# EFFICIENT IRRIGATION FOR WATER CONSERVATION IN THE RIO GRANDE BASIN

### 2011/2012 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 (RGBI)—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.

### 2011–2012 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

This material is based on work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under Agreement No. 2009-34461-19772, Agreement No. 2009-45049-05492, Agreement No. 2010-34461-20677, and Agreement No. 2010-45049-20713.

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.

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#### On the cover

Manuel Pagan, Technician II, checks in-ground lysimeters at the Uvalde AgriLife Research farm. In-ground lysimeters are used in combination with climatological data (weather station) for the development of growth-stage crop coefficients of cabbage, a major crop in the winter garden of Texas (*photo by Daniel Leskovar*).

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TEXAS AGRILIFE EXTENSION SERVICE NEW MEXICO COOPERATIVE EXTENSION SERVICE

### **IRRIGATION DISTRICT STUDIES**

### Canal lining evaluations track long-term effectiveness and durability

Since 1999, nine irrigation districts in Hidalgo, Cameron, Willacy, and Maverick Counties have installed nine different types of synthetic canal lining materials, totaling about 26 miles. In 2005, Texas AgriLife Extension Service engineers began tracking long-term effectiveness and durability of these lining projects and documenting the damage caused by such factors as weather, animals, intentional and unintentional vandalism, and normal irrigation district operation and maintenance activities. The engineers inspected each project and documented any changes using a lining evaluation form. This year, they created new canal lining evaluation forms for synthetic and concrete liners; completed a 2011 canal lining field rating including new canal rider interviews; and set up a draft indicator calculator tool that converts field evaluation data into a single general lining rating index. The best performer continues to be synthetic liner overlaid with shotcrete. The engineers found large variations in performance between the four types of materials/systems used. Problems ranged from improper installation to inadequate freeboard and anchor systems and physical damage caused by people, animals, and mowing operations. The report provides details on these findings and recommendations on appropriate types for various applications, such as remote areas vs. heavily trafficked areas.

## New urbanization and district fragmentation analysis includes new maps and identification

Rapid urban growth in Texas along the Mexican border has caused fragmentation of many irrigation districts that are struggling with the resulting challenges. AgriLife Extension engineers have been analyzing the growth of urban areas in three Texas border counties between 1996 and 2006 and the impact of this growth on water distribution networks. In particular, the engineers looked at alternative procedures to assess such impacts and evaluated their effectiveness in identifying critical areas. This year engineers conducted a new fragmentation analysis, which included the creation of new urbanization maps on a sample area using an automatic procedure, and identified water distribution network fragmentation using these new maps. The automatic procedure was done in collaboration with the Agricultural Research Council, Research Unit for Climatology and Meteorology applied to Agriculture (CRA-CMA); Rome, Italy. The engineers also categorized urban areas with the Morphological Segmentation method, using software available online (GUIDOS). The obtained categories (Core, Edge, Bridge, Loop, Branch, and Islet) not only improved the description of urban fragmentation but also permitted different weights to further describe the impact on the irrigation distribution networks. Engineers used resulting categories to correct fragmentation analysis. A single fragmentation index (0 to 1) was developed for each district in the region, allowing for easy identification of districts facing the most serious problems from urbanization.



## RGBI Economics Team presents findings on key topics and expands into new areas

During the past year, the RGBI Economics Team completed various technical reports and professional journals and presented findings on RGBI water-resource issues to local, statewide, and national audiences. Key topics included: 1) business economics of desalination water-treatment facilities; 2) mitigation cost investigations of increased off-site sediment runoff and nutrients associated with biofuels production; 3) economic and water conservation effects of drip irrigation compared to traditional strategies such as furrow or flood; 4) health-related economic analysis of water quality and household treatment/delivery systems; 5) impacts of analytical techniques involving discounting for time; and 6) regional market economics affected by changing water supply and demand from dynamic climate conditions and increasing population.

In addition, the team provided research and Extension services to stakeholders with on-going works and expanded into new areas. Among the topics addressed were: 1) water market economics; 2) economic consequences of implementing alternative best management practices (BMPs) in a watershed; 3) policy implications of incentives essential for BMP adoption related to water conserving technologies or mitigation strategies when land use changes from pasture to bioenergy cellulosic feedstock; 4) business finances involving costs and delivery rates of irrigation districts; and 5) water implications of producing biofuels.

The project has quantified important economic and investment aspects of water conservation, bioenergy production of feedstock desalination, biological control of *Arundo* policy insight, and rapport with the water leaders in the region. The project contributed to the next generation of water economists and legal professionals, with their training focused on addressing water rights, drought response tactics, and appropriate policies to achieve desired social goals, among other issues.

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Dutton, L. R., Rister, M. E., Lacewell, R. D., & Sturdivant, A. W. (2011, March). *When is a gallon of water not a gallon?* Poster presented at 2011 Student Research Week, Texas A&M University, College Station, TX.

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### **IRRIGATION EDUCATION AND TRAINING**

### Landscape Irrigation Auditing and Management Program receives EPA WaterSense Label-Certification

In 2011, the Landscape Irrigation Auditing and Management (LIAM) Program received the WaterSense® Label from the U.S. Environmental Protection Agency (EPA). Students who complete the course and pass the certification exam become WaterSense Certified Landscape Irrigation Auditors. The program focuses 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 water-use efficiency. Five LIAM training events were conducted statewide, including one in San Antonio that certified 67 Texas Licensed Irrigators, grounds managers, water utility personnel, and other landscape and irrigation professionals. Attendees reported a 93 percent overall satisfaction with the course; 79 percent plan to change their irrigation practices; and 75 percent expect to benefit economically as a result of the training. Students on average increased their knowledge of auditing and irrigation scheduling by 94 percent. Further information about the WaterSense Certified Irrigation Auditor program is available at *irrigation.tamu.edu*.

#### South Texas Irrigation Symposium addresses irrigation concerns and needs

An irrigation symposium, presented in February in Uvalde, addressed the concerns and needs of agricultural producers in the Texas Winter Garden region. Symposium topics included an update on groundwater regulations and government programs for resource conservation assistance. Sessions addressed fertility and irrigated crop management, efficient/effective water management, pumping plant efficiency, and updates in irrigation equipment, products, and options for drip and pivot irrigation. More than 65 agricultural producers, representing over 137,717 acres, attended the event. Those who attended were 90 percent overall satisfied with the workshop, with 65 percent planning to take action or make changes to their current irrigation practices and 70 percent anticipating benefitting economically as a result of the program. On average, attendees increased their knowledge on all topics by 80 percent.

## Smart irrigation controller program completes fourth year and evaluates performance under historic drought conditions

The "smart controller" testing program completed its fourth year. The results demonstrated the abilities of nine residential "smart" irrigation controllers to operate during a historical drought. The controllers supplied different irrigation amounts under the same conditions and seasonal differences. Smart controllers offer a self-adjusting automated approach to watering landscapes. Adjusting irrigation run times to meet changing water needs throughout the season allows more efficient water use and prevents overwatering, when compared to a fixed irrigation schedule. Some Texas cities have 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 proves valuable during drought

The TexasET Network continues to support three regional evapotranspiration (ET) networks: the Lower Rio Grande Valley, El Paso, and San Antonio-Uvalde area with a new station in Uvalde. Each region has its own webpage on the TexasET website at *Texaset.tamu.edu*, which displays maps showing each station's location. Users select a specific station, and the website displays ETo (daily reference ET) and other information useful in determining water requirements of crops and landscapes in that location. During the historic drought year of 2011, the network sent out more than 18,000 emails to homeowners, landscape managers, and agricultural producers who signed up to receive customized irrigation recommendations.

### Drip irrigation project completes fourth 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. Consistent results have shown that drip products with emitters spaced 12 inches apart or less perform best in heavy clay soils and turfgrass. Little difference was found in the performance of the different drip products tested, with inexpensive tape performing as well as a tubing product that costs 10 times as much. Maintenance of some drip products has increased to maintain system performance. Details and photographs are posted on the ITC website at *ITC.tamu.edu*.

### New online water budgeting course available

Municipal and water utility personnel, irrigation professionals, and landscape managers can now receive water budgeting training online. The course offers eight state-mandated continuing education credits for Texas Licensed Irrigators, Inspectors, and Technicians or eight hours of professional development to Professional Engineers and state agency personnel. The course teaches students how to plan irrigation water resources by learning how to: 1) calculate or find local reference evapotranspiration data, 2) determine landscape plant water requirements throughout the year, and 3) use tools available to determine landscape areas.



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Swanson, C., & Fipps, G. (2011, February). *School of Irrigation Short Course Program*. Poster presented at the Dallas Irrigation Association Annual Expo, Dallas, TX.

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### INSTITUTIONAL INCENTIVES FOR EFFICIENT WATER USE

### On-farm water demand integrated with distribution network management

CRITERIA is a soil-water balance model currently being evaluated in Italy for irrigation scheduling. The model was evaluated in Texas to assess its potential in simultaneously predicting on-farm water requirements on all fields within an irrigation district's geographic information system (GIS). Three test sites were chosen—a sugarcane field in Delta Lake Irrigation District, the entire Brownsville Irrigation District, and a lysimetric experimental site at the Bushland U.S. Department of Agriculture's Agricultural Research Service laboratory. This past year, Texas AgriLife Extension Service engineers ran the model for validation purposes, using the setup identified for 2008, the year of calibration. By further analyzing the simulation results, they also identified some need for model improvements, including crop management components such as adding crops and irrigation methods and improvements to the root growth model; algorithms scales; and automation of data management. However, these results show that this model is an easy-to-use and valuable addition to the district management system.

### GIS used as a real-time decision support system for irrigation districts

Pump flow, meter data, and water account information are being integrated into an online geographic information system (GIS) application to support water management and conservation efforts of Brownsville Irrigation District (BID) and Cameron County Irrigation District No. 2 (CCID2). The goal is to provide the districts with a simple tool that will improve the management of water orders, allow landowners to have online access to data, and improve the availability of pump and gate data from the existing SCADA systems. For BID, this year the Irrigation District Engineering and Assistance Program (IDEA) team updated project recommendations, obtained the first evaluation by district personnel, and updated and maintained the project demonstration as a working prototype for other districts. Changes to this working prototype included set up of automatic transfer, use of new Microsoft Office Access<sup>®</sup> water account database, and update of all queries. At CCID2 engineers finalized the project demonstration and recommendations, and set up a water account data automatic transfer. For both projects they introduced password protection to currently running Web applications. Both districts found this system to be extremely helpful in improving operations and efficiencies.

### PUBLICATIONS

Bonaiti, G., & Fipps, G. (2011). *Evaluation of the CRITERIA irrigation scheme soil water balance model in Texas* (TWRI Report No. TR-418). College Station: Texas Water Research Institute, Texas A&M System. Available at *twri.tamu.edu/reports/2011/tr418.pdf*.

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### ON-FARM IRRIGATION SYSTEM MANAGEMENT

# Workshops held in the Rio Grande Valley teach water conservation, irrigation management

Several workshops in the Lower Rio Grande Valley taught water conservation, \*Xeriscaping<sup>™</sup>, drip irrigation, irrigation auditing, and general water management to agricultural producers and homeowners. A sports athletic field education workshop for 30 school personnel was presented on May 24, 2011, at the La Feria Independent School District Educational Center. Topics included auditing turf athletic field irrigation, estimating water needs for athletic turfgrass, setting up a proper irrigation schedule to conserve water and maintain quality, soil-testing, understanding a sprinkler system, calculating plant water requirements based on evapotranspiration and rainfall, and evaluating athletic field irrigation water requirements. The second Texas Irrigation Expo 2011 was presented Dec. 9-10, 2011, in McAllen. Extension specialists presented "Drip Flood Sprinkler in Annual Crops and Grass" to the 300 farmers, irrigation districts managers, and others attending.

A binational workshop was conducted in cooperation with Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency as part of the Border 2012/Border 2020 Initiatives. Texas AgriLife Extension Service specialists gave presentations on water shortage and drought impact strategies during the "Sustainable Water Management for Long-Term Savings" workshop to the 75 attendees. About 20 to 30 officials from Mexico attended. Included were governmental officials from the states of Nuevo Leon and Tamualipas, and the cities of Reynosa, Matamoros, and Monterrey, and representatives from manufacturing plants and businesses. Wastewater operators/managers, water managers, business representatives, colleges/university facility managers, school district facility managers, county and city representatives, stormwater educators, and others from the Rio Grande Valley also attended this workshop.

## Specialists work with producers to develop water-conserving irrigation management strategies

In the Lower Rio Grande Valley, AgriLife Extension specialists worked with producers to develop waterconserving irrigation management strategies. Deficit irrigation targeted crops in selected growth stages and reduced the number of irrigations, the use of polypipe, and the use of soil water sensors to monitor soil water status. Recently, specialists installed two remote soil water stations for a citrus producer.

### Longevity of subsurface drip irrigation evaluated

In West Texas, specialists conducted and published a study that evaluated the longevity of subsurface drip irrigation (SDI) systems, a key factor in profitability when used for lower-value commodity crops such as fiber and grain. The system management and maintenance protocols, as well as the source water quality, can affect the longevity of these systems. This study evaluated 10 SDI systems in 2008 and eight additional systems in 2009; these systems had been in operation between six and 20 years.





System uniformity was evaluated by uniformity parameters, emitter discharge variation (qvar), and the lower quartile distribution uniformity of emitter discharge (DUlq). Pressure measurements along the drip line also were used to determine if qvar was primarily explained by friction losses. Two-thirds of the evaluated SDI systems had qvar less than 20 percent and DUlq greater than 80, which would be acceptable, and one-third of the systems had qvar less than 10 percent and DUlq greater than 90, which would be good to excellent uniformity. Very little correlation in system uniformity and system life was found, with the greatest uniformity in the oldest system (20 years).

Uniformity problems on nearly two-thirds of the systems appeared to have been exacerbated by operating pressure that was either too low or too high, with the six best-performing systems operating between 65 percent and 100 percent of the manufacturer's specified nominal operating pressure. Water hardness and total dissolved salts were the major water quality concerns. Poor maintenance, such as no or infrequent chlorination and inadequate filtration system backflushing, appeared to reduce uniformity in one-third to one-half of the systems. The producer's lack of installation records and operator's guides likely affected system uniformity through these poor management and maintenance procedures. The use of both qvar and DUlq to evaluate performance of SDI systems appeared to enhance the determination of the primary causes of SDI system nonuniformity. This novel technique can be used as a standard to evaluate SDI systems.

### Weather station equipment upgraded and calibrated

Texas AgriLife Extension Service specialists upgraded a network of three weather stations located at Hiler, Annex, and Center research centers. The stations were 10 years old—two of them reported erroneous and/or incomplete data, and one was not working. Specialists upgraded the equipment and calibrated the sensors. The stations are operational and in the process of being connected to the Corpus



Christi weather station network. Specialists plan to keep this station in operation and possibly work in coordination with the Corpus Christi weather station network to improve the system. The stations will be accessible from the Texas A&M University Department of Biological and Agricultural Engineering website. Specialists started to collect the data and are creating a data set.

### Pecan farmers receive information about pecan irrigation scheduling

The increasing demand for pecans means increasing prices. As producers try to meet this demand, New Mexico's limited water supply strains under the pressure. This study has determined that large amounts of water can be conserved if pecan producers use deficit irrigation. Last year a defended master's thesis explained that temporary water deficits during specific pecan growth periods can produce a healthy crop and conserve water.

\*Xeriscape is a registered trademark of Denver Water, Denver, CO, and is used here with permission.

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## URBAN WATER CONSERVATION

### Two electronic courses teach basics of rainwater harvesting

Rainwater harvesting, or capturing and storing rainfall for later use, is a way to utilize a natural resource and reduce the demand on other sources of water, such as municipal water or private well water. To increase this practice, two electronic courses on the basics of rainwater harvesting were developed.

The first course, *Installing a Drip Irrigation System to a Rain Barrel*, is a step-by-step guide on using a rain barrel or other simple rainwater harvesting storage container for drip irrigation. The second course, *Rainwater Harvesting for In-home Use*, is a five-part series that gives directions on installing a rainwater harvesting system for in-home use. This course provides an overview of selected case studies and the Texas Commission on Environmental Quality's (TCEQ) recommended treatment procedures for using rainwater for indoor purposes, both potable and non-potable. It focuses on TCEQ-recommended design and installation techniques as well as water quality considerations.

Both courses are available on CDs, which were distributed at two events in 2011—50 copies were distributed at the Master Gardener Earth-Kind<sup>®</sup> program on September 10, in San Benito, and 20 copies were distributed at the Texas Irrigation Expo on December 10, in McAllen.

*Rainwater Harvesting for In-home Use* also is available on Texas AgriLife Extension Service's Rainwater Harvesting website at *rainwaterharvesting.tamu.edu/in-home-use-videos/*. This webpage was viewed 423 times between Aug. 1, 2011, and Feb. 7, 2012.

### Continued support of Rainwater Harvesting Master Gardener Specialist and Master Naturalist Rainwater Stewards through educational resources development and travel support

Master Gardeners (MGs) and Master Naturalists (MNs) are critical members of the Texas AgriLife Extension Service. The MG Rainwater Harvesting Specialist and MN Rainwater Steward are specialist titles that give these volunteers the credentials to teach about rainwater harvesting. These specialist programs, which began in 2006 and 2007 respectively, continued to play an important role in the RGBI throughout 2011-2012 by conducting rainwater harvesting demonstrations.

On Sept. 10, 2011, the MG Earth-Kind<sup>®</sup> program in San Benito included a presentation with the rainfall simulator. The 50 participants received copies of *Making a Rain Barrel* (both English and Spanish); *Rainwater Harvesting; Harvesting Rainwater for Wildlife; Rainwater Harvesting: Rain Gardens;* and a fact sheet on youth education water conservation activities.

Later that year, October 22, a session on rainwater harvesting was held at the annual Texas Master Naturalist Conference in Hunt. This six-hour class was a combination of hands-on and classroom presentations. The 16 attendees received copies of *Rainwater Harvesting for Livestock; Harvesting Rainwater for Wildlife; Rainwater Harvesting;* and CDs of the online course, *Rainwater Harvesting for Livestock and Wildlife*.

On December 9-10 that year, a booth about rainwater harvesting, shared by Hidalgo County MGs, was set up at the Texas Irrigation Expo in McAllen. This booth featured a poster display, rainwater harvesting simulator, and several publications available for distribution. The 50 visitors to the booth received copies of *Rainwater Harvesting for Livestock, Harvesting Rainwater for Wildlife*, and *Rainwater Harvesting*. In addition, 20 CDs featuring *Rainwater Harvesting for In-Home Use* were distributed.

## Water conservation/alternative water source demonstrations implemented working with county Extension agents

Demonstration sites provide a way to see a rainwater harvesting system in action. These hands-on educational events give real-life examples of how a system works. Demonstration sites also allow Extension offices or other agencies to use water conservation techniques and set an example for the community.

In Laredo, a demonstration site at the Webb County Self-Help Center was improved by repairs to broken pipes and additions to irrigation tubing. This 1,200-gallon metal storage container captures rainwater from a park shelter's roof for the community. The harvested rainwater is used to irrigate landscape plants.

A portable rainwater harvesting simulator constructed on the campus of Texas A&M University in College Station uses a small pond water pump to move water from the inside of the barrel to the top of the roof. There the water flows evenly through a perforated PVC pipe onto a roof, enters the gutter and downspout, and returns to the barrel. The demonstration was first used on December 9–10 at the Texas Irrigation Expo in McAllen. The simulator was given to the Hidalgo County Extension Office in February 2012 for continued use in the Rio Grande Valley.







## Presentations educate participants on rainwater harvesting and RGBI research

Several presentations given throughout the year at local, regional, and national meetings provided information about water conservation and rainwater harvesting and the research done for the RGBI.

Presentations featured rainwater harvesting and research and activities through RGBI as well as water conservation. Presentations were given at the American Rainwater Catchment Systems Association (ARCSA) National Conference, a guest lecture, Youth Agriculture Awareness Day, Texas Irrigation Expo, Texas Nature and Environmental Photographers, and \*Xeriscape<sup>™</sup> Symposium, with more than 460 total participants.

## Rainwater harvesting course held for industry professionals

On Feb. 9–10, 2012, a rainwater harvesting course to promote best practices for industry professionals was held in Edinburg. The five professionals who attended currently incorporate or plan to incorporate rainwater harvesting in their businesses. According to an evaluation survey given to the participants, on average they were very satisfied with the overall program, information, accuracy, understandability, materials, and instructors' knowledge levels. All participants reported a gain of knowledge in critical water issues and below-ground storage tank installation. More than half of the participants said they gained knowledge on pumps and controls and maintenance and troubleshooting of the system.

### Making a Rain Barrel fact sheets distributed in both English and Spanish

Using a rain barrel, one of the most basic forms of rainwater harvesting, often leads to a greater awareness of water use and influences adoption of larger rainwater harvesting systems. The *Making a Rain Barrel* fact sheet is a step-by-step guide in constructing and using rain barrels. Both the English and Spanish versions of the fact sheet were distributed at several events for the RGBI, including Master Gardener Earth-Kind<sup>®</sup> program in San Benito, District 12 Program Planning Meeting, Agriculture Awareness Day, and Rainwater Harvesting–200 Level Workshop. More than 480 copies were distributed in English and 70 copies in Spanish.

## Rainwater harvesting programs delivered to more than 100,000 participants; potential water savings of 70 million gallons

Rainwater harvesting programs provide timely information to assist Texas residents with water conservation. Trainings include information on proper design of systems for capturing rainfall to support landscape irrigation, indoor uses, and water for livestock and wildlife. Rainwater harvesting capture structures were built during workshops to provide hands-on experience and demonstrations.

Through 2011, 114,434 participants received information on rainwater harvesting. Results from preand post-test evaluations showed that 93 percent of participants increased their knowledge on uses, limitations, and proper design of rainwater harvesting systems.

A rainwater harvesting display at the San Antonio Livestock Exposition was seen by 114,407 attendees. Of those surveyed after viewing the Livestock Exposition display in 2011, 50 percent planned to implement rainwater harvesting systems within the next 12 months. These installations will prevent an estimated 70.2 million gallons of rainwater from running off into streams and storm water systems, and will conserve the same number of gallons of potable water that may have been used for irrigation in the San Antonio area during a year of typical rainfall. Water cost savings are calculated at \$63,625, based on the assumption that households of two people visited the exhibit and installed one 50-gallon rain barrel.

### Ranchers learn alternative methods for using rainwater harvesting

A presentation on increasing habitat through rainwater harvesting alternatives was provided at the Bi-National Ranchers Conference held June 29, 2011, in Laredo. Many areas of South Texas and northern Mexico are arid, leaving cattle or wildlife to travel long distances between established watering locations. The conference was attended by 115 ranchers, who learned how to use rainwater harvesting techniques to increase and stabilize water in pastures and wildlife habitat.

### Deer habitats in Webb County improved through rainwater harvesting site

A demonstration rainwater harvesting site was used to improve deer habitats in Webb County, where average rainfall is 21.5 inches per year. The catchment retains on average 10,334 gallons of water annually on Webb County soils too porous for soil tanks. 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 was \$4,247, and the dual catchment system has an expected 20-year life span. Assuming the catchment system increases deer lease value by \$2 per acre, the catchment would pay for itself in four years and yield \$16,000 additional profit for the landowner over the next 16 years.

## Collaborations provide additional rainwater harvesting installations and workshops

A collaborative effort in 2011 with The World Birding Center-Edinburg, Edinburg Rotary Club, RGBI, and the Texas Water Resources Institute (TWRI) has provided grant funding for the design developed the previous year. Installation of rainwater harvesting tanks in November and December provided a visible demonstration site, as well as enough rainwater from the building runoff that 84,100 gallons of water will not have to be purchased from the city each year. In addition, working in cooperation with the Texas State Soil and Water Conservation Board, Texas Commission on Environmental Quality, and TWRI, many rainwater harvesting workshops will be conducted across the state throughout the upcoming year.

### Educational programs conducted throughout Rio Grande Basin counties

Texas AgriLife Extension Service specialists maintained two rainwater harvesting sites in Webb County and one in Starr County, demonstrating the benefits of using harvested rainfall for wildlife, landscape, and other applications. In addition, they supported the Texas AgriLife Rainwater Harvesting Task Force



and provided rainwater catchment designs for demonstration sites in Edwards and Kinney Counties and a rainwater harvesting educational program in Edwards County. Also in 2011, 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.

## Establishing a Virtual Urban Landscape Water Conservation Center in New Mexico

A Web-based demonstration site developed as a clearinghouse of information is now online at xericenter. com. Developers used every Web-based platform available to reach as many users as possible. Web visitors of any age, background, or attention span can see how a low-water-use yard looks, how it "works," and how one is built. For the Web, developers focused on visuals: What does it look like? What does the maintenance look like? How do I build one? Users' appreciation for the hands-on, demonstration-type methods are evident in the response to the YouTube videos: Of the 40 videos filmed in demonstration gardens a year ago, 4,300 of the 11,000 views were of the video, "How to Set up your Drip Irrigation System." Only a few dozen visitors attended a live field day event at the Agricultural Science Center in Farmington in 2011 that demonstrated the same technologies. On iTunes U, most of the ticks marked were for the demonstration garden tours. Still photos were posted on Picasa. A new Facebook page has been set up for user discussions and project photos. All associated sites are linked together-The Center for Landscape Water Conservation at xericenter.com, youtube.com/xericenter, facebook.com/xericenter, picasaweb.google.com/xericenter, and iTunes U on the New Mexico State University channel under Southwest Yard and Garden. An iOS app soon will deliver plant information to consumers. A QR Code will drive smartphone users to the website. All of these efforts will encourage user adoption of water-wise landscape practices.

\*Xeriscape is a registered trademark of Denver Water, Denver, CO, and is used here with permission.

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### ENVIRONMENT, ECOLOGY AND WATER QUALITY PROTECTION

### Herbicide control of giant cane and saltcedar plots evaluated

Herbicidal control plots, established in 2008–2010 near Harlingen and used for screening herbicides for giant cane control, were evaluated in 2011, as were plots established in Navarro County in 2010. The Navarro County plots were established in cooperation with local irrigation districts, county government, and industry representatives.

Evaluations on new herbicides for saltcedar control continue. Plots were established from 2007 to 2010 to evaluate a new unregistered herbicide being developed by DuPont and Dow AgroSciences products. Aerial, ground broadcast, individual plant foliar, individual plant basal, and cut stump application methods were used in establishing these plots. Saltcedar trials conducted in 2009–2010 were evaluated in 2011.

#### Pecos River saltcedar treatment continues

Specialists are working with the Texas Water Resources Institute, local soil and water conservation districts, and private landowners in saltcedar spraying activities along the Pecos River. A total of 2,476 acres of saltcedar were treated with herbicide in September 2011 as part of the Pecos Watershed Protection Plan Implementation Program. Technical advice was provided throughout the applicator bid process, and specialists on-site coordinated and oversaw the herbicide application.

### Grass carp continue to reduce submerged aquatic vegetation

Grass carp demonstrations have reduced or eliminated submerged aquatic vegetation, particularly hydrilla, from irrigation canals. This year three irrigation districts restocked with grass carp. This treatment reduces the costs of labor, equipment, and chemicals. The estimated savings from the six cooperators in 2010–2011 is more than \$500,000 per year. Water savings include reductions in pumping costs, percolation or seepage, evaporation, and mosquito breeding areas. Total water savings have not been estimated.

## Herbicide controls for water hyacinth, water lettuce, and *Arundo* utilized by irrigation districts

Herbicide recommendations for control of water hyacinth and water lettuce continue to be utilized by Cameron County Irrigation Districts No. 2 and No. 6, respectively. This year *Arundo* herbicide control was initiated with Brownsville Irrigation District for security reasons. These programs have reduced water loss due to evapotranspiration and labor and equipment cost. Since water hyacinths increase evapotranspiration by 200–300 percent, the water savings are significant but difficult to calculate.

### Invasive plant resources and outreach

Development of resources on invasive plants in the Rio Grande Basin continued. The invasive species website is undergoing a complete overhaul. For a preview of the new format, go to *essmextension.tamu.edu/plantsdev/*.



The AQUAPLANT website, *aquaplant.tamu.edu*, which is updated regularly, helps pond owners identify and manage aquatic vegetation. New photos and chemical management techniques have been added to the website. In 2011, 181,725 unique visitors viewed 805,547 pages.

Herbicide Tables 1 and 2 and posters on *Invasive Aquatic Weeds of the Rio Grande* are available as requested by county Extension agents. These are standard handouts for Continuing Education Units (CEU) and Private Impoundment trainings. One aquatic vegetation management CEU training was requested in Webb County in 2011. In addition, two Master Naturalist trainings on aquatic ecology— one beginners training and one advanced training—were held in El Paso County in April 2011.

### Private water well screening critical for private well owners

Water from privately owned wells in the Texas Rio Grande Basin is used for irrigating crops and landscapes, providing water to livestock and wildlife, and drinking water in homes. Public water supplies, which are generally of good quality, are monitored through mandates of the Safe Drinking Water Act. However, private well owners are responsible for monitoring the quality of their wells and are frequently at greater risk of compromised water quality.

Private well water screenings provide owners with information on their current water quality. Fecal coliform contamination, the most common problem in privately owned wells, comes from warm-blooded animals that may have contaminated the water. Water contaminated with fecal coliform bacteria is more likely to contain pathogens that can cause diarrhea, cramps, nausea, and other symptoms.

Wells should also be tested for nitrate-nitrogen. Nitrate levels above 10 mg/L can prevent blood from carrying oxygen throughout the body. Nitrate is converted to nitrite that combines with hemoglobin, the chemical that carries oxygen in the blood, to form methemoglobin. Oxygen cannot bind with methemoglobin; therefore, oxygen is not carried throughout the body, and oxygen starvation occurs. If left untreated, oxygen starvation can be fatal. Infants younger than 6 months and young livestock are most susceptible.

Well screenings should also test for salinity from total dissolved solids (TDS). Salinity concentrations can leave private well water unsuitable for irrigation. Elevated salinity concentrations in well water can damage soils and plants and harm livestock and wildlife. Landowners control management and protection of private, domestic water sources; therefore, these private well owners depend on education rather than regulation.

# Salinity, fecal coliform, and nitrate concentration levels screened in private water wells

Private water wells of 265 participants were screened for salinity, fecal coliform, and nitrate concentrations in Edwards, Jim Hogg, Kinney, LaSalle, Maverick, Starr, and Webb Counties. Of the 265 samples taken, 49 were positive for fecal coliform (18.5 percent). The average nitrate-nitrogen level was 3.5 parts per million (range 0–50 ppm), and the mean total dissolved solids (TDS) was 953.6 ppm (range 5–9,350 ppm).

Participants estimated the value of the water screening program. On average, respondents indicated that their individual participation was worth \$696, or a total of \$184,416 for all attendees.

In addition, the program included presentations on well-water quality, well siting, wellhead and aquifer protection, and techniques for remediating identified water well contamination to protect human health and safeguard aquifer integrity. Results from pre- and post-test assessment of training effectiveness indicated that 96.2 percent of participants increased their knowledge of proper private water well management. Emphasis was placed on evaluating the appropriateness of salinity concentrations in screened well water for plant irrigation and beneficial soil properties.

### Saltcedar beetle control continues along the Pecos River and Rio Grande

Saltcedar leaf beetles were released at three locations on the Pecos River in 2006. Based on studies conducted by the U.S. Department of Agriculture's Agricultural Research Service, the Tunisian beetle— *Diorhabda sublineata*—was considered better adapted to the Pecos River watershed than the Crete beetle, *Diorhabda elongata*. The Tunisian beetles were initially released at Leon Springs and Imperial in 2009, with additional releases in 2010 and 2011. A total of 84,000 adult Tunisian beetles were collected for redistribution from the Iraan and Rio Grande sites in 2011. About 27,000 beetles were collected from Iraan and 57,000 from the Rio Grande site; 13,000 beetles were released in Howard County. The following table summarizes the number of Tunisian beetles collected and released in 2011.

Location released	Number of Tunisian Beetles
Pecos	29,000
Imperial	10,000
Grandfalls	10,000
Leon Springs	9,000
Toyah	10,000
Pecos North	3,000

### Zeman Ranch on Pecos River is most successful beetle release site

The Zeman Ranch in Reeves County on the Pecos River has been the most successful beetle release site to date. The Crete beetles released on the ranch in 2006 quickly established and have expanded their range every year. They defoliated all the saltcedar along 11 river miles and had moved from Mentone to Barstow by 2010. Much of the saltcedar along this stretch was sprayed with herbicide several years ago, and beetles are now feeding on the regrowth and surviving trees.

Crete beetles probably did not survive the extremely cold winter of 2011, as none were found during extensive spring and summer surveys in April, May, and June. Areas surveyed included the original release site and about 1 river mile on either side of the Highway 3398 bridge.

About 29,000 Tunisian beetles were released at the original site and near the Highway 3398 bridge during July, August, and September 2011. Counts were taken in July, prior to the release, with no beetles found. On September 19, four-minute counts on each of 10 saltcedar trees at the original release site were taken. For the 10 saltcedar trees, Tunisian beetle adults averaged 45.5 per four-minute count, larvae averaged 30.5, and the saltcedar trees averaged 13.5 percent defoliation.

#### Imperial site, Pecos County on Ronnie Cooper Ranch

This site was established in 2006 with 50 Crete beetles in a cage, but was abandoned in 2009 because of poor survival. A new release was moved to a nearby site. Densities continued to increase. About 10,000 Tunisian beetles were released at the original site in 2011—4,000 on August 11 and 6,000 on September 13. Four-minute counts were taken at three different locations at the Imperial site. By September, Tunisian beetle population densities had increased sufficiently to defoliate all saltceder within a roughly 800-acre area. However, saltcedar in this area is scattered and probably represents no more than 100 covered acres.

#### Grandfalls site, Pecos County on Schylur White Ranch

Crete beetles were released into a field cage in 2008, but by mid-2009 no beetles could be found; the population might have been lost to flooding. About 500 more beetles were released in July 2009. However, in 2010 this site was abandoned because of flooding risks, and the release site was relocated. About 2,300 beetles were released in 2010, and adults and larvae were found on the release tree in September. Tunisian beetles were released on Aug. 5 and 25, and Sept. 13, 2011, for a total of 10,000 beetles. Surveys of the area were conducted on August 12, 24 and 30, and October 5, and neither adults nor larvae were found. In addition, no defoliation was seen. In early October, the Upper Pecos Soil and Water Conservation District technician informed specialists that the area had been treated with herbicide to control the saltcedar. The herbicide's effect on insects is unknown; however, no beetle adults or larvae were found at this site in 2011.

### Leon Springs site, Pecos County in Fort Stockton

In 2010, a new site was selected for Crete beetle establishment at Leon Springs near Fort Stockton. This site was surveyed in late spring 2011, and beetles were not found. The site was not checked again. On August 19, about 2,000 Tunisian beetles were released about .83 miles from the cage study. Another 2,000 were released at this site on September 1, and 5,000 were released on October 14. Counts were not made at this site. In late September, the specialist directing a saltcedar herbicide spray program in the area said saltcedar beetles had defoliated a significant amount of saltcedar. In early October, three specialists collected many beetles from the area and confirmed that all those collected were Tunisian beetles; Crete beetles were not found. By November 2011, beetles could be found in an area covering 1.4 square miles.

#### Iraan site, Crockett County on Jim Cade Ranch

The Iraan site was established in 2008; the site was checked and more releases were conducted during 2009–2010. At a site check for beetle survival on June 22, only Tunisian beetles were found. Beetle population density was high enough to have caused considerable saltcedar defoliation. All transect trees

were 100 percent defoliated. Two counts roughly 0.4 miles apart were made on August 15. At the original release area an average of 16.1 larvae and 43.4 adults per four-minute count were found. About 0.4 miles east of the original site an average of 35 larvae and 20.5 adults per four-minute count were found. On August 31 the area was surveyed for beetle dispersal; beetle adult and/or larvae were found from the bridge and to the west. Beetle activity reached beyond this point was based on visual observation, but travel was difficult because no trails or roads exist. Beetle population densities at this site were considered high enough to collect and translocate to other release sites. A total of 27,000 adult Tunisian beetles were collected from this site and released at other sites in August and September 2011.

#### Mentone/Pecos North site, Reeves County

Established with 800 Tunisian beetles in June 2010, this site's population density increased enough to defoliate 25 trees by September. This site was surveyed at the same time as the Pecos site on Zeman Ranch, and beetles were not found. On Sept. 19, 2011, 3,000 Tunisian beetles were released at this site.

#### Toyah site in Reeves County

The Toyah site in Reeves County was established in 2011. The specialist met with the landowner on June 24, 2011, and determined that sufficient saltcedar existed to support a beetle population. On September 13, about 10,000 beetles were released.

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### SALINE AND WASTEWATER MANAGEMENT AND WATER REUSE

### New anaerobic septic systems course developed

Maintenance is essential for proper function and longevity of on-site wastewater treatment systems. Educational programs offered by the Texas AgriLife Extension Service provide homeowners with information that helps them understand an on-site wastewater treatment system and its uses and maintenance requirements. Research of on-site permitting activity and discussions with experts indicate that aerobic treatment units (ATUs) account for a small percentage of on-site wastewater treatment systems in the Rio Grande Basin Initiative (RGBI) area. As a result, a two-hour course on homeowner maintenance of anaerobic septic systems was developed. An AgriLife Extension program specialist is contacting authorized agents in the RGBI area to raise awareness of the ATUs course, the homeowner septic system course, and other available educational efforts.

### Homeowners learn basics of maintaining their septic systems

A "Homeowner Maintenance of Septic Systems" course was held on March 3, 2012, at the Texas AgriLife Extension Service training center in El Paso. The course also was offered at the Weslaco training center later that spring. This course covers the components of a conventional septic system and drain field and provides a basic understanding of the operational and maintenance activities for such a system. The course explains how activities within the home can impact the operation of a septic system and describes the limitations of the site itself. Participants learn about the practices required to keep a system working at its peak efficiency for their families and their property.

## Online course for operation and maintenance of on-site wastewater treatment systems in development

An online training course on the operation and maintenance of on-site wastewater treatment systems is being developed. It will be available through the *ossf.tamu.edu* website. The course will focus on the components of a conventional septic system and drain field and will provide a basic understanding of the operational and maintenance activities for such a system. Protection of human and environmental health will be emphasized.

## Publications developed on topics associated with on-site wastewater and gray water treatment and management

The Texas AgriLife Extension Service has produced several publications covering on-site wastewater treatment technologies, dispersal methods, and operation and maintenance activities. Research of the Texas Commission on Environmental Quality's On-site Activity Reporting System and discussion with area representatives provide a better understanding of the types of systems in each county. This research identifies publications relevant to each county. Both English and Spanish versions of the publications will be distributed to RGBI-area county Extension agents and authorized agents in 2012.





### NMSU turf scientist examines effects of saline water on establishment and sustainability of turf in semi-arid Southwest

After a six-month lecture series through the Master Gardener (MG) program, participants reported their negative attitudes towards turfgrass' consumptive water use dropped from more than 90 percent to less than 60 percent after they learned about actual turfgrass water use, efficient irrigation, and the role and importance of turf areas in urban environments. A total of 33 percent of all participants in the statewide program requested additional training in the area of turfgrass irrigation. Anonymously surveyed participants' additional comments included:

- "Excellent training. Very important to everyone who lives in New Mexico. This training provides MG with a more balanced approach to turf use."
- "Valuable to have this topic included in basic MG training."
- "I don't maintain a lawn, but I appreciate the info to help me as a MG."
- "Thank you so much for sharing your turfgrass enthusiasm with us."
- "Especially good for all the people moving here from wetter areas."
- "This is an excellent class as it gives solid information and refutes the idea that grass is a very high water use crop."

Presentations on turfgrass water conservation and sensor technologies for turf areas were held at New Mexico State University's Turfgrass Field Day and at the 2011 Southwest Turfgrass Conference. After the presentations, participants rated their knowledge gained at either 4 (35.2 percent) or 5 (42.3 percent) on a scale of 1 (none) to 5 (a lot).

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### BASINWIDE HYDROLOGY, SALINITY MODELING AND TECHNOLOGY

## Traditional irrigation system effects on surface water-groundwater interactions in the Rio Grande Basin

Field data for quantifying different water budget components in the Alcalde irrigated valley in northern New Mexico was collected; some was used to parameterize different models. One of these models, the Root Zone Water Quality Model (RZWQM), was designed to simulate deep percolation following irrigation for different crops. Journal articles, a book chapter, a dissertation, and an outreach publication have been produced from this work. In addition, presentations of research results have been given at local and international forums.



Research results were presented at several meetings with community organizations and local producers, including the annual meeting of the Taos Valley Acequia Association on May 1, 2011, in Taos. Research results were also presented at local, national, and international professional assemblies.

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2011 / 2012

### COUNTY PROGRAM ACCOMPLISHMENTS

TEXAS AND NEW MEXICO

### COUNTY PROGRAM ACCOMPLISHMENTS

### SOUTH REGION

#### Fix-A-Leak campaign raises homeowners' awareness

Cameron, Dimmit, Hidalgo, Starr, and Webb Counties participated in educational programs associated with the Fix-A-Leak (FAL) campaign. A single home can lose an estimated 10,000 gallons of water through running toilets, dripping faucets, and other household water leaks. Nationwide, these leaks total more than 1 trillion gallons of water each year. Through FAL, homeowners learn 25 ways to conserve water in the home and landscape. Many participants also received water-saving showerheads and low-flow faucet aerators for their homes. Homeowners also are taught how to check water faucets and irrigation systems for leaks. Many homeowners sign a pledge to completely inspect their homes for water leaks. Results of this effort included: 1) a pledge to inspect their homes for water leaks that was signed by 1,846 homeowners; 2) a program targeted at Head Start (governmental program) homeowners that reached 716; 3) Better Living for Texans (BLT) programs that reached an audience of 750; 4) four displays set up at youth and community festivals that were viewed by 2,875 people; 5) six school programs that were presented to 1,805 students and teachers; 6) educational displays that reached a total of 608 people; and 7) three news articles that were distributed to a total circulation of 145,000.

## SAFE educational series promotes proper turf management, practices, and irrigation savings techniques

Cameron and Hidalgo Counties implemented the Sports and Athletic Field Education (SAFE) series for managers of sports and athletic turf in La Feria, Los Fresnos, Rio Hondo, Harlingen, Santa Rosa, Donna, Pharr, and San Juan. Through this program, field managers learned turf management, irrigation savings techniques, best management practices (BMPs) for using plant protection chemicals, and proper management of fertilizers. The series included classroom instruction, hands-on workshops, and field demonstrations of BMPs. Upon completion of the series, participants were surveyed on what they learned and what practices they plan to implement. Results from the 21 participants surveyed indicated that all of them agreed the material presented was informative, and all plan to adopt practices of water conservation at their schools; 82 percent learned the importance of using evapotranspiration in irrigation scheduling; and 88 percent learned how to estimate irrigation system output rates in gallons per hour and how to schedule irrigations.

## Earth-Kind<sup>®</sup> program educates homeowners on proper management for home landscapes

The Earth-Kind<sup>®</sup> (EK) educational program teaches homeowners the proper management of water, pesticides, and fertilizers in home landscapes. Hidalgo and Cameron Counties sponsored EK programs focusing on techniques to increase water efficiencies, reduce pesticide and fertilizer use, and lower the risk of pollution. Results included: 52 educational programs attended by 1,902 participants; 19 news articles circulated to 290,000 readers; and one television and two radio programs presented to a total audience of 30,000. In Cameron County, 68 percent of program participants indicated they definitely


will adopt best management practices (BMPs) to increase water-use efficiency in their home landscapes; 73 percent probably to definitely will adopt BMPs related to designing or redesigning their own landscapes to maximize nutrient management; and 52 percent will definitely adopt practices designed to reduce pesticide usage in their home landscapes. In Hidalgo County, participants said the knowledge they gained will result in an average of \$200–\$499 in water-use savings per participant per year, and 82 percent anticipate water savings of 25–49 percent, based on practices learned through the program.

## Educational programs in Starr and Webb Counties target economic and environmental sustainability for rangeland

In uncertain economic times and extreme drought, livestock producers must carefully calculate decisions to increase net returns for their operations. To aid producers in managing their operations, educational programs in Starr and Webb Counties targeted economic and environmental sustainability. As a result, six range and livestock management programs were conducted in each county. Topics presented included best management practices for brush control, hay and forage management, wildlife and cattle production systems, biosecurity for producers, insect control, well water quality protection, and ways to harvest rainwater for future use. In Starr County, 92 percent of participants identified ways to improve their pastures through use of proper and economical methods of brush control, and 94 percent increased their knowledge on proper safety practices on the ranch. In Webb County, 55 percent of participants who returned a survey indicated they increased their knowledge of grass-fed beef production during the Bi-National Ranchers Conference.

## Educational efforts on crop production conducted in Cameron, Hidalgo, and Willacy Counties

Rio Grande Valley producers face different crop management and production techniques required by a variety of growing seasons. The global economic downturn, reduction of rainfall, increase in irrigation and crop protection chemical costs, and urban sprawl all increase farming risks in the Rio Grande Valley. To help reduce these risks, educational efforts on crop production were conducted in Cameron, Hidalgo, and Willacy Counties. Efforts included workshops and seminars on citrus, grain sorghum, corn, cotton, soybean, sunflower, and sugarcane production. On-farm demonstrations in corn, cotton, grain sorghum, soybean, and sunflower production also were conducted. A Valley-wide soil testing and fertility campaign taught producers to more efficiently use fertilizer to maximize crop yield, reduce costs, and protect water quality. In addition, a total of 12 educational events were attended by 474 Valley producers. Since 2001, 4,700 soil samples have been collected and analyzed across 181,000 acres. Based on results from these soil samples, an estimated 4.6 million pounds of nitrogen (N) and 5.5 million pounds of phosphorus (P) were saved by the prescribed fertilizer recommendations. Valley producers have saved more than \$4.67 million in fertilizer-related costs.



#### WEST REGION

Water issues are critical in the West Region and the Rio Grande Basin Initiative counties. Local stakeholder input, legislative efforts, and other indicators reveal the need for timely action to address water issues. Agriculture, the largest water user in the state, is under close scrutiny. Producers must be careful to reduce the risk of water quality contamination from urban/suburban settings. Water use in the municipal environment, including irrigation of athletic fields, parks, and home landscapes, also constitutes a significant portion of water used in the state. Water use in homes and businesses contributes to the growing need for additional water resources.

In 2011, 16 counties in the West Region conducted educational programs and demonstrations to help address the water issues. More than 20,000 contacts were made through these programs. County Extension agents and Extension specialists provided educational programs addressing water issues in the Rio Grande Basin. These programs addressed the issues within the areas following.

#### Irrigation efficiency in agricultural production programs held for farmers

A Winter Garden Irrigation Symposium for grain producers was held in Uvalde; attendance at each of these events exceeds 100 irrigated corn and grain sorghum producers. Irrigation technology and efficiency are the focus of the program.

The Reeves County AgriLife Extension agent continued a soil salinity monitoring program that will last five years and will graph every forage production field in the county at different times of the year. Each field will be evaluated using a GPS (geographical positioning system) and an EC (electrical conductivity) meter that will provide coordinates and measurements on a 20-foot grid. Once the field's data is completed and a simple questionnaire given to the producer, a database will be set up for forage production farmers to view maps. This program will enable farmers to analyze the salinity of their fields and make cost-effective judgments for their operations.

# AgriLife Extension helps small acreage homeowners identify suitable agronomic plant species

More than 10,000 properties in El Paso County can be classified as small acreage tracks, which range from 0.10 to 2 acres each and total 5,685 urban or rural acres. Because of their limited acreage, the landowners rarely have a profitable agricultural enterprise in agronomic crops. Small acreage owners want to know about the most suitable crop or type of plant they can grow while dealing with urban growth, soil salinity, reduced or low water delivery, and production costs. Along with the small acreage tracks, about 15,000 acres of land in the area have a high salt content and limited use because few plant species can do well in this type of soil.





AgriLife Extension faculty and volunteers initiated a program to identify plant species that can adapt to local conditions and fill the needs of small acreage landowners. Vegetables and herbs were not included in the selection, but several species of fruit trees were, including apple, pear, quince, stone fruit, jujube, date palm, olive, fig, and pomegranate. Based on the selection parameters, pomegranate filled the most criteria and provided the best economic potential and revenue. Pomegranates from different El Paso County backyards were analyzed for pH, sugar content, and total dissolved solids. Fruit test panels also were used to select characteristic pomegranate fruit flavor of the ones tested.

Three local pomegranates filled the criteria for fruit size, color, sugar content, and flavor, and were extensively propagated and planted. Rooted pomegranate plants were given to interested farmers in El Paso and Hudspeth Counties to test the plants under their own field conditions. Testing farms' soils ranged from sandy to heavy clay. Pomegranates are being irrigated with water with 400–5,000 ppm of total dissolved solids and a sodium absorption ratio of 3–25.

## Pecan production educational programs address best management practices for crop management

Pecan production is El Paso County's second-most important crop after cotton. However, El Paso County is the state's leader in the amount of acreage, improved cultivars, poundage, and quality of its pecan nuts. Refining and better timing of production practices brought increased yields and quality to established pecan orchards. However, the new market demand for pecans also brought the need to use new pecan cultivars and rootstocks, planting methods, and soils with some limiting production factors, such as poor drainage and salt problems, that in the near future will be detrimental for pecan production. More than 2,000 acres of new or recently planted pecan trees might encounter problems from these soils.

Educational programs in 2011 addressed the best management practices (BMPs) in methods of pecan edging/pruning, fertilization, irrigation, pest control, and nut quality, along with a soil sustainable and health program.

#### Watershed management workshop participants to adopt techniques

A workshop series conducted in Culberson and Hudspeth Counties in 2011 provided information on recommended watershed management practices. To determine the results of this series, an evaluation instrument—retrospective post—was used at the spring and fall workshops. Respondents indicated a 62.5 percent increase in knowledge of woody plants' influence on the amount of rainfall infiltration, and 38.5 percent of participants "definitely will" adopt techniques to estimate groundwater recharge. Respondents indicated a total estimated economic benefit of \$854,753.

# Educational series in Ward, Presidio, and Brewster Counties addresses water conservation in landscapes

In 2011 AgriLife Extension agents in Ward County conducted a series of educational programs to address water conservation in landscapes. The main goal was to teach homeowners to conserve and protect natural resources while creating a healthy and sustainable landscape. Much of the program was spent teaching and showing different species and types of plants that do well in an arid environment. Topics discussed included: 1) the importance of irrigation—timing, length of time, and amounts; 2) the importance of water—rainwater harvesting, drip irrigation, economics; 3) the different species of plants that will grow in the area; 4) the different mulches—water savings and weed control; 5) the safety aspects of pesticides—proper rates, timing, and drift; and 6) the space requirements of trees, shrubs, plants, and lawns.

In addition, AgriLife Extension agents in Presidio and Brewster Counties conducted Tree 101 Workshops in 2011. Participants received information on native and adapted plants in landscapes and other recommended water-conserving techniques.

# Rainwater harvesting programs led to establishment of new demonstration sites

Educational programs on rainwater harvesting were conducted in eight counties in the Rio Grande Basin. Four of the counties established, modified, and/or completed maintenance on rainwater harvesting demonstrations. The programs and demonstrations provided information on rainfall harvesting and the efficient use of captured rainfall.

A rainwater harvesting demonstration in Edwards County showed how to capture rainwater for wildlife. Partnerships and collaborations included commissioner's courts, municipalities, and local chambers of commerce.

In Presidio County, an estimated 4 inches of condensation and rain was harvested at the Marfa Activity Center rainwater harvesting demonstration site, totaling 31,680 gallons of water. The on-site improvements, including a handicap ramp, enhanced the desert landscaping, wildlife water feature, and overall aesthetics of the project. The site continues to benefit the 7,000 Presidio County residents, tourists, and nearby communities by providing them with an educational and aesthetic opportunity. Maintenance was provided by the City of Marfa and Tierra Grande Chapter of Master Naturalists.

The Southwest Texas Municipal Gas Building in Presidio County also established a rainwater harvesting demonstration with a 5,000-gallon catchment tank and a rain garden. Runoff water from the property was also redirected. This collaborative effort with the Tierra Grande Chapter of Master Naturalists, the City of Marfa, and Southwest Municipal Gas provides an educational site. With the drought conditions, an estimated 4 inches of condensation and rain was harvested on-site, totaling 6,480 gallons.

#### Water well screening offered, samples collected from 99 water wells

Water well screenings were offered in Presidio, Brewster, and Jeff Davis Counties, and 99 water wells were tested for bacteria, salts, and nitrates. Of the wells tested, samples showed *E. coli* in 6 percent, coliform in 42 percent, other in 5 percent, no bacteria present in 53 percent, salts (medium to high salt hazard) in 2 percent, and nitrates in 3 percent. A combination of multiple bacteria sources were found in the tests. Survey respondents indicated an 87 percent increase in knowledge regarding water quality of wells (salts, bacteria, and nitrates). Treatment recommendations were made on all excessive or positive well test results, with retesting in three months recommended. Water conservation kits were given to all participants.

## Fix-A-Leak participants will modify or adopt in-home water conservation practices

Pecos and Brewster Counties conducted educational activities on in-home water conservation. In Brewster County, a Fix-A-Leak program at Morrison True Value Hardware store in Alpine was attended by 146 people. The AgriLife Extension Office in Pecos County conducted Fix-A-Leak presentations at Ace Hardware and Wallace Lumber with a total of 150 participants. Evaluation results indicated that 97 percent of participants will use the information to modify or adopt recommended in-home water conservation practices.

#### Youth water education curriculum and presentations increase fourthgraders' water knowledge

Ward County is located in the northern Chihuahuan desert of West Texas. This region, which normally receives only about 12 inches of rainfall a year, received only about 1 inch of rain this past year, making it one of the most water deficient areas of the state. Water education and conservation help residents understand the region's water resource issues. That's why a youth water fair, H2O for You, with seven rotating educational lessons, was presented to 144 fourth-graders at Sudderth Elementary in Monahans. The curriculum and presentations included: The Water Cycle, The Incredible Journey, Amazing Aquifers, Water Pollution/Enviroscape Model, Watersheds/Rainfall Simulator, Indoor Water Conservation, and Outdoor Water Conservation. The "Investigating Water" curriculum from the Texas AgriLife Extension Service was the basis for the lessons. Pre- and post-evaluations were used to determine how much knowledge participants gained. In all cases the respondents increased their knowledge between the two evaluations. A 50-120 percent change in knowledge was gained for all but one question, and an average of 72 percent change overall. Responses indicated more awareness about water issues and the importance water plays in their lives. AgriLife Extension in Ward County partnered with the U.S. Department of Agriculture's Natural Resources Conservation Service, Upper Pecos Soil & Water Conservation District, Ward County Master Gardeners, and Texas Water Development Board. Presentations and/or educational materials from the partners were included in teacher and student resource packets.

#### Signs installed for EarthKind® landscape projects

The landscaping demonstration development at the Ward County Courthouse Annex and the rainwater harvesting demonstration site at the Million Barrel Museum site continued during 2011. Signs at each location describe the specific project to the public. Both locations are highly visible to the public, and therefore provide an excellent passive interpretive opportunity.



TASK AREAS

### ACCOMPLISHMENTS

TEXAS AGRILIFE RESEARCH NEW MEXICO AGRICULTURAL EXPERIMENT STATION

## **IRRIGATION DISTRICT STUDIES**

## Research findings help irrigation districts, farmers develop drought contingency plans and conserve water

Ponding tests and inflow-outflow measurements have been conducted at Hudspeth County Water Conservation and Reclamation District No. 1. The ET (evapotranspiration) Tower and Weather Station collected and shared soil moisture data, groundwater level data, and precipitation and ET data. In collaboration with New Mexico State University and the University of Texas at El Paso, researchers continue to assess water availability in consideration of atmospheric water such as precipitation and evapotranspiration; surface water including river, reservoir, and irrigation network; and groundwater, as well as their variability with climate. The results show that canal seepage ranges from 150 to 350 acre-feet per mile per irrigation season. Those data have been used to develop a drought contingency plan, especially for irrigation districts, and to design better strategies for water conservation and salinity management, especially for farmers. Three journal articles were published and two presentations were given.

# RGBI Economics Team presents findings on key topics and expands into new areas

During the past year, the RGBI Economics Team completed various technical reports and professional journals and presented findings on RGBI water-resource issues to local, statewide, and national audiences. Key topics included: 1) business economics of desalination water-treatment facilities; 2) mitigation cost investigations of increased off-site sediment runoff and nutrients associated with biofuels production; 3) economic and water conservation effects of drip irrigation compared to traditional strategies such as furrow or flood; 4) health-related economic analysis of water quality and household treatment/delivery systems; 5) impacts of analytical techniques involving discounting for time; and 6) regional market economics affected by changing water supply and demand from dynamic climate conditions and increasing population.

In addition, the team provided research and Extension services to stakeholders with on-going works and expanded into new areas. Among the topics addressed were: 1) water market economics; 2) economic consequences of implementing alternative best management practices (BMPs) in a watershed; 3) policy implications of incentives essential for BMP adoption related to water conserving technologies or mitigation strategies when land use changes from pasture to bioenergy cellulosic feedstock; 4) business finances involving costs and delivery rates of irrigation districts; and 5) water implications of producing biofuels.

The project has quantified important economic and investment aspects of water conservation, bioenergy production of feedstock desalination, biological control of *Arundo* policy insight, and rapport with the water leaders in the region. The project contributed to the next generation of water economists and legal professionals, with their training focused on addressing water rights, drought response tactics, and appropriate policies to achieve desired social goals, among other issues.

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## INSTITUTIONAL INCENTIVES FOR EFFICIENT WATER USE

#### Collaboration broadens data and information sharing

The research team continued enhancing collaboration with federal, state, and regional agencies and stakeholders, and promoted international cooperation. As a result, research findings have been widely shared through seminar presentations and fact sheets. The coordinated water resources database and geographic information system (GIS) have been updated, and provide timely data and information for drought planning and water conservation. Collaborative agencies, institutes, and stakeholders include: U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, U.S. Geological Survey, 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. In addition, other collaborators have been farmers in the region, the University of Texas at El Paso, Peking University, China Agricultural University, Chinese Academy of Sciences, and China Institute of Water Resources and Hydropower. Three presentations provided updates to the Paso del Norte Watershed Council and Upper Rio Grande Water Operations Model Technical Team. Eight invited presentations were given at different institutes, and 13 fact sheets were updated.

#### Drought Watch publication produced and distributed

Three issues of the education and outreach publication *Drought Watch on the Rio Grande* were produced and distributed to increase the public's water 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, and Far West Texas Water Planning Group, via e-mail 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 more than 3 million in the United States with 2.2 million of those in the El Paso-Las Cruces-Juarez Rio Grande border region.

## Development of water resources database, GIS, and hydrologic model continues

Efforts on the Coordinated Database for Water Resources and Flow Model in the Paso del Norte Watershed continued with significant additional funding from the U.S. Army Corps of Engineers. 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 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 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.



# Preliminary salinity impact economic assessment used to identify salinity management alternatives

An invited presentation was given on the results of this project and the Rio Grande Salinity Coalition at the Rio Grande Water Resources Workshop in Austin in 2011, organized by the U.S. Army Corps of Engineers (USACE). Scientists are continuing to work with the Salinity Coalition and USACE contracted consultants to improve water quality conditions and extend existing regional water supplies. This task was conducted through collaboration with Texas AgriLife Research, New Mexico State University, 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 Environmental Department, U.S. Geological Survey, USACE, and U. S. Bureau of Reclamation.

#### Continued support provided for Far West Texas Water Planning Group

Researchers continue serving as members and providing support for the next phase of the State Water Plan for Far West Texas and Region M—Rio Grande Regional Water Planning Group. The 2012 State Water Plan identifies water supply and management strategies over the 50-year planning period (2010-2060) that would need to be implemented to meet projected demands for agriculture, municipal, industrial, power generation, and other uses during 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. El Paso's Texas AgriLife Research Center scientists will continue providing their expertise and technical support to the Far West Texas Water Planning Group.

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### ON-FARM IRRIGATION SYSTEM MANAGEMENT

## Alternative irrigation practices evaluated, compared to traditional flood irrigation in citrus grove management

A replicated research study in April 2011 at the Texas A&M University–Kingsville Citrus Center in Weslaco compared two flood irrigation strategies. Traditional large-pan flood (TFd) irrigated plots consisting of three citrus rows were compared again to border flood (BFd) irrigation using raised berms down the middle of each citrus tree row. Water meters were used to accurately determine the total amount of water applied in all plots. Results showed that for the same land area, TFd used 50 percent more water than BFd irrigation; BFd irrigation allows water to be channeled faster down the citrus row and underneath the tree canopy than TFd practices do. Researchers observed that BFd irrigation could apply water where the trees needed it faster than TFd practices could. The results of this replicated study complement previous findings observed at the on-farm field scale and suggest that BFd irrigation may use less water than microjet spray and drip irrigation that require the systems to be turned on more frequently.

The 2011 growing season was one of the driest on record. Some citrus growers using TFd irrigation had 10 separate flood irrigation events. Usually a TFd irrigation event uses a 6-inch irrigation application; thus, 5 acre-feet per acre of water were applied in TFd irrigation fields this past growing season. Although growers using BFd irrigation also applied 10 flood irrigation events this past year, the total water applied may have saved as much as 2.5 acre-feet per acre of water.

If the entire citrus industry faces future water restrictions due to continuous drought conditions in the Lower Rio Grande Valley, growers can switch to BFd irrigation to save water and preserve citrus production until rain replenishes the reservoirs. This field management practice is relatively low-cost to implement and does not include the expense of an irrigation system such as drip or microjet spray. The results of this research study suggest that if all growers changed from TFd to BFd irrigation practices during extensive droughts, 45,000 acre-feet of water could be saved each year.

## Drip irrigation and tile drain evaluation for young citrus grove establishment

In December 2009, 1-year-old orange trees were planted at a drip irrigated demonstration site in the Lower Rio Grande Valley. Extensive land preparation at this site prior to planting included installation of drain tiles throughout the field. Several locations on the field site are known to have elevated levels of salts and sodium that would limit citrus production. Tile drains provide drainage and allow salts to leach from the rooting depth of the orchard. The orange trees are established on a single-line drip irrigation system and receive weekly irrigation and fertilization as needed. The trees at this site have established very rapidly and have surprisingly good yield production for only having been growing for three years. Usually five years are required before adequate fruit is produced to justify harvesting. Trees were harvested at the end of 2011 with initial yields of about 5 tons per acre. The rapid tree establishment and good growth show that some areas can provide promising citrus yields after good land preparation, drain tile implementation, and drip irrigation system installation. Continuing economic assessment of yield generation as these trees mature will need to be compared against yield from young trees under conventional planting to determine whether such practices improve production and overall net cash farm income.



#### Compost source evaluation on water savings in citrus

A five-year study evaluating the value of yard waste/woodchip compost application for water savings and grapefruit trees' yield resulted in improved soil properties, increased soil moisture, higher root growth, and better citrus yields after the first year. The study found that citrus growers could extend the time between irrigations by applying compost underneath the mature citrus tree canopy. Growers also could reduce an estimated one flood irrigation per year by applying compost, which is equivalent to saving 0.5 acre-feet of water per acre. An economic assessment evaluated whether the increase in citrus yield and reduction in water application would pay off for the citrus grower. Results of the evaluation showed that compost application would be an economically feasible and slightly higher financial incentive to conventional or organic citrus growers.

#### Effects of altering on-farm irrigation management for improved fruit quality

An economic assessment compared citrus pack-out from traditional and narrow border flood irrigation. Grapefruit citrus growers using border flood irrigation—raised berms in the center of tree rows—had higher percentage of fruit yield in the fresh market category than traditional large-pan flood irrigators. Texas grapefruit growers make their income on fruit going to the fresh market, rather than fruit sold for the juice market. The method of irrigation the grower uses influences soil nutrient availability for crop growth. Traditional flood irrigators use 30–50 percent more water than border flood irrigators during each irrigation. Most feeder roots that support tree and fruit growth and development are within the top 18 inches of the soil. Traditional flood irrigation practices usually move applied fertilizer beyond these feeder roots. The increased yield and fruit quality from border flood irrigation are a result of better management of the amount of applied fertilizer in the effective root zone.

## Abscisic acid and growth regulators enhance drought tolerance and condition of vegetables

Working with industry, researchers developed methods of abscisic acid (ABA) applications to enhance drought tolerance and condition of watermelon and pepper transplants to better withstand posttransplanting field stresses. Researchers also developed foliar application methods with ABA to improve transplant quality while suppressing stem elongation rates in vegetable transplants grown in the nursery. A cytokinin-type growth regulator (6-BA) improved early yield and fruit number per plant in bell pepper grown with subsurface drip irrigation.

#### Deficit irrigation studies continue in the Winter Garden

AgriLife Research scientists investigated the effects of deficit irrigation on root growth, yield, and fruit quality of cantaloupe, honeydew, and specialty Tuscan-type melons using subsurface drip irrigation (SDI) and plasticulture in the Winter Garden region. Using 50 percent crop evapotranspiration (ETc) irrigation rates after plants were fully established saved 36 percent of irrigation water without significant loss in fruit yield and quality. In melons grown under SDI and plasticulture, researchers determined the spatial variability performance by analyzing phenotypic, genotypic, and environmental variations (GEI analysis) related to soil, climatic conditions, and cultural practices in the Winter Garden, Lower Rio Grande Valley, and Central Texas.

A project evaluated the interaction of nitrogen and deficit irrigation rates on cabbage yield and quality under subsurface drip. Two more projects developed growth stage-specific crop coefficients ( $K_c$ ), using state-of-the-art in-ground lysimeters. The goal is to apply these coefficients to improve irrigation management and increase water savings—estimated at more than 20 percent—in cabbage and artichoke.

# Rainwater harvesting tanks installed at Uvalde Center raise public awareness in saving water

AgriLife Research scientists have installed a 25,000-gallon rainwater catchment system that collects rainwater for use in the Uvalde AgriLife Research and Extension Center's landscape. This complements another system with a 2,500-gallon tank that collects rainwater for drip irrigation used in wildlife food plots planted with Bundleflower and Leucaena. These systems demonstrate and inspire recycling and water conservation for the public.

# Grafting, deficit irrigation, and plant population density impacts investigated

AgriLife Research scientists investigated impacts of grafting, deficit irrigation, and plant population density on stand establishment and water productivity of watermelons. Stand establishment, estimated as percent survival and vine elongation rates, was significantly higher in grafted plants when compared to non-grafted plants. Fruit yields were also significantly higher in grafted plants subjected to 100 percent ETc (crop evapotranspiration) than those subjected to 75 percent ETc. Average marketable fruit yields increased with plant density at about 3.5 percent plant density. Although the average number of fruits per plant declined with increasing plant density, fruit yields increased. Water productivity of grafted plants was about 23 percent higher than that of non-grafted plants and increased with plant density. The data suggest that increased planting density can bring higher net returns with the same amount of irrigation.

High value vegetable crops such as watermelons required ample irrigation to sustain yields and quality. The current results show that growers can increase net returns with the same amount of water by combining grafting with other water-conservation techniques such as drip irrigation, plastic mulching, deficit irrigation, and planting density. Alternatively, productivity could be sustained with fewer inputs, especially water.

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## **URBAN WATER CONSERVATION**

## Evaluating root-zone stresses and role of the root system on rose crop productivity, fertilizer, and water use efficiency

Researchers are evaluating root-zone stresses and the root system's role on rose crop productivity, fertilizer, and water use efficiency. The experimental, or greenhouse, components of this study were completed, and the data is being summarized and analyzed for presentation and publication at scientific and Extension/grower meetings. Poor-quality irrigation waters used in this study were rich with salts and ions such as sodium, chloride, boron, and bicarbonates. Overall study results indicate that despite efforts to use poor-quality irrigation waters on only one sector of a rose plant root system, the standard, non-stressful nutrient solution used on the rest of the root system could not compensate for the stress on the other root-zone sector. This stress eventually led to reductions in flower biomass and quality. Further research should explore the effects of pulsed localized stresses vs. continued localized stresses as a possible way to use drainage and poor-quality irrigation waters and increase water and nutrient use efficiency in this and other greenhouse crops.

## Continue evaluating water and nutrient use of infested Texas native street trees

Researchers continue to evaluate water and nutrient use of Texas native street trees infested by the parasitic xylem-tapping leafy mistletoe (*Phoradendron* spp.). They are currently analyzing and summarizing the data collected for reporting and presenting at meetings for professionals such as arborists and landscapers. Proposals are being prepared for potential funding sources for continued work on mistletoe-prone native tree species used in Texas landscapes and parks.

#### Salt tolerance of more bedding plants evaluated

Bedding plants are extensively used in landscapes in the United States. As high quality water supplies become limited, the use of recycled water to irrigate landscapes is being encouraged. Evaluations were done on relative salinity tolerance of additional bedding plants that were previously proved to be acceptable or excellent in semi-arid environment. Seedlings were irrigated with saline solutions at various salinity levels, and salinity tolerance was determined according to growth, visual quality, and physiological responses. Results indicated that petunia, Gomphrena, and angelonia cultivars were moderately tolerant to salinity, while zinnia and marigold are moderately sensitive and should not be irrigated with saline water.

#### Salt tolerance of garden roses evaluated

Roses are popular garden plants throughout the world. Because of intense competition for fresh water among agriculture, industry, and domestic water users, some regions are turning to alternative water sources such as municipal reclaimed water for irrigating landscapes. The responses of roses to irrigation water with elevated salts are unknown. Two experiments were conducted to evaluate the relative salt tolerance of 13 self-rooted rose cultivars by irrigating the plants with nutrient solutions and saline solutions. Again, variations in salt tolerance among the 13 cultivars were observed. About half of the



cultivars exhibited moderate tolerance. A few cultivars showed salt damage evidenced by leaf edge burn and yellowing. These results can be used as selection criterion for landscapes where low-quality water may be used for irrigation. Further experiments will be conducted in different times of the year to confirm the results.

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## ENVIRONMENT, ECOLOGY AND WATER QUALITY PROTECTION

#### Arundo donax uses soil moisture as its primary source

Based on observations of the isotopic composition of plant water, soil water, river water, groundwater, and precipitation, *Arundo* appears to have used flood water recharged deep soil moisture in 2011. A flood occurred in July 2010 when Hurricane Alex caused Amistad Dam to overflow. Flood water stayed in deep soil layers for about one year and became the dominant water source in the area during an extended drought the following year. Groundwater seems to be an unimportant water source when soil moisture is sufficient. However, isotope data alone cannot totally rule out the possibility of groundwater usage. Possibly *Arundo* uses more groundwater when soil moisture is depleted. Study results show that shallow groundwater exchanges with the river water, and river water flows into the alluvial aquifer during low flow periods. Surprisingly, when a flood saturates the soil, that water is available for plant use for at least a year, even in times of drought. Once that flood water is depleted, the potential use of groundwater by *Arundo* could result in losses of river water.

#### Arundo donax transpiration is not a function of water availability

*Arundo* transpiration exhibited spatial variability, but trends were not associated with gradients in soil moisture, depth to groundwater, or distance from the river. *Arundo* was found to close stomata under high atmospheric demand such as low humidity and high temperatures, causing declined transpiration rates and altered leaf d<sup>13</sup>C composition. The mean top 1 m soil moisture content in summer 2011 was high enough to support continued growth and transpiration and did not vary from month to month. Either the plants were not depleting the soil water rapidly or groundwater was moving upward to replace the lost moisture, suggesting the possibility of hydraulic redistribution by roots. The evidence is insufficient to support the idea of hydraulic redistribution, but future work is needed to rule it out.

# NMSU ecologists study irrigation system wetlands along the Rio Grande Basin of New Mexico

Work on finding solutions to the tug-of-war between agriculture, urban, and biota for limited river water in arid regions continues. Short water supplies complicate the need for water in these three areas. An oral presentation given to the U.S. Committee on Irrigation and Drainage focused on conservation of endangered native species. Several presentations on the health of tadpole shrimp and fish living in the Rio Grande also have been given. In addition, a master's thesis on the fish fauna in the lower Rio Grande of New Mexico has been presented.

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Carrasco, C. P. (2010). Comparisons of the fish fauna within the lower Rio Grande of New Mexico to the adjacent irrigation system and historical records of occurrence. Master's thesis, New Mexico State University, Las Cruces.

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Horn, R. L., Macdonald, K. S., III, Sallenave, R. & Cowley, D. E. (2012). *Links between genetic population structure and morphology of a tadpole shrimp* (Triops newberryi) *in southern New Mexico*. Poster presented at the Functional Genomics Symposium, Santa Fe, NM.

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Schaack, Y. 2011. A molecular toolbox for the living fossil Triops spec. [Notostraca]. Master's thesis, Technical University of Munich (co-advisor with R. Kühn), Bavaria, Germany.

Stoeckle, B. C., Cowley, D. E., Schaack, Y., Macdonald, K. S., III, Sallenave, R., & Kühn, R. (2011). Microsatellites and a mtDNA RFLP for North American Triops (*Branchiopoda: Notostraca*) and their amplification in the European species Triops cancriformis. *Hydrobiologia*. Manuscript submitted for publication.

\*Student publications

### SALINE AND WASTEWATER MANAGEMENT AND WATER REUSE

## Effects of salinity stress on seed germination and emergence of 43 chile peppers evaluated (repeated study)

The production of pepper, one of the most important vegetables in the world, is threatened by soil salinity in arid and semi-arid regions where freshwater is scarce, rainfall is extremely low, and evapotranspiration is high. Therefore, selection of salt-tolerant peppers is imperative. This project screened 43 genotypes of peppers for their salt tolerance. The objectives were to screen the relative salt tolerance of selected pepper genotypes during germinations and to quantify the effect of salinity on seedling emergence. Large variations in salt tolerance during germination stages exist among 43 genotypes of peppers. El Jefe Jalapeno and El Rey Jalapeno are the most tolerant to salinity. The threshold salinity for seed germination was greater than that for seedling emergence. The relative salinity tolerance during seed germination is in agreement with that during seedling emergence stage.

Further greenhouse studies on salt tolerance of the selected varieties are under way, and field study based on greenhouse results on selected varieties will follow to further confirm salt tolerance under field conditions.





#### Salt tolerance of ornamental chile peppers

Ornamental chile peppers are popular container-grown plants and bedding plants with unique foliar and fruit colors. However, information on the ornamental plants' responses to irrigation water with elevated salts is limited. This study quantified the responses of 11 ornamental chile peppers to elevated salinity—NuMex Twilight, NuMex Centennial, NuMex Christmas, NuMex April Fool's Day, NuMex Cinco de Mayo, NuMex Valentine, NuMex Easter, NuMex Halloween, NuMex St. Patrick's Day, NuMex Memorial Day, and NuMex Thanksgiving. Research results indicated that most cultivars were moderately tolerant to salinity with little or no foliar salt injury, although growth is reduced at elevated salinity. NuMex Memorial Day was most sensitive among the 11 tested cultivars, with foliar damage and significant growth reduction.

## Results indicate cellulosic bioenergy crop can be grown with marginal quality soil using treated urban wastewater

Results to date for Year 4 of a five-year project have indicated that growing cellulosic bioenergy crop on marginal quality soil is possible by using treated urban wastewater, and biomass yields are comparable to that obtained from freshwater. The ultimate outcomes of this project can help to utilize about 45,000 acre-feet per year of treated urban wastewater to irrigate agriculture crops, including bioenergy crops. Reuse of urban wastewater has several potential benefits, such as extending the use of existing freshwater supplies, using non-potable water for growing food/fiber/fodder/bioenergy feedstocks, and improving farm income.

#### Switchgrass cultivars evaluated under treated wastewater irrigation

Data from salinity tolerance experiments showed that, among nine switchgrass cultivars studied, Alamo had the best germination and least seedling mortality under treated wastewater irrigation. Alamo also has been successfully established in soil columns of 14-inch diameter by 30-inch depth that were prepared using soils from an agricultural field downstream of Roberto Bustamante Wastewater Treatment Plant. After two years of irrigation with treated wastewater, soil salinity and SAR values were generally higher in wastewater treatments after one year but below the threshold level of 4 dS/m (except for Gypsum amended soils) and 10 mmol<sup>1/2</sup>L<sup>-1/2</sup>, respectively. Switchgrass biomass yields under wastewater irrigation treatments were similar to that under freshwater irrigation. Treatments will be evaluated for one more year with funding from El Paso Water Utilities.

#### Several experiments study switchgrass establishment and performance

Water and soil amendment treatments were imposed during the 2010 and 2011 irrigation seasons, and switchgrass established using freshwater was harvested, leaving stubbles of 6 inches, before the treatments. Split plot design involving water quality as the main effects, soil amendments as sub-effects, and soil depths as sub-sub-effects was used to evaluate switchgrass performance under greenhouse conditions.

#### Collaborators evaluate accuracy of electromagnetic induction technique

In a collaborative study between Texas A&M University and New Mexico State University, researchers evaluated the accuracy of an electromagnetic induction technique to monitor salinity distribution in turfgrass plots irrigated with variable water quality in Las Cruces, NM.

#### PUBLICATIONS

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### BASINWIDE HYDROLOGY, SALINITY MODELING AND TECHNOLOGY

### Decision support system framework for integrated water resources management

Water sustainability and integrated water resources management pose challenges for regional water resources planners and managers. The research team continued to develop numerical models and tools for integrated management of regional water resources and to assess climate variability impacts on water availability. The RiverWare model was expanded to simulate river flow and water operation planning within the Rio Grande project area. The model covers three irrigation districts and two cities in the United States and one irrigation district and one city in Mexico. Additional groundwater data were compiled and have been exchanged between U.S. and Mexico partners, which not only helped researchers gain a better understanding of the regional aquifer system, but also enhanced cooperation among partners. The framework and models can be used by federal agencies, irrigation districts, and water utilities to develop guidelines for optimal water operations and better strategies for water management.

#### Coupling atmospheric modeling with mass-transfer for operational, realtime estimation of Elephant Butte Reservoir (EBR) evaporation

Researchers installed the atmospheric model WRF (Weather Research and Forecasting) on a high performance computer and are analyzing model runs against tower measurements. New Mexico State University's high performance computing (HPC) was quasi-operational from early 2009 until late 2010. Near the end of this period, researchers found that the U.S. Geological Survey land cover map used in the model runs was misplaced by about 3.5 km to the east and 1.5 km to the north. This error was corrected, and researchers were able to modify the land cover map to correspond better to other ground observations.

In the meantime, weather/evaporation flux tower operations were moved from Elephant Butte Reservoir to Caballo Reservoir. Preliminary analysis indicated that using North American Regional Reanalysis (NARR) data for WRF runs did not produce satisfactory results when compared to actual measurements on the ground. Newer versions of the WRF atmospheric model, which were explored for improved results, became available later. However, when researchers ran the model and compared the results with ground-tower measurements, they found the results were not as good as some of the older model runs. Instead, researchers used NAM (North America Model) data. Researchers have also used satellite remote sensing data to learn water temperature at Elephant Butte Reservoir and at Caballo Reservoir for use in determining spatially explicit evaporation over both lakes. The work done in 2010 and 2011 is presented in a final project report. Students continue collecting and analyzing flux data and weather data from research stations at Elephant Butte and Caballo Reservoirs.



## Assessing broad-scale, field-level ET, crop coefficients, economic productivity, and dynamics of depletion in New Mexico's Mesilla Valley

This project tried to quantify total consumptive water use such as evapotranspiration (ET) and depletion for all major crops in the Mesilla Valley. The results for pecans were published in *Irrigation Science* in 2009. In addition, research was completed for alfalfa and cotton. A journal article is currently in review for the alfalfa results. Results have also been published in a New Mexico Water Resources Research Institute technical report.

Research continues to predict changes in total consumptive water use, such as ET and depletion for all major crops in the Mesilla Valley given various scenarios, including changes in cropping patterns, policies, technology, investments, and land use. In 2011, a paper published in the *Natural Resources Journal* dealt with the policy issues and impacts of technical ET results.

Development of crop-specific, real-time, growing season crop coefficients for all major crops in the Mesilla Valley continues. Some results will be or have been published in *Irrigation Science* and in the *Journal of Irrigation and Drainage Engineering*.

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# EFFICIENT IRRIGATION FOR WATER CONSERVATION IN THE RIO GRANDE BASIN

### 2011/2012 PROGRESS AND ACCOMPLISHMENTS









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Produced by AgriLife Communications, The Texas A&M University System

3583-E 07/2012 400 copies