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Higher cotton yields possible with fewer irrigations

No-till and minimum-till mean lower production costs

Joe Bradford has a message, and he is beating a plowshare to get it heard.

The message is that conservation tillage is the best way to farm cotton, corn and grain sorghum. Conservation tillage is a farming practice which leaves the stubble from the previous crop on the surface of the field without plowing or with a minimum of plowing.

Joe Bradford of the Agricultural Research Service stands in a no–till cotton field in Weslaco. Note crop residue in the furrows.

For generations, farmers tilled the soil at least 4 inches deep with plows powered by mules, oxen, or tractors. Conventional wisdom is that plowing broke up the soil in preparation for the next crop.

Today, a cotton farmer using conventional methods might till the soil between 9 and 11 times in a growing season, depending upon rainfall. With conservation tillage, that number would be halved, at a minimum.

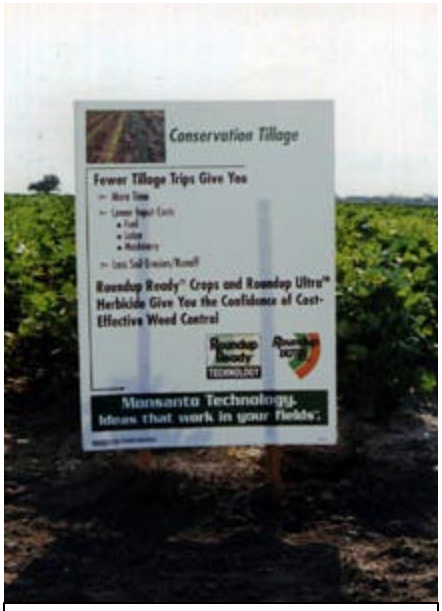
Bradford, a soil scientist, and James Smart, an agronomist, both with the Agricultural Research Service (ARS) of the U.S. Department of Agriculture in Weslaco, said that no-till agriculture, a type of conservation tillage, offers three major advantages.

"First using conservation tillage on cotton can save one irrigation per growing season," said Bradford.

On sandy soil, that could mean a savings of one-half acre-foot of water (162,925 gallons) per irrigated acre, and more savings for clay soils or for long irrigation runs, according to agricultural scientist Neal Namken, who has explored plant soil-water relationships for the ARS and the Texas Agricultural Experiment Station.

One mechanism by which irrigation needs are reduced is that the residue remaining on the field serves as a sort of natural mulch, keeping the soil cooler and preventing evaporation.

"Water is the number one issue in crop production in Corpus Christi, so anything we can do to increase water `harvesting' and use efficiency will help the crops," said John Matocha, a soil scientist at the Texas A&M Agricultural Research and Extension Center in Corpus Christi. "On a sunny, windy day, a field can lose up to 0.3- to 0.4-inch of soil moisture to evaporation. The increased organic residue cover in conservation tillage reduces that loss."



Agricultural chemical manufacturers are promoting conservation tillage, as this sign on SRS Farms in Mercedes shows.

Second is lower production cost. By eliminating one irrigation and the fuel and labor of plowing, a farmer can save $25 to $40 per acre per season in production expenses.

Third, several components of soil health are enhanced by no-till. "The best parameter of soil health is the amount of carbon in the soil. Plowing releases carbon dioxide from the soil," Bradford said.

Organic matter shows a dramatic improvement with no-till. Bradford's research shows that before cultivation began in central Texas, organic matter was about 3.8 percent of soil composition." After years of plowing, however, organic carbon levels dropped to 0.4 percent to 0.8 percent. "Tilling also destroys soil structure. Soil tries to form a natural structure in its profile, but tilling disrupts this process," said Bradford.

In a field test, Bradford found that using no-till, organic matter in the soil doubled in 7 years.

By absorbing energy from the wind and raindrops, the residue also has the effect of decreasing wind erosion of small soil particles and water runoff.

"Our research has shown the mulch cuts down on apparent wind velocity such that under the residue, the soil sees a velocity of zero. I consider no-till the perfect solution to wind erosion," Bradford said.

"After a rain, furrows in conventionally tilled fields see the ponding effect, but in no-till, there is very little ponding, if any," said Bradford.

An interesting process prevents runoff. In a field with no protection, soil particles are splashed up. When they fall back to the ground, the splashed particles have the effect of

bonding and "sealing" the soil so that water cannot penetrate, thus promoting runoff. Residue left on the field absorbs the energy of the raindrop, and fewer particles are splashed up.

The drought of 1998 dramatically demonstrated to Texas farmers another advantage of conservation tillage--increased yields.

"Last year was one of the driest in the 19 years I've been doing this, but we had some of our best yield gain percentages with conservation tillage," said Matocha. "With no-till, we yielded 621 pounds of lint per acre on our test plots last year, compared with 452 pounds for conventional tillage. That's a 37 percent increase. For minimum tillage, we yielded 522 pounds an acre, or 15 percent more."

In agricultural areas where cotton must be terminated by law to prevent boll weevil infestations, farmers pull cotton plants from the soil with a stalk puller or shred the cotton stalk with a shredder.

Weeds present problems in the Lower Rio Grande Valley, where irrigation water is conveyed in open canals which can disperse weed and grass seeds. Also, winters are mild enough in the Lower Rio Grande Valley that weeds in the fields are often not killed by frost. In no-till, weeds are abated with a no-till cultivator or with herbicides.

In a no-till scenario studied by researchers at the Texas A&M Agricultural Research and Extension Center in Corpus Christi, cotton stalks were pulled and shredded after harvest and the regrowth sprayed with herbicide. Before planting, fertilizer was injected into the soil using "narrow-slit" knives.

This stalk puller pulls cotton plants at the end of the growing season. Cotton must be terminated in September to prevent boll weevil infestations.

A minimum-till regime tried by Matocha involved a total of five tillage operations: (1) post-harvest shredding and light disking, (2) root plowing, and formation of low-profile beds in the same operation, (3) knifing in fertilizer, (4) planting, and (5) one cultivation.

Some farmers balk at the use of no-till for fear of propagating harmful pathogens. Bradford has not encountered that problem in the field, and states, "In our research, we don't see the pathogen problem. In fact, cotton under no-till does not exhibit root rot to the extent of conventionally tilled cotton."

Conservation tillage is indicated strongly for dryland agriculture as well. Leaving some residue from the previous crop on the soil surface reduces water lost during a rainfall event by intercepting the falling raindrops to limit the compaction of the soil surface. Moisture loss is held in check by the residue's shading of the soil surface to keep soil

temperatures and evaporation low. The Texas Agricultural Extension Service recommends that the number of tillage operations to prepare the soil for the next crop should be minimized to avoid excessive soil moisture losses. Winter weeds should be controlled in the late fall or early winter months.

"I'm 100 percent convinced we can change this state to conservation tillage, slow as that change may be," said Bradford.

Bradford is a scientist with the U.S. Department of Agriculture Subtropical Agricultural Research Laboratory in Weslaco. He can be reached at (956) 969-4812 or bradford@pop.tamu.edu. Matocha can be reached at (512) 265-9201 or j-matocha@tamu.edu.

The National Conservation Tillage Cotton and Rice Conference will take place January 18-19, 2000 in Tunica, Miss. For more information call (573) 547-7212 or visit http://www.nctd.net/conference/index.html.

El Paso focuses on reclaimed water for turf and landscape irrigation

Seiichi Miyamoto of the Texas Agricultural Experiment Station explains the use of treated wastewater for irrigation at the Hueco Conference Center golf course. In the background can be seen the effect of sprinkler irrigation of treated wastewater on foliage. The tree in the center is in direct contact with the spray, showing salt damage, while the tree on the right is out of direct contact.

El Paso is seizing upon the use of wastewater for irrigation--now, because it's cheaper; later, because there will be no other options.

"It's not a question of an option, this is an imperative," said soil and water resources scientist Seiichi Miyamoto of the Texas Agricultural Experiment Station. "Wastewater will become the standard irrigation water. Eventually El Pasoans won't have another option."

With the Northwest Reclaimed Water Project, El Paso Water Utilities is in the process of installing an entire infrastructure of purple pipes, pumps, backflow prevention devices, and tanks for delivery of reclaimed water to golf courses, parks and athletic fields, and eventually, industrial parks and highway medians, according to David Ornelas, David Ornelas, Water Reclamation and Biosolids Manager of El Paso Water Utilities (*Texas Water Savers*, Fall 1997). The history of the use reclaimed water in El Paso, however, goes back to 1963, when Ascarate Golf Course began pumping in wastewater from the city's central Haskell Street wastewater treatment plant. Now, Ascarate, at 17 million gallons per month, is the city's largest user of reclaimed water.

Reclaimed water is sold for $.48/100 cubic feet ($.64/1000 gallons) , about one-third the rate for potable water sold for irrigation ($1.48/100 cubic feet or $1.97/1000 gallons).

"People need to look at reclaimed as an opportunity instead of as a liability," said Miyamoto.

Salinity is the most critical water quality issue associated with using reclaimed wastewater for landscape irrigation. El Paso potable water has salt in concentrations of about 800 parts per million (ppm), while reclaimed wastewater can be as high as 1,850 ppm.

At a June conference at the Texas A&M Agricultural Research and Extension Center, turfgrass managers shared cultural practices specific to reclaimed water, and scientists discussed issues pertaining to the use of salty and nonpotable water in turf and landscaping plants.

David Ochoa, Wayne Christy, George Flores, all of El Paso Parks, and Guillermo Alarcon, superintendent of Ascarate Golf Course, listen as Raymond Bader, of the Texas Agricultural Extension Service, discusses a field experiment testing the effect of spray irrigation of saline water on foliage of common landscape plants.

"The problem we have now is that many of our landscaping plants, as well as turf, came from freshwater regions. When we try to introduce salty water, we run into problems here and there," said Miyamoto. "As far as turf, Bermuda is very salt-tolerant. I would also like to see some salt-tolerant trees introduced, such as palms, pistache, and mesquite. Palms would do quite well along highway medians."

Although data exist on salt damage due to sprinkler irrigation using reclaimed water on crops and deciduous fruit trees, information on salt-induced foliar damage on landscaping plants was virtually nonexistent.

This spring, the Texas Agricultural Extension Service and Texas Agricultural Experiment Station, under the direction of agents Raymond Bader and John White, conducted an outdoor trial of sprinkler irrigation of 30 ground covers, annuals, shrubs, and trees using three levels of salinity. Results of the field study show varying degrees of tip-burn, margin-burn, and defoliation, with almost all species showing some impairment.

"With this test, we are breaking new ground regarding irrigation with salty water. We will continue to concentrate on plant esthetics other than plant growth," said Bader.

According to Miyamoto, there are two keys to successful irrigation with wastewater--first, proper management, and second, plant selection and soil preparation.

Proper management differs depending upon soil type. If the landscape is developed on well-drained sandy soils using salt-tolerant plants, little or no modification is required. In some cases, salt-sensitive plants may need to be replaced. Some soils may have to be amended to enhance salt-leaching, and sprinkler systems may have to be modified to reduce salt damage to leaves.

In a panel discussion, three golf course superintendents discussed practical management strategies, such use of chlorine for odor, reduced fertilizer need, and solving storage problems.

Soils must be managed to maintain permeability and be irrigated adequately to leach salts and sulfates from the root zone, but not to the extent of causing excessive percolation losses.

On less porous clayey soils, however, or in areas underlain with an impermeable hard pan layer, salts and minerals can build up. Wayne Christy of El Paso Parks has noticed a black layer which develops under anaerobic conditions. The Texas Agricultural Experiment Station has been working with El Paso Parks on possible solutions, including mechanically breaking up the underlying layer.

At the Hueco Conference Center golf course, salt accumulation in high ground might be remedied by aeration to improve water infiltration. Also, two trees at this golf course dramatically demonstrate the deleterious effects of sprinkler irrigation: the tree in direct contact with the spray was almost completely defoliated, while its neighbor, out of direct spray, showed normal foliage.

At El Paso's White Spur Park, Miyamota recommends that a high saline water table and high soil salinity in the silty loam be treated with soil profile modification, sand topdressing, gypsum application and vertical drains.

Perched in the slopes of the Franklin Mountains, Coronado Country Club was the last nonmilitary golf course in the city to receive reclaimed water, and its steep slopes and gravelly soils presented special challenges. One problem, wettability, was solved through the use of a wetting agent. The slopes were also top-dressed with sand. Subsoiling to improve root penetration eliminated localized salt spots.

In an afternoon session, Joe Chwirka of CH2M Hill displayed a quotation from the Minnesota Ecological and Social Policies Council which could well be the essence of water use in the next millennium: "No higher quality water, unless there is a surplus of it, should be used for a purpose that can tolerate a lower grade."

Miyamoto, Bader, and White have prepared a paper entitled "El Paso Guidelines for Landscape Uses of Reclaimed Water with Elevated Salinity." For more information, contact Bader (r-bader@tamu.edu) or White (jm-white@tamu.edu) at the Agricultural Extension Service at (915) 859-7725.

Permian Basin reps share conservation vision

With the vision that has characterized water planning in the Permian Basin since its first reuse project in 1956, leaders in Ector and Midland counties and the cities of Odessa, Midland, and Big Spring have joined forces with a host of state agencies and volunteer groups to form a water conservation task force.

The task force first canvassed participants, including representatives of Master Gardeners, the Colorado River Municipal Water District, county commissioners, Texas Agricultural Extension Service, Habitat for Humanity, and Texas Department of Transportation, to determine concerns and then to get a feel for the amount of water available, said Deborah Benge Frost, Ector County Horticultural Extension Agent.

Next, the group identified five critical issues, and of those, culled out two upon which they believed they could have a material impact--public policy and public education. Deciding that issues dealing with rebates, tax breaks, incentive water rates, and fines would be daunting to achieve at this time, the task force decided against pursuing these in the short term.

Education was further broken down into youth education, home landscapes, and professional and commercial outreach to encourage more efficient use of water in commercial landscapes.

"If water becomes critical, landscapes are the first to suffer," said Benge Frost. "If water use is restricted, people will need good examples of water-thrifty landscapes."

Habitat for Humanity, in cooperation with Keep Odessa Beautiful, will install a waterwise landscape at a volunteer-built house in a low-income area. A similar garden is planned for Midland. Betty Lewis, a Master Gardener and member of the Native Plant Society, coordinated this effort.

"With this garden, we hope to reach a segment of the population which does not have the time to learn about planting and maintaining a low-water-use garden. It will be a low-cost garden, to keep it within the means of most families," said Kathleen Fields, chair of the task force. The landscape will become a public demonstration garden.

For the youth education effort, task force members have met with teachers and students to get their input into a new water-related curriculum to replace the Major Rivers curriculum now being taught, before taking the idea to the school district administration.

On the commercial landscape side, Cindy Lanning of Keep Midland Beautiful presented a compiled list of water-conserving tips for commercial landscapes at a meeting of the local apartment owners association. Fields was a featured speaker at a Midland Library brown bag lunch on waterwise landscaping and the use of native plants.

For licensed irrigators, the task force is also arranging to have a continuing education training course focusing on water-use efficiency offered in the local area. Licensed irrigators now have to travel to larger cities in the past to receive the required annual credits.

Web sites carve out virtual information waterways

A liquid voyage on a yellow submarine

A Texas Water Safari in a yellow submarine awaits elementary school students at the web site http://agweek.tamu.edu/agweek99/water/water.html.

Created by the Agricultural Communications Department of the Texas A&M University, this multimedia web site conveys visitors on a virtual tour of high points of the Texas water frontier.

First stop. Bay Friendly Gardening in the Galveston Bay watershed, where visitors learn that pollution, a little at a time, from home lawn and garden fertilizer and pesticide runoff presents one of the largest threats to the health of Galveston Bay. The Galveston Bay watershed extends to the Dallas-Fort Worth Area, and the bay produces 30% of the oyster catch in the United States.

Second stop. The most heavily irrigated farmland in the state--the High Plains. The potential evapotranspiration network assembled by the Texas Agricultural Extension Service gives farmers a scientific basis for knowing when and how much to irrigate to replace moisture lost to soil evaporation and plant transpiration.

Third stop. The Purple Pipes Water Recycling Project in San Antonio, where miles of purple pipes (painted to distinguish them from potable water pipes) deliver wastewater to thirsty lawns, protecting the Edwards Aquifer water supply.

Fourth stop. A virtual visit to Schlitterbahn in New Braunfels on the Comal River, the most popular water park in the country.

After the safari, visitors can send postcards, take a water quiz, work a puzzle, or print a certificate.

TPWD site explains agency's mission in light of Senate Bill 1

The length and breadth of the Texas Parks and Wildlife Department (TPWD) mission in the context of Senate Bill 1 is meticulously organized at http://www.tpwd.state.tx.us/conserve/sb1/index.htm.

Lavishly illustrated with a dramatic array of photographs, maps, line drawings, and charts, this section of the already information-packed TPWD web site fits together the sum of the agency's water-related activities into a whole.

A Senate Bill 1 Primer linked to the General Information page (click within the text list at the top of the page, for there is no catchy image icon for this important link) first excerpts an excellent article, "Troubled Waters," by Larry McKinney, Senior Director of Aquatic Resources. This paper gives the story behind the story on the agency's place in state water planning--assuring instream flows in rivers and freshwater inflows to bays and estuaries. McKinney's paper speaks of Texas' lost and remaining water heritage: existing and extinct springs, the economic impact of bays and estuaries, and the importance of return flows.

Another comprehensive article, "Watershed Legislation," by the Comptroller's Office, deals with some practical aspects of water transfers, the consolidation of water development loans, small community assistance, and the role of TPWD in data collection and dissemination, and formation of groundwater districts.

Complementing McKinney's paper, under Environmental Target Flows, is a chapter-by-chapter summary of the report, *Freshwater Inflows to Bays and Estuaries*, whose two main themes are the effects of freshwater inflows on living and nonliving components of estuarine ecosystems and a methodology for assessing the freshwater inflow needs of Texas bays and estuaries to maintain an ecologically sound environment.

The next two icons also form a natural sequence. First, the Threatened and Endangered Species section, in portable document format (pdf), lists specific Texas aquatic systems supporting listed species. The Rivers and Stream Segments, in addition to data on selected stream segments, contains a paper giving the methodology for analyzing reservoir sites, *A Natural Resource Survey for Proposed Reservoir and Selected Stream Segments in Texas*.

So useful is the 277-page report, *An Analysis of Texas Waterways* that its pdf version is accessible under its own icon and under the Recreation and Economics icon. This comprehensive report analyzes rivers, creeks, and bayous, organized by geographic area.

Horticulture lab recycles irrigation runoff

Tucked into a corner of the Texas A&M University Horticulture Field Lab is a water garden blooming with canna lilies in summer and Louisiana irises in fall and spring. But in addition to serving a visual interest, this garden has a very practical dimension: it is a remediation facility for irrigation runoff.

Nursery and floral crops are among the highest water-using plants grown commercially. In addition, they require large amounts of fertilizer and pesticides to produce a quality product. As a result, there is a large potential for surface and groundwater contamination, along with high water use.

Using a sequence of mechanical and biological treatment techniques, the water remediation facility treats captured water for reuse at the Horticulture Field Lab.

A network of French drains collects all irrigation and storm runoff from about 20,000 square feet of nursery and greenhouse production area. The water first gravity-flows to a 1,000-gallon reservoir situated at the lowest spot of the facility.

Texas A&M University horticulturist Garry McDonald poses amid constructed wetland cells which cleanse irrigation runoff prior to reuse. In the background are two 2,000-gallon storage tanks.

Captured runoff is then pumped to a sedimentation tank, then passes through disk filters to further remove sediment on its way to two 2,000-gallon above-ground tanks. These above-ground tanks sit atop a 4-foot pad, the elevation providing enough head pressure to supply 10 cattle troughs acting as constructed wetland cells, each filled with 2 feet of coarse gravel. The troughs are planted with a variety of aquatic plants to identify those with the greatest ability to take up fertilizer and pesticides.

From the troughs, effluent flows to a separate 1,000-gallon underground holding tank prior to recirculation.

Treated water can be blended with fresh water in the event the biological treatment does not produce an effluent of sufficient quality for irrigation. Salinity is the primary limiting factor in the reuse of irrigation and storm runoff water.

Nitrate, an important plant nutrient source, has the potential to contaminate ground and surface water via uncontrolled runoff. In addition to minimizing runoff, the water remediation facility reduces nitrate in bioreactors using facultative microorganisms.

For more information, contact McDonald at (409) 845-3658 or g-mcdonald@tamu.edu.

San Marcos granted bed-and-banks permit for wastewater

The City of San Marcos may trade 5,500 acre-feet (af) of treated wastewater per year for an equal amount of San Marcos River water, under a controversial bed-and-banks permit issued by the Texas Natural Resource Conservation Commission this spring.

Under the permit, which was fought by the San Marcos River Foundation, the City of San Marcos may use the San Marcos River to transport treated wastewater three miles downstream, then pump an equal amount out of the river at its drinking water treatment plant. Without the permit, San Marcos woul have been forced to build a pipeline to convey the water to the treatment plant.

Opponents from the San Marcos River Foundation contend that the city would merely use the permit request as a means to polish wastewater as it is conveyed downstream. "We see this permit not really as using the streambed for conveyance of water, but an exchange of polluted San Marcos wastewater for extremely clean San Marcos River flow," said attorney Bill Bunch, who represented the Foundation.

San Marcos maintains that since the city's water originates from groundwater, any effluent remains private property when discharged, assuming the city uses the water for the same purposes as stated in the original wastewater discharge permit. In granting the permit, the TNRCC ruled that the city maintains ownership of its wastewater even after discharge into a public waterway.

Attorney Ed McCarthy, representing the city, maintains that this decision by the TNRCC would not set a precedent, due to the fact that the permit application was filed in 1995, before passage of Senate Bill 1.

The San Marcos River Foundation claimed a partial victory, however, because the TNRCC ruling applies to only 5,500 af of the city's 10,000 af annual discharge. The city cannot use the balance of 4,500 af, as that water has historically been used to fulfill water rights of downstream permit holders.

Conferences

Texas Animal Manure Management Conference,, September 9-10, Austin, Contact Saqib Mukhtar, Texas A&M University, (409) 458-1019 or mukhtar@tamu.edu

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Texas Water Reuse Conference, Texas Section, American Water Works Association/Water Environment of Texas, Sept. 17, Austin. Details in progress.

AWWA Water Resources Conference, Sept. 26-29, 1999, Norfolk, Virginia, (303) 347-6195 or rharmon@awwa.org.

Texas Water: 2000 and Beyond, Sept. 30-Oct. 2, College Station. View preliminary program at http://www.tamiu.edu/water2000. For more information, e-mail Jim Norwine, kfjrn00@tamuk.edu.

National Conservation Tillage Cotton and Rice Conference, January 18-19, 2000, Tunica, Miss. Call (573) 547-7212 or visit http://www.nctd.net/conference/index.html.

Water Reuse Conference, AWWA/Water Environment, Jan. 30-Feb. 2, 2000, San Antonio. Exhibitor prospectus now available, http://www.awwa.org/00reuse/pros/overview.htm

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Texas Water 2000, call for papers, April 4-7, 2000, Adams Mark Hotel, Dallas. See http://www.tawwa.org for more details.

UTEP researcher studies conservation rebates

A researcher at the University of Texas at El Paso is embarking on the second phase of a study to show the effectiveness of a rebate incentive program on conservation by residential public utility customers.

Led by Anthony Tarquin of the University of Texas at El Paso (UTEP) Civil Engineering Department and Robert Moss of UTEP Facilities Services, the project is funded by the U.S. Bureau of Reclamation and UTEP.

The study began in 1998 with 100 volunteers found through a publicity campaign. Those who cut water use by 35 percent during May through August to receive a $250 rebate; those who saved 20 percent, a $100 rebate. The USBR grant, not El Paso Water Utilities, funded the rebates.Comparisons of before and after water use in Fall 1998 indicated the program achieved an overall 15 percent water savings among those who took part.

This year, Tarquin and the study team plan to randomly select candidates from a wide range of water-use behaviors--from as little as 50 gallons per capita per day to more than hundreds of gallons per person daily--to invite for participation in the study. Instead of using self-selected volunteers who may have planned to make changes independent of the rebates, random selection will more likely find customers who were induced to make changes because of the rebate. Rewards for saving water will be based on a sliding scale, in which customers are eligible for rebates only if they save more than 15 percent in the four-month period. In addition, savings of 16 to 30 percent will reward water saving households with $50, while customers who can make $150 if they cut water use by 31 to 45 percent. The greatest incentive, $250, is reserved for those who save more than 45 percent.

"We are finding that people will be very creative at saving water if they know there's a payoff in the end," he said. Many participants saved water by converting lawns to water-wise landscapes. Some people captured evaporative cooler bleedoff. Others reported storing cold water which was running while they waited for hot water heaters to warm up.

Anai Padilla (left), EPWU Conservation Director, while interested to see if the water rebates effect long-term behavioral change as opposed to an incentive-induced temporary effort of extraordinary measures to qualify for the rebate. For instance, Padilla worried that a customer might forego outdoor irrigation to allow the landscape to die, only to later request a 30-day new-landscape waiver from watering restrictions.

To address this concern, Tarquin will ask the cooperation of EPWU to provide data from individual test and control group water bills on water use before, during, and for four months follwing the study to learn if the savings are transitory or permanent.

Tarquin hopes that this project can be helpful for EPWU and other utilities when they contemplate rate-setting strategies. The research may also yield new insights into how today's consumers respond to the use of financial incentives as part of education programs.

Tarquin also plans to study the quality and quantity of El Paso evaporative cooler bleedoff water discharge, also under a USBR grant. Evaporative coolers sometime use a bleedoff system to prevent salt and mineral buildup on cooler parts by dumping some of the recirculating water, similar to the operation of cooling tower, which wastes a portion of recirculating water as blowdown. An earlier study in Arizona showed that coolers with bleedoff systems used an average of nearly 50 percent more total water than those without. On the average, evaporative coolers of all types account of an average of 15 percent of household water use in arid climates.

Houston publishes Waterwise guide

Guide espouses WaterWise Council principles, promotes partners

Houston and other Gulf Coast gardeners will find an easy-to-use, wide-ranging publication a boon to waterwise gardening. The City of Houston Water Conservation Branch covers a wide array of water-thrifty gardening practices in *Water Wise Landscaping: Houston Guide,* a manual for home gardeners in the Gulf Coast area.

Drawing from WaterWise Council information, among others, the guide introduces the principles of waterwise gardening, landscape design, hydrozoning (grouping plants of similar water requirements), and the seven Xeriscape principles.

Lawn care is addressed by "10 Simple Waterwise Steps to Ecological Lawn Care," a common-sense course of water-use efficiency and cultural methods yielding best results for the lawn with efficient water use.

The guide dispels the notion that a waterwise landscape is "a brown, dusty landscape of desert castoffs," but rather introduces the principles of water-efficient landscaping and maintenance in a region receiving 40 to 50 inches of rain annually. Included is a selected plant list specific to Houston adapted from a list of landscaping plants compiled by the Texas Agricultural Extension Service, organized by plant size, from vines to flowers to trees.

Consumers will find the best management practices (BMPs) for irrigation design particularly useful when arranging for the construction of a home irrigation system. It is a goal of the WaterWise Council that consumer awareness will drive the demand for professional efficient irrigation system design. Since up to 60 percent of summer residential water use goes to the landscape, efficient system design will enhance urban water conservation.

The guide also lists WaterWise Partners, Houston-area businesses who subscribe to waterwise principles and who have completed a training course developed by the Texas WaterWise Council. The City of Houston itself is an active member of the WaterWise Council.

To obtain a copy of the manual, contact Jane Kelso at the City of Houston at (713) 837-0421 or jkelso@pwe.ci.houston.tx.us.