

Chapter 5

Possible Changes in Current Practices

Scenarios 2 through 5

This chapter presents the findings from the theoretical application of policy scenarios 2 through 5 over the 20 year time frame of this study. The first scenario, presented in Chapter 4, modeled the current farming and water utilization practices with two-thirds of irrigation by center-pivot methods and one-third by flood irrigation methods. This scenario is the lynch-pin of this analysis because it focuses on current conditions and what is likely to occur in the next 20 years if there are no major water policy or economic changes. The first scenario provides a baseline to measure the implications of possible policy alternatives. These other scenarios represent possible policy alternatives that have been mentioned by various policy makers as probable solutions to the depletion of the aquifer or represent hybrid policy alternatives derived by the Docking Institute.

Four Policy Alternatives: Scenarios 2 through 5 Described

Flood irrigation techniques are less efficient than center pivot. For each section, it takes an average of about 70% more water using flood irrigation than center pivot irrigation. Recognizing this, the second scenario switches the sections that use the more water intensive flood irrigation techniques to the more water efficient center pivot methods. The purpose of this second scenario is to evaluate the possible impacts on cash flow and depletion rates of installing center pivot irrigation systems in place of flood systems.

The third and fourth scenarios build on the second scenario. While both scenarios assume that all irrigation is by center-pivot, the third scenario reduces the amount of water to all crops by 50% of the full irrigation level, and the fourth scenario reduces water usage to all crops such that each crop produces 90% of its current yield. In both scenarios, yield levels of crops are subsequently adjusted to reflect this reduced water usage, and cash flows are reduced to reflect the lower production yields. The purposes of these two scenarios are twofold: First, to underscore the tradeoffs

between these types of policy alternatives and recharging of the aquifer; and second, to note the economic impacts as the capacity of the aquifer for irrigation decreases.

The fifth scenario assumes that all irrigation is by center-pivot and that irrigation for corn is reduced by 50%, thus reducing corn yield by 10%. This scenario, derived by the Docking Institute, represents a hybrid policy alternative based on the findings from the previous four scenarios. The point of this scenario is to provide a policy direction that is economically viable and achieves the major policy goal of extending the life of the aquifer.

Scenario 2: All Center Pivot Irrigation

The second model simply changes the water irrigation methods to all center-pivot irrigation techniques. Center pivot irrigation uses water more efficiently than flood techniques and thus requires pumping less water. However, center pivot systems are costly to install and operate. In this scenario, the farmer replaces labor (time energy and effort to setup flooded field system) with capital investments and variable costs with fixed costs. Scenario 2 maintains the same cropping practices and crop distributions as Scenario 1.

**Table 12:
Scenario 2 Findings**

Scenario	Average Net Present Value per Section	Standard Deviation – NPV	Average Depletion Rate	Average Change In Saturated Depth
Scenario 1: Current Practices	-\$150,000	\$124,000	30.6%	-53.9 feet
Scenario 2: All Center Pivot	-\$206,000	\$94,000	19.3%	-33.1 feet

Not surprisingly, Table 12 shows that using only center pivot irrigation conserves water. The depletion rate is 19.3% for the twenty-year study period and the change in saturated depth is **-33 feet**. This is a considerable improvement over current practices (Scenario 1). However, the average NPV is negative **-\$206,000** per section (standard

deviation = \$94,225). The increased negativity in NPV, compared to Scenario 1, can be traced to the higher fixed and variable costs associated with center pivot irrigation. The fixed costs are particularly burdensome in those years when the land is either fallow or used to grow a low revenue crop, such as wheat.

Scenario 3: Center Pivot Irrigation, Water = 50% Current Level

Scenario 3 continues to assume that all irrigation occurs by center pivot irrigation, except that the quantity of water used for irrigation of all crops is 50% of the current level. This change in water usage obviously affects the yields of irrigated crops. Based on experiments conducted by Kansas State University Agricultural Experiment Station and Cooperative (1999), Table 13 shows how yields are affected for each crop. Interestingly, corn appears to be the least impacted by this change in irrigation practice, while alfalfa yields are considerably negative.

**Table 13:
Decreases in Yield by Crop When Reducing Water Utilization by 50%**

Crop	Change in Water Quantity	Change in Yield
Corn	- 50%	- 10%
Soybeans	- 50%	-20%
Milo	- 50%	-15%
Wheat	- 50%	-30%
Alfalfa	- 50%	-40%

Source: Kansas State University Agricultural Experiment Station and Cooperative

While decreasing the amount of water used for irrigation decreases yield, it also decreases lift costs and variable costs. Table 14 shows the findings from using center pivot irrigation and cutting water use to 50% of current levels. Under this scenario, water is conserved and significant recharge occurs. The depletion rate is -8.8% for the twenty year study period and the change in saturated depth 12 feet. Thus, this scenario will actually reverse the long-term depletion of the aquifer. However, there are substantial declines in yields without reductions in fixed costs. Thus, the NPV becomes considerably more problematic (**-\$337,000**) when compared to the initial conditions noted in Model 1.

**Table 14:
Scenario 3 Findings**

Scenario	Average Net Present Value per Section	Standard Deviation – NPV	Average Depletion Rate	Average Change In Saturated Depth
Scenario 1 Current Practices	-\$150,000	\$124,000	30.6%	-53.9 feet
Scenario 2 All Center Pivot	-\$206,000	\$94,000	19.3%	-33.1 feet
Scenario 3 Water Reduced by 50%	-\$337,000	\$84,000	-8.8%	11.9 feet

Scenario 4: Center Pivot Irrigation, Yield Reduced to 90% of Current Level

The fourth scenario continues to assume that all irrigation is by center pivot techniques, however, this scenario lowers all crop yields by 10% of the fully irrigated level. Based on experiments conducted by Kansas State University Agricultural Experiment Station and Cooperative (1999), Table 15 shows how the quantity of water needed to irrigate each crop is reduced. This change also influences lift costs and variable costs.

**Table 15:
Decreases in Water Irrigated by Crop**

Crop	Change in Water Quantity	Change in Yield
Corn	- 50%	- 10%
Soybeans	-25%	- 10%
Milo	-34%	- 10%
Wheat	-23%	- 10%
Alfalfa	-8%	- 10%

Source: Kansas State University Agricultural Experiment Station and Cooperative

Table 16 shows the findings from using center pivot irrigation and reducing the quantity of water used so that yields are reduced by 10%. The depletion rate is **-2%** for the twenty-year study period and the change in saturated depth is 2 feet. Thus, this model will produce a near-zero depletion outcome as well. However, the average NPV

is negative **\$-268,293** per section (standard deviation = \$82,409). This NPV per section is over \$100,000 more than current levels (Scenario 1). The increased negativity in NPV comes from lower yields and thus reduced revenues and the higher fixed and variable costs associated with center pivot irrigation. Again, the fixed costs are particularly burdensome in those years when the land is either fallow or used to grow a low revenue crop, such as wheat.

**Table 16:
Scenario 4 Findings**

Scenario	Average Net Present Value per Section	Standard Deviation – NPV	Average Depletion Rate	Average Change In Saturated Depth
Scenario 1 Current Practices	\$-150,000	\$124,000	30.6%	-53.9 feet
Scenario 2 All Center Pivot	\$-206,000	\$94,000	19.3%	-33.1 feet
Scenario 3 Water Reduced by 50%	\$-337,000	\$84,000	-8.8%	11.9 feet
Scenario 4 Crop Yields reduced by 10%	\$-268,000	\$82,000	-2.1%	2.2 feet

Scenario 5: Center Pivot Irrigation, Corn Irrigation Reduced by 50%

Scenario 5 represents a combination of the first four models. The scenario assumes that all irrigation occurs by center pivot techniques, while reducing water used on irrigated corn by 50% (see Table 17). Given that this will reduce corn yield by only 10%, in the opinion of the Docking Institute, this model may represent the most feasible means to produce a near zero depletion outcome. However, this near-zero depletion outcome is not without costs.

**Table 17:
Changes in Water Used and Yield by Crop**

Crop	Change in Water Quantity	Change in Yield
Corn	- 50%	- 10%
Soybeans	0%	0%
Milo	0%	0%
Wheat	0%	0%
Alfalfa	0%	0%

Table 18 shows that this model produces an estimated the depletion rate of 1.74% for the twenty year study period. This means that the change in saturated depth is about **-3.8** feet on average. Unfortunately, the average NPV is negative **-\$234,403** per section (standard deviation = \$86,410). While this is a net decrease of more than \$80,000 compared with current conditions (Scenario 1), the decrease in net value is similar to that of Scenario 2.. The increased negativity in NPV comes from lower yields and revenues, and the higher fixed and variable costs associated with center pivot irrigation.

**Table 18:
Scenario 5 Findings**

Scenario	Average Net Present Value per Section	Standard Deviation – NPV	Average Depletion Rate	Average Change In Saturated Depth
Scenario 1 Current Practices	-\$150,000	\$124,000	30.6%	-53.9 feet
Scenario 2 All Center Pivot	-\$206,000	\$94,000	19.3%	-33.1 feet
Scenario 3 Water Reduced by 50%	-\$337,000	\$84,000	-8.8%	11.9 feet
Scenario 4 Crop Yields reduced by 10%	-\$268,000	\$82,000	-2.1%	2.2 feet
Scenario 5 Water for Corn Reduced by 50%	-\$234,000	\$86,000	1.7%	-3.8 feet

Conclusions

Table 18 clearly shows that near-zero depletion is attainable, but it will be expensive for irrigators. In order to achieve the type of policy outcome that many have been promoting (zero depletion), irrigators will need to complete the switch from flood to center pivots as well as endure reduced yields for corn. Given the importance of irrigated agriculture for the economical and social survival of southwest Kansas, one might argue that the best way to attain this policy outcome is through government subsidies. The amount of this subsidy will need to have a net present value of \$84,000 (over 20 years) per section (2,618 sections). On an annual basis, this represents about \$4,200 per section (in 1998 dollars). This will at least bring irrigators back to the initial conditions of average net present value per section noted in Scenario 1.

Chapter 6 Conclusion

This report presented the findings of the Docking Institute of Public Affairs's study of the economic impact of an acre-foot of water on the economy of Southwest Kansas.

The four primary goals of the study were to:

- Develop current ranges of values for an acre-foot of groundwater from the Ogallala Aquifer in Southwest Kansas given its current uses.
- Derive an estimate of the total value of Ogallala Aquifer water over the next 20 years.
- Develop feasible scenarios that will extend the life of the aquifer, based on available technologies.
- Estimate the impact of conservation measures on users and the economy.

To achieve these goals, this study developed a hydroeconomic model for the water based economy in southwest Kansas. This model integrated climatological and hydrological considerations with an irrigation/crop component and a finance component. This integrated model was then used to estimate depletion rates, cash flows, and economic impact over the twenty-year period of the study.

Five scenarios of water utilization and economic impact were developed and analyzed. The first scenario modeled the current farming and water utilization practices. This scenario found that excluding government subsidies, the average net present value per section over 20 years is **\$ -150,000**, while the saturated thickness of the aquifer will decrease by about 30%. Including subsidies from external sources, the analysis found that on an annual basis, the total economic impact on the SWKGMD area from irrigation was an estimated \$188,496,000 in 1998 dollars. This equals about \$80 per acre foot. Over the course of the 20 year period of the study, the net present value of this impact in 1998 dollars was estimated at \$3,769,920,000.

In the remaining four scenarios, the study explored the impact of changing irrigation methods and water requirements (and thus yields) for irrigated crops on depletion and the net present value for irrigators. The study found that the most viable

scenario for achieving near zero depletion is one that changes all flood irrigation to center pivot and reduces the water utilization for corn by 50%. Significant, the reduced water for corn will only result in a 10% reduction in yield. However, the cost to the irrigator of these changes have a net present value per section of **-\$4,200** annually, or **-\$84,000** in 1998 dollars over the course of the 20 year study. The total cost of this near zero depletion scenario to the collective membership of SWKGMD would be about \$11 million (1998 dollars) annually ($\$4,200 \times 2618$ sections). Of course, government subsidies and low interest loans will substantially lower the cost to members of the SWKGMD and the cost for individual irrigators will vary by specific circumstances related to their operations.

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