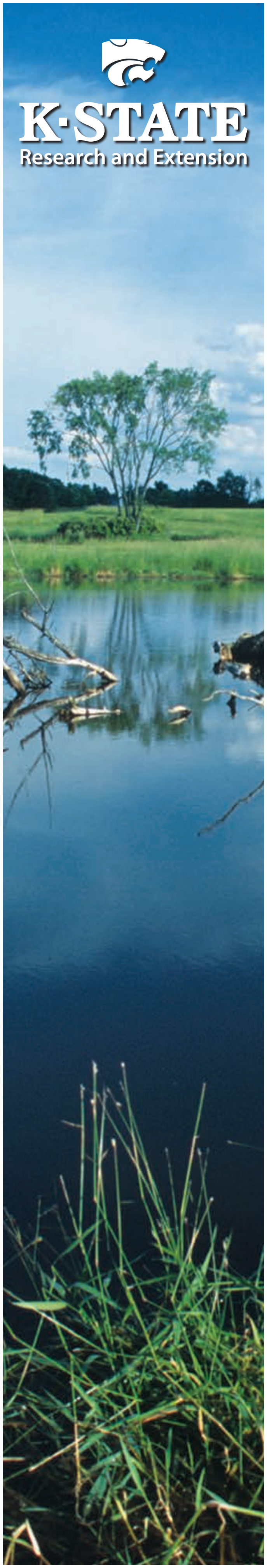

Water Primer: Part 8

Irrigation Water

The earliest known irrigation in Kansas began around 1650 in a Taos Indian village in what is now Scott County State Park. The "modern" era of irrigation, however, began in the 1880s with the organization of irrigation ditch companies that built diversion works and a canal system along the Arkansas River (Erhart, 1969). Following World War II, Kansas irrigation rapidly expanded, as shown in Figure 1. Political/societal will, technology, and readily available energy all helped contribute to the swift increase in irrigated acreage. The 1945 Water Appropriation Act, which provides the basis of Kansas water law today, was designed to encourage development of water resources. With improvements in irrigation well-drilling and pumping equipment and the development of the Hugoton natural gas well field, irrigation acreage increased rapidly, using groundwater initially from the Ogallala aquifer and eventually from across the entire High Plains Aquifer.

The enactment of the Water Appropriation Act (see *Water Primer Part 5: Water Law*, MF3024) may indicate that water resources development in Kansas has occurred systematically, but this is not the case. The Act was initially intended to encourage resource development rather than control. Until 1978 the use of a water source without a permit was not illegal if the developer was not interested in establishing a water right. Consequently, much of the groundwater system became overdeveloped, and groundwater depletion, especially in western Kansas, became a problem by the late 1960s. In 1972, lawmakers passed the Groundwater Management District (GMD) Act, allowing local decision makers to deal with the unique

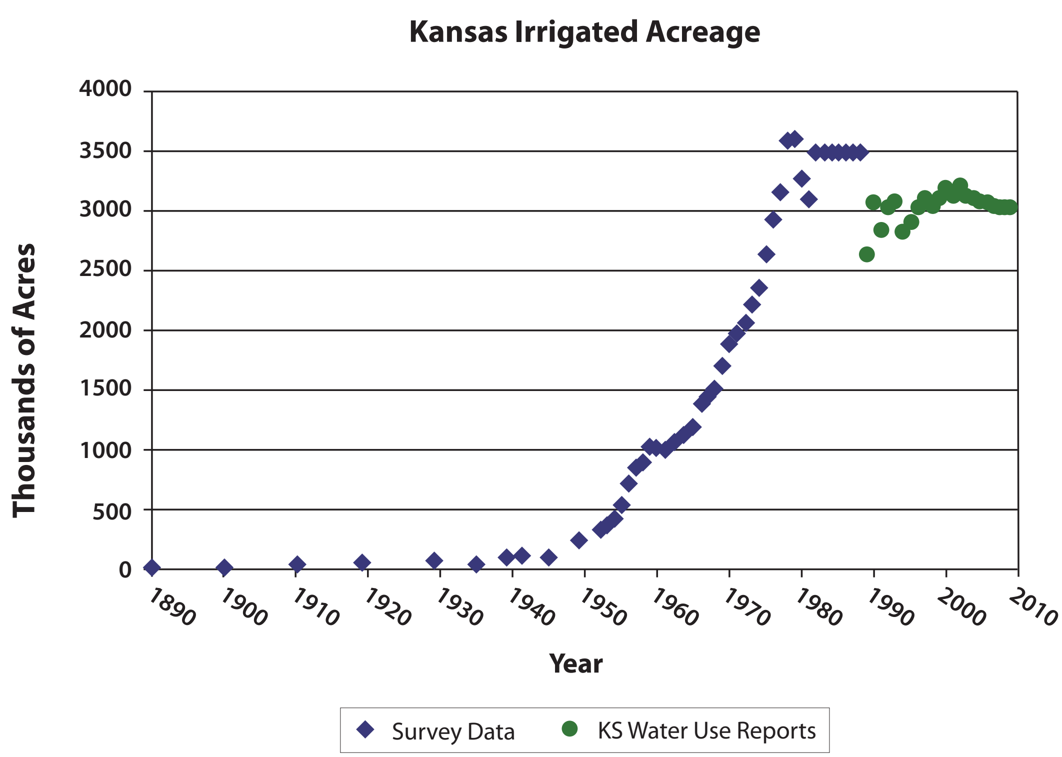

Figure 1: Irrigated acreage trends for Kansas. Early estimates are based on various surveys. Since 1989, the irrigated acreage numbers are based on the annual water-use reported by irrigators to the Kansas Department of Agriculture.

groundwater depletion or quality problems for their area of the state.

Irrigation accounts for 85 percent of water use in Kansas, which is higher compared to U.S. (37 percent) and global (70 percent) water use. Approximately 3 million of the 21 million cropland acres in Kansas are irrigated primarily from groundwater sources.

Irrigated acres and water use is concentrated in the western one-third of the state, particularly in the southwest region of Kansas, as depicted in Figures 3 and 4. Specifically, the source of water for western Kansas is the Ogallala Aquifer, and the source of irrigation water

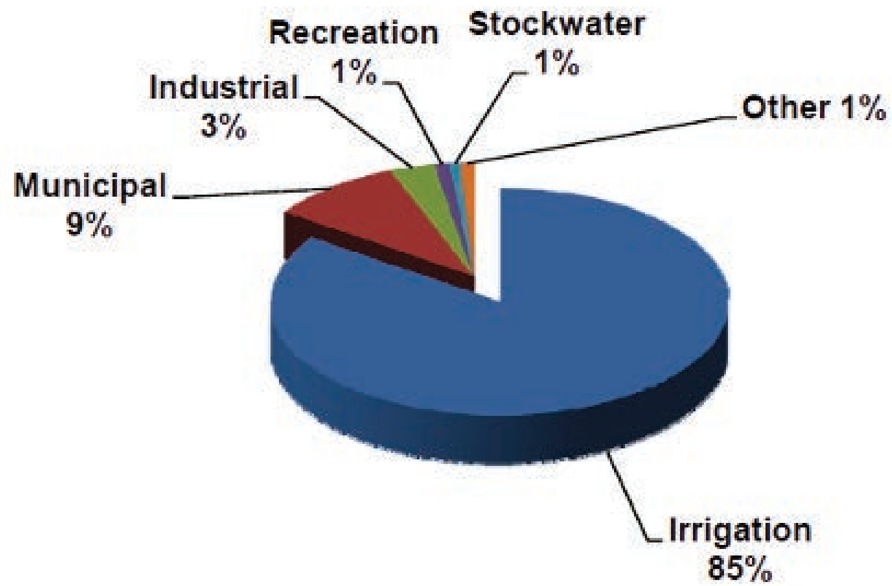

Figure 2: Average water use by type for Kansas from 1990-2008 (KDA, DWR).

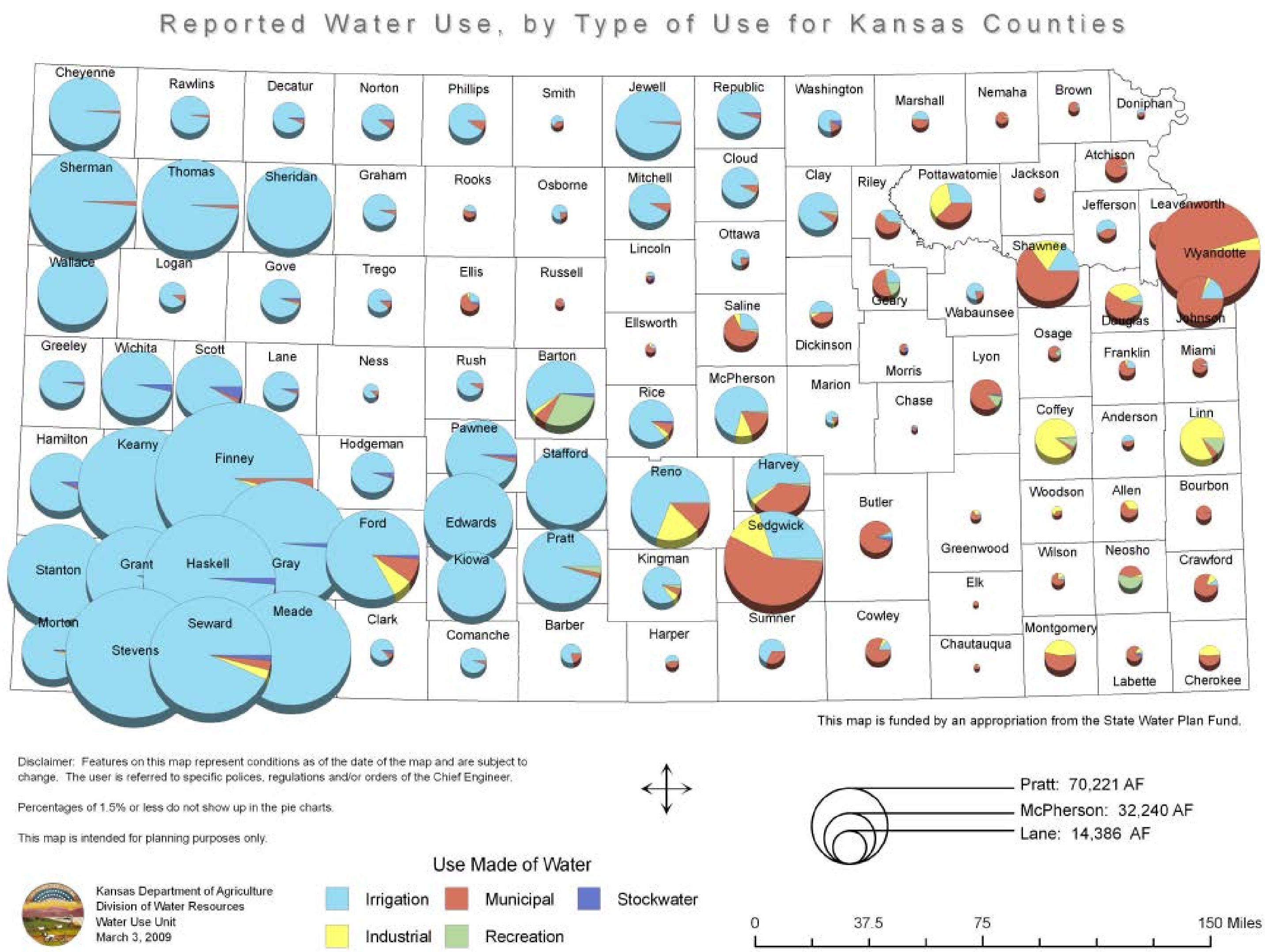

Figure 3: Distribution of water use types and volumes in Kansas (KDA, DWR).

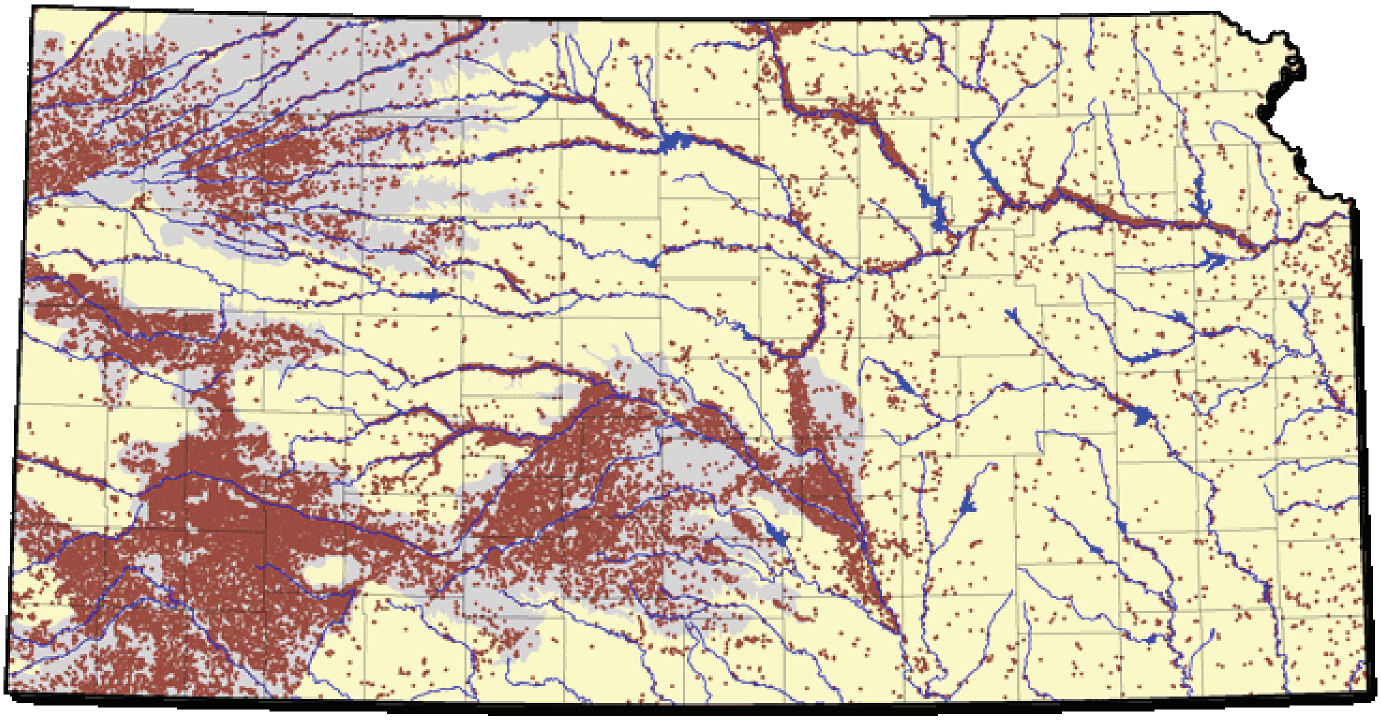

Figure 4: Distribution of Kansas points of diversion (KDA, DWR).

for south central Kansas is the Big Bend Prairie and the Equus Beds aquifers, collectively knows as the High Plains Aquifer.

Irrigation Water Diversion Trends

The distribution of water points of diversion are shown in Figure 4. Some of these points of diversion are from surface water sources and are for all types of water use. The total yearly amount of irrigation water diverted in Kansas is shown in Figure 5. A regression line through the reported pumping amount indicates a reduction in the total amount of water over the years, although the precipitation amount during a given year also influences the annual diversion. Note the increase in pumping amount in 2011, which was an extreme drought year across much of southern Kansas.

In general terms, the 1990s were relatively wet years, while the 2000s were relatively dry. The year 1993 had some of the highest rainfall

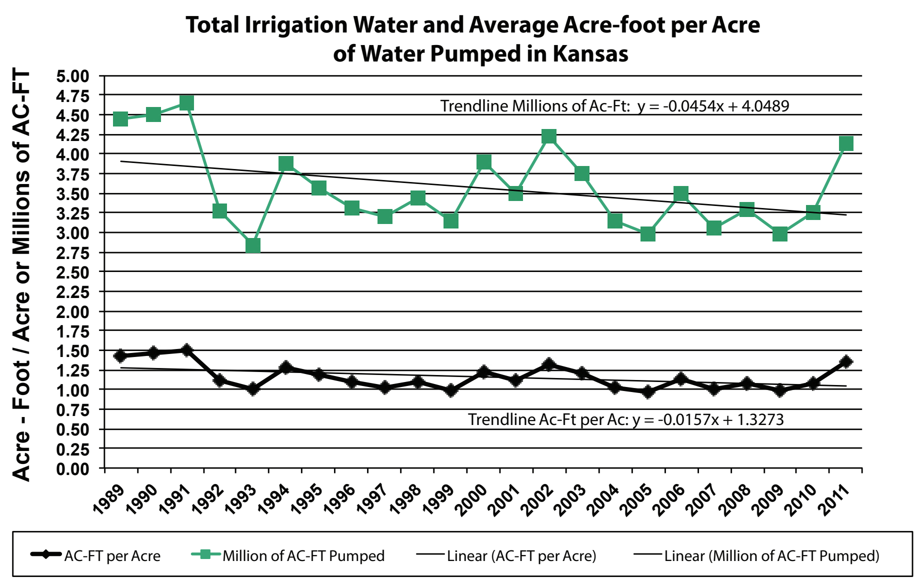

Figure 5: Total irrigation water and average ac-ft/ac water pumped for Kansas

totals on record, while 2002 and 2011 were very dry, accounting for the corresponding valley and peak in water use, respectively.

In 1978, about 30 percent of irrigated land was under center pivot irrigation. Center pivot technology allowed development of fields with sandy soils and rolling topography. However, center pivots were soon used to replace flood irrigation. Rapid conversion began in the early 1980s, changing from roughly 50 percent center pivot irrigated to more than 90 percent being irrigated by center pivots. A center pivot system generally has higher irrigation efficiency than a flood system and is less labor intensive.

Other factors have contributed to reduction in pumping over time, such as the continuing decline of water table levels and a subsequent decrease in well yield. Tillage practices have also shifted to reduced and no-till systems. Reduced tillage decreases soil water losses that are caused by soil disturbance, enhances precipitation capture, and reduces early season soil evaporation losses. The adoption of improved irrigation management practices, such as irrigation scheduling, and the increase of irrigation pumping costs also play a role in reducing application depths.

Economic Impact of Irrigation

The economic impact of irrigated agriculture is significant. Approximately 30 percent of crop value is produced on irrigated land, and 15 percent of the harvested crop acres are irrigated annually (Figure 6). The importance of irrigated agriculture increases in western Kansas, not only in terms of crop value produced but also the value it adds to the Kansas livestock industry. Industry to support irrigated agriculture and similar industries provide substantial support to the economy of the irrigated region.

The economic impact is concentrated in western Kansas, where approximately 60 percent of the crop value is produced on about 30 percent of the harvested cropland acres. In heavily irrigated areas, such as Haskell County, as much as 75 percent of the harvested cropland acres may be irrigated and represent more than 95 percent of the crop value produced.

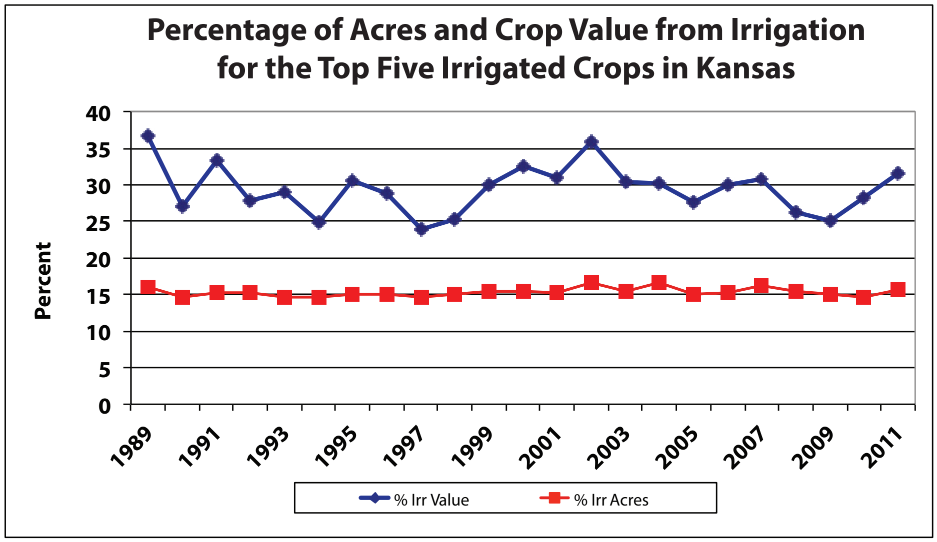

Figure 6: Percentage of cropland irrigated and value of irrigated crops produced in Kansas.

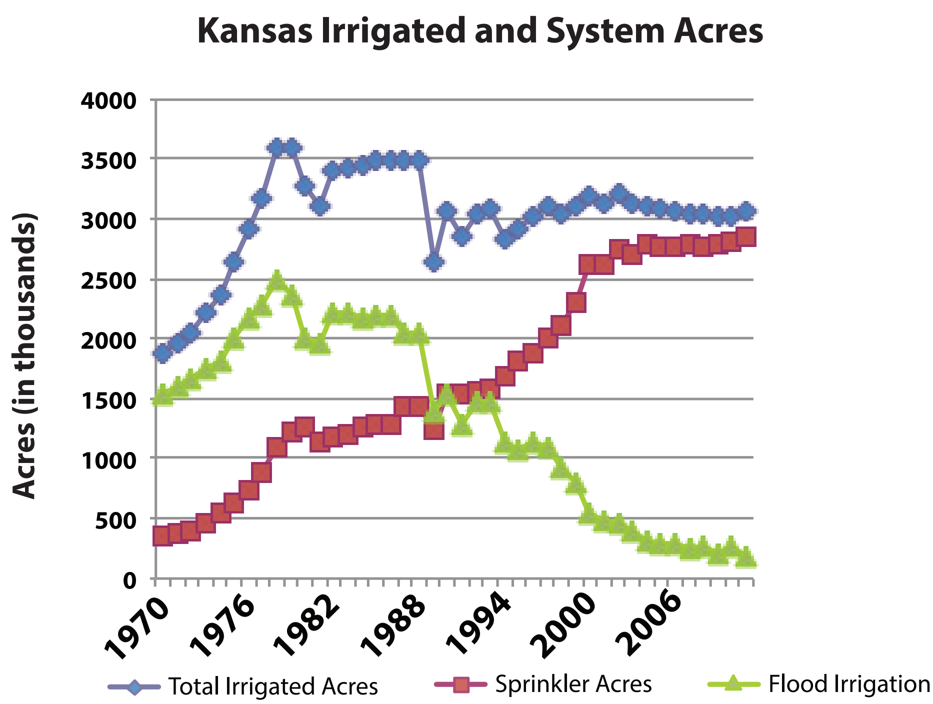

Figure 7: Sprinkler, flood, and total irrigated acres in Kansas.

System Type Acreage Trends

Over time, irrigation systems have changed from predominately surface flood irrigation to sprinkler irrigation, and now to center pivot irrigation systems (Figure 7). In 1970, approximately 18 percent of 1.8 million irrigated acres were sprinkler irrigated. A gradual adoption of center pivot irrigation occurred during the 1970s, with an increase of nearly 1 million additional irrigated acres by center pivots. In 1990, about half of all acres were center pivot irrigated. Since then, the total irrigated acreage base has remained relatively stable, but center pivot irrigation now accounts for more than 90 percent of all irrigated land. Since the first generation of center pivot irrigation, there have been several modifications and improvements of this system, leading to more efficient and robust systems with wider application. Newer center pivot irrigation systems feature variable rate application, integration of remote processing and automation, and tolerance for low-quality water.

Acres irrigated by subsurface drip irrigation (SDI) systems are shown in Figure 8. SDI is an adaptation of micro-irrigation technology for field crop irrigation and consists of permanently installed, below-ground plastic tubes that slowly discharge water into the root zone of a crop through emitters. SDI has been used for field crops in Kansas for more than 25 years and has proven to be a viable system option. Though extremely water efficient, SDI systems have a high initial cost and represent less than 1 percent of the Kansas irrigation base. SDI was not reported as a separate irrigation system type until 2004, so early SDI acreage estimates were based on contractor surveys. Recent data is based on the reported acres from annual water-use reports.

Crop Acreage Trends

Corn production represents about half of all irrigated acres in Kansas. Acreage for irrigated corn set a new peak of 1.78 million acres in 2011, eclipsing the previous peak of 1.70 million acres in 1999. There are approximately 3.1 million irrigated acres for the state (Figure 9). Corn acres declined during the drought and low crop-price years of the early 2000s but rebounded in 2005.

Crop Yields

Crop production requires significant amounts of water. A grass lawn alone can use (transpire) thousands of gallons of water per day. Water is applied to a crop for a variety of reasons, but the most common is to improve crop yield. Table 1 outlines an irrigation study conducted in Scandia, Kan. The average yield improvement for the study was 116 bu/ac. In 1991, a single irrigation at a critical growth stage (tassel) prevented a yield failure with a 121 bu/ac yield increase over dryland production.

The four major grain crops grown in Kansas have increased in yield for corn, soybean, grain sorghum, and wheat for dryland and irrigation production systems. The Kansas corn yield trend has increased most dramatically for both irrigated and dryland production, as shown in Fig-

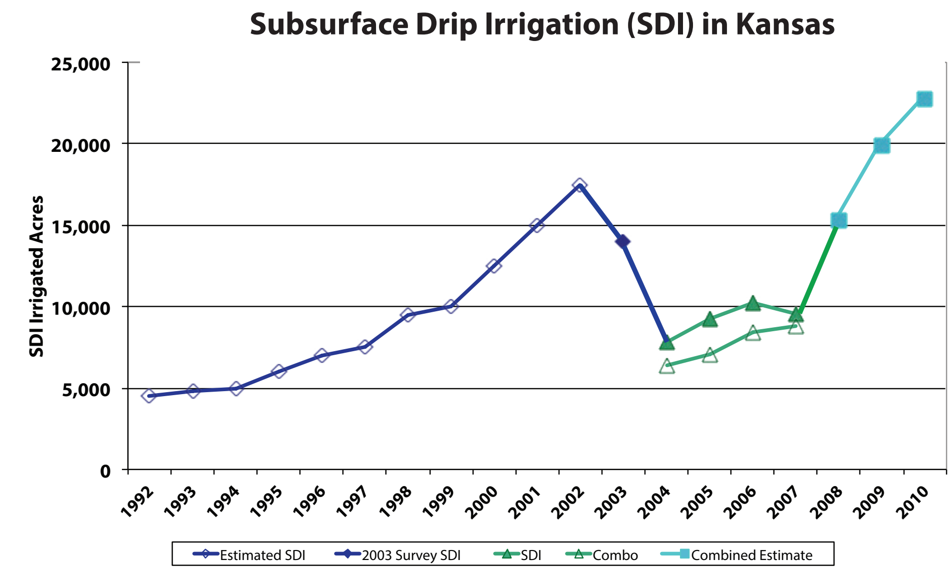

Figure 8: Subsurface drip irrigation (SDI) acres in Kansas.

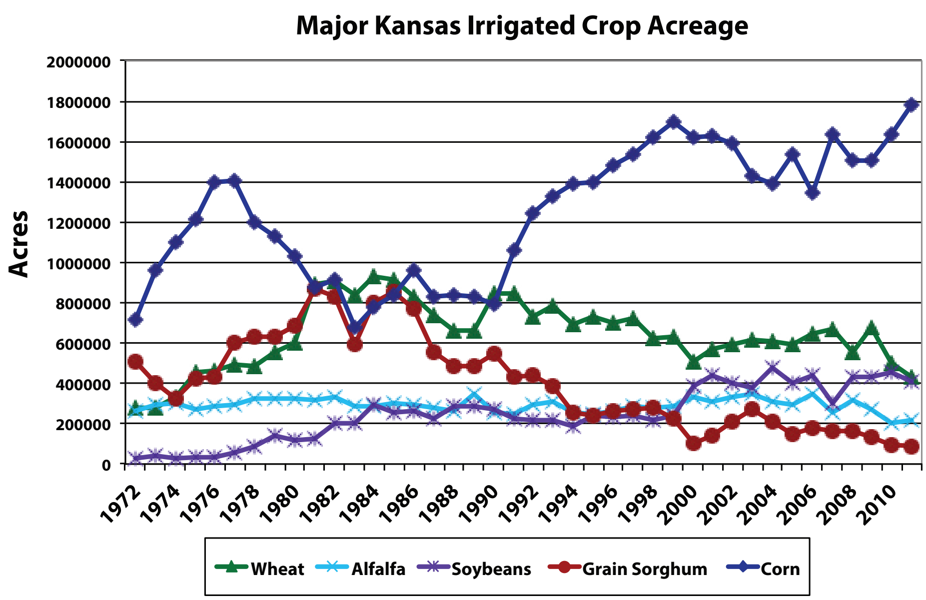

Figure 9: Major irrigated crop acreage trends in Kansas.

Table 1: Effects of Irrigation on Corn Yield, Scandia Experiment Field, Kansas State University.

Treatment	1991 Yield Bu/ac	1980-1991 Yield Bu/ac
No Irrigation	3	56
Irrigation at tassel	124	141
Scheduled Irrigation*	159	172
* Based on 65 percent root zone soil water depletion		

ure 10. Irrigated corn yield showed improvements of approximately 2.5 bushels per acre for the recorded period, which is more than twice the dryland rate of 0.9 bushels per acre. The average irrigated yield increase for soybean, grain sorghum, and wheat are 0.59 bu/ac, 0.60 bu/ac, and 0.31 bu/ac, respectively. Yields for irrigated crops have been increasing faster than yields for dryland crops.

Irrigation Water Use Efficiency

Irrigation water use efficiency (IWUE), or crop water productivity, is the yield of a crop divided by the amount of irrigation water applied. Because yield has increased over time and the average application depth has been reduced, IWUE has been increasing. Southwest Kansas yield, irrigation application, and IWUE for corn are shown in Figure 11. Despite the high year-to-year variability, it could be observed that IWUE has increased over the period of record by a value of 0.20 bushels per inch per year.

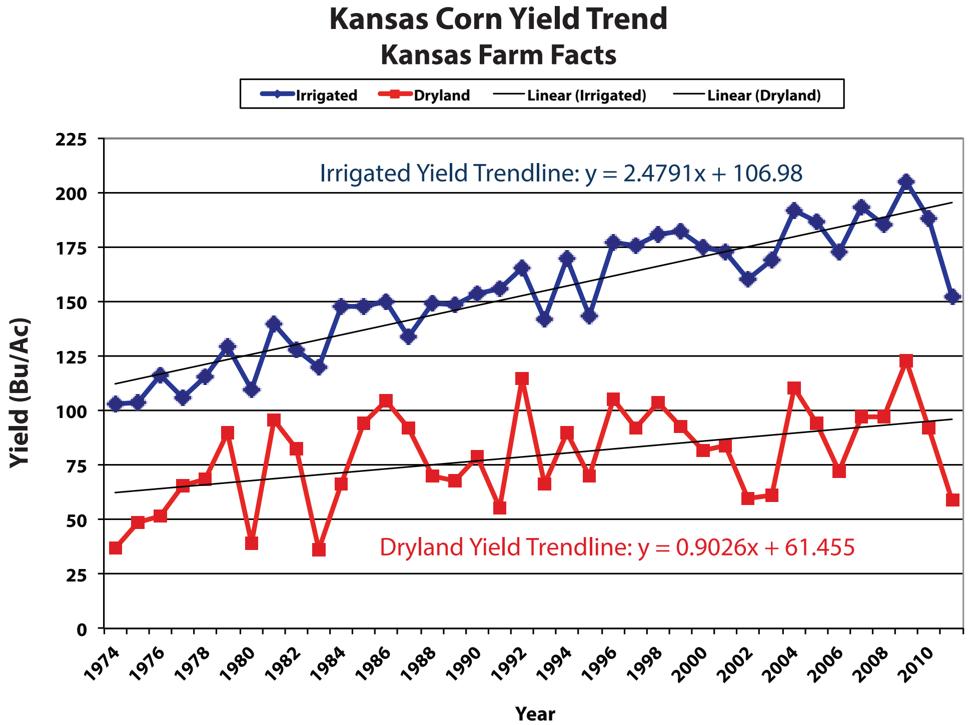

Figure 10: Irrigation and dryland corn yield trends in Kansas.

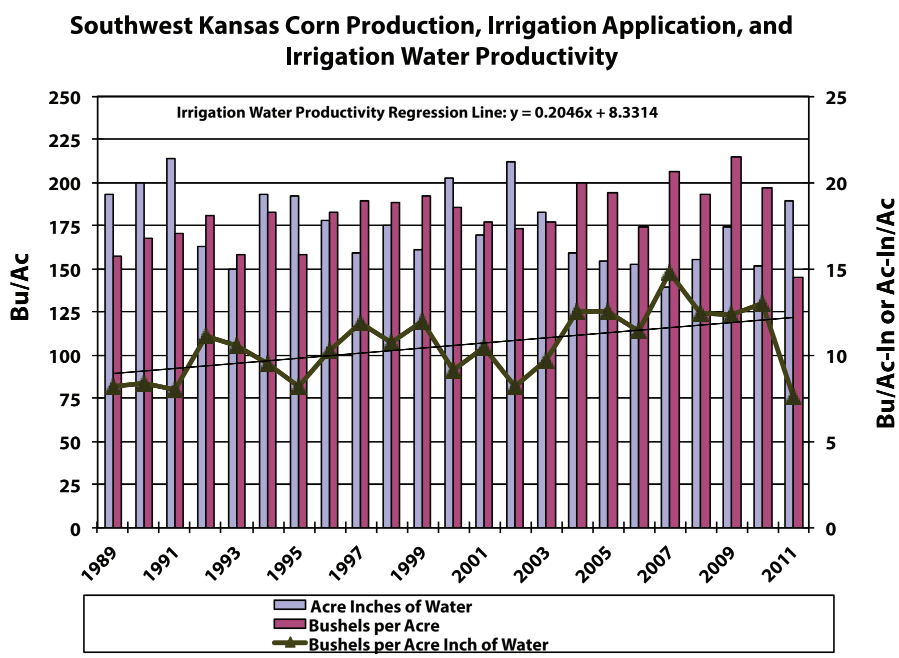

Figure 11: Corn yield, irrigation water application depth, and crop water productivity trends for Southwest Kansas

Summary

Kansas irrigated agriculture is an important contributor to the Kansas economy and is the single largest user of water. Total water diversions for irrigation are decreasing. Reasons include the shift from flood irrigation systems to center pivot and subsurface drip irrigation systems. Reduced application depths can be associated with improved irrigation management and cultural practices that are more easily adapted to sprinkler and SDI irrigated fields.

Another factor associated with decreased irrigation water application depths is the loss of well pumping capacity mainly due to declining water level in the Ogallala Aquifer, the primary water source for irrigation in western Kansas. Despite this fall, crop yield has been increasing because of improvements in crop hybrids and varieties that are better adapted to local growing conditions. More efficient irrigation systems and management also appear to be offsetting productivity losses associated with diminished well capacities in many areas.

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