



Ogallala Aquifer Program

Sustaining rural communities through new water management technologies

Accomplishments for FY16

1. Soil organic matter declined by over 40% after 80 years of cropping. Organic carbon and total nitrogen are important constituents of a healthy soil for crop production; however how soil and crop management optimize these parameters are not fully understood. Scientists from USDA-ARS, Texas A&M AgriLife Extension Service, University of Texas at Austin, and Cotton Research Institute, Kibray District Taskent (Uzbekistan) evaluated long-term (30 - 86 yrs.) soil organic carbon (SOC) and total soil nitrogen (TSN) changes under dryland wheat-fallow and wheat-sorghum-fallow rotations on a clay loam soil in Bushland, Texas. SOC declined by 41% after 86 years of cultivation with half of the estimated change occurring during the first 20 years. Synthetic fertilizer N applications will need to be gradually increased with time to supplement native N sources. These results are of interest to farmers, crop consultants and extension agents who grow dryland wheat and sorghum or advise such growers.

2. Soil heating successfully modeled. Irrigated crops consume a large portion of freshwater resources, but irrigation results in up to four times greater crop production compared with non-irrigated crops. It is therefore important to manage irrigation water in order to maintain or increase crop production for a growing world population while conserving freshwater resources for municipal, industrial, environmental, and recreational uses. Management of irrigation water requires knowledge of crop water use; however, crop water use is related to numerous complex factors. One important factor is how much the soil beneath a crop is sunlit or shaded. Sun lighting and shading of the soil change with time of day, type of crop, crop row direction, and crop growth stage, among other factors. Scientists from ARS laboratories in Bushland, Texas and Beltsville, Maryland, and Ben-Gurion University of the Negev, Israel developed and tested a new mathematical model to calculate soil sun lighting and shading beneath a row crop. The new model resulted in improved estimates of factors related to crop water use. The use of this model will improve irrigation water management and conserve freshwater resources.

3. Water models underestimate evapotranspiration (ET). Groundwater resources are finite and becoming increasingly scarce. Effective water and crop management strategies are needed to maximize and extend the use of these limited resources. In agriculture, crop water use is the major use of rain and irrigation water. Models are commonly used to evaluate alternative water management strategies for their potential to maximize water use efficiency. In this study, scientists from ARS in Bushland, Texas and Texas A&M AgriLife compared simulated daily and monthly ET from the Soil and Water Assessment Tool (SWAT), one of the most widely used hydrologic models, under both irrigated and dryland management practices in the semiarid Texas High Plains to measured ET data from large lysimeters. Results indicated that the SWAT model generally underestimated both daily and monthly ET. Underestimation was worst under dryland conditions. These results indicate that the SWAT model is not accurately simulating a large water loss in semiarid regions.

4. Estimations for evapotranspiration (ET) were inaccurate. Accurate daily reference ET is needed for efficient water management from field to regional scales. To meet this need, scientists at National Oceanic and Atmospheric Administration have developed spatially representative daily reference ET maps for the contiguous United States using data from non-agricultural weather networks. These maps are expected to be used as input into various water demand and availability models. In this study, scientists from ARS in Bushland, Texas, NOAA, U.S. Geological Survey, and Texas A&M AgriLife Research evaluated the accuracy of the NOAA reference ET maps using data from the agriculture-based Texas High Plains ET network. Results showed that the NOAA reference ET values were generally higher than that from the Texas High Plains ET network. Therefore, a bias correction to air temperature and wind speed data used in generating NOAA reference ET or adjustment to the resulting NOAA reference ET may be needed to improve its accuracy.

5. Drought tolerant corn produces similar yields with less water. Corn is an important crop for feeding livestock in the Central and Southern High Plains of Texas. Drought tolerant varieties of corn are now available to farmers. However,

there is little information to determine if these new varieties use less water than common varieties and produce similar yields. ARS scientists at Bushland, Texas and scientists from West Texas A & M University used soil water measurements to determine the weekly amount of water to apply to drought tolerant and non-drought tolerant corn varieties that were grown side-by-side. The drought tolerant variety required less water and produced similar yields when water was applied to meet the full demands of the crop or slightly less than optimal.

6. Water availability from the Ogallala Aquifer will be half in 2110. Water availability from the Ogallala Aquifer has been declining since the development of widespread irrigation in 1950. However, water users and policy makers have a poor understanding of future water availability. Therefore, scientists from Kansas State University in the ARS led Ogallala Aquifer Program applied approaches to estimate peak withdrawals and future depletion of oil reserves to groundwater withdrawals from the Ogallala Aquifer. Peak aquifer depletion occurred in 2006 and annual depletion will be less than half in 2110. Peak depletion occurred in 1999 and 2010 for Texas and Kansas, respectively. These results are of interest to farmers and water policy makers in making decisions regarding water conservation.

7. Cotton's future on the Texas High Plains remains bright. The Texas High Plains contributes about 25% of the U.S. cotton production; however, future production is uncertain because of dwindling groundwater resources from the underlying Ogallala Aquifer, and future climate variability. Scientists from Texas A&M AgriLife Research, ARS, Cotton Incorporated and IntegraShare Solutioneering Inc. working under the ARS led Ogallala Aquifer Program assessed impacts of climate change on cotton production using crop growth simulation models. The evaluated model was able to accurately simulate seed cotton yield under various irrigation strategies over the four growing seasons. Predicted changes in atmospheric carbon dioxide during the 21st century led to increases in predicted cotton yields, while decreases in groundwater availability decreased predicted cotton yields. These results imply that cotton production on the Texas High Plains will remain a viable option for agriculture despite changes in climate and decreasing groundwater availability.

8. Irrigation cannot overcome predicted decreases in corn and soybean yields due to climate change. Future crop yields on the Southern High Plains are uncertain because of the effects of climate change and decreasing water availability from the Ogallala Aquifer. However, information is needed to determine the role of irrigation application on abating the potential effects of increasing heat stress. In this study, scientists from Kansas State University in the ARS led Ogallala Aquifer Program and assessed the adaptive effects of

irrigation on climatic risks for maize, soybean. Results show that irrigation has a significant effect on abating extreme heat in maize and soybean. Approximately two-thirds of the negative effects of extreme heat under rainfed management could be abated by irrigation. However, the remaining third of the yield reduction is caused by heat damage that cannot be alleviated by irrigation. Means other than irrigation will be needed to maintain corn and soybean yield under predicted changes in temperature.

9. Continuous corn has greater returns when groundwater is limiting. As water availability from the Ogallala Aquifer decreases, farmers need management options that optimize returns from limited irrigation water. Scientists from Kansas State University in the ARS led Ogallala Aquifer Program compared the response of corn, sorghum, sunflowers and soybeans to variable rates of irrigation water. When only 5 inches of irrigation water is available, yields and returns from corn, sorghum, soybeans and sunflowers were comparable. With 10 to 15 inches of irrigation water, returns from corn were higher than other crops. These results are of interest to farmers and crop consultants in helping to deal with low irrigation capacities.

10. Unique plant genetic resources maintain yields under drought and saline stresses. Fructokinase, an enzyme key to sugar metabolism, may alter how plants convert sugars into other carbohydrates. Scientists from Texas Tech University, Tohoku University, Henan Agricultural University, Zhejiang Academy of Agricultural Sciences and Karadeniz Technical University and Agricultural Research Organization, Volcani Center in an ARS led Ogallala Aquifer Program examined cotton lint fiber as affected by overexpressing professional fructokinase or sodium transporters. Plants overexpressing fructokinase had larger leaf area and enhanced lint yield, and plants with greater sodium transports could tolerate up to 250 mm sodium chloride. These results are of interest to plant breeders trying to create plants for water limited and/or saline environments.

11. Subsidies for water savings and water efficient crops will encourage water conservation. Scientists from Texas A&M AgriLife Research, South Dakota State University and Black Hills State University analyzed the effects of four conservation policies: 1) subsidy for efficient irrigation systems; 2) increased cost of water; 3) subsidy for water savings; and 4) subsidy for water efficient crops. In areas where groundwater is limiting subsidies for water savings and/or water efficient crops achieved water conservation. These results are of interest to water policy makers like those in the High Plains Water District in Texas.

Review Publications

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