LONG-TERM EFFECTS OF THE DROUGHT ON THE CENTRAL GREAT PLAINS

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INTRODUCTION

Much of the US Central Great Plains is in the midst of a drought that started in 2000 and has persisted through today, 2003. Although the drought areas shift about and there is sometimes some temporary relief, the persistence and severity of the drought has made successful dryland crop production nearly impossible and even strained many of the irrigated production systems. Questions have arisen about the long term effects of the drought. My remarks will be confined to drought effects on crop production and on the Ogallala. Therefore, my remarks will not specifically address the very real problems of wind erosion hazards and of individual financial strains and bankruptcies. These indeed can have long term effects.

WHAT EFFECTS ARE BEING OBSERVED?

In my opinion, we are in a historical drought situation. By that I mean, this extreme drought has not been seen by most of us still actively engaged in farming and ranching and that it will be a story we are likely to refer back to by, "We—ll, I remember back in 02, it was so dry........". Now, having implied that these are rare conditions, let me point out that with our present situtaion, 2003 could be just as bad or worse.

The drought of 2002 was an *Equal Opportunity Drought* in that it had broad conditions:

- Widespread across Central Great Plains
- Affected both dryland and irrigated areas
- Affected all irrigation system types
- Affected winter and summer crops
- Affected all crop types

during 2002. One of the actions was to establish hay and farmer stress hotlines as conditions developed. Both of these hotlines were quickly implemented and provided important resources to the producers around the state. The state also targeted "vulnerable" communities with potential water supply problems in 2000. Working with the communities, and offering workshops and various forms of assistance, fewer communities suffered water supply problems during 2002 than during 2000 across the state despite the fact the drought was more severe. The state had also improved its drought monitoring capabilities in recent years, which helped during the 2002 drought. Lessons learned from 2000 also helped improve the coordination and communication between county, state, and federal officials in 2002. Finally, the University of Nebraska Cooperative Extension had established the backbone of a drought-related website during 2000 that became very easy to re-activate and improve during 2002.

Colorado also recently updated their state drought plan to incorporate mitigation activities. The drought plan was activated completely during 2002 for the first time since it was originally adopted in 1981. Lessons learned during 2002, and 2003 if the drought continues, will help encourage the state to implement the mitigation strategies it has recently included within its drought plan. During the year, Colorado State University and the University of Colorado combined resources and expertise to form a Drought Research Center with the objective of investigating the impacts of drought on Colorado, particularly the potential impacts from multiple-year droughts.

Kansas is one of a handful of states that does not have a drought plan document. Officials have generally been confident and satisfied with their drought response capabilities during droughts in the past. With the trend across the country to begin to adopt mitigation strategies to reduce natural disaster losses, a trend that has recently gained momentum with drought as well, developing a drought mitigation plan for the state could be an important next step in dealing with droughts across the state. It is certainly a suggestion that is encouraged by the National Drought Mitigation Center.

CONCLUSION

Drought in 2002 definitely illustrated that the country remains highly vulnerable to drought impacts, and that mitigation strategies are needed to help begin to address, and hopefully reduce, these impacts in the future. The need for drought mitigation and preparedness exists at all levels: federal, state, local, regional, and tribal. It remains to be seen whether or not the lessons learned from the 2002 drought will move officials across the United States in this direction toward drought mitigation and preparedness.

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In mid-summer 2002, all of Colorado was in extreme or exception drought. Nearly all of Nebraska was in severe to exceptional drought and nearly 2/3 of Kansas was in moderate to exceptional drought (Figure 1). Dryland crop production even with conservation tillage systems often were a disaster in 2002, particularly for corn (Figure 2.) which has less tolerance for extreme drought compared to grain sorghum and sunflowers.

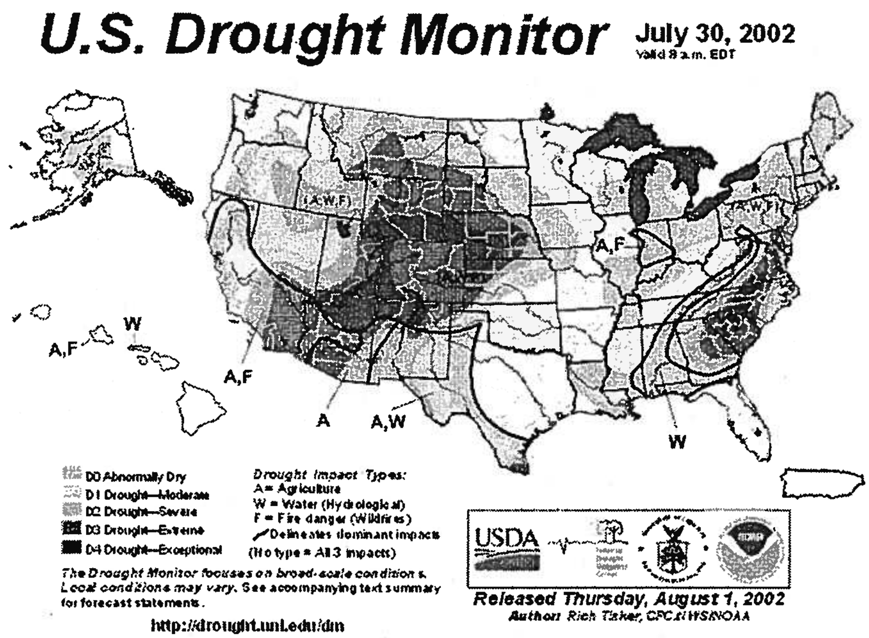

Figure 1. US Drought Monitor for July 30, 2002. Source of graph, National Drought Mitigation Center, http://www.drought.unl.edu/

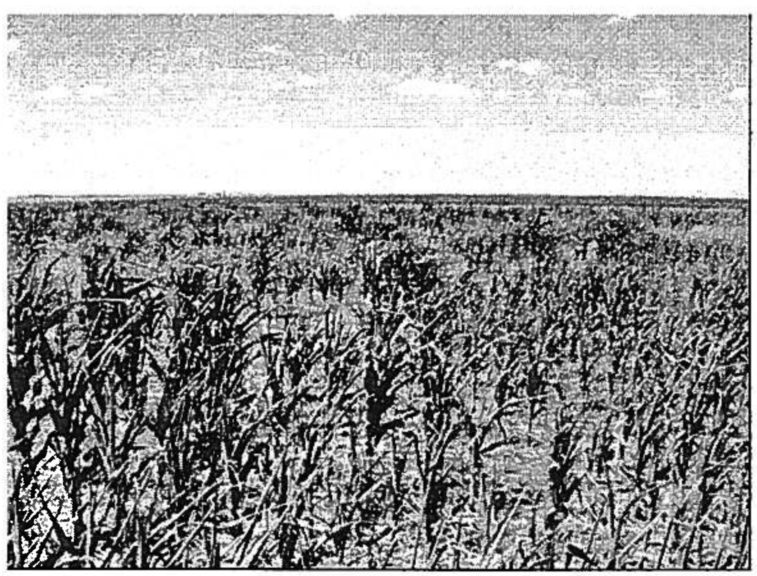

Figure 2. Failure of the dryland corn leg of the wheat-corn fallow system in 2002, Colby, Kansas.

The severity of the drought in 2002 affected all types of irrigation systems.

- Center pivot irrigation systems
  <u>*Problem in 2002:*</u> Erratic crop height, pollenation and grain fill.
- Furrow (Flood) irrigation systems
  <u>*Problem in 2002:*</u> Difficulty staying within water right; Water stress between infrequent events.
- Subsurface drip irrigation (SDI) systems
  <u>*Problem in 2002:*</u> Lack of surface soil water for germination

Since center pivot sprinkler irrigation is the predominate irrigation system in the Central Great Plains, there was obviously a more easily seen and recognized problem with them. Tremendous differences in crop height, pollination and grain fill were even observed over very short distances (Figure 3 and 4). Many of these differences are attributed to slight amounts of runoff and runon occurring within the field. Although these differences probably existed for the problem fields in previous years, more average rainfall and lower evapotranspiration would allow these differences to be masked out. A good way to characterize this problem is to consider a planned irrigation amount of 1 inch. If only 1/10 inch runoff occurs from a small high spot and then runs into a microdepression, now you have nearby areas receiving 1.1 inches and 0.9 inches, a 22% difference in irrigation. Compounding this problem over the course of the season by multiple events, resulted in the extremely erratic corn production we experienced under center pivot sprinklers. The major cause of runoff and runon under sprinklers is too high an irrigation application rate for the soil conditions. High application rates are a potential problem under many incanopy sprinkler irrigation systems, because the wetted radius of the sprinkler is greatly distorted and reduced by the crop canopy. We would expect runoff/runon problems to be worse with widely spaced incanopy sprinklers, poorly regulated sprinkler packages, undulating slopes, and conventional tillage. Examination of many of the problem fields in 2002 showed some of these same design and operational characteristics. An easy way to determine if runoff/runon occurred was to go to an area in the field where the sprinkler had passed over within the previous day or two. You could observe wet damp soil in runon depressions by kneeling down and looking at the microrelief. Another way was to look for a flush of small late season grasses in areas receiving slightly more irrigation. Some of these characteristics are solvable problems that irrigators could avoid, should 2003 be a twin to 2002. The economic benefits of correcting a sprinkler package or spacing problems in a year such as 2002, would dwarf the added costs of correcting the problems. Research conducted at the KSU Northwest Research Extension Center at Colby, Kansas (Yonts et. al., 2003) has shown row-to-row yield differences can be as high as 10-15 bushels/acre for incanopy sprinkler irrigation with 10-foot spaced nozzles. In 2002, these differences could have been greater.

Figure 3. Erratic height and ear size differences over very short distances in center pivot sprinkler irrigated corn in 2002, Colby, Kansas.

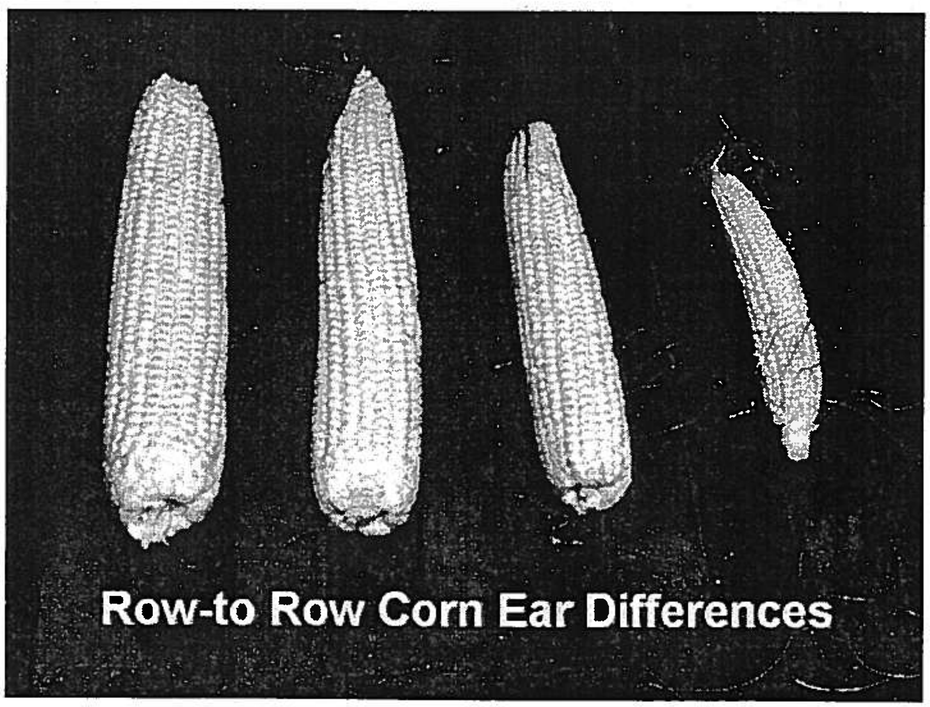

Figure 4. Drastic differences in row-to-row ear size for sprinkler irrigated corn in 2002, Colby, Kansas. Note: Ears from same area depicted in Figure 3.

Often a group of relatively small or unrecognized sprinkler problems combined negatively to add up to a major problem in 2002. Figure 5 depicts a poor yielding area in a field where three additive sprinkler problems existed. This combined problem has probably existed for years, but only became strongly recognizable in 2002.

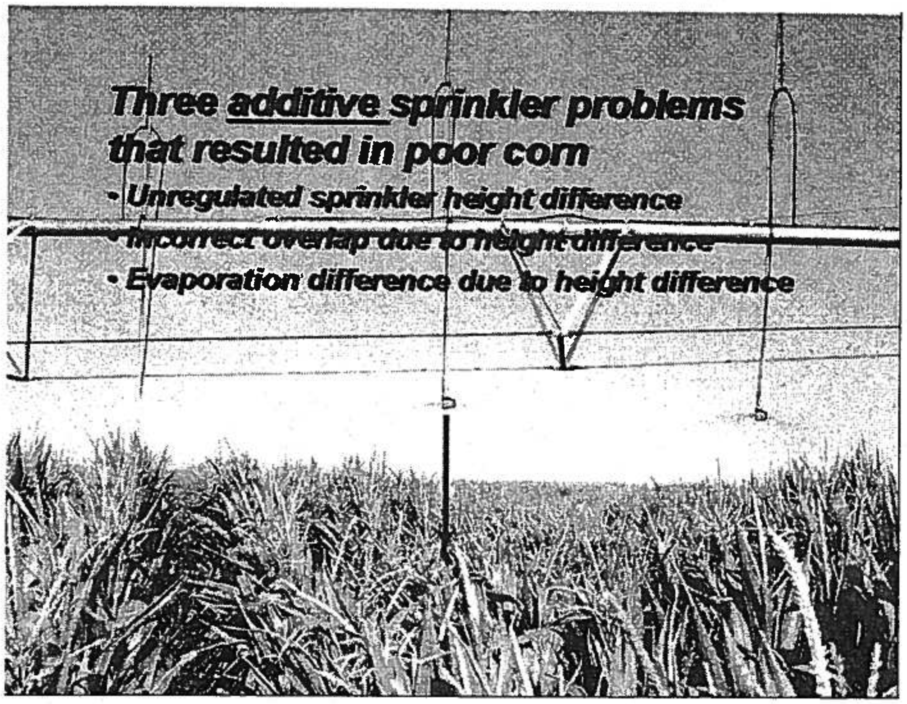

Figure 5. Poor yielding corn under a sprinkler nozzle in 2002, Colby, Kansas. The three problems that caused the reduced yield are sprinkler height differences (approximately 2 ft) with no pressure regulators, incorrect overlap due to height differences and the evaporation difference due to the height difference. Since the system had a relatively low operating pressure (15 psi) it would be presumed that the lack of pressure regulation on the height difference is the major cause of yield reduction.

Other problems in 2002 involved irrigation wells and pumps experiencing decreased pumping capacity, sucking air and cascading water. Some irrigators have expressed concern that these problems are long-term. In general these problems are probably not long term, but will be discussed later in this paper.

Both winter and summer crops were affected in 2002 and this placed additional financial burdens on the producer already experiencing poor economic conditions. No crop really escaped the wrath of the drought. In some cases, lack of germination stopped the crop from day one.

WHAT IS THE SEVERITY OF THESE EFFECTS?

While the individual factors of lower precipitation, higher temperatures and higher evapotranspiration were all abnormal values, their combining in such a negative fashion resulted in the extreme situation we experienced.

The annual precipitation for 2002 at the KSU Northwest Research-Extension Center was 12.93 inches, approximately 2/3 of the long term average value, but the spring and early summer precipitation was extremely deficient (Figure 6). Very similar drought conditions were also present in 2000 and 2001.

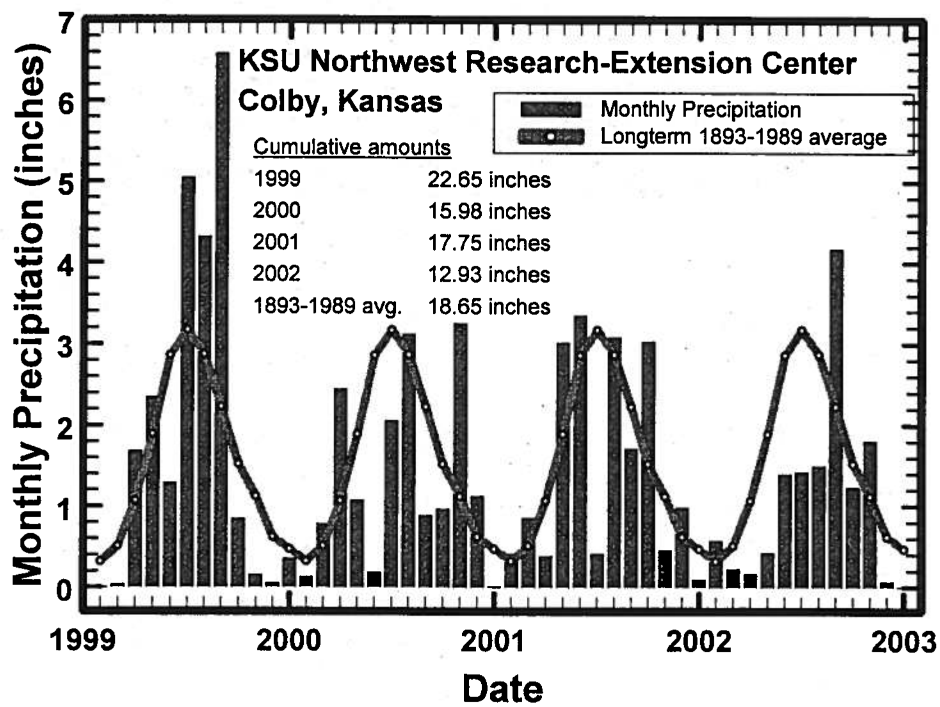

Figure 6. Precipitation patterns at the KSU Northwest Research-Extension Center, Colby, Kansas for 1999-2002.

In addition, elevated temperatures in the early summer (June) and continuing into July (Figure 7.) resulted in larger than normal evaporation and transpiration losses from the soil and crop, respectively. The evapotranspiration for 2000, 2001 and 2002 were all 3 to 4 inches above the long-term average amount (Figure 8).

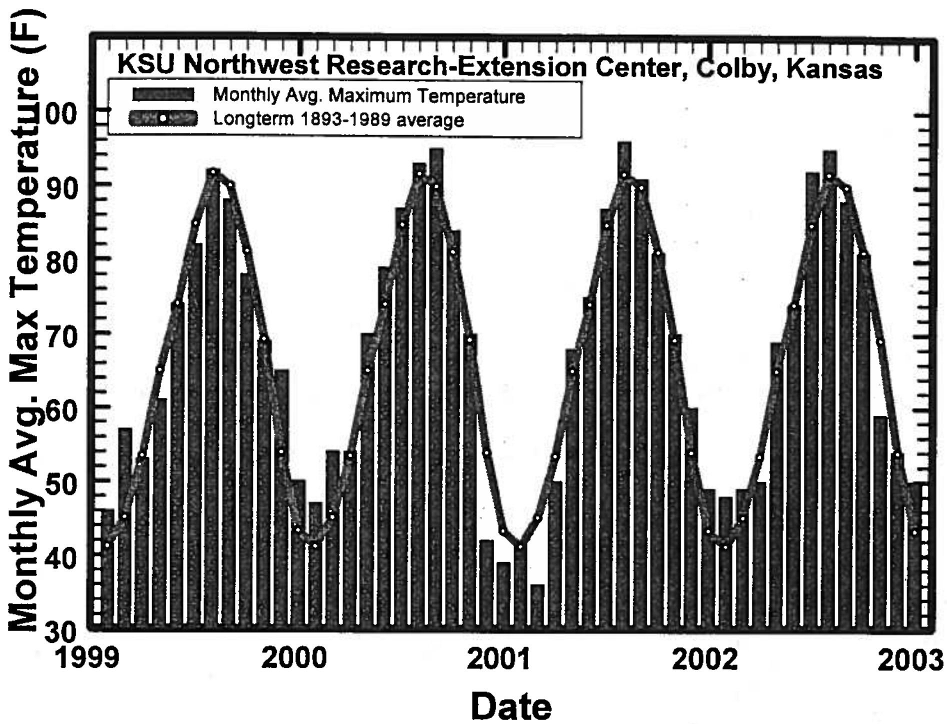

Figure 7. Monthly average maximum daily temperatures for KSU Northwest Research-Extension Center, Colby, Kansas for 1999-2002.

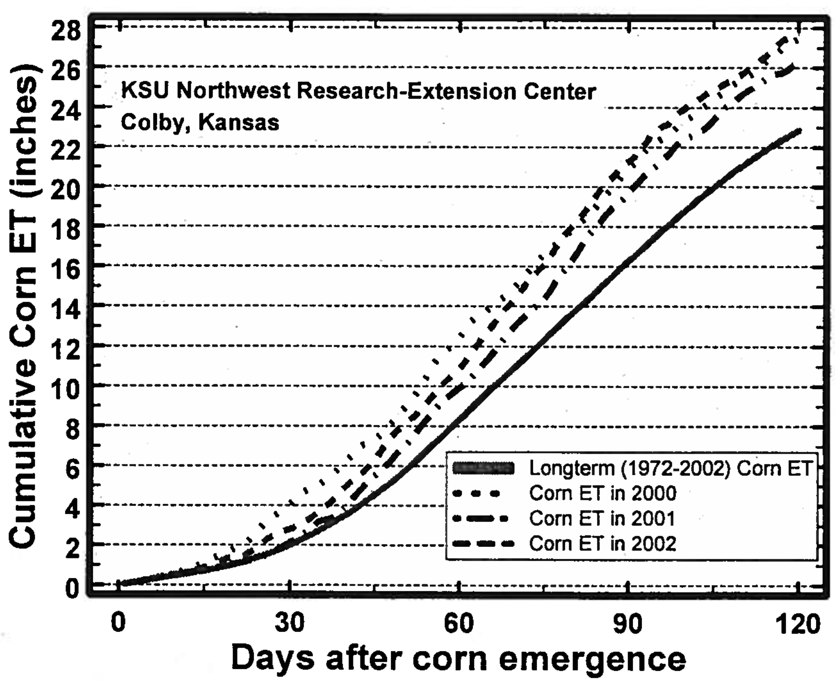

Figure 8. Cumulative corn evapotranspiration (ET) for 2000-2002 as compared to the 30 year average, KSU Northwest Research-Extension Center, Colby, Kansas.

Many irrigation systems in western Kansas do not have the capacity in the typical 90 day irrigation season to apply the irrigation requirements of 2000, 2001 and 2002 Figure 9. Thus, many irrigated corn fields failed or had very poor yields.

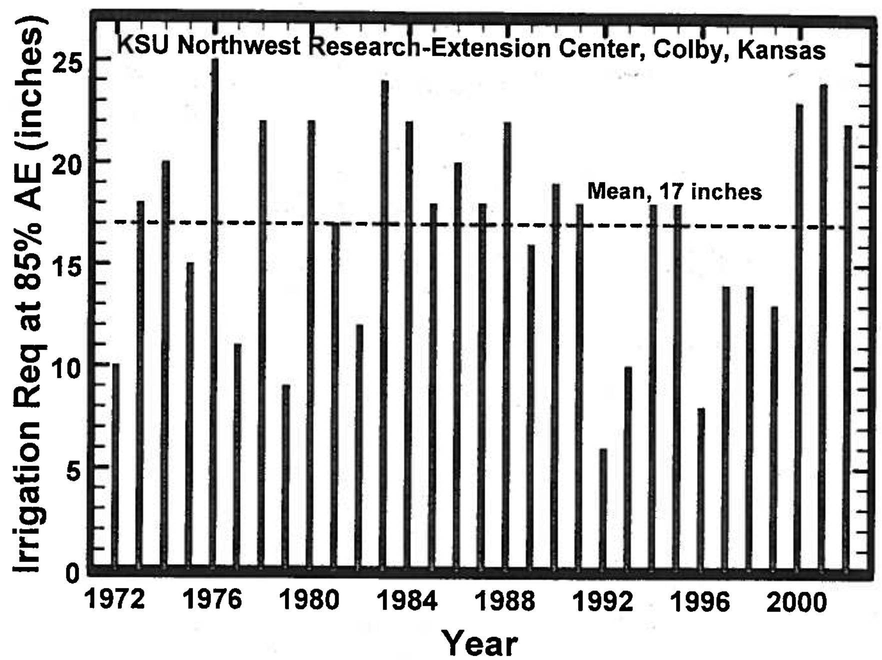

Figure 9. Required irrigation amounts in 2000-2002 were 5-7 inches greater than normal based on simulated irrigation schedules for the KSU Northwest Research-Extension Center, Colby, Kansas.

The problem of decreasing inseason well performance and pumping rates resulted in:

- Increased labor and management to renozzle center pivots.
- Increased water stress due to less capacity.
- Poor uniformity and/or pump damage if not recognized and fixed.

ARE THESE EFFECTS TEMPORARY OR PERMANENT?

Well, it's a good news/bad news situation. The *Good News* is good crop yields will return when more average climatic conditions return. The *Bad News* is the drought continues and the normal winter period precipitation is low, so soil water reserves may be low next spring (Figure 10).

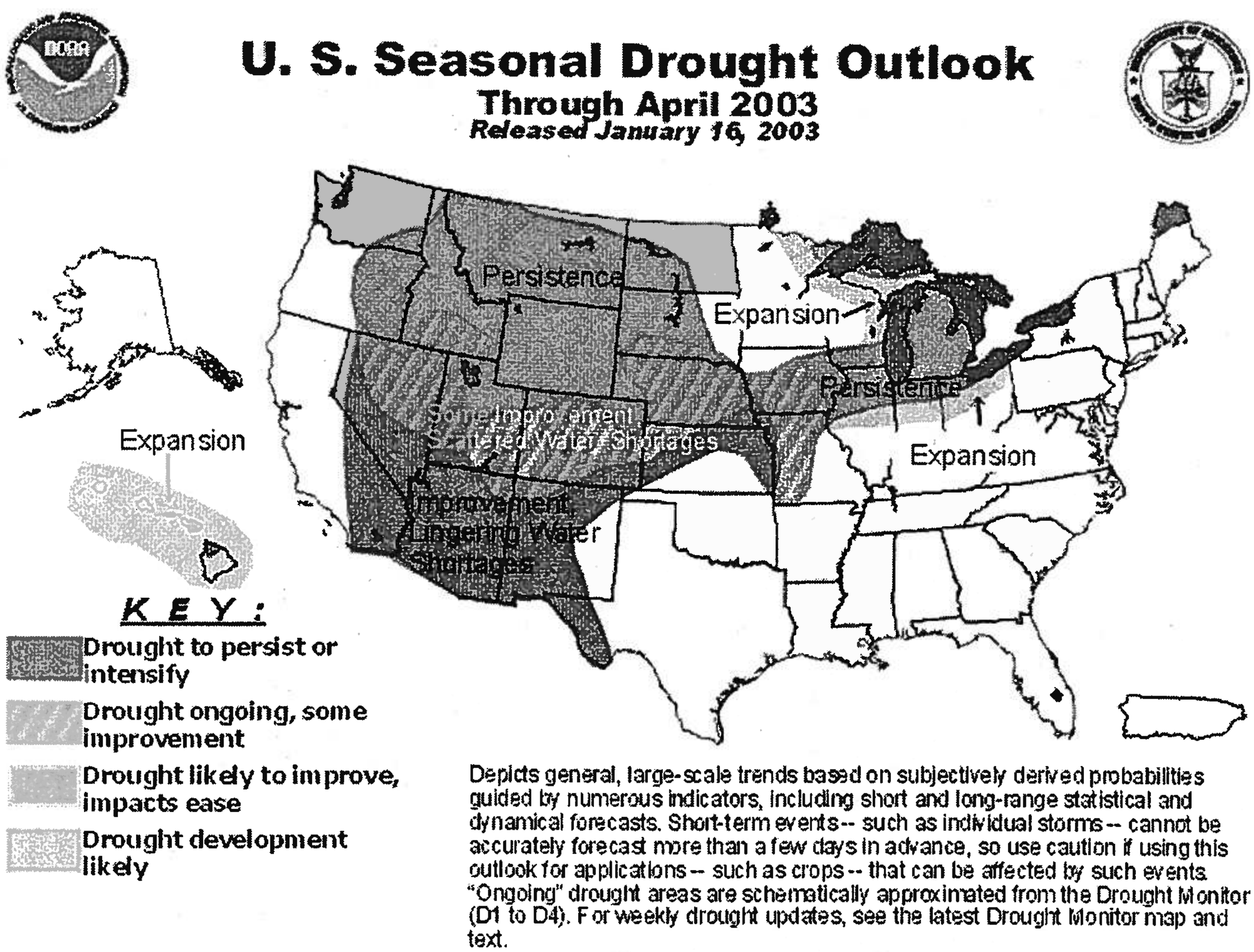

Figure 10. US Seasonal Drought Outlook through April 2003. Source of graph, National Drought Mitigation Center, http://www.drought.unl.edu/

The *Bad News* is increased groundwater use during the drought and for its duration is essentially a permanent loss from the Ogallala. The *Good News* is the Ogallala is still a huge resource and the annual effect of the drought on the aquifer is relatively small.

The *Bad News* is in the future, problems of decreased pumping rates and cascading water will likely increase as groundwater levels further decline. The *Good News* is these effects will be seasonal with considerable overwinter recovery (Figure 11). When the drought ends these effects will lessen somewhat, due to less pumping requirements (time).

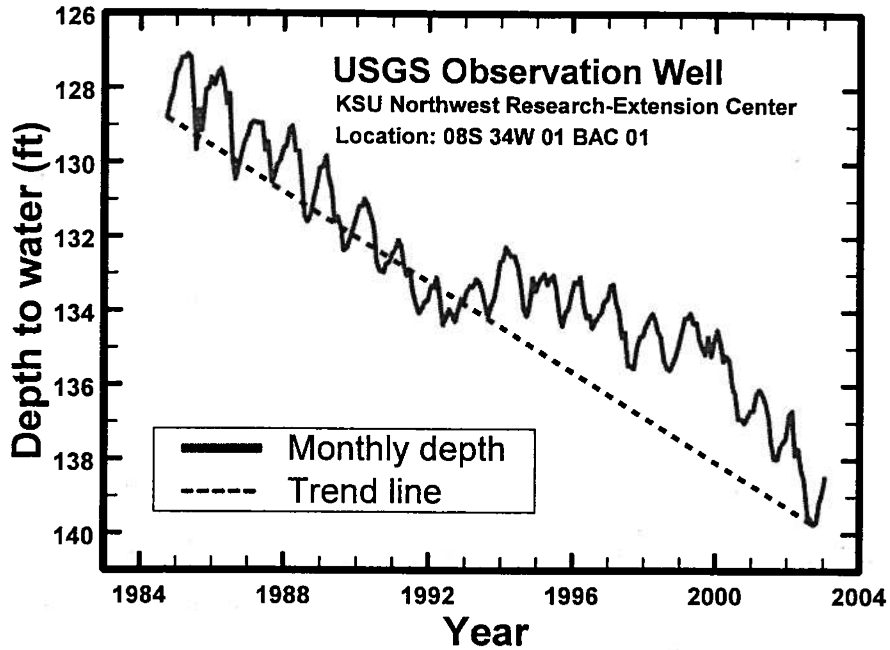

Figure 11. Long term decline in aquifer water levels and partial overwinter recovery of observation well at KSU Northwest Research-Extension Center, Colby, Kansas. Note: Seasonal declines are caused by drawdown.

CONCLUDING STATEMENTS

In summary, the effects on crop production and on the Ogallala are to a great extent temporary. The direct effects on the Ogallala are slow to be realized, so when the drought ends, the scale of these effects is not large. Hopefully, the greatest effect will be social--the renewed understanding of the value of water and its importance in Central Great Plains.

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A REFLECTION ON IRRIGATION CHANGES

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INTRODUCTION

Irrigation has been practiced for many years perhaps first in Egypt several thousand years ago. There is evidence of irrigation in North America that dates back to the year 500 A. D. These systems had evidence of many irrigation ditches moving water from the rivers to the fields in the surrounding valleys. Morgan, 1993 wrote a history of American irrigation titled "Water and the Land." Morgan recognized the irrigation of nearly 200 years ago but wrote that the modern era of irrigation in the United States began in the mid-19th Century as American pioneers moved West. He attributed the teaching of the first college irrigation course in 1883 to Elwood Mead at the Agricultural College of Colorado in Fort Collins. After leaving the college Mead continued his irrigation work for the U. S. Department of Agriculture and as a commissioner of the Bureau of Reclamation. The lake formed by Hoover Dam is named Lake Mead after this agricultural engineer. As a scientist with the Water Management Unit of the USDA in Fort Collins we can trace our roots back to Elwood Mead.

The objective of this paper is to review the evolution of modern irrigation technology in the United States and the Central Great Plains. The major focus will be the last century.

IRRIGATION TECHNOLOGY IN THE EARLY 20TH CENTURY

Irrigation development prior to 1900 in the United States was primarily by local irrigators. They were close to the streams and diverted water to the adjacent land. The United States Bureau of Reclamation (USBR) was established in 1902 to encourage development of the West and migration to the unpopulated area. Without the government policy and goal to populate the West, we would have less area irrigated in the West. Today, approximately 29% of the total irrigated area in the United States is supplied water from USBR projects. Surface irrigation was the dominant method for practically all irrigation systems older than a century. This would be true for all irrigation systems around the world. It is only during the last 70 years with the advent of deep well turbine pumps, combustion engines, rural electrification, sprinkler and drip irrigation systems that we have seen a significant