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KANSAS IRRIGATION TRENDS

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INTRODUCTION

Initial irrigation practices in Kansas emerged around 1650 in a Taos Indian village in what is currently the Scott County State Park. The “modern” era of irrigation began in the 1880’s with the organization of irrigation ditch companies which built diversion works and canal systems along the Ark River (Erhart, 1969). Following World War II, Kansas irrigation rapidly expanded due to political/societal will, technology and readily available energy (Figure 1). The1945 Water Appropriation Act, which provides the basis of current Kansas water law, was designed to encourage the development of water resources. The development of the Hugoton natural gas well field and improved irrigation well drilling and pumping equipment following WWII contributed to the rapid increase in the irrigated area of Kansas, particularly over the Ogallala Aquifer.

IRRIGATION TRENDS

Irrigation System Type

Irrigation system types have evolved from primarily surface flood irrigation to predominately sprinkler irrigation (Figure 2). In 1970, approximately 18 percent of the 1.8 million irrigated acres were sprinkler irrigated. In 1989, there was a change in the water use reporting procedures (i.e., change from total authorized area to the actual area being irrigated within the given year) and this is responsible for the abrupt change in total irrigated area in that year.

The rapid increase of an irrigated land area (approximately 1 million acres) during the 1970's was a result of the adoption of center pivot irrigation. By 1990, approximately 50% of the total area used center pivot sprinkler irrigation and that percentage has increased to nearly 92% today, though the total irrigated area has remained relatively stable at approximately 3 million acres.

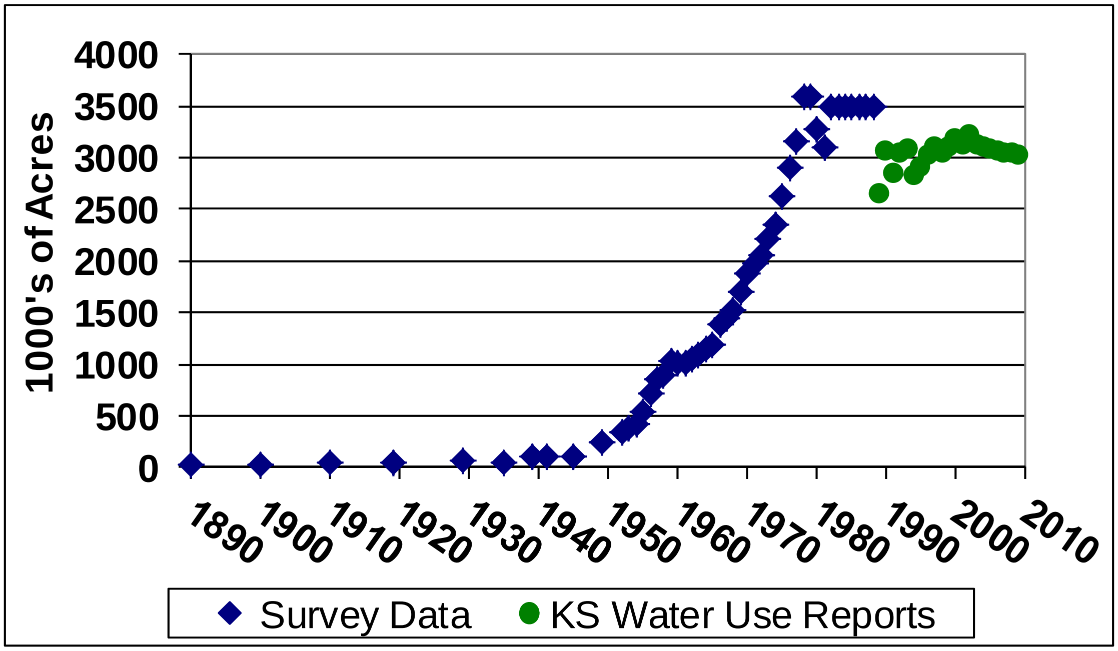

Figure 1. Progression of irrigated land area through time for Kansas. Early estimates are based on various surveys. Since 1989, the actual irrigated land area has been reported on annual water use reports submitted to the Kansas Department of Agriculture.

In 1989, subsurface drip irrigation (SDI) research plots were developed at the Northwest Research and Extension Center of K-State in Colby, Kansas (Lamm and Trooien, 2003). Surveys for SDI systems began in 1992 with an initial estimate of the existing systems of approximately 5,000 acres (Figure 3) and small, steady increases for each year thereafter. Concerns with the accuracy of these estimates led to a review of the annual water use reports in 2003, resulting in SDI estimates of just over 14,000 acres. In 2004, the DWR/KWO Annual Water Use Report began reporting SDI land area and systems combining multiple irrigation system types (i.e., in this case, SDI systems and another system type). A typical example would be SDI being used in the corners of a field irrigated with center pivot sprinkler system. In 2008 and 2009, SDI data include both SDI and SDI combo acres. SDI systems continue to be installed in Kansas but still represent less than 1 percent of the total irrigated land area.

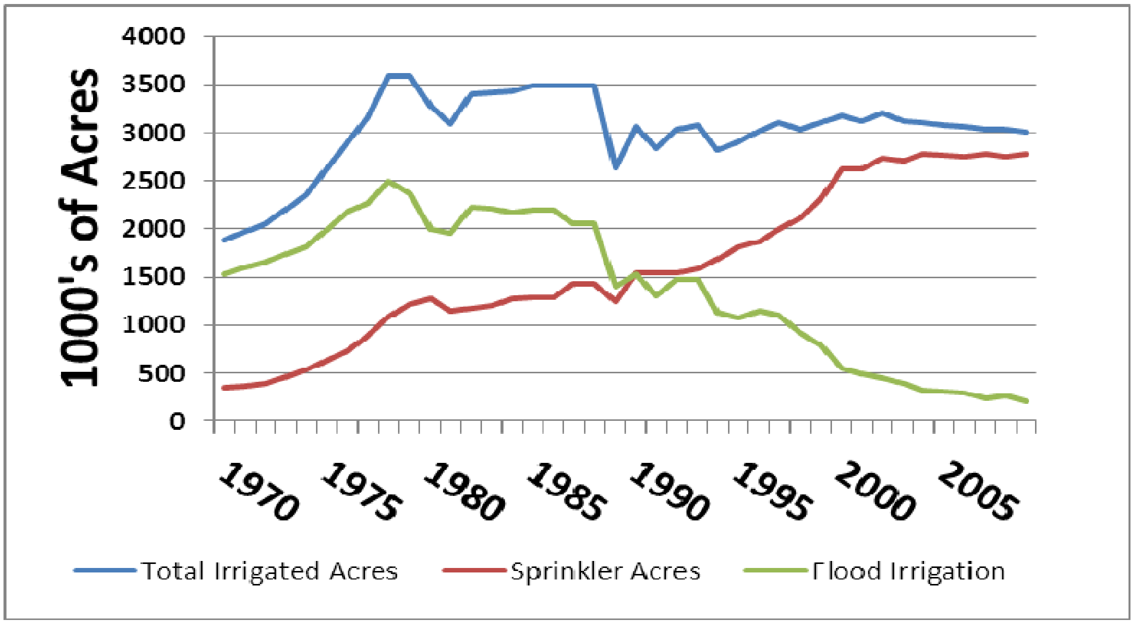

Figure 2. Progression of total irrigated land area, sprinkler systems, and flood Irrigation system Kansas.

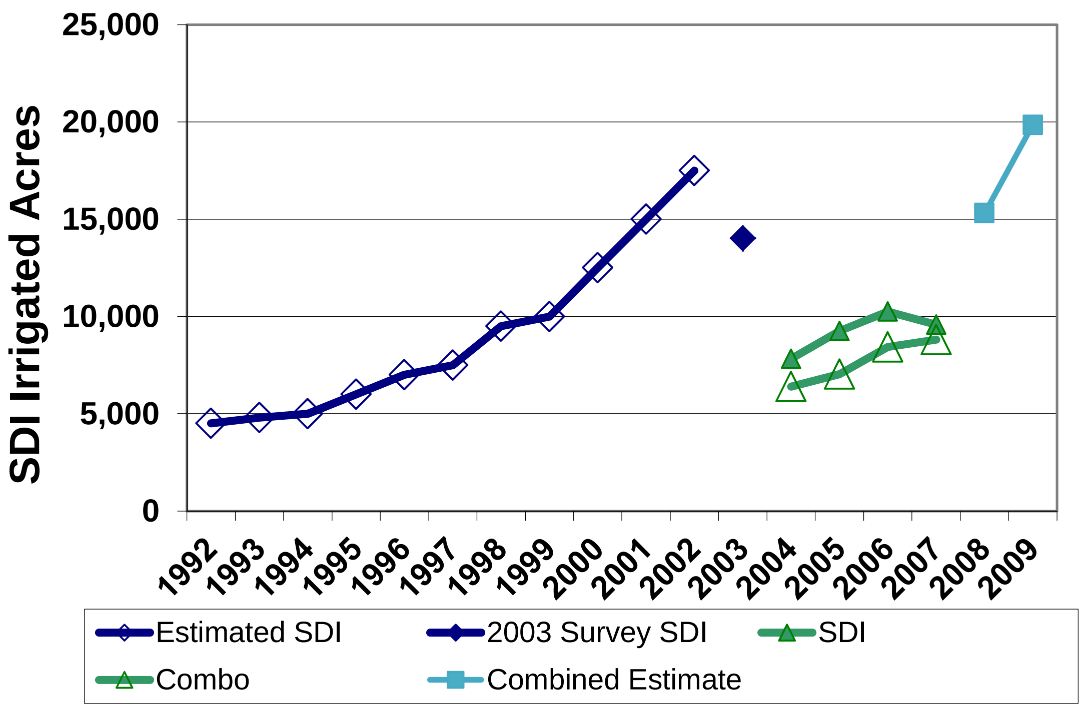

Figure 3. Increase in subsurface drip irrigation systems in Kansas. The abrupt changes in SDI area are due to survey and reporting methods and not due to abandonment of SDI systems. SDI has been increasing steadily in Kansas.

Irrigated Crops

Corn is currently produced on nearly 50% of the irrigated land in Kansas (Figure 4) with a peak land area of about 1.7 million acres in 1999 (Note: data beyond 2008 is not yet available). The area in corn production trended downward during the droughty and low crop price years of the early 2000's, but has rebounded beginning in 2005.

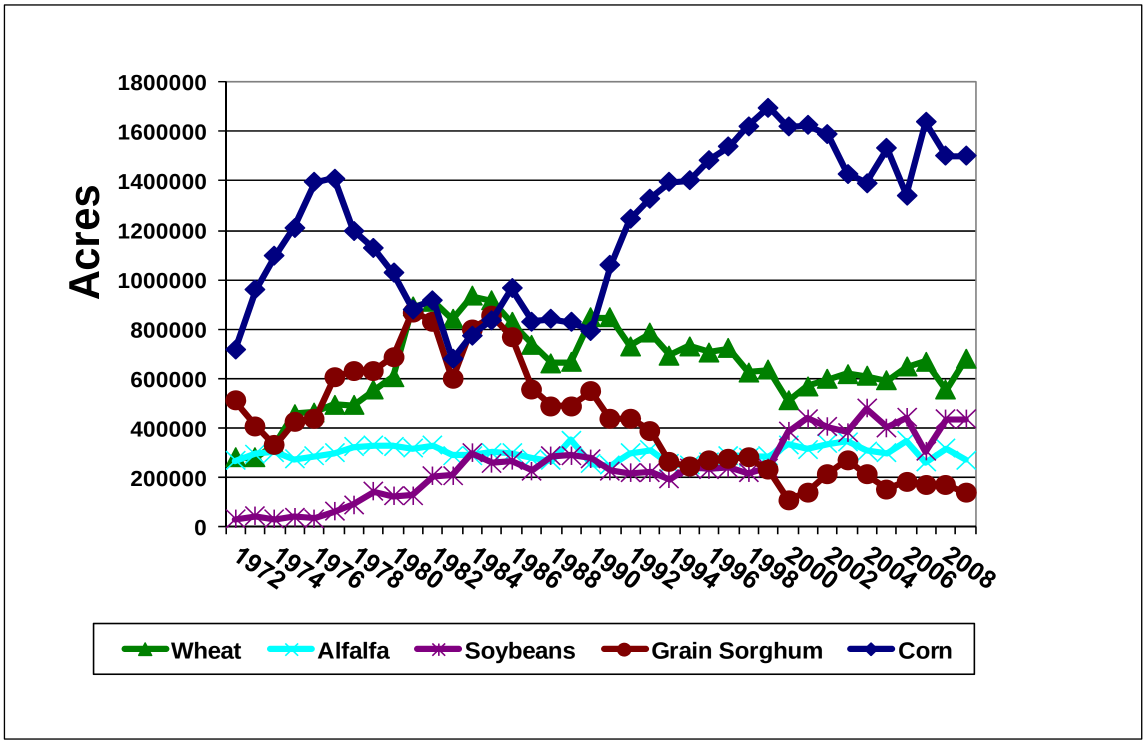

Figure 4. Irrigated area devoted to the five major irrigated crops in Kansas.

Irrigation Water Use

The total amount of annual water diversions and also the amount of water pumped on a given land area has decreased over time (Figure 5) although there are annual fluctuations caused by differences in precipitation and crop water use needs. For example, the 1990's were relatively wet years, while the early 2000's were extremely dry. Crop year 1993 was one of the highest rainfall years on record, while 2002 was one of the lowest and this is reflected in the corresponding valley and peak in water use, respectively (Note: Drought year 2011 data is not available at this time). Part of the rationale for the decrease in water use may be more accurate reporting, but the conversion of flood irrigated land to center pivot sprinklers was also rapid during this time period, changing from roughly 50 percent to 90 percent center pivot sprinkler irrigated land. When appropriately managed, center pivot sprinkler systems typically have greater application efficiency than surface flood irrigation systems.

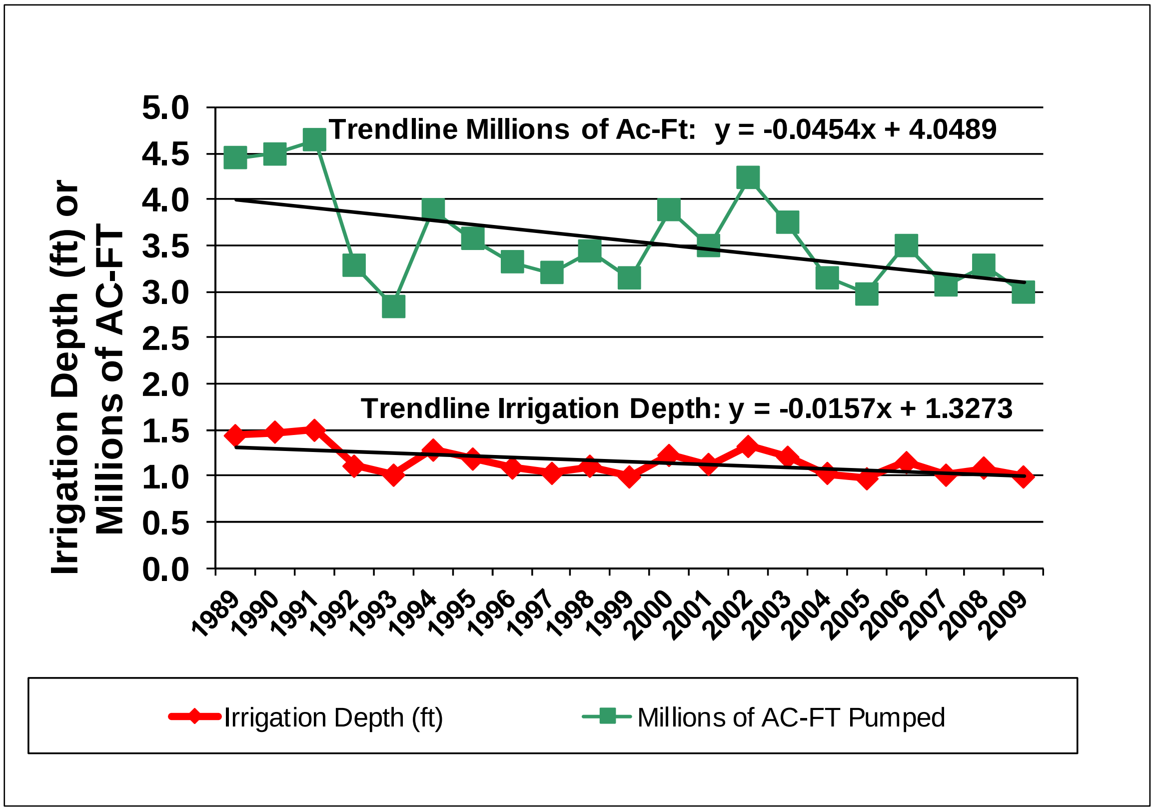

Figure 5. Total irrigation water diverted and average application depth by year for Kansas.

Reduced total water diversion can also be attributed to the continuing decline of water table levels and the subsequent decrease in well yield, and to the shifting of tillage practices (i.e., reduced and no-till tillage systems). Reduced tillage also enhances precipitation capture and reduces soil water losses that are caused by disturbance of the soil surface layers. Greater residue also reduces early-season soil evaporation losses. Increase pumping costs and the adoption of improved irrigation management practices, such as irrigation scheduling, also contribute to less overall water diversions.

Application depth varies (Figure 6) considerably across Kansas (Region 1, 2, and 3 represent the western, middle, and eastern one-third of the state respectively). Since, the majority of the irrigated acres are located in Region 1 and because it has the largest net irrigation requirements, the state total and Region 1 values are very similar.

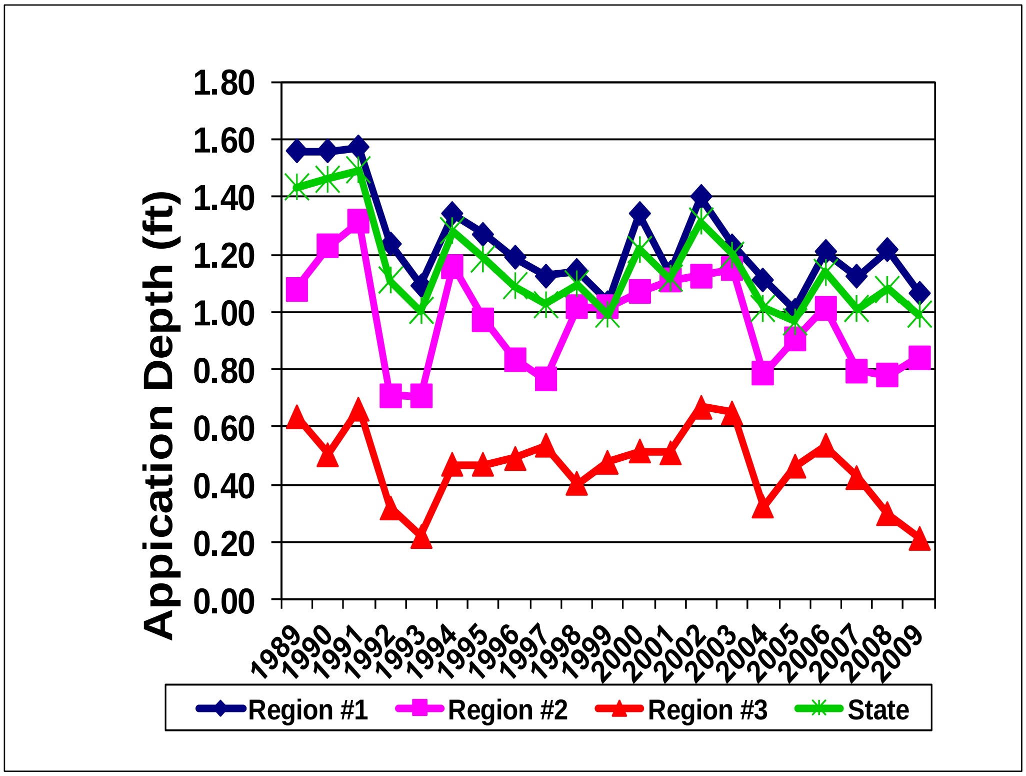

Figure 6. Regional average irrigation application depths by year for Kansas

Crop Yield

The four major grain crops grown in Kansas (corn, soybean, grain sorghum and wheat) have experienced upward trends in yield (Figures 7 – 10). Corn yield has had the most dramatic increase for both irrigated and dryland production with irrigated corn yield improvements of approximately 2.5 bushels/acre for the each year of record, This result is more than twice the dryland rate of 1.1 bushels/acre. The average irrigated yield increase is 0.59 bu/ac, 0.60 bu/ac and 0.31 bu/ac for soybean, grain sorghum and wheat respectfully. Irrigated yield increase trends have been larger than for dryland.

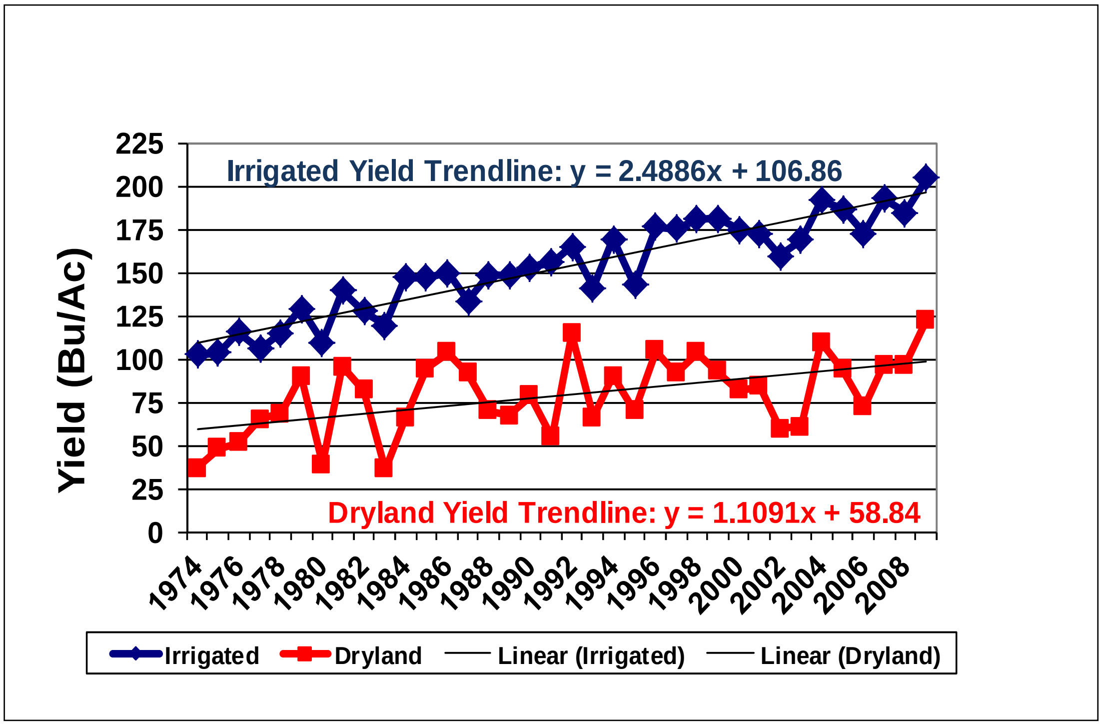

Figure 7. Kansas corn yield trends since 1974 (KDA Kansas Farm Facts).

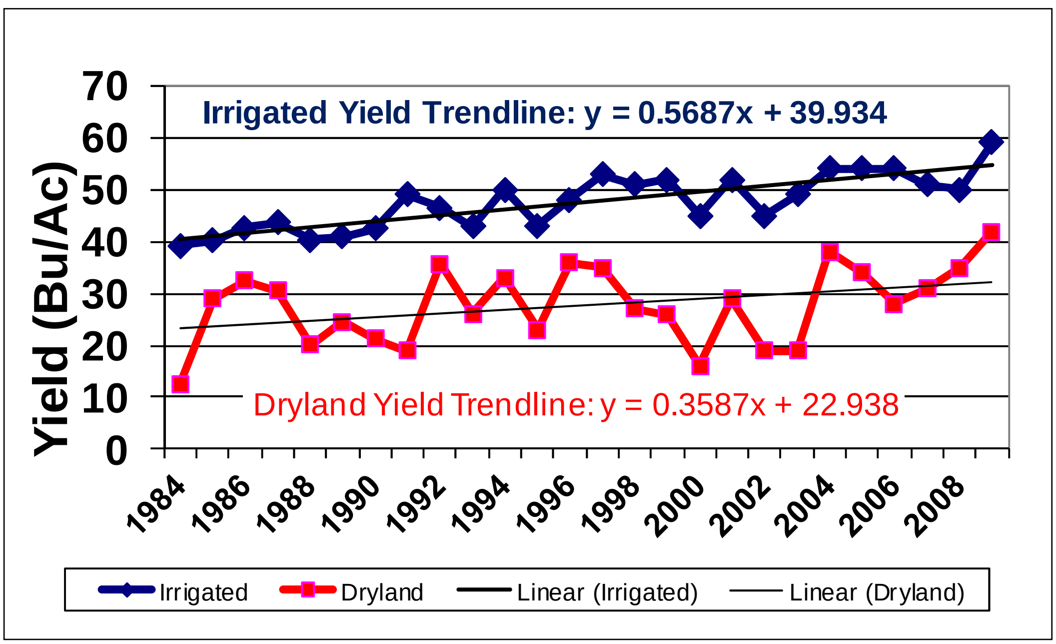

Figure 8. Kansas soybean yield trends since 1984 (KDA Kansas Farm Facts).

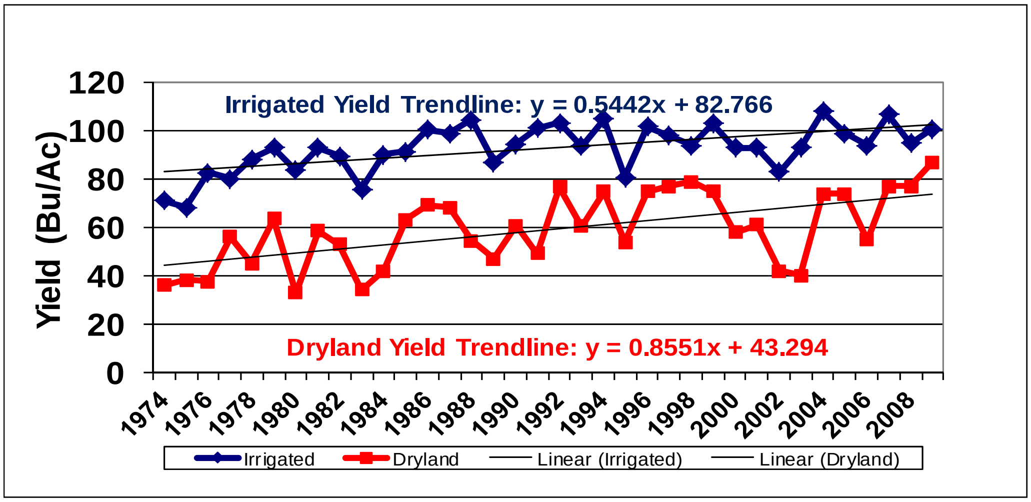

Figure 9. Kansas grain sorghum yield trends since 1974 (KDA Kansas Farm Facts).

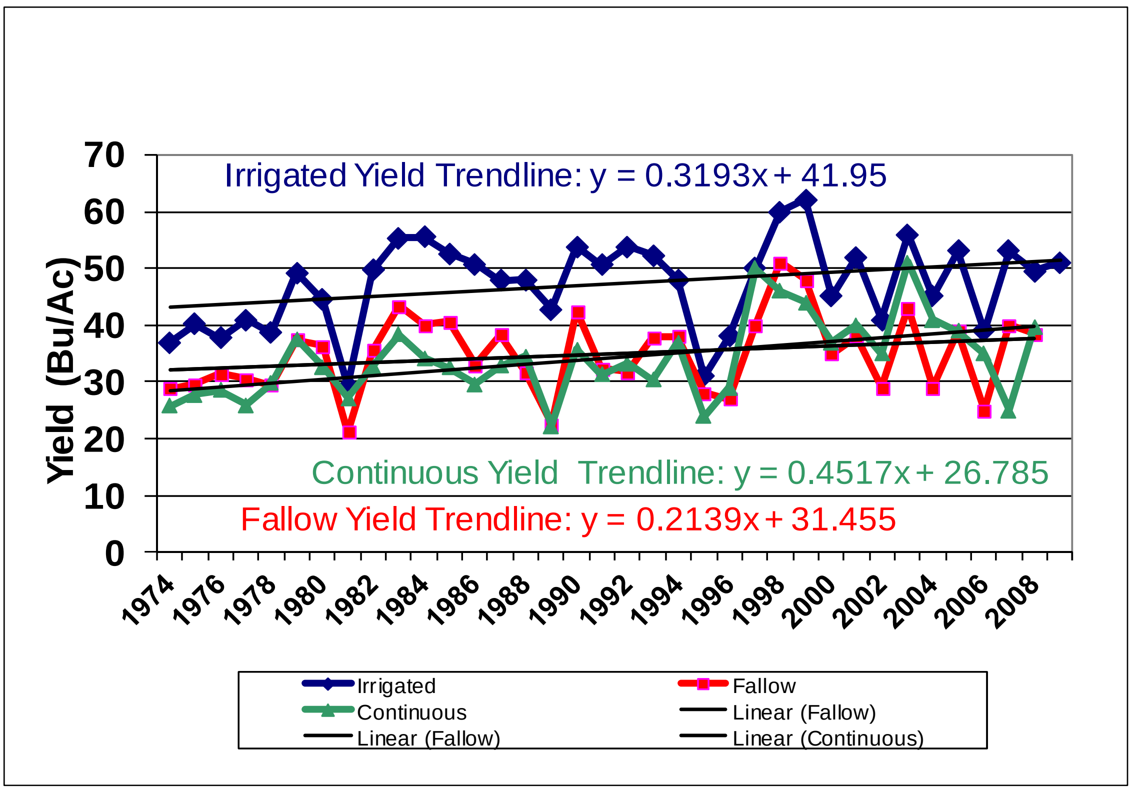

Figure 10. Kansas wheat yield trends since 1974 (KDA Kansas Farm Facts).

IRRIGATION WATER USE EFFICIENCY

Irrigation water use efficiency (IWUE) has sometimes been defined as the yield of a crop divided by the amount of irrigation water applied. Because yield has increased over time (Figures 7 -10) and the average application depth has been trending downward (Figure 6), IWUE has been increasing. Southwest Kansas yield, irrigation application, and IWUE for corn are shown in Figure 11. IWUE has increased by 0.16 bushels/inch for each year of record, although there is considerable year-to-year variability.

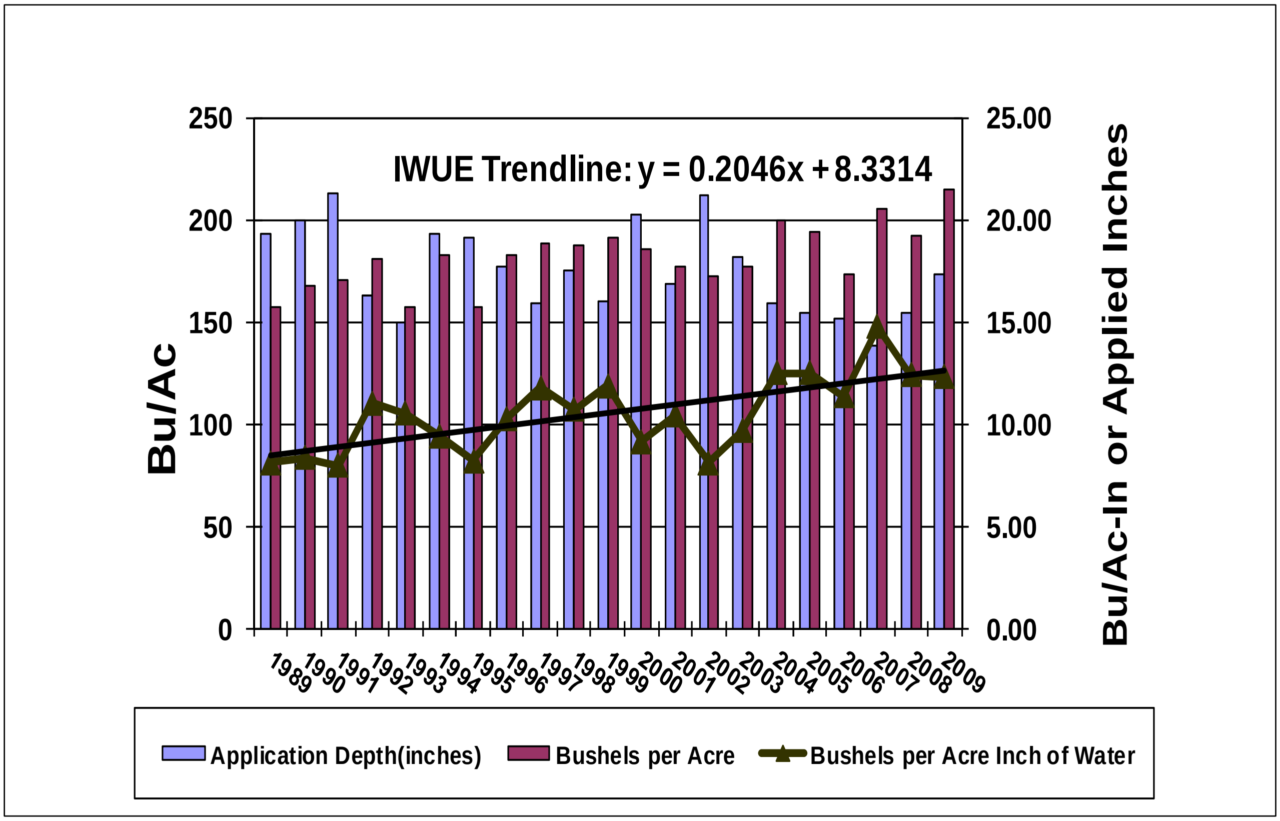

Figure 11. Corn yield, irrigation application depth, and irrigation water use efficiency trends for Southwest Kansas.

KANSAS IRRIGATION ENERGY

The four major energy sources for pumping irrigation water in Kansas are natural gas, electricity, diesel and propane (LP) with natural gas being the most common energy source (Figure 12). The use of electricity has been increasing since the mid 1990s (Figure 12) partially because its costs compared to the other sources has become more competitive (Figure 13).

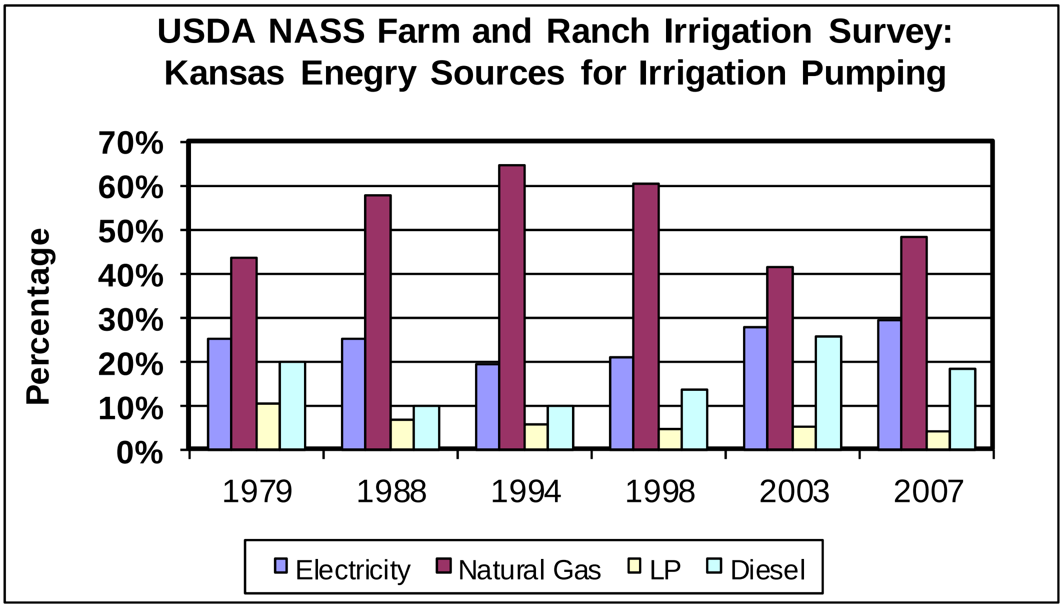

Figure 12. Kansas irrigation pumping plant energy source (USDA NASS Farm and Ranch Irrigation Survey).

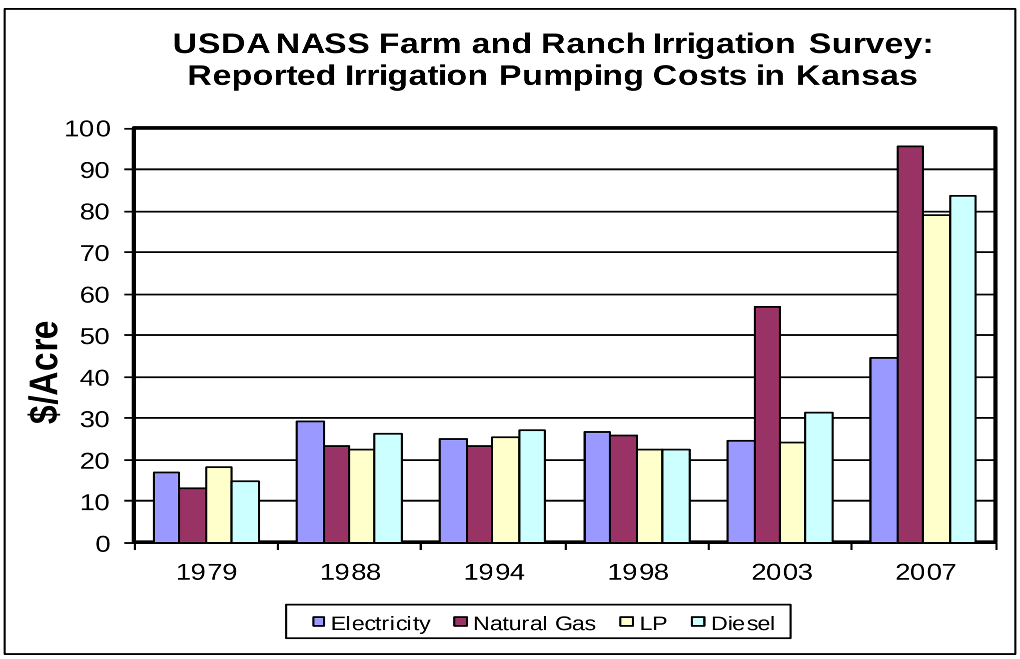

Figure 13. Kansas irrigation pumping costs by energy source (USDA NASS Farm and Ranch Irrigation Survey).

IRRIGATION ECONOMIC IMPACT

According to the 2007 Census of Agriculture (USDA, NASS), the First Congressional District of Kansas ranked as the leading Congressional district in the U.S. for the market value of agricultural products sold (total sales). All of western Kansas and much of the irrigated region in South Central Kansas are part of this Congressional district. Approximately 15 percent of Kansas' cropland area harvested each year is irrigated but contributes about 30 percent of the total value of crops produced (Figure 14 and Table 1). Kansas irrigated land area and irrigation water usage for three selected years, 1993 (wet year), 2000 (normal year), and 2002 (dry year) are shown in Table 1. The area irrigated is relatively stable as compared to the value of production share produced by irrigation. In general, a higher percentage from irrigation is associated with dry conditions resulting in loss of dryland yield productivity.

The total crop value is dependent on both the yield and crop price. Table 2 shows total production, value, and price for the major crops of Kansas in 2000 and 2009. On a percentage basis, irrigated agriculture for Western Kansas produced about 25 percent of the total Kansas crop value in both years, even though the value of total production was nearly twice as high in 2009 as compared to 2000.

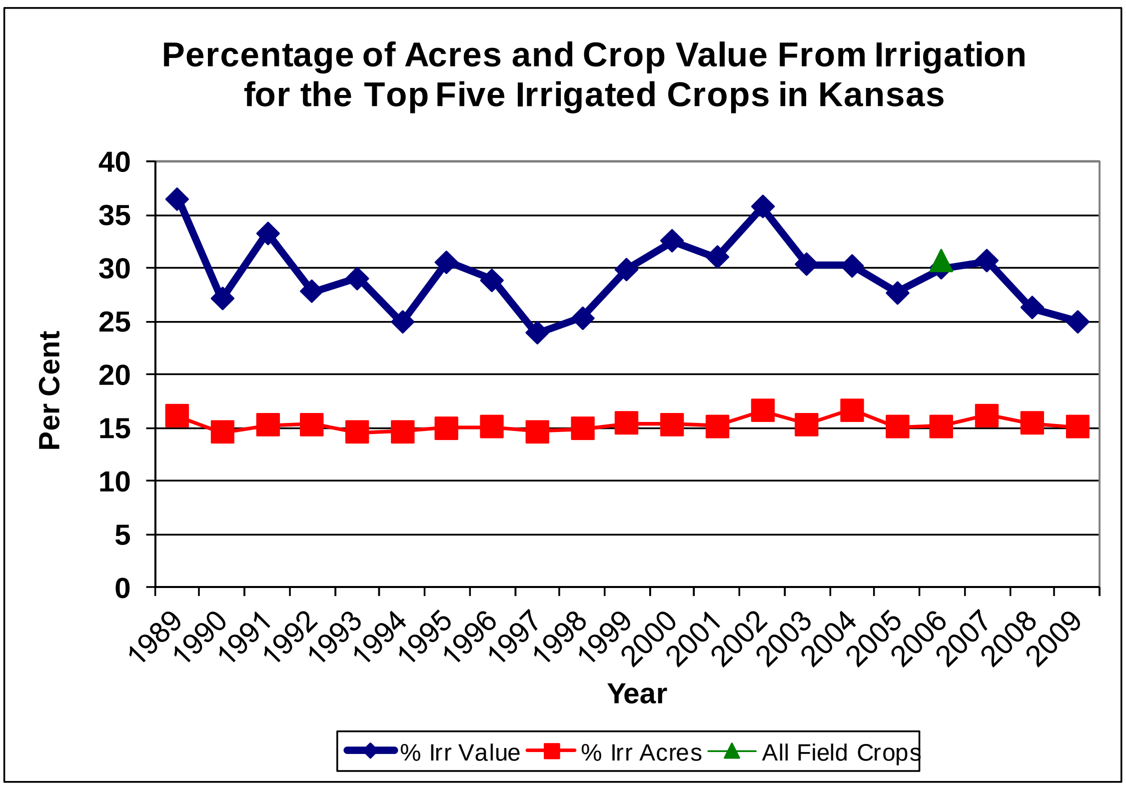

Figure 14: Kansas irrigation percentage of cropland harvested acres and total crop value for the five major crops.

Table 1. Selected example years of Kansas cropland, irrigated acreage, and irrigation water use (Kansas Farm Facts and DWR/KWO Kansas Irrigation Water Use Report).

Year	Total Cropland (Harvested) Acres	Total Irrigated Acres	Irrigation Percentage of Total Cropland	Irrigation Water Use (Acre-Ft)
1993	20,454,400	2,841,000	13.9%	2,828,973
2000	21,656,900	3,183,983	14.7%	3,885,805
2002	20,230,400	3,211,859	15.9%	4,228,410

Table 2. Irrigated crop production and value for Kansas in 2000 and 2009 (Kansas Farm Facts).

Crop	**Production (million bu)**		**Farm value (billions $)**		**Crop price**	
	2000	2009	2000	2009	2000	2009
Alfalfa	1.45**	0.96**	0.1414	0.1041	$97/ton	$108/ton
Wheat	19.9	28.5	0.0681	0.1382	$3.42/bu	$4.85/bu
Grain Sorghum	16.5	13.6	0.0393	0.0434	$2.38/bu	$3.19/bu
Corn	233.0	310.0	0.5778	1.1166	$2.48/bu	$3.60/bu
Soybean	17.0	25.6	0.0935	0.2368	$5.49/bu	$9.25/bu
Total farm value			0.9202	1.639		
Total farm value of all Kansas crops			3.6233	6.5430		
Irrigation percentage of total farm value*			**25.4%**	**25.1%**		
* Irrigation values only include the three Western Kansas crop reporting districts. ** Alfalfa yields in millions of tons, all other crops in millions of bushels.						

Kansas irrigation is concentrated primarily in the Ogallala region of Western Kansas, thus resulting in increased economic impact. Harvested cropland acres, crop value produced and the irrigation percentage for 2002 and 2009 is shown in Table 3 for western Kansas. As compared to 2009, dryland crop failures resulted in fewer harvested acres in 2002. Consequently, the percentage of acres harvested and crop value produced by irrigation was much higher. Table 3 also shows 2009 data for Southwest Kansas and demonstrates the high concentration of irrigated agriculture in the region since over 70 percent of the crop value produced came from irrigated acres. The impact of irrigation in a single county in Table 3 shows 2002 and 2007 county data for Haskell County in Southwest Kansas. In 2002, a dry year, almost 95 per cent of all crop value came from irrigated land, while in 2007 still over 80 percent of the crop value comes from irrigated agriculture. Haskell County is used as an example as the county has been part of several social/economic studies that were initiated in the early

1940's (Williams and Bloomquist, 1996). Six communities across the US were selected originally to study issues of social and economic instability. Williams and Bloomquist (1996) noted that irrigated agriculture had played a key role in providing the foundation of stability for the county.

Table 3. Western Kansas crop production statistics for wheat, grain sorghum, corn, soybeans, and alfalfa* (Kansas Farm Facts).

Location	Total of Irrigated and Dryland (1000s of acres)		Total Value of Irrigated and Dryland Production (1000s of $)		Irrigation Percentage of Total Area		Irrigation Percentage of Total Value	
	2002	**2009**	**2002**	**2009**	**2002**	**2009**	**2002**	**2009**
Western KS	5,372	6,899	905,163	2,333,500	36.7%	28.3%	70.2%	48.3%
Southwest KS	2,532	3,042	565,555	1,120733	53.5%	44.0%	85.8%	70.4%
	2000	**2007**	**2000**	**2007**	**2000**	**2007**	**2000**	**2007**
Haskell County	224.2	274	63,783	134,174	74.9%	62.0%	94.3%	81.6%
* Other crops not included are silage, sunflower, cotton, and dry beans.								

IRRIGATION WATER WITHDRAWAL IMPACT

While some areas of the Ogallala have substantial water in storage (Figure 16), many areas have been depleted to levels that make large scale irrigation no longer possible. Using a minimum threshold criterion of the aquifer being able to support a well with a 400 gpm pumping rate for a 90 day pumping season, some areas have been depleted and other areas have a projected lifespan of less than 25 years (Figure 17). New technologies and cropping systems have allowed producers to adapt to declining well yield associated with the declining aquifer water table, but the irrigated land area in Kansas will eventually decrease.

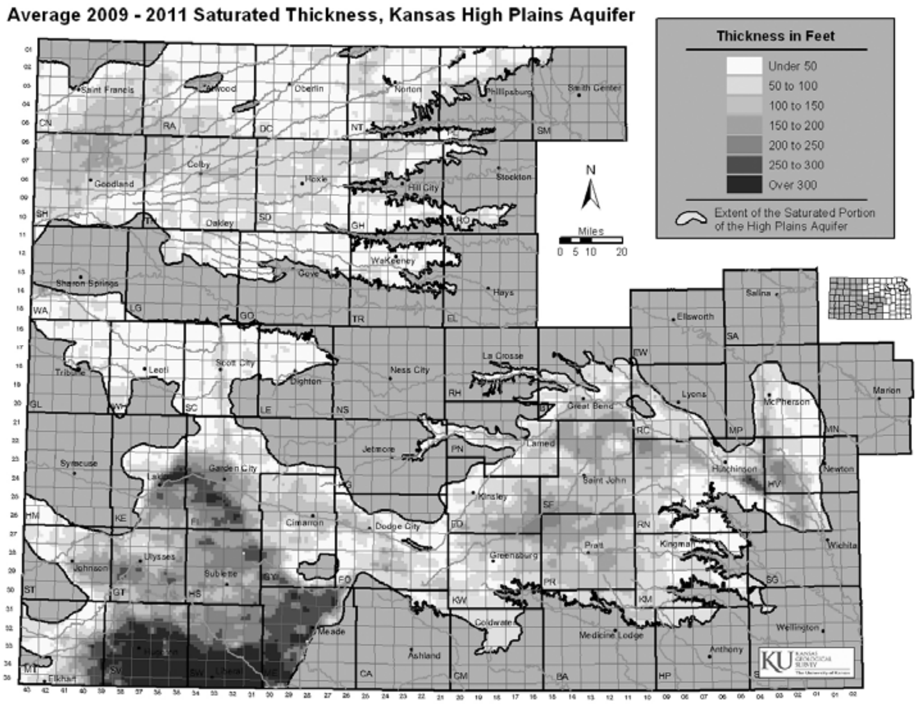

Figure 16. Average saturated thickness for the High Plains Aquifer in Kansas (Kansas Geological Survey, 2012).

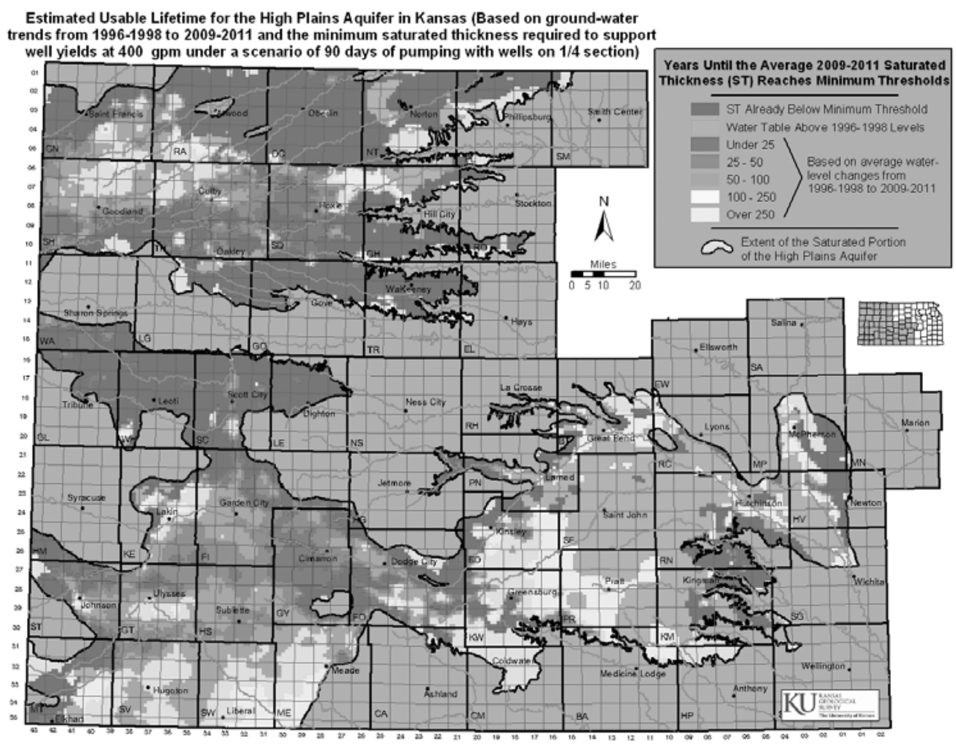

Figure 17. Estimated usable lifetime for the High Plains Aquifer in Kansas (Kansas Geological Survey, 2012)

SUMMARY

Irrigated agriculture initially developed using surface flood irrigation systems but has shifted to using center pivot irrigation systems. The land area irrigated has been relatively. Crop yield and irrigation water use efficiency have continued to improve even as average application depths have declined. Unfortunately, improvements in systems, irrigation management, and cultural practices have not been sufficient to overcome excess water withdrawals in many areas of the High Plains aquifer system, especially the Ogallala. The economic impact is considerable for the state of Kansas, in general, and is dramatic in areas of high irrigation concentration.

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REFERENCES

Erhart, A. 1969. Early Kansas Irrigation. One of three article series, “A page out of Irrigation History”. Irrigation Age Magazine. Feb 1969. 4 pp.

Lamm, F. R. and T. P. Trooien. 2003. Subsurface drip irrigation for corn production: A review of 10 years of research in Kansas. Irrig. Sci. 22(3-4):195-200.

USDA NASS. Various Years. Kansas Farm Facts. In cooperation with Kansas Department of Agriculture.

Kansas Irrigation Water Use Report. Various Years. Prepared in cooperation by the Kansas Water Office and the KDA, Division of Water Resources.

Kansas Geological Service. 2012. Gray scale maps provided by request for conference proceedings.

Williams, D. D. and L. E. Bloomquist. 1996. From Dust Bowl to green circles: A case study of Haskell, County, Kansas. Bulletin 662. Kansas Ag. Expt. Station, Manhattan, Kansas. 44 pp.

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