The Law of Unintended Consequences:
The Ogallala Aquifer, Kansas Water Policy, and Technology Adoption

Introduction

For the majority of the 20th century, state and federal water policies were designed to encourage settlement and to develop the agricultural industry in western states. As a result, agriculture consumes between 70% and 95% of the available water resources in most arid western states. As society moves into the 21st century, public concerns over decreasing wildlife populations, the desire for more water-oriented recreational facilities, the water needs of an expanding industrial sector, and increased population concentration call into question the current allocation of water resources.

The law of unintended consequences implies that actions of people cause government policies to have effects that are unanticipated or "unintended." These unintended consequences often occur because the goals of the policy makers and the goals of the producer are not the same. Since the 1982 High Plains Study, both research and policy have primarily focused on improving irrigation efficiency as the primary means of extending the economic life of the Ogallala aquifer. In Kansas, past trends in water consumption and crop mix, as well as recent economic research, suggests that efficiency gains might have had an unintended consequence. The adoption of more efficient irrigation technology may actually be accelerating water-use and increasing the pace at which the aquifer is depleted. This places the State of Kansas in a difficult position. In administering water policy, State agencies are required to achieve an absolute reduction in consumptive use of groundwater, while at the same time maintaining the economic viability of irrigated agriculture in western Kansas. In order to maintain the profitability of irrigated agriculture, technological innovations continually need to be developed through research and adopted by the agricultural community. The question is how to allow this process to continue while at the same time reducing water consumption from the Ogallala aquifer and avoiding unintended negative consequences.

The purpose of this session is to 1) review past trends in water use, crop mix, and technology adoption; 2) Discuss the role technology plays in reducing the marginal cost of water and increasing the marginal revenue of the crops produced; 3) review two policy options aimed at reducing water consumption, the cost share programs administered by the Kansas Soil Conservation Commission, and the proposed Conservation Reserve Enhancement Program; and 4) hold an open discussion on the pros and cons of alternative policy options.

Trends and Technology

The Desert Land Act in 1877 discounted the price of a full 640 acre-section to settlers who would irrigate their land. Since that time policy makers have consistently followed a policy of encouraging the development of irrigated agriculture. As illustrated in Figure 1, the combination of technology, a seemingly endless supply of high-quality water in the Ogallala aquifer, relatively low-cost energy, deep fertile soils, level terrain, and favorable climate resulted in the rapid expansion of irrigated acreage in western Kansas. The development of irrigated agriculture in western Kansas created an environment that led to extensive growth in crop production, livestock, meatpacking, and other related industries. Today, irrigated agriculture yields $300 million in farm production and $380 million in value added agriculture, and accounts for approximately 20% of the area's economy. In 1990, approximately 3.6 million acre-feet of water were extracted from the Ogallala. Due to aquifer characteristics, the Ogallala receives only 1.5 million acre-feet of water in recharge. The steady decline of the aquifer's saturated thickness raises concerns about the long-term viability of the irrigation-based economy of western Kansas.

Even over the past decade there has been a significant increase in the number of irrigated acres in western Kansas (Figure 2). There can be little discussion as to whether or not reported irrigated acreage has increased. The increasing trend is statistically significant at the 90% level (*p-value* = 0.0689). The causes of increasing irrigated acreage is less clear; it appears to be coming from both an increase in the mean irrigated acreage per farm, as well as an increasing number of producers using their water rights. In so far as increasing reported irrigated acreage implies increasing water use from aquifer then the depletion rate of the aquifer maybe escalating.

Additionally, an increase in the acres of water intensive crops, such as corn, has been observed (Figure 3). In so far as increasing corn acreage implies increasing water use from aquifer, then the depletion rate of the aquifer maybe increasing.

Both increasing irrigated acreage and specifically acres of corn escalates the rate at which water is extracted from the Ogallala aquifer. On the other hand, a steady reduction in the per acre water use for all irrigated crops has been observed. Figure 4 illustrates that, on a per-acre basis, the rainfall adjusted, gross water usage, for corn, sorghum, and soybeans has steadily declined over the past decade. As an example, the gross water usage for corn has declined at an annual rate of approximately 1.2%. Although no empirical studies have analyzed each of the different causes of this trend, this efficiency gain likely has been the result of government regulation, intensive management, advances in technology, public awareness of the situation, and to an extent the lack of water availability and higher energy prices.

As Figure 5 illustrates, western Kansas has seen a shift to more efficient irrigation technology. The rapid adoption of these technology has led to significant economic benefits to production agriculture in western Kansas. It can hardly be argued that technology has not had significant positive impacts associated with reduced irrigation costs, enhanced water management, and improved yields. From the production agriculture standpoint, technological advancements will be applied to enhance producer profitability. It can hardly be argued that future advancements in technology will not have significant positive impacts on future profitability. On the other hand, the past trends in water consumption and crop mix suggest that efficiency gains might actually be accelerating water use and increasing the pace at which the aquifer is depleted. Evolving technologies such as LEPA and SDI will allow both the continued production and possible expansion of the acreage of water intensive crops. Technological advancements in energy sources will lower the cost of water and may potentially encourage producers to use more water. If society's goal is either to "conserve and extend" the life of the Ogallala aquifer, or achieve "sustainable yields" from the aquifer, then future technological advancements without policy/regulation, could have an adverse effect.

The combination of efficient technology and the shift to more water intensive and more profitable crops, such as corn enhance producer profitability. Figure 6 illustrates the temporal relationship between the average revenue generated by an inch of irrigation water used in the production process and the average cost of that inch of water. While both are increasing, the revenue has been increasing more rapidly than the cost of the irrigation water. This increasing profit potential associated with irrigation helps explain the increasing irrigated acreage illustrated in Figure 2.

From a production economic perspective, these trends likely are revealing that the market is efficiently allocating scarce resources. However, from society's perspective, this economic efficiency may be less important than sustainability. Regarding the Ogallala, the Kansas Water Plan focuses on long term sustainability through both mandated and voluntary incentive based regulations. The public policy debate over the sustainability of the aquifer is significant. Several policy alternatives have been suggested, including water taxes, mandatory reductions in current water allocations, voluntary water retirement programs, incentive programs aimed at reducing the planted acreage of water intensive crops, incentive programs aimed at increasing irrigation efficiency (center pivot end gun removal, installation of water meters, low energy precision application (LEPA), sub-surface drip irrigation (SDI), etc), and incentive programs aimed at temporarily converting irrigated land to dryland production.

Water Conservation Policy

The current State water policy calls for achieving an absolute reduction in water consumption from the Ogallala aquifer and slowing aquifer decline rates. At the same time, political forces require that the economic viability of irrigated agriculture in western Kansas be maintained, and if possible enhanced through policy implementation. As previously stated, in order to maintain the profitability of irrigated agriculture, technological innovations need to continually be developed through the research and development process and adopted by the agricultural community. The obvious and very difficult question is how to allow the process of technological development to continue while at the same time reducing water consumption from the Ogallala aquifer. The general consensus is that the solution will require policy alternatives that combine incentive based programs coupled with voluntary participation. However, mandated reductions are possible.

Cost Share Program

Since the 1982 High Plains Study, both research and policy have focused on improving irrigation efficiency as the primary means of extending the economic life of the Ogallala aquifer. One policy aimed at increasing irrigation efficiency is the current cost-share program administered by the Kansas State Conservation Commission (SCC). Under this program, irrigators within the Ogallala aquifer region of western Kansas are reimbursed a portion of the cost of adopting modern irrigation technologies. The majority of cost share funds have been expended on the adoption of 'low pressure with drops' technology (Figure 7).

Researchers at Kansas State University, at the request of the Kansas Water Office, recently completed an analysis of the SCC cost share program. The particular objective was to quantify the change in water use following the adoption of new technology for an average irrigator. This quantification made it possible to compute the reduction in the gross amount of water pumped per dollar of taxpayer expenditure on cost share programs. The study analyzed the water use of 7853 irrigators in western Kansas, including the 1067 producers that participated in the program. Results suggest that there is little to no annual reduction in gross water pumped from the aquifer, and in many cases water use increases as producers expanded irrigated acreage and shifted cropping practices to more water intensive crops. The study also suggested that the estimated cost efficiency of the SCC investments did not appear to compare favorably to an alternative policy such as a water right buyout program.[1]

Conservation Reserve Enhancement Program

The Conservation Reserve Enhancement Program (CREP) is a voluntary and incentive based program that allows owners of irrigated land in western Kansas to retire their irrigated acreage and receive program payments for that acreage. Researchers at Kansas State University, at the request of the Kansas Water Office, recently completed an economic analysis of the CREP program The purpose of this study was to report estimated potential regional economic impacts associated with implementation of the Conservation Research Enhancement Program (CREP) in a 10-county region comprising the Kansas Upper Arkansas River Basin. The stated policy objective was to emphasize conservation of the Ogallala Aquifer through the acquisition and retirement of water rights on 85,000 acres of irrigated

[1] The full report is available at www.agmanager.info/policy/default.asp .

crop land. The land would be enrolled for 15 years in the CREP program, wherein it would be planted to grass, followed by a return to dryland farming after CREP expiration.

The CREP economic analysis suggested that, in fact, the policy would reduce water consumption and extend the economic life of the aquifer. However, the policy had the unintended consequence of negatively impacting the local economies. The combined direct and indirect impacts to regional economic output were estimated to be an approximate reduction of $14.8 million annually.[2]

Unintended Consequences and Companion Policies

The States long term policy of encouraging the development of the Ogallala aquifer met the objective of accelerating the economic growth of western Kansas. Trends reflected in Figure 1 and Figure 2 currently generate in excess of $300 million in farm production and $380 million in value added agriculture. However the policy had the negative unintended consequence of over allocation of the water resource and rapid depletion of the aquifer. The recent cost share program resulted in producers efficiently using the water resource and generating financial benefits to the participant. However, the policy had the negative unintended consequence of expending taxpayer funds without an apparent reduction in gross groundwater pumped. The proposed CREP program may have resulted in a reduction in gross groundwater pumped but would, in all likelihood, have had the negative unintended consequence of prematurely diminishing local rural economic activity.

To ensure that water conservation policies achieve their intended goals, companion-policies could be coupled with any water conservation initiative (cost-share programs, CREP, etc.) implemented. These companion-policies could be incorporated either through rules and regulations within the initiative or through separate legislation. Examples of companion policies, which could have been incorporated with the cost share program might include: requiring enrolled producers to maintain their current crop mix; ensuring that only water-use allotments that are currently being used, rather than the entire allotment, are eligible for the conservation program; limiting total irrigation water-use to at or below the total amount used in the participating areas.

Conclusion

The implementation of an efficient and effective water conservation strategy for the Ogallala aquifer is a complex problem. Policy makers, researchers, and stakeholders must weigh the potential water savings that may be generated from a particular water conservation scheme against the implementation costs and potential impacts on the regional economy. Failure to understand and account for all the relevant factors can lead to the development and implementation of water conservation strategies that may not achieve the goals and/or have unintended impacts on the aquifer and stakeholders.

In order to avoid the potential unintended consequences of water conservation policies, policy makers, researchers, and stakeholders must thoroughly *think-through* the goals and objectives of both the policy and participants, project unintended consequences, and describe any companion-policies that may be necessary to insure program success.

Attached, is a short survey which will be used to evaluate water conservation strategies and focus research on likely solutions. Your participation in helping us *think-through* the issues will be greatly appreciated.

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[2] The full report is available at www.agmanager.info/policy/default.asp

Figures

Figure 1. Historic Irrigated Acres in Kansas

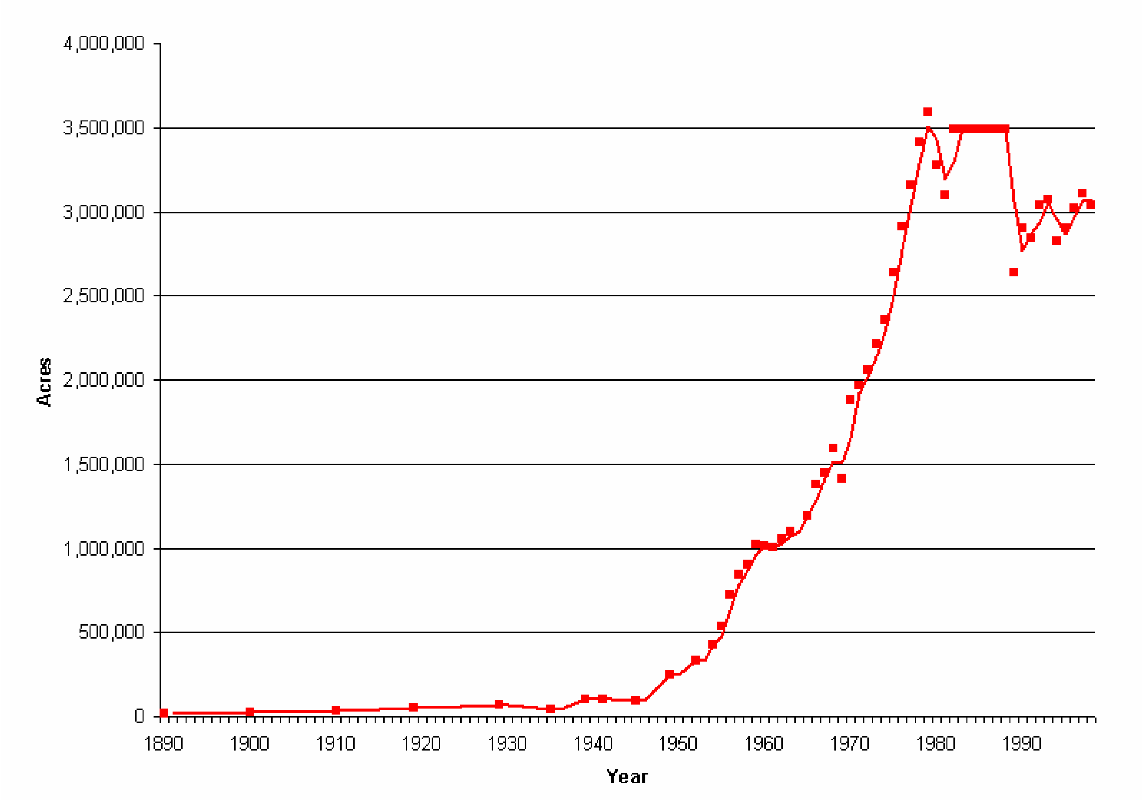


Figure 2. Current Irrigated Acre Expansion in Western Kansas

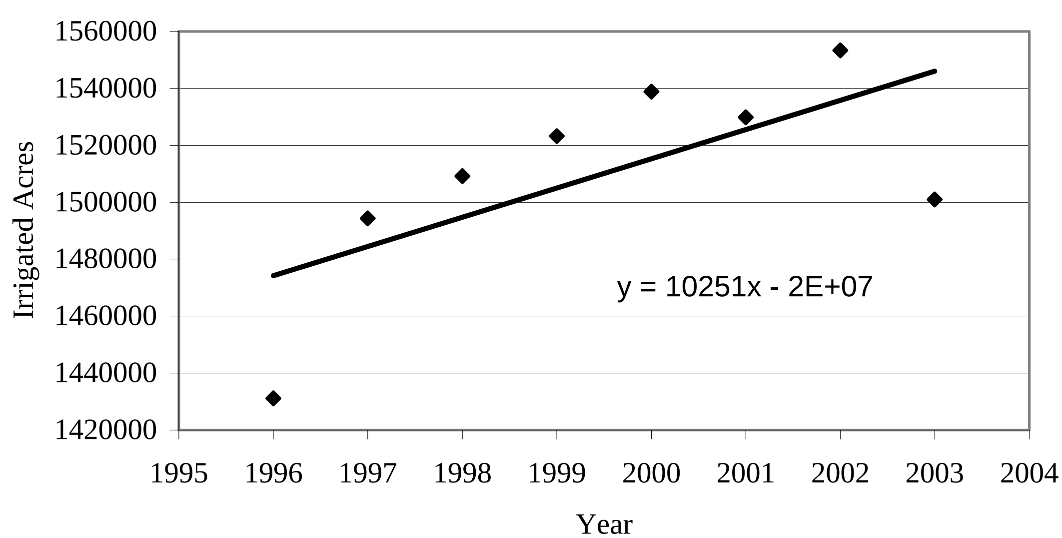


Figure 3. Current Irrigated Crop Mix in Western Kansa

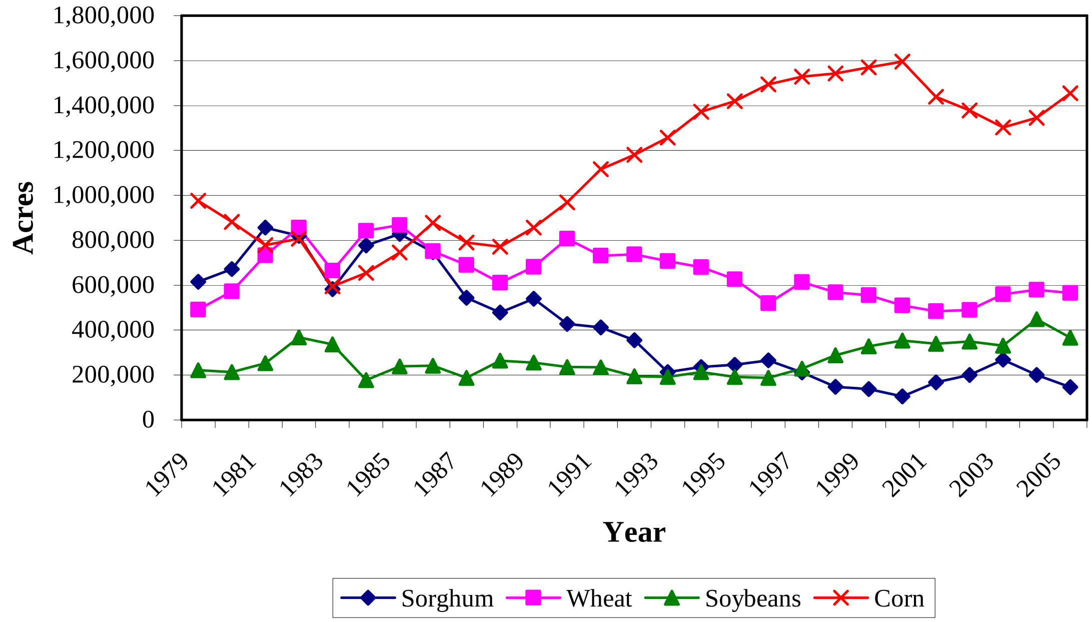
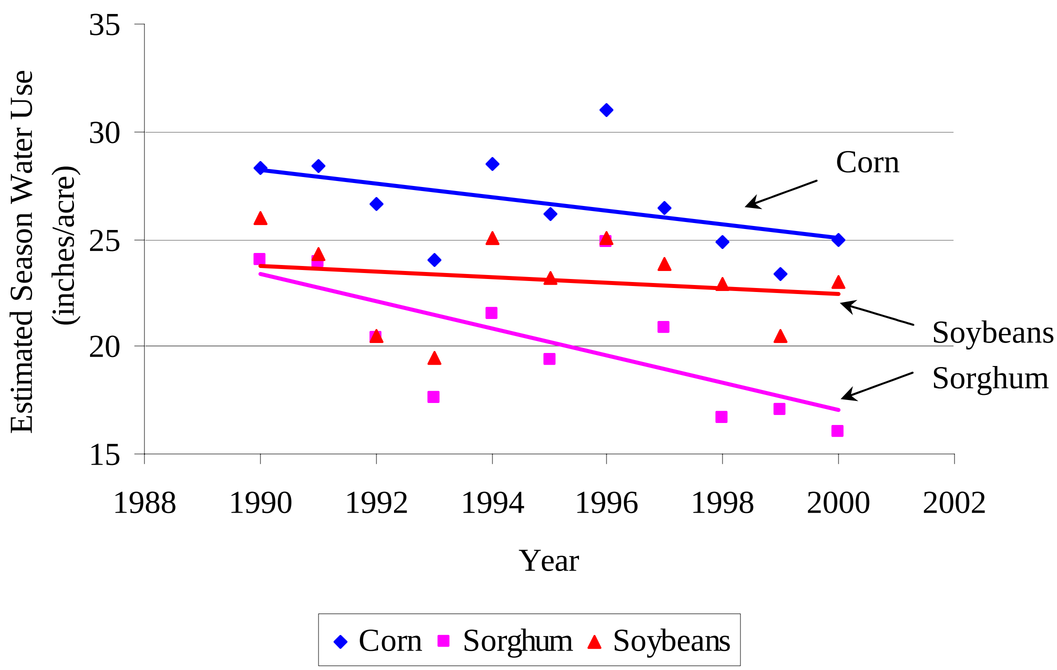


Figure 4. Season Water Use for Select Crops in GMD#3.



Source: Kansas Water Office and Kansas Weather Library.

Figure 5. Technology Adoption in Western Kansas.

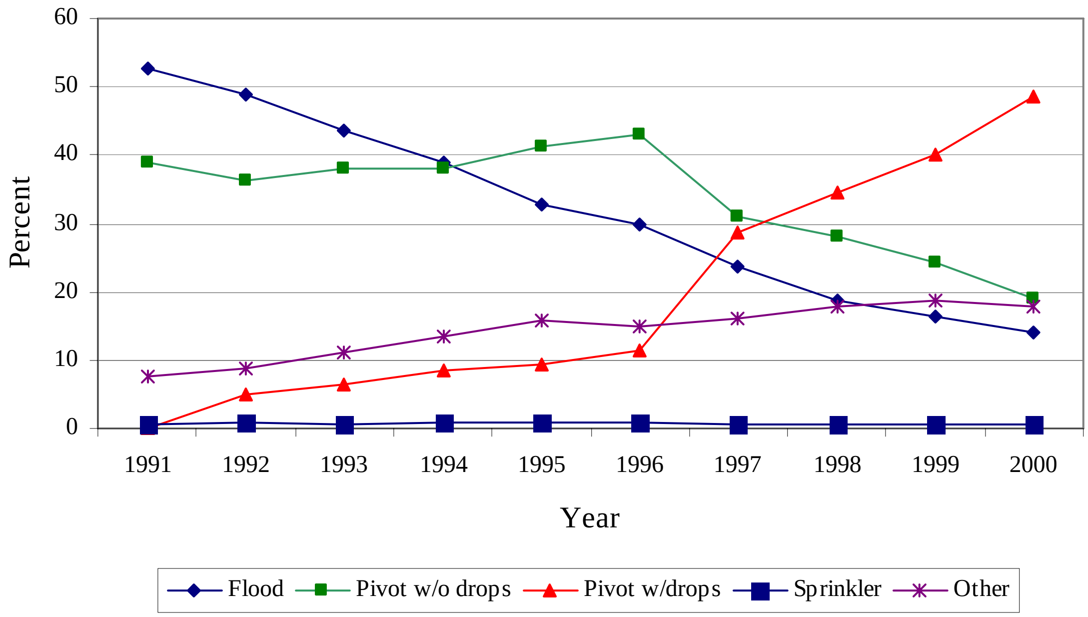


Figure 6. Approximate Average Revenue and Average Cost Associated with an Acre- Inch of Irrigation Water used on Corn, in Thomas County.

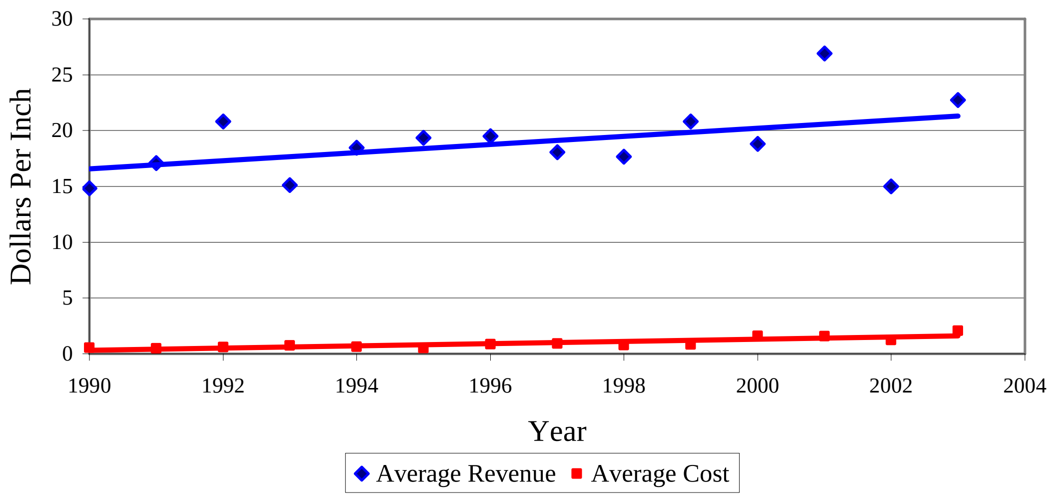


Figure 7. A Low Pressure Center Pivot System with Drop Nozzles

Dear Risk & Profit Conference Participant:

The development and implementation of an effective agricultural water management policy is critical to maintaining and/or improving the economies of communities in the western Kansas. Several studies are being conducted to evaluate the potential impacts of alternative water conservation policies on the Ogallala aquifer. These policies could be currently in place or just being considered for implementation. The objective of these studies is to provide policy makers and other interested individuals with the estimated impacts of alternative water conservation policies with respect to water savings, implementation costs, producer income and the regional economy (economic activity, employment and income). Hopefully, this will be valuable information for policy makers in the design of an optimal water conservation strategy that may contain one or more of the policies evaluated.

We need your help to insure we are selecting the most relevant policies for evaluation. Attached is a brief survey we would like for you to complete. It should only take about five minutes to complete the survey. Participation is voluntary and all individual responses will remain confidential. Information we collect will only be reported in summary form. If you have any questions at all, please feel free to contact me (phone: 254-968-8010; email: bgolden@ksu.edu) or Rick Scheidt (Institutional Review Board, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506; phone: 785-532-3224; email: rscheidt@ksu.edu).

Thank you for your help in this effort.

Sincerely yours,

Bill Golden
Research Economist

Water Conservation Policy Survey

Thank you for filling out the following survey so that we might better recognize the most important water conservation policies to evaluate for the state of Kansas. Your participation in this survey effort is essential to the future of the Ogallala Aquifer and is greatly appreciated.

1. Age _____ 2. Sex: Male____ Female____

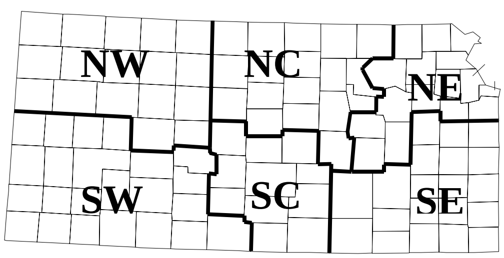
3. Years of formal education _____ **(12=high school graduate, 16=college graduate, etc.**)

4. Years of experience in current profession (since the age of 18) _____

5. My primary occupation is :**(please check only ONE)**

A. ____Farming/Ranching
B. ____Banking/Lending
C. ____Education/Extension
D. ____Agribusiness (e.g., elevator manager, farm supplier, etc.)
E. ____Other:_____________________

6. The district in which your primary business activities lies within **(place an X in your district)**



if not Kansas, which state?

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From the following list of potential water conservation policies, please pick your <u>TOP FIVE</u> and rank in order of preference: (1 - Most Preferred, 5 - Least Preferred)

☐	**Water use restriction**	A mandatory annual or multi-year limit that reduces the amount of water pumped.
	Drawdown restriction	A mandatory restriction on the reduction in saturated thickness over a specified period of time.
	Water use fee	A mandatory per unit tax on the amount of water pumped ($/acre-foot).
	Energy tax	A mandatory per unit tax on the amount of energy (electricity, natural gas, propane, diesel) used to pump groundwater for irrigation ($/unit).
	Convert to dryland – temporary (water CREP)	A voluntary incentive-based program that compensates landowners to temporarily (10 years) convert irrigated cropland to dryland.
	Convert to dryland – permanent (water right buyout)	A voluntary incentive-based program that compensates landowners to permanently convert irrigated cropland to dryland.
	Technology adoption	A voluntary incentive-based program that encourages landowners to adopt more water-efficient irrigation technology.
	Irrigation scheduling	A voluntary incentive-based program that encourages landowners to adopt irrigation scheduling.
	Conservation tillage practices	A voluntary incentive-based program that encourages landowners to adopt conservation tillage practices.
	Biotechnology	A voluntary incentive-based program that encourages landowners to adopt more water-efficient crop varieties.
	Compensated water use restriction	A voluntary incentive-based program that compensates landowners to permanently reduce water use by a specified amount.
	Precipitation Enhancement	A state/local district funded program for rainfall enhancement.
	Do Nothing	Let our free market economy determine the level of future water use.
	Other: Please list any other potential water policies you would like to see evaluated. ______________________________ ______________________________	