Precision Irrigation Management: Challenges and Opportunities

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Introduction

Why Irrigate?

• Increase yield and profit

• Stabilize yield and assist with budgeting

• Reduce overall production risk

• Agronomics
Introduction

• In 2017, South Carolina had approx. 13% of cropland irrigated (210,000 acres)
  – Commodity specific
  • High value crops have larger percentage of irrigated acres

• Relatively low irrigated acreage compared to other southern states
  – Georgia – 1.1 million acres irrigated
  – Mississippi – 1.6 million acres irrigated

• On-going water/irrigation survey 2018-2019

• Water applied for irrigation has increased in SE USA more in last 10 years than other regions of USA

USDA-NASS
Irrigation Water Sources in SC

• Surface Water Reservoirs ~ 38%
  – Important for SC Piedmont and Coastal Plain
  – Ponds and Lagoons

• Underground Aquifers ~ 62%
  – Important for SC Coastal Plain
  – 6 Major Aquifers in SC

• Irrigation is 4th greatest user of water in SC

• Irrigation is 2nd greatest user of groundwater
Water Use Efficiency

Ways to Increase WUE:
1. Increase irrigation system efficiency

2. Utilize an irrigation scheduling method/tool

3. BMPs to capture rainfall/irrigation and prevent runoff

4. Improve genetics/plant ability to use water more efficiently
Precision Irrigation

• Precision technologies are evolving rapidly
• Many new management tools/options available
  – Whole-farm Wi-Fi and connectivity
  – Soil moisture sensors
  – System automation
  – Variable rate systems

“Our precision capabilities have exceeded our decision making capabilities”
Variable Rate Irrigation

What is Variable Rate Irrigation?:

• Site-Specific Management of Water

• The ability to spatially vary irrigation depth across field to account for variability

• Applying water where you want it
Precision Irrigation

1. Does VR Irrigation work in every field?

2. Does the water/pumping savings provide acceptable ROI?

3. How do we accurately and repeatedly make prescriptions?

4. Base prescription on soil characteristic or crop? NDVI?
Variable Rate Irrigation

2 Types of VR Irrigation:

1. **Section/Speed Control**
   - Speed up – Slow down to adjust application depth
   - Whole system approach with “pie-shaped zones”
   - Vary application rate/depth based on field topography, non-crop areas, or distinct soil texture differences

2. **Zone Control**
   - Solenoids on sprinklers coupled with speed vary rate
   - Greater resolution on size and shape of management zones
   - Able to account for irregular shaped zones
Variable Rate Irrigation
Variable Rate Irrigation

2 Types of Prescriptions:

1. **Static** – Prescription stays the same throughout the growing season
   - On/Off
   - Distinct differences in soil texture

2. **Dynamic** – Prescription changes frequently during the season
   - Complex management
   - Maximizes profit
   - Possibly changes each irrigation
Variable Rate Irrigation

When do I need variable rate irrigation?

• Significant soil texture variability under irrigation system

• Variations in topography

• Non-crop areas

• Multiple crops under same system

• Water regulation and/or limited water supply

• Field by field basis – Not all fields are suitable for VR
Variable Rate Irrigation

Soil EC

Up to 2 in/hr Infiltration Rate

0.5 in/hr Infiltration Rate

0.6 in/hr Infiltration Rate

Low

Medium

High

Low

Medium

High

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Variable Rate Irrigation

Soil EC

3.5 inches WHC

7.1 inches WHC

6 inches WHC
Variable Rate Irrigation

Factors to consider when varying irrigation application rates:

• How much do we vary application rate by soil texture?

• If using sensors, do we establish thresholds for each soil texture? Base trigger off one threshold? Skip over areas of the field?

• Frequent applications likely needed
  • Capacity of the system is factor
Variable Rate Irrigation - Research

• VR irrigation research is available across U.S.
  • Water savings up to 25% have been observed with VRI when compared to uniform irrigation
    – Highly dependent on field and variability
• Most of the research conducted evaluates VRI vs. conventional systems
• Limited research on determining when VRI is appropriate
  – How much variability do we need to justify?
Variable Rate Irrigation - Research

• Additional research is needed to evaluate prescription development and repeatability

• Directed $R_x$ – A method to develop variable rate prescriptions

• Utilize existing tools and recommendations for VR prescriptions and implementation
Typical Steps in Developing Variable Rate Prescriptions

1. Zone Development
2. Productivity Assessment by Zone
3. Rate Assignment
4. Rate Assessment
Prescription Then Based on Generic Data
The Clemson “Directed Prescription” System (D-Rx)

Directed Prescription

EC Data

Test Strips

Site-Specific Yield Response
Variable Rate Irrigation

![Graph showing yield vs. soil EC for different treatments](image)
Irrigation Research

• USDA-ARS ~ Florence, SC
• Corn
• Split field into 12 soil types
  – Determined WHC
  – Used ET
  – Determined water balance
• Created 1, 2, and 4 management zones

Stone and Bauer
Irrigation Research

- Concluded only 2 management zones were needed
- Considering historic weather data depending on year, dry or wet, 5-6 zones may be needed
- Irrigation water savings appears to be beneficial in highly variable soil
- Coupling NDVI with crop ET may have merit
Challenges Moving Forward

• Ways to quickly determine variability in field need to be developed
  – How much variability is enough to justify VR
  – Yield map?
• Prescription development needs to be standardized by region
• Other technologies should be coupled with VRI technology to max profit
• Justifying additional cost of VRI
Opportunities

• Depending on the field water savings could be significant
• Incorporating system automation with remote sensing technologies to irrigate would be ideal
• Maximizing IWUE and profit could be obtained with VRI
Thank you!

Questions?

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