# To VRI or Not to VRI:
## Informing Variable Rate Irrigation Investment Decisions

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## Background and Objective

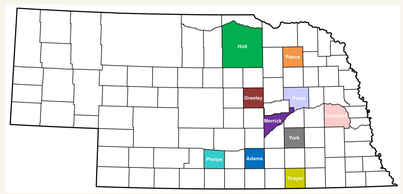
- Increasing competition for freshwater resources and rising nitrate concentrations in aquifers put pressure on farmers to maintain the profitability of their operation while improving environmental stewardship


a hypothetical VRI prescription map

- By tailoring water delivery to each part of a single field based on local characteristics such as topography, soil, crop, and management, variable rate irrigation (VRI) has potential advantages including:
  - Cost savings from reduced pumping and fertilizer applications
  - Environmental benefits of less contaminant transport into surface water and groundwater
  - Higher yield with a limiting amount of water
- Our goal is to inform VRI investment decisions by quantifying its value for individual fields

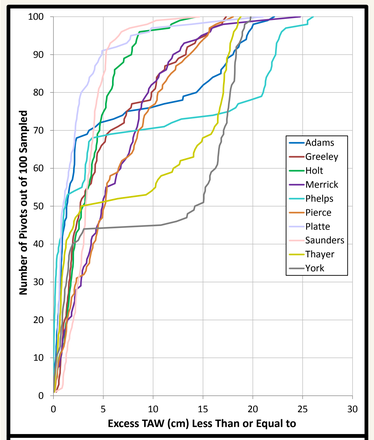
## Approach

- Where water is unlikely to be a yield-limiting factor, much of the gains due to VRI would result from allowing more precipitation capture and greater usage of rainfall-derived soil water
- In this study, we assessed the feasibility of using free, publicly accessible information to calculate 3 statistics related to the spatial variability in "soil water storage" (a term coined to refer to the abundance of rainfall-derived soil water), which will be our basis of making rough estimates of VRI-enabled pumping savings




- With ArcGIS, we sampled 100 center pivot irrigated fields in each of 10 eastern Nebraska counties, where precipitation is often significant relative to irrigation

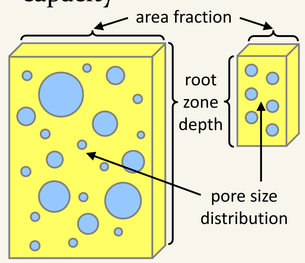
## Results and Discussion

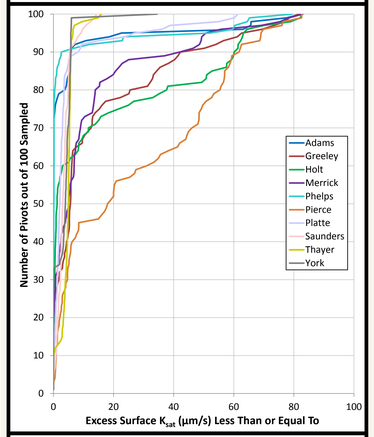



### Excess total available water (TAW)

$\Sigma[(A_i/\Sigma A_i)TAW_i] - \min(TAW)$

- extra soil water reservoir capacity

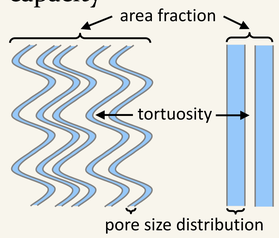


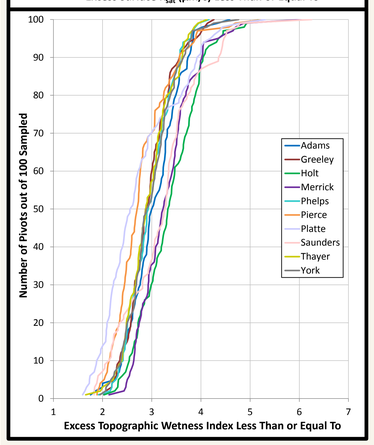




### Excess surface saturated hydraulic conductivity ($K_{sat,s}$)

$\Sigma[(A_i/\Sigma A_i)K_{sat,s,i}] - \min(K_{sat,s})$

- extra infiltration capacity

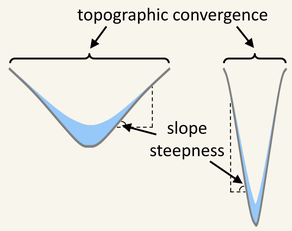



### Excess topographic wetness index (TWI)

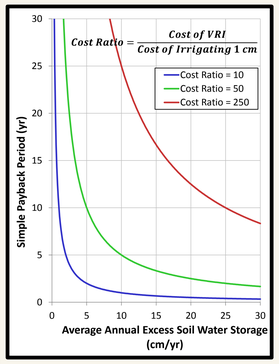
$\Sigma[(A_i/\Sigma A_i)TWI_i] - \min(TWI)$

- extra opportunity time for infiltration




- Overall, some counties' distributions of these statistics appear to stand out, yet their wide ranges highlight the importance of examining each field separately

- Excess TAWs were larger than expected—partly due to assumptions we made about restrictive soil layers
- To better account for their effects on roots and the TAW of the soil above them, our method needs to be refined




- If excess soil water storage were known, then we can express its significance in financial terms (assuming irrigation to be scheduled based on area with least soil water storage and variable irrigation costs to be constant with respect to season-to-date cumulative irrigation)
- The graph above preliminarily suggests that VRI may be appropriate for a substantial fraction of fields, especially as VRI becomes cheaper relative to pumping
- In sum, our current method is simple and quick, but it requires greater complexity to deliver reliable results

## Future Work

- Integrate all three statistics into calculating soil water storage variability through hydrologic modelling, estimate our uncertainty based on field data, and develop an economic decision tool for public use
- Determine an approach to evaluate VRI investments where water is likely to be a yield-limiting factor
- Continue our ongoing work to improve understanding and modelling of spatiotemporal variability in soil water status so that we can eventually offer real-time and scientific guidance on VRI management

## Acknowledgements

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