Irrigation Management Decisions, 2022

Ongoing drought conditions, poor outlook for relief from the current hot, dry weather in the short term, and limited and declining well capacities are making 2022 a tough crop season for the Texas Southern High Plains. Lessons learned from previous droughts and local applied research programs can inform decisions to mitigate effects of seasonal drought.

Summary of rainfall and crop water demand estimates

The current crop season drought is being compared seasons in the 2011-2013 drought. While local conditions can vary, seasonal precipitation and temperature data (based on data from National Weather Service at Lubbock, Texas) can provide some perspective of the current crop weather conditions. From the summary below (Figure 1), one can see that the rainfall for both the current crop season (April-June); year to date (January-June); and since last harvest (October-June) are all below average in 2022, and the rainfall totals approximate those of 2012 and 2013.

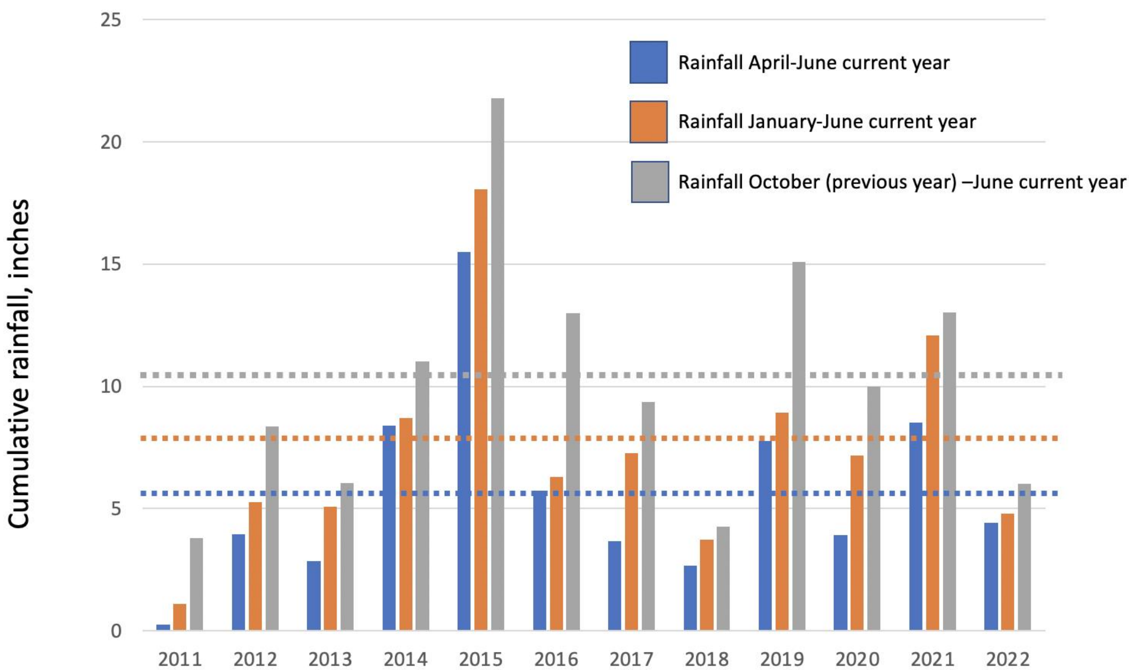

Figure 1. Summary of accumulated rainfall April-June; January-June; and preceding October-June for each year. The dashed horizontal lines represent mean (average) rainfall for the respective periods 2011-2022.
Reference: National Weather Service https://www.weather.gov/wrh/Climate?wfo=lub.

This article is adapted from a previous article, [Porter, Dana. 2011. Irrigation Management Decisions 2011. Texas A&M AgriLife Extension Service, Lubbock, Texas.] For additional information, please contact Dr. Dana Porter, Professor and Extension Program Leader, Texas A&M AgriLife Extension, Biological and Agricultural Engineering at d-porter@tamu.edu.

Using temperature as a proxy for crop water demand, the average monthly temperatures May-July for 2022 are above average, and they are similar to those of 2011 and 2018 (please see Figure 2).

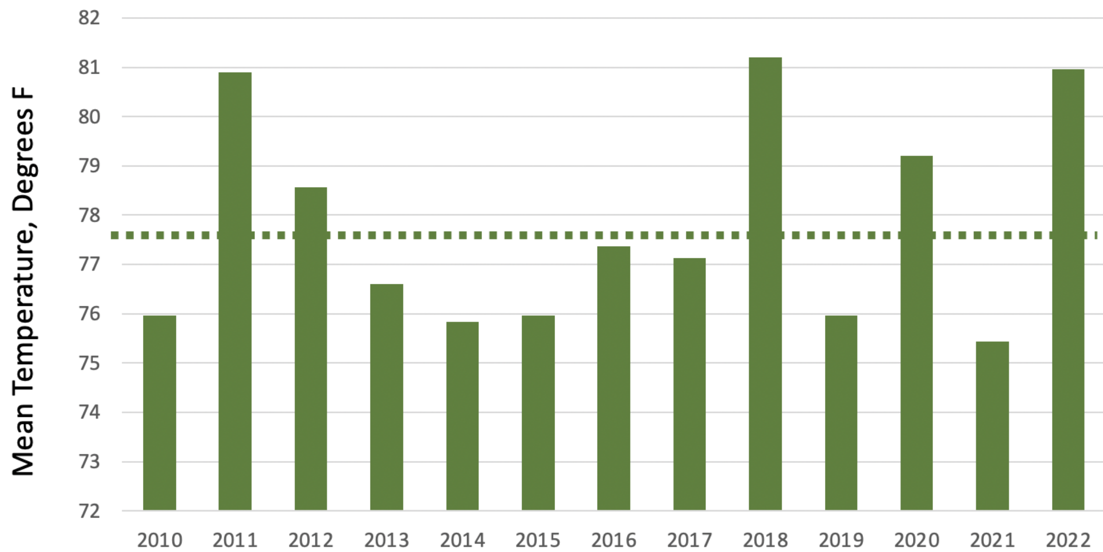

Figure 2. Mean monthly temperatures May-July. The dashed horizontal line represents the overall mean (average) temperature May-July 2010-2022. Source: https://www.weather.gov/wrh/Climate?wfo=lub

Current conditions, short term and long term precipitation and temperature outlooks

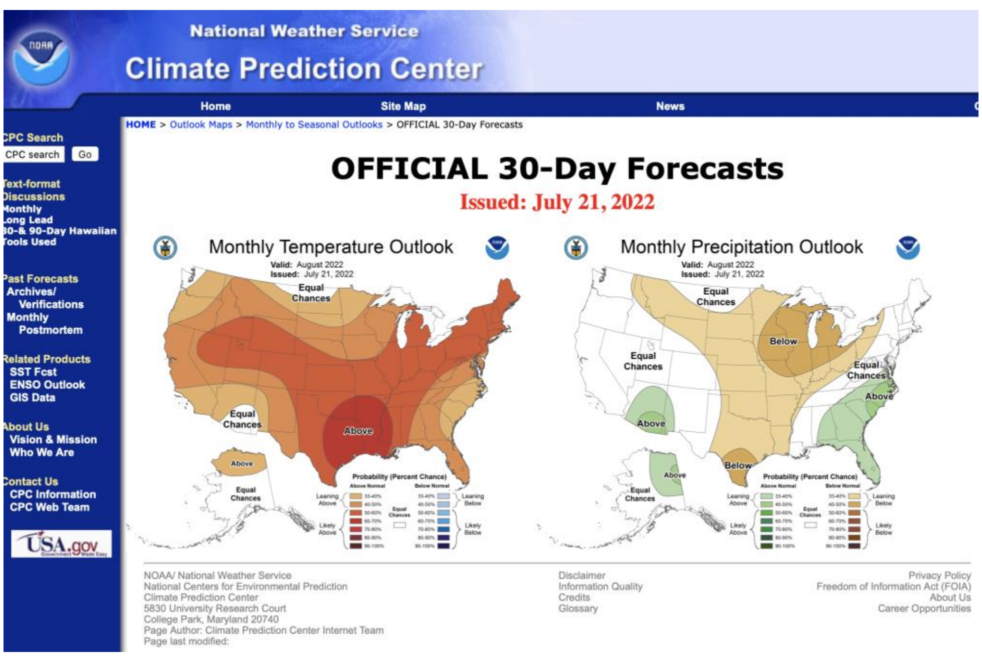

Figure 3. Climate (temperature and precipitation) outlook for August 2022. Reference: US National Weather Service Climate Prediction Center, https://www.cpc.ncep.noaa.gov/products/predictions/long_range/lead14/

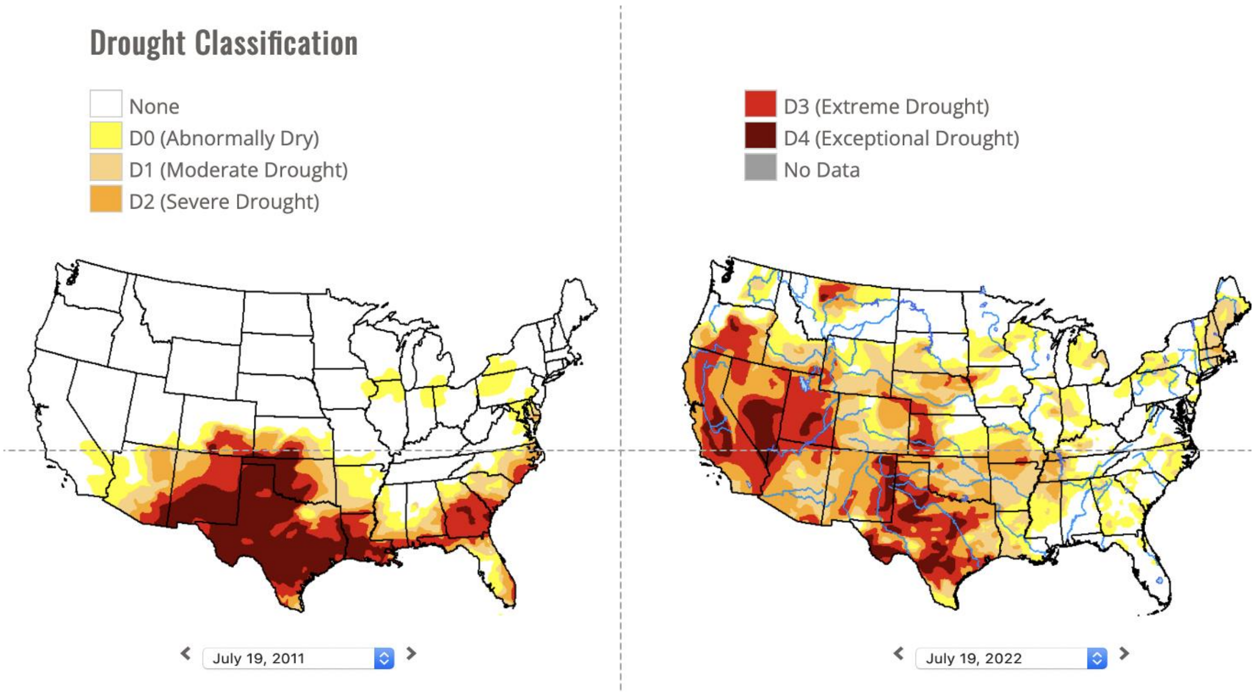

Figure 4: Comparison of drought conditions July 19, 2011 and July 19, 2022.
Source: US National Weather Service Climate Prediction Center,
https://droughtmonitor.unl.edu/Maps/CompareTwoWeeks.aspx

To state the obvious, the 2022 crop season to date is not typical. Higher than normal temperatures (a major driver of evapotranspiration, along with wind, solar radiation and low humidity) indicates atmospheric water demand is higher than average. For reference, a summary of long-term "average" crop water demand for cotton at Lubbock is shown in Figure 5.

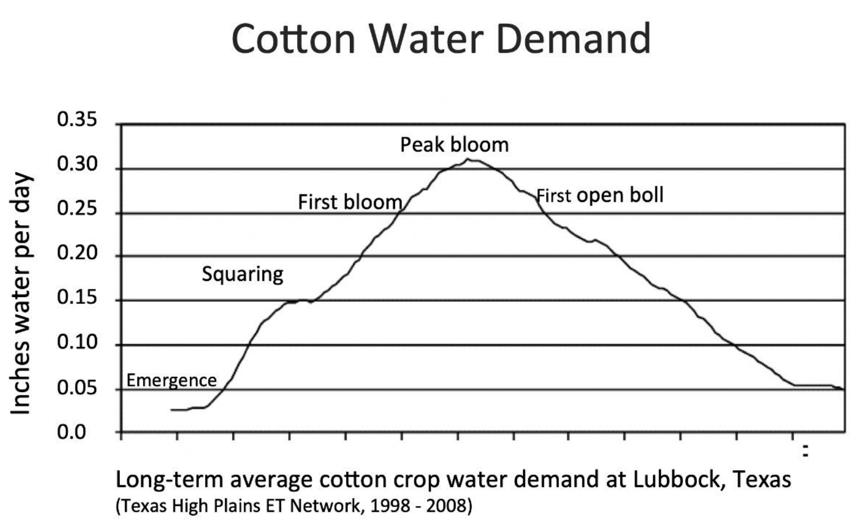

Figure 5. Long-term average cotton crop water demand (crop evapotranspiration) at Lubbock, Texas. Reference: Texas High Plains ET Network.

Relative drought sensitivity is an important concern in irrigation management decisions. Cotton and sorghum are more drought tolerant than corn, peanuts and soybeans. In fact cotton is often irrigated on a managed deficit irrigation strategy targeting 75-80% crop water demand (based upon atmospheric water demand estimates such as those noted in the above table), assuming high irrigation application efficiency afforded by well managed low pressure center pivot (LESA, LEPA) or subsurface drip irrigation systems.

Literature indicates cotton and sorghum require a minimum of approximately 13 inches of available water from stored soil moisture, rainfall and/or irrigation to achieve harvestable yield; full water demand in an "average" year is approximately 27 inches and 24 inches for cotton and sorghum, respectively. Water less than about 75% of this value, or 21 inches for cotton, would be expected to result in yield loss. Of course greater water deficit (drought stress) will result in greater loss in yield, and drought stress occurring at critical growth stages will result in greater yield and/or quality effects. Especially for drought sensitive crops (corn, peanuts), the decision of how much acreage can be irrigated realistically is especially critical in drought years.

Irrigation system capacity

Irrigation system capacity and soil water (moisture) storage are additional critical irrigation management considerations. Irrigation capacities based upon gallons per minute per acre are related to equivalent inches per day and inches per week in the following table.

Table 1. Irrigation capacity equivalents expressed in inches per day and inches per week

GPM/Acre	Inches per Day	Inches per Week
1	0.053	.037
2	0.11	0.74
3	0.16	1.11
4	0.21	1.48
5	0.27	1.86
6	0.32	2.23
7	0.37	2.59
8	0.42	2.97
9	0.48	3.34
10	0.53	3.71

These values assume a high irrigation application efficiency; lower efficiency systems will deliver lower effective irrigation application depths. For example, a 120 acre center pivot delivering 360 gpm will apply about 360 gpm/120 ac = 3 gpm/ac, or about 0.16 inches of water per day. (This is approximately the same as the long-term average of crop water demand at squaring.) If the application efficiency is 88%, the effective irrigation application is only about 0.16 in/day X 0.88 = 0.14 in/day. Many irrigation systems in the Texas Southern High Plains lack capacity to meet full crop water demand for bloom through first open boll periods of cotton development.

Stored soil moisture can help mitigate short term deficit irrigation and rainfall, but only if there is moisture stored in the root zone. Since roots grow in moist soil (neither saturated nor excessively dry soil), soil moisture profile during crop establishment can be very important in determining the relative volume of the effective root zone. Under extremely dry conditions and with limited irrigation capacities, it can be difficult to establish or maintain this stored soil moisture reserve. While many agronomic crops can develop effective root zones of up to 5 or 6 feet, most crops will get most of their water from the top 1-3 feet of soil.

Soils vary in their capacity to store plant available water, but generally speaking, finer textured (clay loam) soils can store more plant available water than coarser (sandy) soils. Approximate soil moisture storage capacities for selected South Plains soils are summarized below for 1, 2 and 3 ft root zone depths. The 50% Management Allowable Depletion (MAD) depths are also listed; MAD is often used to "trigger" irrigation applications to prevent drought stress induced by excess soil moisture depletion. Soil moisture monitoring is helpful in determining how much water is stored in a given field, and at what depth in the root zone it is stored. A method to estimate soil moisture by feel and appearance is described by the USDA-NRCS at https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wy/soils/?cid=nrcs142p2_026833. An overview of soil moisture monitoring is available at: http://www.ogallalawater.org/soil-moisture-monitoring/.

Approximate plant available water holding capacity
(Texas High Plains area)

Soil Series	Available H2O (inches water)			50% MAD (inches water)		
	1 ft. soil	2 ft. soil	3 ft. soil	1 ft. soil	2 ft. soil	3 ft. soil
Acuff	1.9	3.8	5.7	0.9	1.9	2.8
Amarillo	1.7	3.6	5.5	0.9	1.8	2.7
Brownfield	1.2	2.4	3.6	0.6	1.2	1.8
Olton	2.0	4.1	6.1	1.0	2.0	3.0
Pep	1.8	3.5	5.0	0.9	1.7	2.5
Pullman	1.9	3.8	5.7	0.9	1.9	2.8
Sherm	2.0	3.9	5.7	1.0	2.0	2.9

As well capacities decline, center pivot irrigation irrigation nozzle packages (or microirrigation zone management) may need to be adjusted to match capacities and ensure uniform water application. It is notable that the irrigated area under the outer spans of a center pivot irrigation system cover the largest area, so reduced water application to the outer spans will have proportionally larger effects on total crop yield. It also is worth noting that renozzling will change the center pivot application calibration. With declining irrigation capacities, especially under drought conditions, it may become necessary to reduce acres irrigated. If this decision is made in-season, it is helpful to have a realistic understanding of irrigation capacity, irrigation system performance, crop water demand, and climate outlooks.

Crop insurance concerns should be addressed with USDA-RMA Approved Insurance Providers. Insurance of irrigated crops requires adequate facilities and reasonable expectation of receiving water adequate to carry out "good irrigation practice", as well as other requirements and conditions (https://www.rma.usda.gov/en/News-Room/Frequently-Asked-Questions/Crop-Insurance-and-Drought-Damaged-Crops). Often this is interpreted to mean that during drought, irrigation of a crop must continue through the crop season to meet good irrigation practice requirements, and therefore ensure that drought-related crop loss is due to unexpected shortfall of normally expected rainfall, rather than failure to irrigate. However, during extreme drought conditions, irrigation may be diverted to salvage crops under some conditions, with prior approval from Approved Insurance Provider (https://www.rma.usda.gov/en/News-Room/Frequently-Asked-Questions/Crop-Insurance-and-Drought-Damaged-Crops).

Salinity concerns

For the most part, water quality in the Ogallala Aquifer is very good. Yet localized elevated salinity levels in the Ogallala Aquifer, as well as water from the Dockum Aquifer and wastewater effluent sources merit special management consideration. Effects of salinity are more obvious in the current droughty conditions, as there is less opportunity for dilution or leaching of salts by rainfall or by limited irrigation capacities; hence salt accumulation in the seedbed and root zone may be more obvious. Foliar damage by salts in irrigation water is more likely to be a concern with sprinkler irrigation methods. LEPA, subsurface drip or furrow irrigation can reduce foliar exposure to salts where that is a concern. Salinity effects are often most obvious in outer spans of center pivot irrigation fields, often indicating the exacerbating effect of deficit irrigation and likely also indicating a decline in irrigation capacity (well decline). If this is the case, renozzling the center pivot system is probably justified, since the outer spans of the center pivot system represent a large portion of the total acreage under that system. Additional information on management of salinity in irrigation water is available at: https://www.ksre.k-state.edu/irrigate/oow/p06/Porter06.pdf and https://itc.tamu.edu/files/2019/12/B-1667_irrigation-water-quality-standards.pdf.

Additional information and resources

The Kansas State University Research and Extension Mobile Irrigation Laboratory (http://www.ksre.ksu.edu/mil/Tools.htm) offers some convenient online irrigation management tools, including a *Compare Energy Costs* calculator to help with energy conversion decisions and a *Crop Water Allocator* to assist in allocating limited irrigation resources between crops for greatest economic return.

The U.S. Drought Monitor website (https://www.drought.unl.edu/monitoring.aspx) provides additional information on the current drought conditions. Additional irrigation reference materials summarizing applied irrigation research, irrigation technologies and best management practices are included on the Texas A&M AgriLife Extension Service Cotton resources page at http://cotton.tamu.edu/Irrigation.html.