

Site-specific Water Management for Sustainability

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RESEARCH

People on the project

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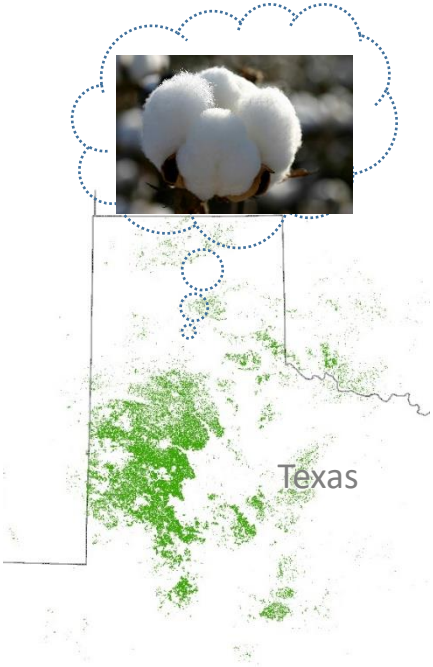
Jasmine Neupane



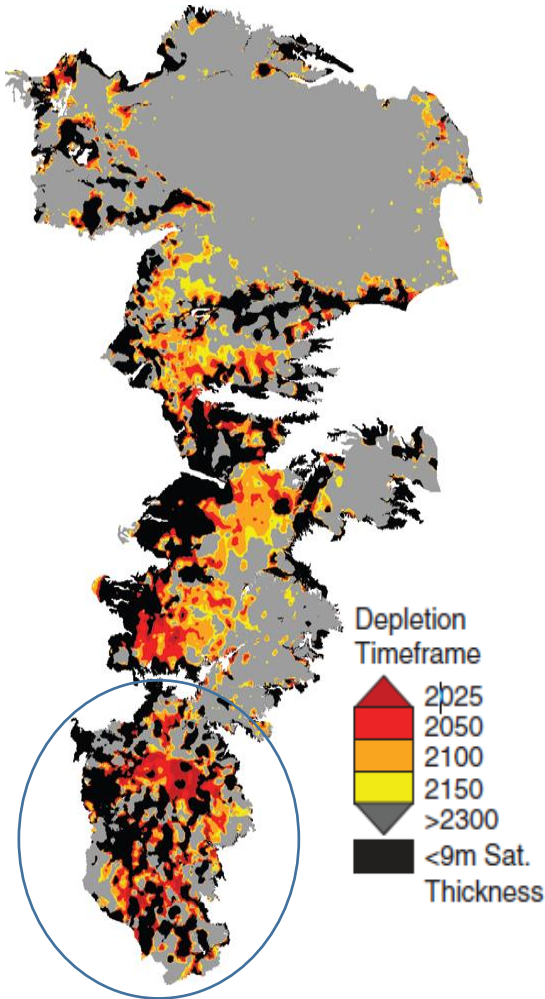
Oluwatola Adedeji

Challenges in agricultural production in a semi-arid region

5.0M AC
(50% US Cotton)



- Major crop production area – **50%** of US cotton acres, ~ 50% of cotton acres are irrigated
- Semiarid climate - Low precipitation and high evaporation



Haacker et al., 2015

Strategies for water conservation and enhancing water use efficiency

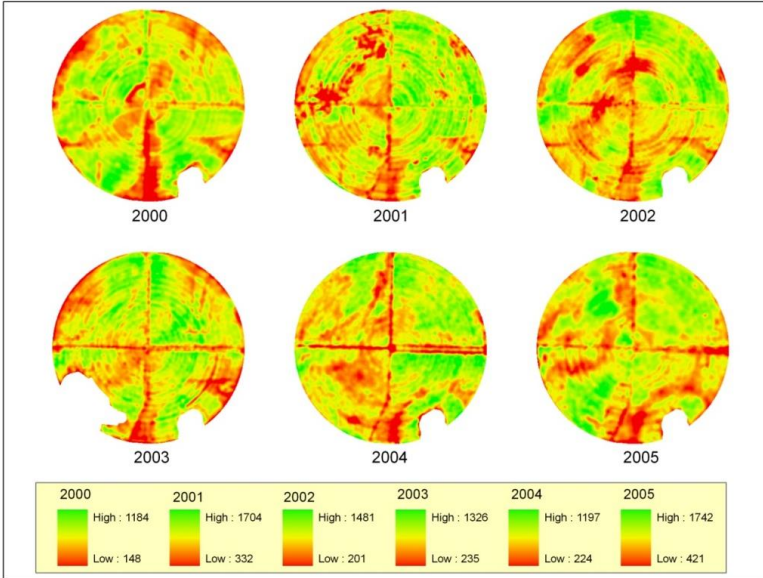
- Water efficient crops: cotton, sorghum, etc.
- Cropping systems: Crop rotations (cotton-sorghum), fallow, etc.
- Irrigation technologies: Drip, LEPA, LISA
- Precision irrigation technologies: site-specific water management (variable rate irrigation)

Goal and Objectives

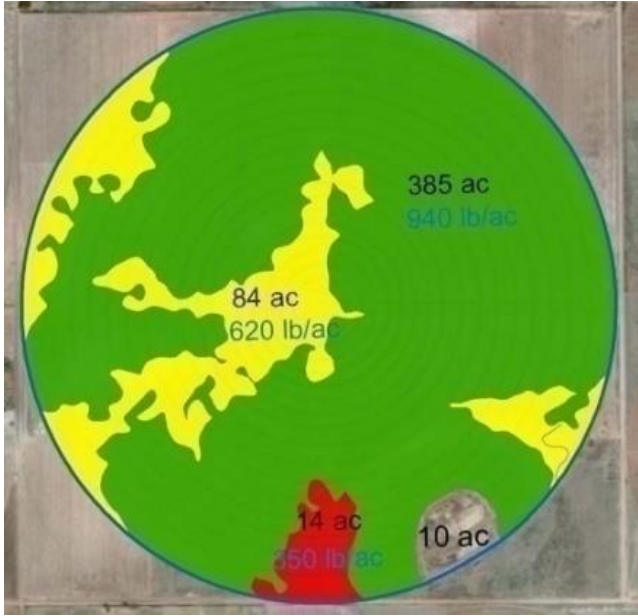
- **Goal:** to develop and evaluate on-farm precision water management strategies to reduce water use and improve WUE in the Southern High Plains of Texas
- **Objective:** develop precision water management (variable rate irrigation) strategies and evaluate its effects on crop yield and economic benefits

The concept – how it may work

Variable rate irrigation has potential to improve farming profitability

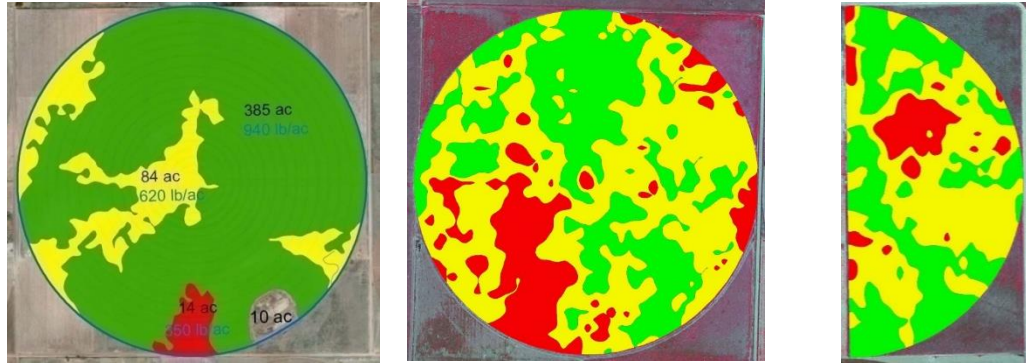


Average water use efficiency
West Texas: 50 lb lint/inch

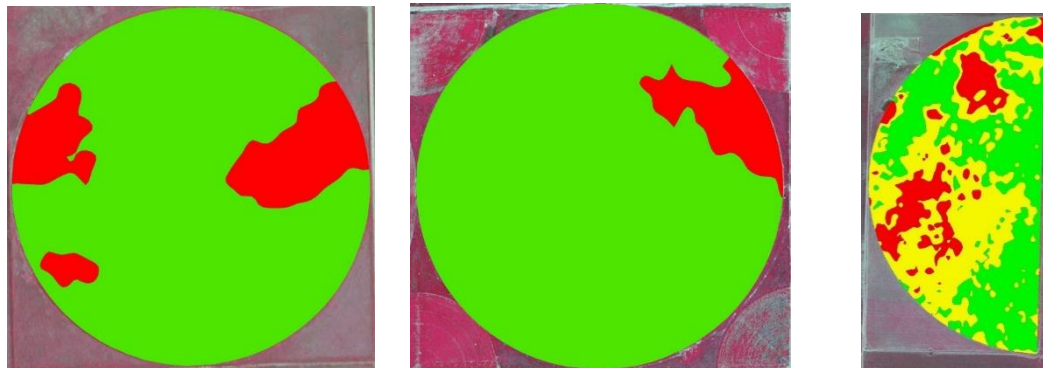


	Yellow Zone	Red Zone	Total
Acres	84	24	108
Inch H ₂ O/ac	15	15	15
Lint lb/ac inch	50	50	50
Cotton Price	\$.60	\$.60	\$.60
	\$ 37,800	\$ 10,800	\$ 48,600

Many fields have substantial soil and yield variability to justify variable rate irrigation



Farm	Pivot Acres	Low-yield acres	Percent
Farm 1	480	108	23%
Farm 2	240	35	15%
Farm 3	120	18	15%
Farm 4	60	7	12%
Farm 5	120	20	17%
Farm 6	120	9	8%
Total	1,140	197	17%



How much water and where?

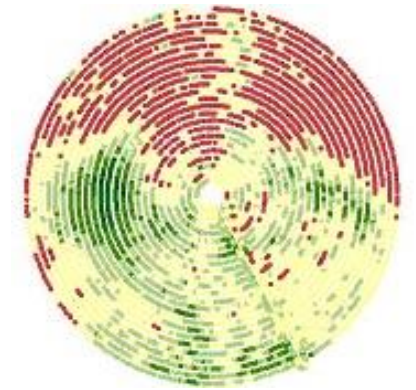
Criteria for factor selection in Precision Irrigation

- Factors that affect water availability and water use efficiency
- Factors Influence yield
- Relatively easy to obtain data to quantify the factors
- Spatial patterns relatively stable

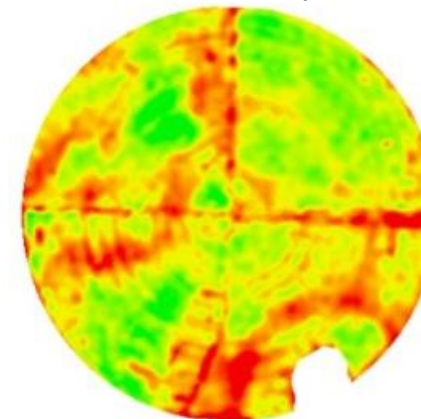
- Commonly used factors and data: topography, soil properties (mainly physical), remote sensing images

Mapping apparent Soil electrical conductivity (EC_a)

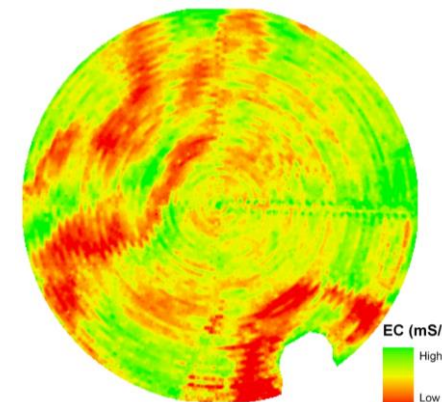
- EC_a mapping:
 - Simple to collect,
 - Low cost,
 - Spatial pattern stable
- EC_a is a function of several soil properties,
 - Soil salinity,
 - texture,
 - bulk density,
 - water content
 - Etc.
- Measures soil EC_a at 30 cm and 90 cm depths.



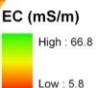
Yield map



2005



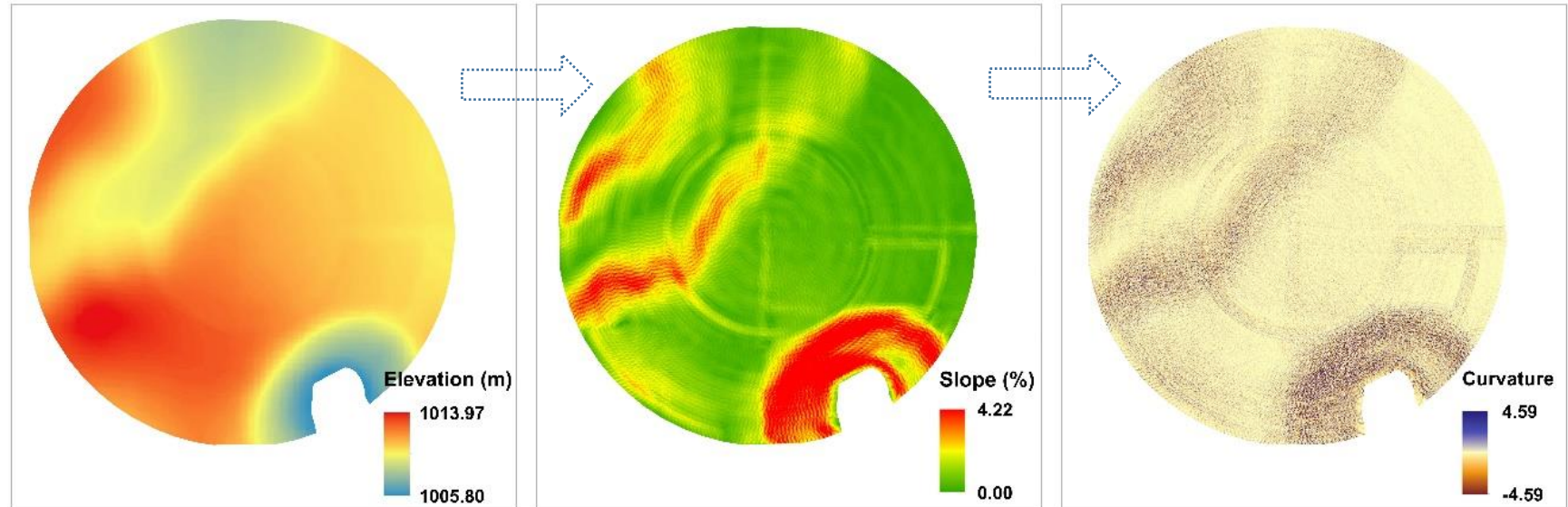
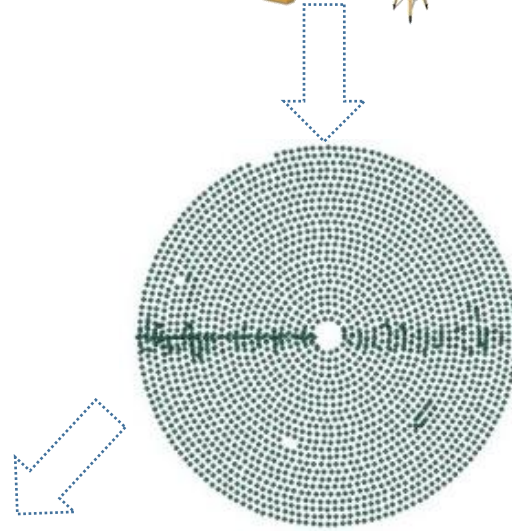
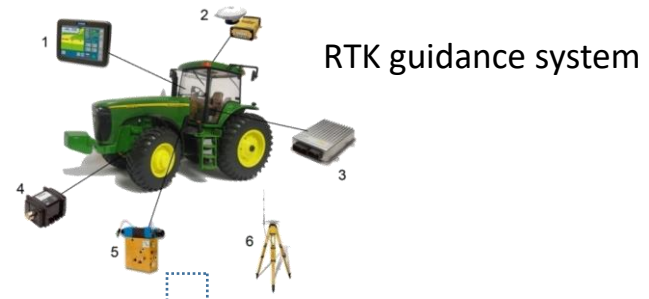
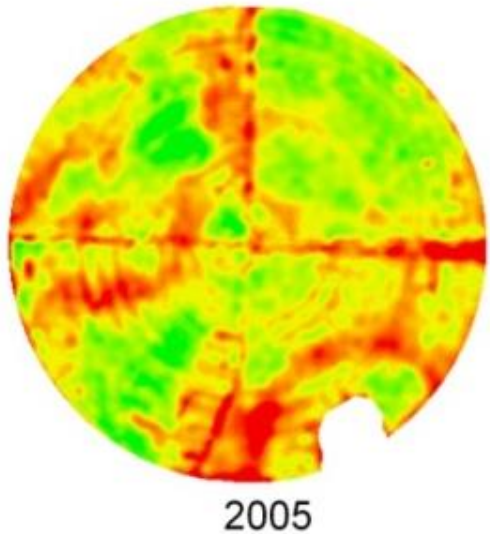
EC
(30cm)



Factors in Precision Irrigation – topography

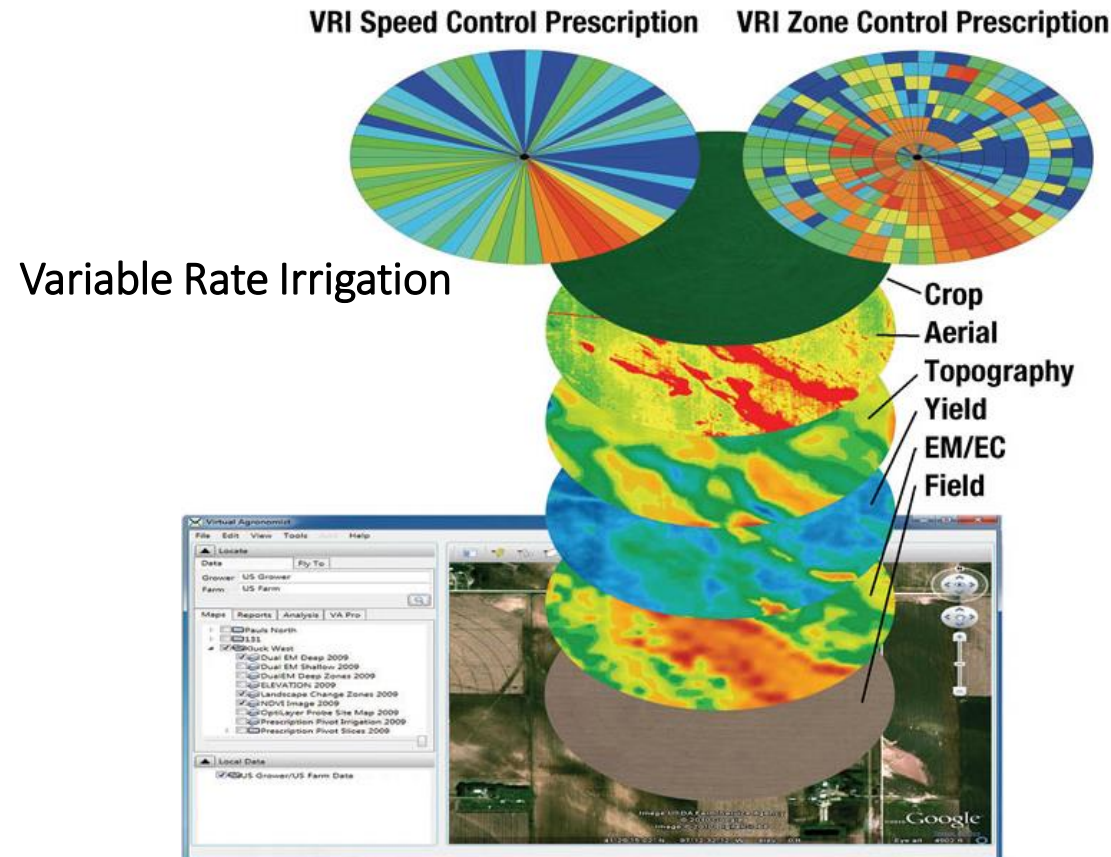
- Relative elevation
- Slope
- Curvature
-

Yield map



Management zones are effective in integrating data for site-specific management

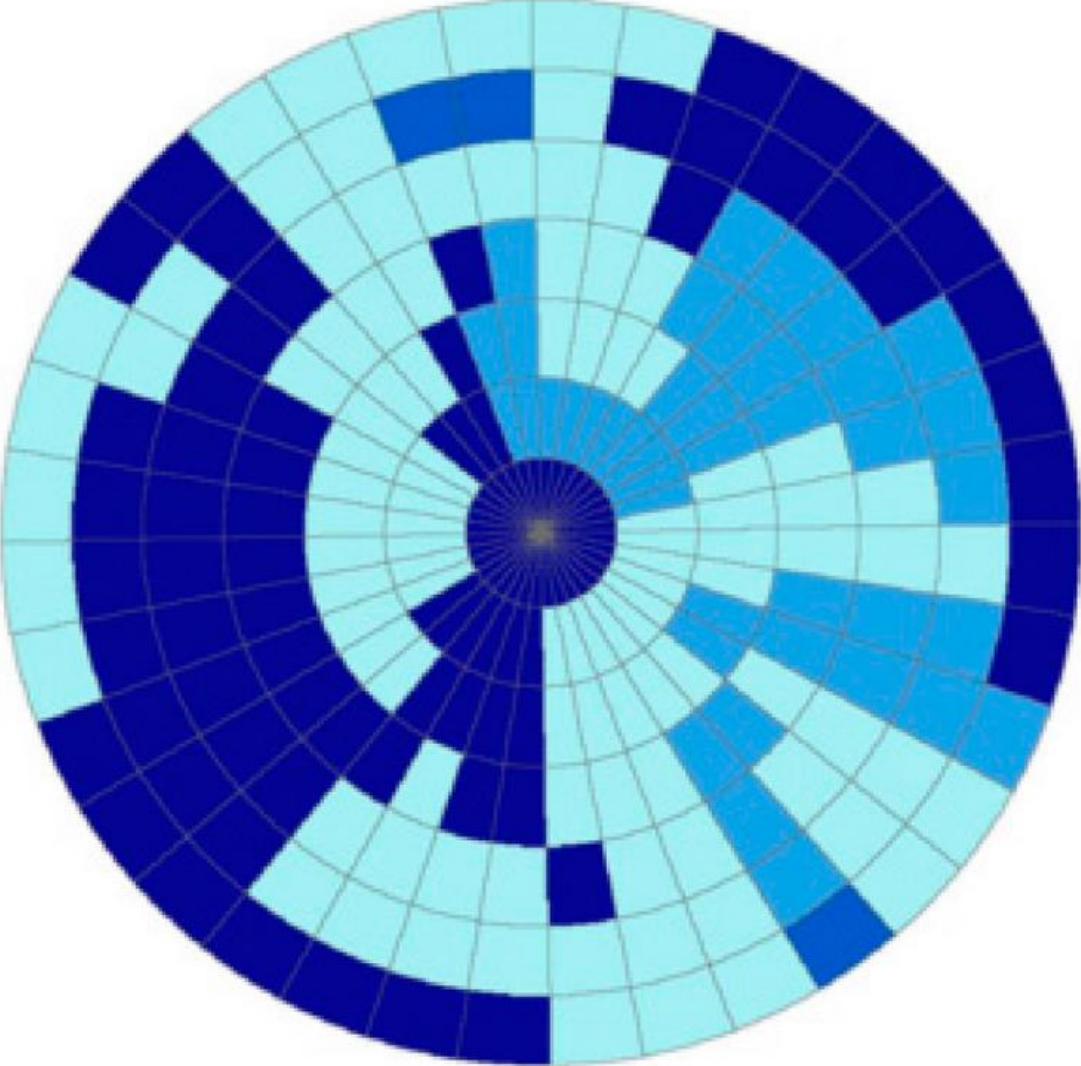
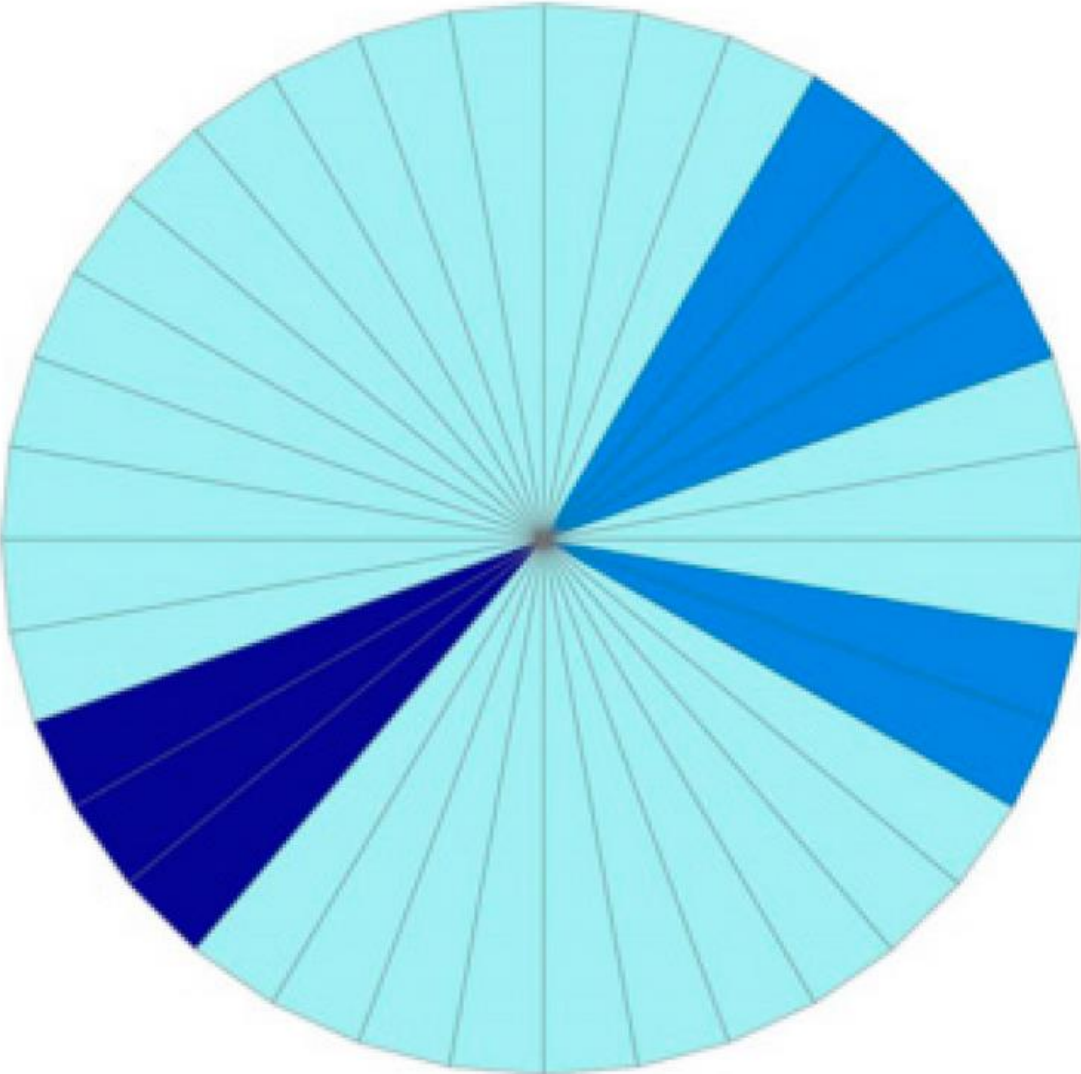
Management zone: A sub-field with homogeneous combination of yield-limiting factors for which a single rate of crop input is applied



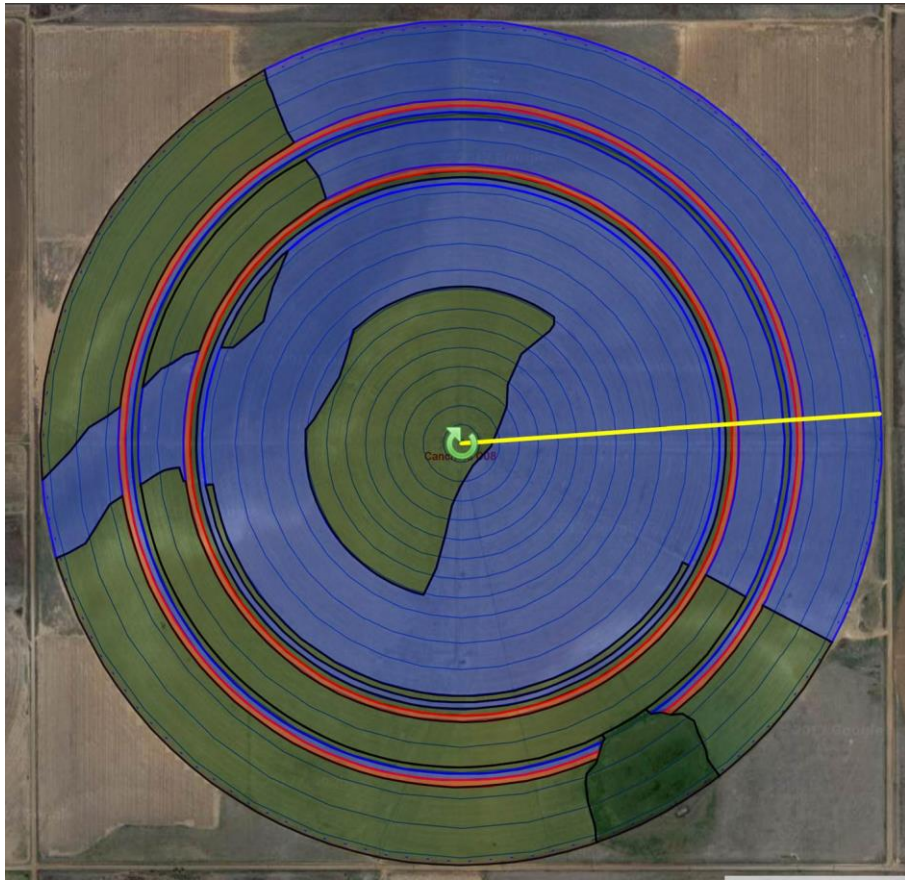
How to apply right amount of water at the right location (right time)?



Two types of Variable Rate Irrigation Systems



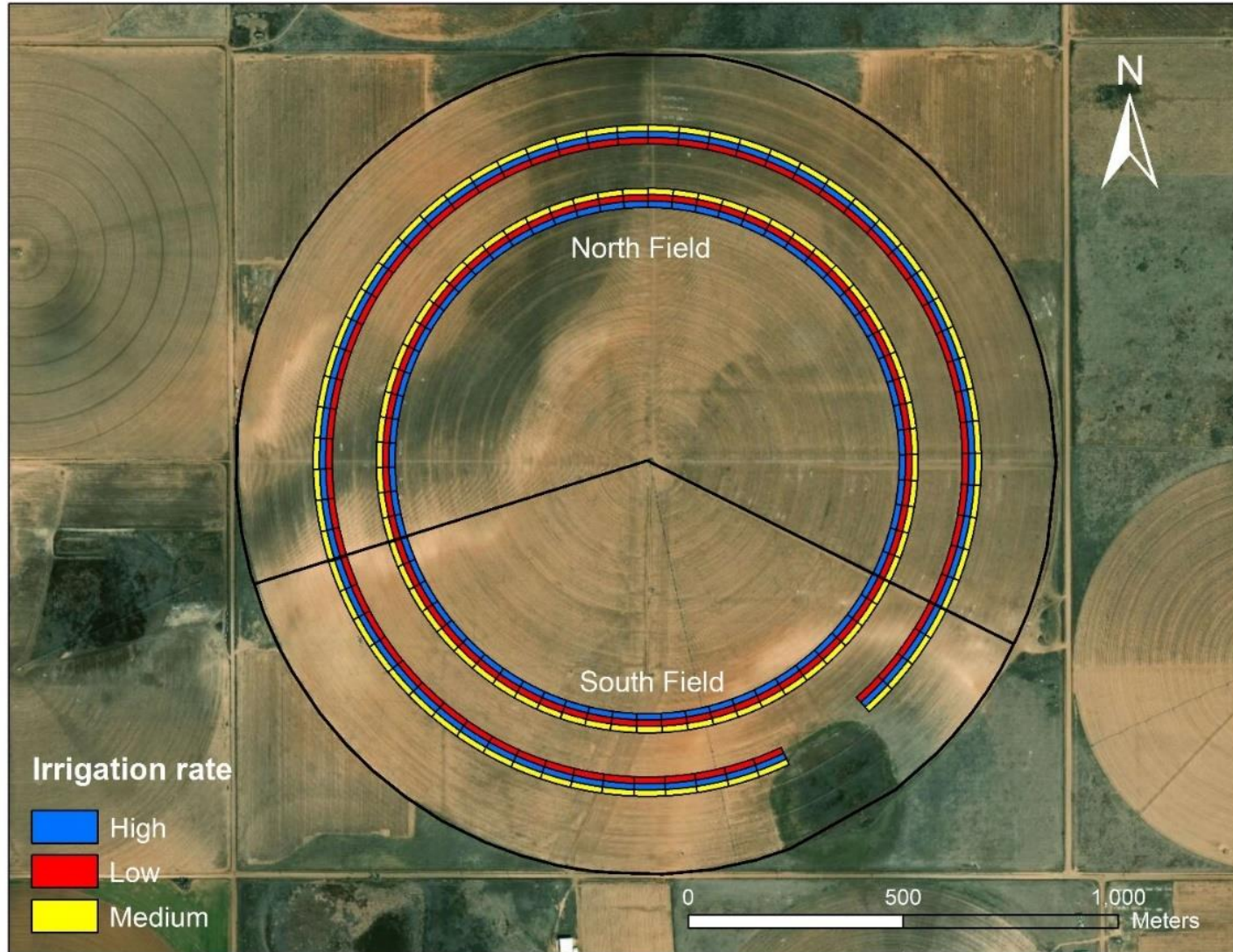
Example of zone control variable rate irrigation



Precision Agriculture in Action: Zone-based Variable Rate Irrigation

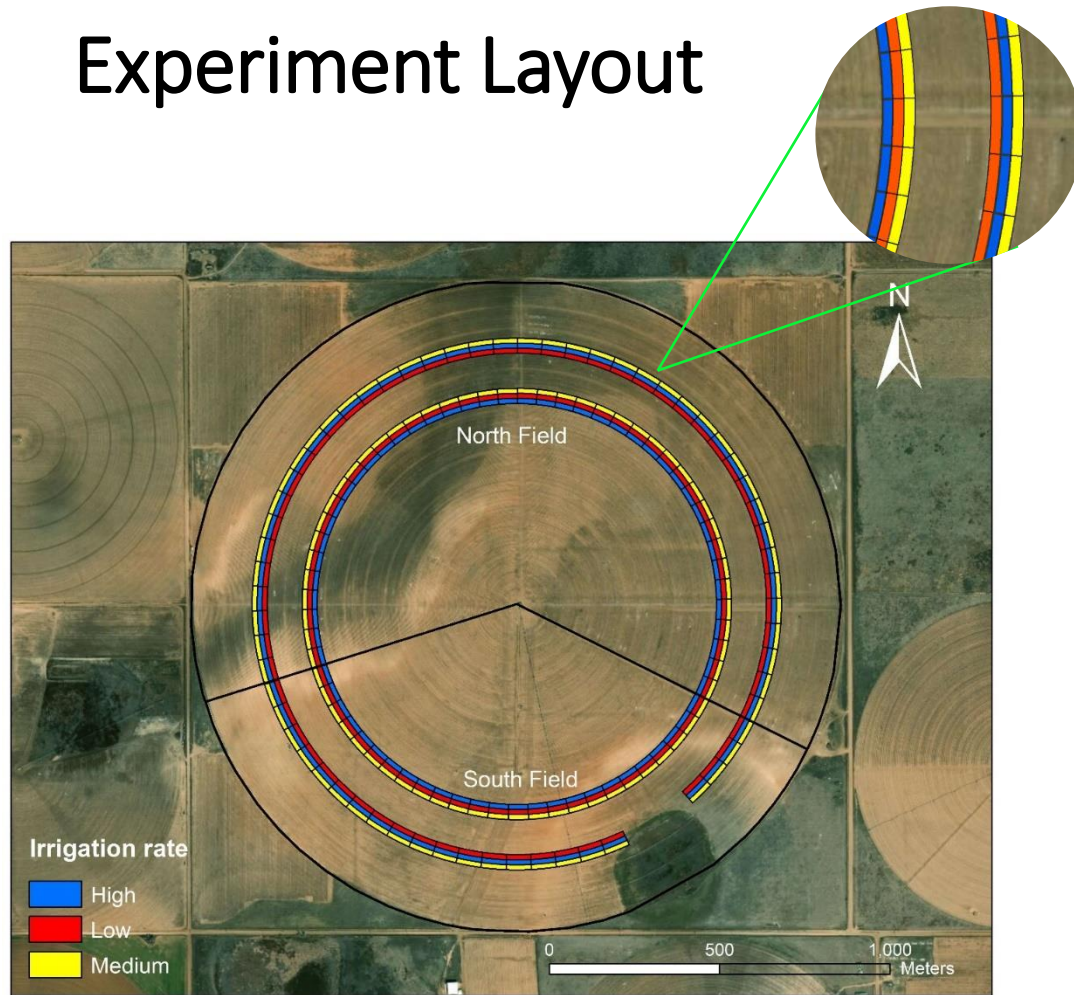


Cotton Yield Variability in Relation to Irrigation Rates, Soil Physical Properties and Topography



Neupane J, Guo W, West CP, Zhang F, Lin Z (2021). **Effects of irrigation rates on cotton yield as affected by soil physical properties and topography in the Southern High Plains.** PLoS ONE 16(10): e0258496.

Experiment Layout



- Two replication of three irrigation rates
- 6 strips, 66 plots
- Each plot: **50m * 12m**
- 16 rows of cotton

High: 25.4 mm (1 inch)

Medium: 12.7 mm (0.5 inch)

Low: 0 mm (0 inch)

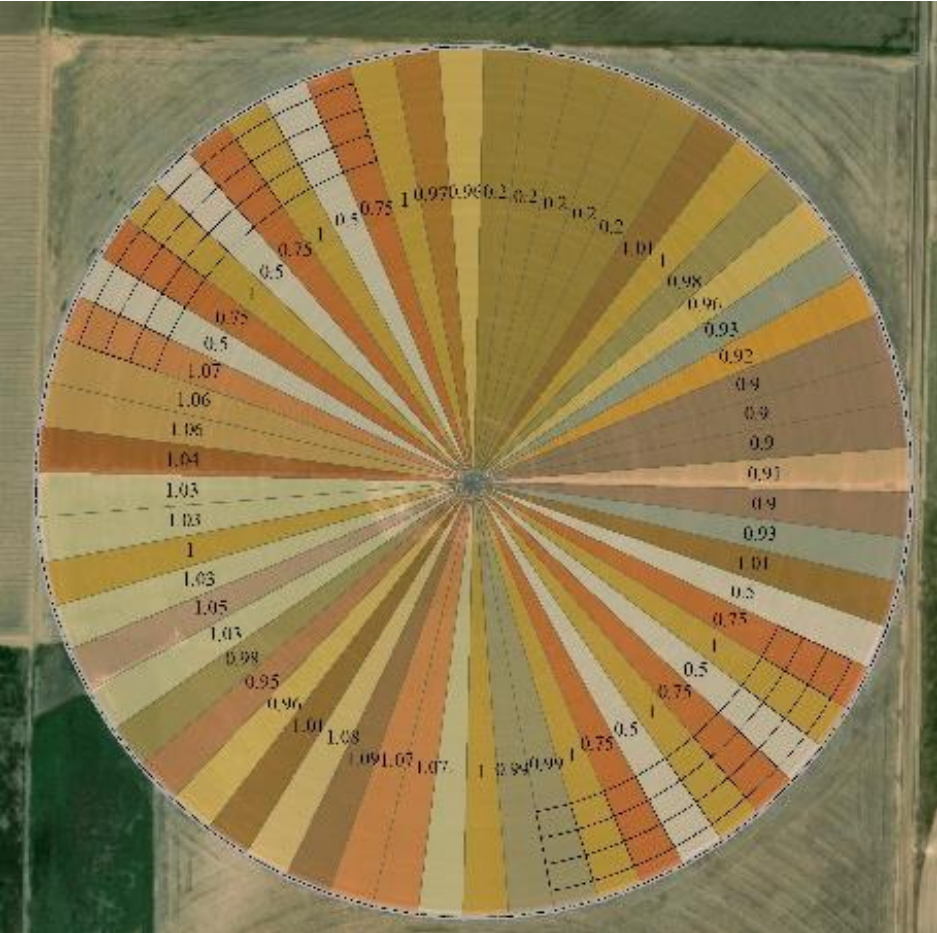
Results

- Cotton yield was significantly different at different landscape positions
- Effect of irrigation treatment on yield was not significant (in 2017, a wet year)
- The effect of irrigation on cotton yield depended on the interaction with soil properties (especially soil texture) and topographical attributes (elevation and slope) -- indicating potential to use **EC and topography** for variable rate irrigation

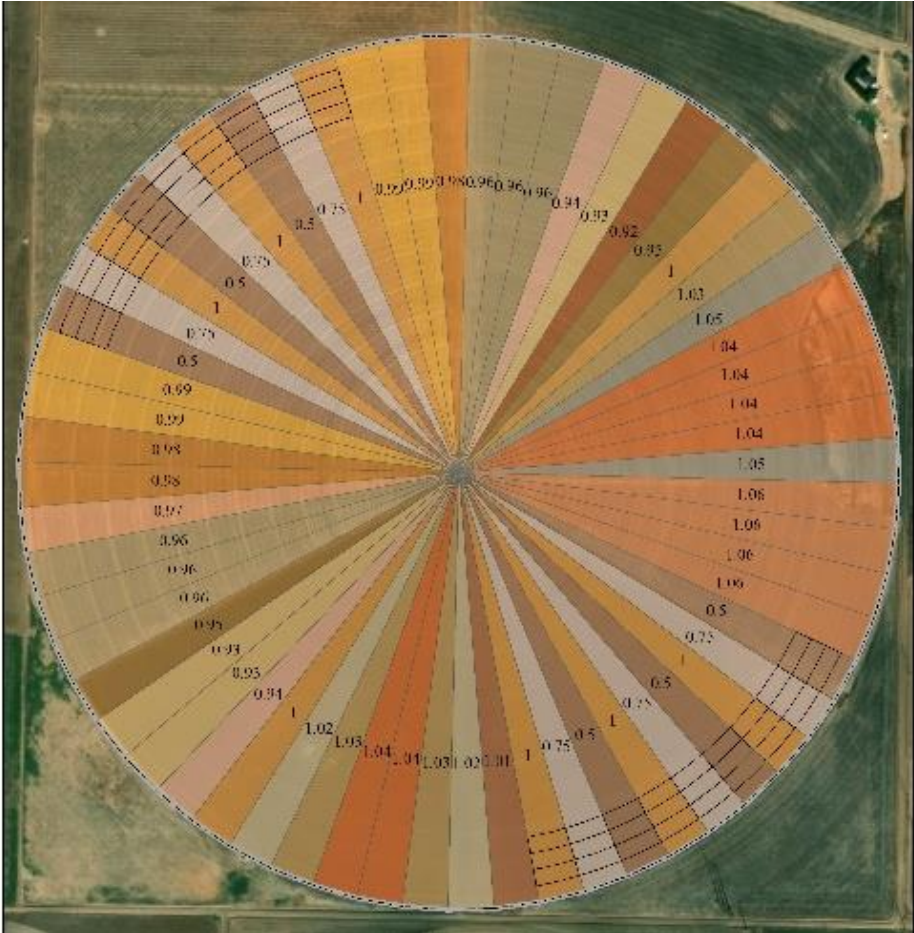
VRI using Speed Control systems

Case Study I

Variable rate irrigation study in Floyd County, TX 2021



Field 1 (120 acres)

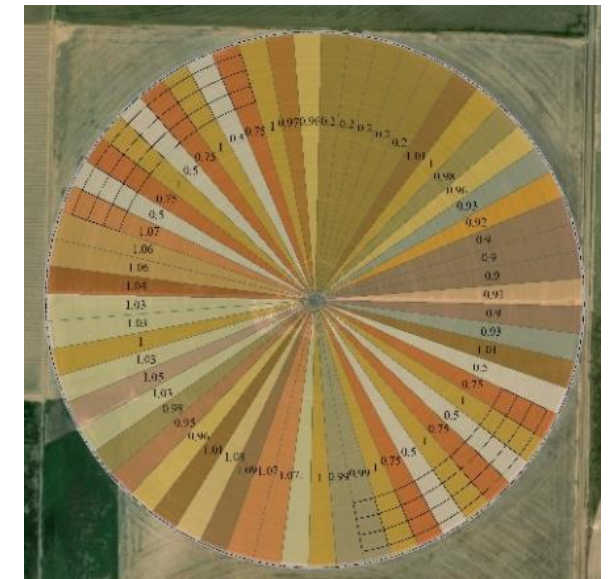


Field 2 (330 acres)

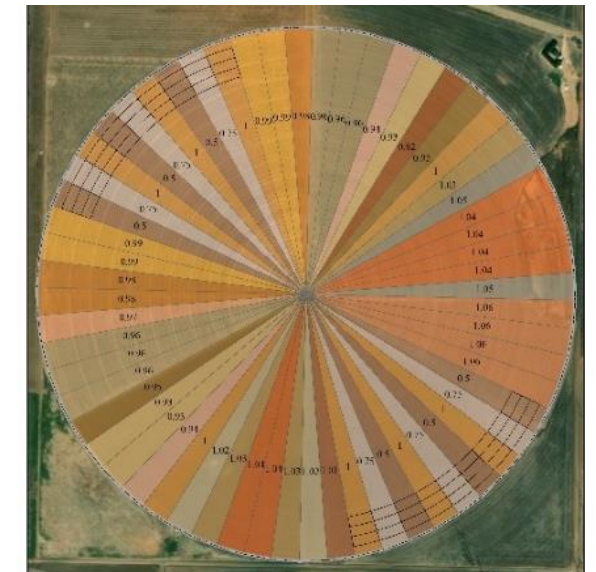
Variable rate irrigation in two fields in Floyd County, Texas, 2021 (Rates: **0.5, 0.75, and 1.0** inch/week)

Cotton lint yield in response to irrigation treatments for two fields in Floyd County, 2021

Field	Treatment	DF	SS	MS	F value	Pr(>F)
Field 1	Irrigation	2	169472	84736	6.27	0.005
	Block	5	792741	158548	11.732	<0.001
	Irrigation × Block	9	91975	10219	0.756	0.656
Field 2	Irrigation	2	7930	3965	1.124	0.336
	Block	5	27201	5440	1.541	0.200
	Irrigation × Block	8	60920	7615	2.158	0.050



Field 1 (120 acres)

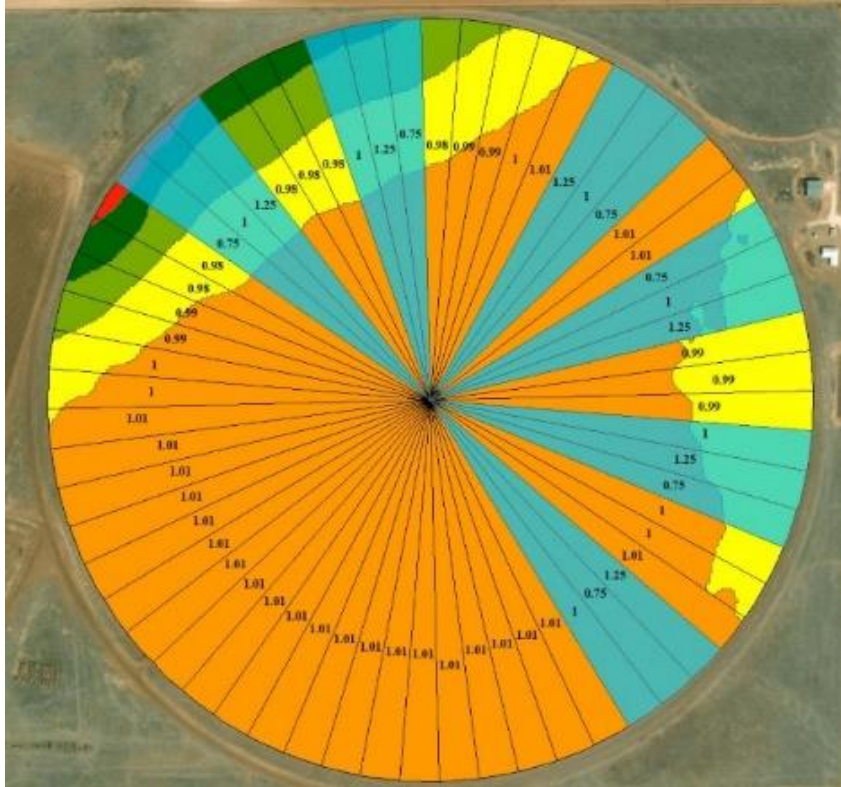


Field 2 (330 acres)

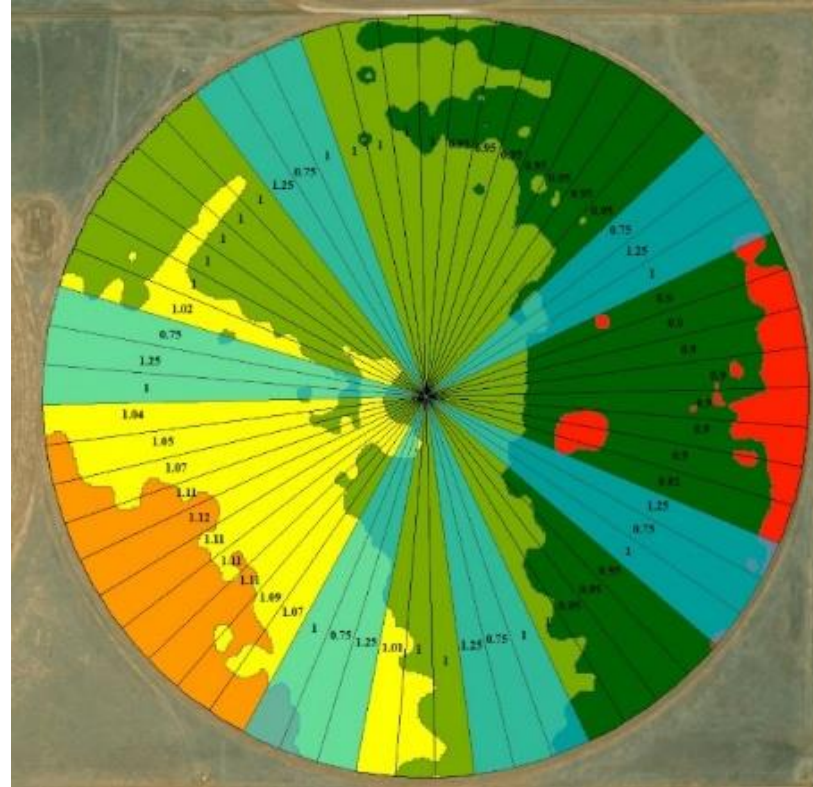
VRI using Speed Control systems

Case Study II

VRI using Speed Control systems Two fields in Parmer County, TX



Field 1 (120 acres)



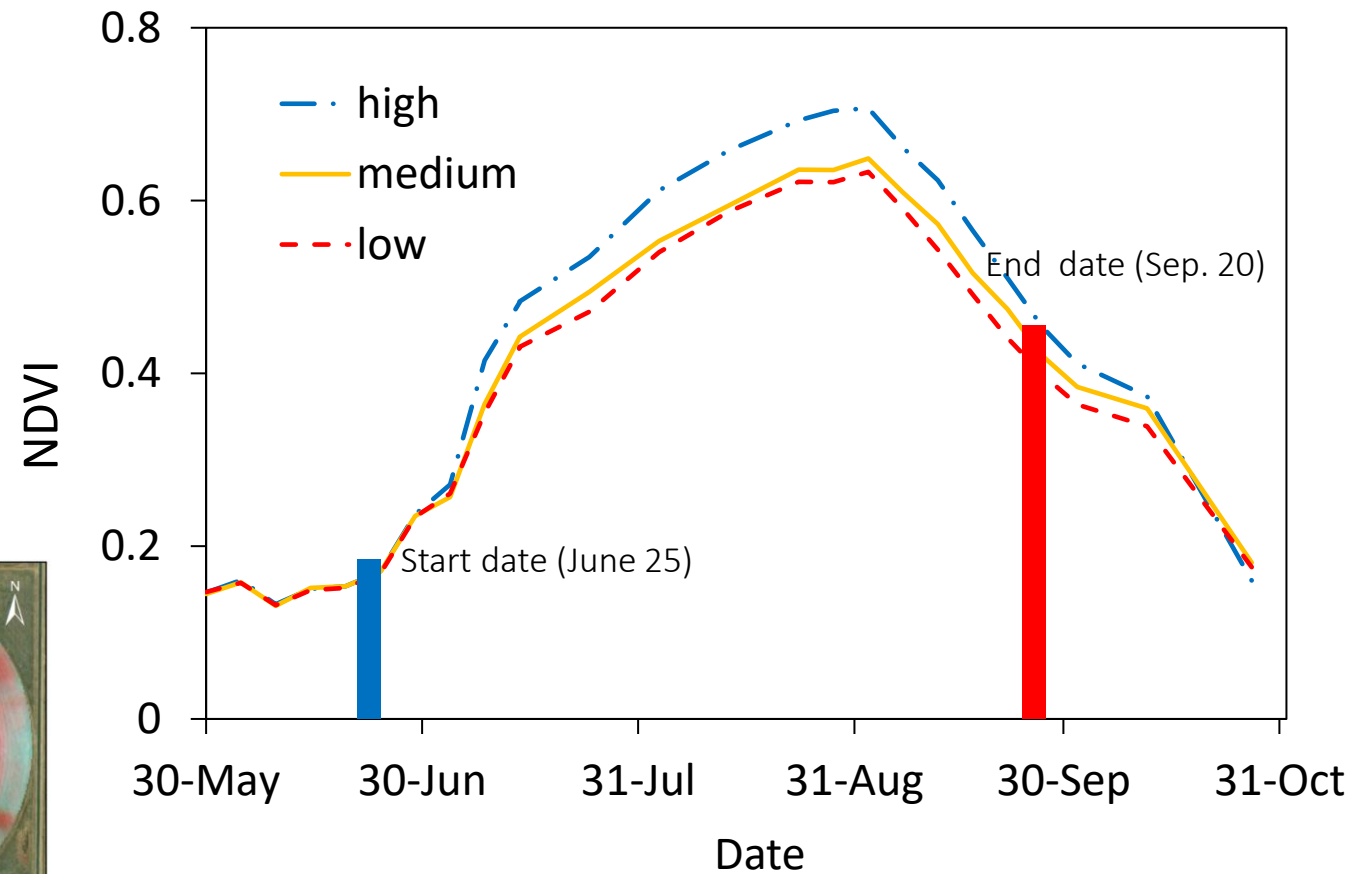
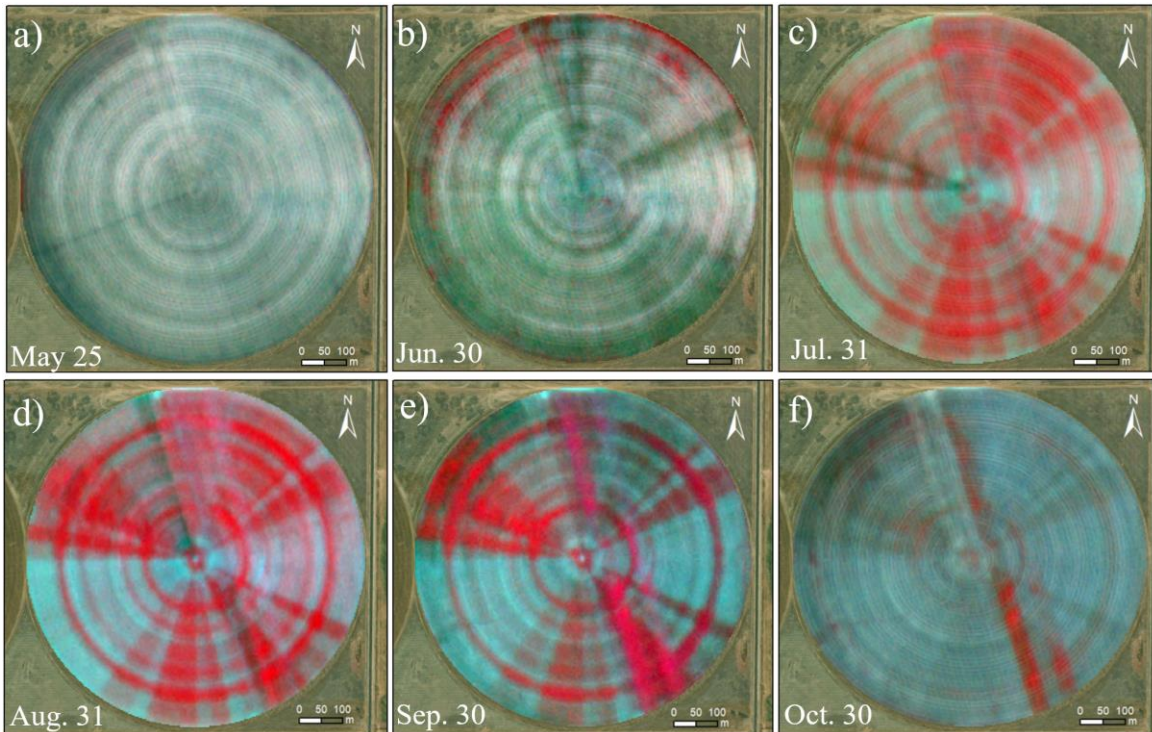
Field 2 (330 acres)

- Irrigation rate: 0.75, 1.0, 1.25 inches/week

Summary and Discussion

- Irrigation treatment did not significantly affect cotton yield;
- Landscape positions (blocks) have significant effect on cotton yield.
- Similar yield with different irrigation rates indicate potential for water conservation

Current Study – applying satellite images in assessing variable rate irrigation



NDVI has strong response to irrigation rates (high vs medium and Low)

Higher biomass (NDVI) in high irrigation did not convert to higher cotton lint yield

Overall summary

- Efficacy of variable rate irrigation depend on the field conditions, especially spatial variations of soil properties and topography
- Low response of cotton yield to high irrigation rate indicate potential to conserve water while maintaining productivity
- Variable rate irrigation has potential to improve water use efficiency and conserve water

Challenges

- Challenging to implement on-farm precision irrigation
- Cropping systems may change – challenging to implement repeated VRI studies
- Data collection (yield monitors may not be available)
- Availability of precision Irrigation systems

Acknowledgements



Cotton
Incorporated



Collaborating Producers

Forefront Agronomy