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Ogallala Aquifer Program

Sustaining rural communities through new water management technologies

Accomplishments for FY14

1. Early maturing sorghum hybrids are more water efficient than later maturing hybrids. Water resources for crop production are limited, and rainfall amounts and timing are unpredictable on the Southern High Plains. Sorghum is drought tolerant relative to corn, making it a better crop where water availability is limited; however, the rain patterns can make it difficult for producers to determine type of hybrid, planting date, and irrigation strategy. In this study, ARS scientists at Conservation and Production Research Laboratory (Bushland, Texas) compared yields and water use efficiency between a later maturing sorghum hybrid planted early in the growing season with an early maturing hybrid planted in June. The advantage to using the early maturing hybrid in years of moderate drought was that water use efficiency was greater than for the later maturing hybrid. During exceptional drought, both hybrids were only able to produce expected yields if irrigation was applied at 80% of evapotranspiration. These results are of interest to sorghum growers in planning hybrid selections and irrigation strategies.

2. Predictions of La Nina mean more water needed for cotton on the Southern High Plains. The falling Ogallala Aquifer level under the U.S. Southern High Plains prompts farmers to improve water use and use more water-smart crops like cotton; however, new tools and management are needed to decrease dependence on the Ogallala Aquifer for irrigation water. The El Nino-Southern Oscillation (ENSO) causes likely weather patterns on the Southern High Plains that could be used when making irrigation decisions. The goal of this research was to optimize cotton yield under various scenarios during La Nina, neutral, and El Nino years. ARS scientists from the Conservation and Production Research Laboratory (Bushland, Texas) and Cropping Systems Research Laboratory (Lubbock, Texas) found that La Nina years had less rain during the growing season than neutral and El Nino phases. Cotton crop models predict yields increase with greater irrigation for drier La Nina growing seasons. These results indicate that farmers need to plan for greater irrigation demand during a predicted La Nina growing season.

3. Groundwater conserved today will increase Ogallala Aquifer's life cycle crop production. As water available from the Ogallala Aquifer declines, water policy makers will need information regarding the possible consequences of their policies. Scientists from Kansas State University in ARS' Ogallala Aquifer Program evaluated past and future trends in agricultural production and water withdrawals from the Ogallala Aquifer. Results indicated that 30% of the groundwater under the Kansas High Plains has already been depleted and an additional 39% will be withdrawn by 2060 under current practices. Results also indicated that groundwater conserved today will yield more crops in the future because of the continued increases in crop yields. These results indicate that overall agricultural productivity and possibly farm income can be increased by conserving groundwater today.

4. Simple energy balance can be used to develop evapotranspiration maps to guide water use. Evapotranspiration (ET) maps for large irrigated regions are essential for developing and evaluating irrigation management strategies. The operational Simplified Surface Energy Balance (SSEBop) approach was developed for this purpose; however, the SSEBop is not evaluated for its ability to derive ET fluxes from Landsat satellite datasets. In this study, the performance of the SSEBop for estimating daily and seasonal ET was evaluated as compared with lysimeter-measured crop ET under dryland and irrigation management practices by scientists from Conservation and Production Research Laboratory (Bushland, Texas), U.S. Geological Survey, and Texas A&M AgriLife Research. Results demonstrated that the SSEBop can produce quick and accurate ET maps that can be used for managing water resources at regional scales. These results may lead to methods for both farmers and water district managers to partition limited available water for irrigation.

5. Determining level of compensation for farmers not to irrigate will be difficult. Water conservation practices will hopefully extend the longevity of the Ogallala Aquifer on the Southern High Plains; however, the economics of potential conservation practices are not known. Scientists from ARS, Kansas State University, Texas A&M AgriLife Research and Extension Service, Texas Tech University, and West Texas A&M University tried to determine the amount that farm-

ers should be paid not to irrigate. The results indicated that determining such a compensation level will be difficult because many factors will need to be considered, including well capacity, suitable crops for an area, and commodity prices. These results are particularly important to farmers, and water policy makers in Texas because of a recent state court ruling that farmers should be compensated when water policies reduce their ability to maximizing water withdrawals and irrigated crop income.

6. Wheat prefers to follow fallow rather than oil seed crops. Dryland and minimally irrigated cropping systems on the Southern High Plains typically include a summer fallow period to capture rainfall for the succeeding crop. However, these production systems do not generate income every year. Alterative cropping systems without a fallow period were compared to the profitability of wheat-fallow in western Kansas. Replacing the summer fallow with an oil seed crop like soybeans or sunflowers decreased the yields of succeeding wheat, resulting in decreased returns relative to continuous wheat or wheat-fallow systems. These results by Kansas State University scientists working in the ARS-led Ogallala Aquifer Program indicate that wheat rotations with oils seed crops are not as economically suitable as wheat and wheat-fallow systems.

7. Climate variability may affect land prices for irrigated acres more than for dryland and rangeland acres. One of the major factors affecting the relative prosperity of agricultural communities is the price for farm land. There is little information on the effects of possible climate change and declining water availability from the Ogallala Aquifer on land prices on the Southern High Plains in Texas. Scientists from Texas Tech University in the ARS-lead Ogallala Aquifer Program evaluated land prices for irrigated and dryland crop acreages, and rangeland from 1991 to 2030 under different climate scenarios. The results indicated that the price of irrigated acres would be more affected by changing climate than would dryland acres or rangeland. These results are of particular interest to water and farming policy makers.

8. Processing data from large weighing lysimeters. As the world's population grows, the scarcity of fresh water for different uses will increase, creating an environment in which agriculture must be water efficient. Evapotranspiration (ET) is the major use of irrigation water and rain. The ET estimation methods can be tested against ET measured using weighing lysimeters. Global interest in ET has resulted in an increased number of lysimeters and measured ET data; however, limited information is available on the proper collection and processing of these data. ARS researchers from Conservation and Production Research Laboratory (Bushland, Texas) developed guidelines and processing methods designed to minimize errors in lysimeter ET data. These results are of interest to other ET researchers and stakeholders who use data derived from such instruments.

9. New program to determine soil moisture more accurately. Accurate soil moisture measurements are required for efficient irrigation management and making decisions about dryland cropping practices. Time domain reflectometry (TDR) is a standard method used to measure soil water content that requires the evaluation of the signals recorded by instruments, and the current computer programs to interpret waveforms can cause large errors. User input of program parameters is often necessary. Research objectives were to develop a new computer program that requires no user input, and reduces water content errors. ARS scientists from the Conservation and Production Research Laboratory (Bushland, Texas) created a new adaptive computer program that yielded consistent evaluation of water contents, and required no user intervention. This program and the underlying principles will be of interest to soil scientists and landowners making decisions regarding water management.

10. Improved crop water use model developed. As water availability from the Ogallala Aquifer declines, farmers will need to implement both irrigation and dryland farming strategies that maximize crop water use, i.e., transpiration, and minimize evaporation from the soil. Evaporation and transpiration are difficult to measure. Therefore, crop water use models are needed that calculate evaporation and transpiration. Scientists from ARS' laboratories in Bushland, Texas, and Beltsville, Maryland, and Ben-Gurion University of Negev found that a commonly used crop water use model overestimated evaporation and underestimated transpiration. A revised model was created, which did a better job of calculating evaporation and transpiration. This knowledge and use of the model will help researchers create new management practices that will reduce evaporation losses from crops, and thus sustain or increase crop production in areas where water is limiting.

11. Feed grain is multi-billion dollar industry on the Southern High Plains. As water availability from the Ogallala Aquifer on the Southern High Plains declines, water policy makers and other water users will need information on the economic productivity used by various sectors of the agricultural economy. Scientists from ARS, Kansas State University, Texas A&M AgriLife Research and Extension Service, Texas Tech University, and West Texas A&M University analyzed data to determine the value of the region's feed grain industry. The feed grain industry (crop production and processing, but not consumption by livestock) was estimated to generate $2,400 per acre foot of water used, totaling $9 billion annually. These returns per acre foot of water used doubled the returns per water use for irrigated crop production. Water use planners and policy makers need

knowledge of the returns per unit of water used by various agricultural industries so that decisions regarding water allocations from the Ogallala Aquifer can have optimal effects on regional economies.

12. Central High Plains growing season is increasing. Recent assessments indicated that agriculture on the Southern U.S. Great Plains is particularly vulnerable to projected changes in climate, and frost days can be indicative of changes in climate over time. In this study, scientists from Kansas State University and ARS (Bushland, Texas) developed frost indices for Kansas. Results indicated that there was a general increase in minimum air temperature and length of the growing season. Detailed geographical and temporal variations of the frost indices revealed in this study can be beneficial for updating management decisions and planting date recommendations for local and regional agricultural productions.

13. Method developed to estimate solar radiation where data are limited. Solar radiation plays an important role in hydrological processes. The lack of observed solar radiation data in developing countries and remote areas of developed countries, including the U.S., limited the ability to estimate future solar radiation scenarios for climate change impact studies. There are no clear guidelines to derive future solar radiation scenarios for regions where data are either measured sparsely or not at all. In this study, scientists from India and ARS (Bushland, Texas) developed guidance to estimate future solar radiation scenarios under different circumstances. Results are of interest to climatologists, agronomists and hydrologists to better understand hydrological processes where data are not robust.

Review Publications

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