Impact of Soil Moisture Probe Data on Agricultural Water Use

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K-State Research and Extension

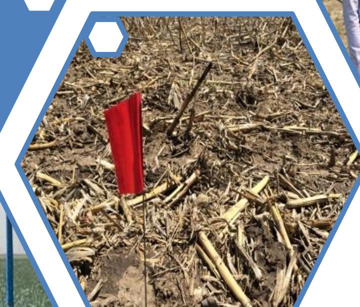
Overview

TAKE HOME MESSAGE

SOIL MOISTURE PROJECTS

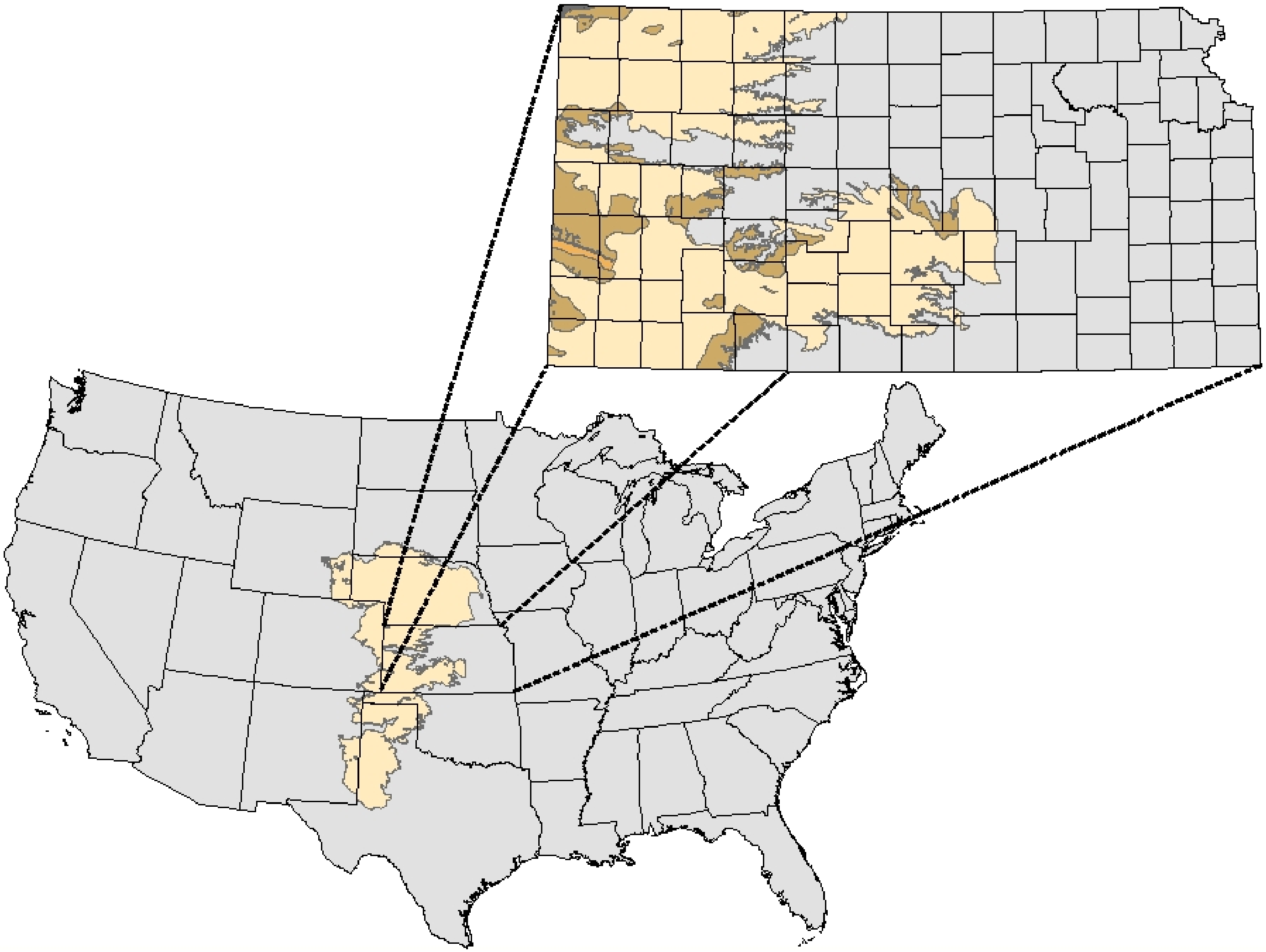
RESULTS

WATER TECHNOLOGY FARM

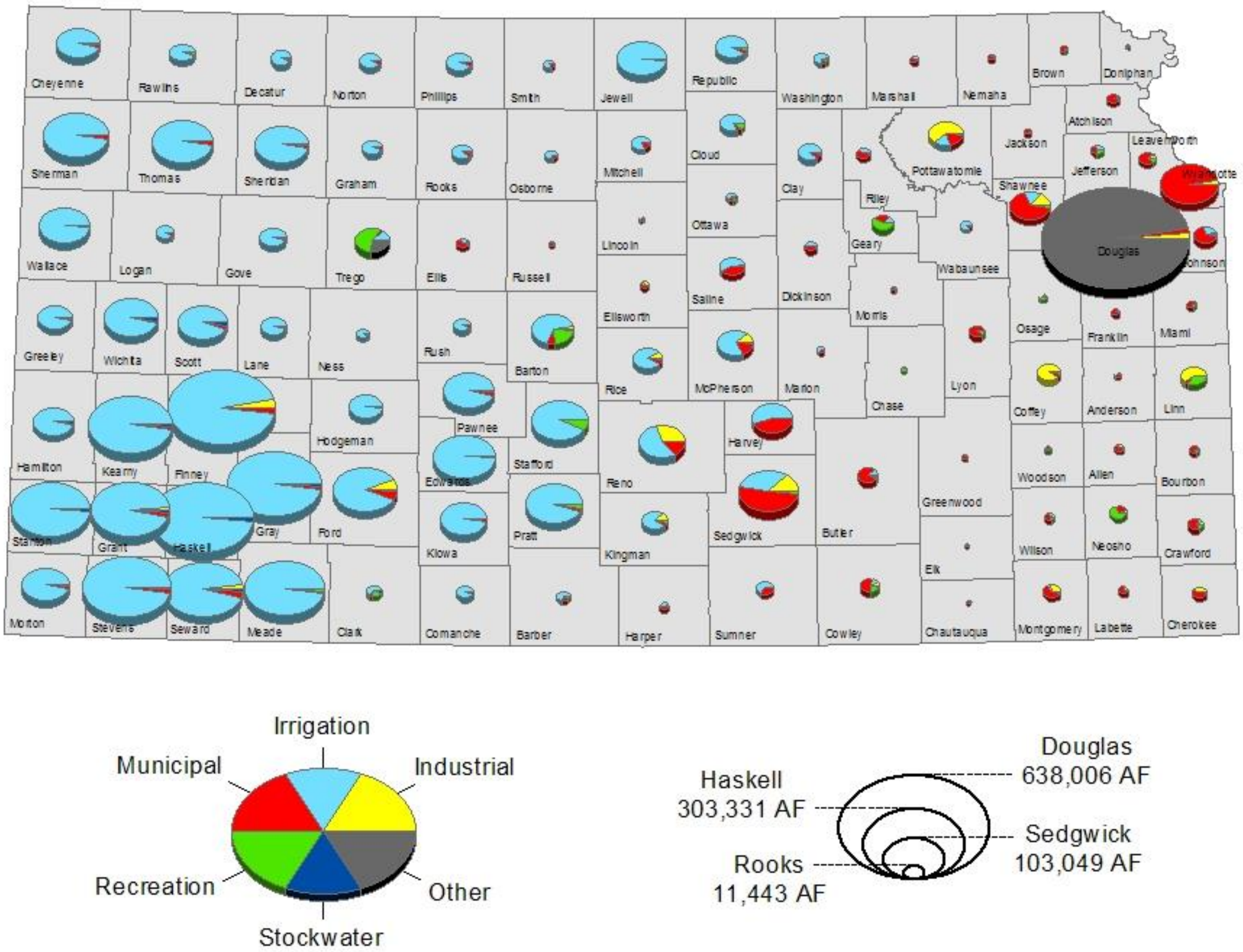


WATER RESOURCE ISSUE

The High Plains Aquifer



Average Reported Use Made of Water



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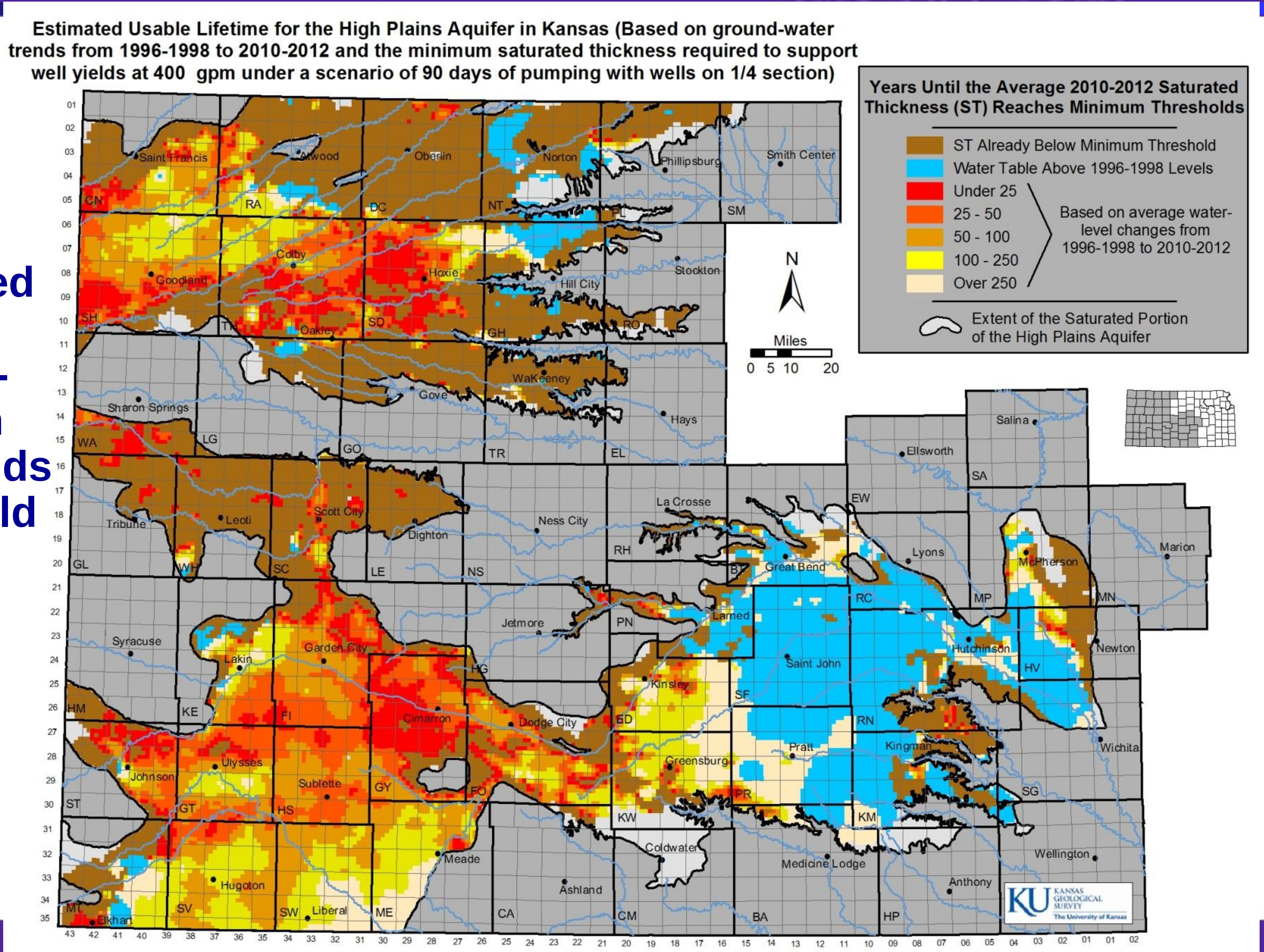
Kansas Geological Survey

Declining Water Supply from Ogallala Aquifer

Estimated Usable Lifetime- 400 gpm Well Yields Threshold



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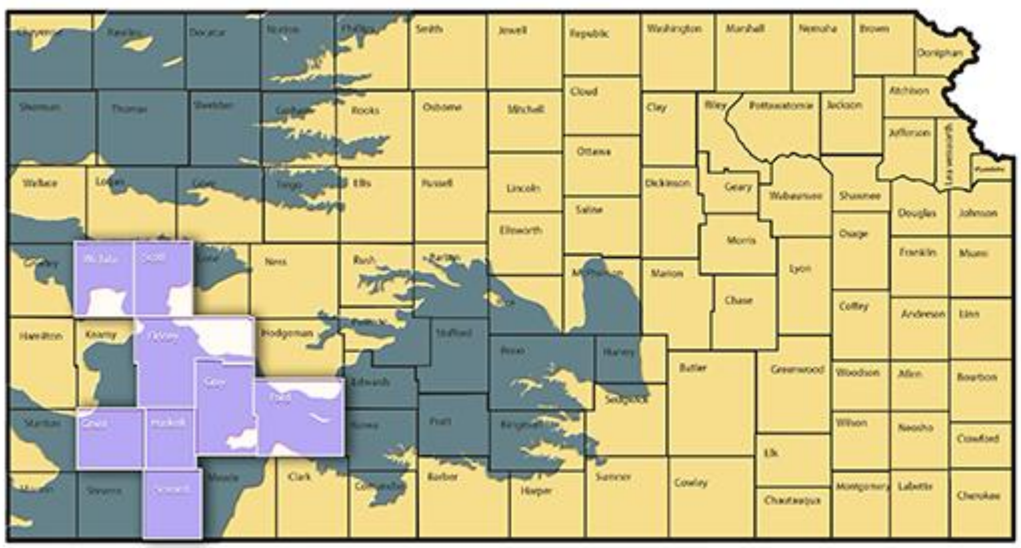
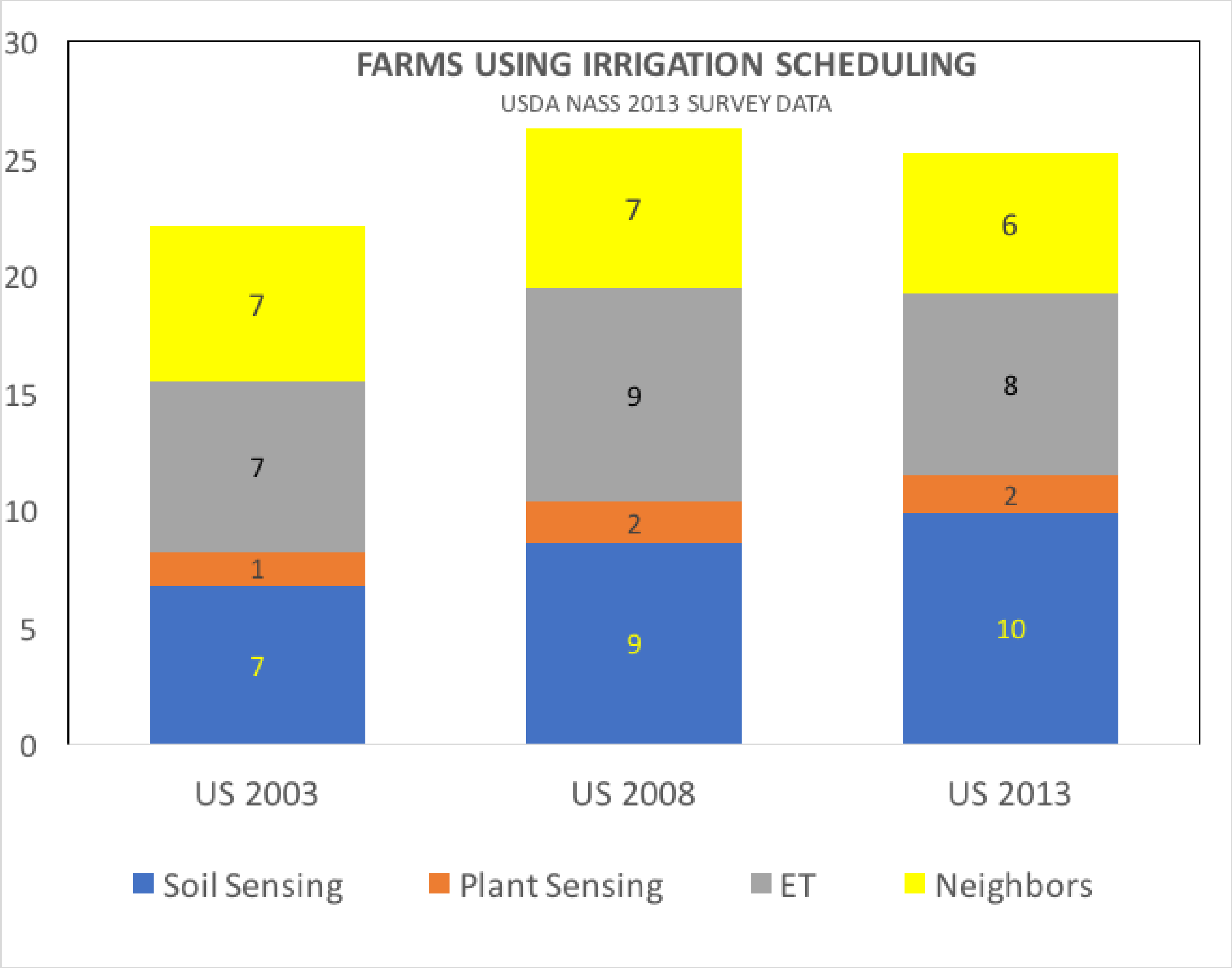
Kansas Geological Survey

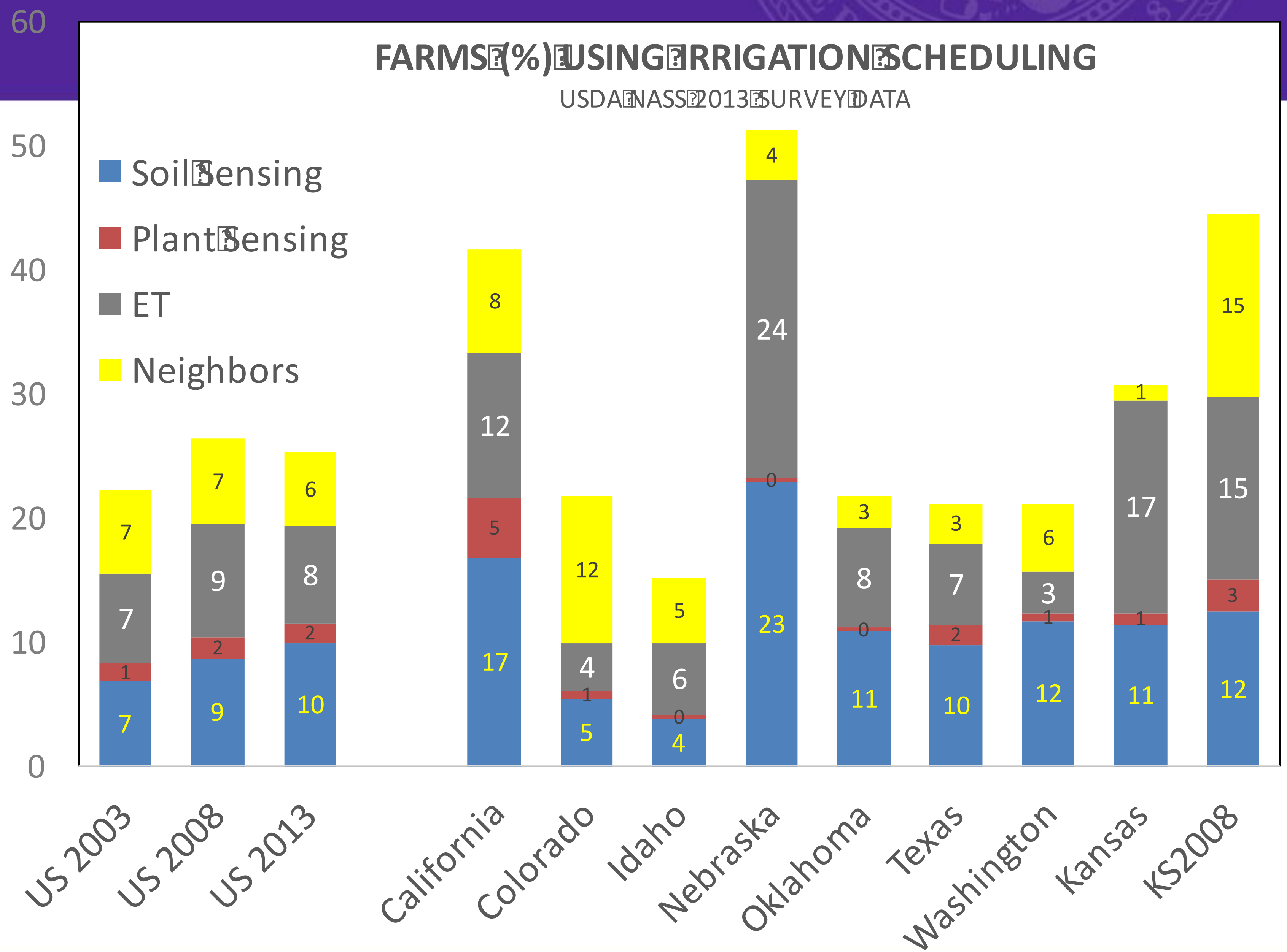
8 Counties

- Produce 1/3 ($6.3B) of the State’s agriculture revenue
- And most other western counties, are dependent on Ogallala Aquifer





FARMS USING IRRIGATION SCHEDULING
USDA NASS 2013 SURVEY DATA
30
25
20
15
10
5
0
7
1
7
7
9
2
9
7
10
2
8
6
US 2003
US 2008
US 2013
Soil Sensing
Plant Sensing
ET
Neighbors


FARMS (%) USING IRRIGATION SCHEDULING
USDA NASS 2013 SURVEY DATA
Soil Sensing
Plant Sensing
ET
Neighbors
60
50
40
30
20
10
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US 2003
US 2008
US 2013
California
Colorado
Idaho
Nebraska
Oklahoma
Texas
Washington
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17
1
12
3
15
15

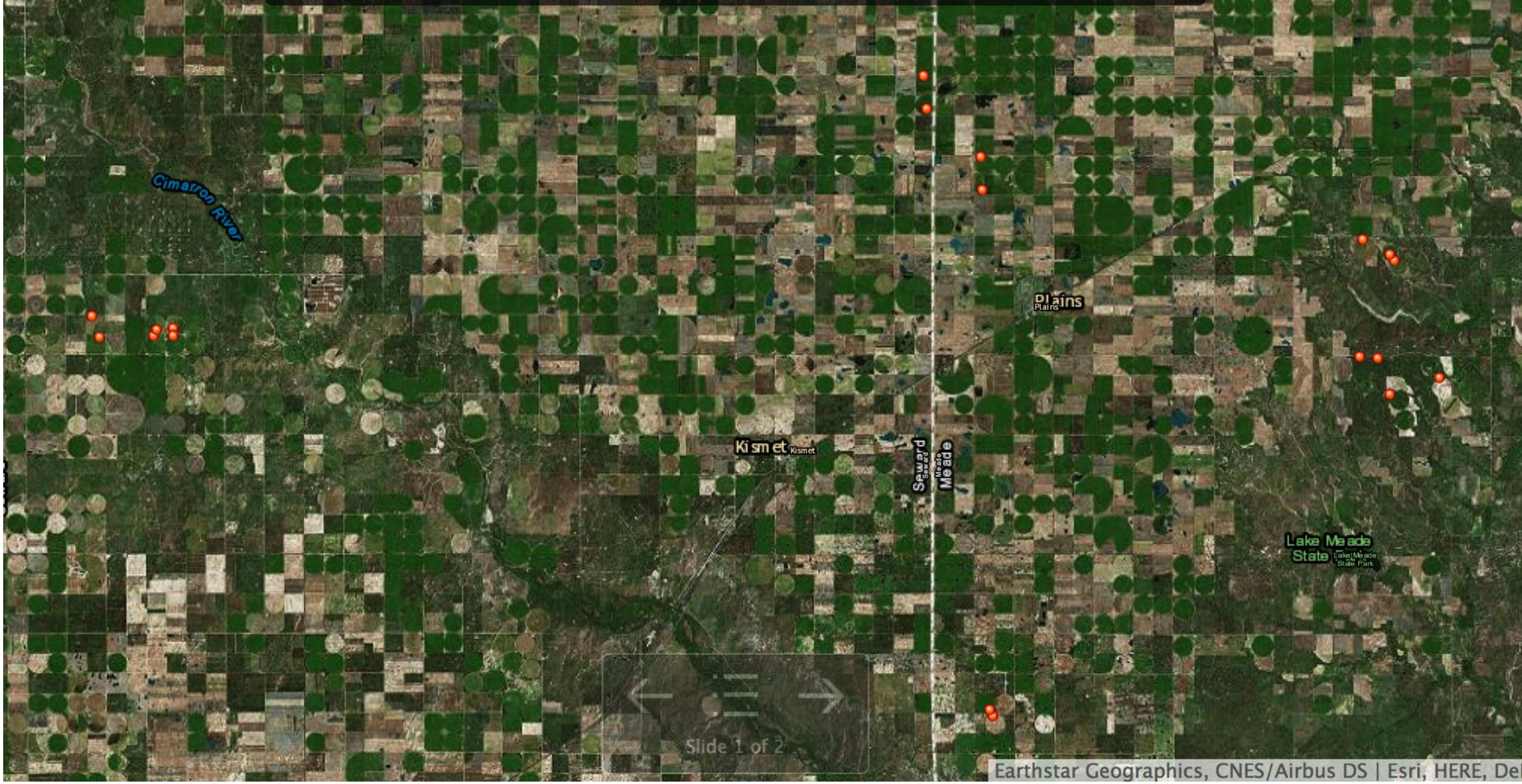
Does soil moisture sensors help farmers save water and increase yield?

IS IT BETTER THAN LOOKING AT MY NEIGHBOR'S SCHEDULE?

Approach

- 10 monitored center pivot circles paired with 10 adjacent "unmonitored" circle
- Irrigation management of monitored CP is based on soil moisture data
- Three different soil types (clay loam, loam, and sandy)
- Corn crop

Soil Moisture Sensor Demonstration



Soil Moisture Sensor Demonstration

Kansas State University

Instrumentation

Instrumentation

Monitoring

THEPROFILER +

1. 53577 12-32-29 #2 S — 75%

8"	:	29 cb	87% FC	0.16" dep.	0.44" PAW
16"	:	139 cb	50% FC	0.60" dep.	0.00" PAW
24"	:	51 cb	77% FC	0.28" dep.	0.32" PAW
32"	:	35 cb	84% FC	0.19" dep.	0.41" PAW
			Total:	1.23"	1.17"

› Rain *last 24hrs*: 0.00in
› Soil: Clay Loam
› Soil Temperature: 72°F

Add Notification

Sep 17 2014 2:13:40 Chart

2. 53578 25-32-29 #3 EAST — 65%

8"	:	35 cb	83% FC	0.20" dep.	0.40" PAW
16"	:	57 cb	74% FC	0.31" dep.	0.29" PAW
24"	:	95 cb	53% FC	0.56" dep.	0.04" PAW
32"	:	214 cb	50% FC	0.60" dep.	0.00" PAW
			Total:	1.67"	0.73"

› Rain *last 24hrs*: 0.01in
› Soil: Clay Loam
› Soil Temperature: 69°F

Add Notification

Sep 17 2014 1:52:12 Chart

3. 53466 NE 11-32-29 #1 — 78%

8"	:	75 cb	66% FC	0.45" dep.	0.22" PAW
16"	:	42 cb	82% FC	0.24" dep.	0.43" PAW
24"	:	53 cb	76% FC	0.32" dep.	0.35" PAW
32"	:	33 cb	86% FC	0.19" dep.	0.48" PAW
			Total:	1.20"	1.48"

› Rain *last 24hrs*: 0.00in
› Soil: Silty Clay Loam
› Soil Temperature: 68°F

Add Notification

Sep 17 2014 1:57:08 Chart

4. 53649 NE 21-32-34 H17 — 87%

8"	:	23 cb	80% FC	0.19" dep.	0.28" PAW
16"	:	24 cb	90% FC	0.13" dep.	0.54" PAW
24"	:	24 cb	88% FC	0.14" dep.	0.46" PAW
32"	:	17 cb	91% FC	0.11" dep.	0.49" PAW
			Total:	0.57"	1.77"

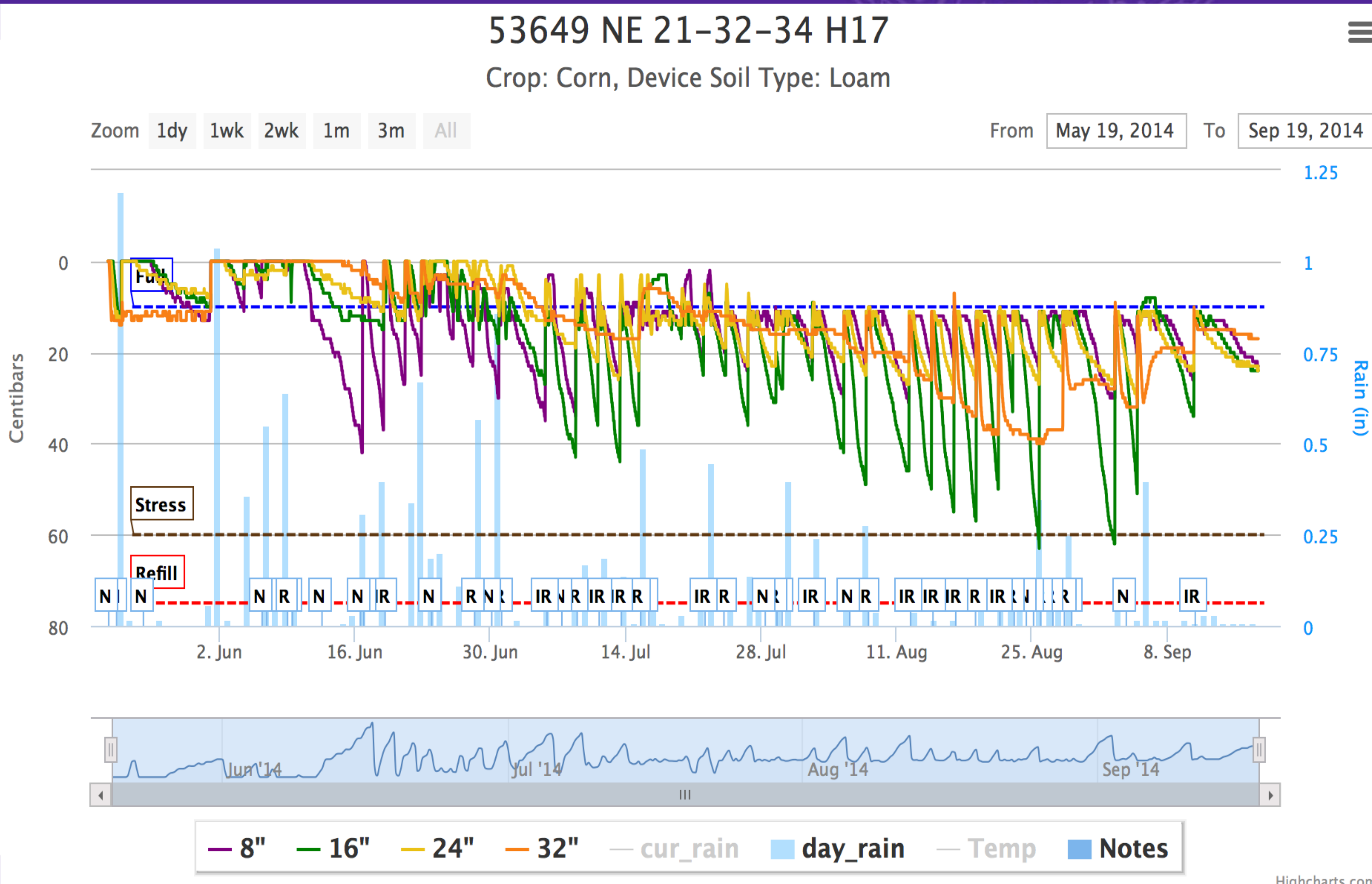
› Rain *last 24hrs*: 0.00in
› Soil: Loam
› Soil Temperature: 65°F

Add Notification

Sep 17 2014 9:01:15 Chart

Results

Parameter	Highest	Lowest
Total Rainfall (in)	12.10	9.18
Measured ET (in)	27.65	21.85
Total Irrigation (in) full yr. with sensors	23.82	16.40
Total Irrigation (in) full yr. without sensors	23.82	18.11



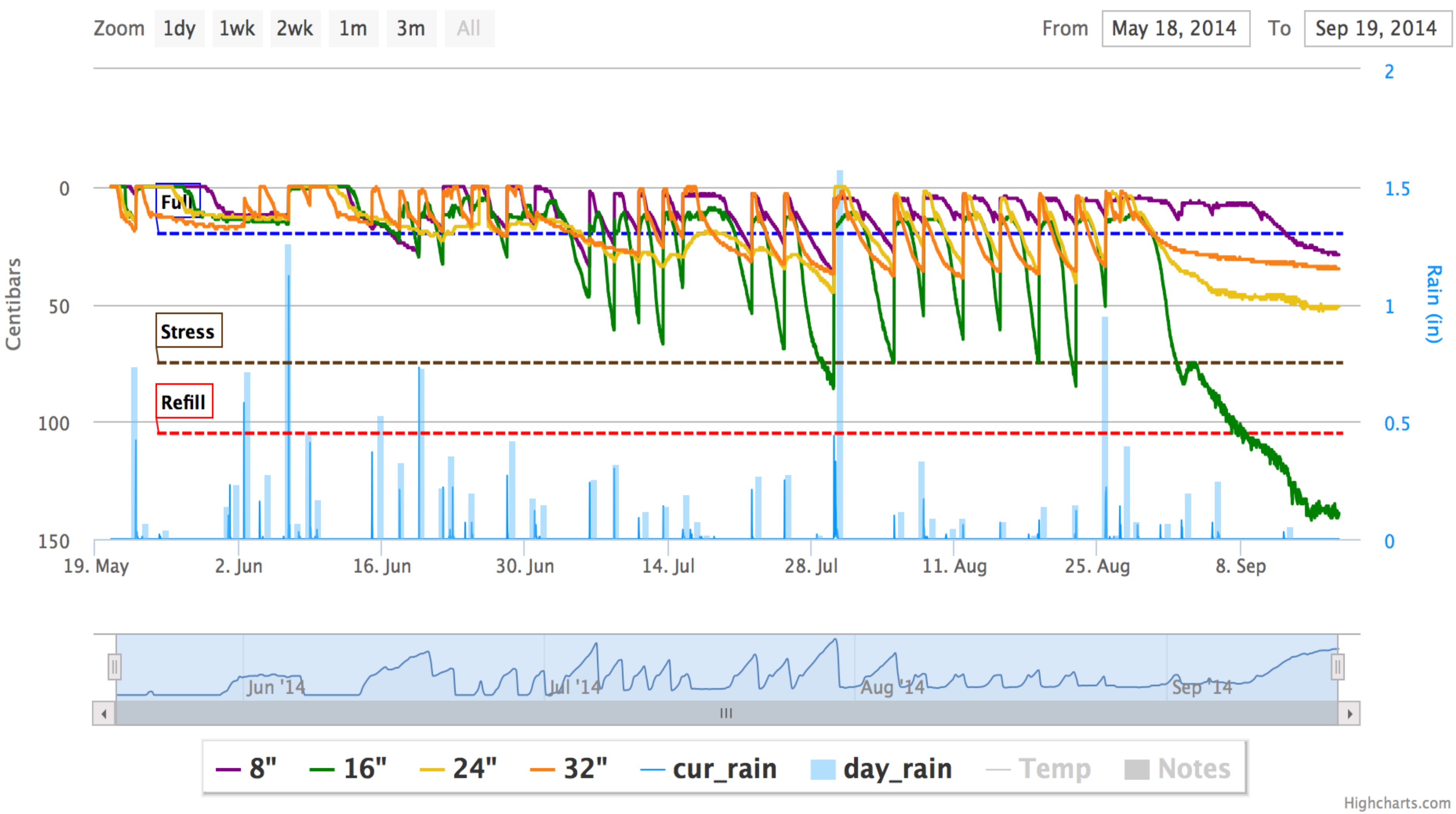
53649 NE 21-32-34 H17
Crop: Corn, Device Soil Type: Loam
Zoom 1dy 1wk 2wk 1m 3m All
From May 19, 2014 To Sep 19, 2014
Centibars
Rain (in)
Stress
Refill
2. Jun
16. Jun
30. Jun
14. Jul
28. Jul
11. Aug
25. Aug
8. Sep
Jun '14
Jul '14
Aug '14
Sep '14
8"
16"
24"
32"
cur_rain
day_rain
Temp
Notes
Highcharts.com

Results Year 1

- In 8 out of 10 weekly visits, the measured soil profile is at 80% or higher volumetric content
- The soil moisture sensors corroborates closely with neutron probe readings except at some readings in the fields with sandy soil
- Though the advisor is recommending shutting off the irrigation system for several days, the producer seldom follows the recommendations

53577 12-32-29 #2 S

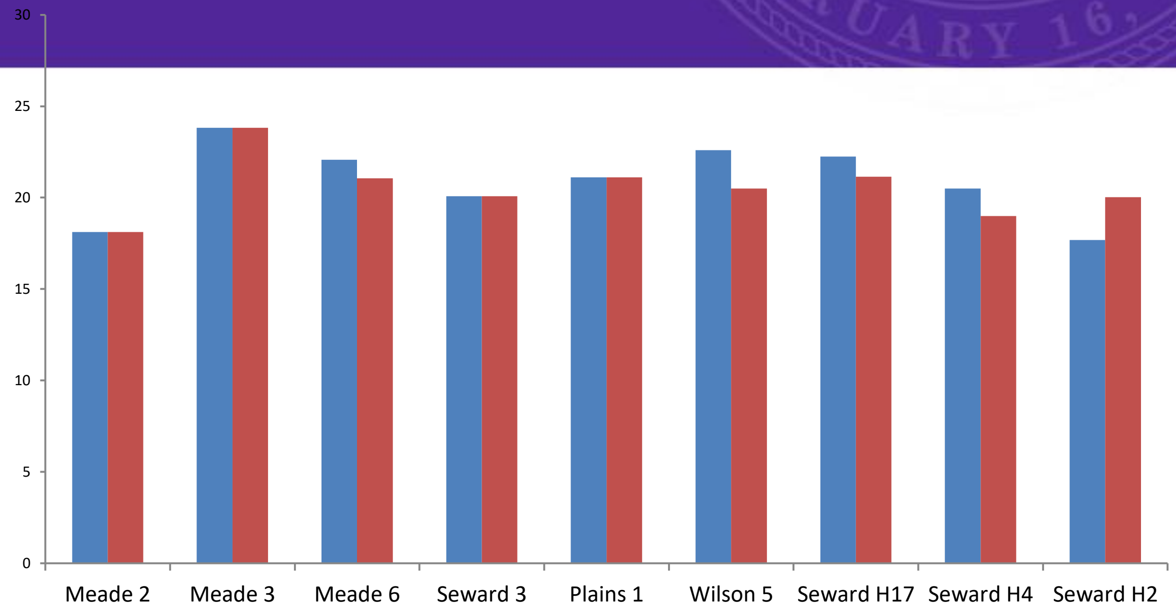
Crop: Corn, Device Soil Type: Clay Loam



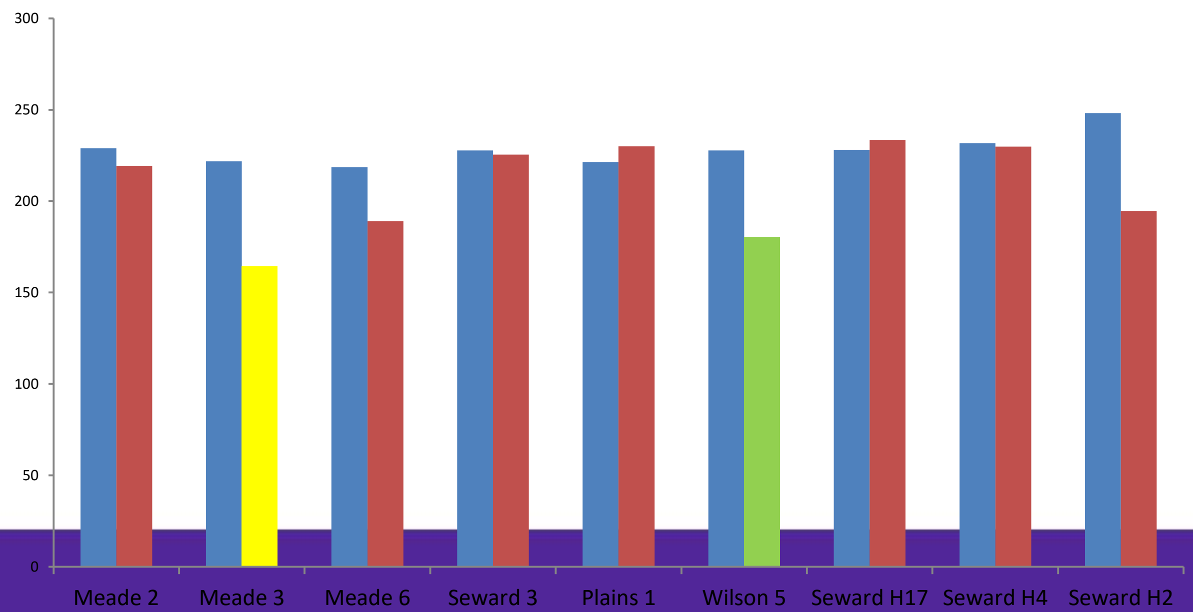
Results Year 2

- Producer was somewhat following the crop advisors in relation to the moisture sensor data.
- Producer pledged that whatever happens in their management approach, their business relationship with the consultant will still be good.

Total Irrigation Applied for 2014



Yield



Conclusion of the Study

- It is a challenge for the producer not be influenced in making split decisions in the paired fields
  - Producer seem to trust the number and the recommendation of the advisor, but we are now unsure if it influenced his decision on the control
- Another challenge for producers to conserve water was related to **local and water governance**

Vision:

***Kansans** act on a shared commitment to have the water resources necessary to support the **state's social, economic and natural resource** needs for **current and future generations**.*

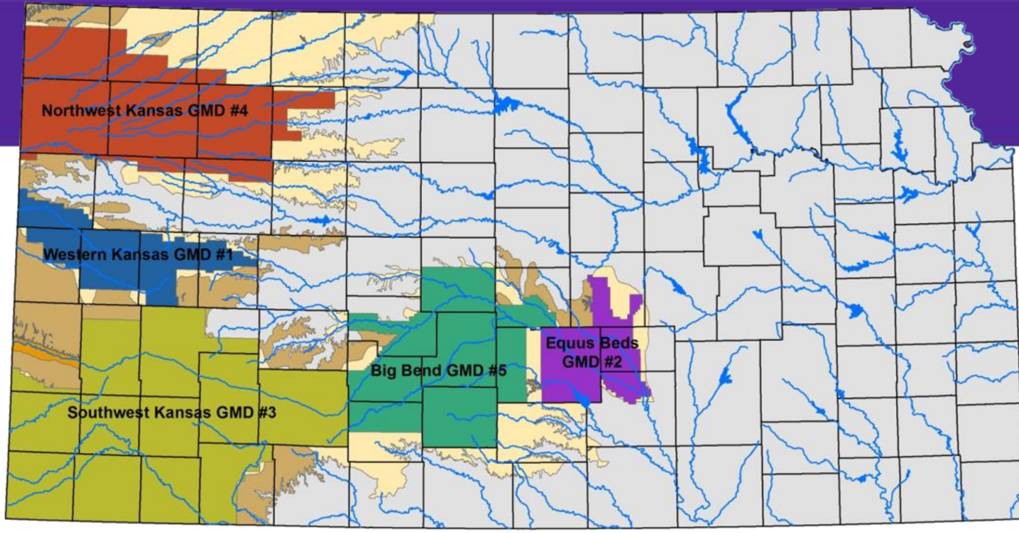
- At every point in the Vision development process, the Water Vision Team has been reminded the key to a reliable, long-term water supply is rooted in every Kansan understanding the importance of the state's water resources.
- The Vision statement calls on every Kansan, as stakeholders, to not only commit to ensuring a reliable water supply but also to act on that commitment.
- The Vision attempts to make clear water is necessary for human-health and welfare as well as environmental stewardship and our economic well-being.
- The Vision is also based on the concept that water is not only important for today but also for our future as a state.

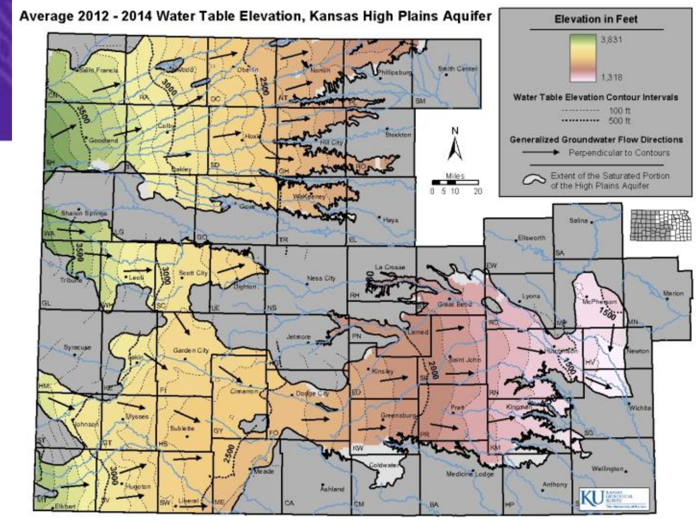
Mission:

Provide Kansans *with the framework, policy and tools,* ***developed in concert with stakeholders****, to manage, secure and protect a reliable, long term statewide water supply while balancing conservation with economic growth.*

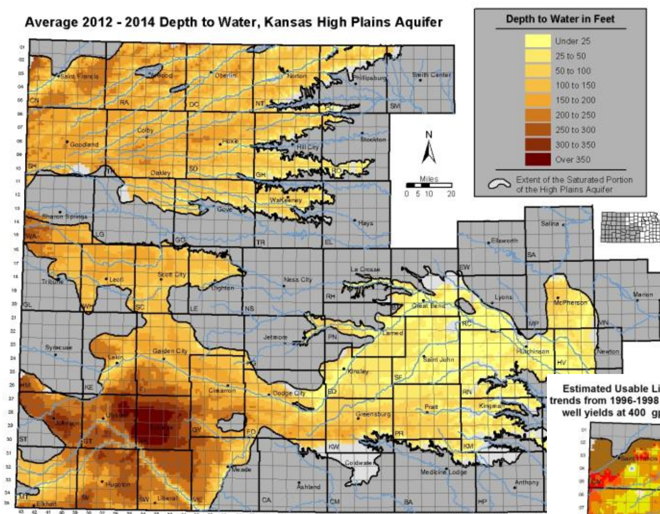
<ins>Locally driven solutions</ins> have the highest opportunity for long term success. Therefore, the intentional focus of the action items presented in the Vision are to provide the necessary tools and support to allow <ins>for greater flexibility and management of water</ins> resources at the local level.

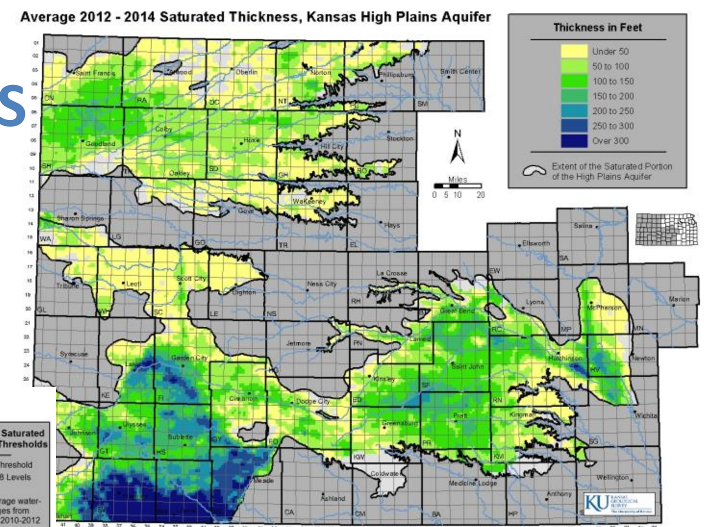
1. Locally driven solutions have the highest opportunity for long term success. Therefore, the intentional focus of the action items presented in the Vision are to provide the necessary tools and support to allow for greater flexibility and management of water resources at the local level.
2. Policies and programs should not unintentionally penalize those who have already demonstrated good stewardship with the state's water resources.
3. Voluntary, incentive and market-based water conservation and land management activities are the preferred tools for ensuring a reliable statewide water supply.
4. Action is necessary now to ensure a reliable supply into the future.

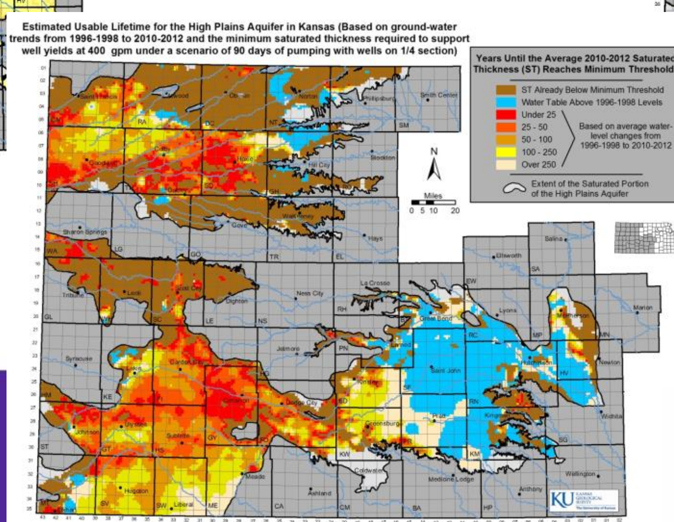




LOCAL CONDITIONS ARE DIFFERENT!







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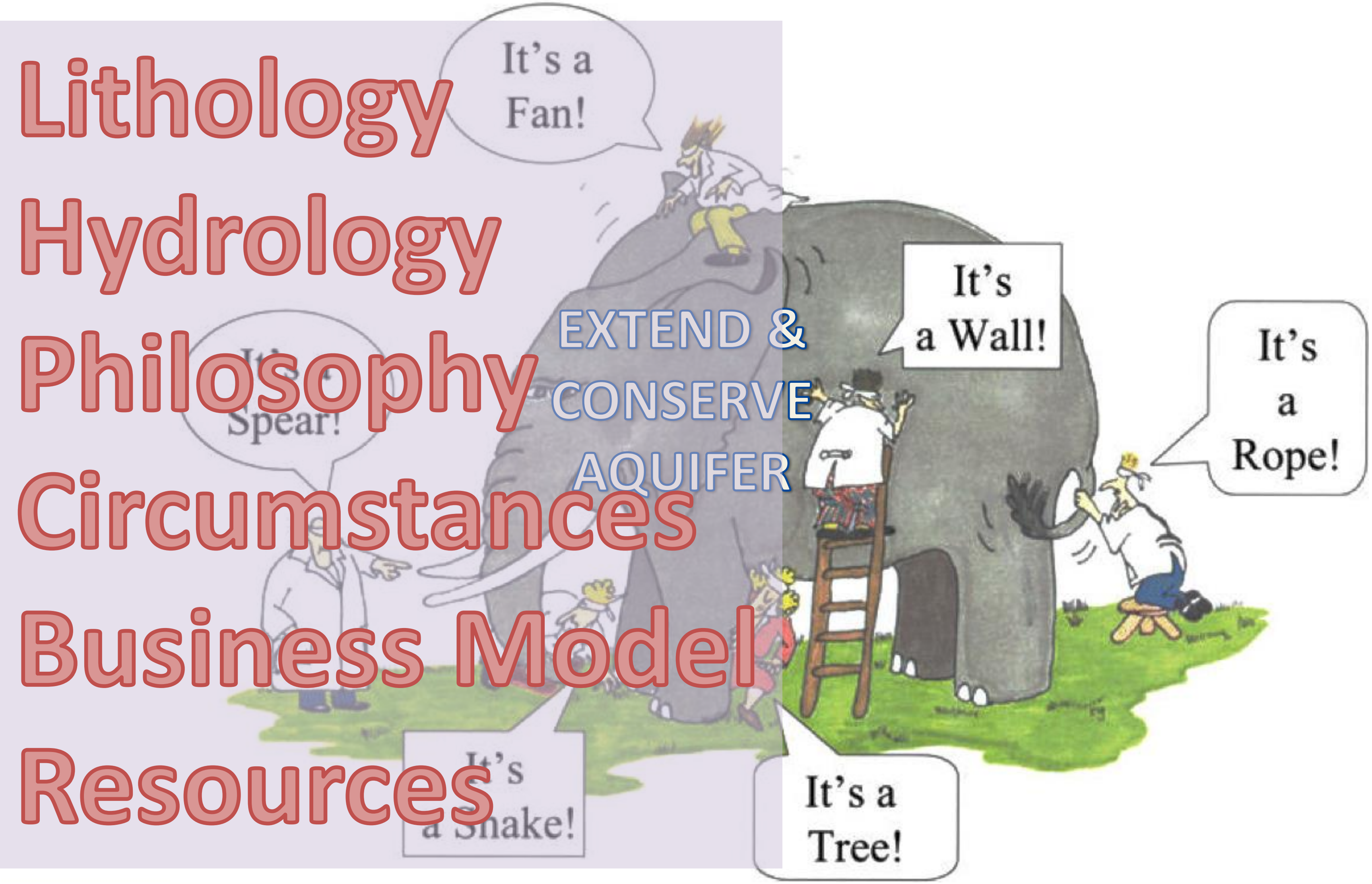
OgallalaWater.org
OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

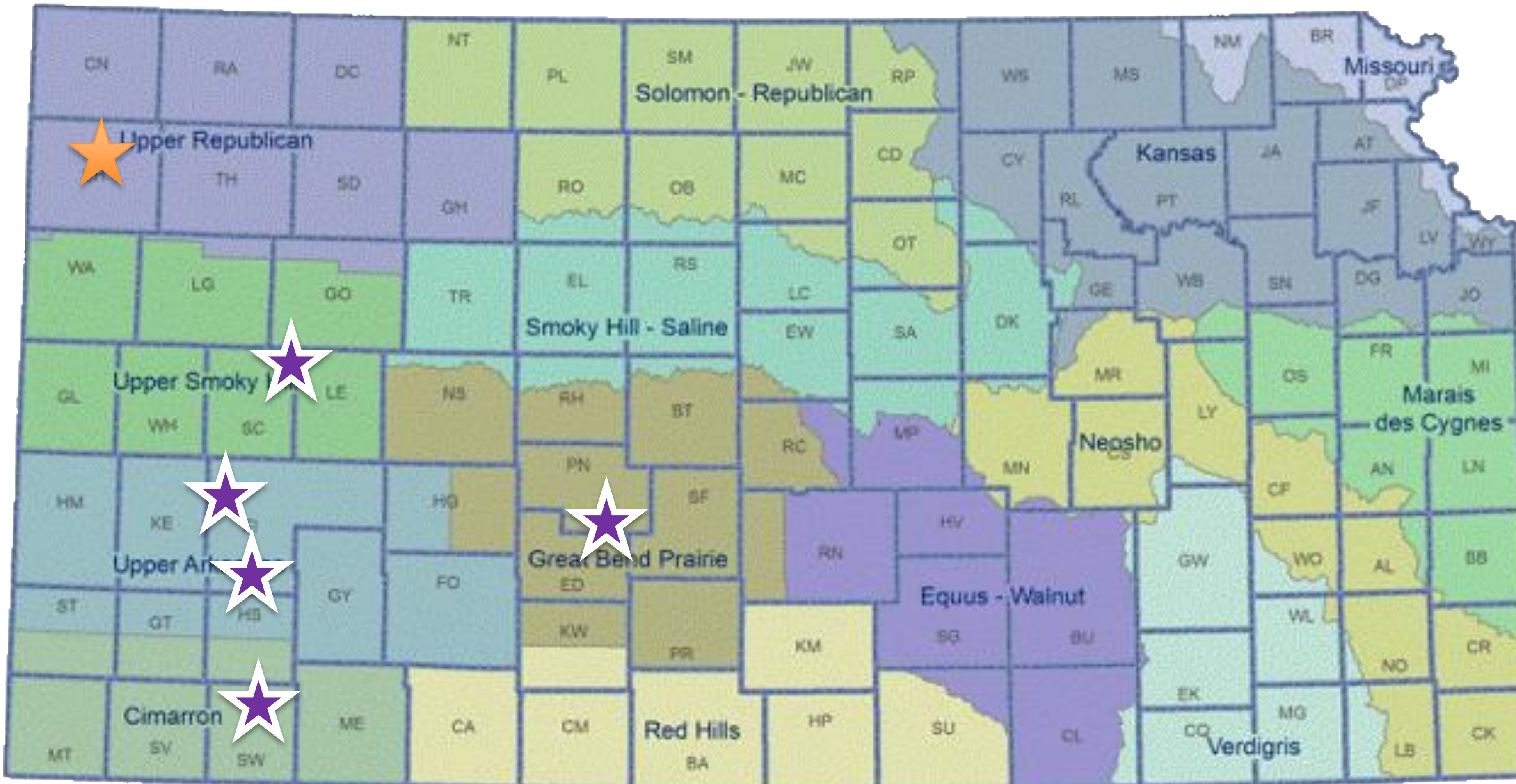
WATER TECHNOLOGY FARMS: The Concept

Lithology
Hydrology
Philosophy
Circumstances
Business Model
Resources

EXTEND & CONSERVE AQUIFER



2017 Water Technology Farms



2016 Water Technology Farms

Willis Farm

-Water conservation (WCA)

-Telemetry

- MDI, Spray

- Soil moisture sensors

Roth-GCCo Farm

-Effectiveness

-MDI, Bubbler, iWobs

-Zone management

-surface/well water

WaterPACK

-Efficiency

-MDI, Spray

-High capacity well, sandy

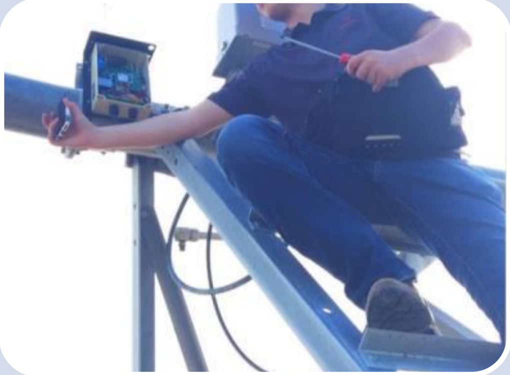
Bubbler and iWob

Bubbler

iWob

Dragon-Line

+ 2017 Water Technology Farms



Hatcher's Farm

- iWob, Bubbler, and spray
- Soil vs plant sensors
- Scheduling

Circle C Farm

- iWob, Bubbler, and spray
- Variable rate irrigation
- Cover crops use and mixes

NW Tech College Farms

- Soil water sensors
- Workforce development

Hatcher and Circle C Farms

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What is common to all farms?

SOIL MOISTURE SENSORS

T&O Farms
Water Technology Farm

T&O Farms

2016 Highlights

Repair Cost

Rainfall = 17 inches

MODE	TOTAL COST	AVERAGE COST
SPRAY (6 circles)	$ 4,596.00	$766.00
MDI (4 circles)	$ 180.00	$ 45.00

Field	Crop	Irrigation (in)	Yield	Water Use Efficiency		Repair Cost ($)
1 MDI	Alfalfa	4.5	365 t	81.8	tons/in	0
2 SPRAY	Sorghum	9.3	145 bu	15.6	bu/in	1,901
3 MDI	Sorghum	9.6	140 bu	14.5	bu/in	475
4 SPRAY	Alfalfa	3.8	385 t	102.1	tons/in	180

2016 Partial Budgets

Pivot Designation	NE20	SW20	SW22	NE19	NW27	SE19	SE20	NW20	SE21	SW21
Technology	MDI	Spray	Spray	Spray	Spray	MDI	MDI	Spray	MDI	Spray
Crop	Alfalfa	Alfalfa	Alfalfa	Corn	Corn	Sorghum	Sorghum	Sorghum	Soybeans	Wheat
Income										
Acres	123	123	122	100	121	90	123	122	122	122
Yield per Acre	2.97	3.13	8.58	160.80	219.52	130.67	140.04	145.25	79.00	118.00
Price	$161.48	$161.48	$161.48	$4.88	$4.88	$4.46	$4.46	$4.46	$10.25	$6.18
Gross Profit ($/ac)	$479.19	$505.45	$1,385.82	$784.70	$1,071.24	$582.77	$624.58	$647.80	$809.75	$729.24
Expenses										
Seed	$74.63	$96.59	$0.00	$81.35	88.45	$8.00	$8.45	$9.00	$73.14	$9.00
Herbicide	$13.18	$13.18	$58.56	$123.20	107.38	$57.26	$60.68	$59.37	$48.60	$18.45
Fertilizer	$25.06	$40.88	$36.54	$145.33	$153.33	$72.46	$77.69	$91.69	$20.35	$59.96
Drive Train Repairs	$0.00	$3.86	$5.74	$4.25	$6.20	$0.00	$0.00	$12.88	$0.00	$1.97
Variable Expenses	$112.87	$154.51	$100.84	$354.13	$355.36	$137.72	$146.82	$172.94	$142.09	$89.38
Profit Above Variable Expenses	$366.31	$350.94	$1,284.98	$430.57	$715.88	$445.05	$477.76	$474.86	$667.66	$639.86
Water Use (ac-in/ac)	4.46	3.77	No Record	14.33	No Record	10.39	9.65	9.36	11.65	5.98
Profit per ac-in/ac	$82.14	$93.10	No Record	$30.04	No Record	$42.83	$49.53	$50.71	$57.33	$106.91
Yield per ac-in/ac	0.67	0.83	No Record	11.22	No Record	12.57	14.52	15.51	6.78	19.72

Notes:
NW20 had a bad SCA infestation that hit the first week of Oct, and a severe pig weed problem
SE20 had a bad SCA infestation that hit the first week of Oct, and a severe pig weed problem
SE19 had hail damage, and a severe pig weed problem
NE19 had hail damage and a bacteria which impacted yield
NW27 had a bacteria which impacted yield

Kansas State University

2016 Partial Budgets

Pivot Designation	NE20	SW20	SE20	NW20
Technology	MDI	Spray	MDI	Spray
Crop	Alfalfa	Alfalfa	Sorghum	Sorghum
Income				
Acres	123	123	123	122
Yield per Acre	2.97	3.13	140.04	145.25
Price	$161.48	$161.48	$4.46	$4.46
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Profit Above Variable Expenses	$366.31	$350.94	$477.76	$474.86
Water Use (ac-in/ac)	4.46	3.77	9.65	9.36
Profit per ac-in/ac	$82.14	$93.10	$49.53	$50.71
Yield per ac-in/ac	0.67	0.83	14.52	15.51

2016 Water Use

- WCA 3-yr allocation 4,533 AF
- WCA yearly allocation 1,511 AF
- 2016 Water Use 1,151 AF

24% Less of Allocated

A Key Lesson

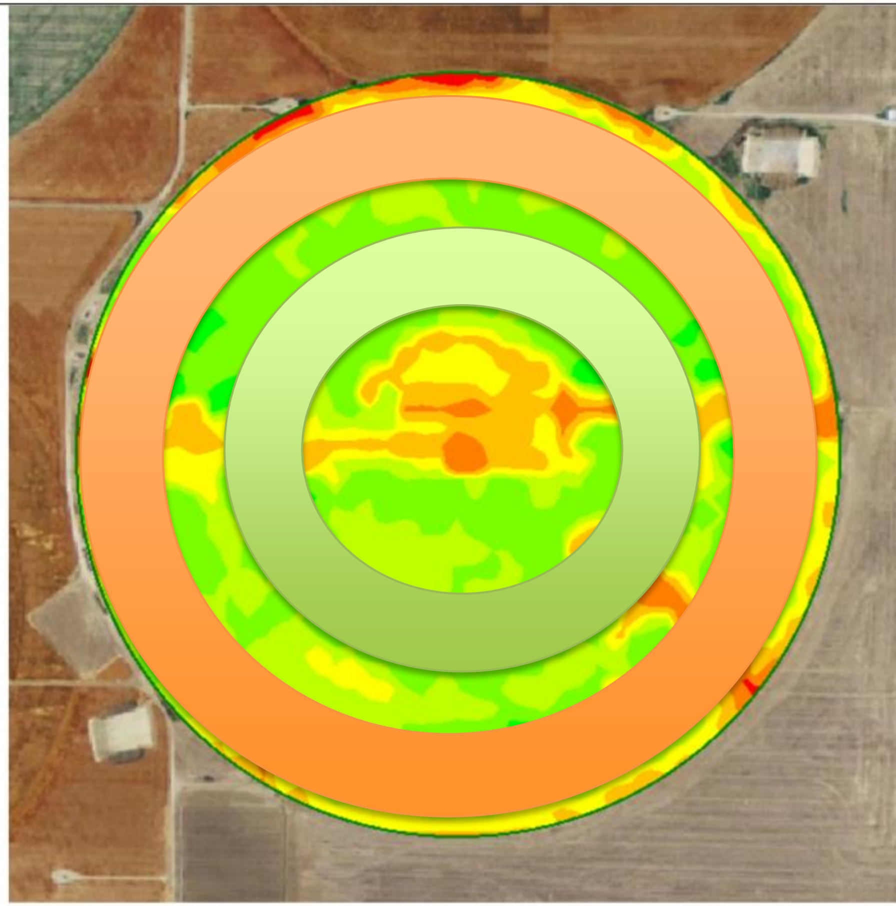
Visual cues from index well,
soil moisture sensors, and water
meters **helped** a lot in
making decisions

Roth/Garden City Co. Farm Features

- MDI vs. iWob vs. Bubbler
- Soil Moisture Sensors
- Center Pivot Telemetry
- Soil mapping and zoning
- Aerial Mapping
- Ground and Surface Water

2016

Dry Yield Surface



Grower: Big D Farms
Farm: Big D Farms
Field: SE22-23-34
Area: 123.71 ac
Lat: 38.03744°N
Lon: 101.03530°W

Season: 2016
Min: 50.23 bu/ac
Avg: 228.84 bu/ac
Max: 317.12 bu/ac

N

One in = 473 feet
0 214 427 641 855 1069

Field Boundary
Dry Yield Surface bu/ac
- 50.2 - 134.7 (2.0 ac) (1.6 %)
- 138.8 - 175.2 (5.2 ac) (4.2 %)
- 175.5 - 202.7 (9.9 ac) (8.0 %)
- 203.5 - 223.9 (14.2 ac) (11.5 %)
- 224 - 238.2 (34.8 ac) (28.1 %)
- 238.3 - 251.2 (47.0 ac) (38.0 %)
- 251.2 - 317.1 (10.7 ac) (8.6 %)

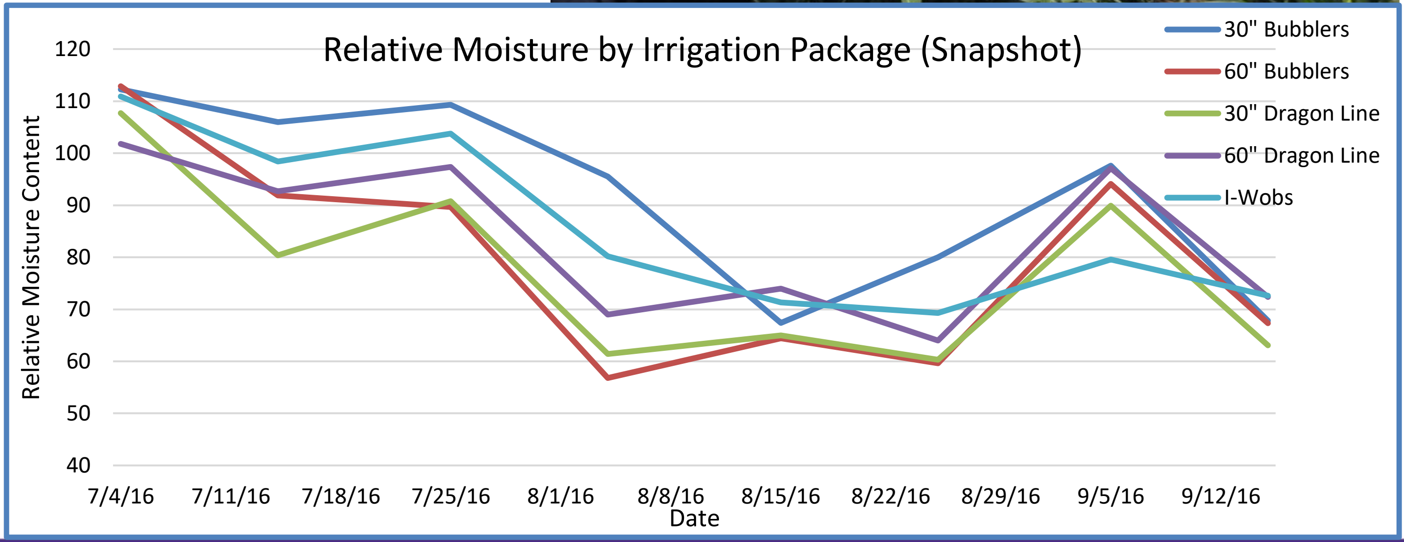
PRECISION AG

Roth Corn Field

- Yield = 228 bu/ac
- Rain = 25.2 in
- Irrigation Applied = 11.1 in

Notes

- This field is only one of several fields where other trials are being performed
- Soil water sensors were used in making **confident** decision



2017

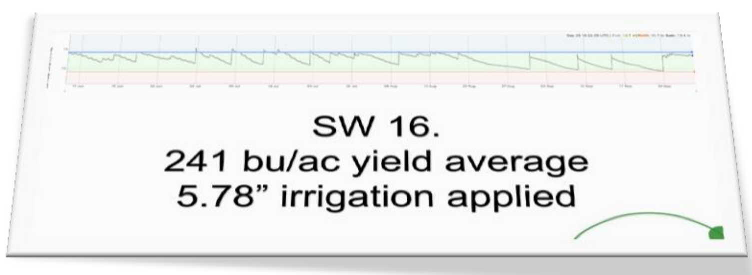
Roth Corn Field

Managed with soil moisture sensor

- Yield = 241 bu/ac
- Rain = 16 in
- **Irrigation Applied = 5.8 in**

Managed by crop consultant –no sensor

- Yield = 240 bu/ac
- Rain = 16 in
- **Irrigation Applied = 13 in**



FRAMEWORK AT THE FARMS

Public-Private Project for the Conservation of the Ogallala Aquifer

Organize field days and other educational events

Educational Component

- Attendance in field days are impressive
  - 2016: more than 325
  - 2017: more than 295
- Some additional tours were organized for key participants
  - KS Policy Makers ~50 in attendance at T&O Farm
  - National Farm Cooperative ~ 45 in attendance at ILS Farm
  - Kansas Water Authority Tour ~ 45 in attendance at Roth Farm
  - Water Congress Virtual Tour ~ 60 in attendance

TAKE HOME…so far

- Water Technology Farm is a great way to **showcase** new technologies and MANagement practices "**in your neighborhood**" at your scale
- Field days on these farms foster **good conversation** between farmers and managers
- Starting to **identify advantages and challenges**
- Leveraging this concept to **expand the conversation** beyond the region

On-farm Soil Moisture Sensors Study

USDA-NRCS CIG by OSU, K-State and Texas Agri-Life

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Irrigation Scheduling

Definition:

Process of determining when to irrigate and how much water should be applied.

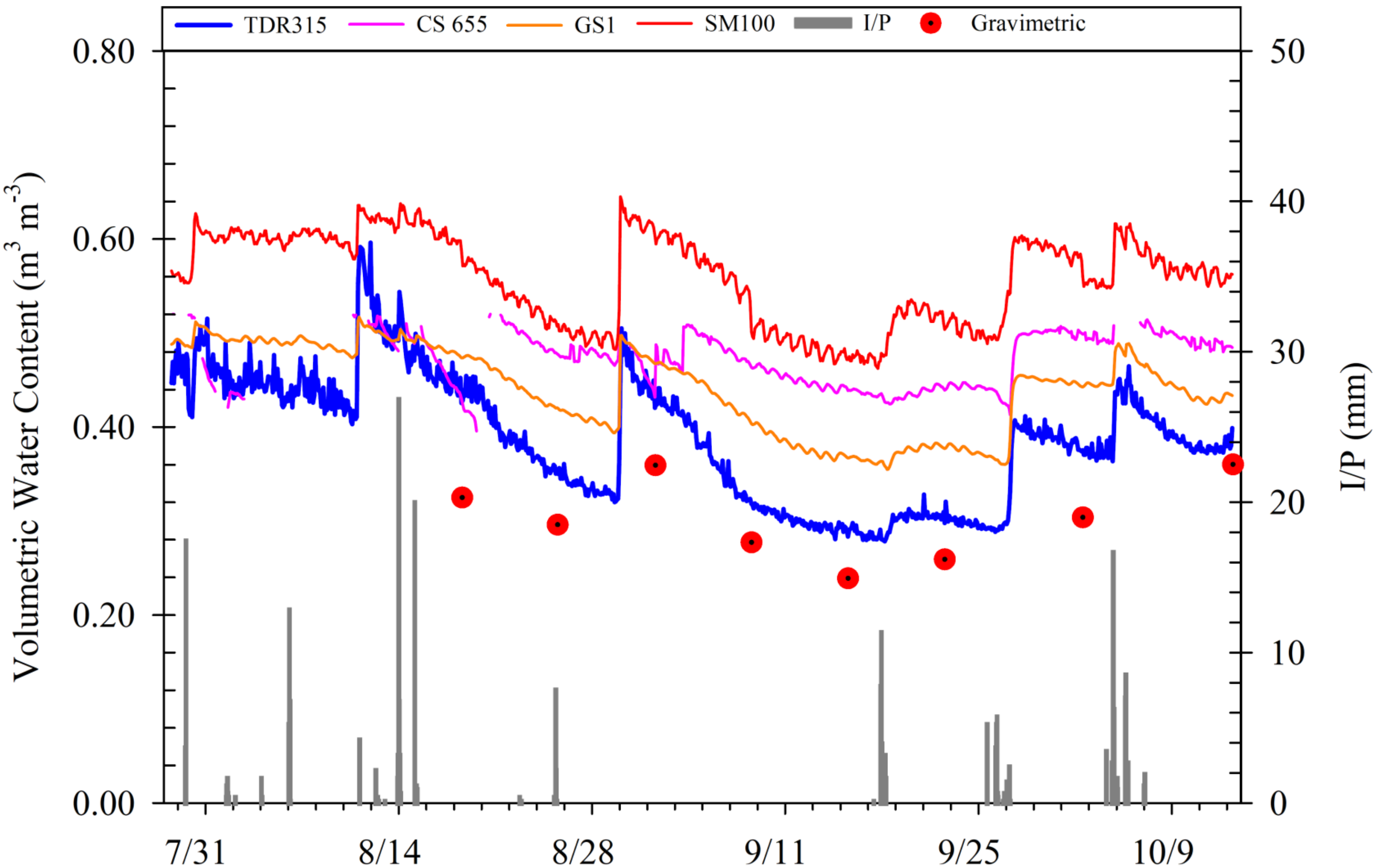
Let's call this a 20th century definition

Irrigation Scheduling

21st century definition** (Lamm, et al. 2014)**:

Process of delaying any unnecessary irrigation with the hope that the cropping season will end before the next irrigation is needed.

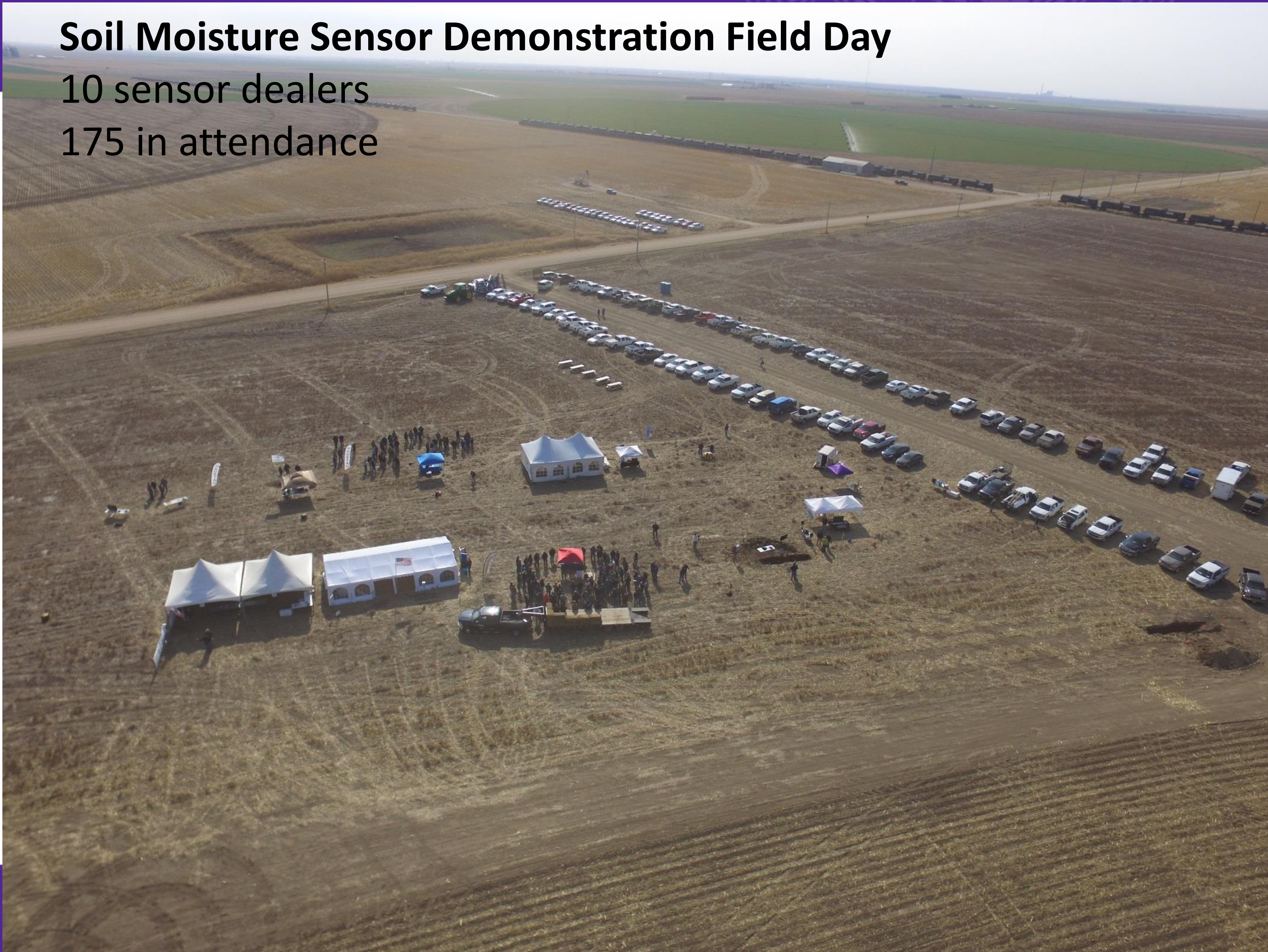
Results – Altus, OK Time Series



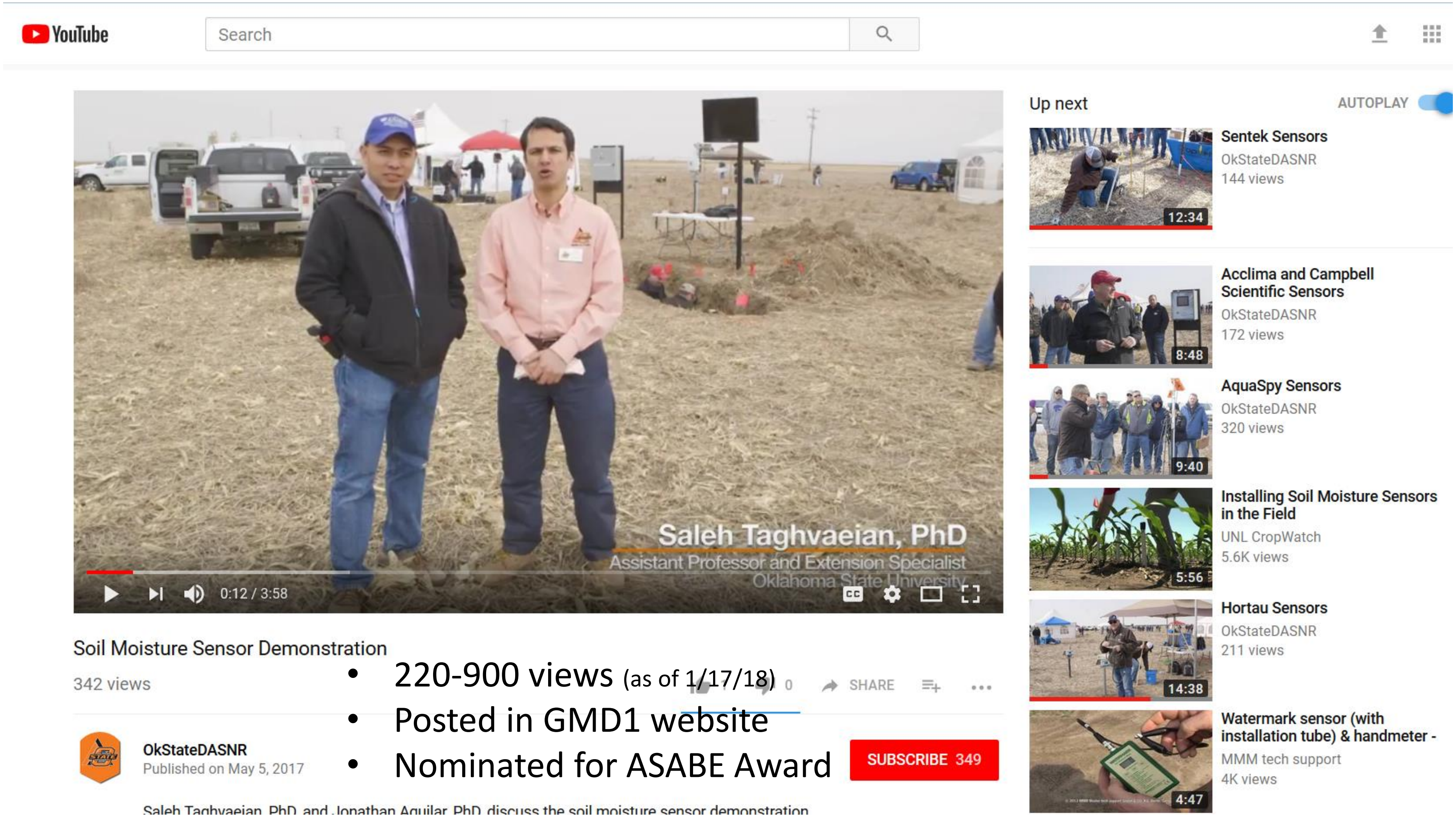
Soil Moisture Sensor Demonstration Field Day

10 sensor dealers

175 in attendance



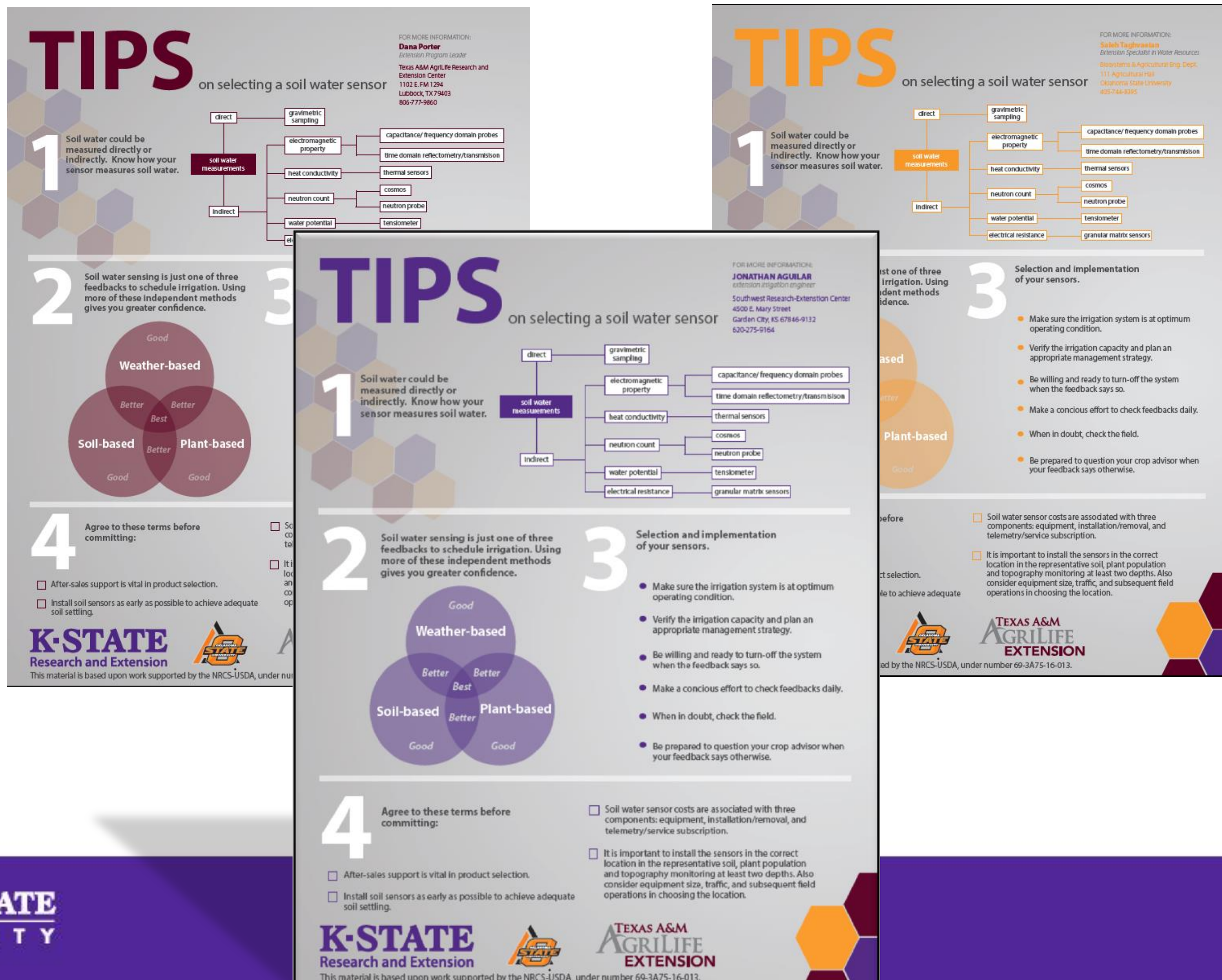
Soil Moisture Sensor Demonstration Videos



- 220-900 views (as of 1/17/18)
- Posted in GMD1 website
- Nominated for ASABE Award

One-pager Fact/Tip Sheet

A multi-State output and format



Take Home Messages

- It is normal to see the **benefits** of technology adoption only **after a year or two**
- **Once they trust** the technology, producers could **take this tool to a different level**
- We could push technology adoption to producers, but **be mindful** that there might also be **other barriers** (policy, economic and business principle) that needs to be addressed

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THANK YOU

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