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Annual Report for FY17

Sustaining rural communities through new water management technologies

Progress Report

Ogallala Aquifer Program (OAP) is an ARS led 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 the NP211 research projects at Bushland and Lubbock, TX and Kansas State University, Texas A&M AgriLife Research and Extension Service, Texas Tech University and West Texas A&M University. Currently each OAP participating university has two NACA, one originated in FY2012 (project numbers 3090-13000-15-05S through 08S) and one originating in FY2015 (project numbers 3090-13000-15-09S through 12S). The FY2012 NACAs terminate on August 31, 2017. No FY2016 funds will be added to the FY2012 agreements; research projects funded under these agreements are nearing completion. Funds from FY2017 will be added to the FY2015 agreements to support research projects in FY2018 and FY2019.

University collaborators in the OAP produced 12 publications in FY16 without ARS scientists as co-authors, of which 5 were from Kansas State University, 4 from West Texas A&M University, and 3 from Texas Tech University. These are listed in the publications for this research project. In addition 5 publications with ARS scientists from Lubbock, TX (3) and El Reno, OK (2) were published in FY16 from OAP supported research.

In September 2016, the American Society of Agronomy and Crop Science Society of America published an update to their sorghum monograph called Sorghum: State of the Art and Future Perspectives, Agronomy Monograph 58. The monograph was edited by two scientists in the Ogallala Aquifer Program from Kansas State University, Drs. I. Ciampitti and V. Prasad. The topics include genetic improvements, development of new hybrids, biotechnology, and physiological modifications, water and nutrient management, rotations, pest control, final end uses, sorghum as a bioenergy crop, markets, and the future of sorghum are presented. Nine of the 16 chapters have participants from Ogallala Aquifer Program as authors.

In 2014, the previous web site for the Ogallala Aquifer Program had to be inactivated due to internet security concerns. On May 5, 2017, a new website was created for the Ogallala Aquifer Program and that website is: http://ogallala.tamu.edu/ . The site and its content is being managed by the Texas Water Resource Institute. The site will provide information of projects, news items, events, awards, other activities or story ideas related to Ogallala Aquifer Program.

In March 2017, the OAP sponsored a meeting of approximately 60 irrigation specialists from federal and state agencies, and the private sector to plan technology transfer events in FY2018 to celebrate 40 years of sprinkler irrigation on the High Plains. The annual OAP was not held in FY2017.

Accomplishments

Irrigation requirements for rotations defined for Texas High Plains.

Groundwater resources on the Southern High Plains are finite and becoming increasingly scarce. Crop water use is the major use of rain and irrigation water. However, crop rotation strategies that minimize groundwater use will help to extend these resources. Thus, researchers from USDA-ARS (Bushland, TX) and Texas A&M AgriLife Research used the SWAT model and long-term weather data to characterize irrigation requirements of several crop rotations used in the Texas High Plains. Results may serve as a decision tool for producers considering alternate crop rotation strategies by providing irrigation requirements for comparison to known irrigation capacities.

Popular crop model overpredicts corn growth under limited water.

Water scarcity due to drought and groundwater depletion has led to an increased number of modeling studies aimed at evaluating crop response to limited irrigation. The Decision Support System for Agrotechnology Transfer (DSSAT) is a widely used crop growth model. However, the ability DSSAT

to represent crop response and water balance under limited irrigation is not well studied. Therefore, scientists from ARS (Bushland, TX) and Texas A&M AgriLife compared simulated and measured plant growth values for corn grown in the Texas Panhandle under full and limited irrigation. Results showed that DSSAT overestimated corn growth, yield, and crop water use (evapotranspiration) under limited irrigation. These results are of interest to agronomist, plant physiologists and crop modelers because they demonstrated the weakness of the current model to simulate corn growth under less than ideal growing conditions.

Soil water assessment tool does not mimic current irrigation practices.

Water scarcity due to drought and groundwater depletion has led to an increased emphasis on irrigation strategies for extending limited water resources. Models are commonly used to assess the impacts of such strategies. The Soil and Water Assessment Tool (SWAT), a widely used hydrologic model, is increasingly being used to evaluate the impacts of irrigation strategies at both field and watershed scales. However, concerns about the ability of the auto-irrigate function in SWAT to simulate actual irrigation practices have tempered results. Scientists from ARS and Texas A&M AgriLife compared simulated irrigation, crop water use (ET), plant growth, and yield to measured values for crops grown in the Texas High Plains. Results showed that the auto-irrigate function was unable to represent irrigation practices of the region, prompting the need for revision of the auto-irrigation algorithm in SWAT. These results are of interest to SWAT users, other modeler and water policy makers using such information.

Increases in crop yields will help offset decreased irrigation water availability.

The continued decline in the availability of water from the Ogallala Aquifer in the Texas Panhandle has led to an increased interest in conservation practices to extend the life of the aquifer and sustain rural economies. However, water policy makers need information on the effectiveness of conservation practices to conserve water in the aquifer while simultaneously considering the economic costs to producers. Scientists in the ARS led Ogallala aquifer Program from West Texas A&M University, the University of Tennessee at Martin, Clarendon College and Fatima Jinnah Women University (Rawalpindi, Pakistan) evaluated the effectiveness of five policies in terms of changes in the saturated thickness, crop mix, water use per acre, and the net present value of farm profits over a 60-year planning horizon. Results indicate that the policy scenarios of biotechnology adoption (germplasm with 3% annual increase in yield) and a water use restriction will conserve the most water. In terms of economic returns, the biotechnology adoption policy by far provided the greatest benefit to producers. These comparisons will aid policy makers in determining the most effective strategy to conserve water while simultaneously considering the economic costs to producers. In addition, the results of this study can be applied to other areas facing similar conditions, either currently or in the future, throughout the Texas Panhandle.

Possibility of groundwater restrictions may increase short-term aquifer depletion.

Concerns about the high rate of depletion of the Ogallala Aquifer in the Southern High Plains of Texas (Texas High Plains) in recent years have led to the enactment of policies designed to slow down water extraction and increase the usable life of the aquifer. However, policy implementation has not been uniform across the aquifer, leaving some farmers in portions of the aquifer with no effective groundwater extraction restrictions only a short distance away from areas where farmers face regulatory limits. Therefore, scientists in the ARS led Ogallala Aquifer Program from Texas Tech University investigated the effects of policy implementation uncertainty on the extraction of groundwater. Producers, in their concern about the implementation of policies to slow down groundwater extraction, increase their use of water in the short-run in order to maximize profits before groundwater use restriction policies are enforced. These results are of interest to water

Effectiveness of water conservation policies affected by discount rates, and crop prices.

Agriculture plays a vital role in the growth and development of the High Plains Region of the United States. With the development and adoption of irrigation technology, this region was transformed into one of the most agriculturally productive regions in the world. The primary source of irrigation in this region is the Ogallala Aquifer. Currently, water from the aquifer is being used at a much faster rate than natural recharge can occur, resulting in a high rate of depletion from this finite resource. However, depletion of scarce water resources will have a significant economic impact on the long-term sustainability of the region. Therefore, scientists in the ARS led Ogallala Aquifer Program from West Texas A&M University and Kansas State University evaluated the impact alternative prices and discount rates have on groundwater policy recommendations. As indicated by results of this study, alternative prices, costs, and discount rates utilized in the study have an effect on policy effectiveness. These results

are of interest to water policy makers and demonstrate the importance of economic assumptions in the outcome.

Future value of groundwater too low to prevent its current use.

Irrigation water from the Ogallala Aquifer has had influential role on the Texas High Plain in making it an agricultural significant region. However, withdrawals for irrigation have greatly exceeded recharge resulted in a decreasing water resource. Scientists in the ARS led Ogallala Aquifer Program from Texas Tech University have attempt to quantify the shadow price of an additional inch of groundwater resource left in situ for the Southern Ogallala Aquifer. We found that the size of the existing groundwater resource is sufficiently small to result in a divergence between the competitive and socially optimal solutions for withdrawals. Finally, we arrive at a marginal user cost for an additional acre-inch of water which is relatively low. These results are of interest to water policymakers and indicate that value of groundwater left in the aquifer is only slightly different from its value for present withdrawals.

Protein that helps confer salt tolerance identified.

Water availability from the Ogallala Aquifer for irrigation is decreasing on the Southern High Plains. Crops that use water more efficient are needed to sustain yields at current levels. Unfortunately there are multiple avenues to breed crops for greater water efficiency and few approaches have been attempt. Scientists have previously associated a specific plant protein with tolerance to salt. Therefore, scientists in the ARS led Ogallala Aquifer Program from Texas Tech University and Zhejiang Academy of Agricultural Sciences (China) investigated the role in root growth under salt stress. Loss of this protein through mutations decreased salt tolerance and over production improved salt tolerance. These data indicate that this specific protein affects salt tolerance and these results are of interest to plant physiologist, plant molecular biologists and plant breeders.

To recover the cost of switching from LEPA to SDI requires increases in crop yields.

Crop yields have not decreased as water availability for irrigation from the Ogallala Aquifer on the Southern High Plains has declined because of advancements in irrigation technology have increased water use efficiency. However, producers can be reluctant to convert to a more efficient irrigation system when the initial investment costs are high. Therefore, scientists in the ARS led Ogallala Aquifer Program from West Texas A&M University and Texas A&M AgriLife Research and Extension Service examined the economic feasibility of replacing low energy precision application (LEPA) center pivot sprinkler irrigation with subsurface drip irrigation (SDI). The increase in water efficiency from LEPA to SDI was estimated to be only 2%. Further analyses demonstrated that the return from investment from switching from LEPA to SDI was only possible with high value crops that require a minimum increase in yield after the conversion and corn was at the top of this list among typically grown row crops. These results are of interest to water policy makers, especially when making decision regarding cost share for water conversing irrigation equipment.

Use of animal waste on crop land requires balancing applications with crop requirements.

Application of cattle manure and swine effluent to cropland builds nutrient pools, affects soil quality, and increases crop productivity. However, application of animal waste in excess of crop nutrient requirements may lead to build up of soil nutrients that may have adverse environmental effects. Scientists in the ARS led Ogallala Aquifer Program from Kansas State University evaluated the rate of change in soil nutrient concentration and soil chemical properties in response cattle manure and swine effluent applications over a ten year period. A significant build up in soil nutrients of phosphorus and nitrate occurred when cattle and swine nutrient applications were supplied to meet or exceed the crop's nitrogen requirement. These results indicate that farmers need to balance nutrient additions to crop requirements to avoid building up soil levels of these nutrients.

Improvements to beef slaughter procedure saves water.

Water availability from the Ogallala aquifer is declining. Beef slaughter is water intensive due to stringent food safety requirements. However, water use by slaughter facilities are high value use. Therefore, scientists in the ARS led Ogallala Aquifer Program from West Texas A&M University conducted a study at a commercial beef processor to demonstrate water conservation by modifying the mechanical head wash. The modified mechanical washer cleaned beef heads as well as the standard washer but used 48% less water. These results are of interest to beef slaughter plants using water from the aquifer.

New design practices for efficient SDI.

As water availability from the Ogallala Aquifer for irrigation decreases, farmers are looking at installing the most water efficient irrigation systems. Water use efficiency by plants growing over sub-surface drip irrigation (SDI) tends to be highest among irrigation systems. However, SDI is a rela-

tively new irrigation technology and design features are still evolving. Therefore, scientists in the ARS Ogallala Aquifer Program from Kansas State University examined the applicability of fluid equations to the design of flushlines. The authors recommend that these modified equations be used with a standard fluid model to ensure reliability of improved flushline design for SDI systems.

Wheat does best with 4 inch of irrigation.

Water availability from the Ogallala Aquifer for irrigation is decreasing, thus increasing the extent limited irrigation on the Southern High Plains. Increasing irrigated wheat yields is important to the profitability of limited-irrigation cropping systems in the region. Scientists in the ARS led Ogallala Aquifer Program from Kansas State University examined the response of various wheat varieties to limited irrigation. Results indicated that, on average, an irrigation allocation of 4 inches increased wheat yield by 14% to 46% compared to rainfed production. Application of an additional 100 mm of irrigation did not improve wheat yield substantially. Applications at booting and heading resulted in the highest yields. This study demonstrates that limited irrigation targeted at sensitive growth stages could enhance wheat yields and improve water productivity of water-limited cropping systems, and are of interest to farmers.

Developing education programs for water management.

Natural resource management and education, including those related to groundwater, must account for both the natural and human components of a very complex interactive system. However, examples of such interdisciplinary approaches are rare, and therefore guidelines for successful natural resource education program are poorly defined. Scientists in the ARS led Ogallala Aquifer Program from Kansas State University, Auburn University and University of Minnesota developed a graduate seminar on water management. While the seminar was a successful in terms of educating students on complexity of water management, several challenges remain when implementing such courses. These challenges include not only the organization and assessment of course deliverables, but also fitting such courses into the administrative structure of the university when represented disciplines are located in several colleges across campus. These results are of interest to other universities developing similar courses.

Late planted sorghum best for irrigation water efficiency.

Many wells on the Southern High Plains drilled into the Ogallala Aquifer can no longer meet full crop water requirements due to declines in Ogallala aquifer water levels. However, these sites are capable of contributing to the regional agricultural economy under appropriate management protocols. Therefore, scientists in the ARS led Ogallala Aquifer Program from Kansas State University conducted a study to determine optimum limited irrigation strategies for grain sorghum with varying planting dates. Planting date was found to substantially affect biomass and grain yield with the highest grain yields with late planting in a wet season. Late planting was associated with lower irrigation requirements. Fluctuations in grain sorghum prices had a substantial impact on economic water productivity. Overall planting grain sorghum under optimum conditions combined with deficit irrigation improved water productivity. However the presence of sugar cane aphids may negate the advantages of late planted sorghum.

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USDA ARS United States Department of Agriculture Agricultural Research Service

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