Workshop: Water Resource Management in Smart and Connected Communities

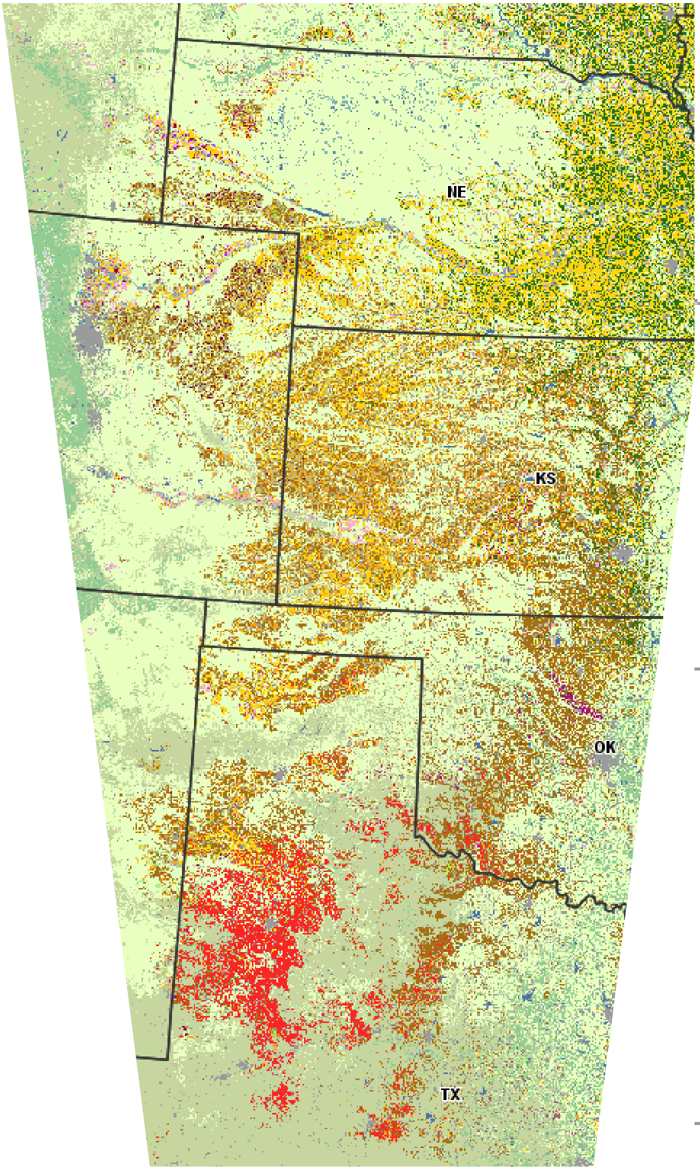
Agriculture in Water Resource Management: Dealing with the Declining Ogallala Aquifer

Chuck West
CASNR Water Center, Plant & Soil Science

What is the challenge?
What are we doing about it?

July 30, 2018

Great Plains agriculture



USDA-NASS, 2016

Ogallala Aquifer

- Ogallala Aquifer supports ~30% of U.S. crop and livestock production
- Increases U.S. agricultural production by more than $12 billion annually
- Value of water for livestock is >$5000/acre-foot

Figure 4. Existing (as of 2010) and future (2060) water demands for each water use category in each water planning region (TWDB 2012).

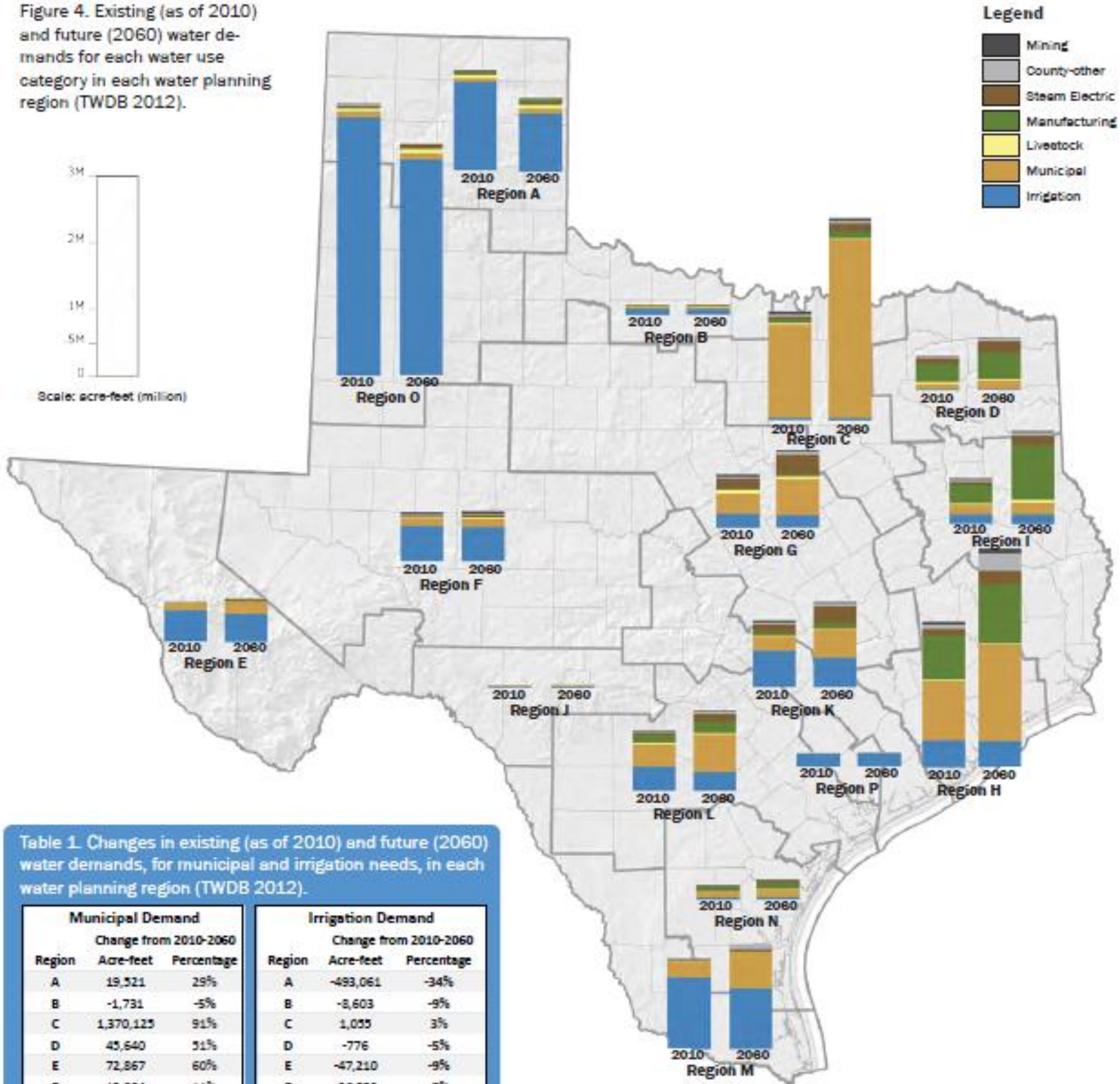


Table 1. Changes in existing (as of 2010) and future (2060) water demands, for municipal and irrigation needs, in each water planning region (TWDB 2012).

Municipal Demand			Irrigation Demand		
	Change from 2010-2060			Change from 2010-2060	
Region	Acre-feet	Percentage	Region	Acre-feet	Percentage
A	19,521	29%	A	-493,061	-34%
B	-1,731	-5%	B	-8,603	-9%
C	1,370,125	91%	C	1,055	3%
D	45,640	51%	D	-776	-5%
E	72,867	60%	E	-47,210	-9%
F	13,004	11%	F	-26,832	-5%

TAMU-TWRI, 2012

Irrigation: Yesterday and Today

Furrow irrigation – 50% loss

Advanced pivot & drip – 2-5% loss

Irrigation Advances

~98% Efficiency increase in return per inch of water since irrigation began. Combination of irrigation, fertility, tillage, pest management (Best Management Practices)

- Underground pipelines replaced open ditches in 1950's and 1960's
- High pressure center pivot and side roll sprinkler systems popular in 1960's and 1970's; had water losses of about 50 percent
- Center pivot sprinkler systems became popular in early 1980's; helped reduce water losses to about 20 percent
- Low energy precision application (LEPA) systems developed by Dr. Bill Lyle with the Texas A&M Research and Extension Center at Lubbock, Texas in 1980's
- Many producers now installing drip irrigation systems
- New technologies being evaluated

Data provided by
Plains Cotton Growers

Hotspots of groundwater depletion

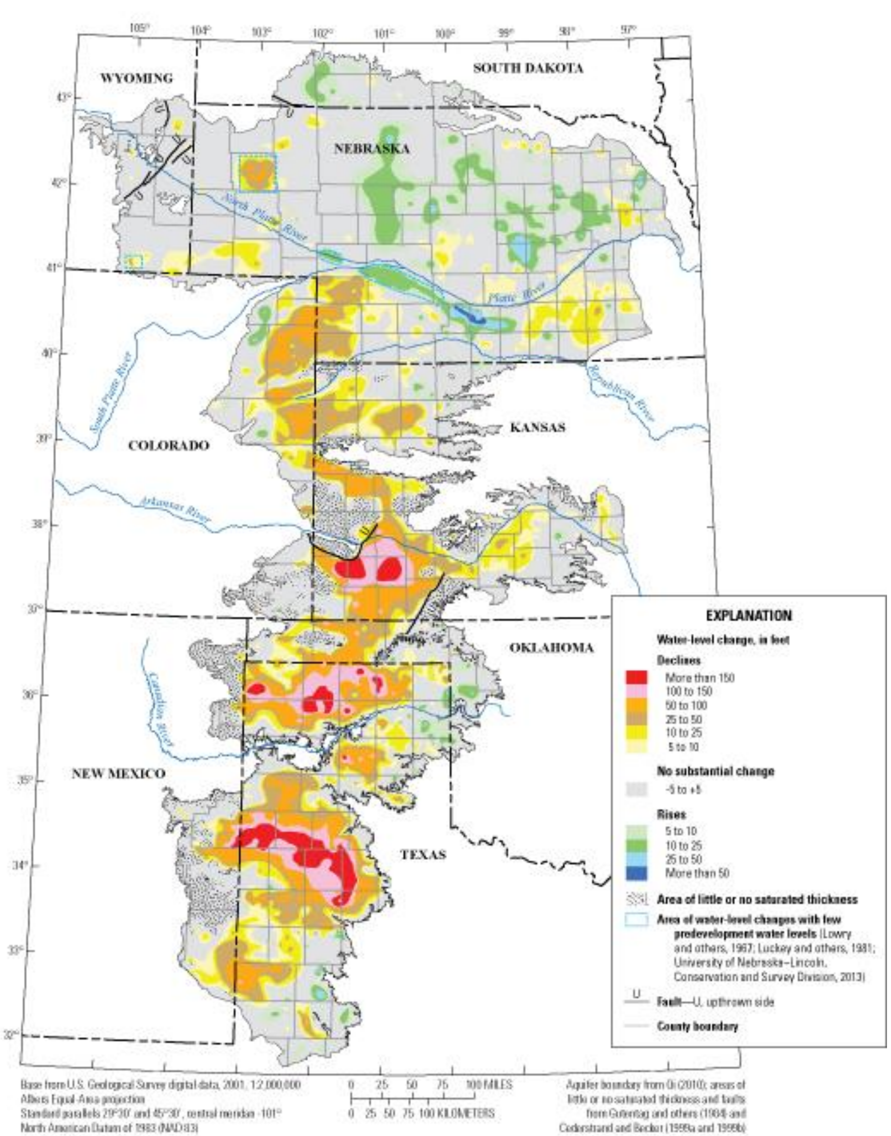
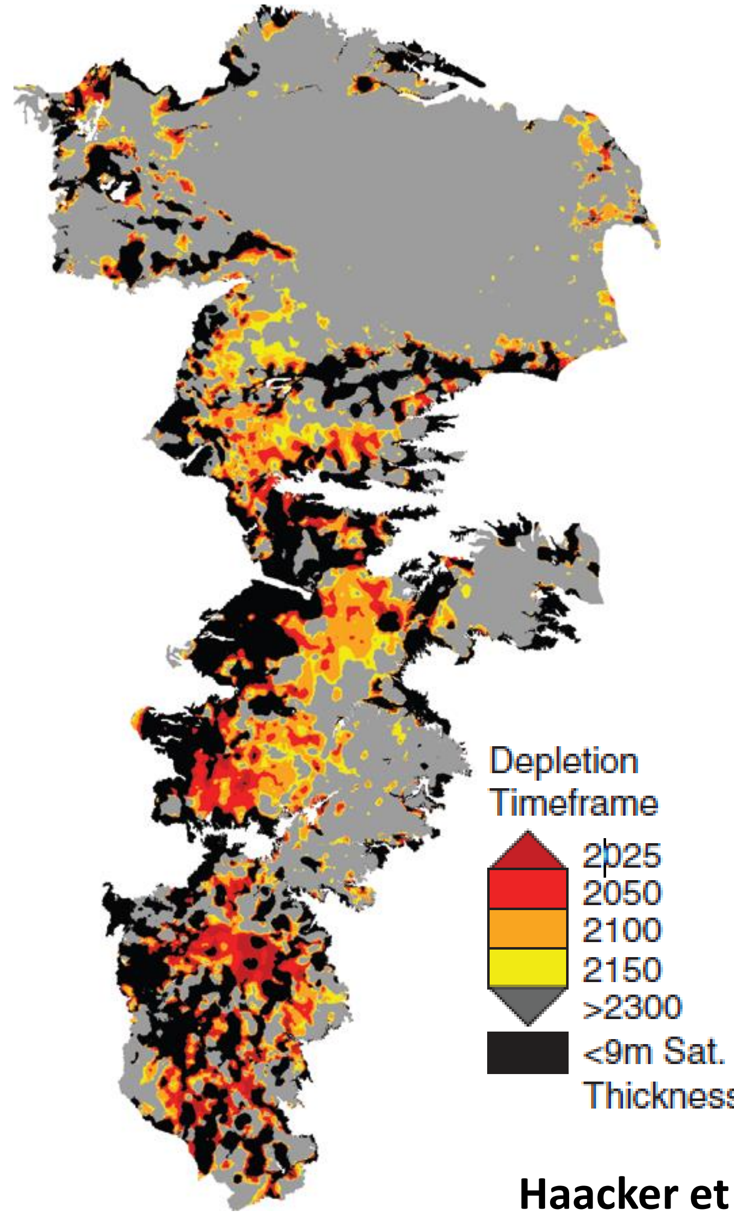


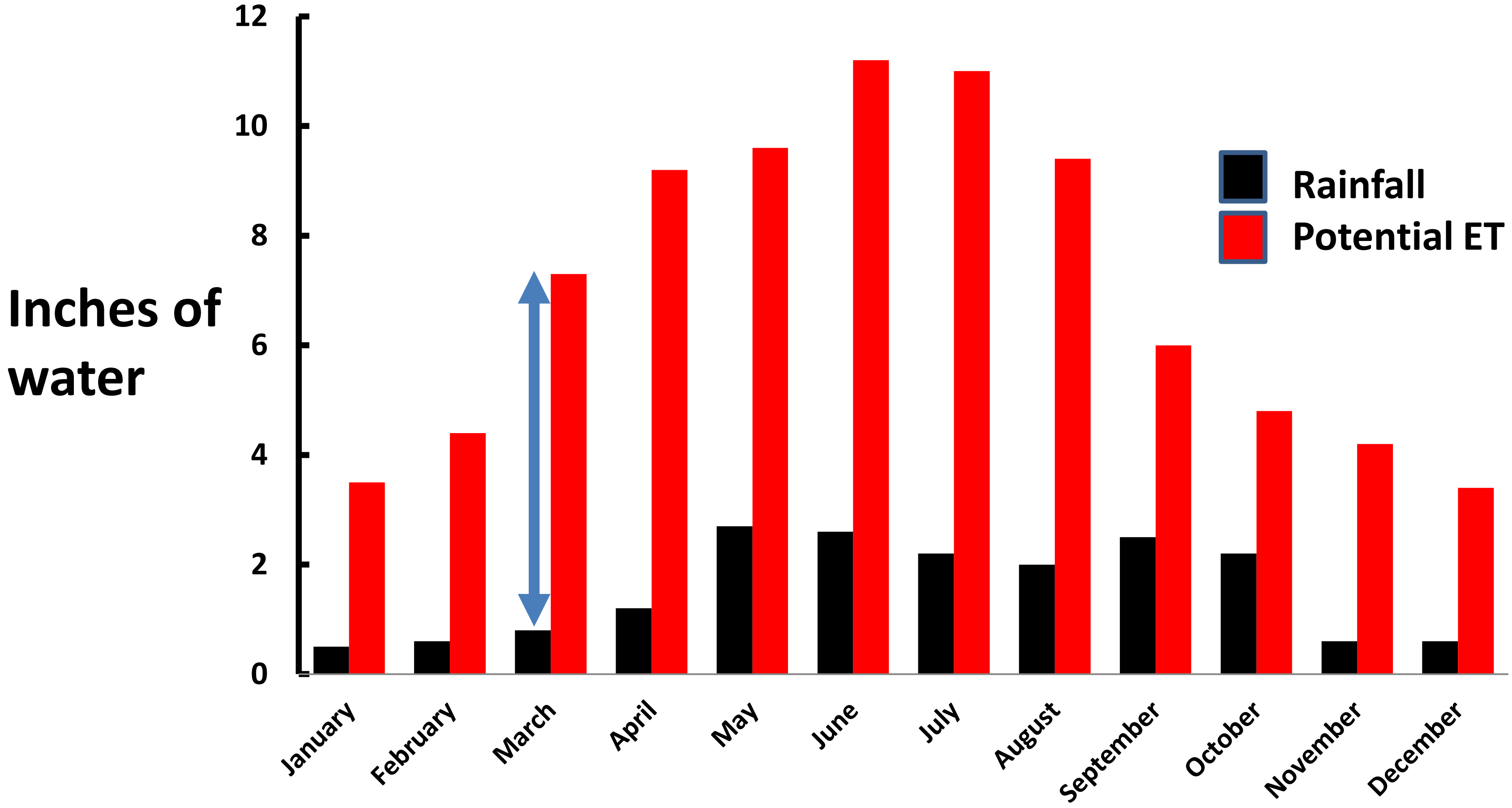
Figure 11. Water-level changes in the High Plains aquifer, predevelopment (about 1950) to 2013.

McGuire, 2014



Haacker et al., 2015

In Lubbock, PET exceeds rainfall in every month.

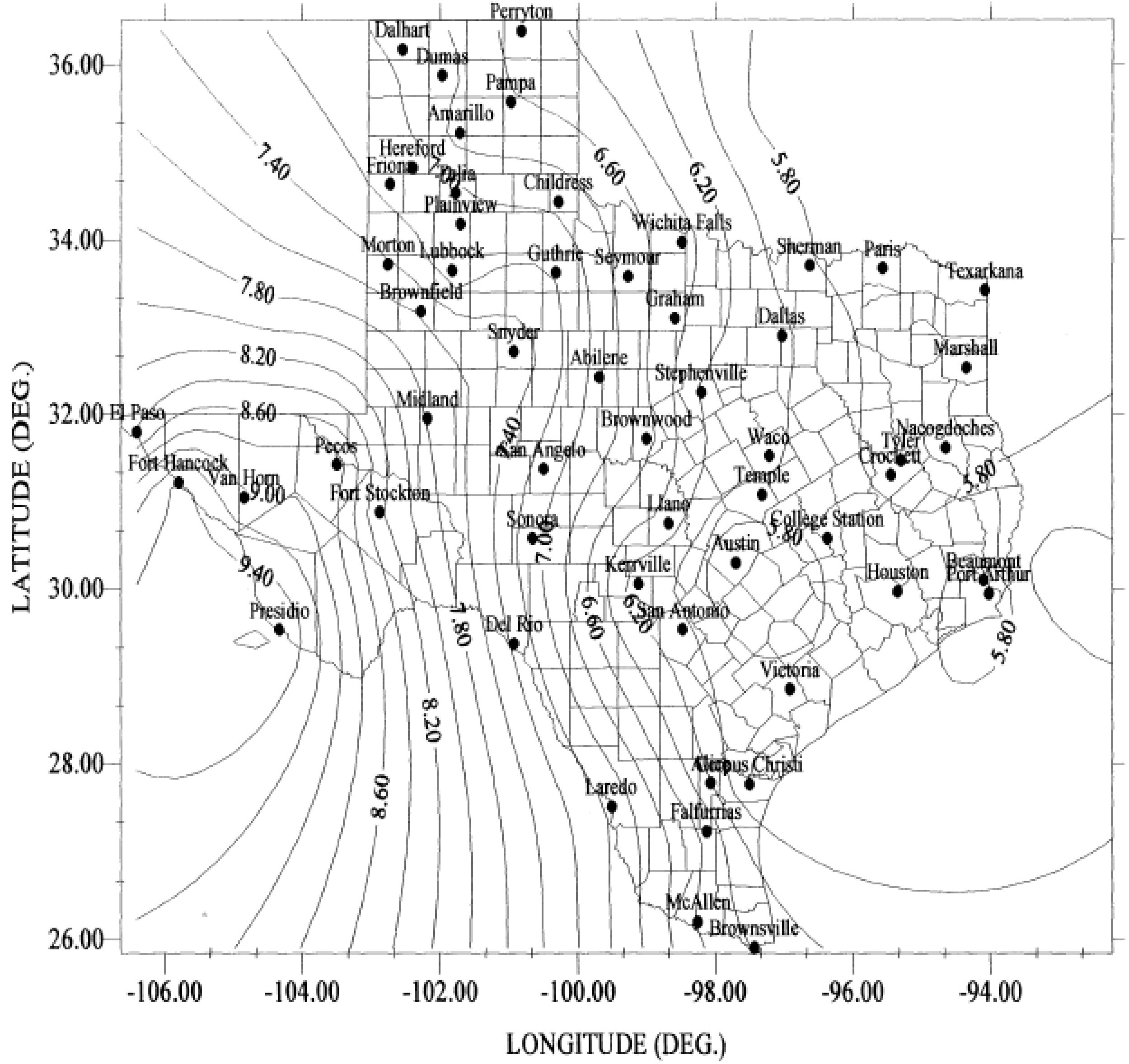


Lubbock: Rain and PET by month

Potential ET depends on:

- temperature
- wind run
- humidity
- solar radiation

May Reference Et_o (in./mo.)



Borrelli et al. (1998)

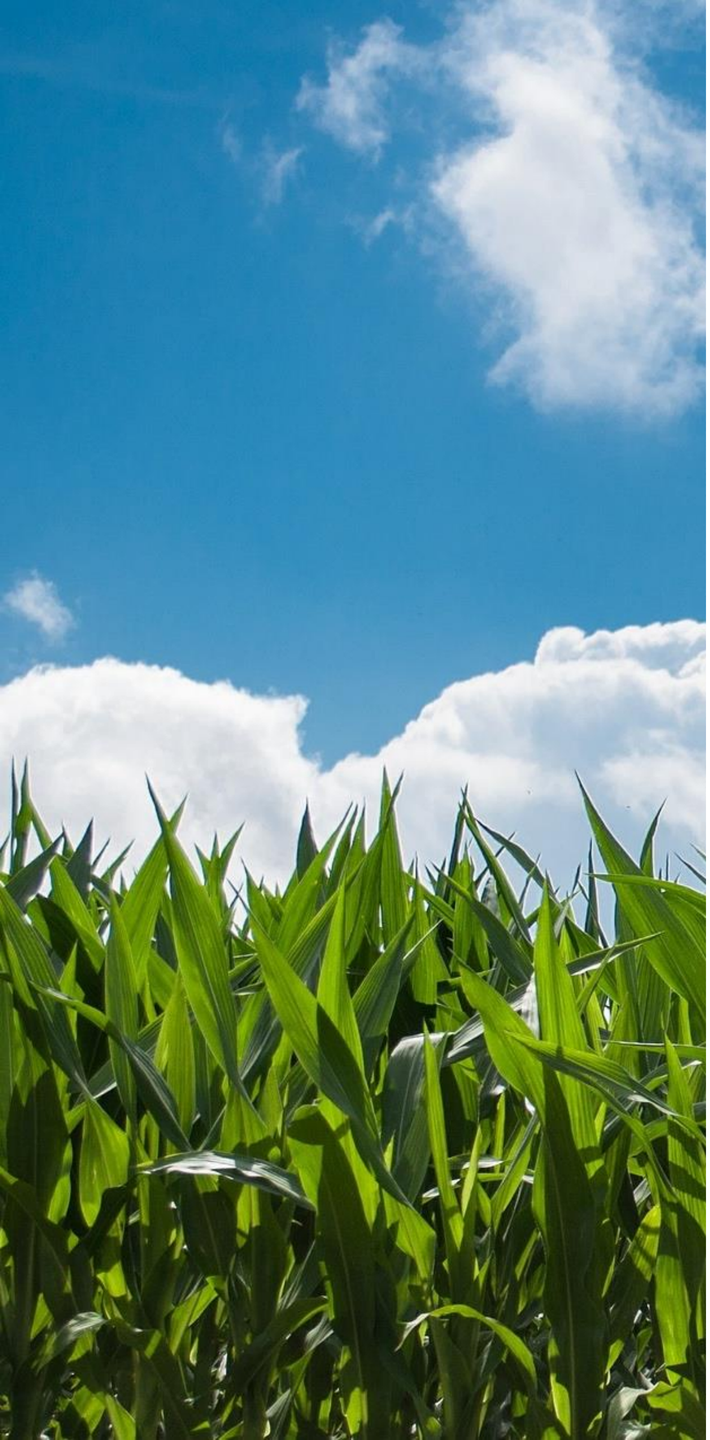
How do we sustain this type of agriculture ?

- **Push back the time when we can’t irrigate.**
- **Maintain profitability with decreasing water inputs → Efficiency**
- **Improve the water retention of soil**
- **Higher-value ag commodity output**

  Vineyards, high-quality cotton, seed crops

Climate models predict :

- **warmer temperatures**
- **higher evaporation rates**
- **stronger droughts**



The Ogallala Water Coordinated Agricultural Project

Optimizing Water Use for Agriculture and Rural Communities

Colorado State University: 40 scientists
Kansas State
Nebraska
Oklahoma State
New Mexico State
Texas Tech
Texas A&M
West Texas A&M
USDA-ARS

OgallalaWater.org
OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

USDA
United States Department of Agriculture

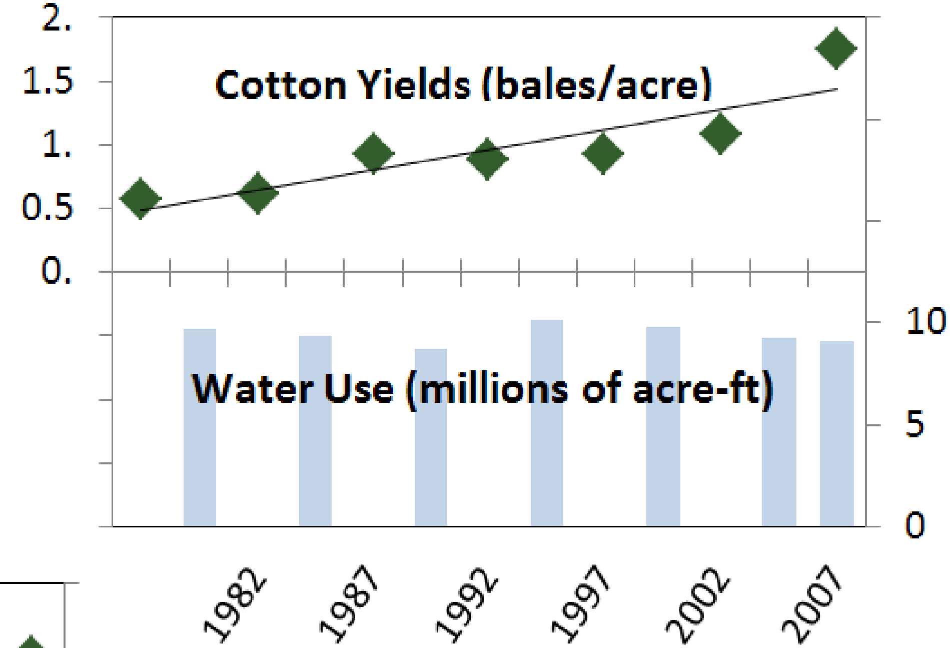
National Institute of Food and Agriculture

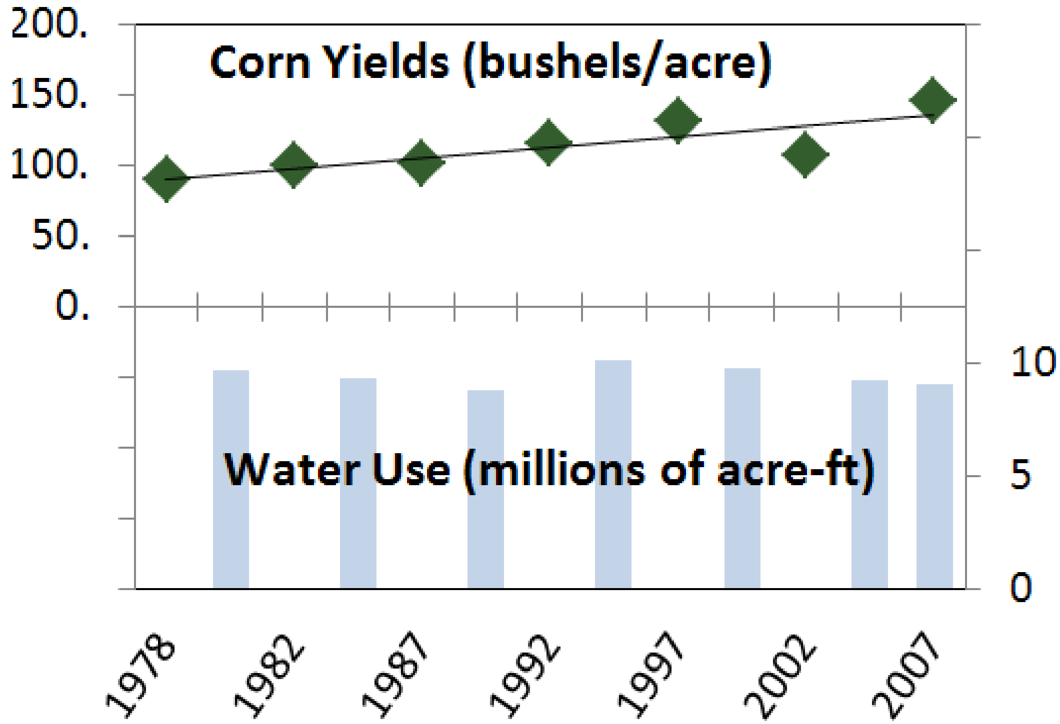
2016-68007-25066

Methods of water conservation -

- Irrigation scheduling – irrigate at 60-80% of PET
- Developing improved irrigation water management technologies
  e.g. LEPA, SDI, VRI, monitoring soil moisture and plant stress …
- Adoption of conservation practices
  e.g. Minimum till, rain capture and retention, runoff reduction, staggering planting dates, irrigate smaller areas,
- Integrating forages and livestock grazing into cropping system
- Adopting drought-tolerant crop varieties and alternative crops

<u>Crop breeding</u> for water use efficiency





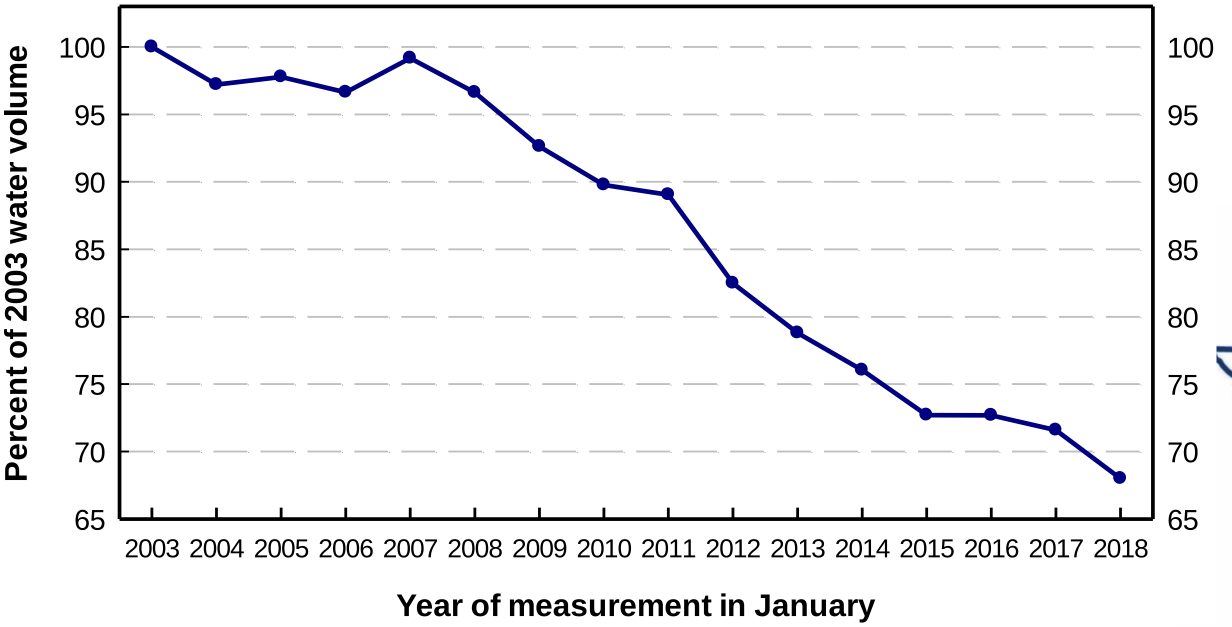
TAMU-TWRI, 2012

Texas Alliance for Water Conservation

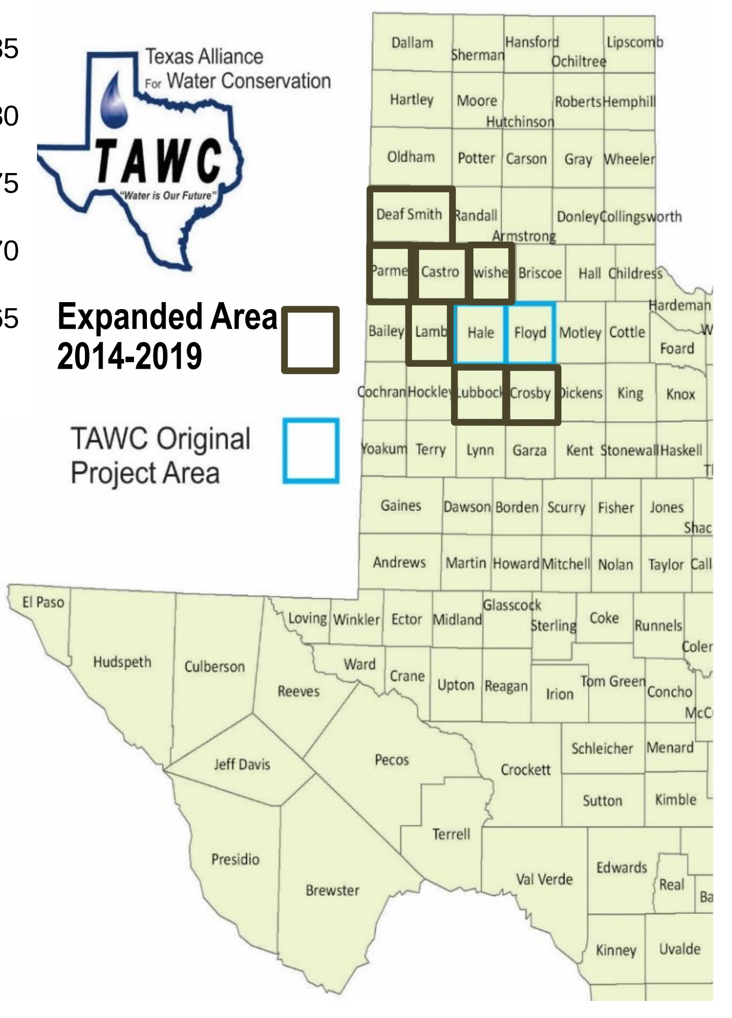
Partners with producers, USDA-NRCS, Texas A&M AgriLife, Water districts

Texas Alliance For Water Conservation
TAWC
"Water is Our Future"

- **Demonstrate how to reduce water use**
- **Identify profitable crop and irrigation systems**
- **Provide online tools for decision-making on water use and economic options**
- **Involves 34 producer fields in nine counties**



Percent of 2003 water volume
100
95
90
85
80
75
70
65
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year of measurement in January



Texas Alliance For Water Conservation
TAWC
"Water is Our Future"
Expanded Area 2014-2019
TAWC Original Project Area
Dallam
Sherman
Hansford
Ochiltree
Lipscomb
Hartley
Moore
Hutchinson
Roberts
Hemphill
Oldham
Potter
Carson
Gray
Wheeler
Deaf Smith
Randall
Armstrong
Donley
Collingsworth
Castro
Briscoe
Hall
Childress
Bailey
Lamb
Hale
Floyd
Motley
Cottle
Hardeman
Foard
Cochran
Lubbock
Crosby
Dickens
King
Knox
Yoakum
Terry
Lynn
Garza
Kent
Stonewall
Haskell
Gaines
Dawson
Borden
Scurry
Fisher
Jones
Andrews
Martin
Howard
Mitchell
Nolan
Taylor
El Paso
Loving
Winkler
Ector
Midland
Glasscock
Sterling
Coke
Runnels
Hudspeth
Culberson
Reeves
Ward
Crane
Upton
Reagan
Irion
Tom Green
Concho
Jeff Davis
Pecos
Crockett
Schleicher
Menard
Sutton
Kimble
Terrell
Presidio
Brewster
Val Verde
Edwards
Real
Kinney
Uvalde

Irrigation methods


Sprinkler


Sub-surface Drip


Furrow


Dryland

Irrigation water use by major crops in TAWC project – 8 yr mean

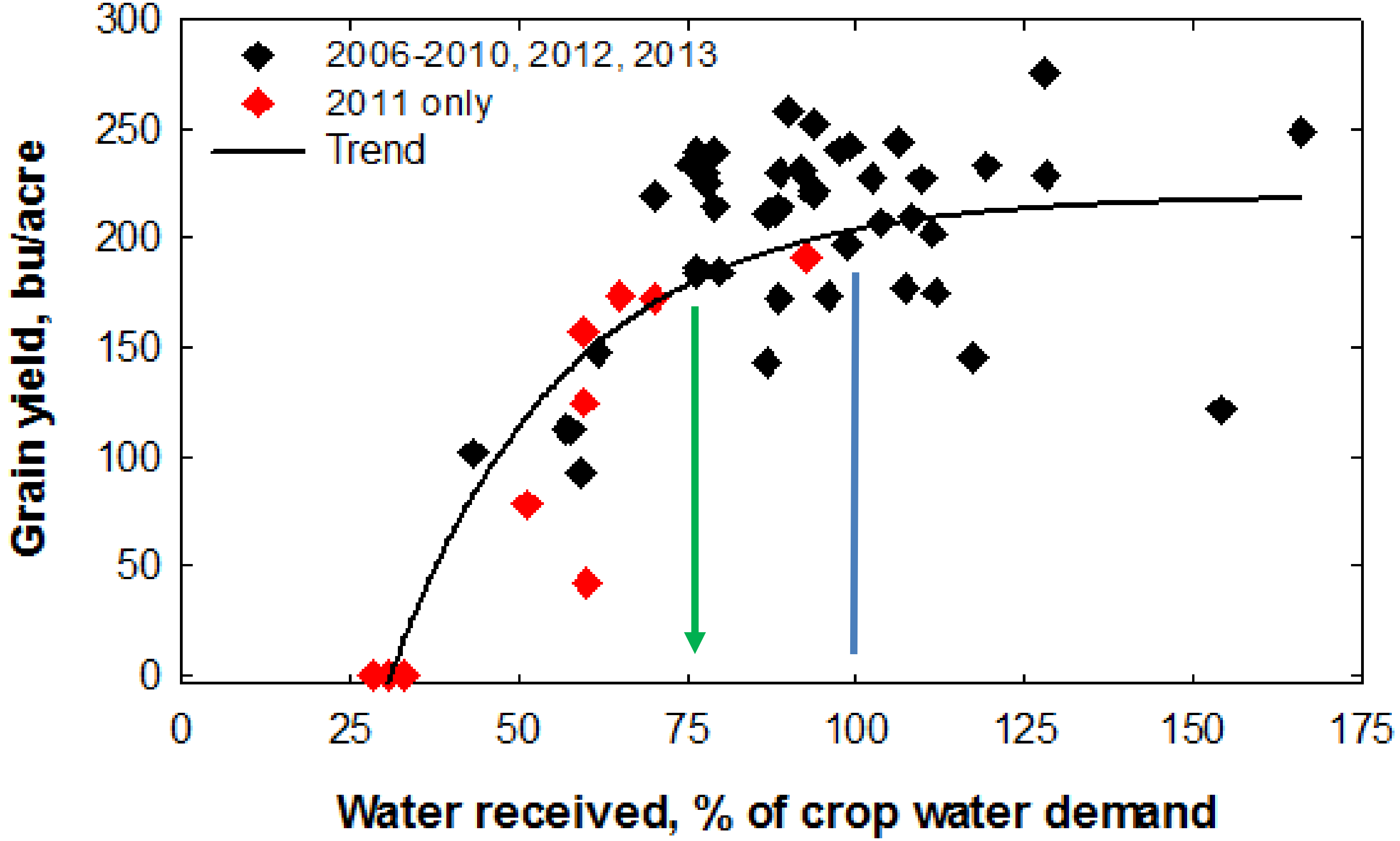
Crop	Irrigation applied	Water use efficiency
	inches/yr	lbs/ac-in.
Cotton lint	13	2990
Grain sorghum	12	760
Corn grain	18	610
Corn silage	22	2990

Irrigation water use by major crops in TAWC project – 8 yr mean

Crop	Irrigation applied	Water use efficiency
	inches/yr	lbs/ac-in.
Cotton lint	13	2990
Grain sorghum	12	760
Corn grain	18	610
Corn silage	22	2990

Drawbacks to sorghum compared to corn:
30% lower yield, 10% lower feeding value, lower price/bu.

Corn response to water received



Technology comparison and demonstration

Spray

PMDI

LEPA

Comparison of LEPA vs. LESA – 3 years

	LESA	LEPA	%
Cotton lint yield lbs/acre	934	1074	+15
Total costs $/acre	937	958	
Net returns $/acre	57	181	+217
Water applied, inches	20.5	20.5	
WUE lbs lint/acre-in.	48	55	+15

(Yates & Pate, 2014)

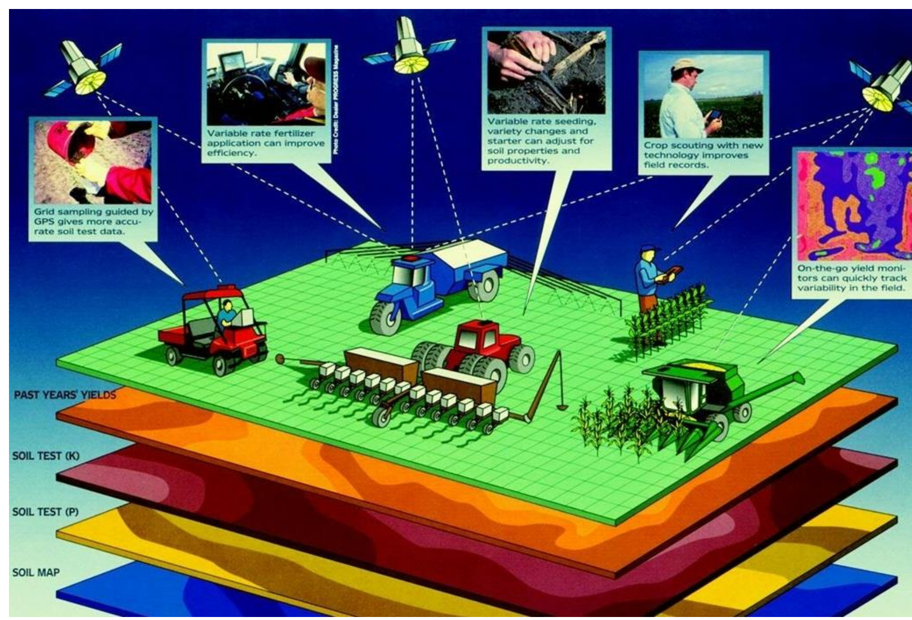
Workshop: Water Resource Management in Smart and Connected Communities

Water Management using Precision Agriculture Technologies

Wenxuan Guo

Assistant Professor of Crop Ecophysiology/Precision Agriculture

Plant & Soil Science, Texas Tech University



Precision agriculture balances production intensification and protection of environment

"A management system that is **information** and **technology** based, is **site specific** and uses one or more of the following sources of **data**: soils, crops, nutrients, pests, moisture, or yield, for optimum **profitability**, **sustainability**, and protection of the **environment**"

-- NRCS, 2007

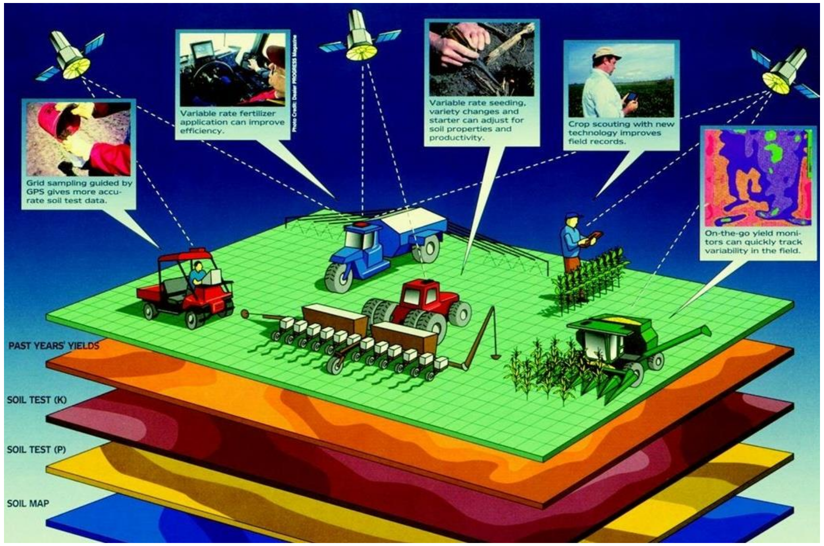
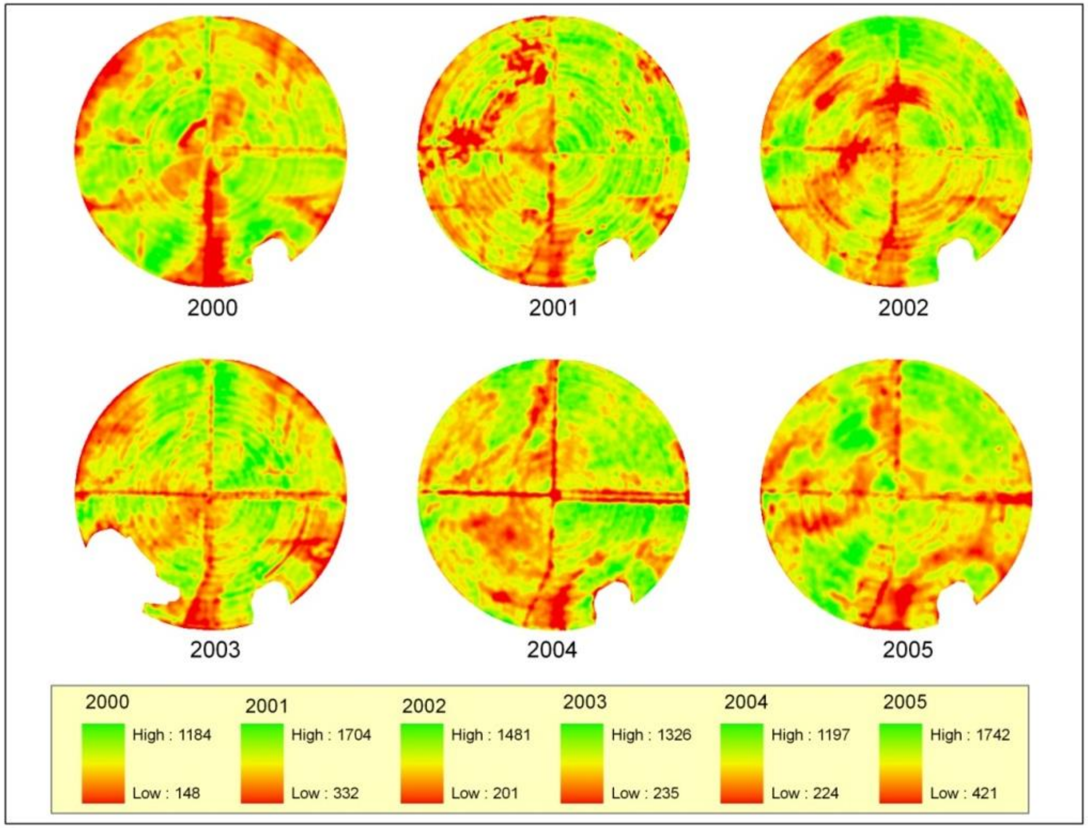


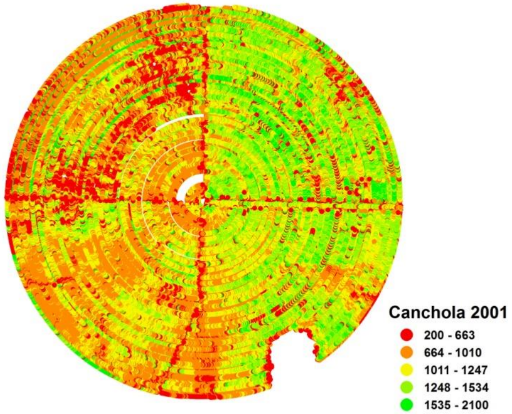
Image source: http://www.gps4us.com

1. Right **source**
2. Right **amount**
3. Right **place**
4. Right **time**
5. Right **manner**

Background and Rationale



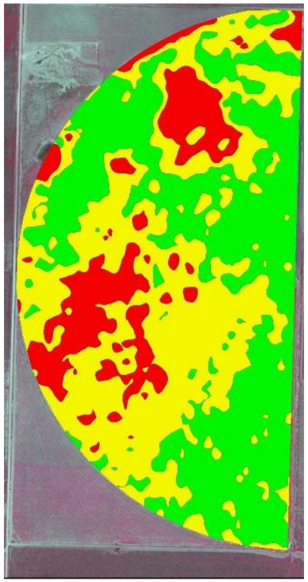
AGRIPlan Yield Monitor

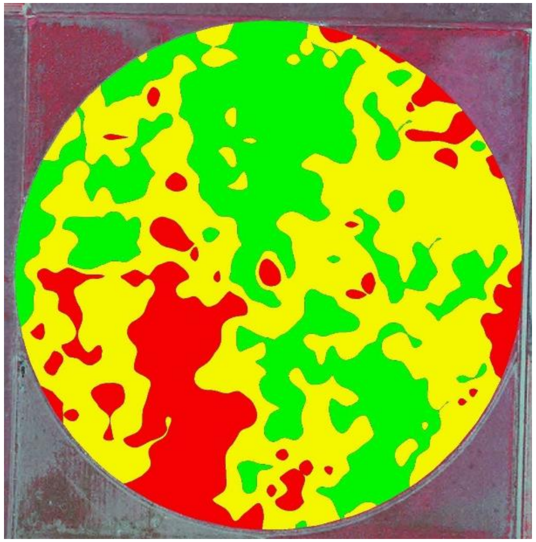


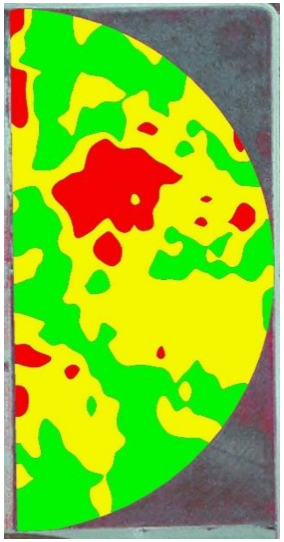
200,000 Points (490 ac)

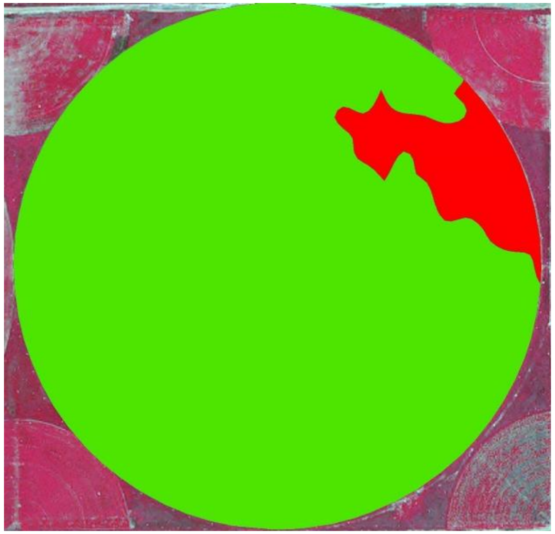
Relatively consistent yield patterns allow optimizing water allocation by concentrating on more productive zones, potentially increasing overall productivity and profitability

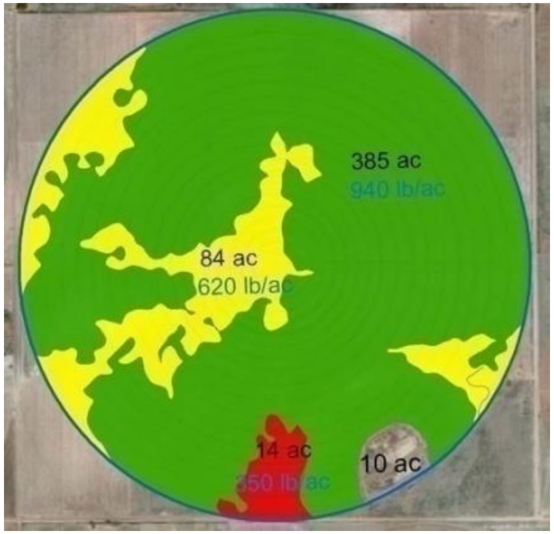
Many fields have similar spatial yield patterns











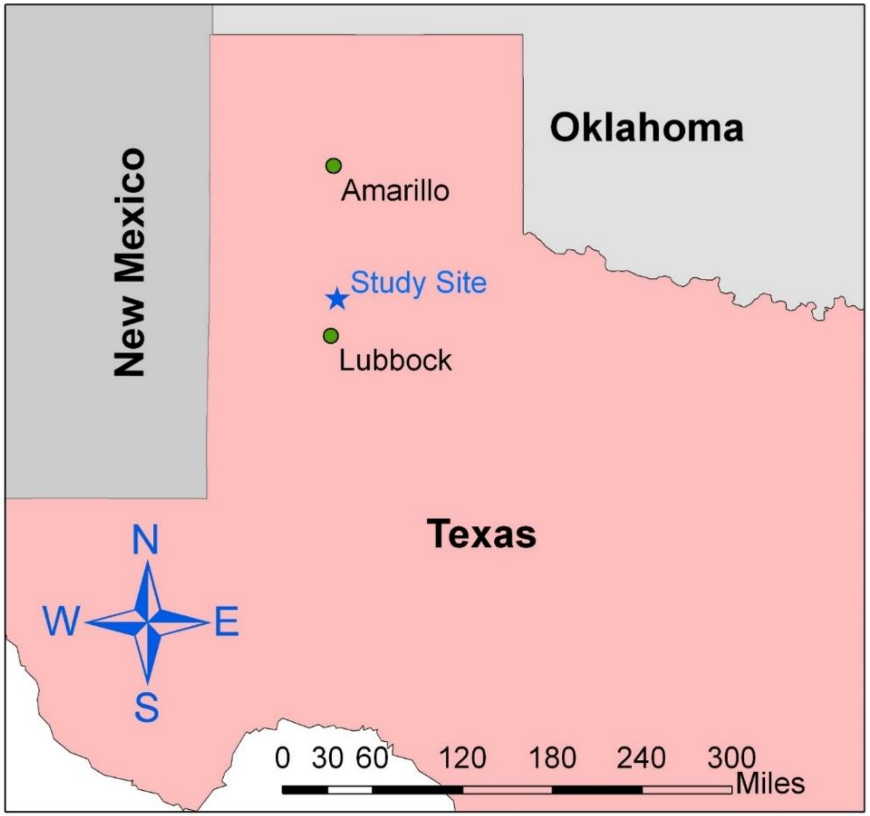
Summary of six farms

	Pivot Acres	Low-yield acres	Percent
Ruidoso 640 Farm	480	108	23%
Sweat Farm	240	35	15%
Starr Farm	120	18	15%
Buck Farm	60	7	12%
Dog Dog	120	20	17%
Sandhill West Farm	120	9	8%
	1,140	197	17%

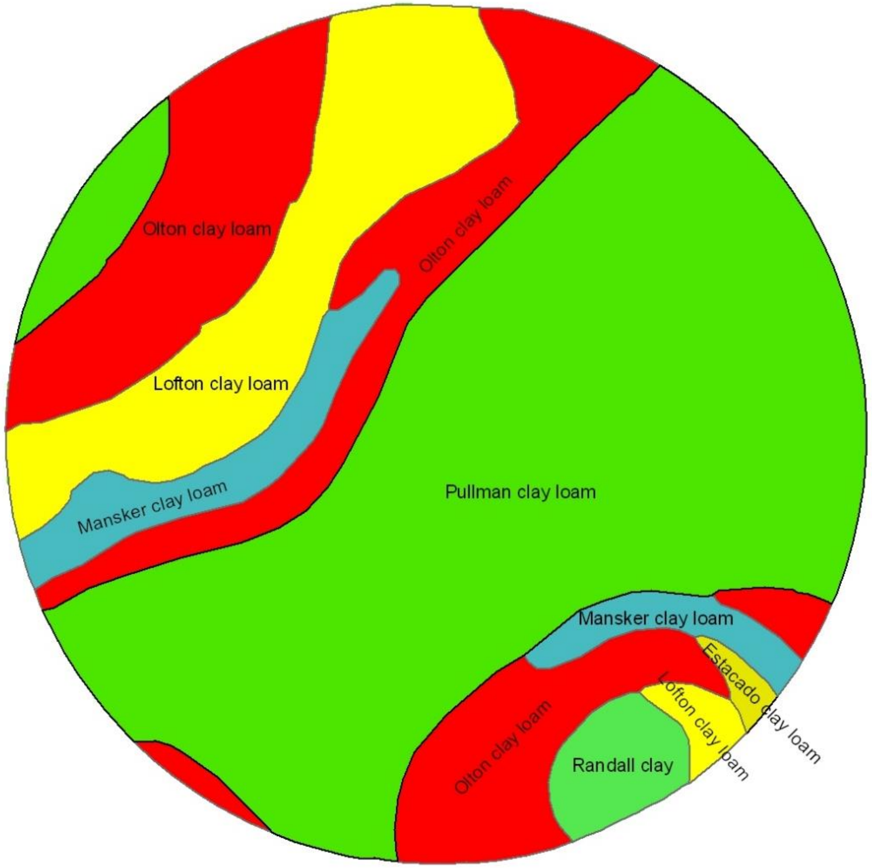
Objectives

- **Identify strategies for optimizing water use efficiency, i.e. variable rate irrigation for improving crop yield and profitability**

Study site

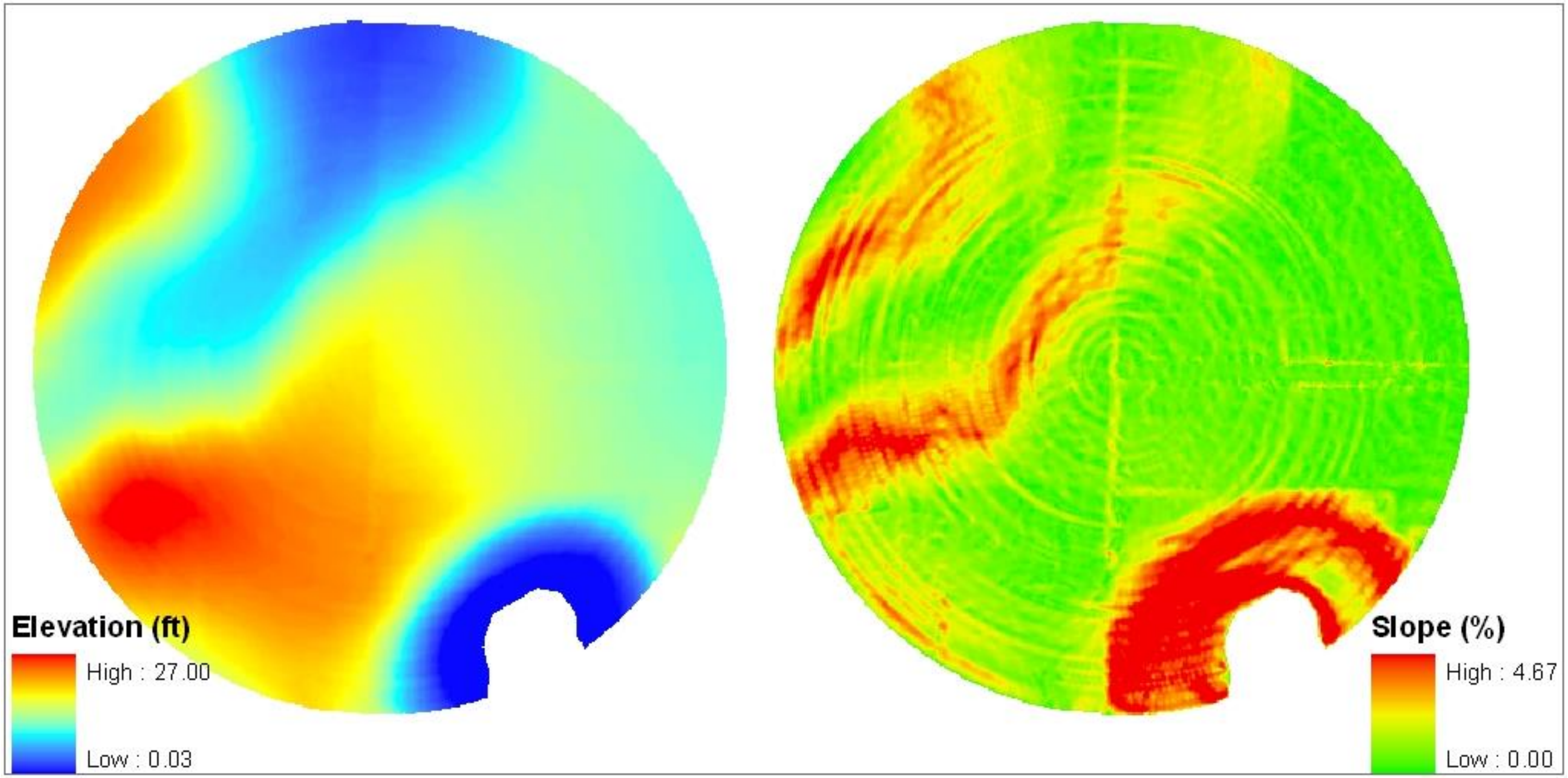


New Mexico
Oklahoma
Amarillo
Study Site
Lubbock
Texas
N
W
E
S
0 30 60 120 180 240 300
Miles

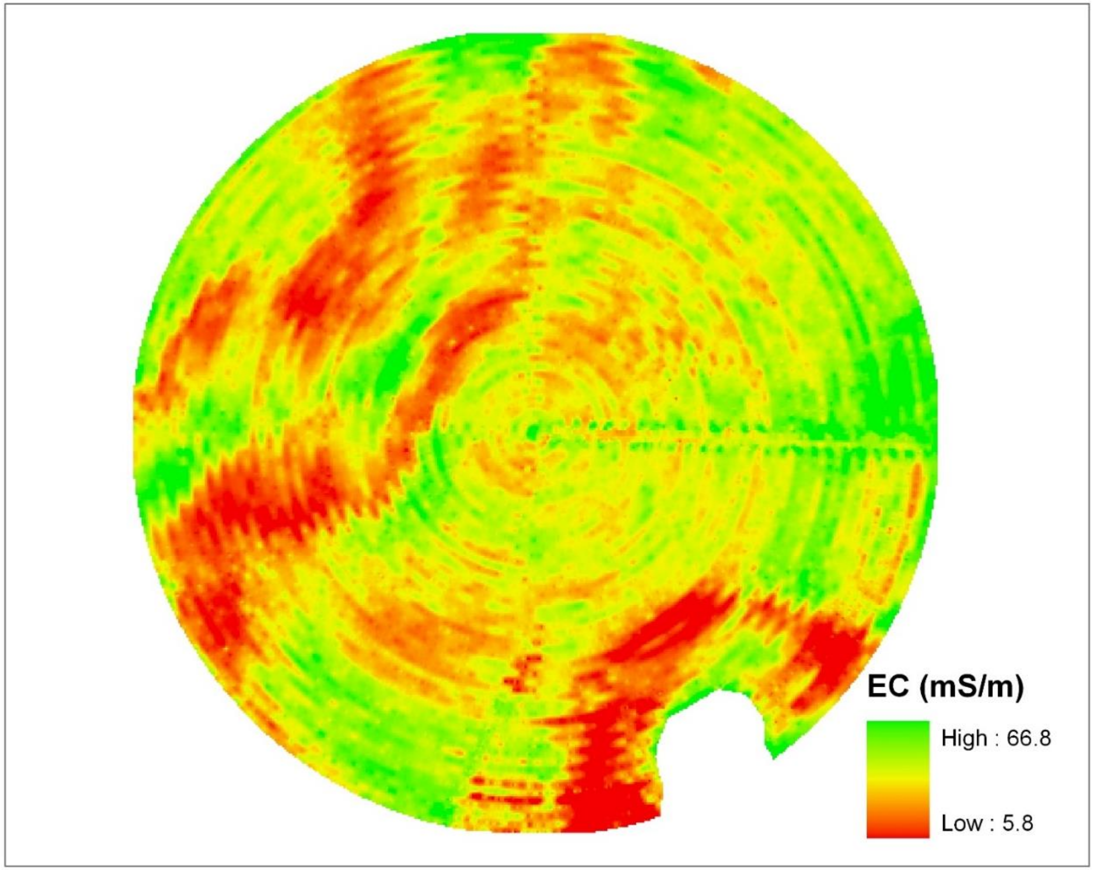


Olton clay loam
Olton clay loam
Lofton clay loam
Mansker clay loam
Pullman clay loam
Mansker clay loam
Estacado clay loam
Lofton clay loam
Olton clay loam
Randall clay

Substantial variation in topography

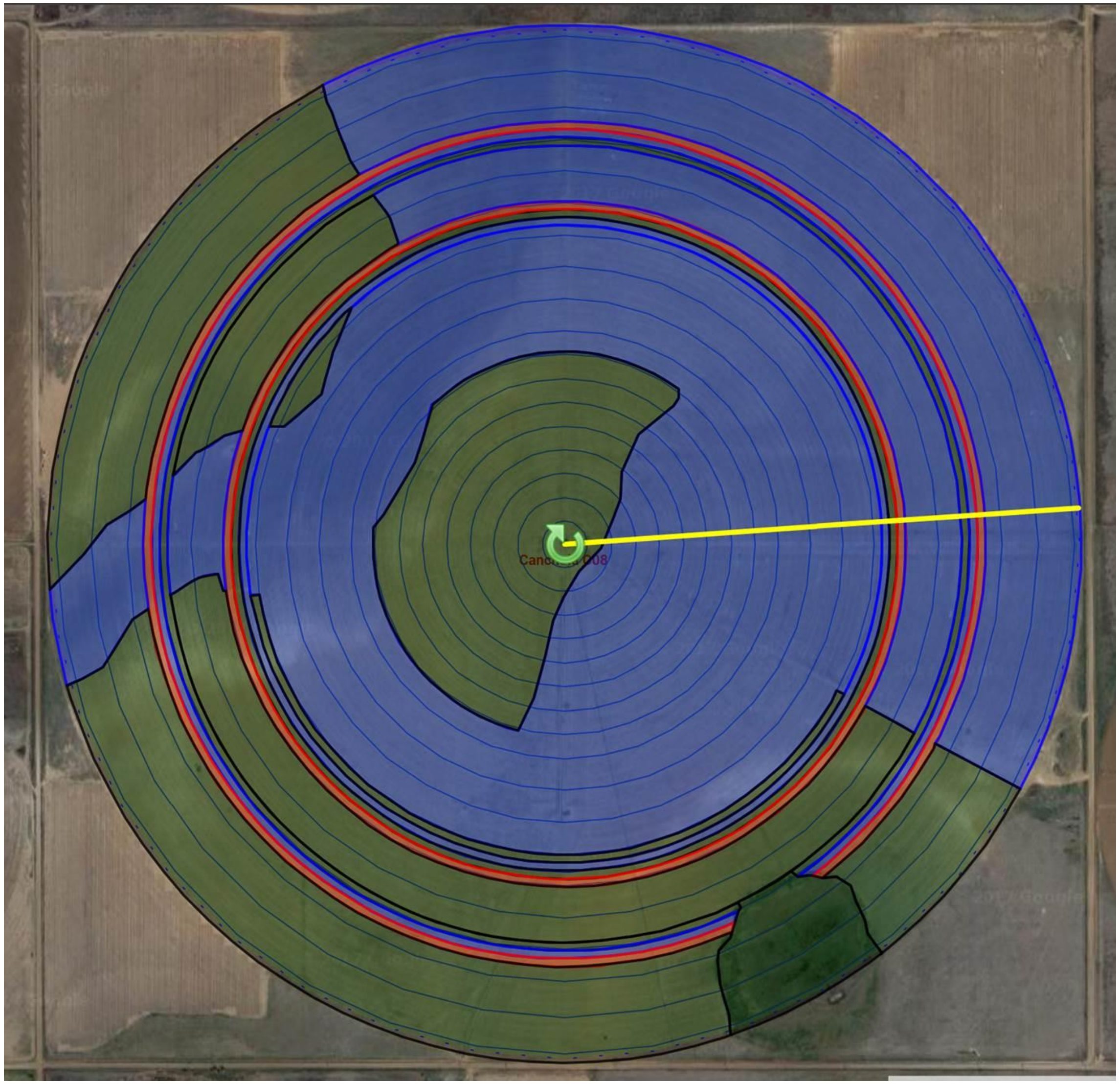


Substantial variation in apparent soil electrical conductivity

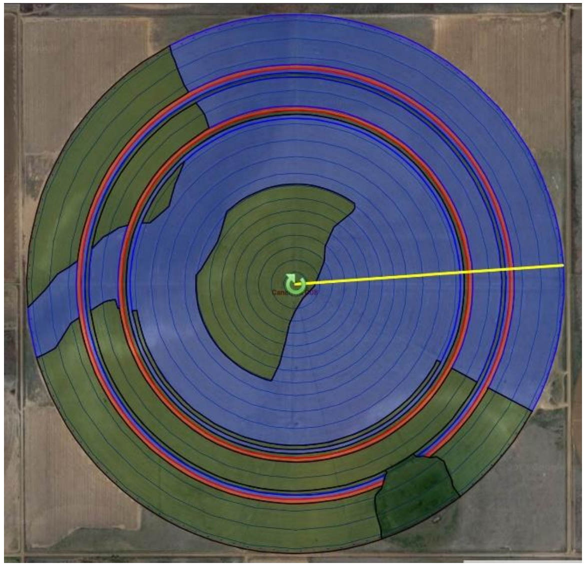


Management zones and variable rate irrigation

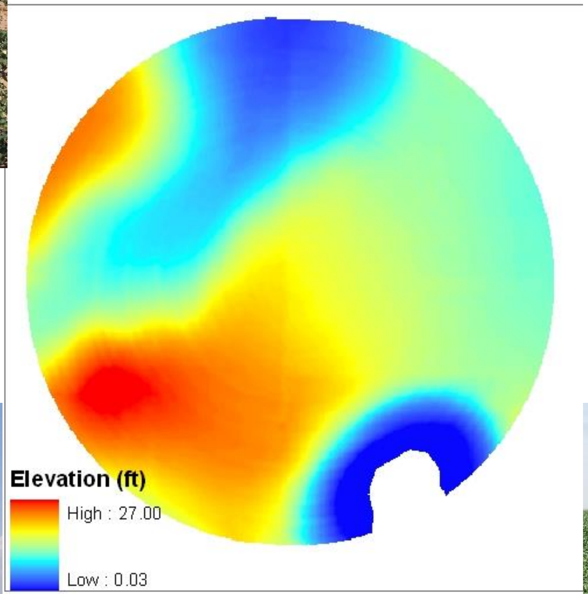
- **Topography**
- **EC**
- **Yield**
- **Producer input**



Variable rate irrigation system – Trimble Irrigate-IQ



Variation in plant growth at different landscape positions



Preliminary results and thoughts

- Under a favorable weather condition, irrigation effects are not obvious
- Landscape positions and soil properties play a key role in plant growth conditions and yield
- The result indicates variable rate irrigation can improve water use efficiency on a field basis

Acknowledgements

USDA

Southern SARE LS14-261

NIFA 2016-68007-25066

Cotton Inc. 17-012

Texas Tech University CASNR

Texas Water Development Board

Contributors

Lisa Baxter

Rick Kellison

Phil Brown

Jasmine Neupane

Jerry Brightbill

USDA United States Department of Agriculture

Cotton Incorporated

OgallalaWater.org

Texas Water Development Board

TEXAS TECH UNIVERSITY College *of* Agricultural Sciences & Natural Resources

Texas Alliance For Water Conservation TAWC "Water is Our Future"

QUESTIONS ?