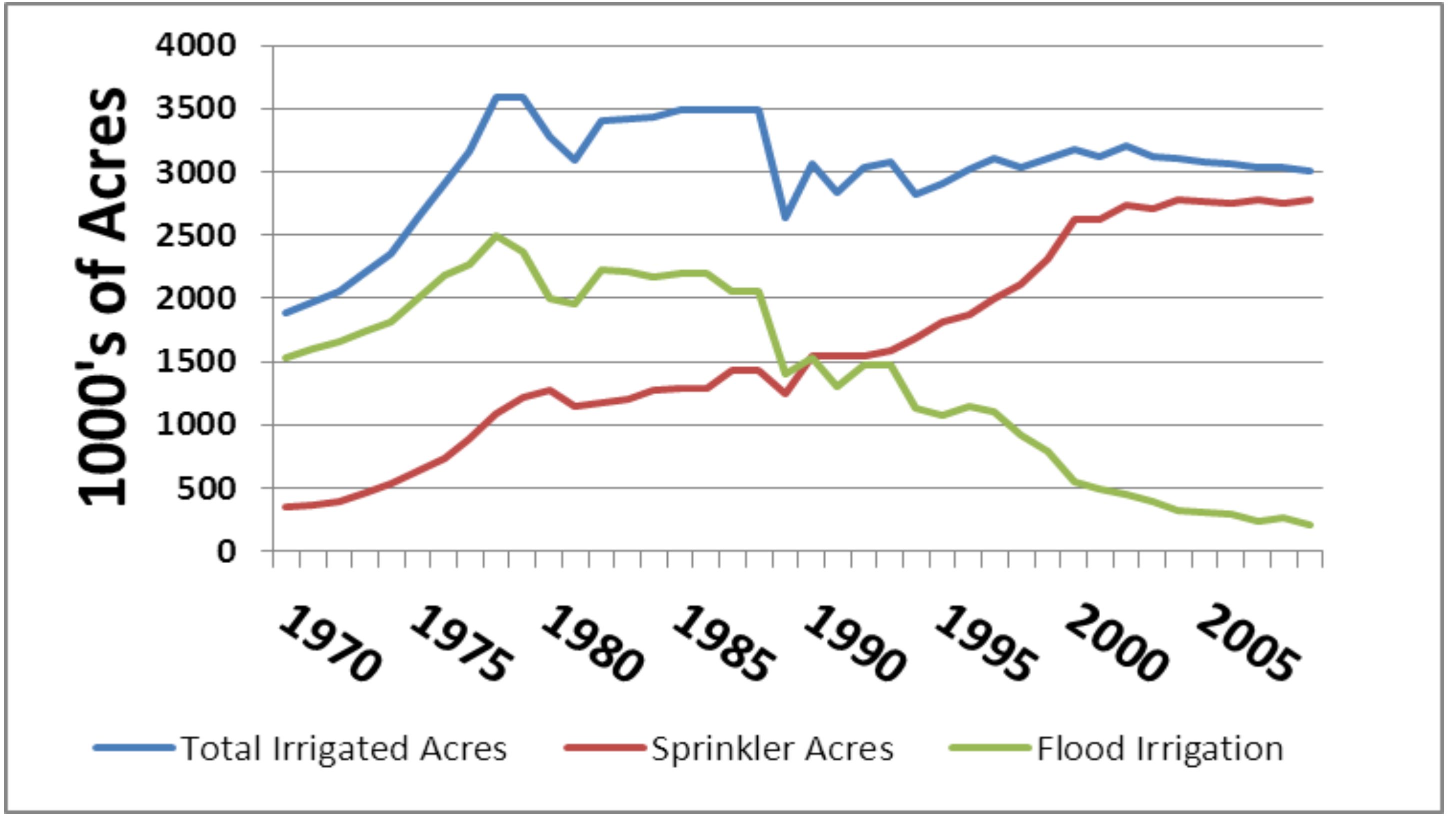
Total irrigated area by system in Kansas



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Kansas: 1989 – 2017 Irrigated Acres

Reporting Unit	1989 acres	2012 acres	2017 acres	Change in acres	% Change since 1989
GMD 1	291,574	198,377	177,528	-114,046	-39.1
GMD 3	1,572,470	1,424,923	1,393,101	-179,369	-11.4
GMD 4	359,016	387,286	392,003	32,987	9.2
Rest of Region 1 (West)	106,915	109,220	113,022	6,107	5.7
Total of Region 1 (West)	**2,329,975**	**2,119,806**	**2,075,654**	**-254,321**	**-10.9**
GMD 2	94,683	136,543	150,786	56,103	59.3
GMD 5	429,133	456,746	458,119	28,986	6.8
Rest of Region 2 (Central)	192,664	248,916	273,152	80,488	41.8
Total of Region 2 (Central)	**716,480**	**842,205**	**882,057**	**165,577**	**23.1**
Total of Region 3 (East)	**52,375**	**80,070**	**100,809**	**48,434**	**92.5**
State	**3,098,830**	**3,042,081**	**3,058,520**	**-40,310**	**-1.3**

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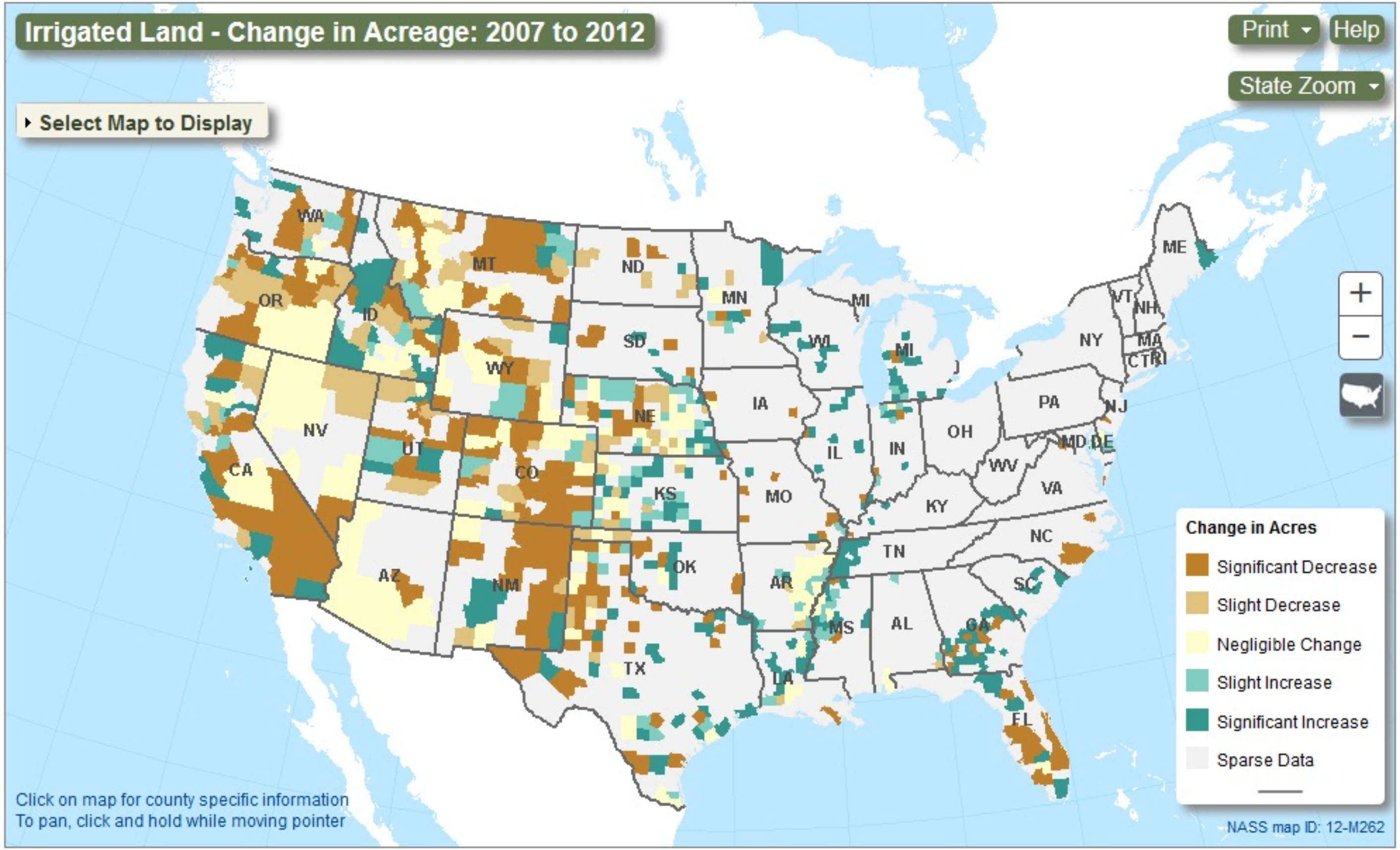

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IRRIGATION MANAGEMENT IS KEY

- System Efficiency
- Application Efficiency
- Planning Tools
- Scheduling
- Strategies

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A pair of binoculars IS NOT an irrigation technology

SURVEY SAYS:
MY IRRIGATION SCHEDULE DEPENDS ON MY NEIGHBOR

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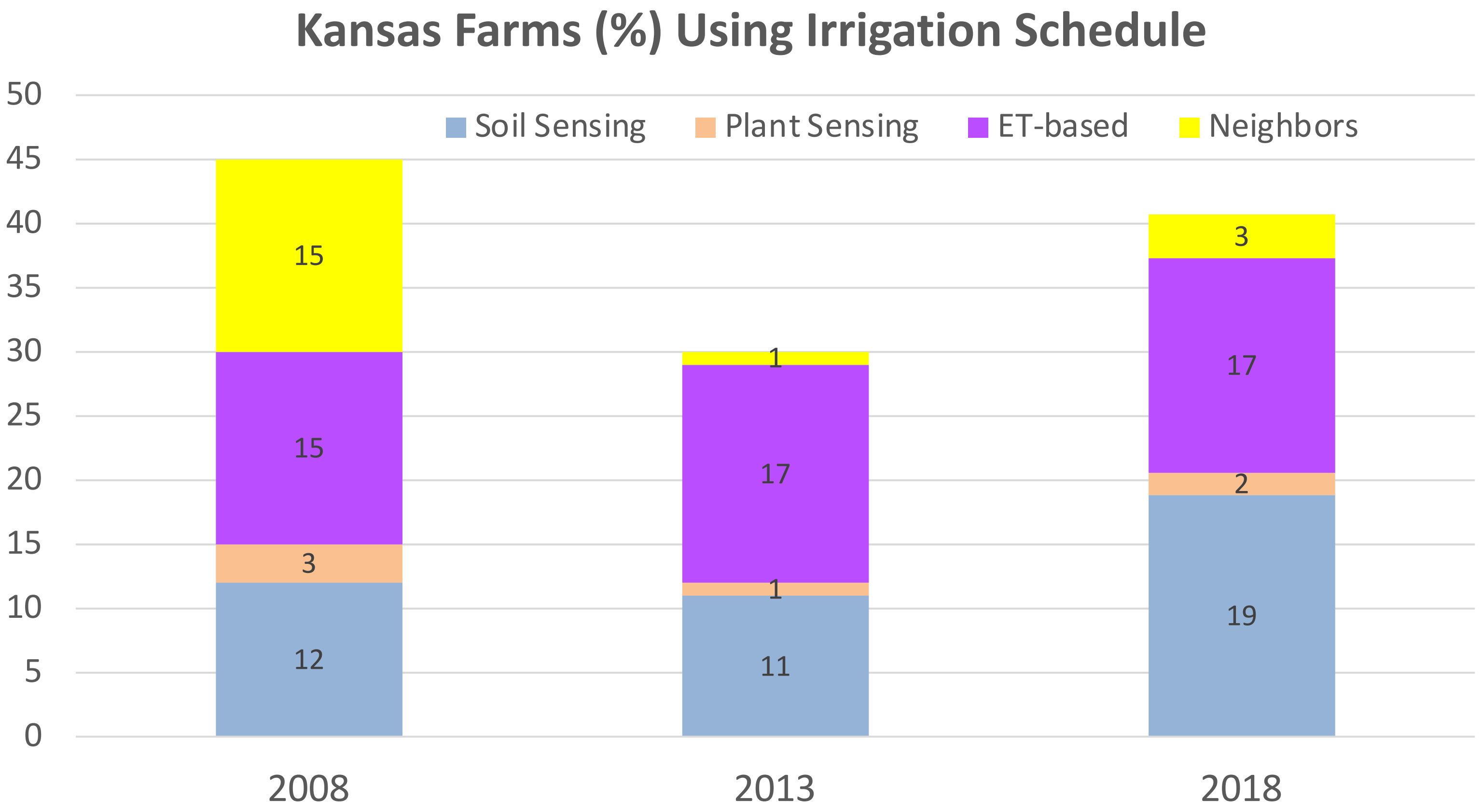

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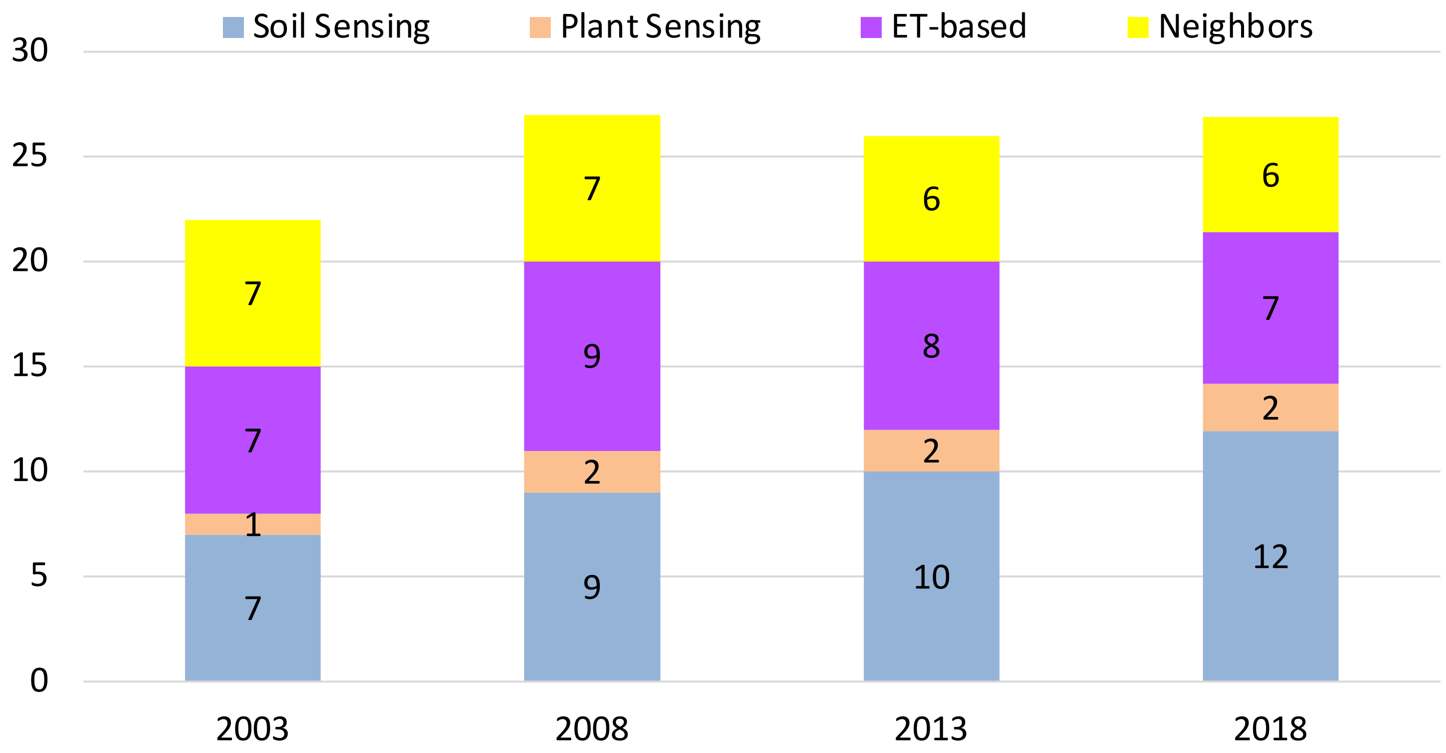
US Farms (%) Using Irrigation Schedule



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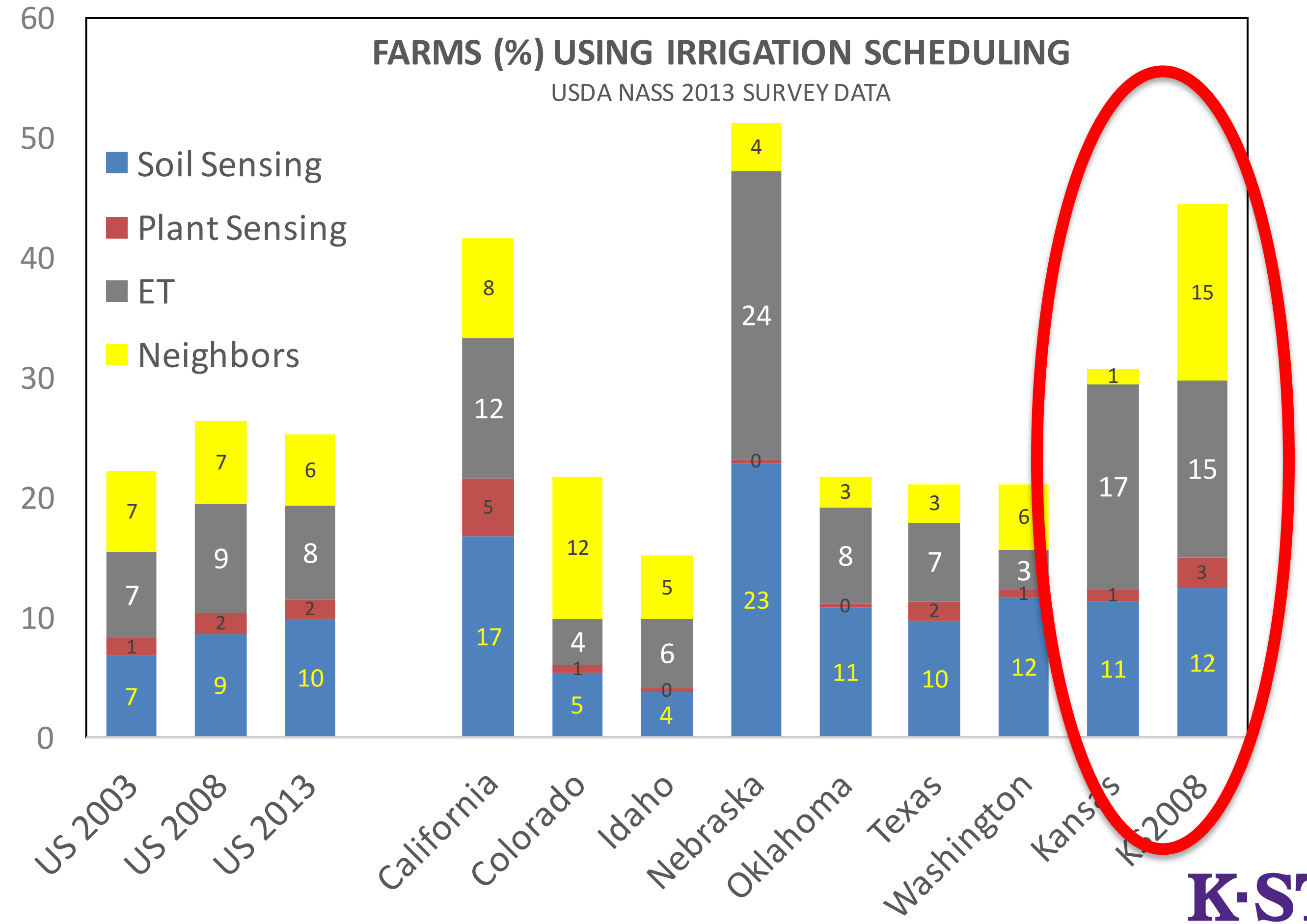
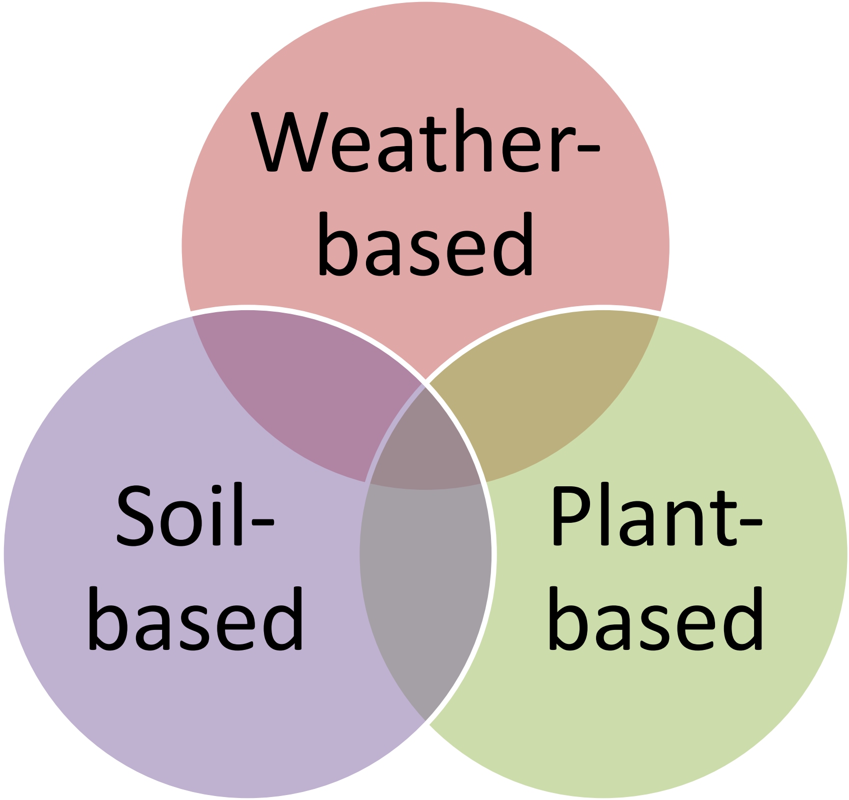

FARMS (%) USING IRRIGATION SCHEDULING
USDA NASS 2013 SURVEY DATA
Soil Sensing
Plant Sensing
ET
Neighbors
60
50
40
30
20
10
0
US 2003
US 2008
US 2013
California
Colorado
Idaho
Nebraska
Oklahoma
Texas
Washington
Kansas
KS2008

How to Schedule



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Irrigation Scheduling Tools

Weather
-based

- KanSched
- ET Gauge/Atmometer
- Checkbook method
- DIEM - TX
- WISE - CO
- *K-State Mesonet*
- *FRET - NOAA*

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Irrigation Scheduling Tools

Soil-based

- Gravimetric
- Tensiometer
- Soil Water Potential
- Neutron count
- Electrical Resistance
- Electromagnetic
- Hand probe / feel

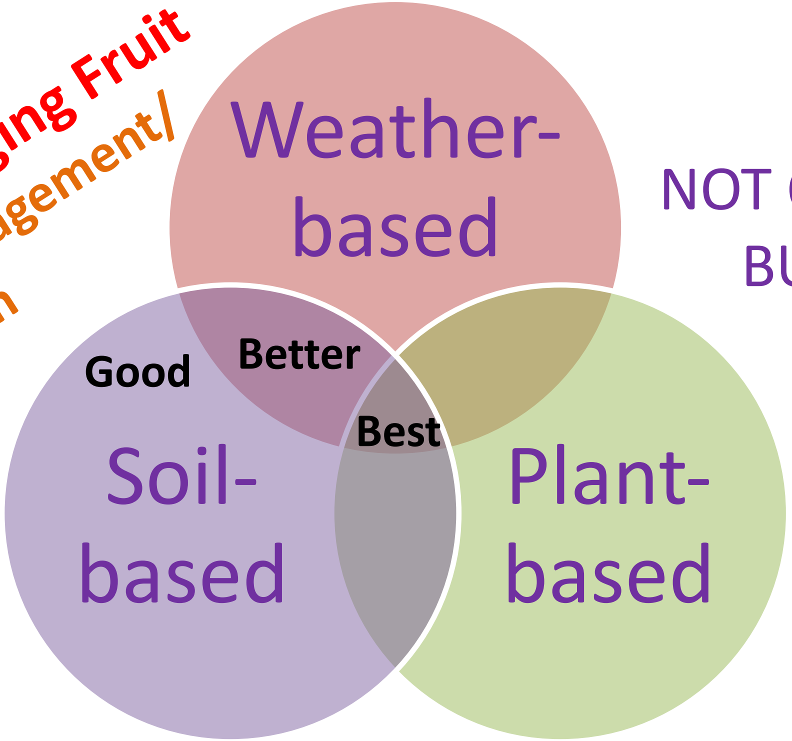
Irrigation Scheduling Tools

Plant-based

- Infrared / Thermal Camera
- Dendrometer
- Micro-tensiometer
- Osmotic/water potential
- NDVI/Aerial Imagery
- Visual

Use One or More Feedback for Scheduling

The Low Hanging Fruit
In water management/
conservation



NOT ONE TOOL IS PERFECT,
BUILDS CONFIDENCE

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Mobile Irrigation Lab

Kansas State University Research and Extension

Home | Resources | Goals of the MIL | Software | Online Tools | The MIL Team | Contact Us

Welcome to the Mobile Irrigation Lab

This web site provides information on the activities of the Mobile Irrigation Lab and to provide free software and media downloads to assist in irrigation management and cropping system strategies.

The MIL program is supported in part by State Water Plan Funds through the Kansas Water Office.

Software Links

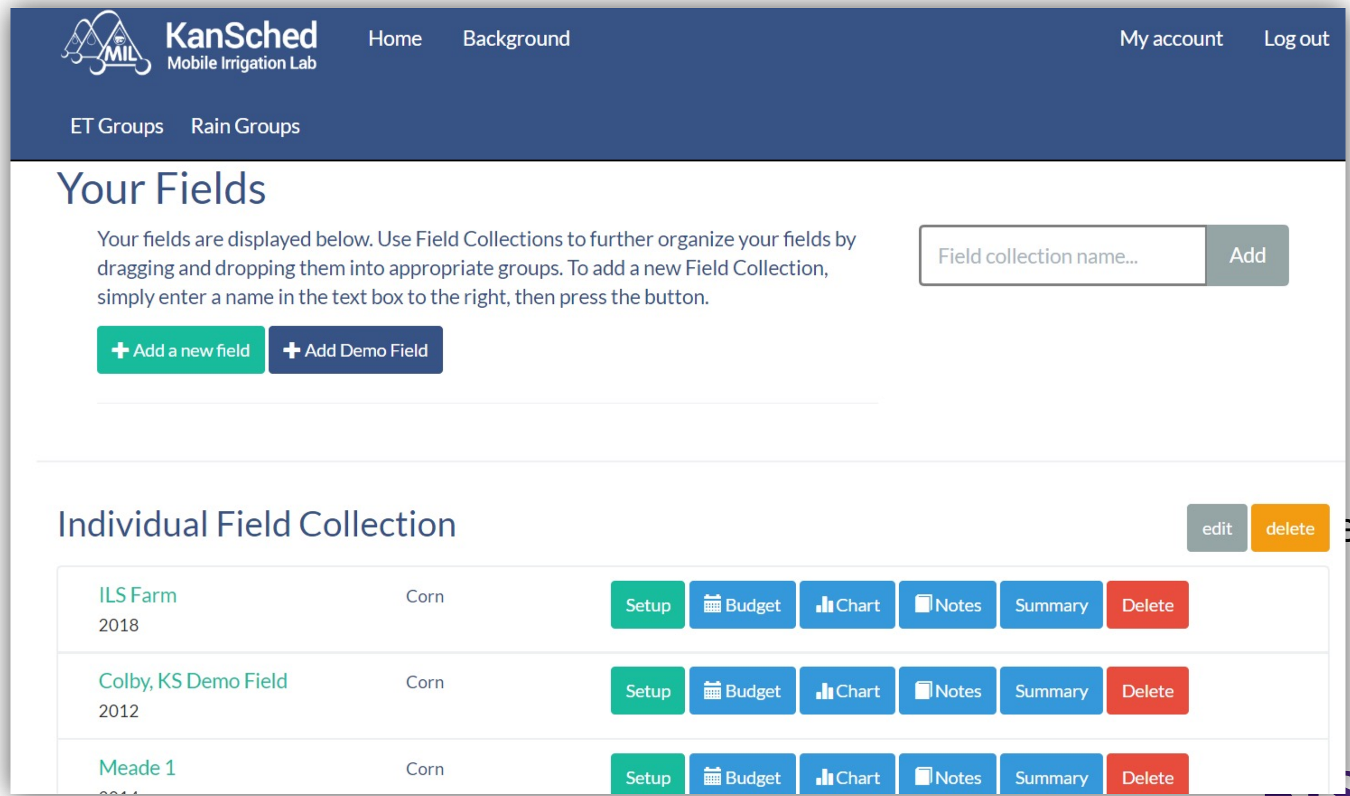
- Crop Water Allocator
- Crop Yield Predictor
- KanSched for Excel
- KanSched2
- SWREC ET Data
- NWREC ET Data
- FuelCost
- Pocket PC Software
- Quiz Master

Online Tools

- Crop Water Allocator
- Crop Yield Predictor
- KanSched3
- Compare Energy

Please update your links and watch out for its upgrade

KanSched 3 – online version (beta)
KanSched 4 – mobile app (beta – test users)



ed3

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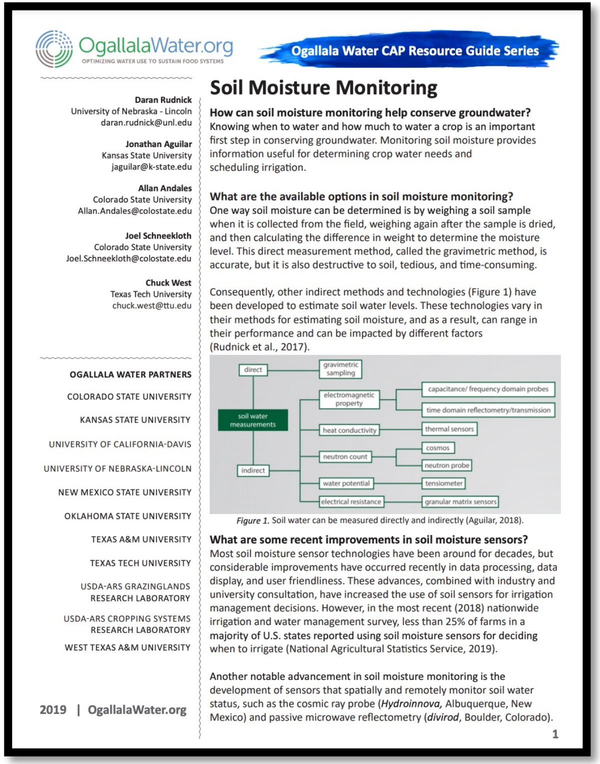
TIPS on selecting soil water sensor



OgallalaWater.org
OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

Ogallala Water CAP Resource Guide Series

Soil Moisture Monitoring

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TEXAS A&M UNIVERSITY
TEXAS TECH UNIVERSITY
USDA-ARS GRAZINGLANDS RESEARCH LABORATORY
USDA-ARS CROPPING SYSTEMS RESEARCH LABORATORY
WEST TEXAS A&M UNIVERSITY

How can soil moisture monitoring help conserve groundwater?
Knowing when to water and how much to water a crop is an important first step in conserving groundwater. Monitoring soil moisture provides information useful for determining crop water needs and scheduling irrigation.

What are the available options in soil moisture monitoring?
One way soil moisture can be determined is by weighing a soil sample when it is collected from the field, weighing again after the sample is dried, and then calculating the difference in weight to determine the moisture level. This direct measurement method, called the gravimetric method, is accurate, but it is also destructive to soil, tedious, and time-consuming.

Consequently, other indirect methods and technologies (Figure 1) have been developed to estimate soil water levels. These technologies vary in their methods for estimating soil moisture, and as a result, can range in their performance and can be impacted by different factors (Rudnick et al., 2017).

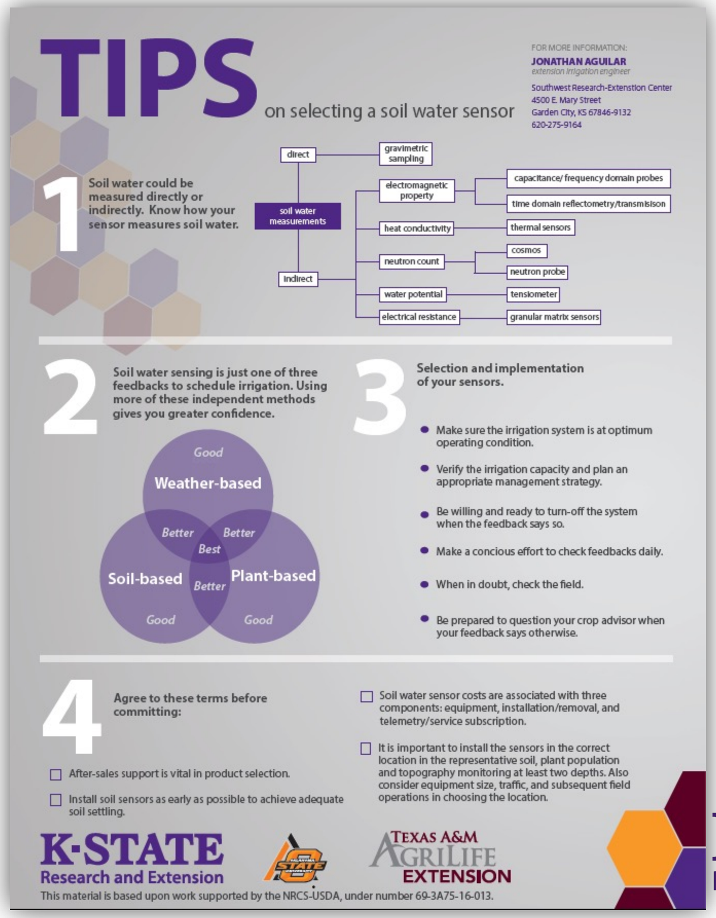
direct — gravimetric sampling
soil water measurements
indirect — electromagnetic property (capacitance/ frequency domain probes; time domain reflectometry/transmission), heat conductivity (thermal sensors), neutron count (cosmos; neutron probe), water potential (tensiometer), electrical resistance (granular matrix sensors)

Figure 1. Soil water can be measured directly and indirectly (Aguilar, 2018).

What are some recent improvements in soil moisture sensors?
Most soil moisture sensor technologies have been around for decades, but considerable improvements have occurred recently in data processing, data display, and user friendliness. These advances, combined with industry and university consultation, have increased the use of soil sensors for irrigation management decisions. However, in the most recent (2018) nationwide irrigation and water management survey, less than 25% of farms in a majority of U.S. states reported using soil moisture sensors for deciding when to irrigate (National Agricultural Statistics Service, 2019).

Another notable advancement in soil moisture monitoring is the development of sensors that spatially and remotely monitor soil water status, such as the cosmic ray probe (*Hydroinnova*, Albuquerque, New Mexico) and passive microwave reflectometry (*divirod*, Boulder, Colorado).

Ogallalawater.org/topics
KSRE Bookstore Search: MF3707



TIPS
on selecting a soil water sensor

FOR MORE INFORMATION:
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extension irrigation engineer
Southwest Research-Extension Center
4500 E. Mary Street
Garden City, KS 67846-9132
620-275-9164

1 Soil water could be measured directly or indirectly. Know how your sensor measures soil water.

2 Soil water sensing is just one of three feedbacks to schedule irrigation. Using more of these independent methods gives you greater confidence.

3 Selection and implementation of your sensors.

- Make sure the irrigation system is at optimum operating condition.
- Verify the irrigation capacity and plan an appropriate management strategy.
- Be willing and ready to turn-off the system when the feedback says so.
- Make a concious effort to check feedbacks daily.
- When in doubt, check the field.
- Be prepared to question your crop advisor when your feedback says otherwise.

4 Agree to these terms before committing:

- ☐ After-sales support is vital in product selection.
- ☐ Install soil sensors as early as possible to achieve adequate soil settling.
- ☐ Soil water sensor costs are associated with three components: equipment, installation/removal, and telemetry/service subscription.
- ☐ It is important to install the sensors in the correct location in the representative soil, plant population and topography monitoring at least two depths. Also consider equipment size, traffic, and subsequent field operations in choosing the location.

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TEXAS A&M AGRILIFE EXTENSION

This material is based upon work supported by the NRCS-USDA, under number 69-3A75-16-013.

- Soil Type, Location, location, location
- Costs include subscription
- After-sales support is vital
- Easy integration to your operation

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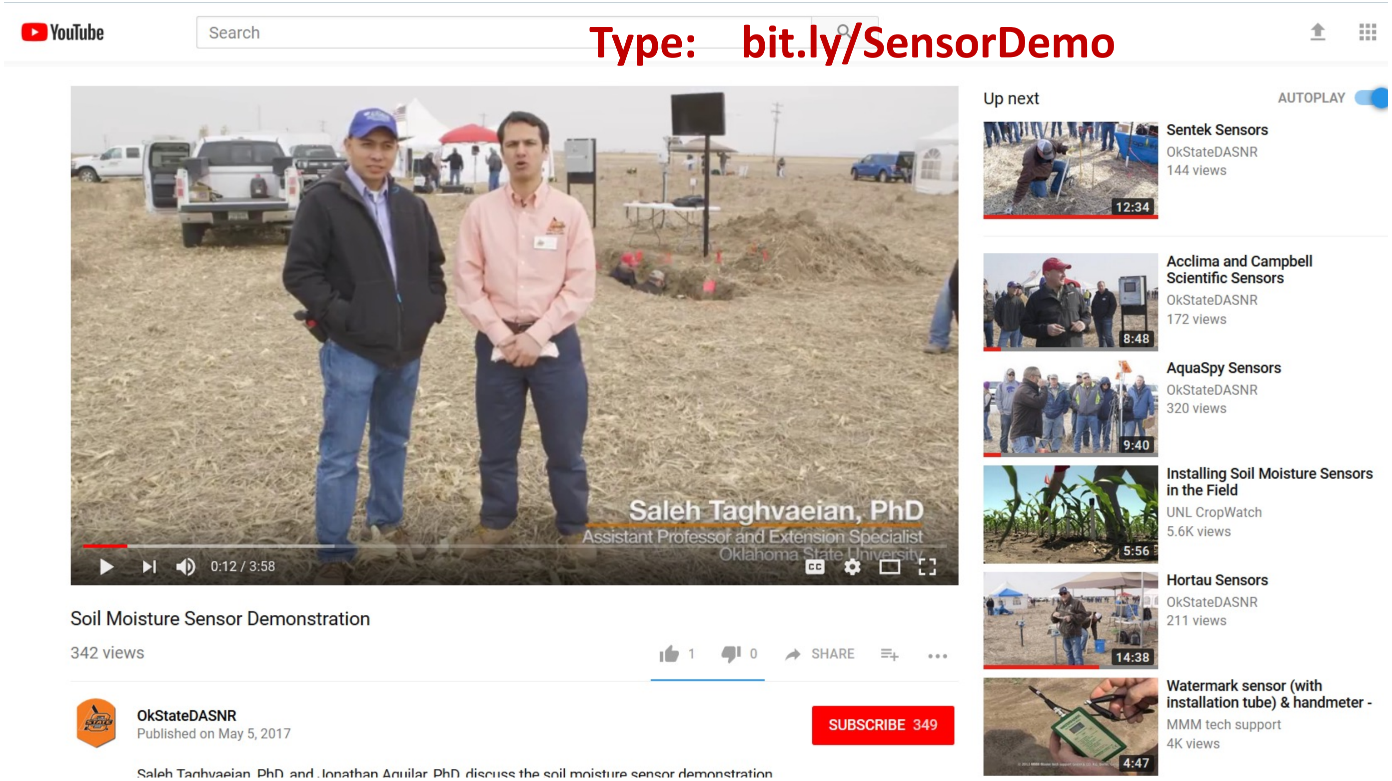
Soil Moisture Sensor Demonstration Videos

Type: bit.ly/SensorDemo



Recognized: 2018 ASABE Blue Ribbon Award

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MORE RESOURCES

- milab.ksu.edu
- ksre.k-state.edu/irrigate
- www.ogallalawater.org
- irrigationtoday.org
- Opportunity: IA’s Agriculture Faculty Academy

THANK YOU

Contact info:

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Economics of Producer-Driven Groundwater Pumping Reductions in Kansas

Dr. Bill Golden

Water resource management and irrigation in Kansas
Understanding Irrigation Systems and New Technologies
March 25, 2021

Ogallala Aquifer

Kansas Water Office

OgallalaWater.org
OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

This research was funded in part by the Kansas Water Office under Contract # 15-0112, the USDA Ogallala Aquifer Project, and the U.S.D.A. – N.I.F.A. Ogallala Water CAP Project

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LEMAs

- LEMA’s are initiated by local producers – but after enactment carry the weight of law
- LEMA’s set their own rules
- LEMA’s are reversible
- Sheridan #6: 5 year 55” allocation => about a 20% reduction

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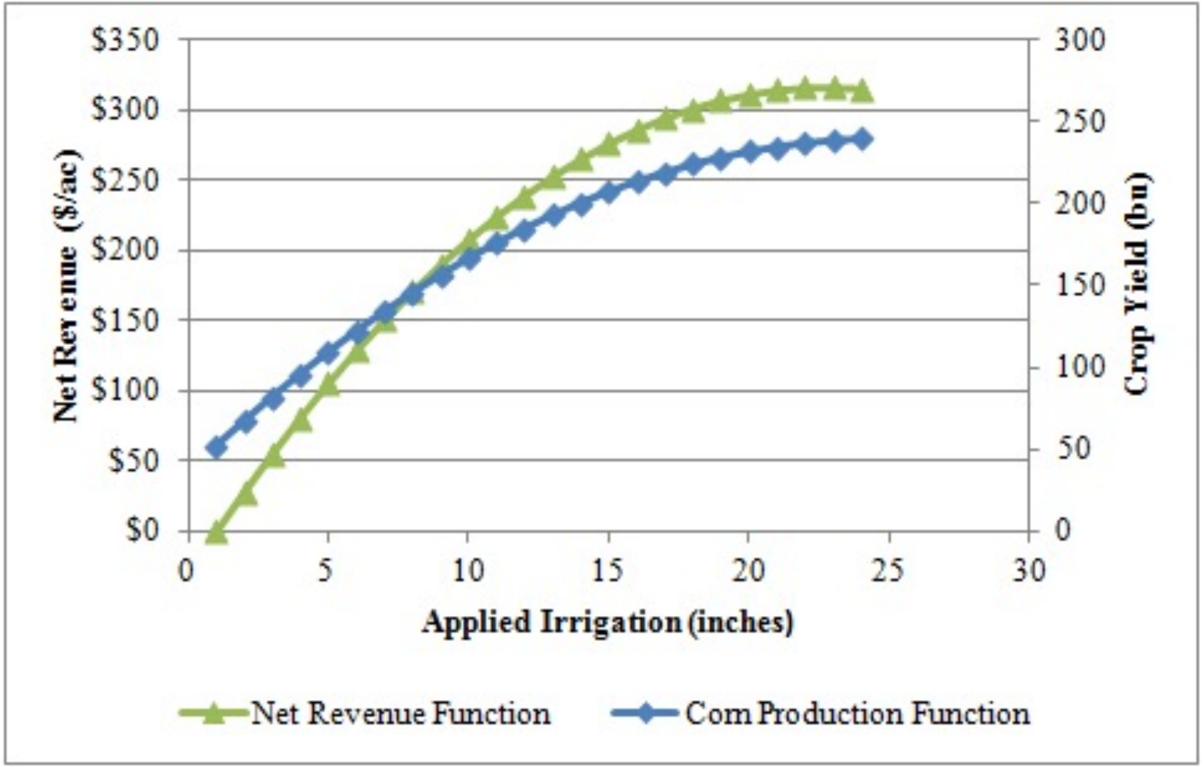
Big Question

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

- Past evidence is not consistent !!!

What We Think We Know



Example from Southwest Kansas. Both curves exhibit diminishing marginal returns to applied groundwater. Curves vary by crop, location, precipitation, and time

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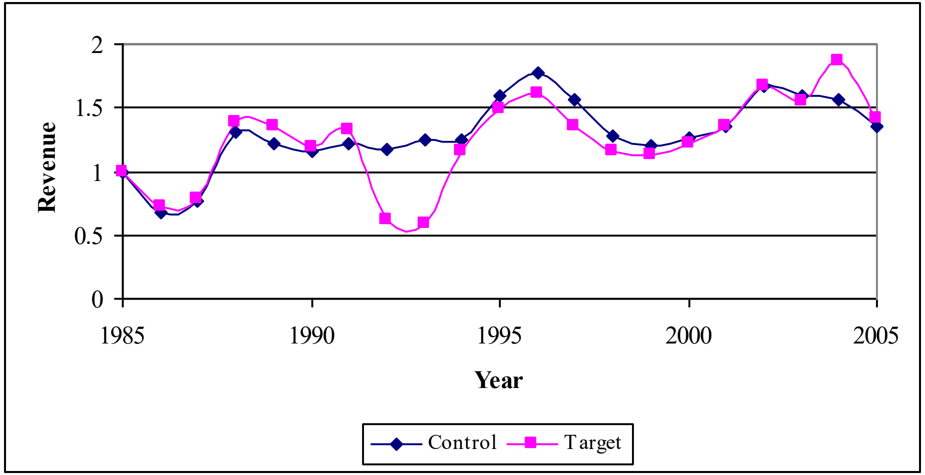
What We Have Observed: Wet Walnut Creek IGUCA: Irrigated Crop Revenue

Figure 6. Time Series Comparison of the Indexed Values of Irrigated Crop Revenue



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

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Since the Evidence is Not Consistent

- We need to monitor irrigated acreage and water use in Sheridan #6 LEMA in real time. Will producers:
  - Shift acres to dryland production
  - Maintain crop mix and reduce water use per acre
  - Shift to crops that require less water
- What are the economic consequences of these changes

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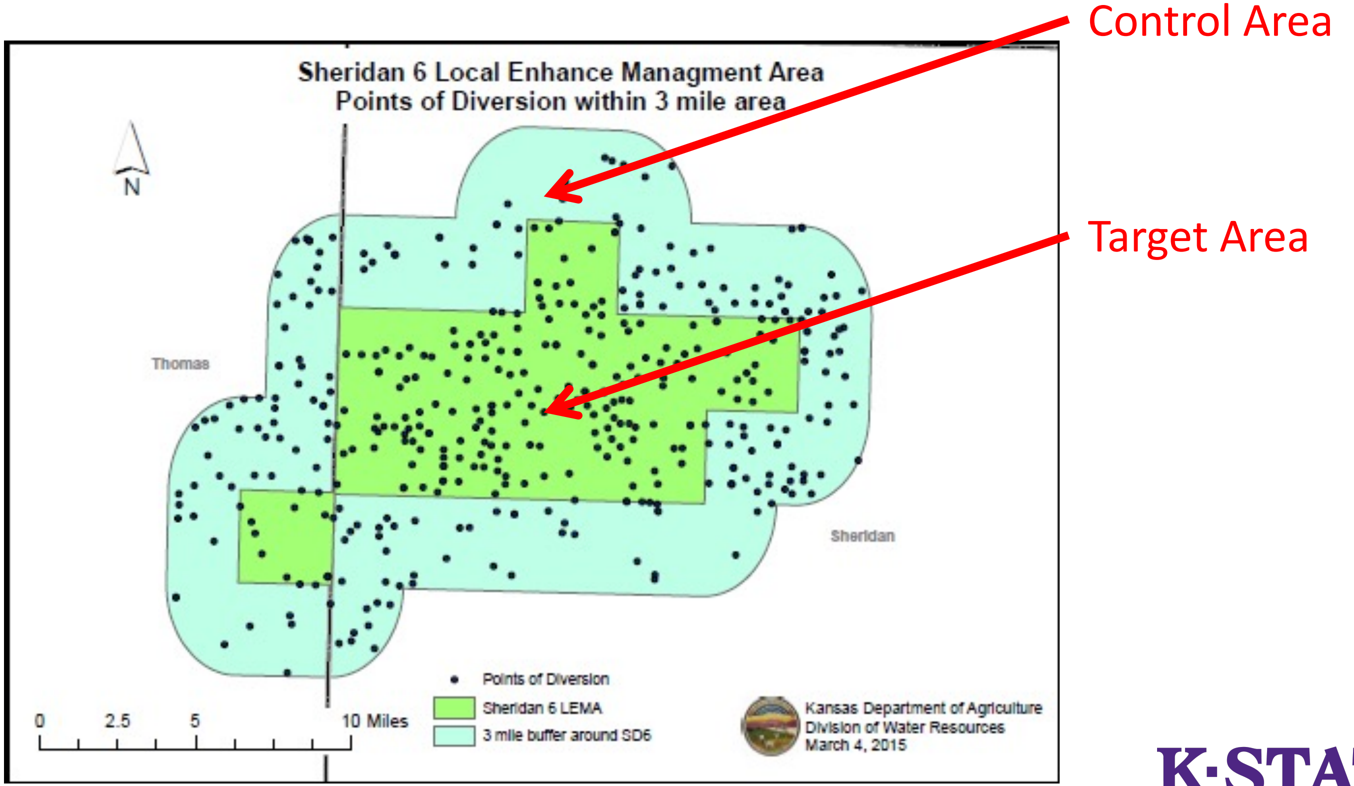
Research Question

- How did the production decisions the producers inside the LEMA made, compare to the production decisions the producers outside the LEMA made
- This originally was a 5-year study.

Sheridan #6 LEMA



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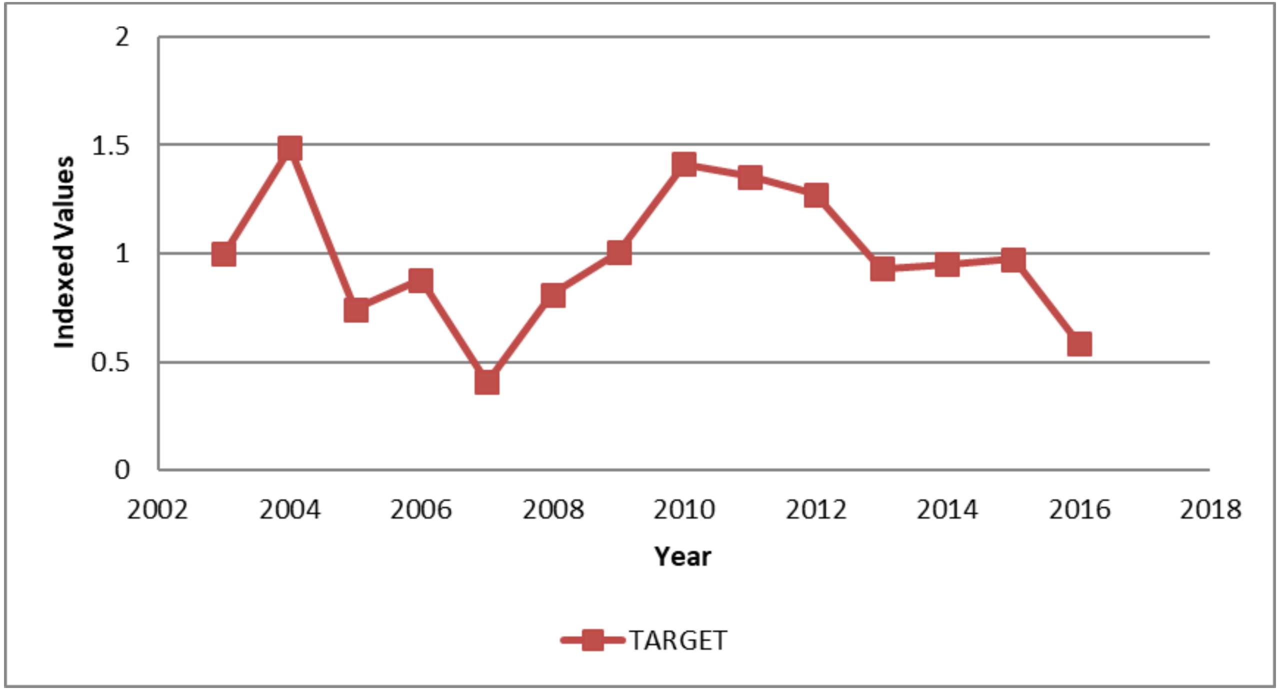
Why Do We Compare Decisions ?



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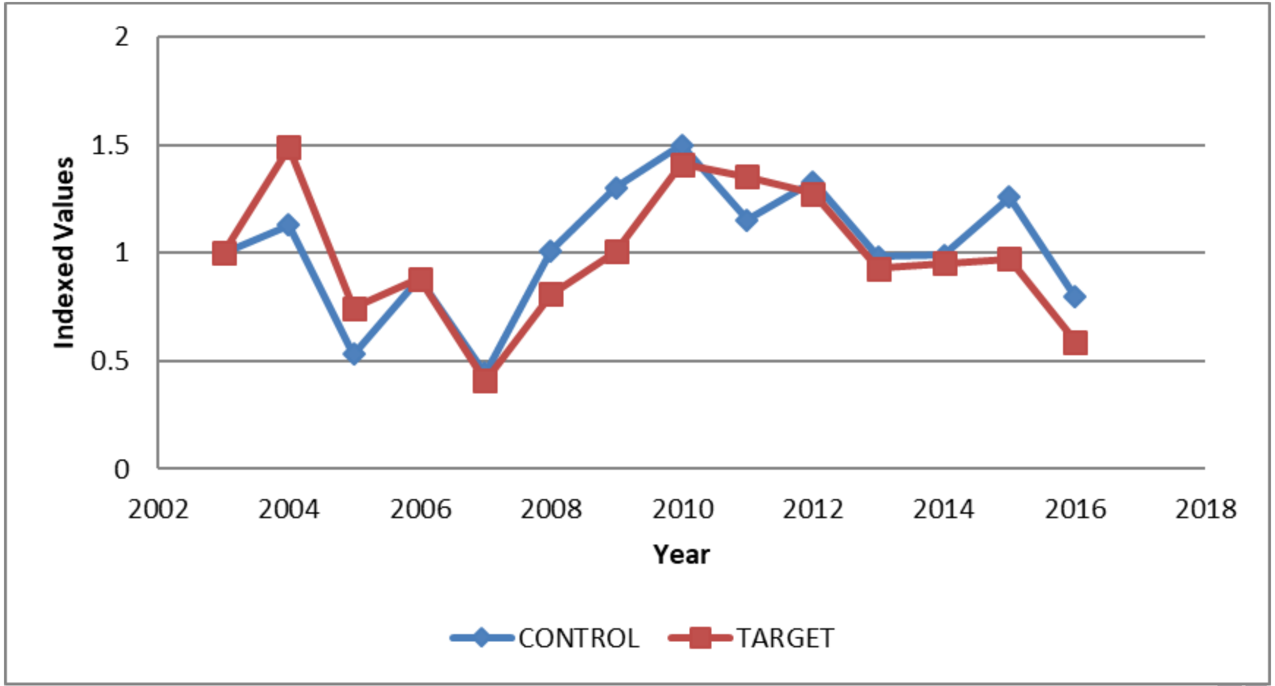

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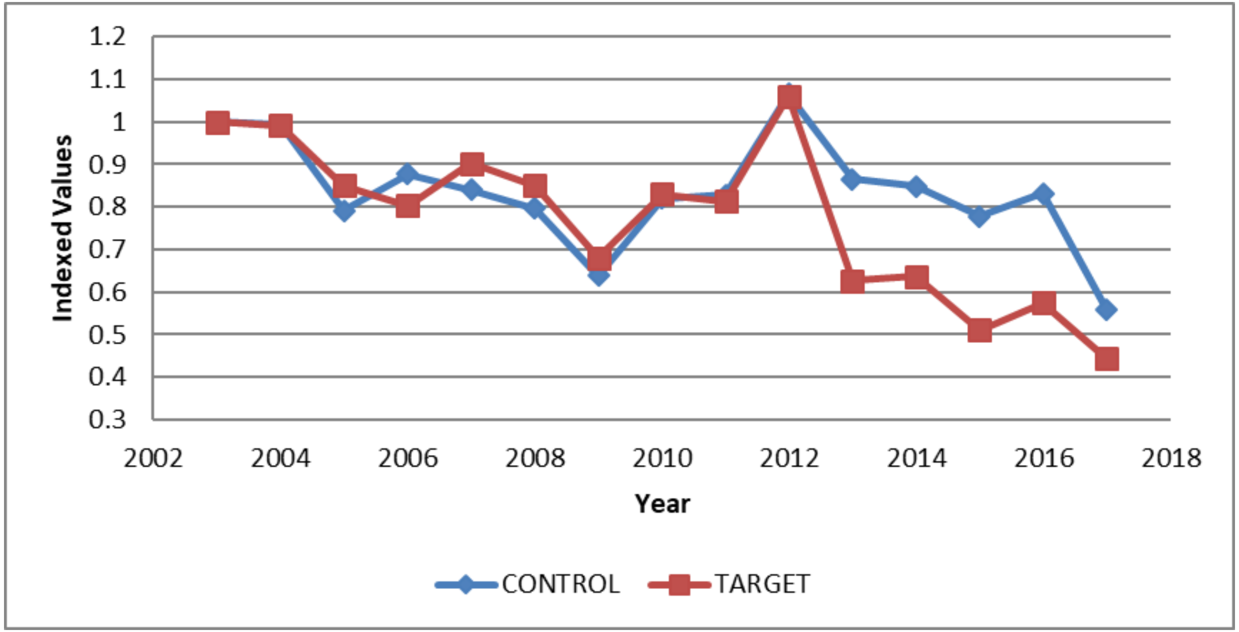
Results

Total Water Use (all crops)



Approximately 23.1% reduction; statistically significant

Based on KDA water use reports

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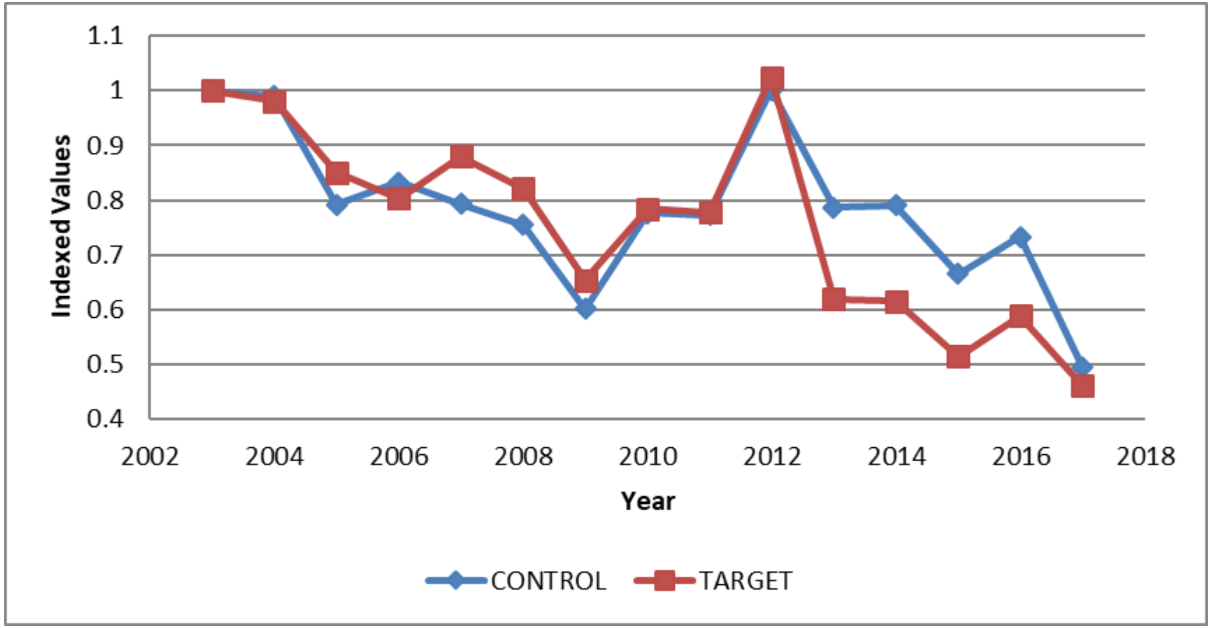
Results

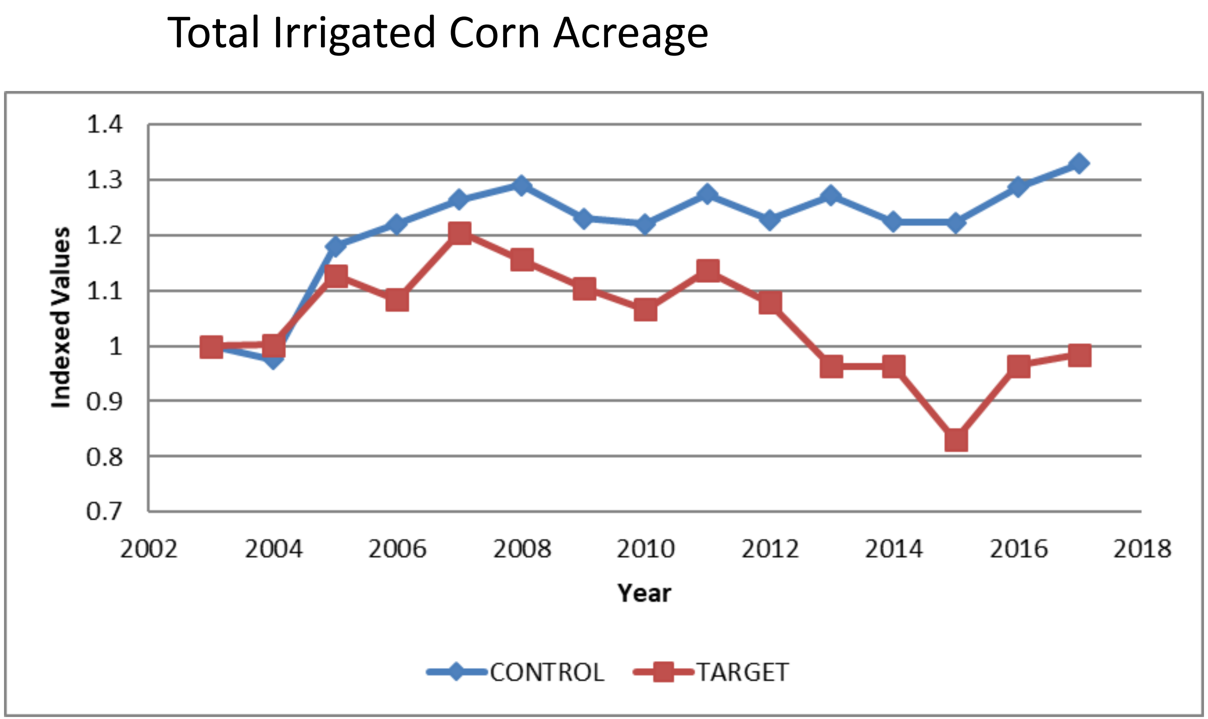
Average Water Use per Acre (all crops)



Approximately 16.0% reduction; statistically significant

Based on KDA water use reports

Results



Approximately 23.3% reduction; statistically significant

Based on KDA water use reports

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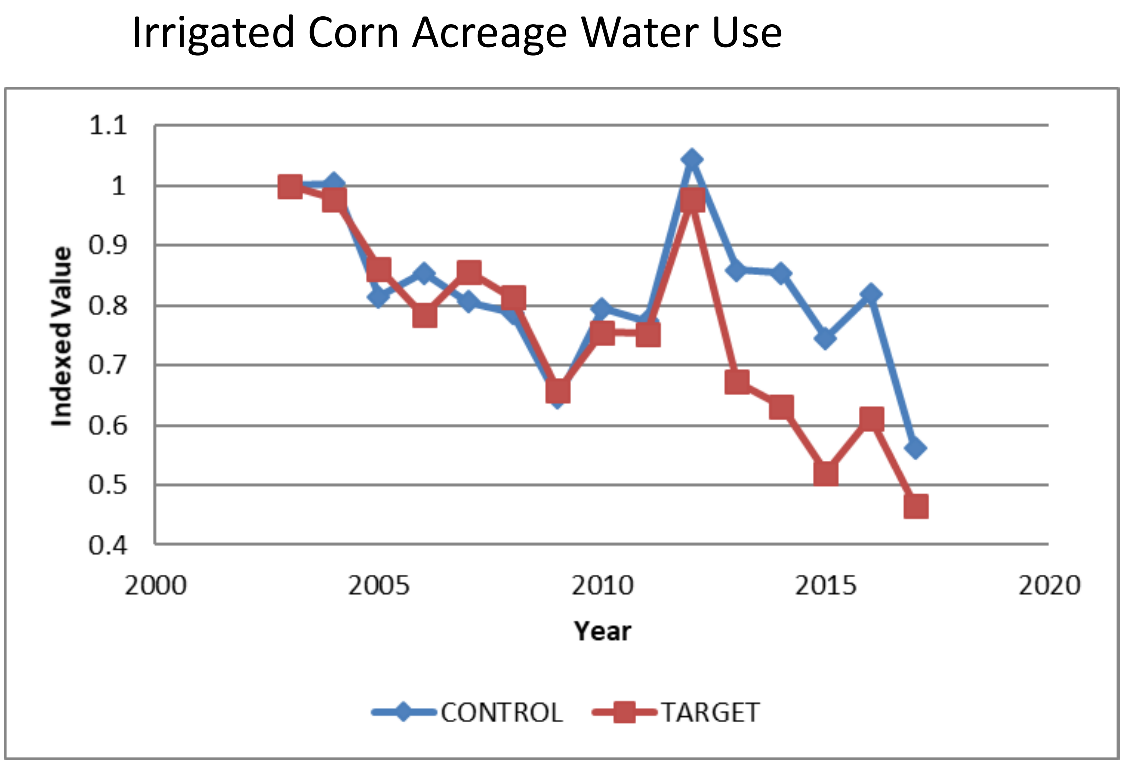
Results

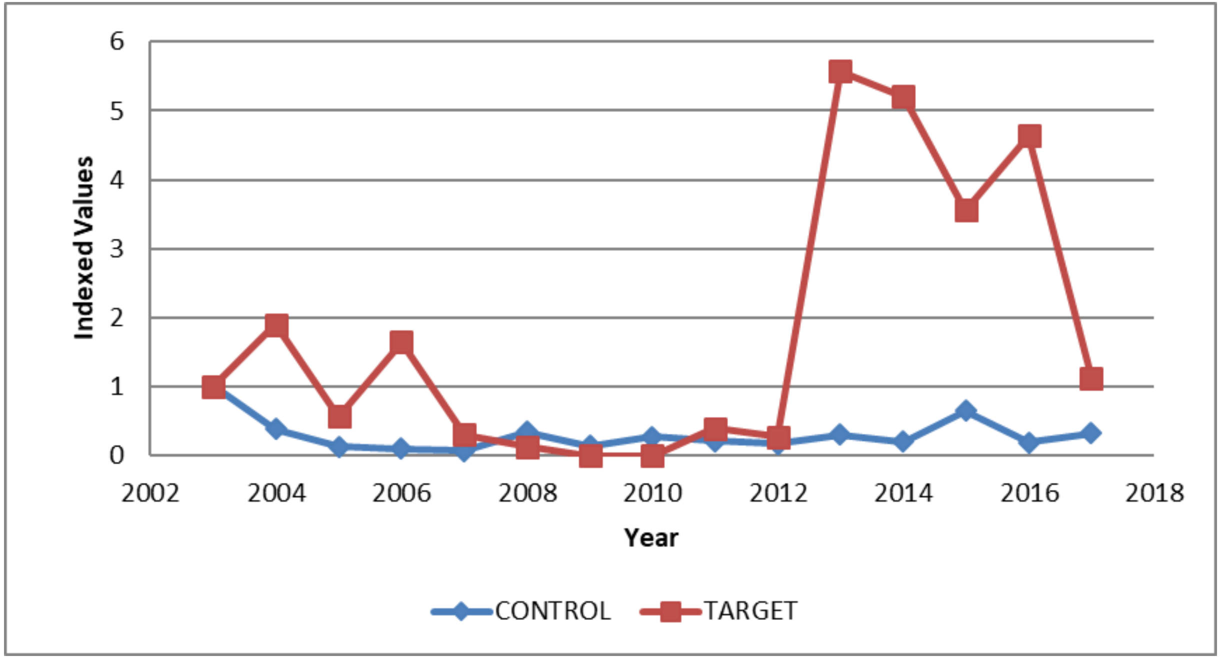


Approximately 17.8% reduction; statistically significant

Based on KDA water use reports

Results

Total Irrigated Sorghum Acreage



Approximately 335.4% increase; statistically significant

Based on KDA water use reports

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2013-2017 Producer Reported Economic Data

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
Sorghum Weighted Average - Inside LEMA	4	4.3	152.6	$361	$83
Sorghum Weighted Average - Outside LEMA	1	11.0	177.0	$226	$21
Soybeans Weighted Average - Inside LEMA	5	9.5	59.6	$315	$33
Soybeans Weighted Average - Outside LEMA	4	9.7	70.0	$358	$37
Sunflowers Weighted Average - Inside LEMA	0	NA	NA	NA	NA
Sunflowers Weighted Average - Outside LEMA	1	6.0	2818	$788	$131
Wheat Weighted Average - Inside LEMA	5	5.7	76.3	$219	$38
Wheat Weighted Average - Outside LEMA	3	7.4	81.8	$178	$24

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Current LEMA Status

- District Wide LEMA in GMD #4
- Sheridan #6 LEMA extended for another 5 years, with larger reductions than required by the district wide LEMA.
- KGS indicates that groundwater declines are being reduced
- Producers report enhanced profits due to
  - Irrigation scheduling with soil moisture probes
  - Better management

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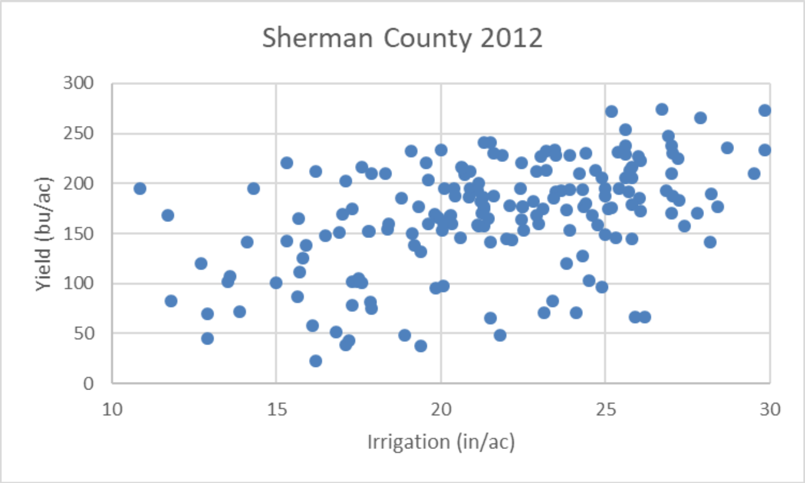
Future Research

- Are we really 95% efficient with our current groundwater use
- Estimate season-long WUE



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Questions

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Water resource management and irrigation in Kansas

Upcoming session: Tuesday, March 30, 8:30am

Topic: Climate and weather resources to support water decisions

Presenters: Mary Knapp, Climatologist, Kansas State University; and Christopher "Chip" Redmond, Assistant Agronomist, Kansas State University

Hosted by: Natural Resources PFT and KCARE

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