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Annual Report for FY20

Sustaining rural communities through new water management technologies

Progress Report

The Ogallala Aquifer Program (OAP) is a research and education consortium seeking solutions to problems arising from declining water availability from the Ogallala Aquifer on the Southern High Plains. The consortium includes Kansas State University, Texas A&M AgriLife Research and Extension Service, Texas Tech University, West Texas A&M University, and the USDA ARS National Program 211 research projects at Bushland and Lubbock, TX. OAP funding is from the USDA ARS at Bushland, and OAP management is led by ARS at Bushland with cooperation of a management team composed of the principle investigators for the funding agreements with the four universities.

University and ARS collaborators in the OAP produced 13 publications in FY20 and in prior years that were not reported previously. These are listed in the publications for this research project. These publications support the seven substantive accomplishments reported here.

Accomplishments

Use of soil and leaf sensors improve irrigation scheduling for water conservation. Because of limited water resources for crop production on the Texas High Plains, producers are interested in growing grain sorghum, which requires less water than corn to produce maximum yields. However, precision irrigation scheduling tools are needed to optimize regional sorghum production. Thus, ARS scientists at Bushland, Texas, the Rural Development Administration of South Korea, and University of Nevada at Reno have used automated irrigation scheduling based on leaf canopy temperature with and without data from soil moisture sensors to manage grain sorghum at high, medium and low irrigation levels. The results indicate that plant and soil water sensing with multiple stress thresholds and several different irrigation volumes led to the most water efficient irrigation management for grain sorghum. The methods achieving the highest yield per unit of water used were readily automated. Irrigators can benefit from implementation of such sensors and control system by reduced groundwater withdrawals, reduced energy input cost, and time savings.

Leaf sensors mounted on a center pivot are accurate. In times of low crop prices, farmers need to produce crops as inexpensively as possible. One way farmers can decrease input costs is to apply irrigation only as needed. Crop leaf temperatures can be easily measured by sensors, which provide a real-time assessment of water stress and data for irrigation scheduling. However, users of temperature sensors have been concerned that measurements from sensors mounted on a center pivot may not be as accurate as non-moving (stationary) sensors. Therefore, ARS scientists from Bushland, Texas, compared irrigation scheduling based on data from stationary temperature sensors to those mounted on a center pivot. There were no differences in accuracy between stationary or moving temperature sensors and irrigation application governed by one type of sensor was similar to scheduling governed by the other. Center pivots are now used on 30 million acres in the U.S. and nearly 90% of irrigated land over the Ogallala Aquifer. Installing temperature sensors aboard center pivots and using them for irrigation scheduling could save farmers substantial water and reduce energy input costs.

Late planted corn required less irrigation water. Declining water levels in the Southern Ogallala Aquifer region require alternative management strategies to reduce groundwater withdrawals while maintaining profitable crop yields. Delayed planting of corn on the Texas High Plains is believed to reduce irrigation requirements by taking advantage of increased precipitation and reduced crop water demand. However, limited field data exist for corn planting dates in the region. ARS researchers at Bushland, Texas, and Texas A&M AgriLife used a calibrated Soil Water Assessment Tool (SWAT) model with long-term historical climate data to simulate corn irrigation and yields for both long and short season corn varieties. Simulation results suggested that irrigation requirements of mid-June planted corn were at least 25% less while grain yields decreased by less than 9%. Data from field experiments conducted in 2016 and 2017 with drought tolerant corn hybrids verified the trends identified from modeling experiments. These results indicate that the delayed planting of corn combined with effective irrigation management have the potential to reduce groundwater withdrawals from the Ogallala Aquifer. These results are of interest to irrigators as a means of extending their groundwater resource and decreasing their energy input costs.

Sub-surface drip reduces seasonal irrigation needs for corn. In the face of declining water supplies, it is important that crop farmers maximize the yield per unit of water used in crop production, the so-called crop water productivity (CWP). It is not well understood how irrigation application methods affect CWP. ARS scientists at Bushland, Texas, compared the water use and yield of grain corn and sorghum grown using sprinkler and subsurface drip irrigation (SDI) methods. Using the SDI application method, losses of water to evaporation from plant and soil surfaces were reduced by at least two inches and as much as five inches during the growing season as compared to losses that occurred with sprinkler irrigation. SDI reduced overall corn water use by up to 6 inches and increased grain yields by up to 20%. The combined effects were an increase in CWP by up to 46% compared with sprinkler irrigation. Increases in CWP are sufficient to overcome the higher installation of cost of SDI.

Successful irrigation scheduling must account for dry subsoils. Development of sustainable and efficient irrigation management is a priority for agricultural producers faced with water shortages. Yield and profitability of irrigated crop production depends on accurately evaluating crop water needs. However, estimates of crop water use can be inaccurate. Therefore, scientists from ARS in Bushland, Texas, University of Castilla La Mancha, Spain, and Texas A&M AgriLife Research used a corn water use model to evaluate the impact of dry subsoil conditions on corn yields. Results indicated that the irrigation strategy for optimum corn yields required deep infiltration of the irrigation water to encourage root growth at deeper soil depths. Similarly, scientists found in a field experiment with grain sorghum that maximum water use efficiency and optimum grain yields were achieved when irrigation applications favored root growth to a soil depth of 5 feet. The results indicate that irrigation applications that encourage higher soil water content in the subsoil were optimum for higher grain production. These results are of interest to irrigators, farmers, and consultants especially those irrigating summer crops after a dry spring and / or winter.

Crop water model identified farms that could conserve groundwater. The fresh water supply for irrigation is decreasing because of dwindling supplies and increased competition for other uses. Water use for irrigation can be reduced by matching applications to crop needs. Theoretically, models can estimate crop water needs using satellite and weather data. An advanced crop water use model was shown to accurately estimate water use of corn in small experimental fields, but the model has yet to be tested on large commercial fields over several seasons. Therefore, ARS scientists at Bushland, Texas, along with researchers from Kansas State University tested the model over a large area in Northwest Kansas using data from five years. The model matched irrigation and precipitation data obtained from farmers' fields during the irrigation season, but the model over-estimated irrigation needs later in the cropping season. The model identified fields that were irrigated more than needed for optimum crop yields. Identifying areas for improved water conservation is necessary for different water management areas in Kansas where groups of farmers are trying to meet agreed upon limits on groundwater withdrawals, thus these results are of interest to farmers, and water policy makers.

Publications

Bell, J.M., Schwartz, R.C., McInnes, K.J., Howell, T.A., Morgan, C.L. 2020. Effects of irrigation level and timing on profile soil water use by grain sorghum. Agricultural Water Management. 232(2020):106030. https://doi.org/10.1016/j.agwat.2020.106030.

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