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Ogallala Aquifer Program

Sustaining rural communities through new water management technologies

Accomplishments for FY15

1. Automated variable rate irrigation control successfully tested. Commercial variable rate irrigation (VRI) center pivot systems can help producers improve crop water use efficiency by controlling where, when and the amount of water applied. These systems require a special set of instructions or a prescription map to control sprinkler movement and watering rates; however, a farmer typically has no data on spatial variation of crop water needs throughout the irrigation season. Working with a CRADA partner, ARS scientists at Bushland, Texas used a wireless network of multiband sensors with their patented Irrigation Scheduling and Supervisory Control and Data Acquisition system (ISSCADAS) to control a commercial VRI system and manage the irrigation of a cotton crop. Lint yields from the automatic-control plots were similar to yields from manual-control plots where irrigation scheduling was accomplished by time consuming soil water content measurements. The patented ISSCADAS system will assist farmers in monitoring crop water stress over a large field and making irrigation management recommendations, which can save time, improve management and optimize crop water use efficiency.

2. New soil water sensor can save millions of dollars by reducing irrigation applications. Knowledge of soil water is needed for efficient irrigation management; however, commercially available soil water sensors have been either too inaccurate or too expensive for routine use in crop management. ARS scientists at Bushland, Texas worked with a commercial partner to develop a new, miniaturized and highly accurate electronic soil water sensor that reduces the cost by 10-fold while maintaining the accuracy needed for irrigation management. The new sensor, jointly patented by ARS and the private firm, hit the market in spring 2015 and has already been adopted by a major, nationwide agricultural consulting firm. Accurate irrigation management allows limiting irrigation without unnecessary yield declines and so increases crop yield per unit of water applied. Savings in the Texas Panhandle alone could exceed $10 million annually if fully implemented.

3. Wireless plant temperature sensor facilitates irrigation management. Crop water use efficiency will need to increase to feed the 9 billion people in 2050, and scheduling irrigation by crop canopy temperatures is one tool to accomplish increases in water use efficiency. ARS research has shown that canopy temperature sensors called infrared thermometers (IRTs) can be used to improve irrigation scheduling and thus crop water use efficiency. However, the wiring associated with IRTs makes on-farm use impractical. ARS scientists at Bushland, Texas, developed a wireless, low power IRT that uses radio waves to transmit crop temperatures to a central irrigation controller. The scientists worked with a private firm to commercialize their design, which is now available to the public. The wireless IRTs are used in sensor networks to pinpoint the location of crop water stress, allowing commercially available variable rate irrigation systems to respond appropriately to improve crop yield.

4. Irrigation scheduling using soil moisture sensors needs additional data to be accurate. As water availability from the Ogallala Aquifer for irrigation decreases on the Southern High Plains, farmers need to implement practices and technologies that will produce as much crop with the least amount of irrigation water. Scientists from Kansas State University in the ARS-led (Bushland, Texas) Ogallala Aquifer Program examined the ability of commercially available soil sensors to guide irrigation scheduling. Although there have been recent advances in soil moisture sensors, their accuracy for measuring soil moisture was not sufficient use as a stand-alone guide for irrigation scheduling. However, these soil moisture sensors played a vital role in scheduling irrigation application when used in conjunction with other inputs like evapotranspiration data, and crop water stress as detected by infrared thermometers

5. A sensor to curtail irrigation applications in the spring for disease-infected winter wheat. As water availability from the Ogallala Aquifer for irrigation decreases on the Southern High Plains, farmers need tools to determine when it is economically viable to irrigate winter wheat in the spring. Scientists from Texas A&M AgriLife Research and ARS (Bushland, Texas) investigated the possibility of detecting wheat streak mosaic infection early in the spring since severely infected

crop does not yield more when irrigated. The results indicated that the severity of wheat streak mosaic infection could be determined by ability of the wheat leaves to reflect certain color of light. Further, these researchers found that the severity of infection could be detected as early as mid-April. These results are of interest to farmers, crop consultants and companies that can create either on pivot or drone based sensors.

6. Crops need to be resistant to biotic stresses so that farmers can realize the full potential of the limited irrigation water available. Wheat curl mites are the vector for the spread of wheat streak mosaic, a disease which can substantially reduce the response of winter wheat to spring irrigation applications. Scientists from Texas A&M AgriLife Research and West Texas A&M University in the ARS-led Ogallala Aquifer Program (Bushland, Texas) examined the resistance of the wheat variety TAM 112 to curl mites. Resistance was found to be governed by at least two genes, both dominant in nature. This information is useful in the development of future wheat varieties for the Southern High Plains that will be able to fully utilize irrigation application because of their low infection rates of wheat curl mites and streak mosaic.

7. Vegetable crops are an alternative to conventional row crops in areas with limited water for irrigation. As water availability from the Ogallala Aquifer for irrigation decreases on the Southern High Plains, some farmers may redirect their limited water resource to high values crops to maintain farm profitability. However, there is little information on water use efficiency and yields for high value vegetable crops. Researchers from Texas A&M AgriLife Research and ARS (Bushland, Texas) compared the yields and water use of several vegetable crops from bell peppers to watermelons. Substantial yields of marketable vegetables were possible with water efficiency being best with peppers. These results are of interest to farmers, crop consultants, and others who are looking for ways to maintain farm income while using less irrigation water.

8. Grain sorghum can reduce risk of dryland farming while being able to increase profits during a wet summer. Dryland farming will increase on the Southern High Plains as water available for irrigation from the Ogallala Aquifer decreases. Farmers, crop consultants, extension agents and etc. will be better able to develop farm strategies if they have knowledge of the relationship between crop yields, and in season precipitation. Researchers from West Texas A&M University in the ARS-led Ogallala Aquifer Program examined 40 years of crop yield and weather data to determine the relationship between summer rainfall and sorghum grain yields. Results indicated that at least 13.6 inches of rain occurred half of the time which resulted in the production of 2,200 pounds of grain sorghum per acre and a net profit of $27 per acre. A ten percent decrease in the rainfall decreased net profits by only $1 per acre, while a ten percent increase in rain increased net profits by $13 per acre. The results indicate that dryland grain sorghum provides some protection from risk from low rainfall while allowing farmers to net more profits in rainy summers.

Review Publications

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Lin, X., Hubbard, K.G., Mahmood, R., Sassenrath, G.F. 2014. Assessing satellite-based start-of-season trends in the U.S. High Plains. Environmental Research Letters. 9(10). doi:10.1088/1748-9326/9/10/104016.

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USDA ARS United States Department of Agriculture Agricultural Research Service

Kansas State University

Texas Tech University

West Texas A&M University