Potential Economic Impact of Water Use Changes in Northwest Kansas

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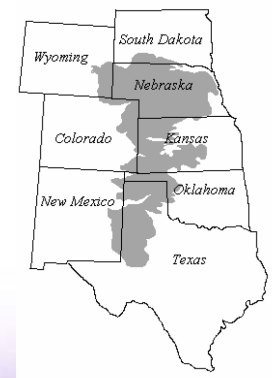
Risk & Profit Conference
Manhattan, Kansas
August 16 - 17, 2007

This research was funded in part by the Kansas Water Office, and the National Research Initiative.

Background

- The Ogallala aquifer is declining
  - Reduced well capacity
    - Impacts total irrigated acres
    - Impacts crop choice
  - Future economic impacts
    - The economy will transition to dryland production
    - Can we control the process ?



Possible Solution

- Extend the economic life of the aquifer through water conservation policy
- Voluntary and incentive based programs
- Trade off between long term economic impacts of a declining aquifer and the short term economic impacts of water conservation policy.

Why Conserve Groundwater ?

- Inter-generational fairness
- Control the transition to a non-irrigated economy
- Stabilize irrigated land prices
- Reduce short term production risk
- Improve outlook for junior water rights
- Enhances existence value
- Protect groundwater quality
- Improve stream flow

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The Technology Solution

- 1982 High Plains Study
  - Pumping cost will control water use
  - Technology adoption = conservation
- Technology → marginal cost of water has increased slightly
- Technology → marginal value of water has increased significantly
- Technology adoption is associated with increased water use
  - Increased yield
  - Increased acres of water intensive crops
  - Increased total acres

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Project Goals

- Predict the future based on the status quo
  - Time path of saturated thickness
  - Time path of well capacity
  - Time path of irrigated acres, crop mix, and water-use
  - Time path of crop revenues
- Evaluate policy options relative to the status quo
  - Immediate conversion to dryland production
  - Limited irrigation
  - Water rights transition program
  - Conservation reserve enhancement program
- Analyze 6 subareas in northwest Kansas

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Project Goals

- Predict impacts to producers
- Predict impacts to the aquifer
- Predict impacts to the regional economy (in progress)
- Funded by local, state, and federal entities
- Supervised/directed by local stakeholders

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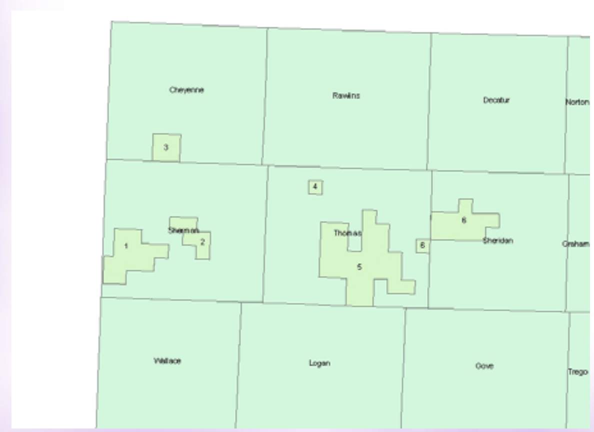
Study Area



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Temporal Allocation Model

- Economic model of producer behavior
- Simple ‘single-cell’ hydrologic model
- Simulates yearly
  - Crop choices
  - Water-Use
  - Aquifer decline rates

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Temporal Allocation Model

Economic Model

Time	Saturated Thickness	Well Capacity	Alfalfa Acres	Irrigated Corn Acres	Soybeans Acres	Revenue	Total Water-Use	Change ST
1	89.8	587.4	1237	18558	4949	$5,279,829	26723.6	1.15
2	88.6	575.4						

Hydrological Model

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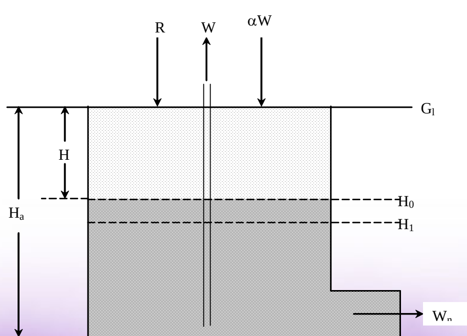
The Hydrological Model

- The Single Cell Aquifer Model → Saturated Thickness
  - Calibrated to MODFLOW (RRCA model)



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The Hydrological Model

Hecox Graphs → Well Capacity

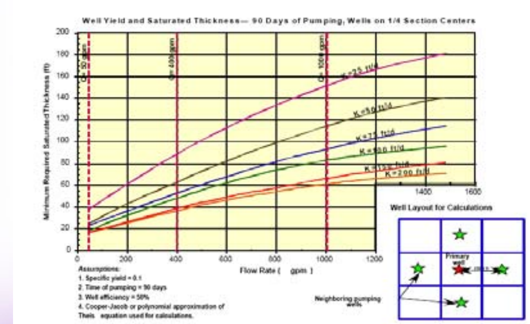

Figure 5. Relationship between Well Yield and Saturated Thickness for Various Hydraulic Conductivity Values, 90 Days of Pumping, Wells on 1/4 Section Centers

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The Economic Model

- Assumed Producer Behavior
  - Yield Maximization → risk adverse
  - Profit Maximization → risk neutral
- Yield Maximization
  - Consistent with the empirical evidence
  - As water becomes limiting a producer maintains maximum yield by reducing acres – which are converted to dryland.

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Yield Maximization

- Requires an assumption as to “when water becomes limiting” ie we need a “trigger point”’

Well Capacity (gallons per minute)	Acres	Gross Daily Application Rate (inches per day per acre)
1200	125	0.51
1150	125	0.49
1100	125	0.47
1050	125	0.45
1000	125	0.42
950	125	0.40
900	125	0.38
850	125	0.36
800	125	0.34
750	125	0.32
700	125	0.30
650	125	0.28
600	125	0.25
550	125	0.23
500	125	0.21
450	125	0.19
400	125	0.17
350	125	0.15

Alfalfa	Corn	Sorghum	Soybeans	Sunflowers	Wheat
0.2	0.2	0.16	0.16	0.12	0.08

Trigger Point

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Revenues

- Irrigation
  - Crop acres (WIMAS/RRCA)
  - Crop mix is subarea specific (WIMAS)
  - Crop yields are calculated from Stone’s data
  - Prices and costs from KSU extension budgets
- Non-irrigated
  - Crop mix is county specific (NASS)
  - Crop yields are county specific (NASS)
  - Prices and costs from KSU extension budgets

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Water-Use

- Average per acre water-use (WIMAS)
- Total water use was calibrated to the RRCA model
  - Required minor adjustments to per acre water use and crop
- The annual decline rate use was calibrated to the RRCA model

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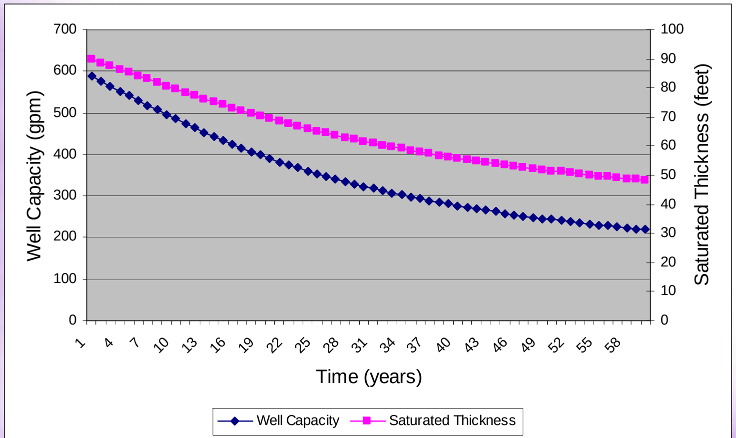
Status Quo: Scenario 1

Figure 2. Scenario 1: Status Quo Projected Time Path for Saturated Thickness and Well Capacity in Subarea 6 of Sheridan County



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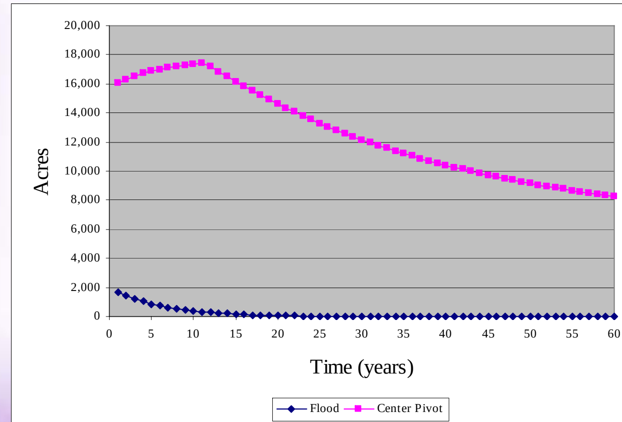
Status Quo: Scenario 1

Figure 3. Scenario 1: Status Quo Projected Time Path for Irrigated Corn Acreage in Subarea 6 of Sheridan County



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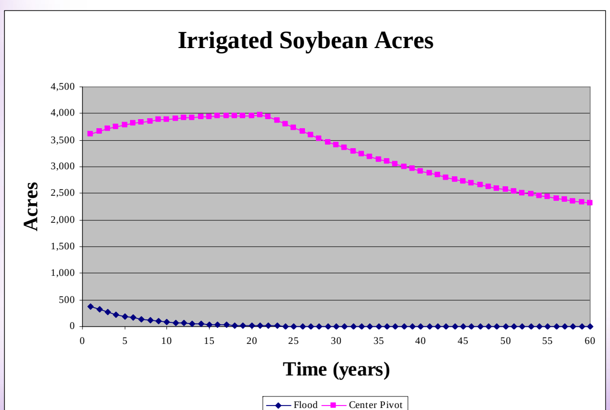
Status Quo: Scenario 1

Figure . Scenario 1: Status Quo Projected Time Path for Irrigated Soybean Acreage in Subarea 6 of Sheridan County



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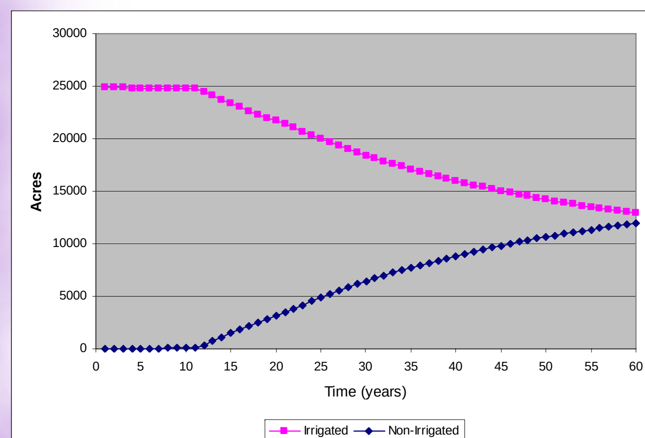
Status Quo: Scenario 1

Figure 4. Scenario 1: Status Quo Projected Time Path for Total Irrigated and Non-Irrigated Acreage in Subarea 6 of Sheridan County



Policy Option: Scenario 2

- Immediate conversion to dryland production
  - Total water Use = 0
  - Irrigated Revenues = 0
  - Non-irrigated revenues = county average

Policy Option: Scenario 3a

- Limited irrigation
  - No producer compensation
  - Total initial irrigated acre reduction = 0%
  - Total water-use = 30% less
    - Uniformly distributed across crops
  - Irrigated yields are approximately 9% less
  - Trigger points are approximately 20% less

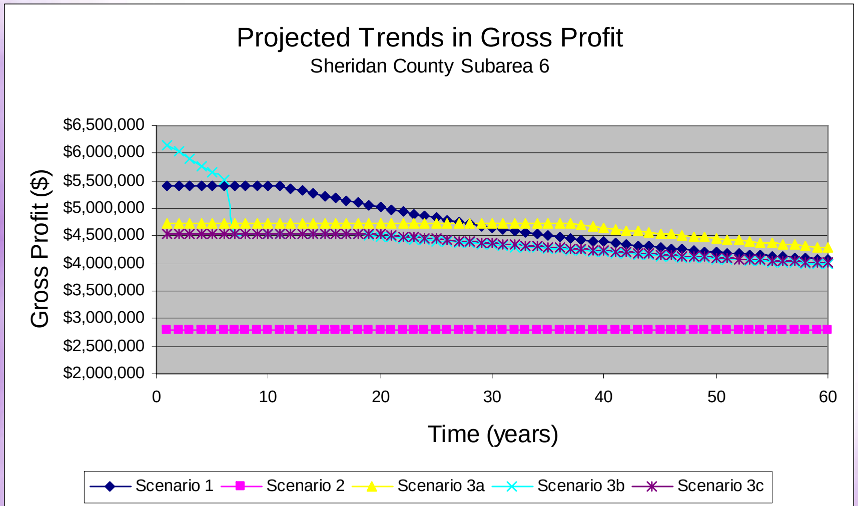
Policy Option: Scenario 3b

- Water Right Transition Program
  - Compensation = $800 per acre
  - Acres are enrolled over 6 years
  - Enrolled acres can produce dryland crops
  - Total acre reduction = 30%
    - Uniformly distributed across crops
  - Total water-use per acre is not limited
  - Irrigated yields are maximum

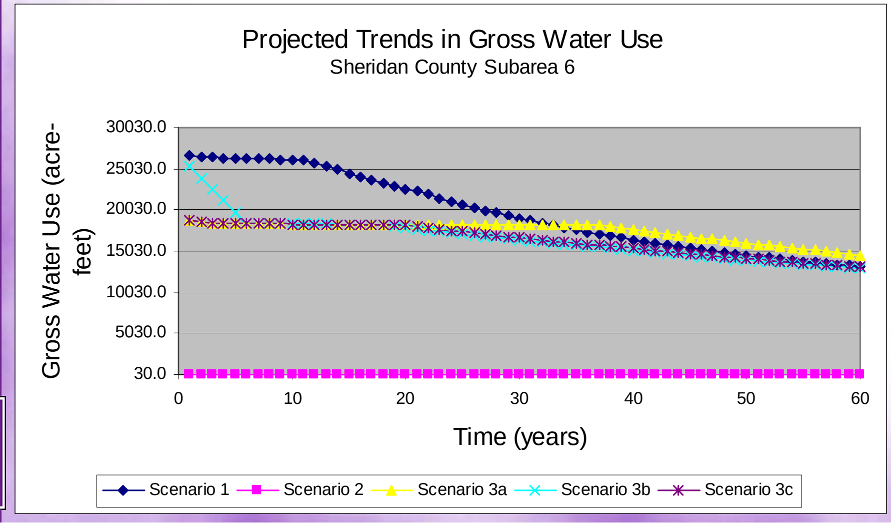
Policy Option: Scenario 3c

- CREP
  - Compensation = $112 per acre
  - Acres are enrolled in year 1
  - Enrolled acres cannot produce dryland crops
  - Total acre reduction = 30%
    - Uniformly distributed across crops
  - Total water-use per acre is not limited
  - Irrigated yields are maximum

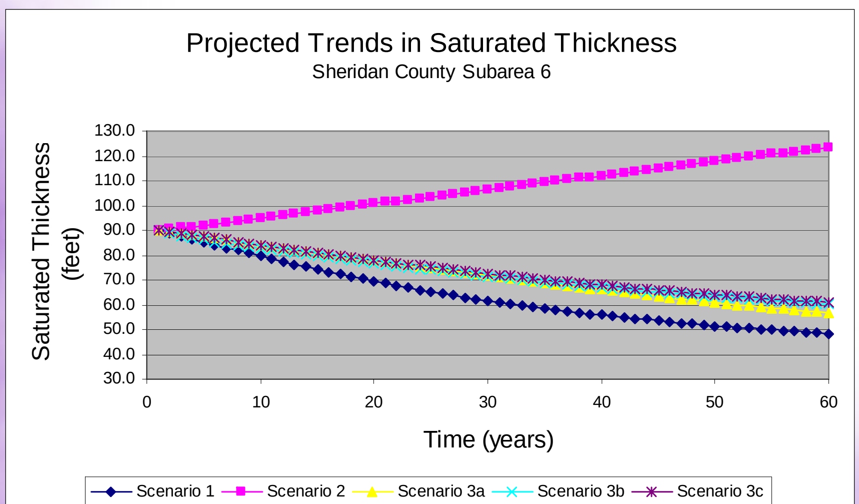
Policy Option Comparison



Policy Option Comparison



Policy Option Comparison



Policy Option Comparison
(Producer Revenues)

Table 25. Difference in Net Present Value Relative to the Status Quo Scenario

Discount	Scenario			
Rate	2	3a	3b	3c
-5.0%	-$655,951,006	$58,069,004	-$78,552,892	-$77,678,880
-2.5%	-$247,976,097	-$6,161,063	-$33,706,413	-$38,905,933
0.0%	-$115,891,063	-$5,733,266	-$16,651,524	-$23,277,742
2.5%	-$65,744,317	-$7,677,310	-$9,065,578	-$15,818,707
5.0%	-$43,277,641	-$7,222,407	-$5,207,811	-$11,711,081

Table 26. Water Conserved Relative to the Status Quo (acre-feet)

Scenario			
2	3a	3b	3c
1,178,002.0	129,216.7	186,350.8	196,531.6

Very Subjective Conclusions

Item	Limited Irrigation	Water Rights Buyout	CREP
Impact on producer revenue	Low	Medium	High
Probable impact of regional economy	Low	Medium	High
Source of funding	State ?	State	Federal
Administrative cost	High	Low	Medium
Feasibility	Low	Medium	High
Long term water savings	Low	Medium	Medium

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Very Subjective Conclusions

Item	Limited Irrigation	Water Rights Buyout	CREP
Inter-generational fairness	✓	✓	✓
Control the transition to a non-irrigated economy	✓ (red)	✓	✓
Stabilize irrigated land prices	✓	✓ (red)	✓ (red)
Reduce short term production risk	✓	✓ (red)	✓ (red)
Improve outlook for junior water rights	✓	✓ (red)	✓ (red)
Enhances existence value	✓	✓ (red)	✓ (red)
Protect groundwater quality	✓ (red)	✓ (red)	✓ (red)
Improve stream flow	✓ (red)	✓ (red)	✓ (red)

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Questions

- Look for the final report on http://www.agmanager.info/