12. Getting the Most Value from Limited Irrigation Water

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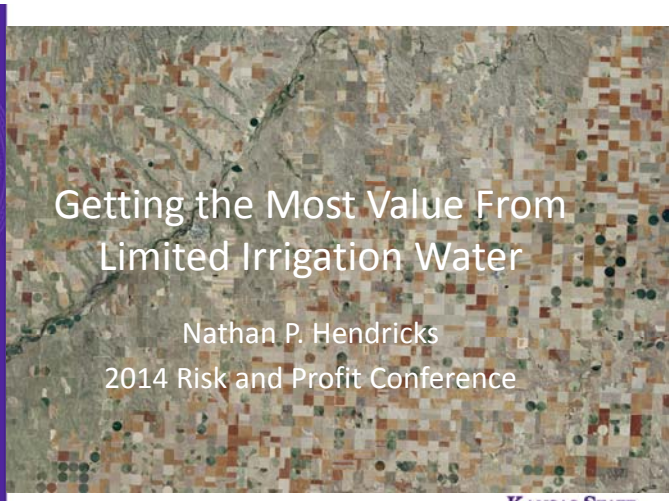
Abstract/Summary

As groundwater supplies diminish and pumping rates decline, farmers face difficult management decisions about how to obtain the most value from a limited amount of water. I will present research findings that show how the value of agricultural production declines as water availability decreases. Of particular importance is that the value of production initially declines quite slowly when farmers begin at full irrigation. However, the value of production begins declining more rapidly as water availability continues to decrease. I will discuss the implications for choosing between deficit irrigation on a larger number of acres or full irrigation on a smaller number of acres. Implications for the design of policies to reduce withdrawals (e.g., LEMAs) will also be briefly discussed.



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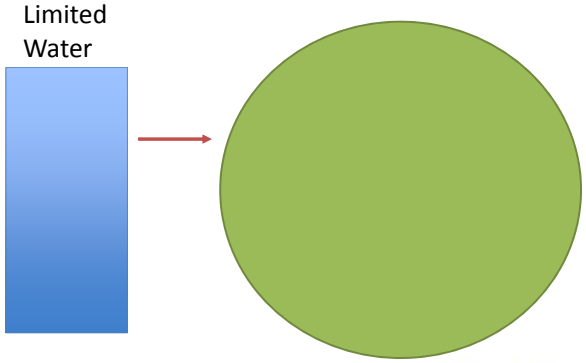
The Problem

Limited Water



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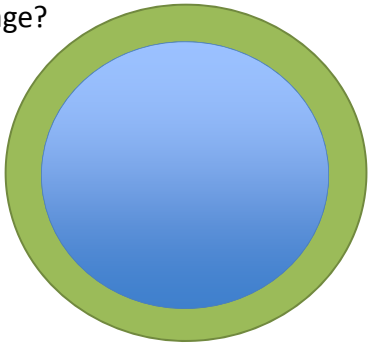
The Problem

1. What proportion of the field do I irrigate?
2. How much water do I apply to irrigated acreage?



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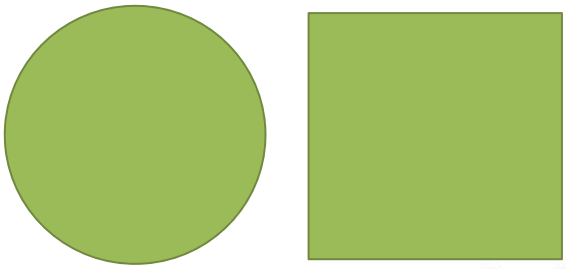
Equivalent Problem

Authorized to irrigate multiple fields, but not enough water to fully irrigate all fields. How many acres do I irrigate and at what intensity?



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A Thought Experiment

- Would I rather decrease irrigated acreage or water use intensity?
  - Decreasing irrigated acreage by 10% decreases returns by 10%
  - Decreasing water use intensity by 10% decreases returns by 5%
- Answer: Decrease water use intensity

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A Thought Experiment

- Would I rather decrease irrigated acreage or water use intensity?
  - Decreasing irrigated acreage by 10% decreases returns by 10%
  - Decreasing water use intensity by 10% decreases returns by 15%
- Answer: Decrease irrigated acreage

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Assumptions

- Assuming limited water
- Assuming 10% decrease in acreage decreases returns by 10% (constant returns to scale)
- Assuming water use intensity has increasing returns to intensity at low levels of intensity and decreasing returns to intensity at high levels of intensity

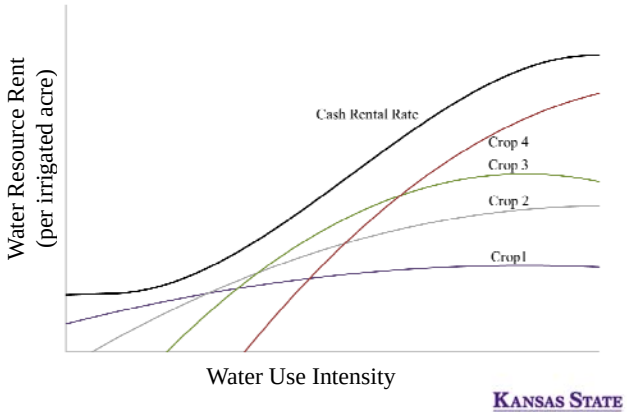
Optimal Acreage and Water Use Intensity

Decision rule:

Choose a water use intensity with constant returns to intensity and irrigate maximum acreage at that intensity (until constrained by pumping capacity or water right).

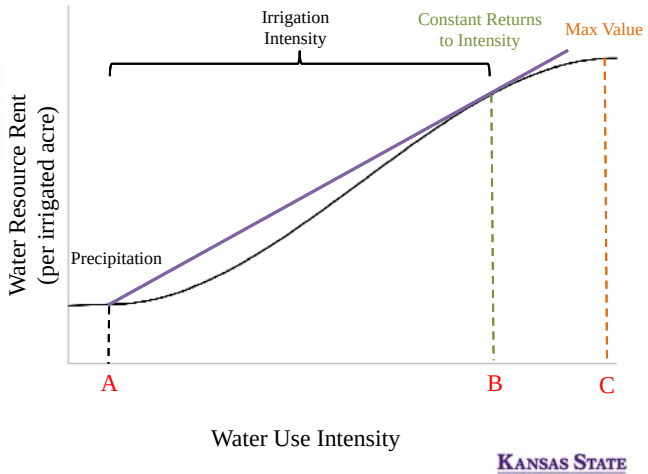
Intuition: 1% decrease in intensity or acreage decreases returns by 1%

The Value of Water

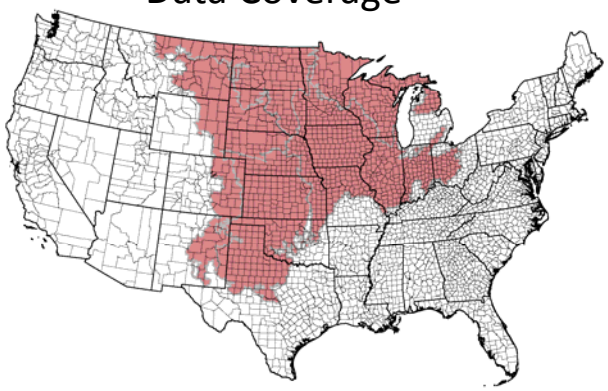


Estimating the Rent Function

- County-level analysis
- Data
  - NASS Nonirrigated Cash Rents
  - Average weather (climate) data from PRISM
    - April-September Precipitation
    - Evapotranspiration for Corn
    - Growing Degree Days
  - Soils data from NRCS



Data Coverage



Estimating the Rent Function

- Method: Regression with a flexible functional form
- Interpretation of results: The economic value (average rental rate) of being allocated *on average* a given quantity of water per acre

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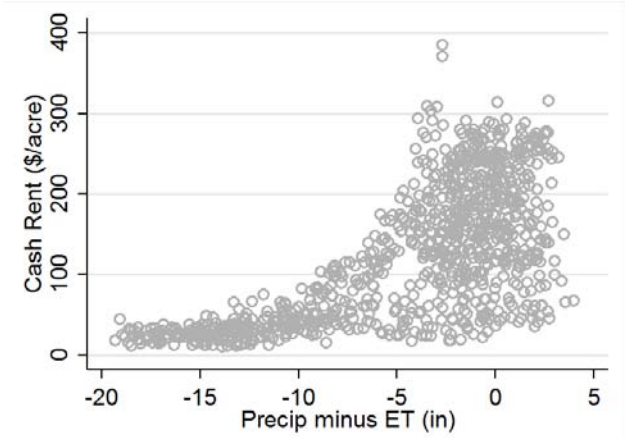

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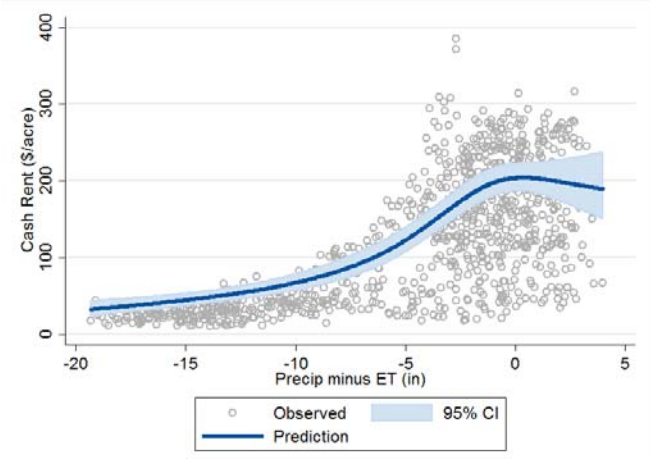
Estimated Value Function with "Average Soils"



Value of Irrigation Water

- Example: Thomas county, KS
- Assume cost of pumping is $3/acre inch

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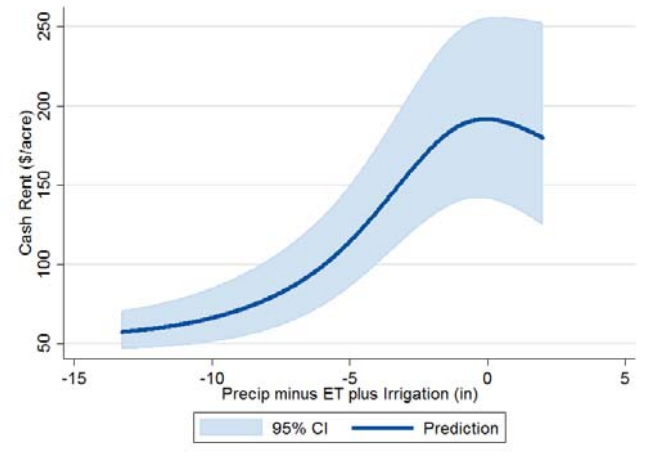
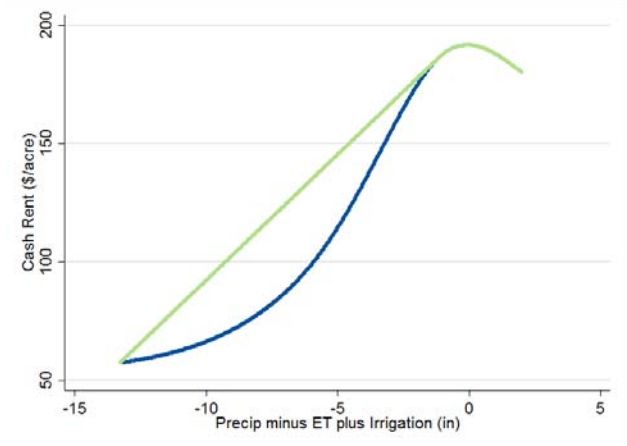
Value of Irrigation Water Intensity



Value of Irrigation Water/Acre (Irrigated and Nonirrigated)



Optimal Irrigation Intensity

- About 1 to 1.5 inches short of meeting ET demand for corn
  - That is average water use across all crops, not just corn
- How much irrigation water? Depends on rainfall and ET in your region and your irrigation efficiency

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Caveats

- Do farmers with "full irrigation" irrigate in excess of profit max intensity?
- Errors in cash rental rate data
- Have not yet quantified additional production risk from "optimal" irrigation intensity
- Value of limited irrigation in reducing risk
- Discrete acreage changes and cost of adjustment not considered

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Consequences of Full Irrigation

- Say you irrigate 100 acres at "full irrigation" and 60 acres dryland
- Irrigated: $192/acre rent
- Dryland: $57/acre rent
- Total: $22,620
  - Average: $141/acre

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Consequences of Full Irrigation

- If you cut irrigation by 1 inch/acre, could expand acreage by about 8.5 acres
- Irrigated: $187/acre rent
- Dryland: $57/acre rent
- Total: $23,225 (increase of $605)
  - Average: $145/acre

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Consequences of Limited Irrigation

- Say you irrigate 120 acres at "limited" irrigation intensity (half of corn ET) and 40 acres dryland
- Irrigated: $93/acre rent
- Dryland: $57/acre rent
- Total: $13,440
  - Average: $84/acre

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Consequences of Limited Irrigation

- Increase irrigation intensity, and reduce irrigated acreage to 66 acres (94 dryland acres)
- Irrigated: $187/acre rent
- Dryland: $57/acre rent
- Total: $17,700 (increase of $4,260)
  - Average: $111/acre

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Production Practices at Optimal Intensity

- Look at nonirrigated production practices in counties that receive rainfall at optimal intensity with similar soils

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Summary

- Water has increasing returns to intensity over most of the rent function
- If potential irrigated acreage is not limited, but allocated water is limited, then
  - Choose optimal intensity with constant returns to intensity
  - Choose irrigated acreage to use all water at this intensity
- A 1% increase in intensity or acreage gives 1% increase in returns

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Summary Continued

- If potential irrigated acreage is limited
  - Choose maximum irrigated acreage
  - Choose water use intensity that maximizes returns per acre
- A 1% increase in intensity gives no increase in returns

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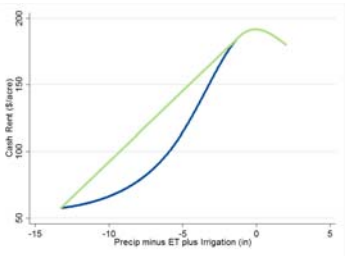
Implications for LEMAs

- Small reduction in value of irrigation for small water use reductions, then declines linearly as farmers reduce irrigated acreage



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Acknowledgements

- This presentation has benefited from conversations with Jeff Peterson at K-State.
- Wang, C. and S. Nair. 2013. "The Economics of Deficit Irrigation." *Natural Resource Modeling* 26(3):331-364.

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