Linking Climate to Groundwater Conservation

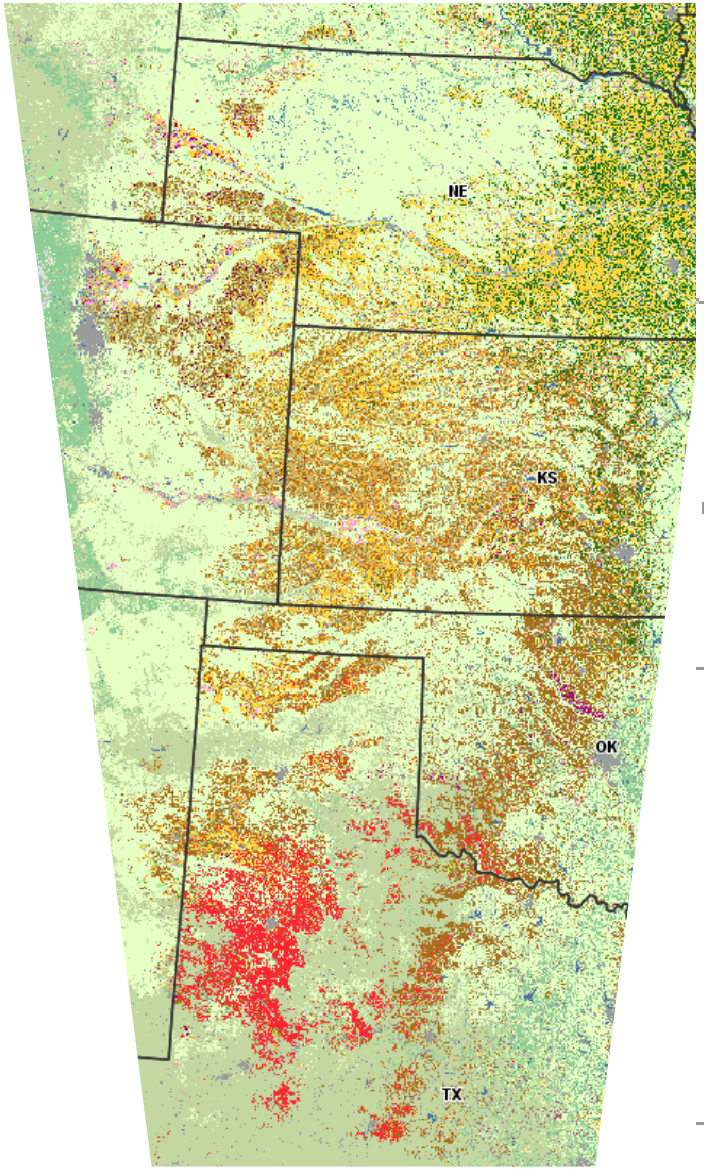
Climate Outlook Forum, Clovis NM April 26, 2017

Chuck West
Texas Tech University

How do we deal with declining water supplies in an agriculturally productive region?



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

Hotspots of groundwater depletion

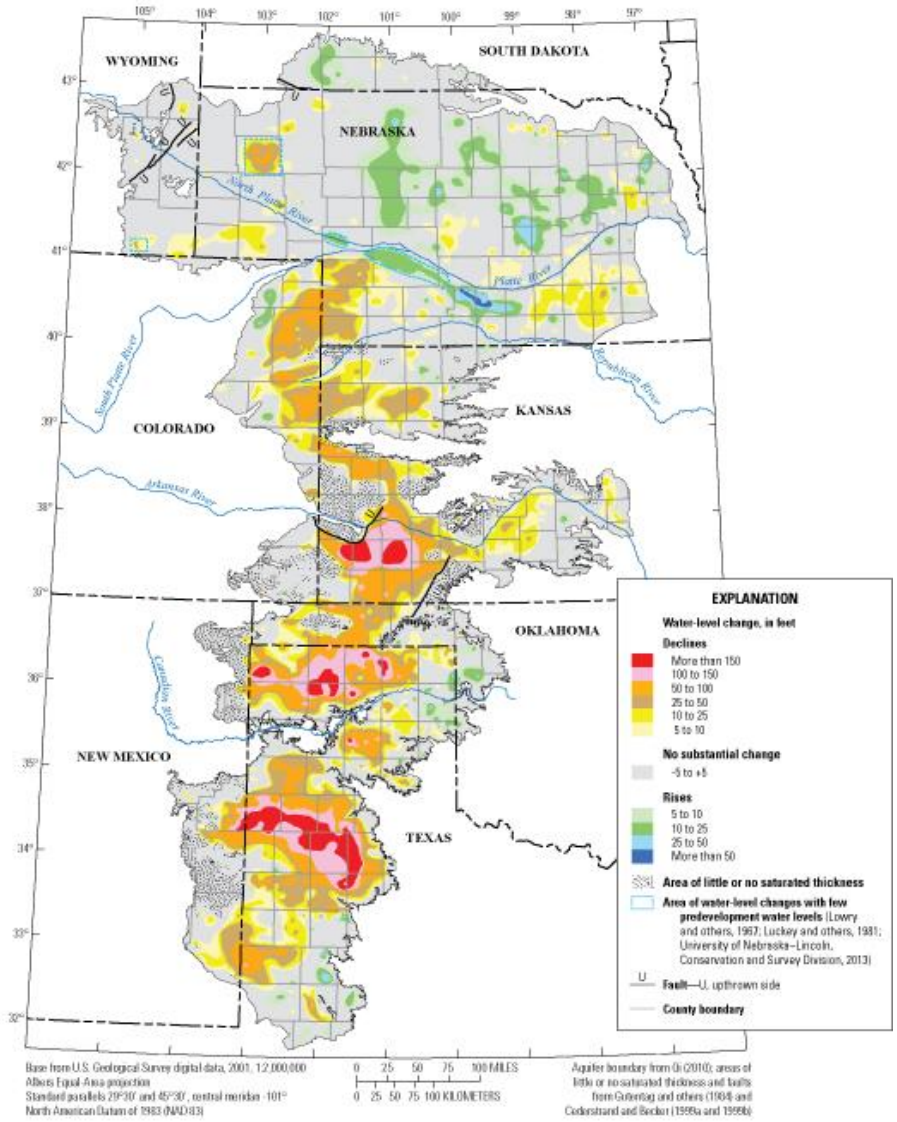
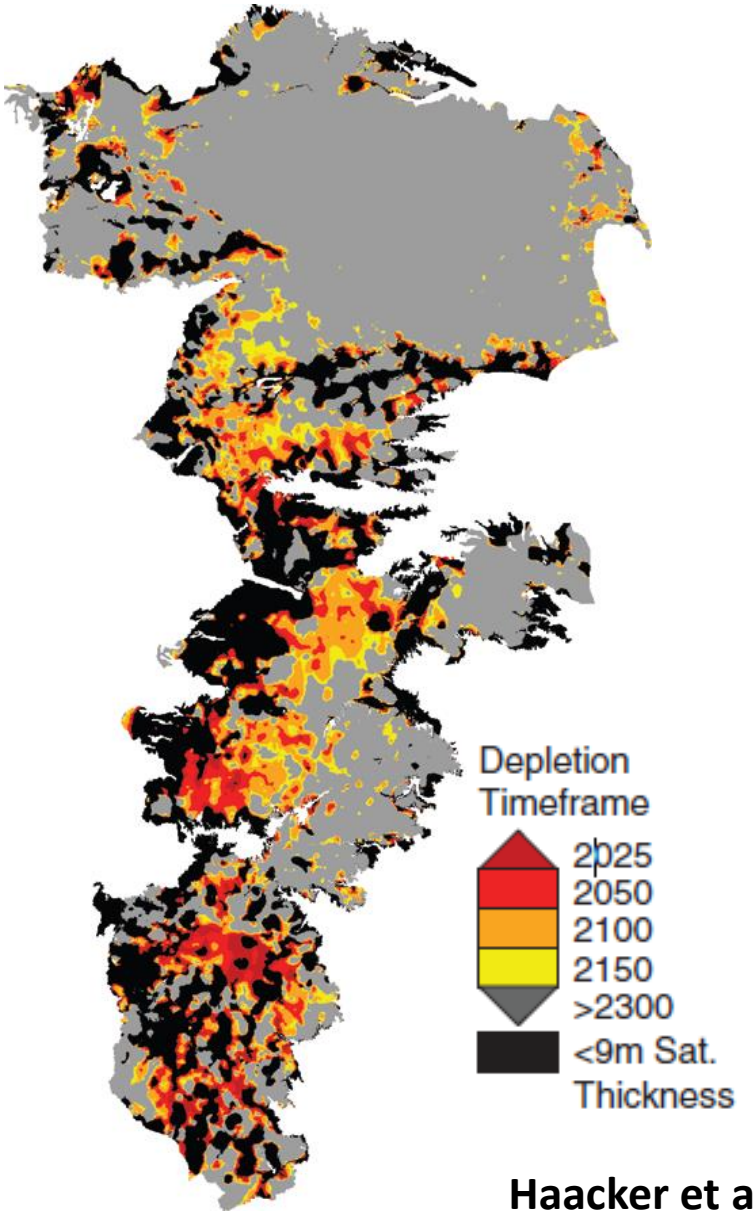


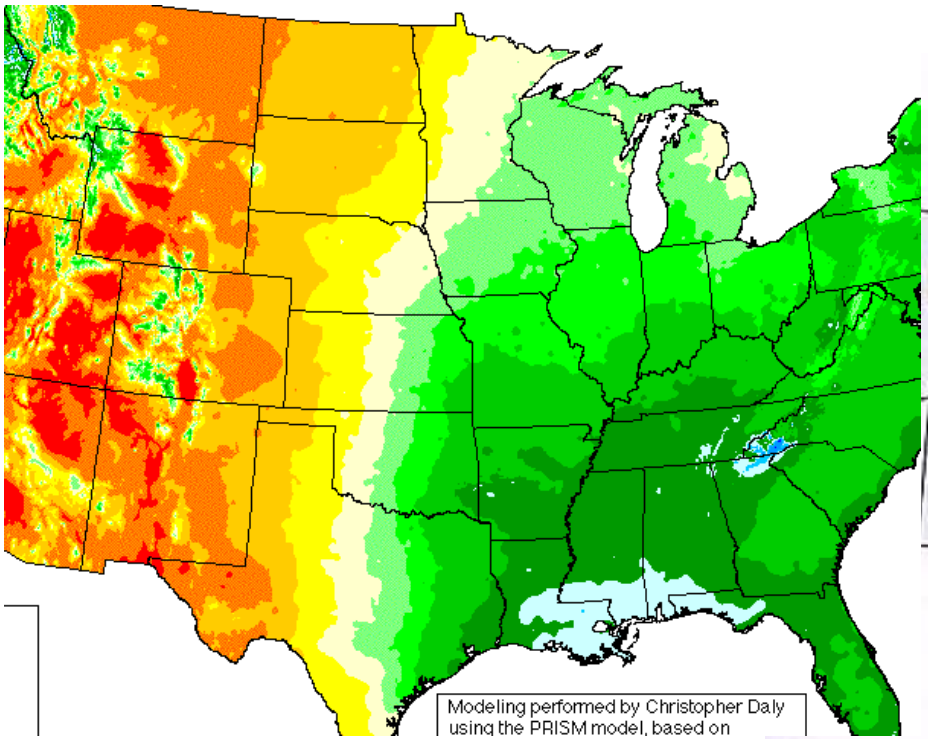
Figure 11. Water-level changes in the High Plains aquifer, predevelopment (about 1950) to 2013.

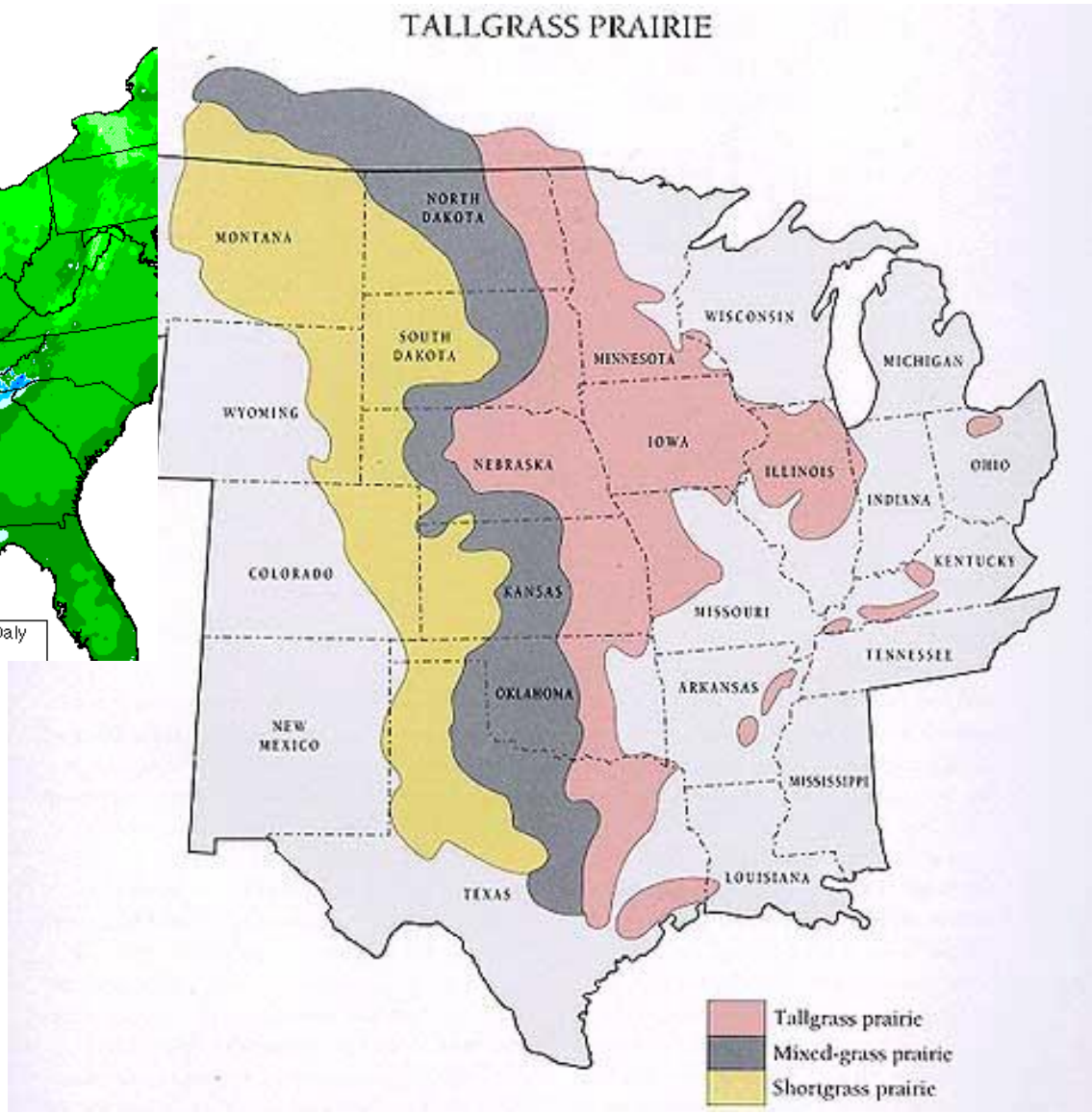
McGuire, 2014



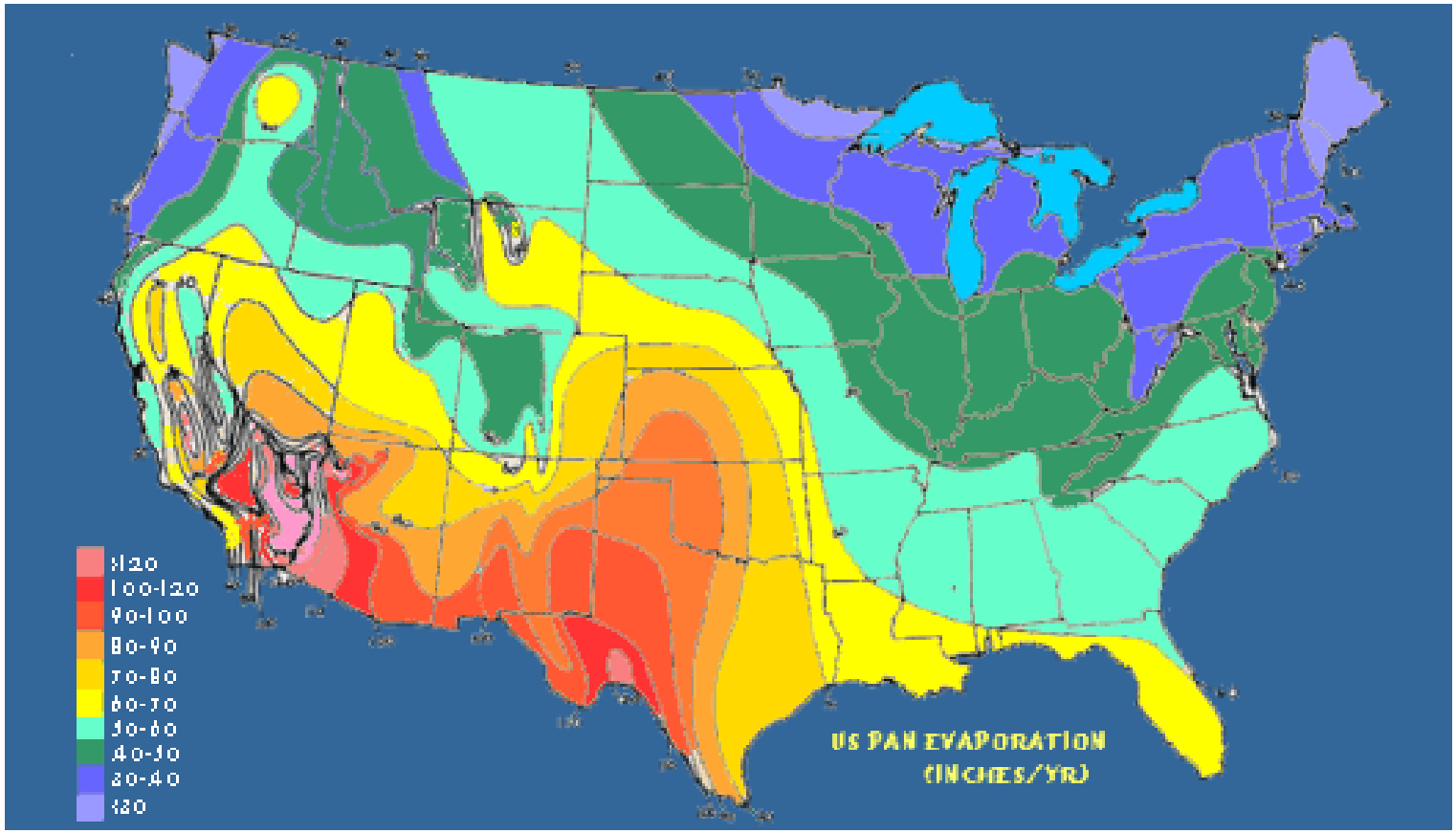
Haacker et al., 2015

Importance of Potential ET in Understanding Water Deficit





Potential Evapotranspiration (PET) drives water demand

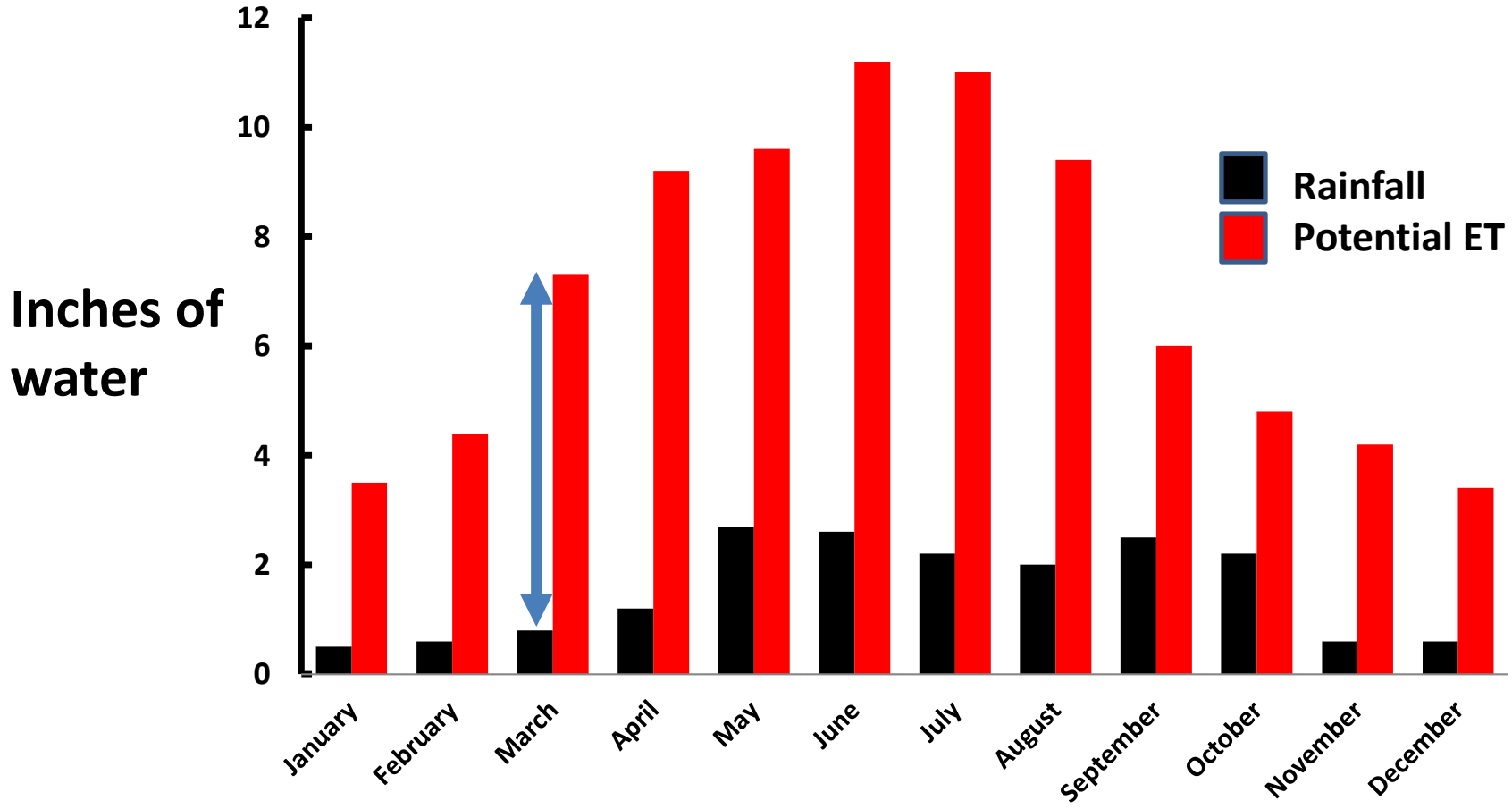


NOAA

Water supply = PET minus Rainfall

Irrigation from the Ogallala balances the water deficit

In Lubbock, PET exceeds rainfall in every month.

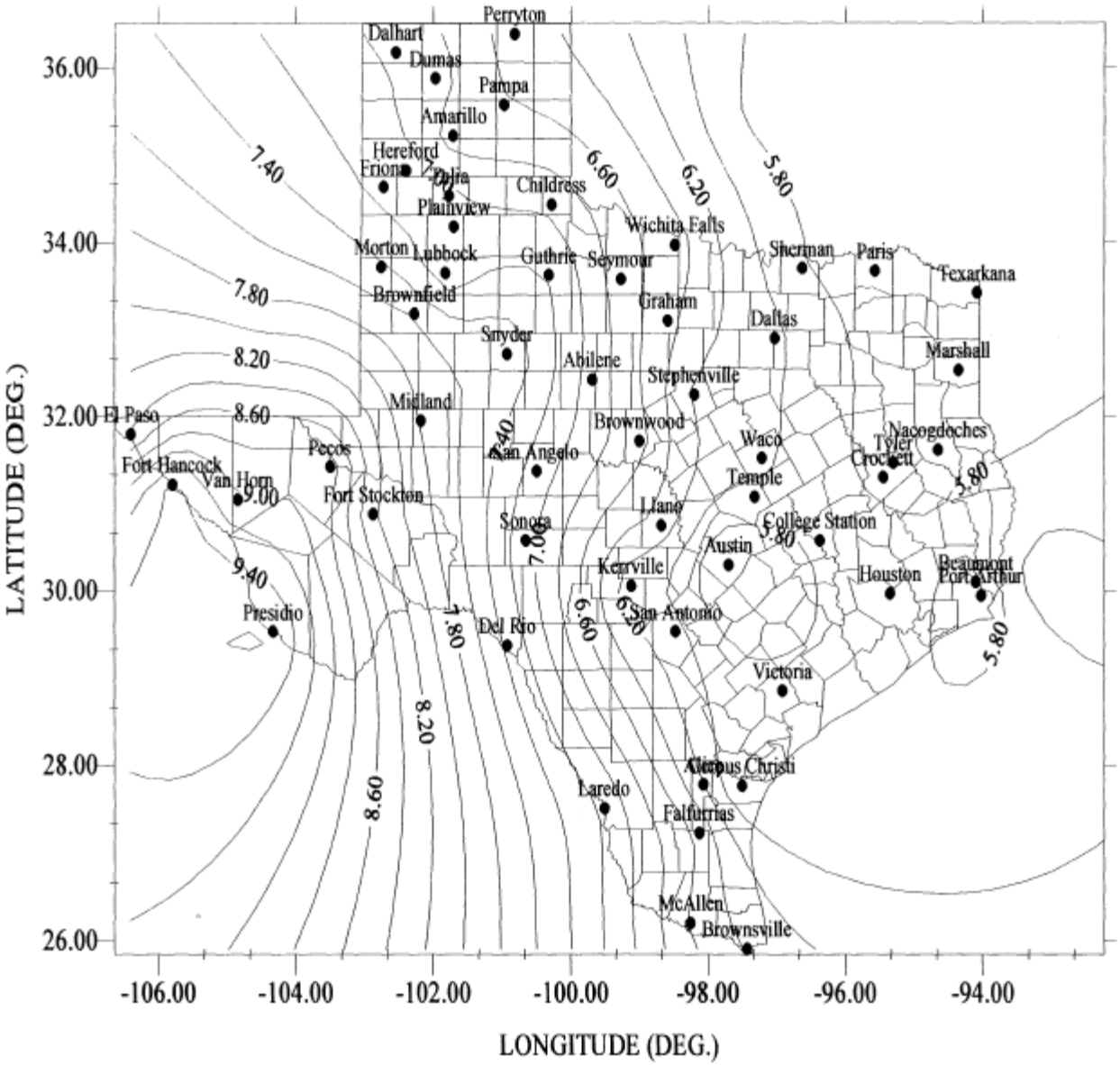


Lubbock: Rain and PET by month

Potential ET depends on:

- temperature
- wind run
- humidity
- solar radiation

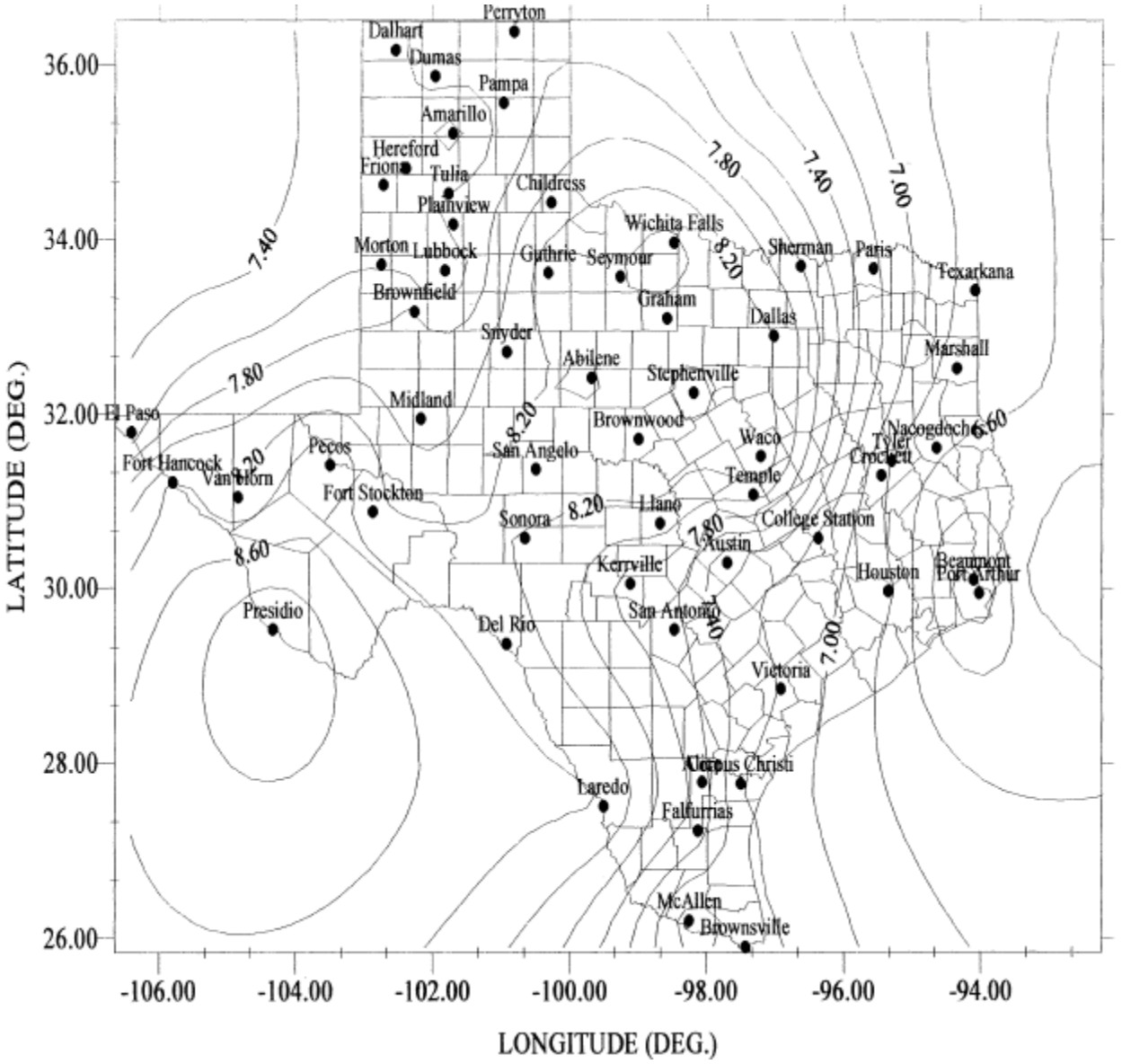
May Reference Et_o (in./mo.)



Potential ET depends on:

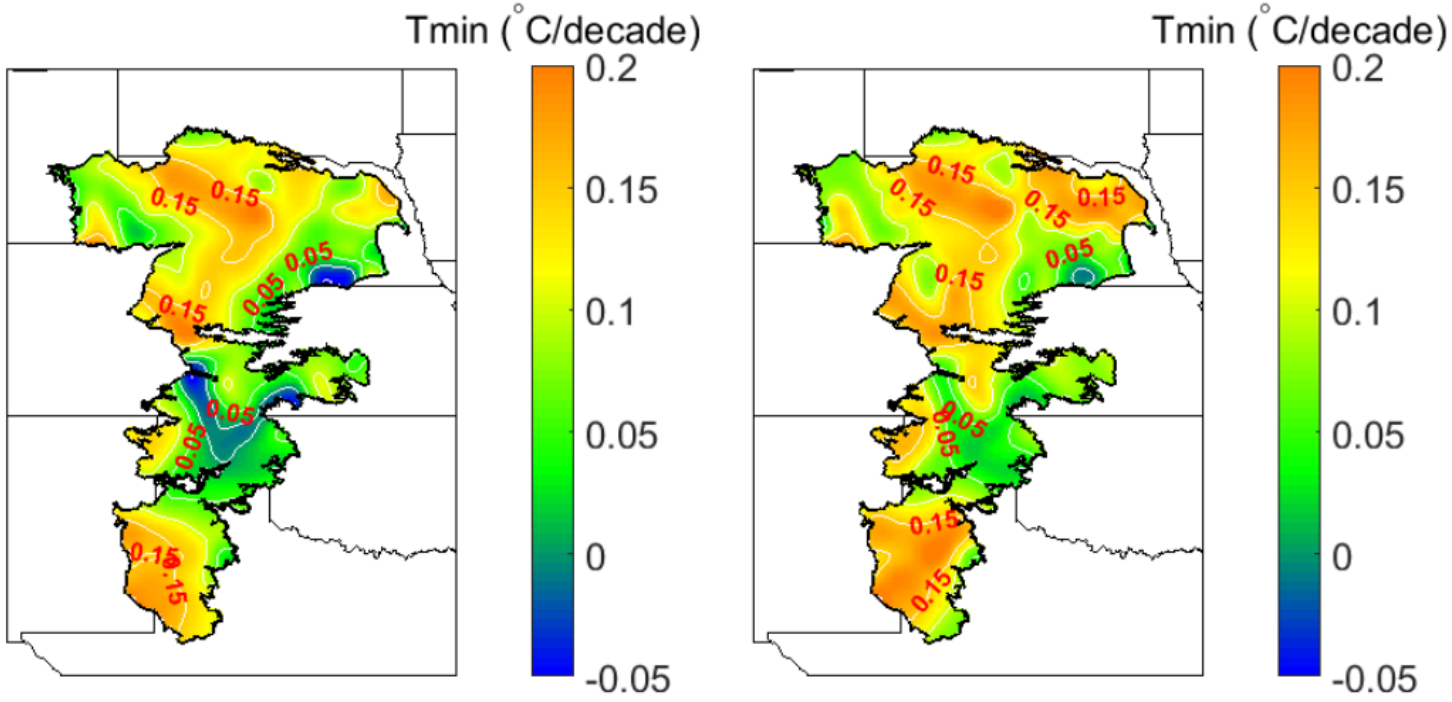
- temperature
- wind run
- humidity
- solar radiation

August Reference Et_o (in./mo.)



Historical temps are increasing

OAR Monthly Nighttime Temperature Trends (1901 to 2015)



Corn growing season

Winter wheat growing season

Xiaomao Lin

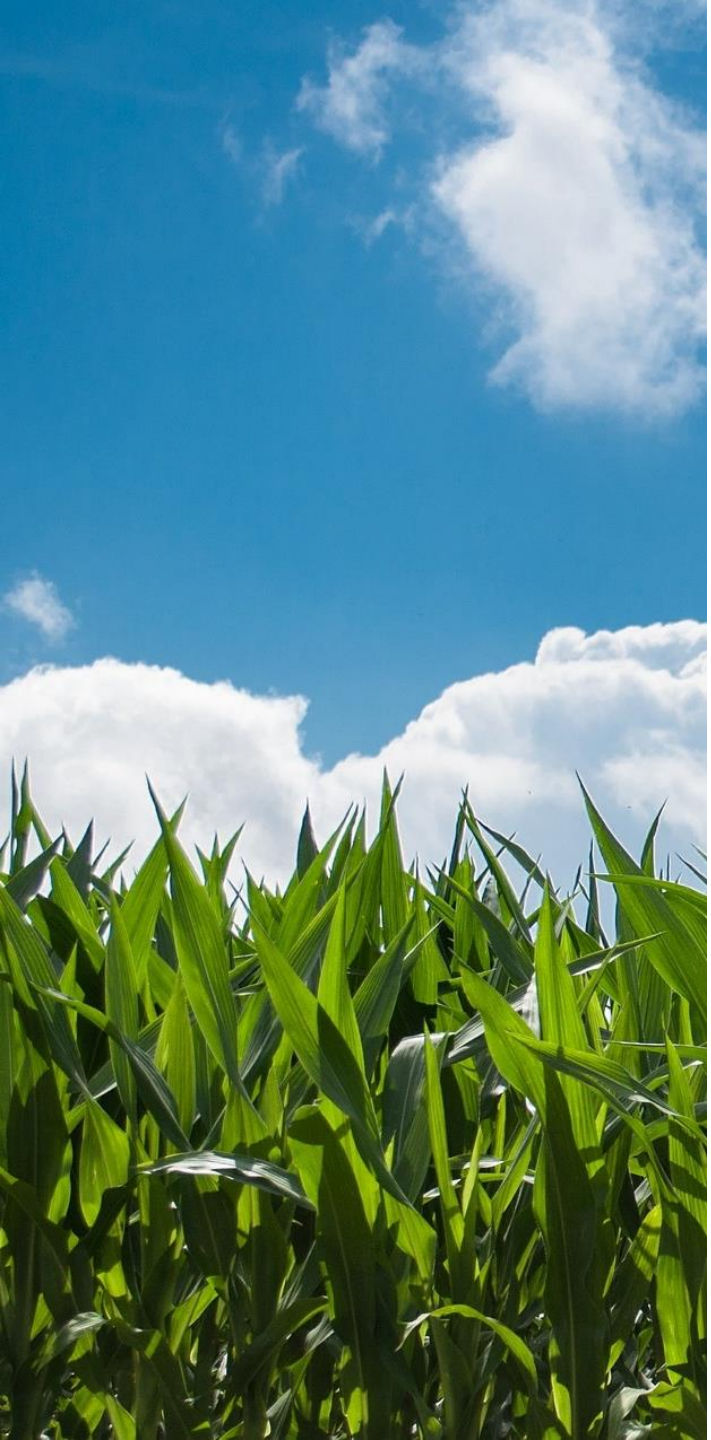
What is are reasonable concepts of sustainability?

- **Just economics?**
- **More than transition with soft-landing?**

- **How to factor climate into improved efficiency and risk reduction?**

Climate models predict :

- **warmer temperatures**
- **higher evaporation rates**
- **stronger droughts**
- **more heavy rain events**



The Ogallala Water Coordinated Agricultural Project

Optimizing Water Use for Agriculture and Rural Communities

Colorado State University: Meagan Schipanski (Dir.)
Amy Kremen (Manager) 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

OgallalaWater.org

OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

Goal: Optimize groundwater use in crop and livestock production systems and rural communities in the Ogallala Aquifer region

- **Improving water use efficiency through irrigation management technologies**
- **Improving and increasing adoption of irrigation scheduling**
- **Improving management of limited-irrigation and dryland systems**
- **Increasing water holding capacity through soil health management**
- **Outreach and Extension**

Connecting resources

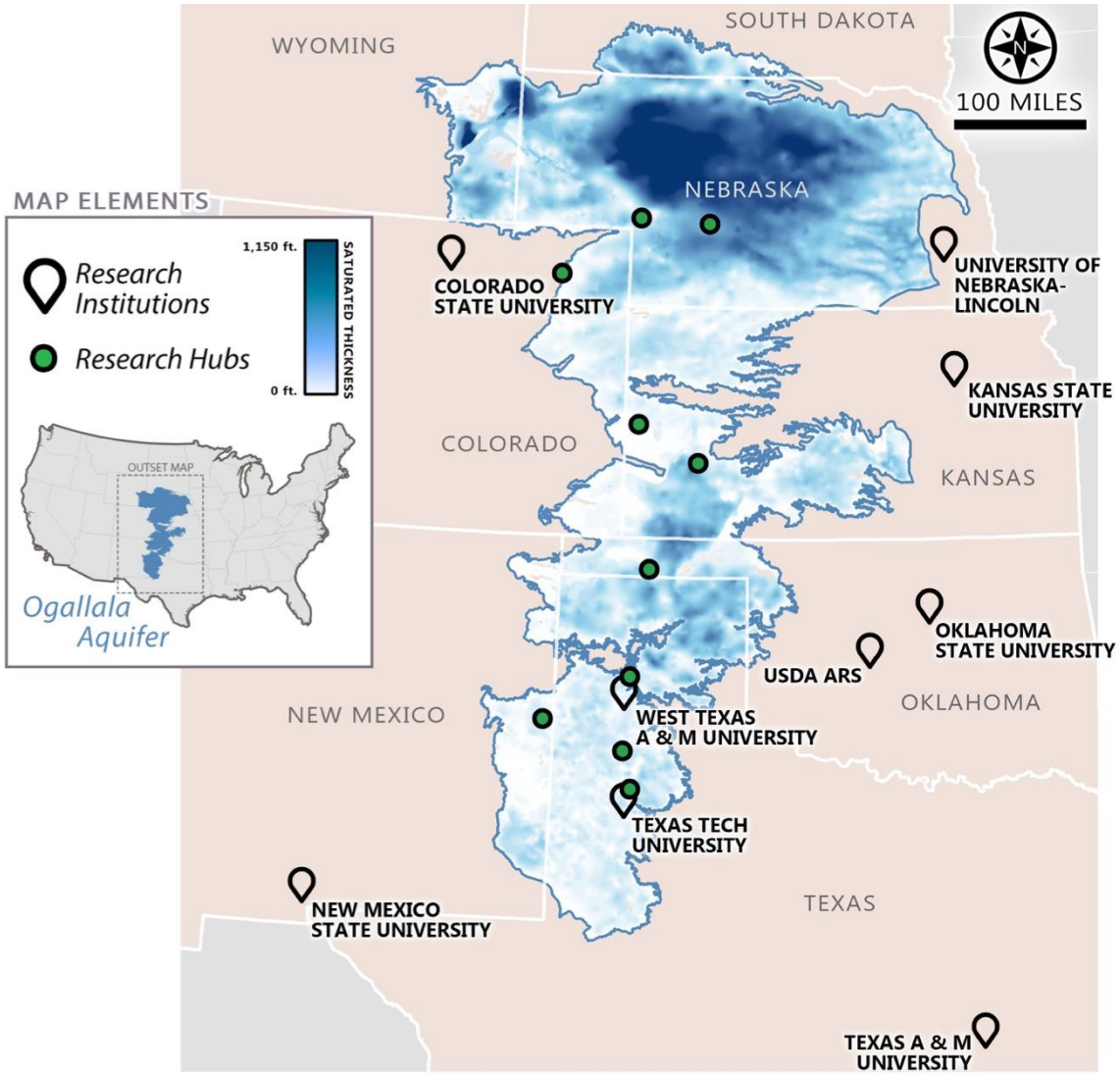
USDA Climate Hubs

USDA NRCS

TAWC

OgallalaWater.org
OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

Saturated thickness variability

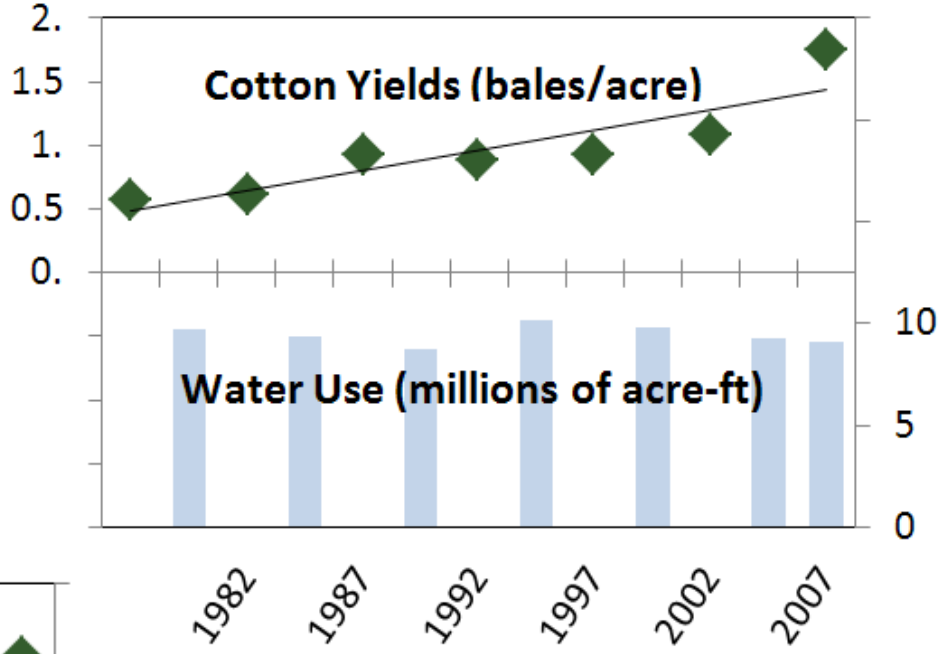


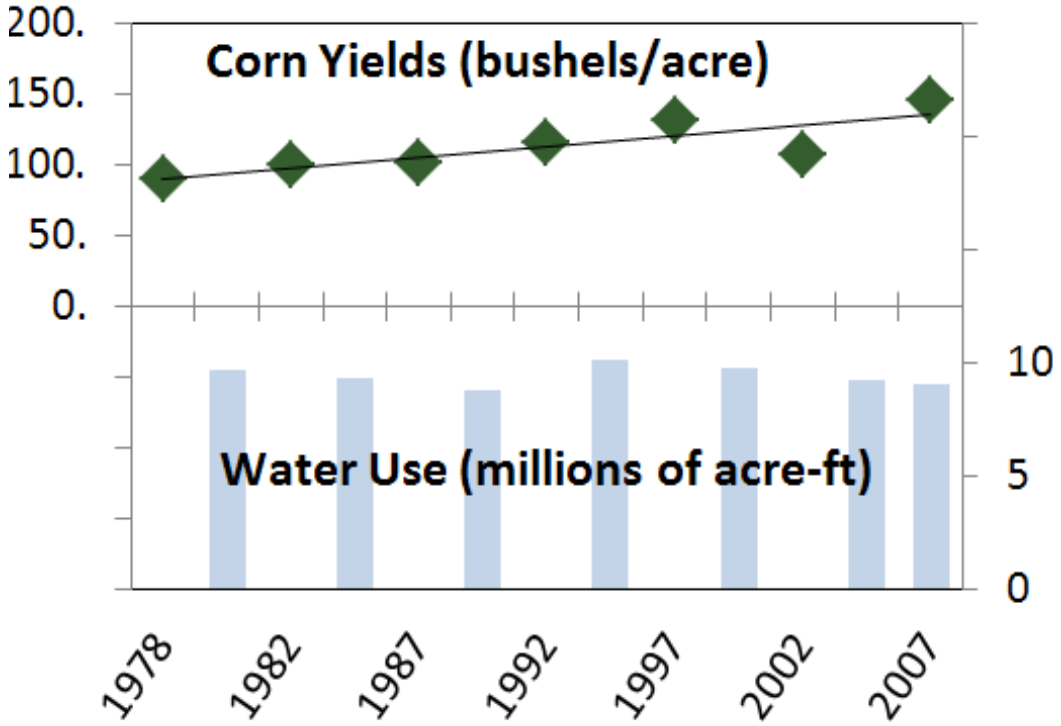
OgallalaWater.org
OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

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**

Crop breeding for water use efficiency





TAMU-TWRI, 2012

Irrigation water use by sorghum and corn silages – 4 yr mean

Bean and McCullem Texas A&M AgriLife-Amarillo

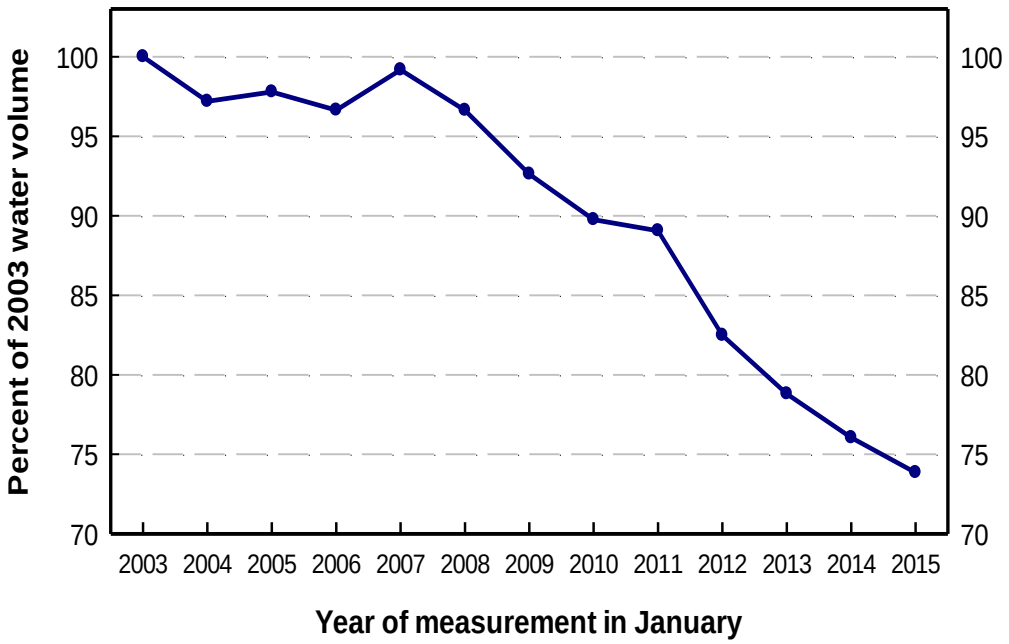
Silage crop	Silage yield	Irrigation applied	Water use efficiency
	tons/acre	inches/yr	tons/ac-in.
Sorghum	22.4	14.9	1.57
Corn	22.5	22.9	1.03

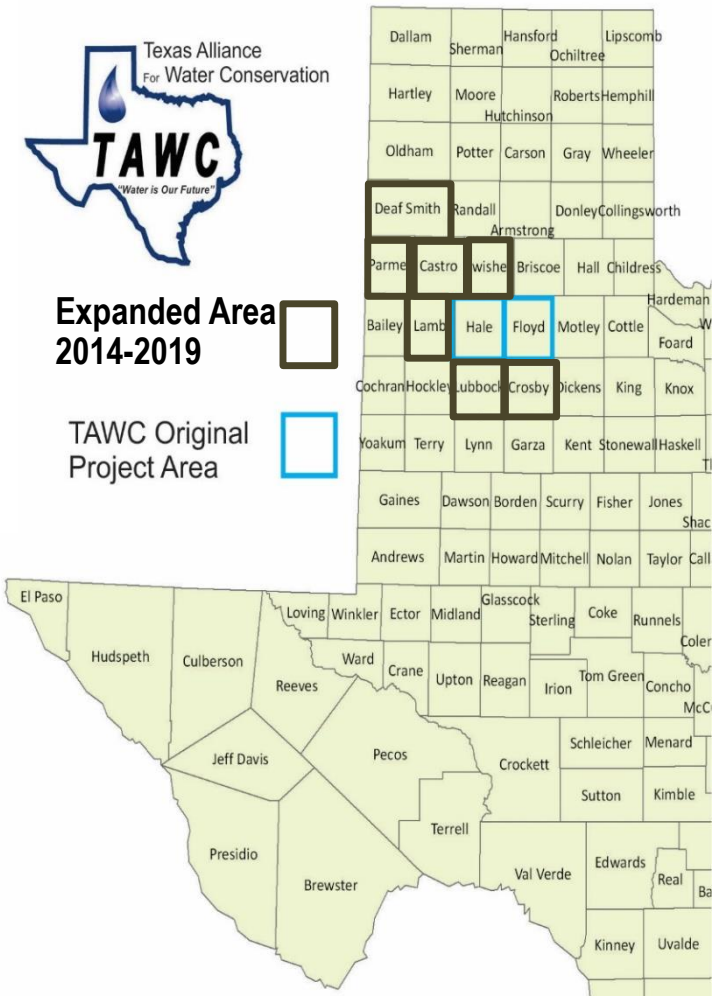
Take-home message: can produce as much silage with forage sorghum as with corn at 2/3 the amount of irrigation.

Texas Alliance for Water Conservation

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

- **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**

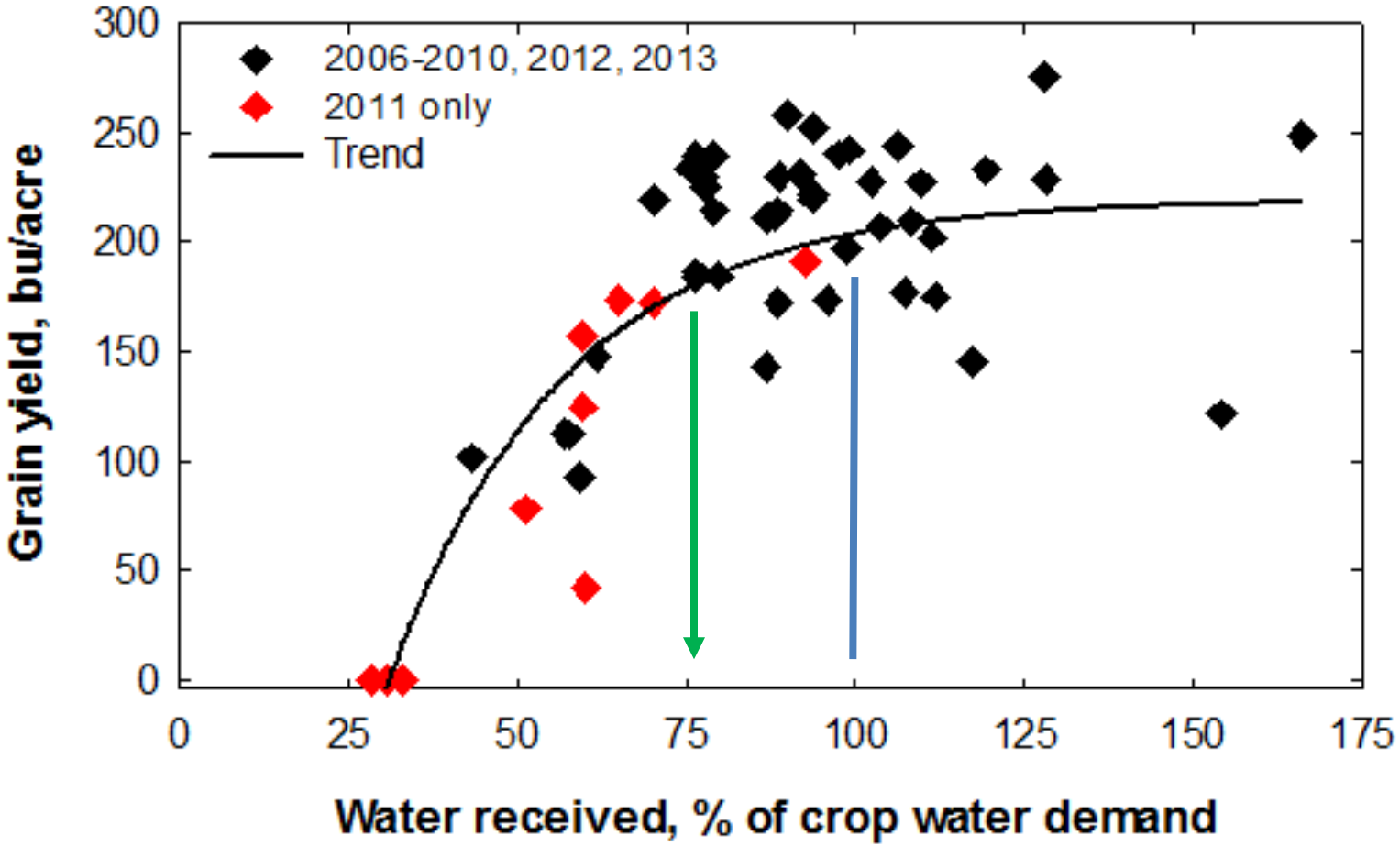

Percent of 2003 water volume
100
95
90
85
80
75
70
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year of measurement in January


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
Parmer
Castro
Swisher
Briscoe
Hall
Childress
Bailey
Lamb
Hale
Floyd
Motley
Cottle
Foard
Hardeman
Cochran
Hockley
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
Hudspeth
Culberson
Loving
Winkler
Ector
Midland
Glasscock
Sterling
Coke
Runnels
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 water use by major crops in TAWC project – 8 yr mean

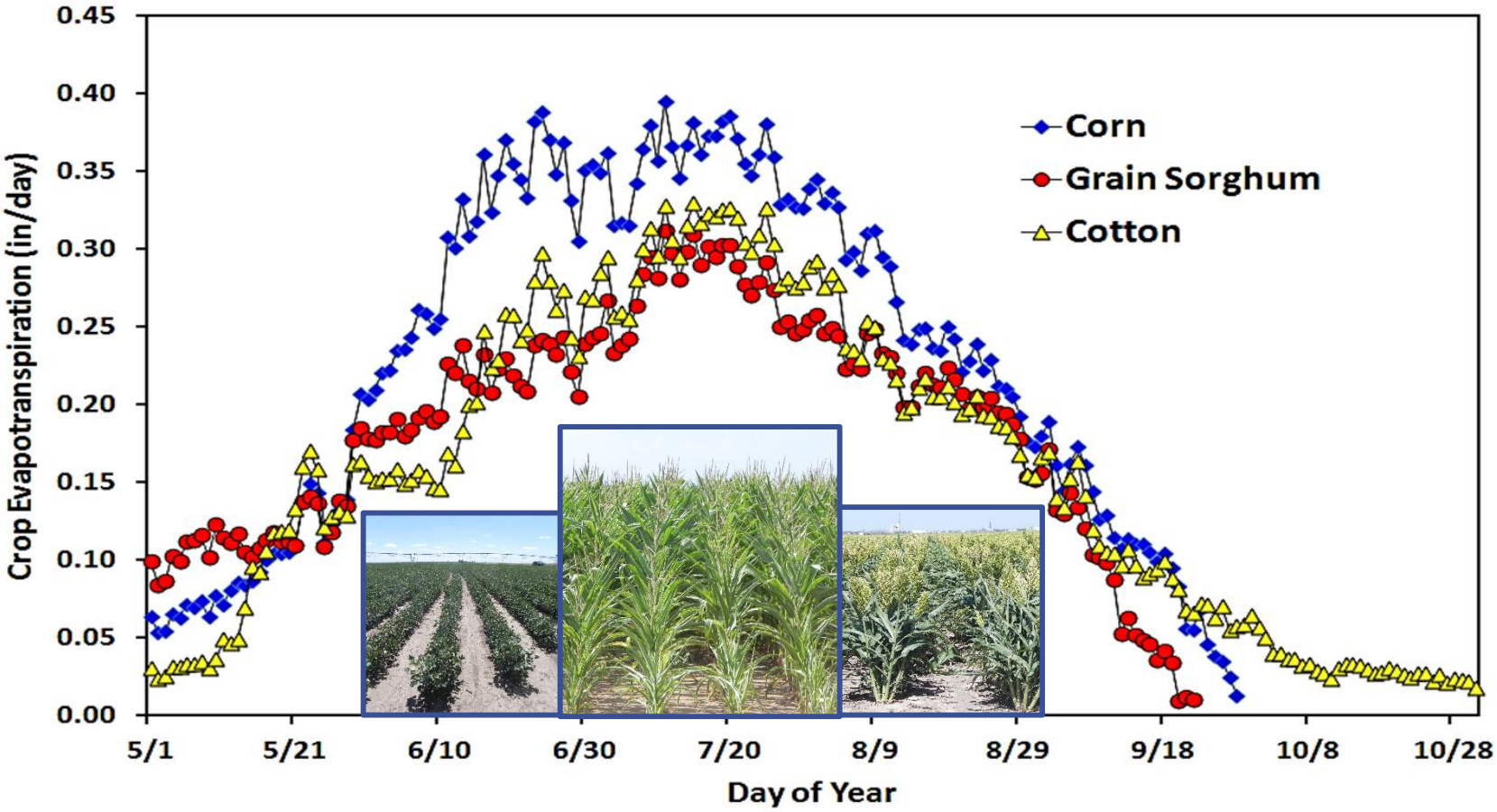
Crop	Irrigation applied	Water use efficiency
	inches/yr	lbs/ac-in.
Grain sorghum	12	760
Corn grain	18	610
Corn silage	22	2990
Cotton lint	13	120

Corn response to water received



Crop Evapotranspiration
Long-term Average (1997-2011)

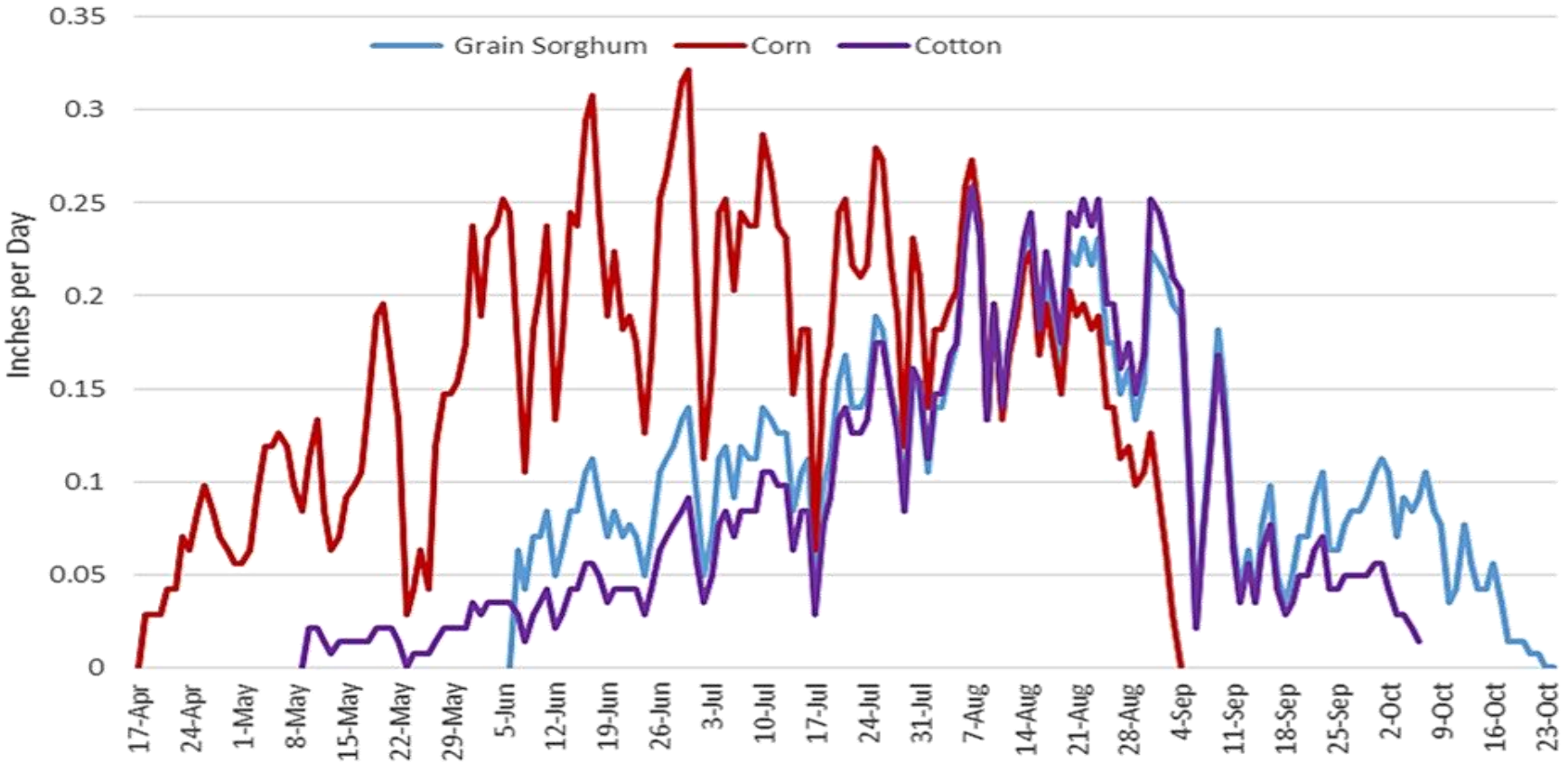
CIG



(Rajan and Maas)

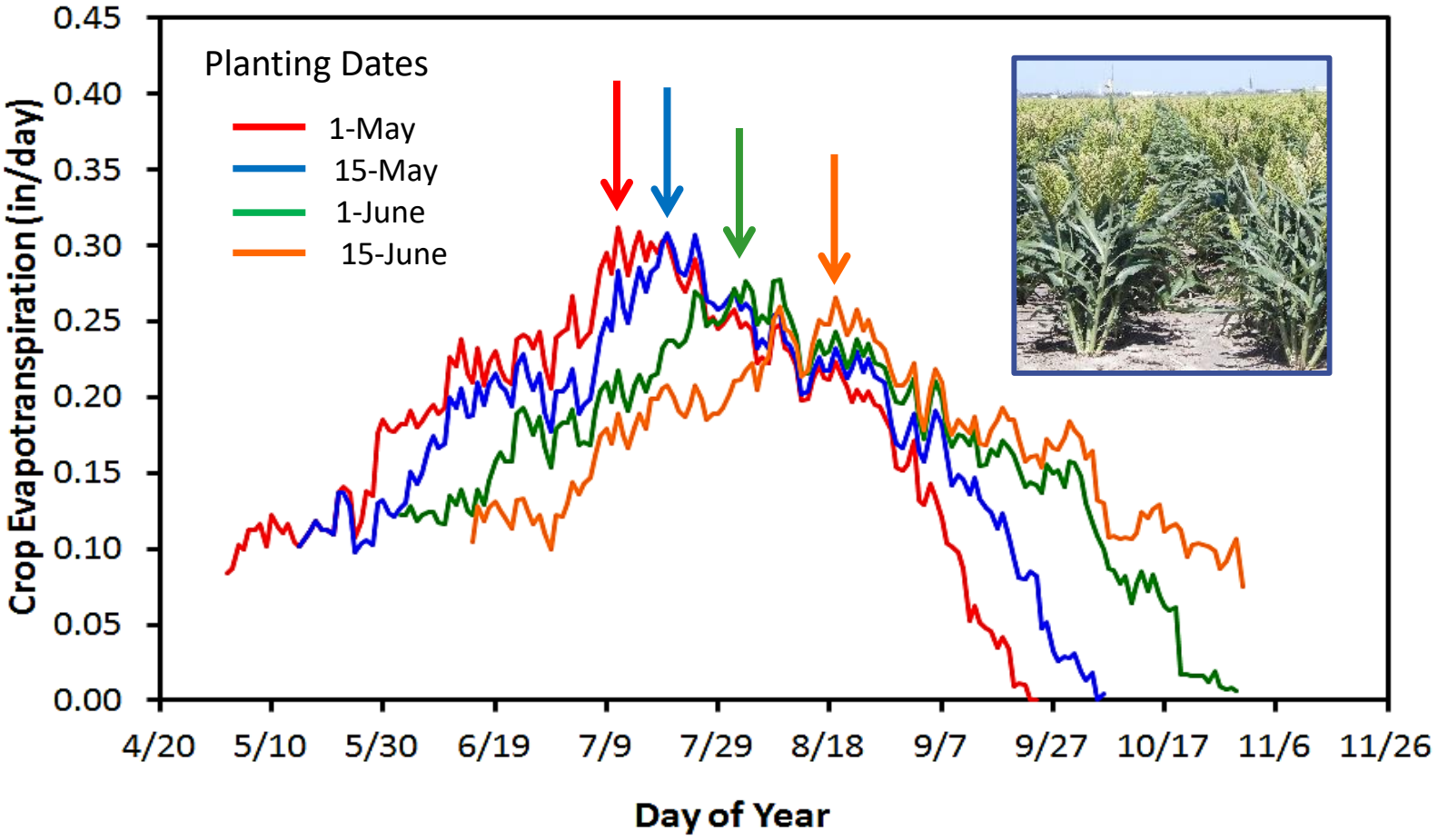
Daily Crop Water Demand by Crop (Site 35 - 2014)

CIG



Sorghum Evapotranspiration
Long-term Average (1997-2011)

CIG



(Rajan and Maas)

Why forages and cattle?

- **Grassland is native ecosystem.**
- **Perennials build soil organic matter, reduce erosion.**
- **Beef cattle and hay are high-value commodities.**
- **Require modest water inputs.**

Forages and livestock provide a profitable means of transitioning to low water-input and dryland agriculture in the Texas High Plains.

Texas Tech University – Sustainable Land & Water

Thank you