

Efficient Irrigation for Water Conservation in the Rio Grande Basin

2010/2011 Progress and Accomplishments

By

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A photograph of a river flowing through a landscape. In the background, there is a small bridge and a line of trees. The foreground shows a rocky bank with some vegetation. The sky is clear and blue.

EFFICIENT IRRIGATION FOR WATER CONSERVATION IN THE RIO GRANDE BASIN

2010/2011 PROGRESS AND ACCOMPLISHMENTS

Texas AgriLife Research and the Texas AgriLife Extension Service
New Mexico Agricultural Experiment Station and
New Mexico Cooperative Extension Service

Rio Grande Basin Initiative

Since 2001, the Efficient Irrigation for Water Conservation in the Rio Grande Basin Federal Initiative—known as the Rio Grande Basin Initiative (RGI)—has saved more than 5 million acre-feet of water. Researchers, Extension specialists, and county Extension agents from Texas AgriLife Research, the Texas AgriLife Extension Service, and the New Mexico State University Agricultural Experiment Station and Cooperative Extension Service work with local irrigation districts, agricultural producers, homeowners, and regional agencies to meet present and future water demand through water conservation and efficient irrigation measures.

This project is funded through the U.S. Department of Agriculture National Institute of Food and Agriculture and is administered by the Texas Water Resources Institute and the New Mexico State University Water Task Force.

2010–2011 Partners

- USDA - National Institute of Food and Agriculture
- Texas AgriLife Research
- Texas AgriLife Extension Service
- Texas Water Resources Institute
- New Mexico Agricultural Experiment Station
- New Mexico Cooperative Extension Service
- New Mexico State University Water Task Force

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The Texas Water Resources Institute is part of Texas AgriLife Research, the Texas AgriLife Extension Service, and the College of Agriculture and Life Sciences at Texas A&M University.

On the cover

An irrigation canal flows from the Cameron County Irrigation District No. 2 pumping plant, covering the southern portion of the district (*photo by Danielle Kalisek*).

2010–2011 Accomplishments

Texas AgriLife Extension Service

New Mexico Cooperative Extension Service

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ACCOMPLISHMENTS

TEXAS AGRILIFE EXTENSION SERVICE
NEW MEXICO COOPERATIVE EXTENSION SERVICE

IRRIGATION DISTRICT STUDIES

Economics team studies water resource issues

During the past year, the Rio Grande Basin Initiative Economics Team has completed a number of technical reports and professional journals and presented their findings on various RGBI water resource issues to local, statewide, and national audiences. Key topics include business economics involving water-treatment facilities and the economics of conserving water through environmentally friendly removal of water-thirsty invasive plant species.

In addition, the team continues to provide Extension services to stakeholders, not only with ongoing projects but also by expanding into new areas. Key topic areas include summarizing comparative economics of methods for adding water to an arid or semi-arid region's water supplies, economics of algae-produced biofuels, business finances involving costs and delivery rates of irrigation districts, and water implications of biofuels production.

Demonstration shows the benefits of proper gate selection and automation

The United Irrigation District radial gate project demonstrates improved canal management through better gate operation, real-time data, and remote control of water flow. This year's activities focused on the technical issues of automation programming and improving gate calibration. Gate calibration has many variables that influence the gate position and flow calculation. The study identified a phenomenon called hysteresis that affects the correlation between the actuator position signal and gate opening. The position of the gate will differ depending on whether the motion was set upward or downward.

The Extension engineering team improved gate calibration by identifying the hysteresis phenomenon and determining equations that will calculate the correct gate position. Programming these equations into the gate control software produced more accurate gate and flow control. After this correction, the estimated flow matched measured flow with an average error of 3.2 percent. This hysteresis phenomenon accounted for up to a 0.1-foot difference, corresponding to about 4.4 cubic feet per second (cfs). This single gate

demonstration project manages a key artery for United Irrigation District. The real-time decision making and control gained from gate calibration improves operation efficiency, reduces costs (estimated at \$2,000 per year), and reduces water use (saving approximately 5 percent of total water allocation, which is approximately 2,800 acre-feet of water per year).



Irrigation canal



Spillway from the Maverick County Irrigation District main canal

Inundation maps created for irrigation district reservoir complexes

Because of local neighborhood safety concerns, many districts are required to produce inundation maps for their reservoir complexes, and local consulting firms have little experience in producing such maps. Extension engineers responded to a request from Hidalgo and Cameron Counties' Irrigation District No. 9 (HCCID9) for assistance in obtaining elevation data for the district's reservoir complex and surrounding areas. The main focus of this project was to determine the extent of the residential areas that could be affected by a flood caused by a breach from a reservoir or the main canal levee. The analysis was performed using a survey-grade Global Positioning System (GPS) unit. HCCID9 used the resulting data to produce required inundation maps for the residential lands adjacent to the reservoir complex. The low-cost, accurate map production methods demonstrated in this project can save irrigation districts approximately \$5,000 per project.

Extension engineering information disseminated via the Internet

The mission of the Irrigation District Engineering and Assistance (IDEA) Program is to improve operational efficiency and promote water conservation in irrigation districts and the agricultural sector. The IDEA Program began in two irrigation districts in the 1990s with projects to introduce surge flow irrigation and lay-flat tubing to determine needed changes in district operations to ensure the success of these technologies. In 1996, the program expanded into GIS (geographic information systems) mapping and use for improved district management and regional water planning. The IDEA Program continued to grow and is now the most extensive university-based program of its kind in the United States. The IDEA website (idea.tamu.edu) showcases the array of work done by the Extension engineering team. The site also serves as a resource for Texas irrigation districts, engineering consultants, and state and federal agencies seeking information on applied research programs, technical assistance, short courses, and other educational opportunities provided by the IDEA team.

The IDEA website lists the educational/training opportunities from GIS to GPS classes and provides free downloads of the latest technical and project reports, publications, newsletters, and articles. High-resolution maps and GIS databases of irrigation district distribution systems, as well as other project maps, are also available. This invaluable information resource saves time and money in collection efforts. Over the past year, the IDEA website has had more than 3,400 unique visits and approximately 19,000 document downloads.

Publications

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IRRIGATION EDUCATION AND TRAINING

Landscape Irrigation Auditing and Management program conducted

The Landscape Irrigation Auditing and Management (LIAM) program conducted in El Paso and San Antonio focused on how to (1) identify irrigation system performance problems; (2) determine irrigation system performance, including uniformity and precipitation rate; and (3) create seasonal irrigation schedules to improve overall water-use efficiency. Students completing the 32 hours of training included Texas-licensed irrigators, grounds managers, water utility personnel, and other landscape and irrigation professionals. Attendees reported a 95 percent overall satisfaction with the course; 82 percent plan to change their irrigation practices and 78 percent expect to benefit economically as a result of the training. Students, on average, increased their knowledge of auditing and irrigation scheduling by 97 percent.

New program educates producers about chemigation

A new training program on chemigation for drip irrigation systems addresses growing concerns about drip irrigation system maintenance, clogging control, and irrigation scheduling. Instruction covers laws and regulations regarding the use of chemicals in irrigation systems and instructions for calculating injection rates and reading chemical labels. Hands-on instruction includes the operation and calibration of different types of chemigation injectors as well as in-field demonstrations on how to install soil moisture sensors and use the data to track soil moisture and calculate irrigation requirements. In total, 85 irrigators attended the pilot trainings. Eighty-seven percent reported being satisfied overall with the workshop, 75 percent plan to change their irrigation practices, and 81 percent expect to gain economic benefits as a result of the training. Students, on average, increased their knowledge of chemigation and irrigation scheduling by 92 percent.

Smart controller evaluation program assesses seasonal adjustments

The highly successful “smart controller” testing program continued in south Texas with testing conducted over a nine-month period (March–November), representing a full landscape irrigation season. Following the release of the 2009 testing report, three manufacturers made changes in their controllers to improve performance. However, results show considerable differences in irrigation amounts supplied by the controllers under the same conditions and seasonal differences. Other new aspects of this year’s study include the use of new virtual landscape parameters developed to test the controllers’ ability to handle scenarios more commonly found in Texas landscapes, such as shallow root zones and heavy soils. Smart controllers potentially offer a self-adjusting automated approach to watering landscapes. Adjusting irrigation run times to meet the plants’ water needs throughout the growing season allows more efficient water use, preventing overwatering, with a fixed irrigation schedule. Some Texas cities have already begun mandating smart-controller installation with every new irrigation system; however, little to no quantitative research has been conducted to evaluate controller performance under Texas conditions. Detailed results of the study are available on the Irrigation Technology Center website at ITC.tamu.edu.

TexasET Network expands in Brownsville and the Winter Garden

The TexasET Network continues to support three regional evapotranspiration (ET) networks: Lower Rio Grande Valley, El Paso, and San Antonio–Uvalde area. This year, the network expanded, adding three new stations in the Uvalde–Winter Garden area and a new station in Brownsville. Each region has

its own web page on the TexasET website at texaset.tamu.edu, which displays maps showing each station location. Select a specific station, and the website displays ETo (daily reference ET) and other information useful for determining the water requirements of crops and landscapes for that location. The TexasET website receives 6,008 visitors and has 61,645 pages viewed annually. The network continues to send out more than 18,000 emails a year to homeowners, landscape managers, and agricultural producers who sign up to receive customized irrigation recommendations.

Drip irrigation demonstration completes second year

The drip irrigation demonstration and research site on the Texas A&M University campus at College Station continues to test the viability of subsurface drip irrigation under turf. After two years, little difference was found in the performance of the different types of drip products tested, with inexpensive tape performing as well as a tubing product that cost 10 times as much. Details and photographs are posted on the ITC website at ITC.tamu.edu.

Publications

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(TOP) Canal gate
(BOTTOM) Canal-lining evaluation

INSTITUTIONAL INCENTIVES FOR EFFICIENT WATER USE

Trainings in geographic information systems (GIS) and Global Positioning System (GPS)

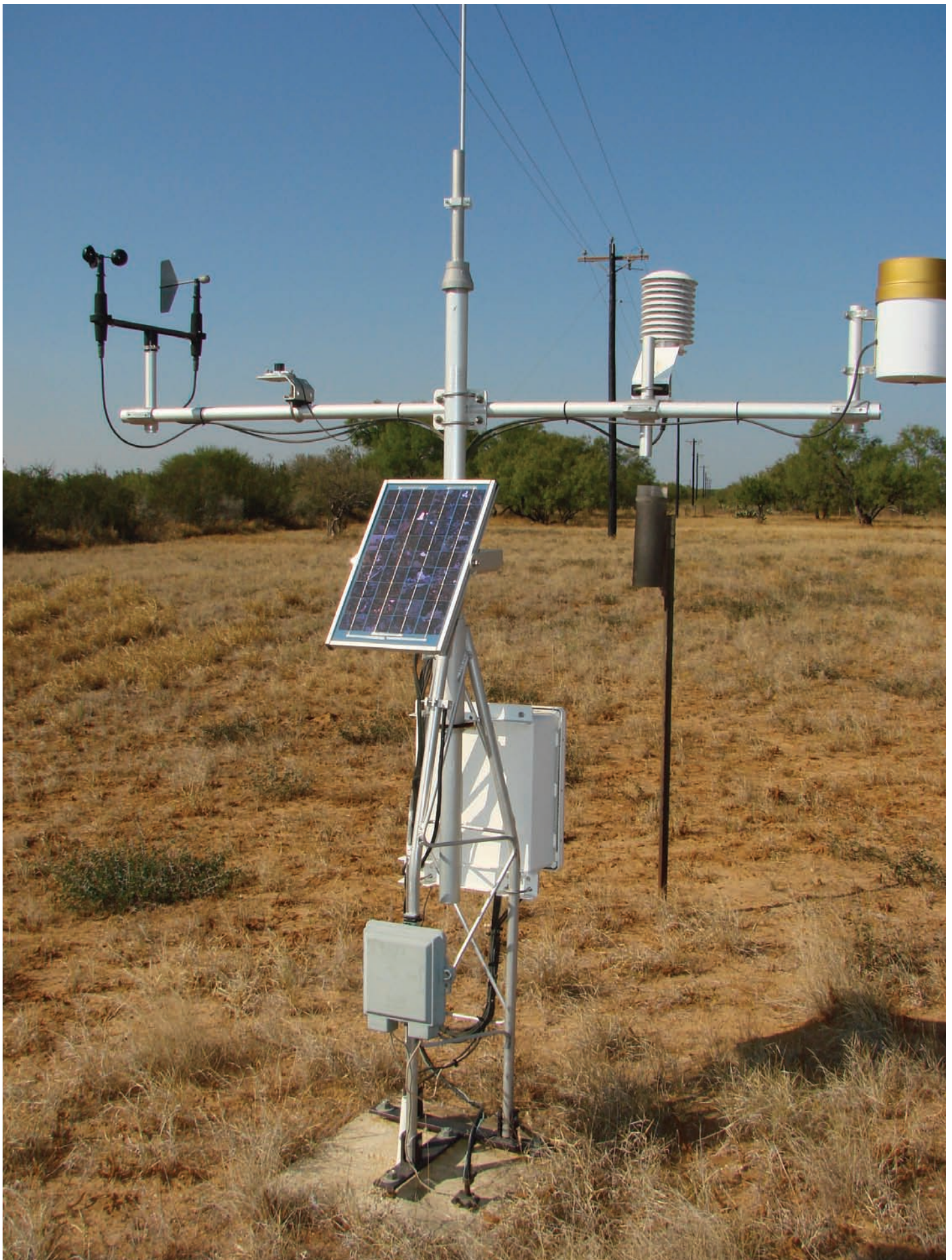
Over the past 10 years, Rio Grande Valley irrigation districts have faced drought, rapid urban growth, and increased scrutiny to make their irrigation systems and water management more efficient while operating more than 2,000 miles of deteriorating canals and pipelines. Geographic information systems (GIS) and Global Positioning System (GPS) technologies are invaluable for better planning of irrigation system rehabilitation projects and improved management strategies to enhance water-use efficiency, including irrigation for agricultural production. To help irrigation districts fully utilize these technologies, Extension engineers held three successful GIS/GPS workshops in Weslaco to educate beginners or refresh the skills of more experienced users.

The 25 workshop participants included irrigation district personnel and managers representing 44 percent of the total irrigated area and 50 percent of the Class A Water Rights area. All students reported that they increased their knowledge of both GIS and GPS by 100 percent and expect to benefit economically by what they learned.

The beginner and intermediate GIS workshops teach district personnel how to use GIS to produce useful and informative maps and perform spatial analysis of their irrigation systems, service areas, and related structures and facilities. The “Introduction to GPS” workshop provides hands-on instruction on using GPS for mapping—from simple, hand-held units to more complex, survey-grade units. Students learn how to record location coordinates and import that data into a computer for display onto GIS and other types of maps.

On-farm irrigation scheduling in irrigation districts

CRITERIA, a soil-water balance model, is being evaluated in Italy for scheduling in irrigation schemes. Research in Texas is assessing its potential for simultaneously determining on-farm water requirements on all fields within an irrigation district. The three demonstration sites are (1) a sugarcane field within Delta Lake Irrigation District, (2) the entire Brownsville Irrigation District, and (3) a lysimetric experimental site at the Bushland USDA Agricultural Research Service laboratory. This past year, Extension engineers completed laboratory tests of soil-core samples collected at the Delta Lake Irrigation District site to test hydraulic conductivity, water retention curve, and texture. Simulations of complete growing seasons for the three sites compared predictive and observed soil-moisture data at several different depths. In addition, engineers evaluated the effects of calibration using different levels of observed data, including reference evapotranspiration, soil texture, and soil water hydraulic properties. The findings to date show the model to be a useful tool for irrigation scheduling. Results were especially promising when soil moisture was measured with a neutron probe and testing was applied to the root zone layer. The input of more detailed observed data into the model yielded further improvements.



Weather station



Water-release gate

Spill data analysis and biological indicators of magnitude and frequency

The Irrigation District Engineering and Assistance (IDEA) team is developing indicators and tools districts can use to predict the seriousness and magnitude of operational spill events, as well as procedures for assessing and solving the underlying problems that cause excess spills in canal systems. This year, the IDEA team continued to estimate water losses from three monitored sites. They analyzed water sales in each spill basin (date and volume of each water ticket) and performed preliminary tests to assess the utility of using periphyton

accumulation rates for gauging spill water losses. The water losses were estimated at 2,300 acre-feet per year for each spill site (total losses of 23,000 acre-feet per year from all 10 spill sites within the district). The water sales analysis identified correlations between water losses and specific management actions.

In cooperation with The University of Texas-Pan American, the team analyzed biological markers for spill analysis. They performed preliminary tests on periphyton accumulation by deploying plastic squares on the wall of a spill structure. Because preliminary results indicate biological markers show good potential in spill analyses, testing is being expanded by using different material substrates and longer exposure times. The results from this project will increase awareness among irrigation district personnel about water losses and associated mechanisms, resulting in future water savings of 50 percent (12,500 acre-feet), corresponding to about 10 percent of the total district water authorized in 2009 for use in irrigation.

Use of GIS as a real-time decision support system for irrigation districts

An online GIS application integrates pump flow, meter data, and water account information to support districts in their current water management and conservation efforts. The objective is to provide the districts with a simple tool to improve the management of water orders, allow landowners Internet access to data, and improve availability of pump and gate data from the existing supervisory control and data acquisition (SCADA) systems. This year, the IDEA team completed this real-time GIS decision-support system for Brownsville Irrigation District (BID) and started working with Cameron County Irrigation District No. 2 (CCID2) to implement a similar system for their SCADA system. The BID website now displays real-time water orders, pump operation information, and links to related historical-use and other operational data. District personnel training was an important component of this project, resulting in an expanded interest in the use of GIS as a real-time decision support system, the identification of limitations of the existing database, and recommendations for further improvement. Implementation of such tools will result in more efficient management of pumps, gates, water orders, and on-farm irrigation scheduling, leading to reduced on-farm water use in at least 25 percent of irrigated areas, corresponding to a reduction of 5 percent of the authorized water use for each irrigation district in 2009 (460 and 2,940 acre-feet in BID and CCID2, respectively).

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ON-FARM IRRIGATION SYSTEM MANAGEMENT

Workshops held in Rio Grande Valley teach irrigation management, auditing

Several workshops held in the Rio Grande Valley taught agricultural producers and homeowners about irrigation management options, irrigation auditing, and drip irrigation. The irrigation management workshop held in San Benito, Texas, in April 2010, attracted 13 participants. The six-hour workshop covered the use of flow meters, calculation of irrigation depths, use of water balance to estimate irrigation, and irrigation scheduling using soil water sensors, as well as evapotranspiration, soil water properties, and soil salinity. At a Master Gardener training on irrigation management in San Benito in May 2010, approximately 21 participants learned about the results of six irrigation audits at this four-hour workshop. Eight participants attended the four-hour “Irrigation Auditing for Homeowners” workshop in Rio Grande City, Texas, in May 2010, and the drip irrigation workshop in San Juan, Texas, in October 2010 had 31 attendees for a three-hour, hands-on training session in drip irrigation.

The Texas Irrigation Expo was held in Mercedes, Texas, in October 2010, with 70 attending. The field tour showcased a 30-minute presentation on irrigation management for sugarcane, and approximately 25 participants attended a 30-minute presentation about Rio Grande Basin Initiative (RGBI) irrigation programs conducted by Texas AgriLife Research and the Texas AgriLife Extension Service.

RGBI polypipe and drip irrigation demonstrations yield results

In more than 40 demonstrations during the past six years, RGBI researchers have shown that using plastic polypipes instead of the traditional irrigation methods of earth ditches or furrows has increased the amount of water conserved from 5 percent to 40 percent, increased labor efficiency for irrigation more than 200 percent, and reduced production costs. During those six years, the use of polypipe increased from 30 percent to about 65 percent. Several Extension publications, field demonstrations, and outcome demonstrations helped promote this change. Using drip irrigation on vegetable crops is another impact of this project; onion production has doubled, using half the water as compared to the traditional furrow irrigation system.

Agricultural Demonstration Initiative for Harlingen Irrigation District complements RGBI

This project evaluates the effectiveness of different improved irrigation technologies on conserving water and improving profits. For example, irrigation scheduling using soil water sensors in several crop fields saved 4 acre-inches per crop by monitoring the soil water content during the growing season. Using irrigation scheduling in demonstrations on approximately 2,000 acres of citrus fields conserved about 4 inches of water during the season on these demonstration sites. The potential to conserve more water increases as more farmers adopt this technology—improving citrus irrigation alone could save about 9,400 acre-feet. Another demonstration compares drip and micro-irrigation for citrus to the traditional method of flood irrigation. Farmers with drip irrigation irrigate more often (twice a week) but for shorter periods, while increasing their yields. In the Lower Rio Grande Valley, where about 28,000 acres of citrus are irrigated, Rio Red grapefruit farmers are increasing their yields from 20–22 tons per acre to 28–30 tons per acre.



Evaluating moisture and salinity sensors to monitor soil conditions for agricultural production

Moisture and salinity data currently being collected in a laboratory setting will help determine the effects of multiple salinity levels in two soil types on moisture readings of reflectance, electrical conductivity, and electrical-resistance sensors. This study assesses the accuracy of salinity readings obtained from reflectance and electrical conductivity sensors and then compares these readings to values obtained using a standard soil test. The soil-sensing devices are also being evaluated in an on-farm project that will monitor salt buildup and subsequently remediate root-zone salinity.



Seasonal timing of regulated deficit irrigation in pecans

This project provides information about pecan irrigation scheduling, allowing Rio Grande Basin pecan growers to optimize water-use efficiency in mature orchards. Pecan growers in the drier areas of the Rio Grande Basin irrigate up to 56 inches per acre per year, making pecans one of the highest-water-demand crops in the arid region. Determining how to implement water stress on a pecan crop during a specific growth stage to increase yield per unit of water has yet to be studied. But preliminary research on what part of the annual growing season is best for regulated deficit irrigation—with the least negative impact on pecan nut yield and quality—suggests annual savings of as much as one-third acre-foot of water.



Crop irrigation and water-use studies

Oilseed production using camelina under varying water availability

Increasing water demand by rural communities has pressured agriculture to justify water availability for use on crops that require substantial amounts of water. Data from this research evaluates how a high-value crop that requires less water, such as camelina, can improve the long-term sustainability of crop production in northeastern New Mexico. Camelina is highly adaptable to dry climates, demonstrates high weed and pest resistance, is easily harvested, and can potentially be a significant component of the biofuel market. Three types of water treatments will be applied to 60 acres of camelina planted into a tilled and no-tilled center pivot area. Data collected will help define the optimum irrigation practices for low-water-use camelina oilseed production relative to seeding date and irrigation schedules. The by-product of the camelina oil will be used for range beef cow supplements.

Publications

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URBAN WATER CONSERVATION

Water education programs target youth audience

Students in areas experiencing water restrictions are the focus of the Kids & Kows & More water resource educational programs. Program participants in 2010 were encouraged to consider careers as water specialists and hydrologists and learned about the hydrologic cycle, projected water shortages, water conservation (including using harvested rainwater to irrigate landscaping), and water pollution sources.

Programs were delivered to 1,100 students in Bexar County, many from underserved audiences. Results from pre- and posttest assessments indicate a 92 percent increase in knowledge as a result of the trainings. Several additional youth-focused trainings will be conducted across the state throughout the coming year as a cooperative effort of county faculty, the Texas Commission on Environmental Quality (TCEQ), the Rio Grande Basin Initiative (RGBI), and the Texas Water Resources Institute (TWRI).

Rainwater harvesting programs assist Texans with water conservation

Rainwater harvesting programs provide timely information to help Texas property owners with water conservation issues. Trainings include information on the proper design of rainfall-capturing systems to support landscape irrigation, indoor water use, and water for livestock and wildlife. During workshop demonstrations, participants gain hands-on experience in building rainwater harvesting capture structures.

In 2010, information was delivered to 142,459 participants. Results from pre- and posttest evaluations indicate that 92 percent of these participants increased their knowledge regarding uses, limitations, and proper design of rainwater harvesting systems.

San Antonio Stock Show and Rodeo

Some 141,300 attendees viewed a rainwater harvesting display at the 2010 San Antonio Stock Show and Rodeo. Of those surveyed, 50 percent said they planned to implement a system for rainwater harvesting within the next 12 months. These installations will prevent an estimated 70,225,000 gallons of rainwater from rapidly running off into streams and stormwater systems. They also help conserve the same number of gallons of potable water that could have been used for irrigation in the San Antonio area during a year of typical rainfall. Water-cost savings are calculated at \$63,625, assuming that visitors were from two-person households that installed one 50-gallon rain barrel.

Webb County deer habitat

A demonstration rainwater harvesting site has improved a deer habitat in Webb County. The catchment retains an average of 10,334 gallons annually on Webb County soils too porous for soil tanks (average annual rainfall is 21.5 inches). Each catchment provides water for 25 additional deer (at a density of one deer per 20 acres) and increases the lease value for 500 acres. The construction cost for the dual catchment system is \$4,247, and the system's life span is at least 20 years. Assuming the catchment system increases the deer lease value by \$2 per acre, it would pay for itself in four years, yielding \$16,000 in additional profit for the landowner over the next 16 years.

Collaborations lead to implementation of rainwater harvesting

A collaborative effort between the World Birding Center, the Edinburg Rotary Club, RGBI, and TWRI provides funding for a rainwater harvesting design developed in 2009. Rainwater harvesting tanks installed in December 2010 established a highly visible site that demonstrates the collection of and uses for building runoff. The completed tanks will conserve 84,077 gallons of potable water each year that would have been used for irrigation, toilet-flushes, and other purposes.

Through cooperation with the Texas State Soil and Water Conservation Board, TCEQ, RGBI, and TWRI, many more rainwater harvesting workshops will be conducted across the state throughout 2011.

Educational programs for Rio Grande Basin counties

In August 2010, 59 attendees participated in a rainwater harvesting educational program in Del Rio, Val Verde County, Texas. Two rainwater harvesting sites in Webb County demonstrated the consumptive-use benefits of harvested rainfall for wildlife, landscape, and other applications. A site in Starr County demonstrated rainwater harvesting benefits for landscape and other urban applications.

Texas AgriLife Extension Service specialists supported the Texas AgriLife Rainwater Harvesting Task Force by providing rainwater catchment designs for demonstration sites in Edwards and Kinney Counties. A rainwater harvesting educational program was also held in Edwards County. In addition, specialists co-led a comprehensive, regional rainwater harvesting educational session on capture techniques, in-home use, and filtration for Brooks, Duval, and Jim Wells Counties.

Rainwater harvesting program supports Master Gardeners and Master Naturalists

The rainwater harvesting program continues to grow and develop. More than 248 Master Gardener and 91 Master Naturalist volunteers have completed training during the past five years. Master Gardener volunteers (129) have submitted 3,423 hours, valued at \$66,763 (\$19.50 per hour), contacting 15,393 individuals regarding rainwater harvesting. Through course evaluations, it is clear that participants understand not only the value of rainwater harvesting, but also that implementing rainwater harvesting techniques directly benefits Texas by reducing demand on the water supply and reducing urban and



Rainwater harvesting display



rural runoff, erosion, sedimentation, and surface water contamination. Rainwater harvesting protects surface water supplies through limiting contaminant transport off the land surface, reducing peak stormwater flow rates through stream channels, and conserving potable water supplies through landscape water conservation.

A Master Gardener rainwater harvesting specialist class was held in Denton, Texas, with participants from across the state. Two more courses are planned for Williamson and Hood Counties.

Master Gardener specialist: Rainwater harvesting training

Rio Grande Basin Initiative Extension specialists trained 11 rainwater harvesting specialists in a 16-hour session. As part of the requirements for training as a specialist in rainwater harvesting, each person must volunteer at least 12 hours of their own time to teach others about rainwater harvesting in order to receive their specialist patch. Evaluations given as a retrospective pre-posttest at the end of the training quantify participant knowledge gain in specific areas.

The overall program evaluation results indicate participants ranked the accuracy of the information as excellent and easy to understand; the quality of materials and instructors' knowledge levels were ranked excellent as well. On the retrospective pre-posttest, all individuals reported they gained knowledge on rainwater harvesting systems and irrigation issues. Eighty percent said they gained knowledge on stormwater and its impacts on the environment as well as landscape water conservation.



Evaluating sprinkler landscape-irrigation amounts

Rainwater harvesting training course for landscape and irrigation professionals

The recent resurgence of rainwater harvesting as a significant water source has caused many landscape and irrigation professionals to include it as part or all of their contracting business. Most rainwater harvesting installers in Texas do not have special licensing requirements. To maintain high-quality water for the users and increase the legitimacy of the rainwater harvesting industry, professionals need to learn and implement best practices. A one-day course for these professionals created by the Texas AgriLife Extension Service includes presentations on the case for rainwater harvesting, sizing of rainwater harvesting system components, methods of improving stored water quality, treatment of harvested water, and maintenance. The pilot training program held in Harris County on November 18, 2010, drew 20 participants from throughout the state. Overall satisfaction of the participants was excellent, and participants gained knowledge in the topics of rainwater harvesting systems and irrigation issues. Most participants also gained knowledge in the areas of stormwater and its impact on the environment and landscape water conservation.

New rainwater harvesting online training courses

The "Tap into Rainwater for In-Home Use" training course will be available as an online course through the rainwaterharvesting.tamu.edu website in the spring of 2011. The seven- to eight-hour course focuses on the current water situation in Texas and how to harvest, treat, and disinfect rainwater for safe in-home use, based on TCEQ treatment and design recommendations.

Rainwater harvesting demonstrations across the Rio Grande Valley

Development and installation of demonstration systems are critical in showing the public the value of harvested water for irrigation purposes. To date, there are five demonstration system locations across the Rio Grande Valley: Brackettville, El Paso, Marfa, Edinburg, and Leakey. More demonstrations will be installed throughout the rest of the project year.

Rainwater harvesting education leads to water conservation/alternative water sources

Texas water resources are of critical importance to its people, environment, and businesses. While some places have ample water to supply these needs, others currently have or are projected to have water shortages. In the next 50 years, the state's population is expected to increase by 83 percent and the state's water supply to decline by 18 percent. Many localities are desperately searching for ways to increase water supply or decrease demand. Many of these strategies include building new reservoirs, using interbasin transfers, desalination, conservation, and identifying other new sources. Rainwater harvesting can increase supply and decrease demand on municipal sources. General programs and demonstrations are critical for educating the public about rainwater harvesting as a means to conserve water, control stormwater runoff, and manage irrigation.

To meet the demand for education on rainwater harvesting, RGBI specialists conducted 14 general programs across the state and made presentations at fairs and conferences, most of which were held in the Rio Grande Valley. These training programs reached 771 individuals, including 51 youth. Presentations were also made at the national rainwater harvesting conference in Austin, the irrigators' conference in El Paso, and the Eco Fest in Wimberley.

The Rainwater Harvesting Training Camp was held in Junction, Texas, on August 16–20, 2010, to meet the demand of landscape and irrigation professionals for information on rainwater harvesting. The training covered advanced topics and included train-the-trainer sessions. All 33 individuals attending the camp said they would recommend the training course to others. Eighty-two percent of the respondents reported a gain in knowledge, 32 percent indicated a willingness to implement more robust disinfection systems, and 64 percent indicated they would install rainwater harvesting systems for livestock and wildlife.

New rainwater harvesting fact sheet translated into Spanish

Teaching people to make rain barrels for rainwater harvesting is a useful tool for educating them about water literacy, with the goal that they will progress to more extensive methods of water conservation. The Texas AgriLife Extension Service publication *Rainwater Harvesting: Making a Rain Barrel* (L-5518) explains the basics of rainwater harvesting, followed by a step-by-step guide on how to make a rain barrel, plus guidelines on rain barrel uses, installation, and maintenance. The Spanish version of the fact sheet, recently translated, was sent to 22 county agents in the Rio Grande Basin for distribution and use in local programs.

Establishing the Virtual Urban Landscape Water Conservation Center

The Virtual Urban Landscape Water Conservation Center is a website that gathers online information about Xeriscaping*, urban irrigation, and other landscape water conservation topics relative to New Mexico and Far West Texas to strengthen educational and Extension outreach related to these subjects. The center compiles the information from existing New Mexico State University, state, county, and nonprofit websites into a single website with integrated services. The center's goal is to become a single clearinghouse of information and information transfer by expanding knowledge about demonstration



Youth water education

landscapes, increasing training opportunities for county agents and Master Gardeners, and supporting the dissemination of academic and applied research techniques appropriate for cities in New Mexico and for El Paso, Texas. The Center for Landscape Water Conservation blog at xericenter.wordpress.com coordinates information concerning water conservation issues in the Southwestern landscape and posts details about events and community resources (Master Gardeners and organizations dedicated to waterwise landscape issues) as well as short, timely articles and announcements. Future additions to the blog include links to best-practice websites, relevant professional blogs, and destinations (gardens and parks). The Urban Landscape Water Conservation

Coordinating Committee, a regional professional group that develops waterwise landscape education and water management tools for the people of the southwestern United States, maintains the blog.

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Expansion of the precipitation network in New Mexico

The New Mexico Community Collaborative Rain Hail and Snow (CoCoRaHS) Network greatly increased its network capacity this past year. Specialists installed more than 112 new rain gauges in rural counties in New Mexico and also installed four new scan sites at (1) the USDA Natural Resources Conservation Service (NRCS) Northwest Climate Center in Los Lunas, (2) Alcalde Agricultural Experiment Station facilities, (3) the Jornada USDA Agricultural Research Service (ARS) facility, and (4) the Sevilleta National Wildlife Refuge. In addition, weather stations were installed in the Las Uvas area (near Hatch, New Mexico), El Rito (northern New Mexico), and the South Valley area of Albuquerque. A National Science Foundation Experimental Program to Stimulate Competitive Research (EPSCoR) climate change research grant funded the infrastructure and network expansion. This project will promote water conservation and drought preparedness and help evaluate and reduce drought impacts by fostering the continued development of New Mexico's CoCoRaHS and weather station networks.

Youth learn about watershed management and conservation

Youth in the Navajo Four Corners area of New Mexico learned about their watershed and took part in several building activities that encourage water conservation and good management skills. In one activity they made and decorated rain barrels and installed them throughout the local area. The program, held in Gallup, New Mexico, taught youth ranging from ages 13 to 19 how to conserve water in and outside their homes and how good stewardship practices can protect their watershed.

Fix a Leak Week reminds homeowners to check for household leaks

Because minor water leaks account for more than 1 trillion gallons of water wasted each year in U.S. homes, AgriLife Extension agents in Rio Grande Basin Initiative counties promoted Fix a Leak Week March 14–20, 2011. Sponsored by the U.S. Environmental Protection Agency WaterSense Program, Fix a Leak Week serves as an annual reminder to check household plumbing fixtures and irrigation systems for leaks.

During Fix a Leak Week in 2010, more than 1,500 families pledged to follow a checklist to locate and repair leaks in their homes. Every pledge signed represents an estimated water savings of 11,450 gallons.

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ENVIRONMENT, ECOLOGY AND WATER QUALITY PROTECTION

Grass carp demonstrations reduce aquatic vegetation

Triploid grass carp demonstrations have reduced or eliminated submerged aquatic vegetation, particularly hydrilla, from irrigation canals, reducing costs associated with labor, equipment, and chemicals. In 2010, the six cooperators reported an estimated savings of more than \$500,000 per year. Water savings include reductions in pumping costs, percolation or seepage, evaporation, and mosquito breeding areas. Because these are continuing demonstrations, total water savings have not been estimated. In addition, herbicide recommendations for the control of water hyacinth and water lettuce continue to be used by Cameron County Irrigation Districts No. 2 and No. 6, respectively. These programs have resulted in significant savings in water loss due to evapotranspiration and labor and equipment costs. Because water hyacinths increase evapotranspiration by 200–300 percent, the water savings are significant but difficult to calculate. Demonstration reports are published in the annual *Rio Grande Districts Aquatic Vegetation Management Newsletter*.

Invasive aquatic weed materials available

The herbicide tables and posters in the *Invasive Aquatic Weeds of the Rio Grande* series, available to Texas AgriLife Extension Service agents, continue to be popular handouts for Continuing Education Unit and Private Impoundment trainings. Two Master Naturalist trainings were held in El Paso County in April 2010, one a standard beginning training and the other an advanced training in aquatic ecology.

The AQUAPLANT website was completely revised, with new photos, frequently asked questions, and new chemical management techniques. In 2010, the website (aquaplant.tamu.edu) had more than 198,000 unique visitors, viewing over 1.1 million pages.

Leaf beetles defoliate saltcedar

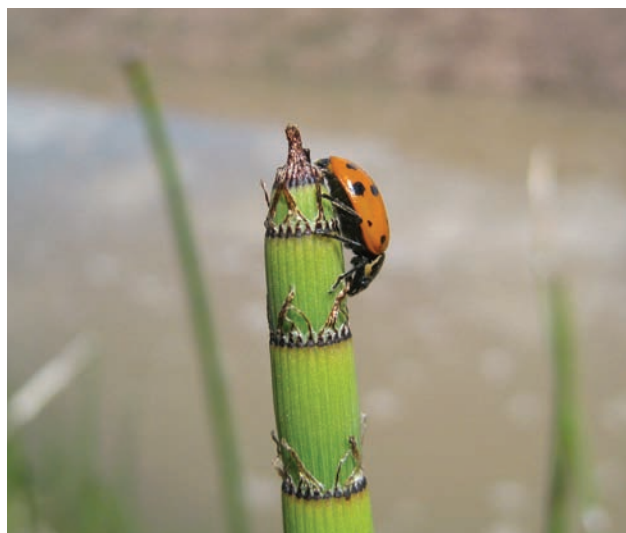
Tamarisk (*Tamarix* spp.) leaf beetles have defoliated saltcedar on approximately 11 river miles and 2.6 miles off the Pecos River. This equates to approximately 14,000 acres in the Pecos River area on which Tamarisk leaf beetles have defoliated saltcedar. This site also serves as a nursery location for obtaining adult *Diorhabda elongata* (Crete) beetles for release at new sites—approximately 13,400 of which have already been collected and released.

Highway 18 site

At the Highway 18 site, 6,700 larvae and 2,300 adult Tunisian beetles were released on July 20 and August 13. When beetle population data were collected, no beetle adults or larvae were found on transect trees on either sample date. However, adults and larvae were found on the release tree. The slow dispersal and population increase occurred, at least in part, because most of the beetles at this site were not released until after July 20. In the September 21 sample, beetles and larvae were found 250 or more yards west of the release tree and 100 or more yards east of it, indicating that the beetle population had increased dramatically after the July 20 and August 13 release dates.

Imperial, Texas, site

At the Imperial site, both species of saltcedar beetles increased. On the June 25, 2010, sample date, population densities of Crete beetles found from transect trees averaged 2.75 larvae and 0 adults per four-minute counts, with transect trees showing no defoliation. On July 28, population densities had increased to 8.6 larvae and 3.6 adults per four-minute count, and defoliation was at 1.6 percent. By the August 9 sample date, beetle populations increased to an average of 27.4 larvae and 5.1 adults per four minutes and 6.1 percent defoliation of transect trees. On September 15, researchers counted 52 defoliated trees. At the Tunisian site, 9,000 beetles were released on July 30, and 4,500 were released on August 6. On September 15, Tunisian beetle population densities had increased sufficiently to defoliate 25 trees.



Beetle on stem of giant cane

Iraan, Texas, site

At Jim Cade's ranch near Iraan, Texas, both species of Tamarisk leaf beetles increased. Prior to July 1, 15,000 Crete beetles were released; an additional 7,500 Crete beetles were released on August 11. Crete beetle population densities and transect tree defoliation were monitored, and data was collected on July 6, July 21, and August 6. No adults or larvae were found on transect trees in the July 6 sample. On July 21, there were an average of 7.25 larvae and 0 adults per four minutes on transect trees (which were approximately 10 percent defoliated). Beetles averaged 0 larvae and 4.9 adults per four-minute counts on August 6, and transect trees averaged 3 percent defoliation. On September 15, Crete beetles had completely defoliated 52 saltcedar trees and dispersed 474 feet from the release tree. A total of 26,000 Tunisian beetles were released approximately one-half mile from the Crete beetle release site. On August 6, 82 larvae and 3 adults per four minutes were found on the release tree, which was approximately 70 percent defoliated. On September 15, 20 trees were defoliated at the Tunisian site, and beetles had dispersed 310 feet from the release tree.

Mentone, Texas, site

On June 29, 800 Tunisian beetles (*Diorhabda sublineata*) were released in an open field at a new site near Mentone, Texas, and 10 trees were selected for population monitoring. On July 27, 10 larvae and 1 adult were found in four minutes on the release tree, with an average of 3.9 larvae and 0.2 adults per four minutes recorded from the transect trees. On September 15, beetle population density had increased sufficiently to defoliate 25 trees.

Leon Springs site

A new site was selected for Crete beetle establishment near Leon Springs, which is near Fort Stockton, Texas. Approximately 5,000 Crete beetles were released between July 13 and August 3, and on August 16, an average of 20.4 larvae and 12.5 adults per four minutes were found on transect trees. On October 6, beetle population densities had increased sufficiently to defoliate 10 trees.

Santa Elena Site

Crete beetle establishment at the Santa Elena site began in 2008. On April 1, 2010, the field cage was reestablished and inoculated with 62 locally collected adults. This cage was opened May 10 and reinoculated with local beetles on May 19; the beetles developing in this cage were released June 4. On May 21, a four-minute visual search of 10 sample trees along a 200-meter transect found an average of

13 larvae and 1 adult per tree. Larvae were present on 50 percent of the sample trees, and large numbers of larvae were present on the tree where 10,000 adults were released the previous fall. Although no tree defoliation was observed on this date, this population level was considered sufficient to increase to levels capable of defoliating trees by midsummer.

On July 17, the 10 trees along the same transect were again sampled during a four-minute search and found to have large numbers of adults and larvae on all sample trees, an average of 84 larvae and 13 adults per tree. Seventy percent of these 10 trees were defoliated, and 30 percent were more than 50 percent defoliated. A survey of the release site identified about 35 large saltcedar trees that were entirely defoliated by the beetles. The use of GPS to search and mark the surrounding area found beetles and larvae distributed along a transect 0.2 miles long and throughout the area extending south from the initial release site through the picnic area and to saltcedar trees along the Rio Grande.

No additional offsite beetles were released at this site during 2010, since this population of *D. elongata* is considered to be established. The population has overwintered, increased, and defoliated trees without the release of additional beetles.

Gravel Pit Campground Site

Establishment of the *D. sublineata* (Tunisian beetle) began in 2009, but by April 2010 the saltcedar seedlings were suffering from drought stress and only a few first instar larvae were reported.

On July 17, a survey of the site found saltcedar leaf beetle larvae and adults common on saltcedar throughout the area and several hundred trees entirely defoliated by them. Beetles and defoliated trees extended both up- and down-river from the release site and along at least 0.53 miles of the Rio Grande, as measured by GPS readings taken at the site. Beetles probably dispersed further than measured as rock cliffs prevented access beyond this range in both directions. Some athel trees up to 4 meters tall and immediately adjacent to defoliated saltcedar trees were also defoliated. A row of large athel trees was not defoliated, although some larvae were present on these trees. Specialists examined 30 athel trees along a 360-foot transect through the defoliated area, recorded the presence or absence of *Diorhabda* larvae, and estimated the percent of defoliation due to larval feeding. Larvae were present on 100 percent of the sampled athel trees, about one-half (46 percent) of these trees had some degree of defoliation, and 23 percent (seven trees) were 50–100 percent defoliated by *Diorhabda*. This population is likely established, given the large number of defoliated trees, abundance of beetles, and distribution of the population.

Sublette-Duncan Site started in 2010

On May 21, 2010, 640 Crete beetles collected from a field near Pecos, Texas, were released in the open field. Sampling on July 17 found a mean of seven adults or larvae per four-minute count. Specialists will monitor the dispersal of beetles and their impact on saltcedar and athel trees at these three sites. It will also be important to establish plots to monitor long-term changes in vegetation following repeated defoliation and expected decline in saltcedar canopy size and distribution.

Development of online invasive plant resources

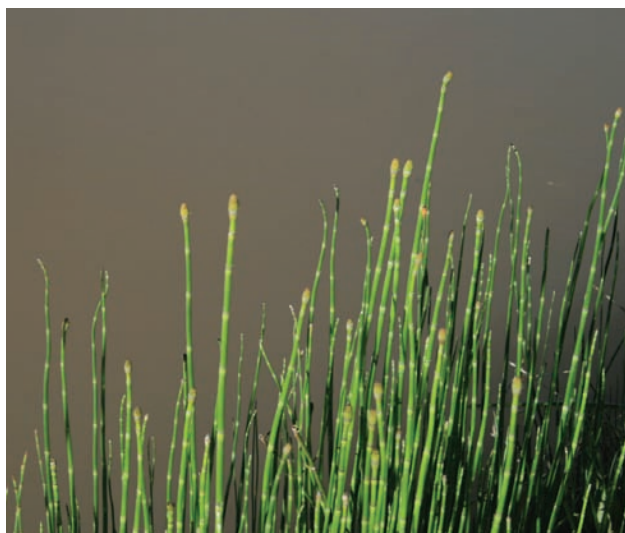
The Department of Ecosystem Science and Management invasive species website is undergoing a complete overhaul, and specialists will continue to add plants to the database during 2011. A preview of the new format is available at essmextension.tamu.edu/plantsdev/.

Development of herbicide alternatives for invasive species

Herbicidal control plots were established in 2008–2010 near Harlingen to screen various herbicides for control of giant cane. In addition, plots were established during 2010 in Navarro County in cooperation with representatives from local irrigation districts, county government, and industry to make plot evaluations.

Specialists continue to assess new herbicides for controlling saltcedar. Plots established from 2007 to 2010 have evaluated the efficacy of a new, unregistered herbicide being developed by DuPont and Dow AgroSciences. Plots have been established using aerial, ground broadcast, individual plant foliar, individual plant basal, and cut stump application methods. In all, 12 individual studies will continue for at least two more years.

Specialists are also looking at the use of Clearcast herbicide, produced by BASF, for use on Chinese tallow trees. In 2010, aerial application plots on Katy Prairie Conservancy (KPC) land near Katy, Texas, were used to evaluate different rates and tank mixes. The work is being done in cooperation with KPC and BASF.



Invasive Arundo donax

Pecos River Watershed Protection Plan Implementation Program begins

To establish the Pecos River WPP Implementation Program, specialists worked closely with the Texas Water Resources Institute, landowners, and local soil and water conservation district boards. Obtaining landowner easements for saltcedar management were the primary focus of 2010 efforts, and specialists hope to coordinate aerial spraying efforts on the Pecos River in the fall of 2011.

Trainings educate thousands of Rio Grande watershed citizens

Through Rio Grande Basin Initiative funding, citizens across the Rio Grande watershed have been able to attend trainings on water-related topics. Fifteen separate training sessions were held across the watershed, training more than 1,000 citizens. Topics included rainwater harvesting and water conservation, graywater reuse, irrigation efficiency, lawn irrigation efficiency, testing well water quality, cleaning water, pesticide contamination and control, oil field reclamation and pollution control, and water law and rights.

Other specialist activities included cooperating with the Texas–New Mexico Pecos River Compact, serving as the water quality experts for the desalinization project at Malaga Bend, and continuing work with the Red Bluff Irrigation District and its seven associated irrigation districts. Professional assistance has also been given to local groundwater districts in formulating their rules and procedures as well as helping to establish the Pecos River WPP Implementation Program to clean the river water for more efficient irrigation. Specialists have also worked with the Nature Conservancy to help educate citizens on the importance of clean water. In addition, participation in the Texas State Youth Water Camp helps teach youth about their water and what they can do to preserve it.

Evaluating scouringrush found in Elephant Butte Irrigation District canals

Research along the irrigation canals of Elephant Butte Irrigation District (EBID) discovered that scouringrush (*Equisetum hyemale*) could cause significant water loss via ponding and evapotranspiration. While control of scouringrush is difficult using conventional

methods, research has shown that it has a high silica content that prevents herbicides from being effectively absorbed. Due to its perennial characteristics, the weed is able to quickly reestablish from its underground creeping rhizomes. Research notes that the effects of the canal and soil characteristics on scouringrush growth indicate that soil salinity affects the weed, but further study is needed to clarify this effect. Research also shows that current management practices conducted by EBID have no negative effect on scouringrush growth, and in fact, the herbicide mix currently used by the irrigation district increases the weed's coverage. Based on these results, a further long-term field study is recommended.

The presence of *Equisetum hyemale* is a concern to EBID managers because of its impact on irrigation management and efficiency. The *E. hyemale* population interrupts and slows down water flow, resulting in wasted water that could have been used for irrigation. Past RGBI studies have shown that soil and irrigation water quality may also be affected by excessive weed growth in the canals because ponding and evaporation concentrate salts in the soil and water. Information from this study will help develop management strategies for this horsetail variety and determine the effects it has on soil physical and chemical properties.

NMSU ecologists study irrigation system wetlands along the Rio Grande Basin

Changes in Rio Grande river ecology increase along with the growing population in the Rio Grande Valley. Ever-increasing demands to convert water used for agriculture to urban populations, and the resulting effects on the biota of arid-land rivers such as the Rio Grande, are often lost in the tug-of-war between competing interests for water that is in short supply. This project seeks strategies that (1) benefit agriculture and the environment, (2) collaborate with the Middle Rio Grande Conservancy District on developing refugial fish habitats in association with irrigation return canals, (3) conduct research on wetlands connected to irrigation and drainage systems, and (4) conduct pilot studies on the genetic adaptability of fish to elevated salinity, which is common for irrigation-return waters. Considerable tension exists along the Rio Grande, where agricultural water users are under attack to surrender water to keep the Rio Grande wet during climatically dry years. This project identifies strategies that allow the two to work in harmony.



Rainwater harvesting tank demonstration

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SALINE AND WASTEWATER MANAGEMENT AND WATER REUSE

On-site wastewater treatment course successful

The course “Basics of On-Site Wastewater Treatment Systems” (OWTS 101), held in Weslaco on June 2, 2010, provided eight on-site professionals with an overview of basic on-site wastewater systems topics such as on-site regulations and permitting, siting an on-site system, pretreatment systems, and soil-based final treatment and dispersal systems. Of the eight who attended, six said they would recommend this course to another wastewater professional. Four said they anticipate benefiting economically as a direct result of what they learned through the training.

Training courses conducted by Texas and New Mexico specialists

In cooperation with New Mexico State University, specialists conducted three trainings for wastewater practitioners. Beginning on June 30, 2010, local tribal members in New Mexico attended the 16-hour “Analyzing High-Strength Wastewater” training course. A four-hour session on fats, oils, and grease (FOG) management, focusing on restaurants and food service entities, was held on July 2, 2010, in Santa Ana Pueblo, New Mexico. This training was also held for wastewater operators from the Tribes and Pueblos in New Mexico. On August 26–27, an installer training workshop was held in New Mexico.

Training course being developed for wastewater practitioners

The course “Spray Distribution” (OWTS 310) is currently under development. Once completed, it will be submitted to Texas Commission on Environmental Quality (TCEQ) for approval as a training course for wastewater treatment practitioners.

Short course developed for homeowners on maintaining wastewater treatment systems

The Texas AgriLife Extension Service now offers the short course “General Guidance for Aerobic Treatment Units” (OWTS 210), targeting homeowners who wish to maintain their on-site wastewater treatment system. In the six-hour training, students gain a better understanding of how an aerobic treatment system provides effective removal of wastewater constituents. Topics include the evolution of wastewater treatment systems, the operation and maintenance of wastewater treatment systems, and how to construct wastewater treatment systems to provide effective on-site systems and protect the public. Course materials and activities are based on the manual *Checking My Aerobic System: General Guidance for Monitoring Aerobic Treatment Units, Disinfection Units, and Spray Fields in Texas*.

Electronic wastewater use and management trainings in development

An electronic training course addressing the use of wastewater for landscape irrigation will be available through the ossf.tamu.edu website in spring 2011. The online course focuses on the use of wastewater from an on-site sewage facility, protecting human and environmental health, the evolution of on-site wastewater management, and how a septic tank and trench drain field work.

Homeowner aerobic treatment system course in development

An online course for homeowners interested in maintaining their on-site aerobic treatment system will be



available through the ossf.tamu.edu website in spring 2011. The course contains about six hours of video presentations that accompany the manual *Checking My Aerobic System: General Guidance for Monitoring Aerobic Treatment Units, Disinfection Units, and Spray Fields in Texas*, along with access to additional on-site wastewater fact sheets developed by the Texas AgriLife Extension Service.

NMSU scientist examines effects of saline water on turf establishment and sustainability

Work has begun at New Mexico State University to assess whether salt levels in the soil can reach intolerable levels during long-term saline water use, even when appropriate salt-tolerant grasses are used. This research examines changes in soil salinity below the turfgrass root zone to evaluate the potential impact of irrigating with saline water. Information from this project will help municipalities and developers plant appropriate grasses in combination with the use of impaired waters for irrigation, allowing substantial savings of potable water. This research will also determine whether the Desert Southwest (USDA climate zone 8a) has a sufficiently long growing season to successfully establish and sustain varieties of warm season turfgrasses (bermudagrass, seashore paspalum, and zoysiagrass) and cool season turfgrasses (alkaligrass, tall fescue, hybrid bluegrass, and Kentucky bluegrass) when exposed to multiple environmental stresses such as salt, heat, and cold.



Turfgrass demonstration plots to determine those best suited for New Mexico's climates

Identifying potential governing policies, institutions, and procedures for water reuse

Interest in the potential for water reuse as a means of extending existing supplies and mitigating drought shortage impacts in New Mexico is growing. However, there is much uncertainty about state policy, agency involvement, legal and regulatory requirements, and procedures governing water reuse. The New Mexico State University Water Task Force has developed a modified policy analysis matrix (PAM) designed to examine a policy application in its basic form and establish its costs and benefits. The PAM then analyzes the costs and benefits associated with the policy as it changes. The analysis can be used to design a well-understood framework for a particular policy. Decision makers and interest groups can use the analysis to understand the consequences of policy action as well as the resulting effects if no laws or regulations are created. The water reuse PAM identifies the legal ability to reuse water, ownership of

water rights, downstream or third-party impacts, regulatory and procedural requirements, water quality concerns, state and local agency involvement, and cost-effectiveness of water reuse compared to that of alternative sources. This project intends to identify people who are involved in water reuse policy and allow them to clearly evaluate the policy and make sound decisions.

New Mexico training for tribal members regarding decentralized wastewater

The goal of this program is to provide each tribal community in New Mexico with the means to protect public health by training wastewater operators and installers in making wastewater systems operate at their most efficient level. The main objective is to engage New Mexico's tribal communities in evaluating and assessing their community septic and wastewater systems. With collaboration from the Texas AgriLife Extension Service and NMSU, this project has trained 143 tribal members, representing 14 tribes, Indian Health Services, EPA Region 6 environmental engineers, and New Mexico environmental engineers. This year, the four-session training was made available to the Navajo Nation (in EPA Region 9), with participants representing three chapters. Course evaluations show an overall increase in knowledge of approximately 300 percent among tribal members. Tribal leadership has supported this project, which is listed as an EPA Region 6 success story, and many of the tribes are in the process of converting their wastewater systems from ponds/lagoons to cluster-type systems.

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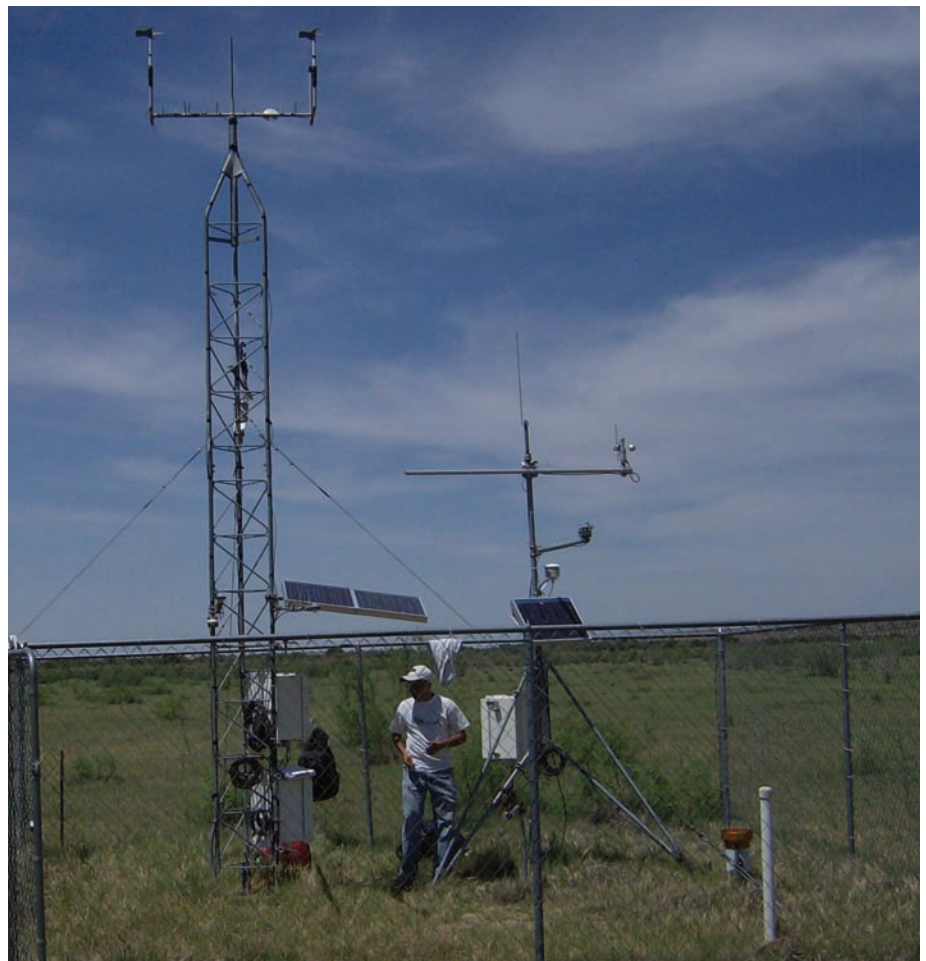
BASINWIDE HYDROLOGY, SALINITY MODELING AND TECHNOLOGY

Scientists developing operational model to estimate evaporation losses

Scientists at New Mexico State University (NMSU) are developing a more accurate method for estimating evaporation losses from the Elephant Butte Reservoir, a process that can also be used on other New Mexico reservoirs and lakes. Evaporation at Elephant Butte Reservoir, located in the arid Southwest, is one of the major loss terms in the hydrologic balance of the Rio Grande. In 1999, a study by the Action Committee of the Middle Rio Grande Water Assembly placed the reservoir's average evaporation loss at 140,000 acre-feet per year, with a high of 228,000 acre-feet per year and a low of 41,000 acre-feet per year. This wide range of estimated evaporation combined with continued increasing regional water demands makes accurate estimation and forecasting a critical management need. Currently, a single evaporation pan placed near the dam at the southern end of the reservoir estimates the reservoir evaporation losses. (Stage surface-area tables developed during periodic bathymetric surveys relate the point measurement of evaporation by a pan to the volume of water lost from the reservoir.) The new operational model estimates evaporation losses for the entire reservoir on a near real-time basis, helping decision makers manage reservoir water storage for more efficient hydroelectric power production and assess water-budget requirements for irrigation and other uses in the Lower Rio Grande Basin.

Acequia research studies interactions of traditional irrigation systems and surface water–groundwater

Valuable field data provides cutting-edge synthesis of how traditional acequia irrigation systems affect surface water and groundwater hydrology. This project data is then used to populate, calibrate, and validate GSFLOW (Coupled Ground-Water and Surface-Water Flow), a model released in March 2008 by the U.S.



Weather station to study evapotranspiration

Geological Survey. This is the first model to simultaneously demonstrate surface water and groundwater interactions and show the effects acequia irrigation systems have on water supplies in the Rio Grande Basin. Information from GSFLOW will demonstrate how to better manage traditional groundwater and surface water irrigation water interactions, which have important implications for water management in the semi-arid western states. Understanding groundwater flow paths gives insight to flow direction and recharge as well as chemical interactions of groundwater and surface water.

REEM assesses broad-scale, field-level ET, crop coefficients, economic productivity, and depletion dynamics

The Regional Evapotranspiration Estimation Model, or REEM, confirms that the majority of pecan orchards in southern New Mexico are irrigated well below potential evapotranspiration, resulting in lower yields and gross economic returns. REEM, which has been extensively validated for pecans, was the subject last year of a study sponsored by the New Mexico State Attorney General. An international expert on remote-sensing applications in irrigated agriculture reviewed the REEM research results at the request of the New Mexico Office of the State Engineer, the engineering and economic team for this project. The office delivered the project findings to the New Mexico Legislative Water and Natural Resource Committee. Currently, REEM is used in the Middle Rio Grande Basin in the South Valley area of Albuquerque, New Mexico, through a USDA National Institute of Food and Agriculture Agricultural Prosperity for Small and Medium-Sized Farms program grant. This project is expanding its REEM applications to alfalfa and expects to extend its use to other major crops produced in New Mexico's Mesilla Valley.

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Maintaining the weather station and collecting data

2010 / 2011

COUNTY PROGRAM ACCOMPLISHMENTS

TEXAS AND NEW MEXICO

COUNTY PROGRAM ACCOMPLISHMENTS

TEXAS COUNTY PROGRAMS

SOUTH REGION

Youth water quality protection program teaches teens about hydrology, pollution

An ongoing effort teaches Starr County rural residents about the dangers of water well contamination. The youth population in these areas also needs an awareness of how to screen water well samples for contaminants and learn the value of groundwater protection.

As a result of this concern, the Starr County Youth Board, with assistance from local agriculture science teachers, developed a youth water quality protection program designed for high school students from all three schools in Starr County. This event provided educational material for teachers and students, a hands-on workshop about water quality and conservation, and a student evaluation.

AgriLife Extension agents worked with high school agricultural science teachers from each of the school campuses to select topics for the workshop, set up schedules for the event, and develop the student evaluation instruments. Students collected 31 water well samples 24 hours before the workshop, screened the samples with water testing kits, and shared the results with the rest of the workshop participants. A nonpoint source pollution display highlighted information about the hydrology cycle.

Based on the evaluations given to the students to determine how much knowledge they acquired, 95 percent of all respondents better understand the benefits of conducting water well tests, 87 percent understand the importance of testing for nitrates and bacteria in water used for human consumption, and 92 percent learned more about the potential hazards related to drinking contaminated water. Almost all the respondents indicated they have a better understanding of the hydrology cycle and the advantages of using in-home rainwater harvesters for lawn irrigation.

AgriLife Extension agents submitted a feature story about the event to the local newspaper and shared a summary of the program evaluation results with the agricultural science teachers, 4-H youth board, and county residents. This program design (enlisting the support of the agricultural science teachers) will continue next year, possibly addressing another emerging issue.

Fix a Leak Campaign raises water conservation awareness

A single home can waste more than 10,000 gallons of water every year due to running toilets, dripping faucets, and other household leaks. Nationwide, more than 1 trillion gallons of water leak from U.S. homes each year, and research shows that 10 percent of homes have leaks that waste 90 gallons or more per day.

The goal of the Fix a Leak Campaign, “Every Water Drop Counts,” is to save thousands of gallons of water in Starr County by encouraging homeowners to check their household fixtures and irrigation systems for leaks.

Programs conducted in March 2010 reached more than 3,500 residents, who signed a pledge to conduct audits in their homes to check for leaks. To find leaks, participants learned to read their water meters and check them again after a two-hour period of water use.



Measuring soil moisture

This program increased awareness among Starr County citizens of the need to conserve water in their homes and landscapes. Many of the program participants not only applied the information presented but also took the water-saving devices distributed and installed them in their own homes or landscapes. Eighty-five percent of the participants who received water-saving fixtures installed them, and a total of 78 households reported they installed additional retrofitting water-saving devices.

South Texas white-tailed deer management program for ranchers successful

This program offered information to landowners in Dimmit and Maverick Counties about habitat management, plant identification, food plot management, and aging and scoring deer on-the-hoof, with Boone and Crockett criteria.

An increase in the number of absentee landowners in Dimmit and Maverick Counties has led to a decrease in cattle operations and more emphasis on wildlife management. Since both counties have long been known for producing high-quality white-tailed deer due to the abundance of native forbs and browse, the Dimmit County Range and Wildlife Committee considered wildlife management to be a great topic for this year’s outcome program.

AgriLife Extension agents included the following topics in the educational programs: recognizing and identifying native plants; using effective brush-removal techniques; facilitating controlled burns; determining property stocking rates; conducting browse surveys; knowing the effects of summer and winter burns; understanding Boone and Crockett scoring; learning how to score white-tailed deer, mule deer, and pronghorn antelope; understanding the importance of soil surveys; using the best forages for South Texas; and planting desired plant species.

After each program, participants were given a test and customer satisfaction survey with questions about the knowledge they gained and about whether they planned to adopt any of the practices they learned. Survey results indicated that 98 percent of the individuals were completely satisfied with the program they attended, including location and speakers, and almost all said they would recommend the programs to others.

Strategies for ranching sustainability taught at Webb County workshops

Many ranchers are having difficulty making a good living. The U.S. Department of Agriculture reports that of the nation’s 2.2 million farms and ranches, nearly 70,000 are technically insolvent and another 73,000 have debts equaling 70–100 percent of their assets. Nearly one third of family-run ranches have significant financial problems. In Webb County, many large family ranches are being partitioned by

family heirs or sold to large corporations for recreation and hunting purposes. To address these concerns, educational programming in the county focused on ranching sustainability for future generations through education about native and improved forage management, rainwater-capture techniques, beef cattle management and health, economics, total resource management, and ranch estate planning. A combination of field days, tours, workshops, and seminars will be conducted to cover these topics for the benefit of local agricultural producers. The Webb County Extension Agriculture and Natural Resources Committee provided program planning, implementation, and evaluation leadership to this plan in cooperation with the county Extension agent for Agriculture and Natural Resources.

The 2010 target audience included local and area agricultural producers who own, lease, or manage farming and ranching property in Webb and adjoining counties—primarily cow/calf operators who also lease their ranches for hunting. According to the 2007 Census of Agriculture, the average size ranching operation in Webb County is about 3,600 acres. The target audience ranch size varies from 1,300 acres to over 100,000 acres. Over 80 percent of the participants attended an average of three Extension programs during 2010. Retrospective surveys indicated that they received much educational value from their participation in the programs. Overall, the customer satisfaction surveys indicated that participants were either mostly or completely satisfied with the program content, instructors, facilities, and meals and planned to take action or make changes based on the educational information they received.

Rio Grande Basin Initiative programs address water quality and quantity

Local input, legislative efforts, and numerous other indicators show that water quality and quantity have emerged as the preeminent issue in the Rio Grande Basin and across the state. Agriculture, the largest water user in the state, is under close scrutiny because of the potential for negative environmental impacts on water quality. Water use in the municipal environment (including irrigation of athletic fields), in parks, and in homes and home landscapes also constitutes a major portion of water used in the Rio Grande Basin. Programs designed to educate adults and youth about water conservation help reduce overall water use, increase water-use efficiency, and lower the risk of water quality contamination from urban/suburban settings.

It is essential that consumers, homeowners, agricultural producers, and communities understand how to adopt best management practices to protect water quality and enhance conservation so that agriculture, jobs, and the economy in both rural and urban areas can expand water supplies to meet Texas' future water needs.

Numerous RGBI events conducted in 2010 provided rainwater harvesting demonstrations and homeowner education, turf trial water savings demonstrations, agricultural producer training, rain barrel workshops, and native grass tours. Volunteers and specialists facilitated 12 programs, with 553 contact hours. In addition, four Master Gardeners took advanced irrigation system training at a San Antonio workshop sponsored by the Texas AgriLife Extension Service; another Master Gardener took the Rainwater Harvesting Specialist training.

A rainwater harvesting demonstration project implemented at North San Juan Park in cooperation with County Commissioner Palacios, Precinct 2, allows for outdoor rain barrel workshops for larger groups in addition to the programs conducted indoors for small groups. Evaluations conducted at a workshop on water conservation in the landscape showed that 100 percent of the participants would change their behavior to use native plants, mow grass at the recommended height to reduce moisture loss, mulch around trees and shrubs, irrigate only when needed, and make efforts to reduce fertilizer use on turf.

Grasses established at a native grass trial in North San Juan Park are thriving so well that Master Gardeners removed some of the plants and began another demonstration site at Precinct 4 in North Edinburg. These sites will be used for tours for home gardeners and Master Gardener classes.

Landscape water conservation message reaches residents through Earth-Kind® program

Landscape irrigation in Texas accounts for 40–60 percent of total residential water use during peak summer months. Landscape water conservation issues critically important to millions of urban residents throughout Texas and in Hidalgo County include the following:

- *Fertilizer use in the landscape.* Improper landscape management increases the risk for water resource contamination from nitrogen and phosphorous fertilizers, posing a threat to valuable natural resources.
- *Chemical pesticide use in the landscape.* The improper use of chemical pesticides in the landscape increases the risk that these materials will enter the environment, affecting residents' long-term health and safety.
- *Landscape waste management.* Grass clippings and other landscape wastes are a major source of materials entering landfills.
- *Landscaping for energy conservation.* Conserving energy through Earth-Kind® landscaping principles and practices contributes to the long-term economy and environment. Native and well-adapted plants use less water and are better adapted to environmental conditions, reducing the need for replacing plants in landscapes. Trees planted in the landscape can reduce the amount of energy needed to cool homes.

Fifty-one programs were delivered in 2010 to 2,465 people, totaling 5,187 contact hours. Programs included train-the-trainer classes for Master Gardener volunteers and interns; multi-county, advanced Master Gardener specialist training; Earth-Kind® landscape design classes; tours of native plant landscapes and water-thrifty gardens; and native landscape grass trials for turfgrass establishment. In addition, a series published in two newspapers four times a month covered information on reducing fertilizers and chemicals in landscapes, conserving water in landscapes with efficient irrigation and use of mulch, and selecting native and well-adapted plant materials.

Evaluations indicate that 97 percent of the participants were satisfied with the completeness and quality of the materials presented, with 99 percent indicating they are likely to recommend Texas AgriLife Extension Service programs to friends and family.

Grow'n Growers program helps low-income families grow and sell backyard organic produce

Community and economic development is a major issue in Texas. Residents in Hidalgo County identified these issues, along with adult education, as community needs. They also indicated the need for a farmers' market offering locally grown, organic produce.



Earth-Kind® water conservation demonstration

Working with a county commissioner, the Texas AgriLife Research and Extension Center at Weslaco and members of the horticulture committee developed Grow'n Growers, a community development program to meet the needs of low-income Spanish community members interested in developing horticultural and business skills and opening a farmers' market. A pilot program in 2007–2008 trained 15 Hispanic families in growing organic produce in their backyards and opening a farmers' market. Instruction, offered in Spanish, included organic horticultural practices, food safety, nutrition and health, finance, marketing, business establishment, and leadership development. All participating families improved their family income and increased their consumption of vegetables. Additional families have been taught in annual programs since September 2007.

Participants increased their monthly income from \$200–\$500 per month in 2008 to \$500–\$900 per month in 2010. Four families sell produce and eggs from their homes and are selling to local chefs. Program evaluations from classes show that approximately 82 percent of the participants improved their knowledge, and 74 percent changed their behavior or intend to adopt new practices such as drip irrigation.

WEST REGION

In 2010, 16 counties in the West Region conducted educational programs and result demonstrations to address local water issues in the Rio Grande Basin. Working with collaborators and partners, AgriLife Extension agents and specialists made more than 40,000 contacts through water education programs that addressed issues within each of the following areas.

Irrigation efficiency and water quality in agricultural production

AgriLife Extension programs continue to address irrigation efficiency in crop production systems. At the South Texas Irrigation Conference and cotton workshops in Medina and Uvalde Counties, agenda topics included precision irrigation and irrigation efficiency. More than 200 people attended the programs, which were directed toward producers in the Winter Garden area. Evaluation surveys indicated increases in knowledge and understanding of available cost-efficient irrigation technologies, the most efficient water-conserving irrigation methods, the ET (evapotranspiration) network and how it functions, and how to install and use moisture sensors.

Soil salinity monitoring program begun for forage producers

In April 2010, the AgriLife Extension agent in Reeves County began a five-year soil salinity monitoring program that will require graphing every forage production field in Reeves County. Each field will be evaluated using GPS coordinates and electrical conductivity (EC) measurements on a 20-foot grid, collected at different times of the production year. A database will be set up once the individual field data is completed, along with a simple questionnaire given to each farmer. Then each forage producer will have access to view the maps to analyze the salinity of his or her fields and make sound judgments on forage variety type and cost-effective management strategies. During the past year, a 12-square-mile area was evaluated or surveyed. Early results show an average EC reading across the production sites of 4–10 EC units. This information clearly shows forage producers the need for using salt-tolerant varieties and recommended irrigation management practices.

Extension and volunteers help small-tract landowners find best fruit trees

In El Paso County, more than 10,000 accounts fit the small-tract category (ranging from one-tenth to 2 acres), totaling 5,685 urban or rural acres. The size of the small tracts makes profitable agricultural

activity difficult, since many agronomical crops require extensive acreage to be economically feasible. Eventually, this acreage becomes nonfarmed land with weeds that harbor pests and pose a fire hazard. Small-tract owners are evaluating the most suitable crop or plant they can grow under local conditions, considering soil salinity levels and reduced or low water delivery in drought years. Most small-acreage landowners are interested in a crop with low production costs and enough profit to make farming sustainable. Along with the small-tract acreage, there are close to 15,000 acres with a high salt content that do not have a varied use because there are limited plant species that can do well in this type of soil.



Landscape water conservation demonstration

AgriLife Extension agents and volunteers in El Paso County initiated the search for plant species that can grow under small-tract conditions and perform well based on the following parameters: high soil salinity, low water quality and quantity, survival under drought conditions, early producer, long shelf-life, low pest and disease incidence, and, if possible, already growing in gardens or backyards of the region. Vegetables and herbs were not included in the selection, but several species of fruit trees were found to be grown in the area: apple, pear, quince, stone fruits, jujube, date palm, olives, fig, and pomegranate as well as some citrus species grown in containers. Based on the selection parameters, pomegranate filled most of the selection criteria and presently is the plant with most economic potential.

Pomegranates from different El Paso County backyard plants were analyzed for pH levels, sugar content, total dissolved solids, and fruit flavor. Presently, three local pomegranate accessions filled the criteria for fruit size, color, sugar content, and flavor and have been extensively propagated and planted. Selected farmers in El Paso and Hudspeth Counties were given rooted pomegranate plants to observe the plant behavior under their own field conditions. The test farms have soils ranging from sandy to heavy clay. The pomegranates are being irrigated with water ranging from 400 to 5,000 parts per million of total dissolved solids and a sodium absorption ratio ranging from 3 to 25. Nineteen farmers participated in the project; 125 pomegranate test plants were provided, and 60 pomegranate crop contacts were made.

Best practices help pecan producers improve yields

Pecan production is the second most important crop in El Paso County (after cotton). The county ranks first in Texas for the number of production acres, improved cultivars, yield, and quality of its pecans. Improved timing of production practices allowed already established pecan orchards to increase their yields and quality. However, new market demand for pecans created the need for new pecan cultivars and rootstocks, planting methods, and production in soils with limiting factors such as poor drainage and salt problems. Presently, there are more than 2,000 acres of new or recently planted pecans that might have problems in the near future because they are planted in problem soils.

In 2010, holistic and timely educational programs were presented to cover best management practices such as edging and pruning, fertilization, irrigation, pest control, and pecan nut quality. Timely soil health programs provided the pecan trees with needed requirements for full and healthy pecan nut development and reduced alternate bearing.

In the past, the average five-year pecan yields were 2,000 pounds per acre, with a big difference between “off” and “on” years. Farmers who have adopted best management practices increased their average production to 2,700 pounds per acre with a drastic increase in the number of pecan nuts classified as No. 1’s and a big reduction in low-percentage kernel yield. Pecan yield has increased by an average of

500 pounds per acre per year on 5,000 acres for a total of 2.5 million extra pounds per year in El Paso County. Gain in percent kernel is more substantial, increasing by an average of 10 percent of second and third nut-grade quality and will represent a gain of 3 million pounds. Both gains from yield and kernel quality will account for an increase of \$8 million to \$12 million, based on current prices.

Attendees of the Texas–New Mexico Sustainable Agriculture Workshop expressed interest in adopting minimum tillage and cover crop practices to improve soil health and aggregation. This represents more than 3,000 acres of pecans that will save over \$100 in the direct cost of tillage and herbicides, plus the indirect benefits of saved nutrients. More than 200 participants attended one of four pecan programs held in 2010.

Master Gardeners spread the word about horticulture

El Paso County Master Gardener volunteers contribute an estimated 11,000 hours of service each year on programs and demonstration gardens that educate the public on water conservation and natural resource issues. El Paso County residents and other clientele also call the Extension Gardening Hotline, regularly staffed by Master Gardeners, to ask questions related to gardening, landscape water conservation, landscape design, and other horticultural topics. Another popular venue for horticultural education is Ardivino's Farmers' Markets, where Master Gardeners distribute educational materials on gardening and lawn-related topics every Saturday from June through October. At this weekly event, El Paso County Master Gardeners and the county Extension agent for horticulture also visit with people at length about various horticultural topics, landscape issues, and problems. More than 150 visitors per week stopped by the Extension booth. Over the course of the season, an estimated 800 clients asked horticulture-related questions and discussed their particular horticultural concerns.

AgriLife Extension conducts chile pepper workshops

In September, AgriLife Extension in Hudspeth and El Paso Counties conducted chile pepper production workshops at the Wild West Chile Fair, attended by more than 1,000. Producers benefited from the best management practices presented in the educational programs such as how water-use efficiency practices affect the yield and quality of chile (paprika). Over 3,000 acres of chile (paprika) are grown in the El Paso and Hudspeth Counties area.

Field demonstrations help alfalfa farmers choose cultivars

For the past seven years, in-field demonstrations have tested new alfalfa varieties or cultivars for salt tolerance. Alfalfa cultivars that performed well under salty conditions from 2003 to 2008, such as 'GT 13 Supreme' and 'AmeriStand 801S' (America's Alfalfa), still have a good stand and are producing well. Average alfalfa stand usage for the El Paso Valley is four years, due to stand decline. The cultivars that exhibit salt tolerance or resistance have a longer life and a longer production cycle. Data from variety trials were provided to local alfalfa farmers, and best-performing cultivars, such as 'AmeriStand 801S' and 'AmeriStand 802', were used in more than 2,500 acres of newly planted alfalfa in El Paso and Hudspeth Counties.

West Region watershed management workshops increase knowledge, income

During 2010, programs and demonstrations on watershed management, many of which addressed brush management on watershed areas, were conducted across the Rio Grande Basin counties in the West Region. In Val Verde County, data collection on paired-plot demonstrations continues. Water runoff is measured from areas where brush management practices were implemented to determine which practices or methods best capture rainfall in watershed areas.

A workshop series in Culberson and Hudspeth Counties in 2010 provided information on recommended range watershed management practices. An evaluation instrument used at the spring and fall workshops helped determine the programmatic results of this educational program series. Respondents indicated a 41 percent increase in knowledge of using rangeland monitoring techniques to determine stocking rates, and a 40 percent increase in knowledge of brush and weed management to improve rangeland health. Fifty percent of the producers indicated they would definitely adopt photo monitoring to help meet range and watershed management goals. Respondents indicated they anticipate a total estimated economic benefit of \$194,900.



Rainwater harvesting workshop

More than 100 attend 'Tree 101' workshops

In 2010, AgriLife Extension in Presidio and Brewster Counties conducted "Tree 101" workshops, which addressed the need to use native and adapted plants in landscapes as well as other water-conserving techniques recommended for West Texas landscapes. More than 100 people attended the programs.

Ward County demonstration garden teaches homeowners about sustainable landscaping

AgriLife Extension agents in Ward County continue to maintain and update a demonstration garden at the AgriLife Extension office that showcases native plants recommended for local landscapes. The general public and interested clientele can view native and adaptive plants in an attractive landscape setting.

The main goal for landscape outcome programs in 2010 was to teach homeowners how to conserve and protect water resources while creating a healthy and sustainable landscape environment with species and types of plants that do well in Ward County's arid environment (low water and fertilizer requirements). Program participants learned more about

- plant suitability for different soil types
- fertilizers and pesticides
- safety aspects of pesticides (proper rates, timing, drift)
- mulches for water savings and weed control
- irrigation (timing, length of time, and amounts)
- rainwater harvesting, drip irrigation, economics
- plant species that will grow in the local area
- seasonal plant color in the landscape
- space requirements of trees, shrubs, plants, and lawns

Rainwater harvesting demonstrations showcase efficient water use

Ten counties in the Rio Grande Basin conducted educational programs on rainwater harvesting, and five of eight counties established, modified, and completed maintenance requirements on rainwater harvesting demonstrations. El Paso, Presidio, and Ward Counties also completed or began construction on rainwater harvesting demonstrations and gardens. These ongoing programs and demonstrations showcase rainfall harvesting and how to efficiently use captured rainfall on various landscapes.

Information on other uses of rainfall harvesting, such as the water needs of wildlife and livestock, is also provided. Partnerships and collaborators for these demonstrations include commissioners courts, municipalities, and local chambers of commerce.

Kinney County Extension conducts rainwater workshops

During 2010, Kinney County AgriLife Extension conducted educational workshops to teach ranchers and homeowners how to conserve water by building rainwater catchment systems that can be used for wildlife and home landscapes. Eighteen ranchers and homeowners attended a workshop in which an AgriLife Extension specialist discussed topics related to water quality and quantity, constructing rainwater harvesting systems, and in-home water conservation practices. A larger rainwater harvesting system was installed at the AgriLife Extension office in Kinney County. The system holds 750 gallons of water and has a 1-horsepower pump for watering the turf and landscape plants. It also has a gravity drip irrigation line that waters a plot of native grasses. A smaller catchment system with a 50-gallon drum was also installed to provide water to a birdbath and an introduced-grasses plot. These two rainwater harvesters are used to teach youth and adults about the water cycle, water conservation, and how these systems can manage runoff and provide water to targeted landscape plants and wildlife.

Marfa Activity Center rainwater site gets improvements; new system constructed at STMG

A Marfa Activity Center rainwater harvesting demonstration, constructed in 2009, harvested more than 18,000 gallons of water on-site. Quality improvements added in 2010 include desert landscaping, a wildlife water feature, and other aesthetic improvements. The project serves as an educational tool, and many Presidio County residents and nearby communities have benefited from it. Maintenance is provided by the City of Marfa and the Tierra Grande Master Naturalists chapter.

Also constructed in 2010 is a rainwater harvesting system at the Southwest Texas Municipal Gas building, which includes a 5,000-gallon catchment tank and rain garden to redirect problem runoff water from the building. The demonstration project was a collaborative effort with the Tierra Grande Master Naturalists chapter, the City of Marfa, and Southwest Municipal Gas. The City of Marfa provided the labor, large equipment, and half of the cost of materials.

A series of workshops conducted in Presidio County educated local residents about water harvesting techniques, resources, in-home water use, rainwater harvesting for wildlife, and waterwise selection of landscape plants. Respondents indicated a 47.8 percent increase in their understanding of how rainwater harvesting reduces potable water demand and a 55 percent increase in their understanding of ways to estimate rainwater yield based on rainfall probability and catchment system size. Sixty-one percent increased their knowledge regarding the use of rain gardens to capture water for plant irrigation and water infiltration and to minimize soil erosion and runoff.

Culberson County Extension hosts rainwater program

The Culberson County AgriLife Extension office hosted a "Harvesting Rainwater with Rain Barrels" program on July 22, 2010. Gary Bryant, AgriLife Extension water management program specialist, led the program, which focused on rainwater collection systems and how to collect rainwater according to guidelines. The group then toured the rainwater harvesting demonstration at the Culberson County courthouse and learned how the 3,000-gallon tank was installed and operates. In a hands-on demonstration, participants constructed their own rainwater barrels, which they immediately put to use. It rained on the day of the program, and by the next day, all of the newly installed rain barrels were full.

Of the 27 participants, 20 responded to a participant satisfaction survey. All respondents were mostly or completely satisfied with the activity and the relevance of the examples used. Almost all were mostly or completely satisfied with the helpfulness of the information in decisions about their own situations, and most anticipate benefiting economically as a result of what they learned.

Bentley Center in Ward County receives new rainwater system

Two water tanks were installed at the Bentley Center to beautify the shooting range and water newly planted trees. Plans are to complete this project in 2011 by completing the ductwork and drip hoses to the trees. A metal cistern installed at the Million Barrel Museum collects rainwater for the landscape and serves as a rainwater harvesting demonstration. This highly visible location will be seen by local residents as well as by tourists visiting the museum. The metal cistern fits the 1890s home and makes an attractive rainwater harvesting system. Extension agents are searching for metal gutters to match the historical look.



Rainwater harvesting demonstration site

Hudspeth County Livestock Barn rainwater harvesting system gets additions

Each year the Leadership Advisory Board in Hudspeth County adds to the rainwater harvesting system located at the County Livestock Barn in Sierra Blanca. In 2010, they installed the electricity and pump needed to irrigate the native and adapted plant species landscape showcased in the landscape demonstration. The Hudspeth County 4-H and Youth Group planted spineless prickly pear. Some will be sold to help purchase more plant material for the future. Plants selected will be used in the Desert Landscape Garden, and the harvested rainwater will ensure an adequate water supply.

Water well screenings held; treatment recommended

Water well screening was offered in Presidio, Brewster, Jeff Davis, Terrell, Hudspeth, Val Verde, and Edwards Counties in 2010. In Presidio County, 49 water well samples were tested for bacteria, salts, and nitrates. The results are shown in Table 1.

Table 1. Presence of bacteria, salts, and nitrates in Presidio County water well samples.

<i>E. Coli</i>	36.7%
Coliform bacteria	59.1%
Other bacteria	26.5%
Salts (medium-to-high salt hazard)	4.08%
Nitrates	8.16%
None	16.3%

Treatment recommendations were made on all excessive or positive well test results, with retesting in three months recommended on all wells with positive results. Water conservation kits were given to all participants. In addition, 45 people attended an educational program on plugging abandoned water wells conducted in Val Verde County.

In-home water conservation and Fix a Leak programs provide outreach

In 2010, four Rio Grande Basin Initiative (RGBI) counties in the West Region conducted educational activities on in-home water conservation. The AgriLife Extension office in Val Verde County conducted the Fix a Leak educational program at the local Home Depot store on March 20. Eighty-seven

participants signed a pledge stating that they would adopt recommended practices and conserve water in the home, check leaky faucets, and use recommended plumbing fixtures in their homes. Family fact sheets on water efficiency were distributed to customers in the store.

The AgriLife Extension office in Pecos County developed several activities to address in-home water conservation, including two Fix a Leak presentations, RGBI news releases, RGBI homeowner education, in-home water conservation training, customer satisfaction evaluations, and agriculture and natural resources school outreach.

Evaluation results indicated that 98 percent of the participants would use the information to modify or adopt recommended in-home water conservation practices. All participating youth agreed to develop a plan for household water conservation.

Young people participate in 4-H National Youth Science Day; learn about carbon dioxide

Youth in El Paso County have limited knowledge and skills related to water conservation and its relationship to environmental issues or concerns for the community. Youth need to gain a stronger understanding of local water and related environmental issues while expanding their personal educational base to help prepare them for their educational goals and the future.

On October 6, 2010, millions of young people across the nation became scientists for a day during 4-H National Youth Science Day (NYSD). In this year's experiment, 4-H₂O, youth learned about carbon dioxide and discovered how we as a nation can reduce our environmental impact. El Paso 4-H and the AgriLife Extension office in El Paso County partnered with the El Paso Water Utilities (EPWU) Tech₂O Education Center to coordinate the 4-H National Youth Science Day in El Paso. To acquire funding to help organize a special promotional event for El Paso County youth, the local team developed a Texas 4-H grant proposal.

The El Paso 4-H program collaborated with 13 sites that included public, charter, and private schools to implement the 4-H National Youth Science Day experiment and provided 34 NYSD kits to these sites. The kits were shared with five after-school youth program sites with Fort Bliss (U.S. Army). The resource kits helped students learn how everyone contributes to carbon dioxide in the atmosphere and its impact on the environment and global warming. The NYSD experiment helped students see themselves as scientists in discovering common issues that affect the environment. Scientific discovery related to water was expanded with classroom groups attending and participating in the El Paso Water Festival hosted by EPWU at the Tech₂O Education Center.

The experiment was designed to demonstrate the powerful effects of CO₂ on animals, plants, and other living organisms whose habitats are our natural water sources. As we calculate our carbon footprints—like the kind we create with CO₂ emissions from cars, factories, and power plants—we will discover the impact these choices have on our water sources. Feedback from teachers representing 280 youth at six sites reported the following:

- Students were able to make a connection between global warming and an excess amount of carbon dioxide in the atmosphere. The experiment allowed them to see consequences of such issues.
- Students learned that everyone makes a difference when taking care of the planet.
- The hands-on kit allowed the students to learn about water quality testing.

- Students gained an appreciation for science because they conducted the experiments.
- The kits were complete and age-appropriate. Students in the second grade and younger had difficulty with language and concepts.
- Eighty percent of the reporting groups continued to use the 4-H resource materials beyond the one-day science experiment.



Small grains crop irrigation site

Uvalde County students learn about water use and conservation

The Stop the Drip program educates fourth-grade students and teachers about water, where it comes from, its uses, and how to conserve and protect it. The program was designed to increase knowledge and promote behavior change. For the past two years at the annual Uvalde County Fair, AgriLife Extension staff members have taught 855 youth from throughout Uvalde County how to identify basic needs involving water and the way people, animals, and plants use it. Stage sets of bathroom, kitchen, and outdoor areas help students visualize how much water is a part of their daily lives and emphasizes cautious and frugal use of water resources. Students learn about water-saving practices and devices to help them limit water use.

Kinney County students and adults learn about rainwater harvesting

In October 2010, 46 fourth-graders from Brackettville ISD participated in a water conservation course at the AgriLife Extension office in Kinney County. With the help of Rio Grande Basin Initiative funds, a larger rainwater harvesting system was installed that holds 750 gallons of water and has a 1-horsepower pump that allows the system to be used to water turfgrass. It also has a gravity drip irrigation line that waters a plot of native grasses. A smaller rain barrel catchment system with a 50-gallon drum provides water to a birdbath and waters an introduced-grasses plot. These two rainwater harvesters were used to teach youth and adults about water conservation.

Edwards County students help process water samples

In 2010, the AgriLife Extension office in Edwards County conducted a water well testing day at the Rocksprings Junior High School, allowing 21 seventh- and eighth-grade students to process water samples. Children learned the importance of water quality, aquifers, and water conservation. A 1,100-gallon water tank will be used in a rainwater harvesting system to provide water for a youth garden project.

State Youth Water Camp teaches teens about water in agriculture, environment

Thirteen high-school-age youth from across Texas participated in the 2010 State Youth Water Camp. Six county Extension agents worked with volunteers to provide hands-on classroom and outdoor educational experiences and recreational activities for the five-day camp. Discussion topics included rainwater harvesting, water conservation practices in landscapes, in-home water conservation, irrigation efficiency in agriculture, watershed management, and wastewater treatment.

Ward County water fair features lessons from *Investigating Water* curriculum

In October 2010, 137 fourth-grade students at Sudderth Elementary School in Monahans participated in the “H2O for You” Water Fair, a series of seven educational lessons from the *Investigating Water* curriculum developed by AgriLife Extension. Topics from the curriculum included “Amazing Aquifers,” “Indoor Water Conservation,” “Outdoor Water Conservation,” “Rainfall Simulator,” “The Incredible Journey: The Water Cycle,” “Water: The Beverage of Life,” and “Watersheds: Enviroscape Model.” □

NEW MEXICO COUNTY PROGRAMS

Low-head bubbler irrigation demonstrated on high-value crops in Valencia County

Partnering with a local raspberry producer, New Mexico Cooperative Extension agents presented a low-head bubbler irrigation system demonstration on a .25-acre berry plot. This was an effective demonstration of efficient, low-cost, and energy-free irrigation methods for local farmers.

Annual Valencia County Forage Workshop covers broad range of topics

More than 70 local forage and irrigated pasture producers in New Mexico’s Middle Rio Grande Valley attended the Second Annual Valencia County Forage Workshop, made possible with Rio Grande Basin Initiative funds. This popular one-day workshop covered topics ranging from soil management and weed control measures to improved forage productivity, quality, and irrigation efficiency. Ninety-five percent of the workshop attendees reported learning about agronomy, with the intent of using this knowledge to improve their forage crops and irrigated pasture operations.

RGBI supports Valencia County Extension rainwater demonstration

Rio Grande Basin Initiative funds were used to maintain a rainwater harvesting and waterwise gardening demonstration constructed in 2008 at the Valencia County Extension Office.

Home and landscape water program held for urban residents

In 2010, funds were used to host an in-home and landscape water conservation program for urban residents. Workshop attendees received an in-home water conservation kit and learned how to reduce both in-home and residential landscape water consumption and waste. They also learned how to use their home’s roof for rainwater harvesting. □



Installing drip irrigation

TASK AREAS

ACCOMPLISHMENTS

TEXAS AGRILIFE RESEARCH
NEW MEXICO AGRICULTURAL EXPERIMENT STATION

IRRIGATION DISTRICT STUDIES

Economics team presents findings and continues research for stakeholders

During the past year, the Rio Grande Basin Initiative (RGBI) Economics Team completed various technical reports and professional journals and presented their final findings on various RGBI water-resource issues to local, statewide, and national audiences. Key topics included (1) business economics involving water-treatment facilities and (2) economics of water conservation, with environmentally friendly ways of removing water-thirsty invasive plant species.

In addition, the team continues to provide extension services to stakeholders with ongoing works and to expand into new areas of research. Key topics that remain a focus and/or are new areas of research for the team include (1) economics of different ways to add water to an arid or semi-arid region's water supplies, (2) economics of algae-produced biofuels, (3) business finances involving costs and delivery rates of irrigation districts, and (4) water implications of producing biofuels.

Researchers help farmers implement BMPs for water conservation

Soil moisture data, groundwater-level data, water quality data, and precipitation and evapotranspiration (ET) data from ET towers have been used to help farmers schedule irrigation and assess impacts of irrigation on groundwater and adjacent drainage systems. In collaboration with New Mexico State University, researchers have assessed the hydrologic cycle, considering atmospheric (precipitation, ET), surface (river, reservoir, irrigation network), and groundwater factors and their variability with climate change in arid regions. Current studies also expand the research focus to a much broader scope, taking in precision agriculture and the use of soil and crop monitoring data, weather observation, and remote sensing data to schedule and control irrigation and fertilization. The research findings are expected to help regional water stakeholders develop management strategies for improving irrigation efficiency and handling extreme hydrological conditions such as droughts or floods. In collaboration with Stephen F. Austin State University, the first phase of geophysical investigation (resistivity and conductivity mapping) was completed along the Riverside and Franklin Canals. The study concluded that geophysical methods provide a feasible tool for characterization of canal beds. The research findings were summarized in a master's thesis.

Publications

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INSTITUTIONAL INCENTIVES FOR EFFICIENT WATER USE

Scientists enhance information sharing and strengthen collaboration

Scientists have compiled and shared irrigation district information, including crop acreage and irrigation delivery, with districts, agencies, and the public. The coordinated water resources database and GIS (geographic information systems) website have been updated and publicized. Beyond regional stakeholders, scientists have shared information with other researchers and international collaborators, giving four invited presentations. Federal, state, and regional agencies and stakeholders benefit from timely sharing of historical and real-time hydrologic data as well as weather monitoring data. U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, International Boundary and Water Commission, El Paso Water Utilities, El Paso County Water Improvement District No. 1, Elephant Butte Irrigation District and Hudspeth County Conservation and Reclamation District No.1, as well as farmers in the region, also supported the enhancement of the database and GIS website. Multiple fact sheets have been updated and shared.

Analysis of water rights prices in New Mexico's Lower Rio Grande Basin provides insight

The transfer of water rights is an important institution used to stretch available water supplies to meet growing water demands. In the Lower Rio Grande Basin (LRGB), it is used to support sustained population and economic growth. Potential sellers are unsure of what price to charge for water rights, whereas buyers are unsure of what price to pay. This lack of information creates an uncertain and unpredictable market, which in turn jeopardizes the future of water availability to meet growing demands. Improved understanding of the economic forces influencing water rights prices will help buyers and sellers, adding vital information to support continued economic development of the region. Starting in the LRGB, this project assembled actual verified water rights market data into a database that can be used to characterize the price of water rights. The database includes data from 1980 to 2007. The database and a model were established to explain what factors support a better understanding of the economic and hydrologic forces affecting the demand, supply, and price of water rights.

Drought Watch outreach publication produced and distributed

Two issues of the education and outreach publication *Drought Watch* on the Rio Grande were produced and distributed to increase public and water-user knowledge and encourage conservation. *Drought Watch* is a collaborative effort of the Rio Grande Basin Initiative and Texas AgriLife Research, with the U.S. Bureau of Reclamation. *Drought Watch* is distributed to news media, water managers, government agency staff, elected officials, irrigation districts, farmers, Far West Texas Water Planning Group, via email subscription (300, including elected officials and local, state, and federal agencies), and at public and professional meetings. This publication has been cited in numerous newspaper articles and television reports and is posted on several websites, including Southwest Irrigated Cotton Growers. In the Far West Texas–Southern New Mexico area alone, newspaper and television reports reach an audience of over 800,000 in the United States and more than 2.2 million in the El Paso-Las Cruces-Juarez Rio Grande border region.

Development of water resources database, GIS and hydrologic model continues

Two new studies and components were completed for the Coordinated Database for Water Resources and Flow Model in the Paso del Norte Watershed: a Lower Rio Grande Flood Control Model (RiverWare Model) and Analysis of Availability of Flow and Water Quality Data for the Rio Grande Project Area. A two-part technical report was peer reviewed and jointly published by New Mexico Water Resources Research Institute (TR-348) and Texas A&M University, Texas Water Resources Institute (TR-359). This project is being conducted with the Paso del Norte Watershed Council in partnership with numerous local, state, and federal agencies and organizations. Resources and partnerships are being leveraged with support from the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation. Efforts involve scientists from Texas AgriLife Research, New Mexico State University, and the University of Juarez, as well as other stakeholders. Information and results from RGBI Tasks 1, 3, 4, and 8 are contributing to development of this effort.



Measuring flow rate in canals

Preliminary salinity impact economic assessment used by coalition

Results from the preliminary economic assessment of salinity impacts within the Rio Grande Basin Initiative area completed in 2009 by a team of scientists from Texas AgriLife Research and New Mexico State University are being used by the tri-state Rio Grande Salinity Coalition to identify feasibly salinity management alternatives. Researchers are continuing work with the Salinity Coalition and with U.S. Army Corps of Engineers contracted consultants to improve water quality conditions and extend existing water supplies in the region. This task was conducted through collaboration between Texas AgriLife Research and New Mexico State University. Stakeholders include Texas Water Development Board, Texas Commission on Environmental Quality, El Paso County Water Improvement District No. 1, El Paso Water Utilities, Hudspeth County Conservation and Reclamation District No. 1, Elephant Butte Irrigation District, New Mexico Office of the State Engineer, New Mexico Interstate Stream Commission, New Mexico Environment Department, U.S. Geological Survey, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation.

Technical support provided for Far West Texas Water Planning Group

Researchers provided technical support to the Far West Texas Water Planning Group in development of the State Five-Year Water Plan submitted to and approved by the Texas Water Development Board in 2010. The 2012 State Water Plan identifies water supply and management strategies over the 50-year planning period (2010–2060) that would be implemented to meet projected demands for agriculture, municipal, industrial, power generation, and other uses during worst-drought-of-record conditions. Members of the Planning Group include El Paso Water Utilities, El Paso County Water Improvement District No. 1, Hudspeth County Conservation and Reclamation District No. 1, Hudspeth County Underground Water Conservation District, Fort Bliss, and rural and environmental interests.

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ON-FARM IRRIGATION SYSTEM MANAGEMENT

Six-years of polypipe and drip irrigation demonstrations help conserve water

RGBI researchers have conducted more than 40 irrigation demonstrations over a period of six years. Using plastic polypipe instead of the traditional earth ditches or furrows has conserved 5–40 percent of water, increased labor efficiency for irrigation more than 200 percent, and reduced production costs. In six years, use of polypipe increased from 30 percent to about 65 percent. Several Extension publications, field demonstrations and result demonstrations helped promote this change. Another impact of this project has been the use of drip irrigation on vegetable crops. Onion production has doubled, using half the amount of water used in the traditional furrow irrigation systems.

RGBI project complemented by grant from other projects *Result demonstrations on the Arroyo Colorado*

Six sites using surface irrigation were selected to evaluate irrigation efficiencies and the impact of leaching and runoff on water quality during two irrigation events. The sites were monitored to determine whether improving irrigation management with surface systems could save water. Researchers observed that the required irrigation depth is between 6 and 10 inches in each irrigation event. Two out of six farmers applied more than 15 inches in one irrigation event. These farmers were taught how the excess water is lost as a result of deep percolation from the root system. One farmer lost about 6 inches to runoff. Other farmers produced approximately 10–12 percent runoff in each irrigation event of 6 to 10 inches. If runoff is avoided, the farmer can conserve about 0.7 inch to 1 inch of water per acre per irrigation in all furrow irrigation and improve the water quality of the effluents that are eventually discharged into the Laguna Madre. Considering that 95 percent of the crops are irrigated with surface irrigation systems, it is possible to conserve water by improving the management of these systems. Several options are developing guidelines for system management, which will require programming more tests, using computer models, and determining the flow-rates per outlet of the polypipe. This project might continue into the next year. The results were presented during several meetings to explain irrigation management strategies to farmers.



Lower Rio Grande Valley irrigation canal



Watermelon crop at Weslaco



Irrigation district canal on the Rio Grande

Second year of watermelon investigations completed

The second year of investigations to determine the impact of planting density and deficit irrigation on yield and water productivity of vegetable crops (watermelons) was completed. By using subsurface irrigation, nearly 8 acre-inches of irrigation water were saved compared to furrow irrigation of watermelons, which normally requires about 15 inches per season. Increasing the plant population density by reducing in-row plant spacing increased total yields by about 23 percent for the same amount of water input. The combination of increased population density and deficit irrigation increased fruit yields on average by 53 percent, with no change water input. Water productivity was increased by 30 percent (ranging from 4.1 tons to 5.6 tons per acre-inch) as a result of an increasing plant population density.

Plant regulation mechanisms investigated

The physiological and molecular mechanisms regulating plant responses and tolerance to water deficit stress were investigated in sugarcane. Identifying the relevant genes and characterizing their functions and regulation in response to drought is necessary in crop improvement programs aimed at increasing productivity with limited water supply. At least 23 transcript-derived, differentially expressed gene fragments (TDFs) were identified. Up- or down-regulation of some of these TDFs correlated with observed drought responses of different sugarcane genotypes in the field.

By increasing the planting density, growers can significantly increase net returns with the same amount of water applied. The current findings demonstrate that high-density plantings can improve resource (land, water, fertilizer, etc.) use efficiency as well as productivity. The combination of increased planting density and deficit irrigation resulted in significant increases in net fruit yields and water productivity—that is, more yield per drop of water—without sacrificing quality. The combination of higher planting density and deficit irrigation increased the water productivity (yield per drop) of watermelons by about 38 percent, which translates to efficient use of available water, land, and other inputs.

Jalapeno, melon, bell pepper, artichoke, and onion plant treatments studied

Improved drought tolerance characteristics—compact size with high root-to-shoot ratio—was obtained for jalapeno transplants by spraying abscisic acid (ABA) one week before transplanting. Treatment with ABA before water stress was effective in maintaining water relations and promoting post-stress recovery

of melon transplants. Field applications of ABA on bell pepper resulted in slow growth, delayed fruit set, and yield reductions under both optimum and deficit irrigations. Establishing artichoke plants by offshoots was less effective for growth and production than using containerized transplants.

Irrigation studies on short-day onion revealed that growers could implement water-conserving practices (e.g., 75 percent crop evapotranspiration rate) and specific planting densities to target high-priced bulb sizes without reducing flavor or nutritional components. Researchers estimate 2,500 acre-feet of water could be saved with 75 percent crop evapotranspiration.

Results from this research and collaborating projects were published in one book chapter, five peer reviewed publications, and five abstracts (national and international horticultural conferences) and were orally presented at 12 events. Articles about the project on transplant shock and onion irrigation appeared via 63 online news outlets.

Evaluating alternatives to flood irrigation saves water in citrus grove management

Demonstration and research citrus field sites over the past five years have shown that using border flood irrigation can save on average 7.5 inches of water annually over traditional flood irrigation, whereas drip and microjet spray irrigation would slightly increase average water savings, by 10 to 11 inches annually.

The potential water savings that the South Texas citrus industry could anticipate if all current growers converted from traditional flood to one of the alternative irrigation systems—border flood, microjet spray, or drip—is an average of 18,000–23,000 acre-feet of water. The results suggest that water savings could most easily be implemented in the citrus industry by performing minor changes in cultural practices, such as raising wide berms between citrus rows (border flood) to channel water down the row at a faster rate and more localized to the citrus root zone. This minimizes the amount of water that the traditional flood method applies between the rows and is the most economical water-saving practice to implement. Researchers recommend that citrus growers convert to border flood irrigation methods immediately to conserve water and also expand the use of microjet spray and drip irrigation systems in the Lower Rio Grande Valley in anticipation of years of future drought and/or water restrictions.

The transition citrus growers will need to perform to convert to microjet spray and/or drip irrigation systems has been shown to be economically profitable, will conserve water over traditional flood irrigation, and can produce high-quality fruit when groves are managed well.

Evaluation of varying irrigation practices shows water savings in young citrus

Three demonstration sites were initiated in 2010, two on citrus four years old on narrow border flood irrigation and another on two-year-old citrus trees under drip irrigation. Heavy rains due to a June 2010 hurricane in Mexico and in late summer led to the flooding and destruction of one of the two narrow border flood irrigation sites. Drain tiles established under the drip trees prevented further flooding problems in 2010. Data collection is in the initial phases, but scientists expect to establish the two remaining sites as five-year sites to monitor water use and irrigation-use efficiency from young citrus trees as they come into full production.

Changing sugarcane harvesting methods may increase atrazine movement and affect groundwater quality

Altering sugarcane harvesting practices from traditional burning of foliage prior to harvesting the cane to clean harvesting was shown to potentially lead to increased atrazine movement through the soil profile.



Sugarcane ash from burned leaves was 100 times more adsorptive to atrazine than green or dry leaf residues. Thus, soils with ash incorporated led to only 3 percent of the available atrazine leaching through simulated soil profiles, while over 75 percent of the atrazine applied leached from soils containing the green or dry leaf residues. This study indicates the importance of proper irrigation management practices in the Lower Rio Grande Valley to prevent the movement of atrazine into groundwater systems.



(TOP) Microjet spray irrigation on citrus
(BOTTOM) Vegetation along the Rio Grande

Evaluation of surge irrigation in citrus shows it is impractical, does not save water

Surge irrigation practices for the citrus industry do not appear to be a viable method, and growers are not yet prone to implement it in South Texas, even for agricultural row crops. Surge irrigation is best suited for row crops and has been shown to save up to 40 percent of water in sugarcane production. Border flood irrigation, however, has shown to be an effective, water-saving practice capable of saving approximately 25 percent of irrigation water in on-farm demonstration sites, near the savings obtained by using drip and microjet spray irrigation.

It does not appear that surge irrigation will be practical to implement, nor does it provide additional

water savings beyond those obtained using the previously mentioned practices. This objective will be replaced with one evaluating the impact of irrigation practices and foliar- and soil-applied calcium treatments at reducing damage by the Asian citrus psyllid.

First 2010 Irrigation Expo held

The first Irrigation Exposition was held in Mercedes, Texas, and funded by the Texas Water Development Board. The expo was held October 20–22, hosted by the Harlingen Irrigation District, with collaborating scientists from Texas A&M University-Kingsville and the Texas AgriLife Extension Service. Presenters provided the results from the first five years of a 10-year on-farm evaluation study for water conservation for Lower Rio Grande Valley growers. Field tours provided instruction on water-saving technologies and irrigation practices. Summary response from those in attendance provided a highly favorable rating of the event, and plans have been initiated to host the second annual irrigation expo in late 2011.

NMSU turfgrass specialist and viticulturist evaluating sensors for on-farm production

This project studies the effects of multiple salinity levels in two soil types on moisture readings of reflectance, electrical conductivity, and electrical-resistance sensors in a laboratory setting. Long-term irrigation in arid and semi-arid regions leads to the increase of salt and alkalinity in soils. Every year an estimated 5–10 million hectares of land is removed from agricultural production because of increased salinity. As salinity in irrigation water increases, decreasing water quality, this project examines different

types of on-farm irrigation methods that address soil salinity problems through root-zone management. Currently, the study is assessing the accuracy of salinity readings obtained from reflectance and electrical conductivity sensors. Readings are being compared to values obtained using standard soil tests. Several sensing devices have been evaluated in the field to monitor salt buildup in the soil and subsequently remediate root-zone salinity.

Pecan farmers receive information about pecan irrigation scheduling

As the price for pecans continues to be high, the increase in pecan acreage grows. Pecans in New Mexico are one of the top five U.S. agricultural commodities and exports, with nearly 50,000 acres of pecans in the Rio Grande Basin. New Mexico and Texas are the second- and third-largest pecan producing states, with a combined annual production value of \$119.7 million in 2009. Pecan growers in the drier areas of the Rio Grande Basin irrigate approximately 56 inches per acre per year, making pecans one of the highest-water-demanding crops in the arid regions. Information from this study helps pecan farmers learn what part of the annual growing season is best for using regulated deficit irrigation with the least negative impact on pecan nut yield and quality. Data suggests that as much as one-third acre-foot of water (4 inches or 108,617 gallons per acre of land) can be saved annually.

NMSU teaching farmers about economic opportunities of camelina

This project continues to define the opportunities *Camelina sativa*, or camelina, may provide to northeastern New Mexico's agricultural economy. Research findings on this project clearly indicate that camelina, when planted in late February, can be grown to harvest maturity on 8 inches of irrigation, compared to 18 inches applied to winter wheat in the same period. Challenges for growing camelina is below-average harvest yields compared to the northern and central plains of the United States, increased shattering potential at maturity, and late fall plantings. In 2010, New Mexico State University partnered with the Sustainable Agriculture Research and Extension Center at the University of Wyoming with the oil extrusion process and providing demonstration equipment. Data from the field trials is being used to develop a camelina crop budget examining potential crop profitability in New Mexico.

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Variable-rate subsurface irrigation of vegetables

URBAN WATER CONSERVATION

Salt tolerance tests of eight bedding plants show reclaimed water is safe

Bedding plants are extensively used in landscapes in the United States. As high-quality water supplies become limited in many parts of the world, the use of recycled water to irrigate landscapes is being encouraged. Researchers evaluated the relative salinity tolerance of eight bedding plants that were previously proved to be acceptable or excellent in a semi-arid environment. Seedlings were irrigated with saline solutions at various salinity levels, and salinity tolerance was determined by their growth, visual quality, and physiological responses. Results indicated that all species were moderately salt tolerant and may be irrigated with alternative water sources with salinity up to 4.0 dS m^{-1} (deciSiemens per meter) without any salt damage or significant growth reduction. These bedding plants were evaluated twice for their salt tolerance, in an outdoor shade house and in the greenhouse. Therefore, it is safe to use reclaimed water to irrigate landscapes where these bedding plants are used. Assuming 50 percent of landscapes in El Paso are irrigated with recycled water, potential water savings may reach 19,528 million gallons per year.

Salt tolerance of wildflowers evaluated

Native wildflowers are appropriate plants for water-conserving landscapes because of low maintenance requirements, including less application of fertilizer, pesticides, and water. This study evaluated salt tolerance of five wildflowers, *Salvia farinacea* (mealy cup sage), *Berlandiera lyrata* (chocolate daisy), *Ratibida columnaris* (Mexican hat), *Oenothera elata* (evening primrose), and *Monarda citriodora* (lemon horsemint). Seeds were germinated and seedlings were grown in the greenhouse before initiation of the treatments. Plants were moved to a shade house with 25 percent light exclusion. After being acclimatized for two weeks, plants were treated with saline solutions at electrical conductivity (EC) of 0.8 (tap water, control), 2.8, 3.9, 5.5, and 7.3 dS m^{-1} for 38 days. Lemon horsemint was most sensitive to salinity stress and could not tolerate any elevated salinity in irrigation water. Chocolate daisy was moderately sensitive and may be irrigated with low-salinity water of less than 3.9 dS m^{-1} . Based on the current study, the order of salt tolerance among the five species was Mexican hat > evening primrose and mealy cup sage > chocolate daisy > lemon horsemint. Mexican hat, evening primrose, and mealy cup sage may be irrigated with recycled water at EC less than 3.9 dS m^{-1} without loss of aesthetic value.

Researchers evaluate rootzone stresses and the role of the root system on rose crops

Rose plants were grown in an experimental split root system that allowed for the imposition of stressful conditions to one half of the roots. The stresses implemented included high salinity, high alkalinity (pH), high boron, and high ammoniacal nitrogen concentrations (using excess urea). The data accumulated after the first three flowering cycles (harvests) showed significantly higher biomass and flower yields, higher individual stem dry weights, and the highest average chlorophyll readings (darker green color) in the plants receiving urea (high ammonium-N) in one-half of their root system. Researchers hypothesize that, contrary to the expectation of ammonium-toxicity symptoms, the coupling of higher solar radiation conditions in the summer months maximized productivity with the supplemental $\text{NH}_4^+\text{-N}$ provided with urea, but this scenario would reverse in the winter months.

The plants receiving high NaCl (sodium chloride) in one-half of their roots showed the classical salt burn damage to the lower (older) leaves, indicating that rose plants are still fairly sensitive to NaCl stress, even when it is localized in only one sector of the root system. The half receiving the standard (nonsaline) solution apparently cannot offset those global effects on the aboveground tissues. The plants receiving high pH (alkalinity) in half of their roots started to show lighter-colored leaves by the third harvest, suggesting the likely onset of chlorosis, which is expected to become more severe with time. Data from subsequent flowering cycles is being collected to ascertain the observed plant responses and lead to the development of management practices that could minimize the deleterious effects of those stresses, maintaining their productivity quality and even enhancing their water- and fertilizer-use efficiency.

Evaluation of Texas native street trees infested by mistletoe continues

The daily patterns of water use by the leafy mistletoe and its host cedar elm (*Ulmus crassifolia*) showed that the semi-parasite mirrored the patterns of transpiration similar to the host, with higher rates observed at noon and lowest rates at midnight. Scientists also confirmed that mistletoe leaves transpired at about the same rate (per unit time and unit leaf area) as the host but transpire from both sides of the leaf, thus effectively transpiring about twice as much as the host. Mistletoe infections were destructively sampled from cedar elm trees to determine their average size, dry biomass, and leaf area. An average mistletoe infection consists of a sphere about 2 feet in diameter with a dry biomass of 1.2 pounds and a leaf area of 1,340 square inches (9.28 square feet). Using this data and stomatal conductance data collected over a 24-hour cycle, scientists estimated that a single mistletoe infection of these dimensions could be extracting as much as 10 gallons of water per day from its host tree on a typical summer day in North Texas. This is substantial water use by the parasitic mistletoe—a mature urban tree can use as much as 70–90 gallons of water per day. More data will be collected during the winter months, when the trees are dormant, to assess the potential daily water use by parasitic mistletoe during this and other seasons. Researchers will then integrate the information to estimate the annual water use by these parasites (as well as water savings if they are controlled in or eliminated from the host trees).

Lateral run lengths of drip irrigation tubing determined for rainwater harvesting systems

Drip irrigation products are used to distribute water to the landscape. Harvested rainwater is typically stored in a tank and distributed throughout the landscape, sometimes using long lengths of drip irrigation tubing. Understanding the emitter discharge rates throughout the entire length of the tubing is necessary to effectively determine proper design criteria to ensure uniform distribution of water. Lateral run lengths of drip irrigation tubing for rainwater harvesting system applications using gravity pressure on two common products was tested in the spring. Data will be analyzed to establish guidance for sizing drip fields with water supplied by gravity pressure alone.



(TOP) Salinity tolerance study on wildflowers
(MIDDLE) Mistletoe-infested tree
(BOTTOM) Landscaping with native plants

Water quality parameters evaluated from multiple irrigation demonstration sites

There are at least 40 rainwater harvesting demonstration sites throughout Texas. The rainwater harvesting systems at these sites are all used to supply water for irrigation. Much of the irrigated areas are vegetable and ornamental gardens. Some plants in these gardens are sensitive to pollutants that could be found in untreated water. To test the water quality of the rainwater used, scientists will analyze four demonstration systems in two counties. At two of the sites, they will analyze temperature, pH, and nutrients, while at the other two they will test only pH and nutrients.



Athletic field before and after subsurface drip irrigation demonstration

Tests determine effect of tank colors and shading on harvested-rainwater quality

Storage tanks are a major component of rainwater harvesting systems. Water temperature is one water quality parameter that can be controlled by shading a tank or changing its color. Scientists tested the effect of four color treatments and three shade treatments on water temperature in tanks. They set up 12 barrels in three groups of four. Each group had a different shade treatment: full sun, 30 percent shade, and 63 percent shade. Within each group, there were four color treatments: white, blue, green, and black. Water temperature within each barrel was recorded every hour for 20 weeks during the summer of 2010. The complete results and analysis of this study will be published in Brent Clayton's thesis, titled *Storage Container Color and Shading Effect on Water Temperature*.

From data trends, researchers determined that the white color treatments resulted in the lowest water temperatures (28.6°C). The water in the white barrels was cooler than in the remaining nine barrels, regardless of the shade treatment. The green and black color treatments in full sun resulted in the highest water temperatures (33.9°C and 34.2°C, respectively). When the differences of the means were analyzed, the trends showed that the greatest difference was between the white and black color treatments and the full-sun and 63 percent shade treatments. The white color treatment should be considered for storage tanks to keep water cooler. Only when the barrels were in full shade did the trend show no major differences.

Online urban water conservation center being established

The Virtual Urban Landscape Water Conservation Center is a website that will become a clearinghouse of online information from New Mexico State University, state, county, and nonprofit websites about Xeriscaping*, urban irrigation, and other landscape water conservation topics related to New Mexico

and Far West Texas. The center will integrate services to strengthen educational outreach related to urban water conservation topics in the urban landscape. It will expand knowledge about demonstration landscapes, increase training opportunities for AgriLife Extension agents and Master Gardeners, and support dissemination of academic and applied research techniques as appropriate for the region. The center has established a blog (xericenter.wordpress.com), along with public pages on such topics as household resources, a searchable database on plants of the region, Xeriscape irrigation, how-to tools, and a list of regional retailers and landscapers. There are also resource pages for students, as well as state and municipal resources.

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Ranchers working together to measure precipitation, hail, and snow

In a state that receives on average only 9–14 inches of rain annually, measuring that rain becomes a necessity. New Mexico has been active in a nationwide project called the Community Collaborative Rain, Hail and Snow (CoCoRaHS) Network. Approximately 500 rain gauges placed throughout the state monitor rain, hail, and snow in both urban and rural areas. The program has begun work with the state USDA Farm Service Agency to expand its network to document rangeland conditions in New Mexico. Through a combined coordination with USDA FSA and New Mexico State University range and water resource specialists, training on CoCoRaHS for climate monitoring and grass monitoring will help the FSA and New Mexico ranchers document rangeland conditions and trends. The ranchers' monitoring program will help determine the effectiveness of management practices, determine whether forage supply and demand are in balance, document the effects of livestock grazing on natural resources, and provide a better understanding of resources and their management.

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ENVIRONMENT, ECOLOGY AND WATER QUALITY PROTECTION



Studying water ecosystems

Arundo donax vigor is highest in sandy soils

Heavy infestations of giant reed (*Arundo donax*) are found throughout the lower Rio Grande, especially between Laredo and Del Rio, and often extend from the riverbank to the farthest reaches of the floodplain. Floodplains are widest inside of concave river meanders (called vegas), whereas the floodplain is constricted to a narrower band of vegetation on the outside of convex meander bends. While the *Arundo* appears at a coarse scale to be largely uniform in these zones, researchers found high variation in density, height, and water usage that corresponded to variations in soil texture and moisture that occur from the riverbank to the farthest extent of the *Arundo* infestation. Stands of *Arundo* were more vigorous with increasing sand content, even if the areas were quite far from the river. Surprisingly, even though soil moisture was lower in sandy soils, transpiration rates were highest in the sandiest soils. Possibly, river water is transmitted best through sandy riparian deposits, although researchers currently lack a mechanistic explanation for this observation. Based on observations of the isotopic composition of plant water, surface soil water, river water, and precipitation, it appears that access to deeper water varies across transects and between riparian zone types, although groundwater data will be critical here (preliminary collections this year, with intensive observations planned for spring/summer 2011).



Research finds *Arundo donax* rooted in shallow groundwater

Rio Grande Basin Initiative researchers' findings suggest complex patterns of water use by *Arundo donax* (giant reed) in spite of the apparent homogeneity of many riparian zones dominated by this species. It is likely that *Arundo* has significant dependence on groundwater resources and some spatial variability in this dependence. Early evidence suggests shallow groundwater actively exchanges with the river water, which could result in significant losses of river water via *Arundo* transpiration. Researchers did not find evidence of long-distance resource sharing through rhizomes, although short-distance sharing cannot be ruled out. Future work aims to better characterize the source of water used by *Arundo* in the floodplain and to quantify the proportion of river water extracted by this invasive species.



(TOP) Lonesome Dove Arundo site view
(BOTTOM) *Arundo donax* watering experiment

Two master's students are continuing work on this project for their graduate degrees in the Department of Ecosystem Science and Management in the Texas A&M University College of Agriculture and Life Sciences. One student is on track to complete a master's of science thesis in spring 2011, with the second expected to finish by fall semester 2011. The project also partially supports a research technician at the Texas AgriLife Research and Extension Center in Uvalde, and a

stable isotope technician and a student worker in College Station. A new doctoral candidate will begin dissertation work in 2011 to build on and extend project findings.

Field tasks accomplished in 2010 were (1) completed installation of groundwater wells and initiated monthly sampling that includes water isotopic composition and well levels; (2) initiated continuous observations of well and river levels to identify potential diurnal patterns associated with vegetation water use and other hydrologic dynamics of the riparian zone; (3) collected rain water, river water, plant water, and soil water for comparison of hydrogen and oxygen isotopes and leaf material for carbon and nitrogen isotopes (this work is continuing); and (4) completed an isotope-labeling and rhizome-severing experiment to begin to understand the potential for resource sharing among ramets through rhizomes.

Scouringrush dominant weed species in irrigation canals

Research has continued along the canals of Elephant Butte Irrigation District (EBID), and scientists have discovered that scouringrush (*Equisetum hyemale*) can cause significant water loss via ponding and evapotranspiration. While control of scouringrush is difficult with the use of conventional methods, research has shown that the weed has a high silica content that prevents herbicides from being effectively

absorbed. Due to its perennial characteristics, the weed quickly reestablishes from its underground creeping rhizomes. Research from this study has noted that the effects of canal and soil characteristics on the Scouringrush growth indicate that soil salinity seems to affect the weed, but further study will be needed to clarify this effect. Researchers also found that the current management practices conducted by EBID have no negative effect on scouringrush growth, and in fact the herbicide mix currently used by the irrigation district increases the weeds' coverage. Based on these results, a long-term field study is recommended.

The *Equisetum hyemale* presence is a concern to the managers of EBID because of its impact on irrigation management and efficiency. The *E. hyemale* population interrupts and slows down water flow, resulting in potential irrigation water being wasted. Past RGBI studies have also shown that soil and irrigation water quality may be affected by excessive weed growth in the canals because ponding and evaporation concentrate salts in the soil and water. Information from this study will contribute to developing management strategies for this horsetail variety and determine the effects it has on soil physical and chemical properties.

NMSU ecologists study irrigation system wetlands in the Rio Grande Basin

As populations grow in the Rio Grande Valley, so do changes in the river's ecology. Ever-increasing demands to convert water used for agriculture to urban populations, and the resulting effects on the biota of arid-land rivers such as the Rio Grande, are often lost in the tug-of-war between competing interests for water that is in short supply. This project seeks strategies that (1) benefit agriculture and the environment, (2) collaborate with the Middle Rio Grande Conservancy District on developing refugial fish habitats in association with irrigation return canals, (3) conduct research on wetlands connected to irrigation and drainage systems, and (4) conduct pilot studies on the genetic adaptability of fish to elevated salinity, which is common for irrigation-return waters. Considerable tension exists along the Rio Grande, where agricultural water users are under attack to surrender water to keep the Rio Grande wet during climatically dry years. This project identifies strategies that allow the two to work in harmony.

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SALINE AND WASTEWATER MANAGEMENT AND WATER REUSE

Effects of salinity stress on seed germination of 40 chile pepper varieties evaluated

Effects of salinity and drought stresses on seed germination of more than 40 commercial varieties of chile peppers were investigated. Salinity stress (saline solution) at electrical conductivity (EC) of 4.57, 9.14, 13.71, or 18.28 dS/m (deciSiemens per meter) was created by adding appropriate amounts of NaCl (salt) to distilled water. Tolerance to salinity and water stresses was evaluated based on time to germination and final germination. Although final data analysis is yet to be completed, a wide range of tolerance to salinity and water stresses was observed. Further studies in the greenhouse and field will be followed for the selected varieties, based on germination results, to quantify the effects of salinity stress on seedling growth and yield.

Evaluation of salt tolerance of pecan rootstock accessions

Production of pecans (the number one crop in the Middle Rio Grande Basin) requires large quantities of low-salt water. This need was met without difficulties when pecans were introduced to the basin many decades ago. Today, the availability of freshwater is becoming less certain, especially for pecan growers in the area south of El Paso. One method to cope with this situation is to introduce rootstocks that have



Rio Grande flowing in winter at El Paso, Texas



a higher salt tolerance. Researchers completed a greenhouse experiment design to evaluate the growth and ion uptake response of 17 rootstock accessions when irrigated with water high in Na (sodium) or Cl (chlorine). These accessions are maintained by the USDA and came from various parts of the United States as well as from Mexico. Also included in the test were common rootstock cultivars currently used by pecan growers in the United States and Mexico. Researchers found a great deal of differences in growth rate. Their plan was to complete the project by spring 2011, but it is being delayed because of uncertainty related to leaf Cl determination, which was subcontracted to a testing laboratory. As soon as the question on this issue is resolved, the researchers plan to begin writing a paper. An additional greenhouse experiment (destroyed by a hailstorm in 2009) to evaluate Cl uptake by selected accessions was reactivated and will continue for another season. Some of the pecan accessions that have shown promise may be developed as a viable rootstock cultivar after follow-up field testing.



(TOP) Rio Grande flowing through saltcedar
(BOTTOM) Switchgrass irrigated with treated urban wastewater

Soil salinity management practices tested in pecans

This topic is a carryover from a salinity management research project founded by the Rio Grande Basin Initiative for fiscal year 2005–2006. In 2006, researchers prepared a Texas Water Resources Institute (TWRI) technical report titled “Diagnosis and Salinity Management for Irrigated Production of Pecans.” Following the release of the report, they received comments and requests for technical information related to salt leaching.

The Rio Grande Basin is facing potential drought, making it necessary to use saline groundwater to supplement irrigation. A technical report was prepared and submitted to TWRI and to *Pecan South* (published by Pecan Growers Association) as a supplement to the earlier report. It was also presented at the Arizona Pecan Growers Meeting in Tucson (September 2010). Field research was conducted to evaluate the effectiveness of various soil management measures on salt leaching. The key finding was that a combination of minimum-till subsoiling and minimum-till surface chisel is effective for leaching salts from clayey alluvial soils. Root pruning with the straight shank proved to be effective for developing fibrous root systems. This method of soil management can help sustain pecan production using water of elevated salinity.

Salinization of irrigated ball fields relieved by new treatment

Irrigation of urban landscapes, especially turfgrass areas, consumes large quantities of water. There is a strong push to use non-potable water, such as reclaimed water and groundwater with elevated

salinity, for irrigation. Irrigation of ball fields with reclaimed municipal effluent in the City of El Paso, however, has caused some salinization in certain soil types. Following the exploratory soil survey in the Rio Grande Valley and the Northwest District of El Paso, a formal survey in the East District was completed. The result of the survey indicated that typical calcic soils developed in upland areas are not prone to salinization even though the calcic horizon is present. Researchers are starting the formal survey of the Valley and the Northwest District. They also completed a survey of soils in the top 10 ball fields (judged by supervisors in the El Paso Parks Department) and found that all those fields consisted of deep loamy sand or sandy loam. This finding was provided to the Parks Department for consideration. The preliminary survey also indicated that ball fields developed in clayey soils of the Valley had been severely salinized. A test plot was established to evaluate a cost-effective soil-handling method in which clays are broken into blocks with straight shanks and the space between clay clods is filled with loamy sand. The test provided good results, and a full-size demonstration was conducted in one soccer field in cooperation with the Parks Department's Lower Valley Maintenance Division. Before this treatment, the field soil had extremely low permeability, and irrigation water could not infiltrate; this made the soil susceptible to salt accumulation. After treatment, there was no ponding. The method tested is considerably less expensive than excavating clay and replacing it with sandy soil or sand.

Assessment of salt tolerance of bioenergy crops provides insight into best species

Domestic production of bioenergy crops can reduce dependence on imported oil. However, there is concern that it could compete with food production. The purpose of this project is to evaluate salt tolerance of bioenergy crops as the first step toward producing these crops in saline areas where food crops are rarely grown. Rio Grande Basin Initiative funding served as seed money for this project, and researchers subsequently received state matching funds. They are working to complete a greenhouse study for assessing soil tolerance of oilseed crops at germination and seedling stages. Results so far indicate that safflower and canola are highly salt-tolerant, followed by camelina. Lesquella and pennycress were found to be highly salt-sensitive at germination. Salicornia, a halophyte, is extremely salt-tolerant and grows better with saline water. Another project deals with salt-tolerant woody species that can be used as fuel for power generation, gasification, or to produce biomass for conversion to alcohol. All experiments are exploratory, using seedlings. Research indicates that screw bean and Chilean mesquite are salt-tolerant and can be grown with saline water. Cold-tolerant eucalyptus species were not found to be salt-tolerant, except for one species tested. Chinese tallow and jatropha were only moderately salt-tolerant.

NMSU scientist examines effects of saline water on turf establishment and sustainability

Work has begun at New Mexico State University to assess and determine whether soil salinity can reach intolerable levels during long-term use of saline water even when salt-tolerant grasses are grown. This research will examine changes in soil salinity below the turfgrass root zone to evaluate the potential impact of irrigating with saline water. Information from this project will help municipalities and developers choose appropriate grasses in combination with the use of impaired irrigation waters, allowing a substantial savings of potable water. This research will also determine whether the Desert Southwest (USDA climate zone 8a) has a sufficiently long growing season to successfully establish and sustain varieties of warm season turfgrasses (bermudagrass, seashore paspalum, and zoysiagrass) and cool season turfgrasses (alkaligrass, tall fescue, hybrid bluegrass, and Kentucky bluegrass) when exposed to multiple environmental stresses such as salt, heat, and cold.



Condition of a soccer field developed on clayey soil, before (top) and after (bottom) soil treatment

Economist and engineer develop policies, institutions, and procedures for water reuse

Interest in the potential for water reuse as a means of extending existing supplies and mitigating drought shortage impacts in New Mexico is growing. However, there is much uncertainty about state policy, agency involvement, legal and regulatory requirements, and procedures governing water reuse. The New Mexico State University Water Task Force has developed a modified policy analysis matrix (PAM) designed to examine a policy application in its basic form and establish its costs and benefits. The PAM then analyzes the costs and benefits associated with the policy as it changes. The analysis can be used to design a well-understood framework for a particular policy. Decision makers and interest groups can use the analysis to understand the consequences of policy action as well as the resulting effects if no laws or regulations are created. The water reuse PAM identifies the legal ability to reuse water, ownership of water rights, downstream or third-party impacts, regulatory and procedural requirements, water quality concerns, state and local agency involvement, and cost-effectiveness of water reuse compared to that of alternative sources. This project intends to identify people who are involved in water reuse policy and allow them to clearly evaluate the policy and make sound decisions.

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BASINWIDE HYDROLOGY, SALINITY MODELING AND TECHNOLOGY

LID techniques and modeling tools used to manage regional water resources

In collaboration with The University of Texas at El Paso, a hydrological model was developed to assess impacts of flood runoff in a watershed and potential for water conservation using Low Impact Development (LID) techniques (rain harvest, infiltration of runoff for groundwater recharge, and others). One master's thesis summarized research findings of this study. Local developers are expected to adopt the new design concept for beautifying the environment and conserving precious water resources in arid regions. In collaboration with New Mexico State University scientists, researchers continued to develop tools for conjunctive management of regional water resources and assess impacts of climate variability on water availability. Assessment of hydrological data, GIS information, hydrologic framework, and models for the Mesilla Basin Aquifer, as well as the Rio Grande, were completed. The RiverWare model has been upgraded to simulate river flow within the Rio Grande project with an emphasis on conjunctive uses of surface water and groundwater. Scientists designed the model to assess different operation planning and conjunctive management strategies under new operation agreement as well as flood-control planning. The simulation results will eventually be incorporated into the coordinated water resources database. Federal agencies, irrigation districts, and water utilities are expected to use those tools to develop guidelines and optimize water operations and water planning and management.

NMSU scientists and engineers estimate reservoir evaporation

Using a simple ground-measured weather parameter coupled with atmospheric modeled data, scientists at New Mexico State University are developing a more accurate method for estimating evaporation losses from the Elephant Butte and Caballo Reservoirs. This process application, when completed, can be used on other reservoirs and lakes throughout New Mexico and the United States. Evaporation at the Elephant Butte Reservoir, located in the arid Southwest, is one of the major losses upsetting the hydrologic balance of the Rio Grande. A study conducted in 1999 placed the average evaporation loss from the reservoir at 140,000 acre-feet per year, with a high of 228,000 acre-feet per year and a low of 41,000 acre-feet per year. This wide range of estimated evaporation, combined with continuing increasing demands for water in the region, makes accurate estimation and forecasting a critical management need. Reservoir evaporation loss measurements, which are conducted by the Bureau of Reclamation, are estimated from a single evaporation pan placed near the dam at the southern end of the reservoirs. While this process is usable it does not make accurate estimates and create data for forecasting water demand. Researchers are currently testing a visual interactive tool for determining surface area and volume based on depth of water measurements. The tool will assist reservoir operators/managers with daily water management and will estimate evaporation losses for the entire reservoir on a near real-time basis. This will allow decision makers to manage reservoir water storage for more efficient hydroelectric power production and assess the water budget requirements for irrigation and other uses in the Lower Rio Grande Basin.

Acequia research identifies irrigation's effects on seasonal fluctuations

Using a combination of water balance and water level fluctuation methods, scientists can characterize surface water and groundwater interactions at different temporal and spatial scales in the northern valley area of New Mexico. The valley's average canal seepage and deep percolation from irrigation



Assessing evaporation loss

has greatly contributed to seasonal fluctuations of the shallow aquifer, which yields a water table rise of up to 0.8 meters during peak irrigation season. Researchers are using the Root Zone Water Quality Model (RZWQM) to simulate deep percolation following irrigation for different crop and soil types, and HYDRUS software is being used to simulate hydrological interactions in the soil surface–vadose zone shallow aquifer for different transects in the valley. These models will show the effects of acequia irrigation systems on water supplies in the Rio Grande Basin. Information from this model is designed to demonstrate the management of traditional irrigation interactions of groundwater and surface water and illustrate the advance knowledge of traditional acequia hydrology. Interactions between surface water and groundwater have important implications for water management in the semi-arid western states. Field data from this project is being used to parameterize different models that will allow expansion of local results to larger spatial scales, especially to other irrigated valleys with similar physiographic and water management settings. Understanding groundwater flow paths is an important step in understanding not only flow direction and recharge, but also the chemical interactions of groundwater and surface water. The ongoing research made possible by Rio Grande Basin Initiative funding has resulted in new collaborative efforts, including a recent grant award from the National Science Foundation for \$1.5 million.

ET estimation model used to validate crop consumptive use

The Regional Evapotranspiration Estimation Model (REEM) is being used to validate the hypothesis that most pecan orchards in southern New Mexico are irrigated well below potential evapotranspiration (ET) and thus achieve yields and gross economic returns below potentials. REEM has been extensively validated for studying pecan orchards and was the subject of a comparison study sponsored by the New Mexico State Attorney General in 2009. As part of the study, an international expert on remote sensing applications in irrigated agriculture reviewed REEM research results at the request of the New Mexico



Weather station on Elephant Butte Reservoir in New Mexico

Office of the State Engineer. The goal of this project is to extend the application of REEM to all major crops produced in New Mexico's Mesilla Valley. REEM will provide the most accurate estimates available for field-level, broad-scale consumptive crop water use (e.g., depletion) as well as monthly coefficients for all major crops. REEM results have been used to develop a yield-ET relationship for pecans, which has provided a broad-scale assessment of water productivity, allowed for an estimate of yield costs of deficit pecan irrigation, and given insight into the potential for water conservation by pecan producers.

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EFFICIENT IRRIGATION FOR WATER CONSERVATION IN THE RIO GRANDE BASIN

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