



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

***Invited presentation at the 2018 Southern Agricultural
Economics Association Annual Meeting, February 2-6, 2018,
Jacksonville, Florida***

Copyright 2018 by Author(s). All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

OPTIMAL NITROGEN/WATER USE IN THE SOUTHERN SUB- REGION OF THE SOUTHERN OGALLALA AQUIFER

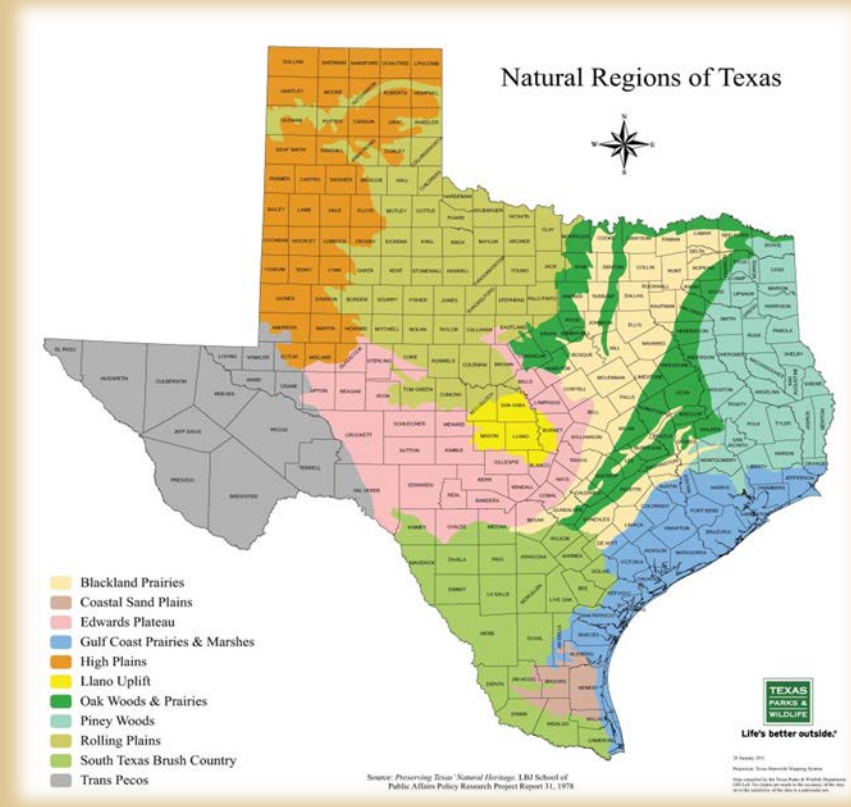
Authors: Rebecca McCullough
Donna McCallister
Ryan B. Williams
Bill Golden
Bridget Guerrero



A research consortium between USDA-Agricultural Research Service, Kansas State University,
Texas AgriLife Research and Extension, Texas Tech University, and
West Texas A&M University

General Problem– Texas High Plains (THP)

- Sustainability in agriculture
 - 7.4 billion people
 - Increase to 10.9 billion by 2050
 - Strains natural resources needed to support a growing population
- Why the Texas High Plains?
 - 25% of U.S. cattle (Johnson et al., 2013)
 - West Texas supports 85% of the state's fed beef (Almas, 2004)
 - 30% of U.S. Cotton (Johnson et al., 2013)
 - 61% of the state's cotton
 - Irrigated agriculture directly accounts for \$6.6 billion of industry output (Guerrero and Amosson, 2013)
- Texas High Plains
 - Semi-arid
 - Low annual precipitation
 - Relies heavily on Ogallala Aquifer to meet irrigation needs



Ogallala Aquifer Important Facts

- Covers 174,000 miles across eight states
 - 35,000 square miles in Texas
 - 11% of total land in Texas
- Contains 3.3 billion acres of fresh water
 - Saturated thickness range
 - 1,300 ft in Nebraska
 - <1 ft in Texas
 - Average of 200 ft
- 170,000+ pumping wells
 - 50,000+ in Texas alone
- 90%+ used to irrigate crops
 - \$20 billion in food and fiber production each year

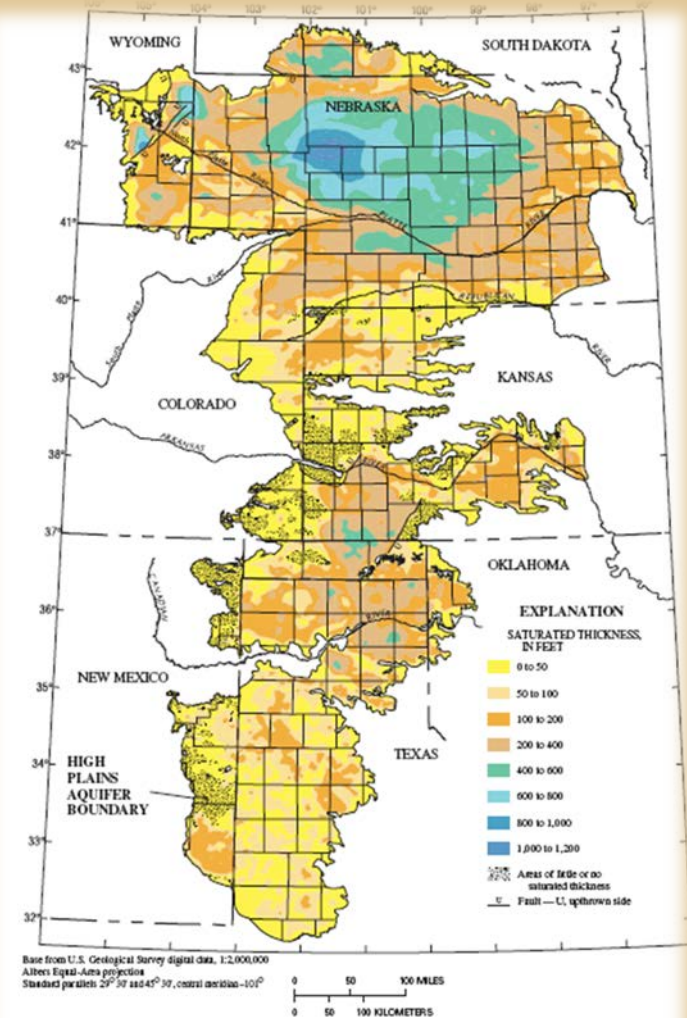


Figure 14. Saturated thickness of the High Plains aquifer, 2000. (Modified from Weeks and Gutentag, 1991.)

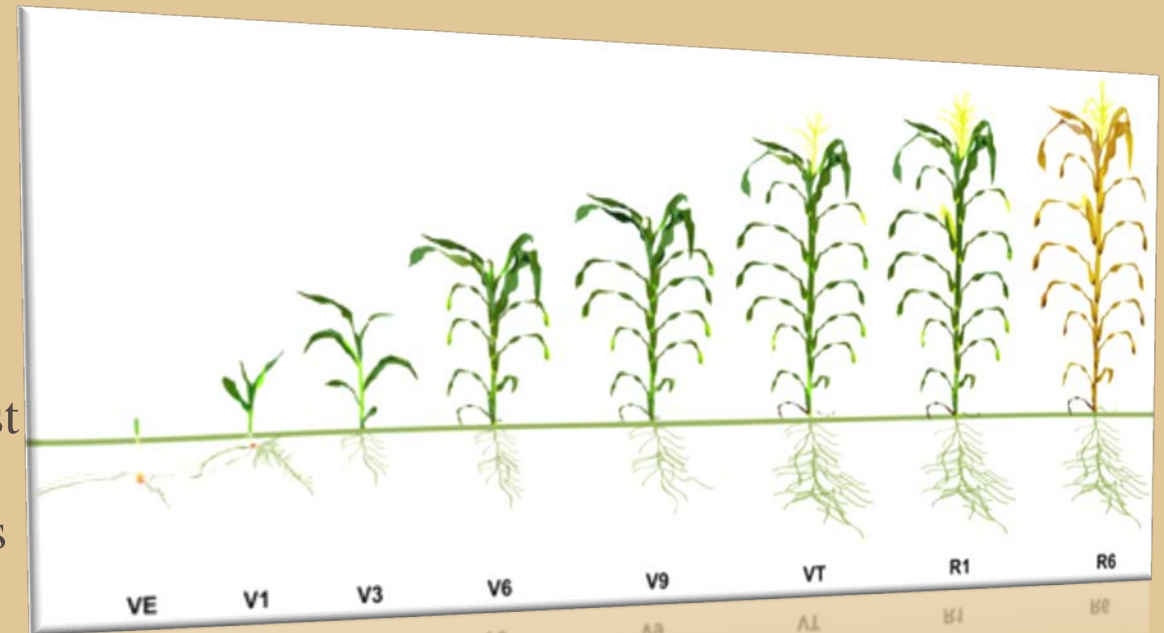
Objective

- Determine the economically optimal nitrogen and water use for corn production in the southern sub-region of the Southern Ogallala Aquifer using producer-level data.



Rationale

- Improved nitrogen and water use efficiency can reduce water use and increase profit.
- Agronomic studies on optimal nitrogen application amounts and timing largely overlook economic impacts (Al Kaysi and Yin, 2003; Bullock and Bullock, 1993).
- This analysis will provide producers with best management practices for nitrogen application for center pivot irrigation systems with varying amounts of water availability



Corn Requirements

■ Water

- Average 22 inches
- Range 20-25 inches

*More vulnerable to water stress

■ Limited resource in Texas High Plains

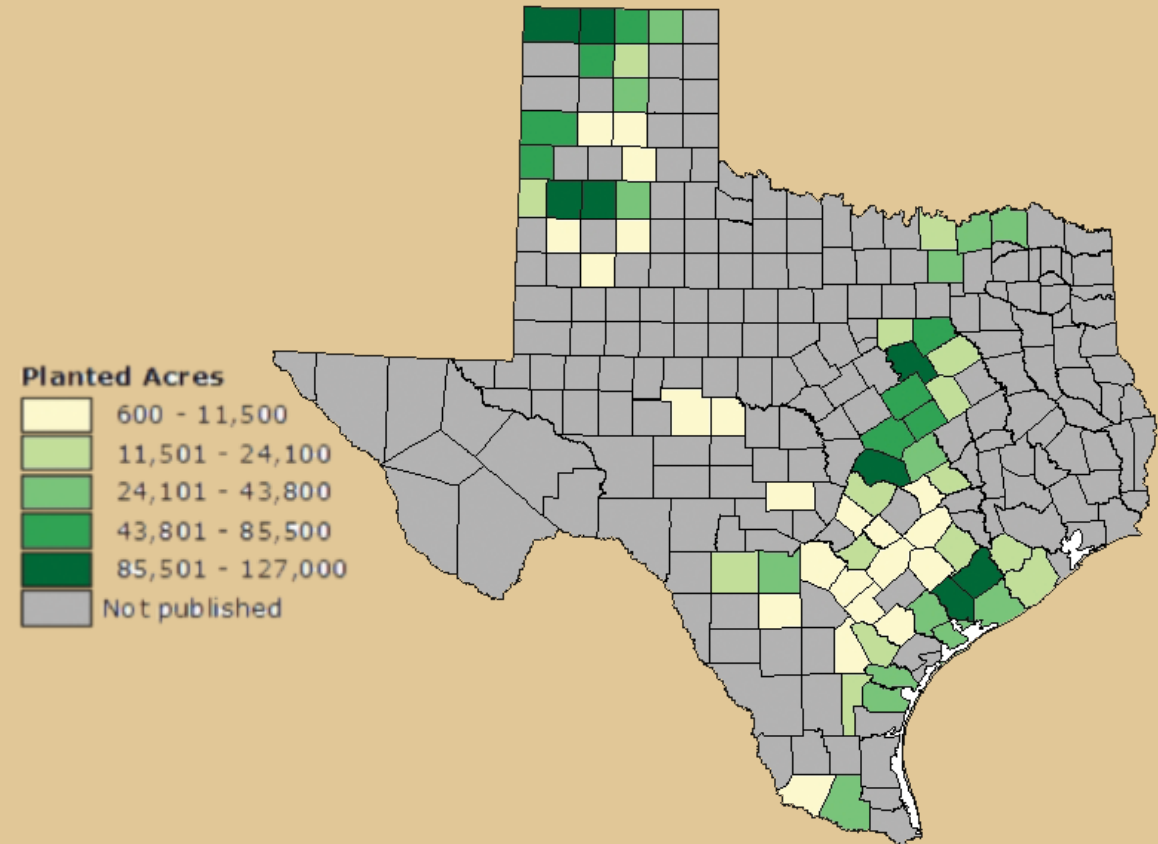
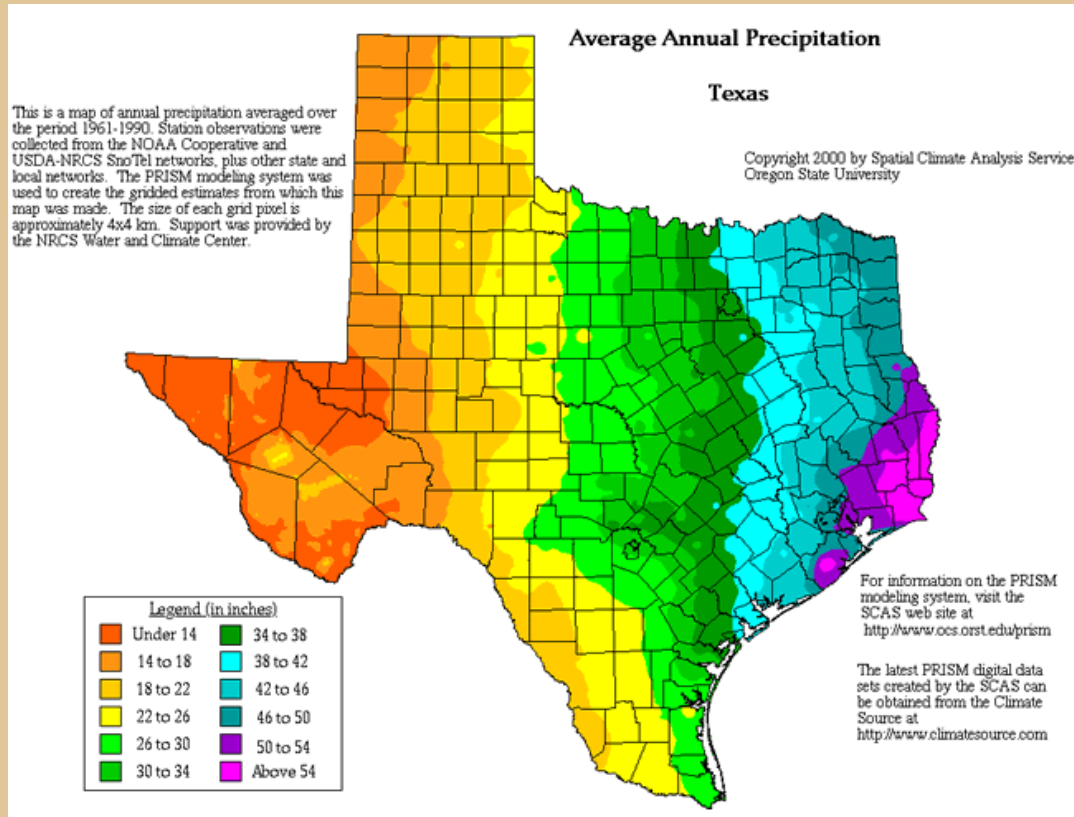
- Producers must become more water efficient
 - Genetic improvements
 - Better irrigation scheduling
 - Adoption of conservation tillage
 - Adoption of more efficient irrigation systems

■ Nitrogen (N)

- The most commonly applied nutrient
- Costliest
- Benefit to Cost Ratio exceeds that of other nutrients
- Increases strength of individual plants and yield of the crop
- Requires good management (best management practices) to reduce environmental consequences
 - Oxygen depletion aquatic ecosystems
 - Biodiversity losses
 - Water and air pollution



Corn Production in Texas



Data

Texas High Plains Counties

- 7 counties (Dallam, Deaf Smith, Hartley, Moore, Ochiltree, Sherman, Stanton)
 - data ranging over the years 1998-2016
 - 42 -762 observations per county
- Data includes:
 - Yield (bu/ac)
 - Water Applied
 - Nitrogen Applied

Methodology

- Lu, Camp, and Sadler (2004)
 - Quadratic Production Functions by County by Year
 - OLS
 - $\text{Yield} = \beta_0 + \beta_1 W + \beta_2 W^2 + \beta_3 N + \beta_4 N^2 + \beta_5 W * N + \varepsilon$
 - Use estimated coefficients to determine optimal Water/Nitrogen given a range of prices for Corn, Water, and Nitrogen

Results

- Expected Signs for Quadratic Production Functions

Intercept	Water	Water ²	Nitrogen	Nitrogen ²	Water*Nitrogen
-	+	-	+	-	+

- 2 Counties with correct signs
 - Dallam ('07, '09, '10)
 - Sherman ('00)

Results

		Price of N-Fertilizer								
Price of corn \$/bushel	Price of Water ac-in	30 cents lb/acre			40 cents lb/acre			50 cents lb/acre		
		Water	N	Net Return	Water	N	Net Return	Water	N	Net Return
4	5	52.0094	76.61997	676.4583	22.47112	76.801	669.2743	18.942	76.9814	661.5852
4	7.5	12.6542	-11.6012	660.2565	9.1256	-11.4205	652.5861	5.5957	-11.239	644.8943
4	10	-0.6957	-99.8222	610.1991	-4.2237	-99.6415	602.5323	-7.7534	-99.4607	594.8389

Next Step

- A different functional form will need to be used to evaluate the optimal level of Water/Nitrogen for Corn production in the Southern Sub-Region of the Ogallala Aquifer
- The following authors support the use of Stochastic Linear Response Plateau as the correct functional form for modeling crop response to Nitrogen input.
 - Grimm, Paris, and Williams (1987)
 - Tumusiime, Brorsen, Mosali, Johnson, Locke, Biermacher (2011)
 - Boyer, Larson, Roberts, McClure, Tyler, and Zhou (2013)
 - Ouedraogo and Brorsen (2014)
 - Rodriguez and Bullock (2015)

A photograph of a cornfield at sunset. The corn plants are tall and green, with some showing signs of maturity. The sky is a mix of blue and orange, with scattered clouds. A dirt path runs through the center of the field, leading towards the horizon. The word "Questions?" is written in a large, bold, black font across the upper part of the image.

Questions?