New Waves
The Research Newsletter of the Texas Water Resources Institute

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Editor's Note

This special issue of the *New Waves* newsletter highlights accomplishments of Soil and Water Conservation Grants awarded by TWRI in 2001. These grants are administered annually by TWRI and support research and extension projects carried out by professionals with the Texas Agricultural Experiment Station and Texas Cooperative Extension.

Recently, TWRI announced a new series of Soil and Water Conservation Grants for 2002-2003. The titles of these projects and the names of project leaders are shown on page 12 of this issue.

In addition to the articles presented in this newsletter, detailed reports about many of these projects can be found by going to the TWRI website at http://twri.tamu.edu and clicking on the link to Soil and Water Conservation Grants.

The Soil and Water Conservation Grants program is funded through the Texas Legislature. It provides a way for Texas A&M Agriculture Program professionals to engage in cross-cutting multidisciplinary projects. The program also provides seed money for new studies and assistance to support and expand ongoing research and demonstration efforts.

More information about these grants can be obtained by contacting TWRI Communications Manger Ric Jensen at rjensen@tamu.edu or (979) 845-8571. The TWRI fax number is (979) 845-8554.

The next issue of *New Waves* will revert back to its regular format.

— Ric Jensen, Editor

Reclaiming, Restoring West Texas Rangelands is Goal of Multidisciplinary TAMU Project

Throughout much of West Texas, the quality of once-productive rangelands and improved pastures is being degraded. To address this problem, an interdisciplinary team of Texas Agricultural Experiment Station researchers is exploring and testing ways to once again make these rangelands productive.

This project, "Water Conservation Treatments for Restoration of Hydrologically Dysfunctional Rangelands," is led by researchers Darrell Ueckert and Joe Petersen and Extension specialists Chris Sansome, Allan McGinty, and Dale Rollins of the Texas A&M University (TAMU) Agricultural Research and Extension Center in San Angelo. Other participants include researchers Steve Whisenant and Wayne Hamilton of the TAMU Rangeland Ecology and Management Department, Roger Gold of the TAMU Entomology Department. This study was funded in part through a Soil and Water Conservation Grant awarded in 2001 by TWRI.

According to Ueckert, much of the problem is that a high percentage of grazing lands and wildlife habitats in West Texas have been plagued over the past several years by overgrazing, a lack of rainfall, and infestations by desert termites and other insect pests. As a consequence, perennial grasses have been lost, leaving soils bare and vulnerable to severe erosion and rainfall runoff. "Millions of acres of historically valuable rangelands are being adversely affected by desertification and will continue to degrade unless we step in and find some solutions," Ueckert said.

A remarkable aspect of this project is that the research team is exploring a variety of remedies that can possibly restore and reclaim these damaged rangelands. The researchers are testing the use of contour ripping, wing ripping, and other mechanical land treat-

Photo by Darrell Ueckert/ TAES

Researchers treat this range plot near San Angelo to increase infiltration.

See Rangelands (page 12)

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TAES Researchers Seek to Reduce the Volume of Water to Control Dust Emissions in Cattle Feedyards

Lysimetry studies are underway in the Texas North Plains to reduce the amount of water required to control dust in the region's cattle feedyards. This project, funded by a TWRI Soil and Water Conservation Grant in 2001, is carried out by staff members with the Texas A&M University Agricultural Research and Extension Center in Amarillo. Participants include Brent Auvermann, Thomas Marek, Don Dusek, David Parker, Gary Marek, Erica Cox, Kevin Heflin and Chris Rogers.

Photo by Brent Auvermann/ TAES

Researchers gather field data at the North Plains Research Foundation north of Amarillo.

Auvermann said that dust emissions from feedlots in the region are often the source of complaints from cities and neighboring landowners. There is some evidence that feedyard dust causes respiratory problems in young cattle. Conventional methods to control feedyard dust by wetting corral surfaces can double or triple daily water use during the summer, Auvermann said. One remedy may be to develop a sprinkler scheduling and management tool that limits feedyard dust emissions while conserving water resources.

This project involves estimating the daily evaporative demand from simulated feedyard surfaces, and relating feedyard evaporation rates to the evapotranspiration from well-watered reference crops. This evaporation data is used to recommend the optimal amount of water to apply. The research team has also created an interpolation tool that uses the geographical location of a feedyard to estimate its daily evaporative demand from the three nearest weather stations in the North Plains Evapotranspiration (NPET) network.

Although data for this study is still being collected, Auvermann said some observations can be made. Smoothing out the manure and creating an even, flat surface will likely reduce PET losses and thus require less water. It appears that evaporation rates from feedyard surfaces will be significantly lower than reference evapotranspiration rates. The study may be especially useful for feedyard managers who pump water from wells near the aquifer margins who, as a result, often have limited groundwater supplies available for dust control.

Note: Auvermann can be contacted at (808) 677-5663 or b-auvermann@tamu.edu.

TAES Scientists Work to Improve Crop Management Model; Will Help Farmers Better Manage Water Resources

Refining computer models that help farmers better manage crop water and irrigation needs is the focus of an ongoing research project funded through the Soil and Water Conservation Grant program. The study is led by researchers Tom Gerik and Wyatte Harman of the Blackland Research and Extension Center at Temple, Raghavan Srinivasan of the Texas A&M University (TAMU) Mapping Science Laboratory, and Terry Howell of the U.S. Department of Agriculture Research Service (USDA–ARS) in Amarillo. The focus of this project is to improve and expand the "CropMan" Crop Production Management Model developed at TAMU. This model utilizes information on soils, climate, and crop management to help agricultural producers minimize risk and boost yields and profits.

Much of the recent work to improve the model involves developing a software utility that allows users to download, format, and update daily weather data from weather stations throughout Texas. The research team incorporated the irrigation cost calculator developed by Extension specialist Leon New into CropMan, and they are working with Howell to evaluate how well CropMan estimates yields and evapotranspiration needs of irrigated field crops.

Work to improve CropMan continues. Economic analysis tools are being added to help agricultural producers who lease or share-rent farmlands estimate their production costs and profits. Other improvements will help farmers gauge how cover-crops and double-cropping systems influence productivity, profitability, and water use. Ultimately, Gerik hopes CropMan and other computer decision aids will help Extension professionals, crop consultants, and farmers improve the profitability of Texas agriculture.

Note: To learn more, contact Gerik at (254) 774-6118 or gerik@brc.tamus.edu.

New Waves

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Full text of the *New Waves* newsletter is available on the World Wide Web at http://twri.tamu.edu.

Extension Aims to Improve Water Quality in Trinity River Basin by Encouraging Better Landscape Management

The Trinity River watershed stretches from above Fort Worth through the Houston area and eventually flows into Galveston Bay. Recently, specialists from Texas Cooperative Extension developed a program that uses the same educational programs to teach people about how to better manage landscapes and lessen nutrient inputs throughout the watershed.

Photo by Eddie Byrom/ TCE

Part of this project involved working with Girl Scouts in the Fort Worth area.

The project, "Reducing Non-Point Source Pollution in the Upper Trinity River and Galveston Bay," is led by Galveston County Extension agents Julie Massey and William Johnson and Tarrant County Extension agent Eddie Byrom. It was supported through a 2001 Soil and Water Grant awarded by TWRI.

In Galveston County, Massey and Johnson expanded the principles in Extension's existing "Galveston Bay Yards and Neighbors Program" to include more information on how improved landscape management can lessen nonpoint source pollution. They taught Extension agents in Harris, Jefferson, and Brazoria counties, Sea Grant professionals, homeowners, and other consumers how to develop and maintain "bay friendly" landscapes that survive and flourish with fewer chemical inputs. Part of this education program included developing hands-on curriculum materials for public schools and establishing demonstration landscapes.

In Tarrant County, Byrom teamed up with the City of Fort Worth Parks Department to examine whether too much phosphorus might be applied on greens at six city golf courses. After taking large numbers of soil, plant, and water samples, Byrom learned that the existing amount of phosphorus at some sites could meet the golf courses' nutrient needs for up to five years. As a result, he convinced golf course managers they could substantially cut back phosphorus applications while still maintaining a high quality landscape. Byrom also worked with several Girl Scout troops and other target audiences to show how the use of native plants could lessen pesticide needs. Byrom is now cooperating with a group of 20 homeowners who live near a creek in northeast Tarrant County that flows into the Trinity River. They will monitor nutrient levels at sites upstream and downstream from this subdivision to see if landscape practices may be adding phosphorus to the stream.

So far, more than 50 Extension programs have been offered in the watershed to teach more than 2,200 people how to better manage lawns and landscapes. "If these people all changed their landscape management practices," Byrom said, "we expect nutrient inputs to the Trinity River would be substantially reduced."

Notes: To learn more, contact Massey at (281) 534-3413 or jk-massey@tamu.edu, or Byrom at (817) 884-1291 or e-byrom@tamu.edu.

Extension Project Seeks to Determine if Drip Irrigation is the Best Way to Irrigate Field Corners Near Center Pivots

When center pivot irrigation systems are used to water crops they create a circle in which crops are watered and grown. However, since most tracts of irrigated land are rectangles or blocks, the problem then becomes what to do with those corners of land that the center pivot doesn't irrigate. A team of specialists and agents with Texas Cooperative Extension recently carried out field studies to identify ways to water these corners that are water-efficient and produce high yields. The goal was to determine if drip irrigation was a more efficient way to irrigate these corner sections than furrow or sprinkler irrigation.

This project was led by Frank Dainello of the Texas A&M Horticulture Sciences Department, Extension Horticulturist Larry Stein, and county Extension agents Marcel Valdez of Zavala County and Kenneth White of Uvalde County. It was funded in part by a 2001 Soil and Water Conservation Grant awarded by TWRI.

The study was carried out on the Tiro Tres Farms near LaPryor in the Texas Winter Garden area. Two corners, covering 6 acres, were planted to successive crops of spinach, watermelons, onions, and grain sorghum. The crops were irrigated with drip, furrow, and sprinkler systems, and the use of rainfall capture beds was also evaluated. Rainfall capture beds can be constructed and covered with mulch to increase the amount of water available for watermelons and other row crops.

Results of the project show that the crops grown with drip irrigation produced better than expected yields. Somewhat surprisingly, the drip-irrigated grain sorghum used more water than those watered with the sprinkler systems. Dainello said that when water use is considered in terms of yield, the drip irrigation system did the best job at optimally using water to produce crops. Although installing a drip system is somewhat expensive, Dainello said that increased yields, water savings, and lower maintenance needs make drip irrigation practical and feasible over the long term. "Drip irrigated corners are best suited to high value crops with limited demand that can be used as mixed load or fillers," Dainello said.

According to Dainello, the study is important for several reasons. First, the amount of corners that need to be irrigated can be substantial, creating maintenance problems or presenting challenges when attempting to irrigate them with conventional sprinkler or furrow systems. Secondly, if drip irrigation can be shown to be a successful method to water corners, agricultural producers in the region might want to use it to irrigate larger sections and more acreage of vegetable and row crops.

Note: To learn more, contact Dainello at (979) 845-8567 or f-dainello@tamu.edu.

TAES, NMSU Scientists Explore Water Savings from Reducing Leaks in El Paso Agricultural Canals

How much water might be saved if agricultural irrigation canals in the El Paso region were lined with concrete to prevent seepage? That's the question being investigated in a research project recently carried out by scientists with the Texas A&M University Agricultural Research and Extension Center in El Paso and New Mexico State University (NMSU) in Las Cruces.

Researchers Zhuping Sheng of the Texas Agricultural Experiment Station in El Paso and Phillip King of NMSU led this project. It was supported in part by a 2001 Soil and Water Conservation Grant awarded by the TWRI.

Photo Courtesy of Zhuping Sheng/ TAES

TAES researchers install this piezometer in the Lower Rio Grande Valley

According to Sheng, a significant amount of water may be lost as it flows through agricultural irrigation canals in the region. The problem is that water may seep through earthen canals and percolate in soils rather than reaching agricultural fields as intended. Little is known about the exact magnitude of these losses and the opportunities for water savings.

To learn more about this issue, Sheng carried out three ponding tests in agricultural canals in El Paso County in January 2002. In addition, Sheng and King carried out similar tests along the New Mexico–Texas border. A ponding test consists of blocking off a 1 or 2 mile section of canal using earth berms, allowing the banks to become saturated, and filling that section with water for 24 to 48 hours. By measuring changes in the water level in the canals, researchers can determine the magnitude of seepage losses.

According to Sheng, test results are very promising. Seepage losses for a 3-mile section of the Franklin Canal show that more than 1,160 acre-feet of water could be saved during the 8-month-long growing season. When considering there are more than 500 miles of canals and laterals in the El Paso County Water Improvement District No. 1 and the Elephant Butte Irrigation District, the potential savings from reducing seepage could be substantial.

As a result of these studies, local water district managers and policy makers are discussing whether lining earthen canals with concrete makes sense and when and how this could be done because lining the canal is expensive. In large canals, lining can cost $600,000 to $1 million per mile. "This study strengthened cooperation between universities, irrigation districts, and many partners," Sheng said.

Sheng suggests ponding tests provide a starting point for more detailed studies. Sheng has already conducted some follow-up studies that use piezometers to provide a clearer understanding of whether seepage is moving water into nearby soils and shallow groundwater systems. Another idea being investigated is monitoring flows above and below areas blocked off for ponding studies to better understand how water is being lost.

Note: This project was supported by the El Paso County Water Improvement District No. 1, the Elephant Butte Irrigation District, and the TWRI Rio Grande Basin Initiative, which is funded by the U.S. Department of Agriculture. For details, contact Sheng at (915) 859-9111 or z-sheng@tamu.edu.

Extension Demonstration Shows West Texas Farmers How Subsurface Drip Irrigation Conserves Water, Increases Yields

A major challenge facing many farmers in West Texas is how to produce the highest yields of cotton and other crops while at the same time using as little water as possible and remain profitable. Through a TWRI Soil and Water Conservation Grant, a team of Texas Cooperative Extension professionals evaluated different agronomic practices with subsurface drip irrigation systems to meet these goals.

The project, "Effect of Row Pattern and Spacing on Water Use Efficiency for Subsurface Drip Irrigated Cotton," was led by Extension Specialists Juan Enciso, W.L. Multer, Russell Baker, and County Agents Steve Sturtz, Robert Scott, and Raymond Quigg

In this effort, the research team evaluated the water use efficiency and net return generated under various cotton row spacings and patterns and drip spacings of subsurface drip irrigation systems used in a cotton field at St. Lawrence, Texas, near Midland. A subsurface drip irrigation system (SDI) was installed in this field in 1997 and data were collected and evaluated for the next three years.

The study was designed to evaluate the effects of row spacings, planting patterns, and the volume of water applied on water use efficiency and cotton yields. This experiment investigated whether cotton planted in ultra-narrow rows used less water than plants grown in conventional width rows. It also compared how planting cotton in every row might use more water than situations where cotton was grown in every other row. A SDI system was used to apply irrigation water and nitrogen fertilizers to increase water use efficiency.

According to Enciso, planting cotton in ultra-narrow rows (with a spacing of 15 inches) and narrow rows (30 inches wide) resulted in greater water use efficiency than growing cotton in traditional width rows (40 inches). Also, when experiments focused on applying the minimal amount of water that might be needed, the use of ultra-narrow rows also resulted in the best water use efficiency (greater yields with less water applied).

Enciso said that this evaluation provides useful results for cotton growers in West Texas for many reasons. It exposed farmers to different strategies to plant and water cotton in the region with SDI systems. It demonstrates that agricultural producers in the region can maximize production per unit of water applied though the use of this technology. "Perhaps in the future, more cotton growers may consider using subsurface drip in their operations as a result of this demonstration and many other efforts," Enciso said.

Note: For details, contact Enciso at (915) 336-8585 or j-encsico@tamu.edu.

TAMU Researchers Use Soil and Water Grant to Construct, Field Test, Rainfall Simulator

How can scientists carry out runoff studies if it doesn't rain where and when they want it to? That problem was investigated by a team of Texas A&M University researchers through a 2001 TWRI Soil and Water Conservation Grant.

Photo Courtesy of Clyde Munster/ TAMU

Students field test this rainfall simulator on the Texas A&M campus.

Researchers Clyde Munster and Binayak Mohanty of the Biological and Agricultural Engineering Department and Brad Wilcox of the Rangeland Ecology and Management Department constructed and tested a rainfall simulator for brush control research. The rainfall simulator will be used to learn more about the extent to which brush control affects runoff and infiltration.

The research team constructed a rainfall simulator consisting of six masts. Each mast can be extended as high as 35 feet above the ground and is fitted with four sprinkler heads. "A unique aspect of these rainfall simulators is that they apply water above the tree canopy, allowing us to simulate how rainfall is utilized by woody plants in real world settings," Wilcox said. The water supply for the rainfall simulator is stored in a 5,000 gallon collapsible tank that is typically filled by a tanker truck. The rainfall simulators can apply as much as 6 inches of precipitation per hour, can be configured to meet site specific conditions, and can be effectively used on steep slopes.

In the summer of 2002, the rainfall simulator was developed on the Texas A&M University campus in College Station. A preliminary data set from these initial tests is being developed to evaluate the distribution of simulated precipitation as well as droplet size. In October 2002, the rainfall simulator was utilized in controlled field experiments at the Texas Agricultural Experiment Station research station at Sonora.

According to Munster, the opportunity to conduct experiments with rainfall simulators will allow the researchers to better investigate the conditions under which removing juniper and other brush species may increase water yields. These tools will allow the research team to simulate rainfall over the canopy cover of brush plants. The testing of the rainfall simulators has already paid off in other ways. Because of these studies and other efforts, the research team attracted follow-up funding from the National Science Foundation and recruit graduate students to work on this project.

Notes: To learn more, contact Munster at (979) 847-8793 or c-munster@tamu.edu, Mohanty at (979) 458-4421 or mbmohanty@tamu.edu, or Wilcox at bwilcox@tamu.edu or (979) 845-5579.

Extension "Panhandle Agripartners" Program Helps Farmers Conserve Water throughout the High Plains

A team of Texas Cooperative Extension professionals is helping agricultural producers conserve water resources throughout a 21-county region in the Texas Panhandle. The "Panhandle AgriPartners" program has been in place since 1998. Since then more than 15,000 people have participated. Project leaders include Bob Robinson, John Sweeten, Leon New, Steve Amosson, Brent Bean, Carl Patrick and Brent Auvermann. The project is coordinated by Reggie Jones of the Texas Agricultural Experiment Station. Cooperators include researchers Greta Schuster, Bonnie Pendleton, and Bobby Stewart of West Texas A&M University, and staff with the North Plains and Panhandle groundwater conservation districts.

Photo by Ordie Jones/ TAES

Leon New (to right) gathers water use data from this field.

The Panhandle AgriPartners program provides professional staff support and training for County Extension Agents and technicians who carry out on-farm demonstrations with farmers. The program provides practical training on how to use and apply data from the North Plains Potential Evapotranspiration (PET) Network to reduce water use, as well as how to apply variable rates of crop protection chemicals and irrigation. It educates users about precision agriculture, integrated crop and livestock production, the use of reduced tillage practices to reduce evaporation losses, and ways to link water use and crop yields.

According to New, the strength of the program is that it provides practical hands-on instruction for individual farmers. More than 100 field tests were carried out in 2002 to teach farmers how to measure soil moisture, to calculate crop water needs based on PET, and to determine the amount of water to apply. Charts and graphs were developed that show the potential for water conservation by using these practices. Information was developed for major crops grown in the region (wheat, cotton, grain sorghum, corn, soybeans, peanuts, and sunflowers). This crop water use and yield data was the basis for creating the irrigation demands for the Panhandle associated with Senate Bill 1 water planning requirements, New said. New suggests that farmers participating in this program can save as much as 2 acre-inches of water each year. If all the agricultural acreage in the region participated in the Panhandle Agripartners program, more than 330,000 acre-feet of water could be conserved annually.

Note: To learn more, contact Jones at (806) 677-5600 or or-jones@tamu.edu, Sweeten at (806) 677-5600 or j-sweeten@tamu.edu, or Robinson at r-robinson3@tamu.edu.

South Texas Extension Project Demonstrates Sustainable Approaches to Pasture Management

Teaching South Texas agricultural producers about sustainable ways to fertilize pastures is the emphasis of a Texas Cooperative Extension program.

The project, "Sustainable Agriculture Approaches to Pasture Management," is led by Extension County Agents Dwight Sexton, Lytle Arche, and Travis Franke. The program was funded in part through a 2001 Soil and Water Conservation Grant awarded by TWRI.

According to Sexton, many pasture managers in the region purchase commercial fertilizers to facilitate crop growth. However, this practice is often expensive, may result in overapplying nutrients, might increase the risk of nonpoint source pollution. On the other extreme, some producers do not monitor or manage soil fertility and thus mine soils of nutrients over time.

As an alternative to the use of traditional commercial fertilizers, this program teaches producers how poultry litter and legumes might be used to supply needed nutrients to soils. For example, applying poultry litter can add organic matter to soils and may improve soil aeration and water holding capacity. By growing clover and other legumes, producers can naturally fix nitrogen in the air and convert it to a form that can be used by plants, thereby potentially reducing fertilizer needs.

Photo Courtesy of Dwight Sexton/ TCE

Dwight Sexton discusses pasture management at this field day.

In this effort, plots were established at the Luling Foundation Farm. Some of the plots were planted with native clover, and turkey litter was later land applied. At other plots, commercial fertilizers were utilized. Throughout the project, data were gathered on the cost of using these various methods and pasture production and yields. Some of the lessons learned from this effort are that using poultry litter when growing native clover produced the highest net income per acre, and that potential odor problems can be overcome when poultry litter is properly applied. The project also gathered insights on how lime applications can reduce the acidity of soils, and how nitrogen from poultry litter is released gradually over time.

In 2001, 275 producers took part in activities associated with this program. Sexton says the goal is to expose pasture managers to more options to consider that, along with traditional methods, can boost profits and protect the environment.

Note: For details, contact Sexton at (830) 672-8531 or d-sexton@tamu.edu, Arche at (512) 398-3122 or l-arche@tamu.edu, or Franke at t-franke@tamu.edu.

Extension Program Teaches South Texas Farmers About Benefits of Reduced Tillage in Dryland Farming Operations

An ongoing Texas Cooperative Extension demonstration program in Luling is teaching South Texas farmers the potential benefits of reducing tillage practices. The program, "Conservation Tillage System Evaluation and Demonstration of Best Management Practices," is a demonstration effort led by Extension Specialist Charles Stichler and Michael Kuck of the Luling Foundation Farm. The program was begun in 1999.

Conservation tillage had not been widely used in the region before this project began, Stichler says, in large part because the area near Luling is characterized by clay soils. To counter these perceptions, Stichler and Kuck developed a program to demonstrate how conservation tillage works well in association with the dryland production of row crops throughout South Texas. At the same time, the project team wanted to demonstrate the extent to which conservation tillage is cost-effective and generates high yields when compared to conventional farming methods now used in the region.

At the Luling Foundation Farm, 15 acres are planted in such crops as corn, cotton, grain sorghum, and wheat. Each 15-acre plot is tilled in three ways—conventional practices like plowing, discing, and chiseling; reduced tillage; and no tillage. The project includes educational efforts, demonstrations, field days, publications, and personal contacts. In 2001, the project team planted a 30-acre pasture to dryland corn without using any tillage, and produced yields of 92 bushels per acre. More than 800 producers have learned about conservation tillage strategies through this program.

Photo Courtesy of Charles Stichler/ Texas Cooperative Extension

Michael Kuck implements reduced tillage at the Luling Farm.

Stichler says conservation tillage offers farmers a way to reduce the need for tractors and associated energy costs while keeping soil moisture and water resources on the fields. At the same time, weeds can be controlled in reduced tillage systems by planting herbicide-resistant crops and more precisely applying pesticides. The project has effectively demonstrated that reduced tillage practices may benefit dryland farmers in the region. In the future, project activities will focus more fully on reduced tillage and no-till methods.

Note: This ongoing program was funded in part by a Soil and Water Conservation Grant provided by TWRI in 2001. To learn more, contact Stichler at (830) 278-9151 or c-stichler@tamu.edu or Kuck at (830) 875-2438 or lff@bcsnet.net.

TAES Researchers Evaluate Methods to Better Identify Sources of Salinity in the Rio Grande

Researchers at the Texas A&M University Agricultural Research and Extension Center at El Paso recently carried out studies to evaluate methods that can be used to identify sources of salinity in rivers.

Texas Agricultural Experiment Station researchers Seiichi Miyamoto and Fares Howari led the studies. The project was funded in part by TWRI through a 2001 Soil and Water Conservation Grant.

Photo by Seiichi Miyamoto/ TAES

Fares Howari (to right) gathered field data on sources of salinity to the Rio Grande.

According to Miyamoto, salinity problems along much of the Rio Grande are worsening over time. Salinity levels in the river near Amistad Reservoir have increased from 560 parts per million (ppm) in the 1960s to more than 900 ppm today. Salinity concentrations along parts of the river bank are so high that traditional riparian vegetation like willows and cottonwoods are being replaced by salt cedars that can better tolerate poor high soil salinity.

The goals of this project were to obtain salinity data for selected stream reaches in the middle Rio Grande, to develop an automated system to monitor salinity in the river, and to evaluate whether spectral methods could be used to determine the chemistry of salts on the banks of the Rio Grande. The research team obtained numerous soil samples from 10 sites along the middle Rio Grande from New Mexico, the El Paso valley, and Fort Quitman. Samples were taken from sites that parallel the river as well as locations that are perpendicular to the Rio Grande. The researchers worked with the International Boundary and Water Commission to install salinity sensors near the Rio Grande at Fort Quitman and Candelaria and near the Pecos River at Langtry and Girvin. These gauging stations should provide improved database on salinity trends, Miyamoto said.

An innovative aspect of this project involves determining whether spectral signatures can be used to identify the amount of salts that are accumulating and the chemical composition of these deposits. Howari and Miyamoto measured the reflectance from soil surfaces to estimate salinity buildup at three sites on the Middle Rio Grande in February 2002. Results show that there is a consistent relationship between reflectivity and soil salinity. Howari also developed a digital library of spectral signatures for saline soils containing varying levels of gypsum, halite, and thenardite. The idea is that researchers could determine the concentrations of these chemicals in saline soils by matching spectral signatures at these sites to ones found in the chemical digital library. Results show that spectral signatures accurately matched the saline soil properties of salt crust in 86% of test cases. According to Miyamoto, salt releases from the banks of the Rio Grande might play an important role in influencing salinity levels in the river.

Notes: For details, contact Miyamoto at (915) 859-9111 or s-miyamoto@tamu.edu. Howari is now with Southwest Applied Earth & Environmental Services and can be contacted at fhowari@uaeu.ac.ae.

Demonstrating How to Rehabilitate West Texas Rangelands is Aim of Texas Cooperative Extension Program

A Texas Cooperative Extension program in West Texas is demonstrating how rangelands that have deteriorated due to a lack of rainfall or poor management may be reclaimed. The program, "The Wagon Wheel Demonstration Area," is being conducted near Midland. The program is led by Extension Specialist Charles Hart and County Extension Agents Raymond Quigg and Sam Field. Cooperators include Darrell Ueckert of the Texas Agricultural Experiment Station, Philip Dickerson and Calvin Richardson of the Texas Parks and Wildlife Department, and Charles Anderson, Ray Schimcek, and Gary Askins of the U.S. Department of Agriculture Natural Resource Conservation Service.

Project leaders treat brush at the Wagon Wheel Ranch. Photo by Charles Hart/ TCE

The demonstrations are being carried out on 10- to 20-acre plots at the Wagon Wheel Ranch in Upton County. So far, more than 125 people have been introduced to the program through field days. Signs at the site provide information about what is being done and results of the program. According to Hart, the purpose of this program is demonstrate and educate landowners about techniques that are available to rehabilitate West Texas rangelands including chemical and mechanical ways to effectively remove nuisance brush species as well as strategies to treat soils to increase infiltration. The program includes killing mesquite plants with a mix of herbicides and removing them with a backhoe grubber. Treatment techniques that promote water infiltration are shown. The program demonstrates how rangeland ripping and furrowing can make soils more productive. After the soils were modified, they were planted with a mix of such range grasses as bristlegrass, sideoats grama, and green sprangletop. Future plans involve more herbicide studies and the use of aerators to increase the water-holding capacity of soils.

Note: This project was funded in part by a 2001 TWRI Soil and Water Conservation Grant. For details, contact Hart at cr-hart@tamu.edu or (915) 336-8585.

TAES, Baylor Researchers Examine Whether Small Dams Provide Ecological Benefits

A study by researchers with the Texas Agricultural Experiment Station (TAES) and Baylor University is investigating the ecological benefits provided by small rural flood control dams located throughout Texas.

TAES researcher Ranjan Muttiah of the Blackland Research and Extension Center at Temple and Baylor researchers Joseph White, Peter Allen, and John Dunbar lead the project. This study was funded in part by a 2001 TWRI Soil and Water Conservation Grant.

Photo Courtesy of Joseph White/ Baylor U.

Researcher Joseph White of Baylor installs a probe in this tree to monitor how water flows through it.

Originally, the intent of this ongoing investigation was to develop a way to determine if thousands of small dams (known as public law or PL 566 structures) were sound or needed to be replaced. As those studies were begun it also became apparent that much more needed to be known about how water flows through these systems and the impacts of these dams on riparian zones and water quality.

"Part of determining whether these dams should be removed or repaired should include assessing if these structures provide ecological benefits," White said. "It may be that these PL 566 dams are providing a way to preserve and enhance riparian areas at a time when we are losing a lot of native streambanks."

The researchers focused on investigating the hydrology of one PL 566 dam at Cow Bayou in McLennan County. With the help of Baylor graduate student Jacquelyn Duke, they instrumented the site to monitor surface and ground water flows, the amount of water taken up by trees and other vegetation, and meteorological data. White and Duke focused on water use by vegetation at the site. Allen investigated soil and stream interactions. Muttiah modeled the hydrology of the ecosystem and investigated the use of isotopes to validate water relationships between the streams, groundwater, and vegetative cover.

Results show that the hydrology at the site is much more complex than was first envisioned. Water seems to be moving laterally from the stream to nearby groundwater systems where it is used by trees for growth and transpiration during the late summer and early fall. Trees located near the stream appear to be using much more water than those sited farther away. The research shows how the amount of water used by trees varies throughout the day and throughout the year as a consequence of changes in flows and other factors.

According to White, this project suggests that ecosystems associated with small dams may be much more complicated than first thought both from a hydrologic and ecosystem point of view. White suggests that examining the microwatersheds near PL 566 dams will help planners and policymakers better understand the ecological value these sites provide in terms of improved water quality and the richness of aquatic and terrestrial species. By analyzing stream and vegetation water use, White suggests a more functional definition of the riparian zone can be developed.

Note: For details, contact White at joseph_d_white@baylor.edu or (254) 710- 1038, Allen at Peter_Allen@baylor.edu, or Muttiah at (254) 774-6103 or muttiah@brc.tamus.edu.

Extension "Source Water Protection" Program Screens Water Wells for Fecal Coliform Bacteria; Protects Water Quality

Working with rural Texans to protect groundwater quality is the emphasis of an outreach and education program of Texas Cooperative Extension.

The program, "Source Water Protection," is led by Extension specialist Monty Dozier of the Texas A&M University Soil and Crop Sciences Department and researcher Dennis Hoffman of the Texas Agricultural Experiment Station Blackland Research and Extension Center in Temple. It was supported by a Soil and Water Grant awarded by TWRI in 2001.

Photo Courtesy of Monty Dozier, Texas Cooperative Extension

Monty Dozier analyzes this water quality sample.

Throughout this project, Dozier traveled throughout Texas to screen and sample groundwater wells for the presence of fecal coliform bacteria. Samples were obtained from the High Plains, the Edwards Aquifer region, and the Gulf Coast. In basic terms, water samples were filtered and these filters were placed in petri dishes and incubated. Afterwards, samples were visually scanned for blue raised bumps that indicate fecal coliform bacteria are present. To-date, more than 3,319 samples have been screened, and 7.5% of them have tested positive for fecal coliform bacteria. Owners of wells that tested positive for fecal coliform bacteria were advised to submit a sample for testing by a laboratory approved by the U.S. Environmental Protection Agency to determine if follow-up actions were needed.

The Source Water Protection program also strengthens ongoing educational efforts like "Tex*A*Syst." By involving schoolchildren, adults, and interested individuals in the well screening, the program provides increased awareness and education. "This program enables us to create teachable moments," Dozier says, "where people are exposed to water quality issues and learn how to protect groundwater quality."

Note: For details, contact Dozier at (979) 845-2761 or m-dozier@tamu.edu or Hoffman at d-hoffman@tamu.edu or (254) 774-6040.

Extension Project Uses Paired Watersheds to Answer Whether Brush Control Increases Flows, Saves Water

What is the best way to determine the extent to which clearing nuisance brush species might increase water yields? According to the Texas Cooperative Extension "Water for Texans" program, a promising method to evaluate the success of brush control efforts may be to compare nearby sites within watersheds.

Photo Courtesy of Larry White/ TCE

Larry White explains the potential benefits of brush control at this site.

The "Water for Texans" program has been ongoing since 1998. Since its inception, it has been supported in part by Soil and Water Conservation Grants awarded by TWRI. Project leaders include Extension Specialists Larry White, Barron Rector, and Charles Hart. Cooperators include more than 20 county Extension agents, personnel with federal and state agencies, and several private landowners.

According to White, little data exists for sites within the same river basin where brush control has been implemented and nearby locales that have been left intact. "As a result, it's difficult to tell whether the water savings are a result of the best management practices (BMPs) that were used, site-specific characteristics, or just quirks in the weather," White said. In addition, White suggests that more long-term data has to be collected to best judge how brush control efforts may boost water yields over time, especially since rangelands gradually change after brush is cleared.

To overcome these problems, White, Rector, and Hart began the "Water for Texans" project. The project tries to develop paired watershed studies in which the results of brush control in nearby sites can be compared. The first step of this project involves calibrating the sites to characterize hydrology and flows. Then, such BMPs as brush removal by mechanical or chemical means, reseeding, or changes in grazing rates are introduced. Later, runoff from the treated areas is compared to flows from sites that are left intact. "The benefit of the 'Water for Texans' program is that it gives policymakers a clear idea of how much water can be created by brush clearing over the long-term," White said. "These studies provide a better understanding of the specific circumstances under which brush control may yield the most water." So far, more than 40 watersheds throughout Texas have been calibrated. As a follow-up, BMPs have been incorporated in watersheds in Kaufman, Hays, Mason, and Kerr counties. The effectiveness of implementing these BMPs is now being monitored and evaluated. In the near future, the project team hopes to initiate BMPs in rangeland watersheds in Blanco, Bastrop, Brazos, Comal, and Jim Wells counties. Other project activities include numerous demonstrations, field days, and the testing of such new equipment as rainfall simulators.

Another major component of this project involves evaluating the extent to which clearing saltcedar on the Pecos, Colorado, and Canadian rivers in West Texas may increase water yields. Hart is studying how removing saltcedar may increase groundwater levels.

Note: For details, contact White at ld-white@tamu.edu or (979) 845-2755 or Rector at b-rector@tamu.edu or (979) 845-2755.

TAES Research in the High Plains Helps Agricultural Producers Save Water, Maintain Yields and Profits

Researchers at the Texas A&M University Agricultural Research Center at Lubbock are investigating technologies and management practices to help agricultural producers conserve water, thanks in part to a Soil and Water Conservation Grant from TWRI. Much of this research is being carried out at the Texas Agricultural Experiment Station research station at Halfway on the Texas High Plains. The research team includes researchers James Bordovsky and Eduardo Segarra, and Texas Cooperative Extension professionals Dana Porter and Calvin Trostle.

Photo by James Bordovsky/ TAES

Stacey Ontai, Robert Stanaland, and Andrew Hurt check the flow rates of this LEPA irrigation system.

The researchers are evaluating the extent to which limited preplant irrigation of cotton saves waters and influences yields. They are also studying whether applying spray irrigation to cotton planted in narrow rows uses water more efficiently than traditional farming techniques. Other aspects of these studies seek to determine if a cotton-grain sorghum rotation better takes advantage of limited groundwater supplies than continuously growing cotton, and if cotton flowers and bolls may be adversely affected by coming into contact with irrigation water. Results provide practical advice farmers can use to better manage their operations, reduce water use, and maintain yields and profits. "The emphasis of this research is to help farmers take a careful and intelligent look at the water resources that are available as they think about irrigating," Bordovsky said. "We suggest that farmers should first look at potential rainfall, soil moisture, and available groundwater levels through the growing season, and then manage limited supplemental irrigation to achieve stable crop production rather than maximum yield. It's going to become even more important in the future." To learn more, contact Bordovsky at j-bordovsky@tamu.edu or (806) 889-3315 or Segarra at e-segarra@tamu.edu or (806) 746-6101.

TAES Scientists Work to Develop Improved Drought Prediction Tools; Map Drought Risks

Developing improved methods to warn agricultural producers, cities, and other water users of impending drought risks is the goal of a research project now underway by Texas Agricultural Experiment Station scientists.

The study, "Development of a Soil Moisture Index for Agricultural Drought Monitoring Using a Hydrologic Model, Geographic Information Systems (GIS), and Remote Sensing," is led by researcher Raghavan Srinivasan and graduate student Balaji Narasimham of the Texas A&M University Spatial Sciences Laboratory. It was funded in part through a 2001 Soil and Water Conservation grant awarded by TWRI.

Although methods to identify drought risks now exist, Srinivasan said they are limited and can be improved. For example, the Palmer Drought Severity Index calculates the likelihood of drought over relatively large regions or climate zones (ranging in size from 4,000 to 62,000 square miles) based on simplistic representations of soil moisture. As a result, results from this method are often not as accurate or precise as they need to be.

As an alternative, Srinivasan and Narasimhan propose that GIS technology, remote sensing, and increased computational power can be utilized to develop improved hydrologic computer models that can better display drought threats. For example, Srinivasan is working to incorporate remotely sensed data on weather patterns, soils, land use and land cover into the Soil Water Assessment Tool (SWAT) computer model to calculate the severity of droughts. Because SWAT is an advanced hydrologic model, it can produce needed data to model soil moisture. Then, results of these SWAT modeling exercises will be displayed in computer-generated maps using GIS technologies.

Recently, the research team carried out a case study of how well SWAT and GIS could work to model droughts in the Trinity River basin. After gathering data on land uses and land cover as well as historic flows, the researchers ran the SWAT model and compared results to actual field data. According to Srinivasan, results show this method does a good job of replicating historical data. The model provides data on 2.5-square mile grids, allowing users to much more precisely know how their lands may be affected by water shortages and droughts. The next phase of this project, Srinivasan says, will be to further test this method in other watersheds. In the near future, Srinivasan hopes both this new method and modeling results will be accessible from the Spatial Sciences Laboratory's website.

Note: Srinivasan can be contacted at (979) 845-5069 or r-srinivasan@tamu.edu. The website for the Spatial Sciences Lab is http://www-ssl.tamu.edu.

New Websites Developed by TAES, Extension, Provide Quality Data about Climate, Potential Evapotranspiration

New websites developed by the Texas Agricultural Experiment Station (TAES) and Texas Cooperative Extension provide accurate and timely information about weather-related issues. The project is a team effort being led by researcher Thomas Marek of the Texas A&M University Agricultural Research and Extension Center in Amarillo, Extension specialist Guy Fipps of the Texas A&M University Biological and Agricultural Engineering Department, and researcher Raghavan Srinivasan of the Spatial Sciences Laboratory.

A major component of this project included developing the Texas Drought Information System website. This effort was led by Srinivasan and the staff of the Spatial Sciences Laboratory and can be accessed from http://webgis.tamu.edu. This website displays estimates of precipitation from NEXRAD sites on a 16-square-kilometer grid. It also allows users to obtain weather data obtained by the Federal Aviation Administration, as well as advanced very high resolution weather data (AVHRR) procured by orbiting earth satellites maintained by the National Oceanic and Atmospheric Administration. The Drought Information System website includes information and related links about how Texas is affected by droughts.

This project also helped update and develop other websites. For example, a new website is titled "Texas Weather." It is located at http://texasweather.tamu.edu. This website was created by Fipps and system analyst David Flahive of the Texas A&M University Biological and Agricultural Engineering Department. The Texas Weather website includes links to the North High Plains and South High Plains PET (potential evapotranspiration) Networks, the Texas ET (evapotranspiration) Network, and the Crop Weather Program of the Texas Coastal Bend. Some of the most useful features of the Texas Weather website allow users to determine landscape irrigation recommendations based on climate conditions and the grasses they have planted, and help agricultural producers calculate the daily irrigation water needs of crops. As a result, those using the Texas Weather website should be able to optimize the amount of irrigation they choose to apply.

According to Marek, although a number of websites contain weather-related information, much of that data is not standardized or checked for quality control. As a result, the research team identified a need to create an official website that presents high quality weather information in a standardized format. "By developing a high quality data set that will be archived in a central location, we are providing a secure long-term database that will be valuable for water resources planners and the public," Marek said. In some cases, the research team converted existing data to a standardized format. The real benefit may result from data collected in the future now that information will be collected using common standards.

Note: This project was supported with a 2001 Soil and Water Conservation Grant awarded by TWRI. To learn more, visit the Texas Weather website at http://texasweather.tamu.edu. You can contact Marek at (806) 359-5401 or t-marek@tamu.edu or Srinivasan at (979) 845-5069 or r-srinivasan@tamu.edu.

Texas A&M Researchers, Extension Specialists Seek to Develop Better Methods to Estimate Soil Nitrogen

Can a better and more accurate test be developed to determine the nitrogen needs of crops and thus help protect water resources and the environment? Developing and evaluating innovative nitrogen soil testing methods is the aim of Soil and Water Conservation Grant funded by TWRI in 2001.

The project, "An Innovative Soil Test to Improve Nitrogen Fertilizer Recommendations in Cotton," is led by Texas Cooperative Extension specialist Mark McFarland and researcher Frank Hons of the Texas A&M University Soil and Crop Sciences Department. Participants include researcher John Sloan of the Texas Agricultural Experiment Station and Extension professionals Archie Abrameit, Todd Baughman, Randy Boman, Jed Elrod, Roger Havlak, Rick Jahn, and Jeff Stapper.

Photo by Frank Hons/ TAMU

Researchers gather nitrogen data from this cotton field.

According to McFarland, the soil test method now most commonly used to make nitrogen fertilizer predictions for crop production is a one-time estimate of soil nitrate before crops are planed. This method does not account for additional nitrogen released from soil organic matter during the growing season. As a result, too much nitrogen may often be applied which might result in nitrate pollution of waters and nutrient runoff. On the other hand, if the present soil testing methods lead farmers to apply too little nitrogen, yields and cotton quality can be greatly reduced. The best solution, McFarland says, is to develop a practical, quick, and cost-effective method that provides a better estimate of actual crop nitrogen needs.

The researchers evaluated the effectiveness of a new method to estimate soil nitrogen needs. In basic terms, this new procedure involves quantifying the amount of carbon dioxide that evolves for 24 hours after dried soils are rewetted. In theory, this method can yield better data about nitrogen mineralization (the amount of nitrogen released by soils that is available for plant growth) and the amount of soil microbial biomass that is produced.

To test how well this new procedure actually works, the researchers carried out field studies to determine the nitrogen content in clay soils where cotton is produced throughout the growing season, and the extent to which better meeting cotton nitrogen needs could boost yields. In 2001, evaluations were carried out in 10 counties covering the Lower Rio Grande Valley, the Coastal Bend, Central Texas, the Blackland Prairie, the Southern High Plains, and Far West Texas. The research included measuring plant growth, taking soil samples at depths from 2 inches to 4 feet, and determining residual soil nitrogen and nitrogen and carbon mineralization throughout the growing season. Soil samples were analyzed by the Texas A&M Soil and Water Testing Laboratory in College Station.

According to McFarland, results from 2001 suggest that this new method is promising in better estimating the amount of nitrogen that is mineralized and thus available to cotton plants. Results suggest that the use of this new method correlated soil mineralization and cotton lint yields. "We hope this new way of determining the amount of soil nitrogen will help farmers more accurately know how much nitrogen is in their soils that cotton plants can use," McFarland said. "It will help farmers more precisely apply the correct amount of nitrogen crops need, thus reducing the risk of applying too much or too little."

Note: For details, contact McFarland at (979) 845-5366 or mlmcfarland@tamu.edu, Lemon at r-lemon@tamu.edu or (979) 845-2935, or Hons at f-hons@tamu.edu or (979) 845-4620.

MEETINGS

• The University Council on Water Resources Annual Conference will meet July 30–August 1, 2003 in Washington, DC. The theme is "Water Security in the 21st Century." To learn more, visit their website, http://www.uwin.siu.edu.

• The American Water Works Association (AWWA) Annual Conference is set for June 15–19, 2003 in Anaheim. For more details, visit their website at http://www.awwa.org.

• StormCon '03, the North American Surface Water Quality Conference & Exposition, will meet July 28–31, 2003, in San Antonio. The meeting will deal with several issues pertaining to stormwater management including regulations, best management practices, and education. For details, go on the web to http://www.stormcon.com.

The American Water Resources Association (AWRA) 2003 Spring Specialty Conference, "Agricultural Hydrology and Water Quality," meets May 12–14, 2003 in Kansas City, MO. The 2003 AWRA International Water Congress Watershed Management for Water Supply Systems meets in New York City June 29-July 2nd, 2003. For details, visit them on the web at http://www.awra.org.

• The Water Environment Federation (WEF) is sponsoring the 9th Annual Industrial Wastes Technical and Regulatory Conference that meets in San Antonio, TX, on April 13–16, 2003. To learn more, visit them on the web at http://www.werf.org.

• The 106th annual meeting of the Texas Academy of Science (TAS) will be in Nacogdoches, TX, and will be hosted by Stephen F. Austin University, February 27–March 1, 2003. Sessions deal with aquatic biology, aquatic ecosystems, and surface and groundwater hydrology, and other topics. For details, visit them on the web at http://www.texasacademyofscience.org.

• The Texas Engineering Extension Service (TEEX) offers several training courses pertaining to water and wastewater, including classes required by regulatory agencies. To learn more, visit TEEX on the web at http://teexweb.tamu.edu.

• The Texas Section of the American Water Works Association meets April 1–4 in Corpus Christi. For details, go to http://www.tawwa.org.

Rangelands (from page 1)

ments to promote rainfall infiltration. In addition, they are reseeding lands with warm-season forage grasses that have the potential to lessen the amount of bare soils and conserve soils and organic matter. Another aspect of this project involves testing ways to control desert termites that now consume large amounts of native vegetation and leave soils barren. The idea is that managing insect pests will expedite the recovery of desirable forage grasses.

According to Ueckert, preliminary results of this project are very promising. For example, the research team monitored the extent to which rainfall infiltrated into soils during July 2002 rains. In areas that received mechanical treatments like ripping, precipitation infiltrated 5 feet into the soil. In contrast, rainfall penetrated soils to a depth of only 8 to 10 inches in rangelands that were not treated.

Notes: For details, contact Ueckert at d-ueckert@tamu.edu or (915) 653-4576, Whisenant at s-whisenant@tamu.edu or (979) 845-0317, or Gold at r-gold@tamu.edu or (979) 845-5855.

TWRI Soil and Water Conservation Grants for 2002-03

Grants Awarded to Texas Agricultural Experiment Station (TAES) Researchers

• "Efficient Irrigation and Fertilization Practices for Urban Landscapes," John Sloan, TAES, Dallas.

• "Development and Evaluation of Dual Application Pivots that Use Low-Energy Precision Application and Spray Irrigation," James Bordovsky, TAES, Plainview.

• "A Water Management Education Program," Ronald Kaiser, Texas A&M University (TAMU), Recreation, Parks, and Tourism Sciences Department.

• "Restoration of Hydrologically Dysfunctional Rangeland Watersheds and Wildlife Habitats and Improved Pastures in Western Texas," Darrell Ueckert, TAES, San Angelo; Chris Sansome, Allan McGinty, and Dale Rollins, Texas Cooperative Extension (TCE), San Angelo; Stephen Whisenant and Wayne Hamilton, TAMU Rangeland ecology and management; and Roger Gold, Texas A&M Entomology Department.

• Development of a Multi-Scale Geographic Information System, Topography Based, Screening Model for the Assessment of Watershed Surface Water Pollutant Loading," Mauro DiLuzio, TAES, Temple; Jeff Arnold, U.S. Department of Agriculture Research Service (USDA/ ARS), Temple; and Steve Bednarz, USDA Natural Resource Conservation Service Temple.

• "Rainfall Partitioning with Juniper Communities," Keith Owens, TAES, Uvalde.

• "Utilizing Subsurface Drip Irrigation and Conservation Tillage in Crop Production Systems in the Texas Rolling Plains," John Sij, Jeffrey Slosser, and David Bordovsky, TAES, Vernon.

• "Limited Irrigation for Biotic and Abiotic Stress Management-A Precision Farming Approach to Water Conservation," Giovanni Piccinni, Daniel Leskovar, TAES, Uvalde; and Noel Troxclair and Charles Stichler, TCE, Uvalde.

• "Genetic Variability for Physiologic Traits Related to Water Use Efficiency in Sorghum," William Payne and Maria Balota, TAES, Amarillo.

• "Subsurface Drip Irrigation for Forage and Livestock Systems," David Forbes and Hagen Lippke, TAES, Uvalde.

Grants Awarded to Texas Cooperative Extension (TCE) Specialists and Agents

• "Cover Crops to Capture Rainfall to Augment Deficit Irrigation in Subsurface Drip Systems," John Sij, Todd Baughman, David Bordovsky, Vernon, and Stan Bevers, TAMU Agricultural Economics Department.

• "Enhancing Capacity for Water Quality and Nutrient Management Education of Minority and Underserved Audiences," Jeffrey Koch, Prairie View A&M Cooperative Extension, and Mark McFarland, TAMU Soil and Crop Sciences Department.

• "Forest Soils-Based Best Management Decision Support System," Darwin Foster, TAMU Forestry Sciences Department.

• "Junior Master Gardener Program," Lisa Whittlesey and Dee McKenna, TCE, TAMU Horticultural Sciences Department.

• "Mills County Nitrate Education and Remediation Program," Monty Dozier, TAMU Soil and Crop Sciences Department.

• "Natural Resources Conservation and Protection on the Colorado River Watershed," Billy Kniffen, TCE, Menard County; Scott Edmonson, TCE, Concho County; Michael Palmer, TCE, Irion County; and Marc Tucker, TCE, Schleicher County.

• "New Irrigation Technologies for Nursery and Floral Producers and Commercial Landscapes," Don Wilkerson and Michael Arnold, TAMU Horticulture Department; and Bruce Lesikar, TAMU Biological and Agricultural Engineering Department.

• "Rangeland Rehabilitation through Water Conservation and Concentration," Alyson McDonald, TAMU Rangeland Ecology, and Management Department, and Charles Hart, TCE, Fort Stockton.

• Reclamation of the Upper Colorado River Watershed," Allan McGinty, TCE, San Angelo.

• "Training and Demonstration Support for Irrigated Crops and Livestock Production," Bob Robinson and John Sweeten, TCE, Amarillo.

• "Validation of Restoration Practices on Rangeland Health at the Landscape Scale," C. Wayne Hanselka and Steve Livingston, TCE, Corpus Christi; and David McKown and Rogelio Mercado, TCE, Alice.

• "Water for Texans," Larry White and Barron Rector, TAMU Rangeland Ecology and Management Department.

• "Wellhead Protection Program," Monty Dozier, TAMU Soil and Crop Sciences Department.