2013 Annual Report

Agricultural Water Conservation Demonstration Initiative

February 16, 2013 – February 15, 2014

submitted to the Texas Water Development Board

by Harlingen Irrigation District, Cameron County No. 1

Water-saving surge valves ready for distribution through the Surge Valve Cooperative

photos and graphics by WaterPR

August 14, 2014

Cameron Turner
Team Lead, Agricultural Water Conservation Programs
Texas Water Development Board
1700 N. Congress Ave.
Austin, TX 78711

Re: TWDB Contract #2005-358-013

Dear Cameron:

The Harlingen Irrigation District, Cameron County No. 1, is pleased to submit the final Annual Report of activities and achievements associated with our Agricultural Water Conservation Demonstration Initiative grant for the period February 16, 2013 – February 15, 2014.

This report addresses comments by Texas Water Development Board staff on the draft of June 2, 2014. Included with this report is a compact disc containing high-resolution, ready to print files of all education and outreach materials produced during the 2013 report period.

In FY 2013, the District and our ADI project partners have moved the Texas Project for Ag Water Efficiency into implementation mode. Previous years of the project focused on the critical groundwork: (1) **research** to identify potential strategies and techniques for enhancing ag water efficiency in the Lower Rio Grande Valley, and (2) **in-field, practical demonstrations** of techniques that showed the most promise to meet our specific regional conditions.

In last year's annual report, we highlighted Texas AWE's new focus on outreach and education—getting the word out to producers as well as other groups similarly focused on water issues in the Valley. Since then, we have achieved some notable successes in teaming up with new partners to leverage resources and put into practice— on-farm and in-district—proven water efficiencies.

We have continued to crunch the numbers and discerned new data showing the positive economic impacts of water efficiency measures. Ultimately, the research, demonstrations, and economic analyses clearly show it makes both dollars and sense for the ag community to adopt conservation strategies.

As dry conditions continue, the results from Texas AWE become more valuable and vital.

Very best regards,

Tom McLemore
Project Manager
Harlingen Irrigation District
301 E. Pierce Ave.
Harlingen, TX 78550

HARLINGEN
IRRIGATION DISTRICT
Delivering Water Since 1914.

Foreword: A Message from the General Manager

The Texas Project for Ag Water Efficiency has earned significant attention for the excellent tools we've developed for districts and producers. This project is now recognized as playing an important leadership role in the Lone Star State's critical efforts to assist agriculture with efficient practices in water conservation.

Texas AWE has an excellent facility at its Rio Grande Center and, as this *2013 Annual Report* documents, an outstanding track record in demonstrating and providing training in workable solutions for agricultural water conservation.

One of the challenges to implementing water-conservation concepts and utilizing water-efficient tools has been the traditional low cost of water, which often does not justify the expense of the changes in operation required. However, prolonged drought is making an impression on producers as well as state leadership. Simultaneously, predictions of overwhelming population growth in Texas, coupled with water shortages, force water managers to be more progressive and accepting of water use efficiency measures.

Ag water efficiency is critical, not only for the Rio Grande Valley, but also for Texas as a whole. As we tell the good news of Texas AWE accomplishments in its final year of funding, we must also emphasize to policy makers the real necessity of finding a sustainable mechanism for converting the status quo to new and better ways of adding water to one of our state's most valuable economic engines.

Sincerely,

Wayne Halbert
General Manager
Harlingen Irrigation District
301 E. Pierce Ave.
Harlingen, TX 78550

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IRRIGATION DISTRICT
Delivering Water Since 1914.

Table of Contents

TEXAS AWE 2013: OVERVIEW & OBSERVATIONS

In 2013, the extreme and exceptional drought that had gripped the Lower Rio Grande Valley for the previous two years was finally abated somewhat by autumn rains, validating once again the time-honored saying that Texas weather – particularly in the arid western and southern regions of the state – is best characterized as "prolonged drought interrupted by periodic flooding events."

The National Weather Service Station in Brownsville summarized 2013 in the Lower Rio Grande Valley (LRGV) as "The Year of Increasing Drought Relief," with "worsening drought early, welcome rain and cooler temperatures late." Nevertheless, despite the region's "water emergency [being] averted by autumn rains . . . local crises continued." *(Annual Weather Capsule for 2013 for the Rio Grande Valley,* accessible at www.srh.noaa.gov/bro/?n=2013event_annualsummary)

For agricultural producers in the Valley, "the 2013 crop year will be remembered for water shortages and restrictions," reported Texas A&M specialists working with the Texas Project for Ag Water Efficiency. And they don't expect much – if any – improvement in the future.

> "The availability of water to fulfill urban and agricultural needs in the LRGV will continue to be issues in the foreseeable future. Irrigation conservation and efficient use of available water supplies will likely become more and more important, even after drought conditions are alleviated."
>
> (*FARM Assistance Focus* 2013-4, Dec. 2013)

Because of growing demands in Mexico, where upstream reservoirs are holding back inflows into the Rio Grande, and from non-agricultural uses in the Valley, more efficient delivery of agricultural water to farms and more precise application on crops continues to be imperative.

Now, thanks to nine years of funding from the Texas Water Development Board, intensive research by Texas A&M partners, and significant cooperation from area growers, the Texas Project for Ag Water Efficiency can point with certainty to some simple, easy, and economical tools and strategies for achieving these two imperatives.

FROM DEMONSTRATIONS TO IMPLEMENTATION

In 2013 — the penultimate year of funding for this Agricultural Water Conservation Demonstration Initiative — the Texas Project for Ag Water Efficiency took decisive actions to promote more efficient delivery of agricultural water to farms and more precise application on crops. This was a transitional year, building on previous accomplishments from demonstrations and economic analysis and making significant achievements in transferring to the field findings from previous research. These achievements came from the concerted actions of the entire Texas AWE team to (1) disseminate facts about and processes for water-efficient irrigation, (2) leverage resources, and (3) build partnerships to establish agricultural water conservation habits and technologies throughout the Lower Rio Grande Valley.

Among the 2013 highlights:

- Texas AWE demonstrations of on-farm irrigation efficiencies conclusively show that tens of thousands of acre-feet of agricultural water in the Lower Rio Grande Valley could be saved with easy modifications to traditional flood and furrow flood techniques. For example, converting all 28,000 acres of citrus groves in the Lower Valley from traditional large pan flood irrigation to narrow border flood would conserve some 37,000 acre-feet of water annually.
- Updated and expanded economic analyses of surge irrigation in row crops and narrow border flood in citrus confirm these practices to be not only water-efficient, but also economically sound for producers.
- New demonstrations at Texas A&M–Kingsville Citrus Center show that narrow border flood techniques can be enhanced to further reduce water consumption in citrus irrigation and maintain crop yield even under significant drought conditions.
- Texas AWE activities are successfully leveraged to draw down federal funding totaling $388,000 for activities focused on expanding water-efficient irrigation in the Lower Valley. One example: the Surge Valve Cooperative, which is providing surge valves to growers at a deeply discounted price along with training in their use.
- The Rio Grande Center for Ag Water Efficiency sets a new record for meter-calibration and other related services, including surge valve workshops and flow meter training, while interest grows in its unique capabilities to develop open channel control mechanisms and test and evaluate meters in a real time environment.
- Also at the Center, a new weather station is installed, expanding the on-line South Texas Weather Network sponsored by the local Texas A&M AgriLife Research Center with the aim of providing growers with information to help determine evapotranspiration rates for their crops.
- Harlingen Irrigation District’s achievements with Texas AWE are honored with a Blue Legacy Award for Agriculture by the Water Conservation Advisory Council, which cites the District’s leadership in conservation outreach and exemplary use of cutting edge technologies in water conservation.

After a decade of work, Texas AWE has amassed incontrovertible data on the best means of conserving ag water in the Lower Valley. The vision of what is achievable in terms of agricultural water conservation in the Lower Rio Grande Valley has crystallized:

- using new, low-cost technology, surface water irrigation districts can achieve significant improvements in water management and substantially reduce water conveyance losses;
- making simple modifications to decades-old field and furrow flood irrigation, ag producers can accurately target water delivery to crops and achieve high yields even in drought conditions.

In 2013, Texas AWE developed important partnerships and leveraged resources to promote broad based implementation of these water efficient practices, trained a cadre of experienced cooperators increasingly eager to share their stories, and generated interest among districts in the benefits of metering. An ongoing campaign to promote water-efficient irrigation practices in the Lower Rio Grande Valley is positioned for success.

2014 & BEYOND: OPPORTUNITIES FOR SUCCESS

Throughout 2014, Texas AWE will continue on this campaign trail, promoting ag water efficiency and supporting projects that implement water-saving techniques in agriculture. One important task for this ultimate year of funding is packaging into easily accessible formats all the information accumulated and analyzed. The goal is to continue to inspire water conservation efforts beyond the life of the project.

The Texas AWE website is configured as an on-line one-stop resource for districts and growers on the specific, concrete steps for implementing the strategies identified. The initial video collection developed in 2012 will be augmented with new additions focused on surge and narrow border flood as two of the most effective and economical ways to conserve water in the Lower Rio Grande Valley. All data and publications by project partners also will be assembled into a concise "go-to" primer of efficient water use and water delivery tools in surface water irrigation systems.

Without additional funding, however, Texas AWE cannot continue to actively support new water conservation efforts now developing as a result of the project's success in building partnerships and leveraging resources. One critical example: the surge subsidies provided by the Surge Valve Coop are funded through 2015, but not the outreach, training, and data collection support provided by Texas AWE. The opportunity to put surge valves in the hands of properly trained growers so that they can instantly and significantly reduce their water use should not be lost.

New opportunities also are arising for training and technical assistance at the Rio Grande Center for Ag Water Efficiency. The Center witnessed considerable action in 2013: surge valve workshops for participants in the SVC, flow meter training for the Texas Commission on Environmental Quality, meter calibration for several irrigation districts in the Valley, and requests from district managers and water meter companies for help in providing training on meters and in developing new meters. News about the unique capabilities of the Center has spread.

As detailed in succeeding sections of this report, the proven potential for water conservation in the Lower Rio Grande Valley is huge. Achieving that potential, however, requires ongoing outreach, training, education, and partnership building. Dry conditions are predicted to continue; Texas AWE is ready.

Section 1: Executive Summary

In 2013, the Texas Project for Ag Water Efficiency took decisive actions to realize the dual imperatives of more efficient delivery of agricultural water to farms and more precise application of irrigation water on crops.

In the penultimate year of funding for this Agricultural Water Conservation Demonstration Initiative, Texas AWE made significant achievements in transferring its previous demonstrations and technical analyses to the field. These achievements came from the concerted actions of the entire Texas AWE team to (1) disseminate facts about and processes for water-efficient irrigation, (2) leverage resources, and (3) build partnerships to establish agricultural water conservation habits and technologies throughout the Lower Rio Grande Valley.

Highlights include:

- Texas AWE demonstrations of on-farm irrigation efficiencies show that tens of thousands of acre-feet of water could be saved with easy modifications to traditional flood and furrow flood techniques. Some 37,000 acre-feet of water could be saved annually if all 28,000 acres of citrus groves in the Lower Valley were converted from traditional large pan flood irrigation to narrow border flood.

- Updated and expanded economic analyses of surge irrigation in row crops and narrow border flood in citrus confirm these practices to be not only water-efficient but also economically sound for producers, generating high-quality yields and, thus, higher net cash farm income.

- New demonstrations at Texas A&M–Kingsville Citrus Center show that narrow border flood techniques can be enhanced to further reduce water consumption in citrus irrigation and maintain crop yield even under significant drought conditions.

- Texas AWE activities are successfully leveraged to draw down federal funds totaling $388,000 for activities focused on expanding water-efficient irrigation in the Lower Valley. Texas A&M AgriLife Research and Extension Center at Weslaco receives a $233,000 Conservation Innovation Grant to develop guidelines for managing irrigation under drought conditions and computer programs for linking weather stations with irrigation scheduling. Additionally, the Rio Grande Regional Water Authority is awarded a $155,000 U.S. Bureau of Reclamation WaterSMART grant to heavily subsidize the cost of surge valves and controllers for producers growing row crops in the Lower Rio Grande Valley.

- The Rio Grande Center for Ag Water Efficiency sets a new record for meter-calibration and related services. Also at the Center, a new weather station is installed, expanding the on-line South Texas Weather Network sponsored by the Texas A&M AgriLife Research Center District 12 Office with the aim of providing growers with information to help determine evapotranspiration rates for their crops.

- Harlingen Irrigation District's achievements with Texas AWE are honored with a Blue Legacy Award for Agriculture by the Water Conservation Advisory Council, which cites the District's leadership in conservation outreach and exemplary use of cutting edge technologies in water conservation.

Details follow.

2013 WATER SAVINGS: PROVING THE POTENTIAL IN-DISTRICT & ON-FARM

In 2013, the Harlingen Irrigation District pumped a total of 48,667 acre-feet (AF) of agricultural water and delivered it to 78,084 surface acres of cropland. This equates to an average of 0.55 AF of water pumped per surface acre irrigated, with a 10-15 percent loss to the system. This very low loss ratio is due in large part to the efficiencies provided by the telemetry and canal automation improvements undertaken by the District over the course of the ADI project. Besides these continued efficiencies in moving water from the river to the farm, the improvements also have reduced the expenses and staff-hours required to manage the canal system.

HID also made improvements to its water-accounting processes in 2013 using geographic information system (GIS) technology, as discussed below.

Meanwhile, on-farm demonstrations continued to verify that easy modifications to traditional irrigation techniques in the Lower Rio Grande Valley could save tens of thousands of acre-feet of water per year if adopted region-wide.

Chief among these are: (1) surge irrigation for cotton, corn, sugarcane, and other row crops. and (2) narrow border flood for citrus and other grove crops.

Surge Irrigation

In 2013, Texas AWE researchers managed a 31-acre surge demonstration site planted in sugar cane. The site was irrigated four times, using an average of 0.2 AF per irrigation, for a total volume of 30 AF of water applied. If traditional furrow flood irrigation instead had been applied to the same site with the same crop under comparable weather conditions, the amount of water used would have totaled 68.82 AF, 56 percent more water than with surge. (See Exhibit 1.1 below.) Such efficiency means that considerable water savings are achievable even with only a modest increase in the use of surge valves in the Lower Rio Grande Valley.

Texas AWE has discontinued the surge demonstration site for 2014. However, data are being collected on water savings being realized by growers participating in the Surge Valve Cooperative (described more fully below). So far, the Coop has distributed 28 surge valves, each of which is capable of irrigating 50 acres at a time. Based on average irrigation amounts for furrow flood irrigation in the Harlingen Irrigation District, compared to actual irrigation amounts on the surge demonstration site, each valve will potentially save 17.75 AF of water per irrigation. The 28 valves now in operation are projected to save a total of almost 497 AF per irrigation.

Exhibit 1.1: Water Savings from Modifying Traditional Furrow Flood Irrigation with Surge

Irrigation Method	Acres Irrigated	Number of Irrigations	Water Applied			Total Savings (AF)
			Per Irrigation (inches)	Total (inches)	Total (AF)	
Traditional Furrow Flood	31	4	6.66	825.84	68.82	-
Surge Irrigation	31	4	**2.40**	**360.00**	**30.00**	**38.82**

Narrow Border Flood

In 2013, Texas AWE managed a number of citrus demonstration sites, comparing traditional large-pan flood to the more efficient narrow border flood, dual-line drip, and micro-jet spray. Combined, the alternatives techniques saved some 170 AF of water over traditional flood. As shown in Exhibit 1.2, the biggest savings came from narrow border flood, demonstrated to use 16 inches less water per growing season than traditional flood.

The citrus industry in the Lower Rio Grande Valley encompasses 28,000 acres. Applying narrow border flood to the entire 28,000 acres under citrus production in the region would save more than 37,000 acre-feet of water per year. Although Texas AWE will continue to maintain four citrus demonstration sites through the end of the project, the data clearly show it’s time to move past demonstrations into implementation.

Exhibit 1.2: Water Savings from Modifying Traditional Flood Irrigation with Efficient Alternatives					
Irrigation Method (with Total Acreage of Demonstration Sites)	**Water Applied** (average inches/ac)	**Demonstrated Water Savings**			**Potential Savings Valleywide (AF)**
		Inches/Acre	**AF/Acre**	**Total (AF)**	
Traditional Flood (105 ac)	48.0	-	-	-	-
Narrow Border Flood (108 ac)	**32.0**	**16**	**1.33**	**143.6**	**37,240**
Dual-Line Drip (16.6 ac)	41.0	7	0.58	9.6	16,240
Micro-jet Sprinkler Spray (15.5 ac)	35.0	13	1.08	16.7	30,240
All data from 2013 harvest season. Water Savings = (inches applied with Traditional Flood) – (inches applied in alternate methods). Acre-Feet/Acre = inches/acre ÷ 12.					

ALTERNATE IRRIGATION MANAGEMENT STRATEGIES: ECONOMICS & EFFICIENCIES

In 2013, Texas A&M agricultural economist and Texas AWE team member Mac Young reviewed eight years of Texas AWE data on surge and narrow border flood irrigation. While previous studies had unequivocally demonstrated that these techniques use substantially less water than flood irrigation, the new analyses confirmed that they also maintain the *quantity* of yields in field crops and citrus and improve yield *quality* in citrus, meaning higher net cash farm income (NCFI) for producers.

The analyses show that these easy adaptations to furrow/flood irrigation methods can result in significant financial gains, especially under conditions of high water prices. NCFI increased 56 percent with surge irrigation in cotton and 68 percent with border flood in citrus. Following are summaries of the evaluations; the full texts of the analyses are presented in Appendix A of this report.

- "Average cash costs were lower for surge under current in-district and out-of-district purchased water pricing scenarios. Using average net cash farm income (NCFI) as a criterion, surge is more profitable than furrow." *Water Savings and Higher Profit Margins Possible in Cotton and Other Field Crops in the Lower Rio Grande Valley,* FARM Assistance Focus 2013-4, Dec. 2013.

- For sugar cane, "the additional cost of a surge valve is covered by the water cost savings from using less water . . . [the] NCFI advantage under surge over furrow improves significantly as the price for irrigation water increases." *Furrow vs. Surge Irrigation in*

Sugar Cane under Restricted Water Availability in the Lower Rio Grande Valley, FARM Assistance Focus 2013-1, May 2013.

- "Border flood's advantage over conventional flood is largely reflective of higher average annual yields (21.2 tons/acre for border flood and 18.9 tons/acre for flood) and higher average fresh pack-out." *Increased Water Use Efficiency and Profitability in Citrus Production Possible in the Lower Rio Grande Valley,* FARM Assistance Focus 2013-5, Dec. 2013.

Surge in Sugarcane & Cotton Ups Profits, Farm Income

In FARM Assistance Focus 2013-4, Young evaluated data on the amount and cost of water used plus expenses for labor and equipment required for furrow and surge in irrigated cotton, using actual 2013 water pricing scenarios in the Lower Rio Grande Valley.

- "in-district" pricing (meaning the grower owns the water rights) at $18 per acre-foot (AF), or $1.50 per acre-inch; and
- "out-of-district" pricing (where water is purchased from another district or grower owning the water rights) at $37/AF with 15 percent water loss and a $18/AF pumping charge, or $5.40 per acre-inch.

As shown in Exhibit 1.3 following, the analysis found that despite a $2,000 price tag for a surge valve, under both scenarios, "the additional cost of a surge valve is covered by the water cost savings from using less water." Furthermore, "the NCFI advantage of surge over furrow improves significantly as the price for irrigation water increases," a situation becoming increasingly more common due to drought and reduced inflows into the Rio Grande. Under this scenario, surge irrigation produces a 10-year average cash flow of $363 per acre, 56 percent higher than furrow.

An earlier analysis of surge in sugar cane (FARM Assistance Focus 2013-1) also found economic incentives for using surge in sugar cane, even with a lower in-district water price of $1.32 per acre-inch. Ten-year average financial indicators showed surge with a three percent NCFI advantage, even with the lower in-district price of water. With out-of-district prices, the advantage increased to almost 19 percent.

Exhibit 1.3: Surge Beats Furrow in Cotton; Lower Costs, Higher Cash Flow				
	In-District Water* ($1.50/ac-in)		Out-of-District Water* ($5.40/ac-in)	
Costs per Acre per Year	**Furrow**	**Surge**	**Furrow**	**Surge**
Water	$27.00	$21.00	$97.20	$75.60
Polypipe & Labor	37.00	37.00	37.00	37.00
Surge Valve (over 10 yrs)	-	5.13	-	5.13
TOTAL COSTS/ACRE	**$64.00**	***$63.13***	**$134.20**	***$117.73***
10-Year Average Financial Indicators	**Furrow**	**Surge**	**Furrow**	**Surge**
Total Cash Receipts/Acre	$1,024	$1,024	$1,024	$1,024
Total Cash Costs/Acre	892	891	985	963
Net Cash Farm Income/Acre	132	133	39	61
Cumulative 10-Yr Cash Flow/Acre	**$1,368**	**$1,382**	**$252**	**$363**
Cumulative 10-Yr Cash Gain/Acre	**-**	***$14***	**-**	***$111***

*Based on actual 2013 water-pricing scenarios in the Lower Rio Grande Valley: *"In-District"* = grower owns the water rights at $18/AF; *"Out-of-District"* = grower acquires water from another district at $37/AF with 15% water loss plus $18/AF pumping charge.
Source: *Water Savings and Higher Profit Margins Possible in Cotton and Other Field Crops in the Lower Rio Grande Valley*, FARM Assistance Focus 2013-4, December 2013; Department of Agricultural Economics, Texas A&M AgriLife Extension, Texas A&M University System.

Border Flood in Citrus Improves Pack-Out, Raises NCFI

Adapting traditional flood irrigation in citrus to "narrow border flood" (NBF) substantially improves pack-out percentages and yields and thus net cash farm income, according to Young's analysis of data collected for Texas AWE by Dr. Shad Nelson and Dr. Juan Enciso over eight growing seasons for Ruby Red grapefruit production (FARM Assistance Focus 2013-5).

In narrow border flood, raised berms channel water faster down rows and underneath the tree canopy. Because NBF irrigation applies water at a faster rate, it more adequately targets the root zone of the trees and retains fertilizer within that target zone. The result is higher yields of better quality, substantially enhancing net cash farm income (NCFI). Narrow border flood uses one-third less water than traditional large-pan flood irrigation and requires minimal investment in equipment.

As indicated in Exhibit 1.4 following, the data conclusively show that NBF irrigation produces the highest net cash farm income for citrus growers in the Lower Rio Grande Valley. Young's analysis puts the projected 10-year average annual NCFI for border flood at $1,360/acre, almost 68 percent higher than the projected NCFI for flood irrigation.

Exhibit 1.4: Border Flood Irrigation Produces Highest NCFI for Ruby Red Grapefruit					
Irrigation Method	Pack-Out Scenario	10-Year Averages per Acre			Cumulative 10-Yr Cash Flow/Ac
		Total Cash Receipts	Total Cash Costs	Net Cash Farm Income	
Flood	High	$3,330	$2,200	$1,130	$12,040
	Average	3,010	2,200	810	8,550
	Low	2,600	2,200	400	4,220
NBF	High	$3,970	$2,160	$1,810	**$19,180**
	Average	3,530	2,160	1,360	**14,460**
	Low	3,440	2,160	1,280	**13,560**
Drip	High	$3,520	$2,280	$1,240	$13,170
	Average	3,350	2,280	1,070	11,360
	Low	3,160	2,280	880	9,330
Micro-jet	High	$3,650	$2,310	$1,330	$14,160
	Average	3,600	2,310	1,290	13,700
	Low	3,390	2,310	1,080	11,490

Crop prices calculated from actual 2005-2012 net prices received by collaborators, adjusted for harvest, packing, and commission charges: $285.80/ton for fancy; $99.52/ton for choice; $5.44/ton for juice.
Source: *Increased Water Use Efficiency and Profitability in Citrus Production in the Lower Rio Grande Valley*, FARM Assistance Focus 2013-5, December 2013; Department of Agricultural Economics, Texas A&M AgriLife Extension, Texas A&M University System.

With narrow border flood, net cash farm income is higher than drip, by more than 27 percent, and higher than micro-jet, by more than 5 percent.

According to Young's analysis, narrow border flood's cash advantage over flood comes from its higher yields and fresh pack-out ratios; its advantage over drip and micro-jet are due to lower equipment costs.

The three economic analyses are provided in Appendix A to this report. The reports reflect results of the economic analyses completed by FARM Assistance specialists in 2013 for four AWE cooperators involving three whole-farm and 13 demonstration sites. Those specific results are presented in Section 5 of this report.

Citrus Center Refines Proven Strategies to Achieve Further Water Savings

Building on demonstrated successes in citrus irrigation, Dr. Shad Nelson and the Citrus Center focused in 2013 on establishing new field sites to demonstrate strategies and technologies for further reducing water use while maintaining fruit yield, quality, and shape under drought and other water stress conditions.

Impressive results already are evident with “partial root-zone drying” (PRD). In partial root-zone drying, irrigation occurs one week on one side of selected trees and on the other side the following week. Alternating irrigations so that only one half of the tree is irrigated at a time creates conditions of water stress. The roots sense these conditions, causing the tree to respond with increased stomatal closure, thus reducing transpiration. First-year data from the new PRD site show up to 40 percent water savings compared to conventional dual-line drip and micro-jet sprinkler spray irrigation system configurations used in citrus grove practices without compromising fruit yield and quality.

The Center also set up a new site that will be used to demonstrate variations on narrow border flood irrigation, including “trench furrow flood” (TFF). This practices entails cutting a trench on each side of the tree along the outer drip line of the tree in order to even more precisely direct the irrigation. Water runs down the length of the trench to the end of the row until the trench is full of water and then percolates into the soil from the trench.

Groves of mature trees accustomed to being flood irrigated may be more readily adaptable to trench furrow flood. In mature groves, changing from traditional flood to narrow border flood irrigation can be stressful on tree roots that reside near the drip line of the outer tree canopy.

As the field site is fully established in 2014, a variety of irrigation options will be evaluated, including a partial root-zone drying scenario in which irrigations are alternated between the trench on one side of the tree and the trench on the other.

Full details on these and other Citrus Center projects are provided in Section 4 of this report.

LEVERAGING RESOURCES TO IMPLEMENT NEW IRRIGATION EFFICIENCY PROJECTS

In FY 2013, Texas AWE moved beyond demonstrations and analyses toward implementation by leveraging its resources to support other regional projects focused on agricultural water conservation. Texas AWE activities have helped attract federal funding for two major projects aimed at implementing results of demonstration studies:

- The U.S. Department of Agriculture–Natural Resources Conservation Service awarded a $232,552 grant for “Developing Irrigation Management Strategies Under Drought Conditions in Texas.” The project is led by Texas AWE partners Dr. Juan Enciso with the Texas A&M AgriLife Research and Extension Center in Weslaco and Dr. Shad Nelson with Texas A&M University–Kingsville Citrus Center and has been designed to continue Texas AWE core activities related to irrigation scheduling and management.

The project is focused on enhancing mechanisms to guide producers in scheduling irrigations at optimum times and in precise volumes, i.e., when the plants need water and in the amount of water needed. The grant will be used to develop guidelines for managing irrigation under drought conditions and computer programs for linking weather stations with irrigation scheduling.

- The U.S. Bureau of Reclamation awarded a $155,000 WaterSMART grant to the Rio Grande Regional Water Authority (RGRWA) for the Surge Valve Cooperative (SVC), a regional agricultural water conservation effort receiving major support from Texas AWE and its partners. The project is a direct result of Dr. Juan Enciso's research for Texas AWE on the substantial water savings that can be achieved by using surge valves in furrow irrigation.

  SVC is focused on putting surge valves in Valley fields by significantly subsidizing the cost. Participating growers pay only $300 for a valve and controller; in return, they must participate in a half-day training workshop and document their water use with the valves. The information they provide will expand considerably the database on surge valve efficiencies in the Valley collected through the Texas AWE demonstration studies.

These projects are described in greater detail in Section 2 of this report.

SERVICE & OPERATIONAL ENHANCEMENTS AT THE RIO GRANDE CENTER & HID

Enhancements to the in-district component of Texas AWE also continued throughout 2013 with expanded services at the Rio Grande Center for Ag Water Efficiency and within the Harlingen Irrigation District.

The Rio Grande Center saw significant increases in the number and kinds of activities.

- The Center hosted a series of workshops for producers in surge irrigation, in support of the Surge Valve Cooperative. In 2013, participants at Center workshops included personnel from other districts and governmental agencies, such as the Rio Grande Watermaster, Texas Water Development Board, U.S. Bureau of Reclamation, U.S. Department of Agriculture, and Texas State Soil and Water Conservation Board.

- Texas AWE calibrated some 50 meters for three other irrigation districts in the region, installed and repaired meters for two additional districts, repaired meters for two growers, and verified open channel meters in an irrigation district and even one municipal water district.

- The Center provided space for the latest weather station in the online South Texas Weather Network sponsored by Texas A&M AgriLife Research Center District 12. Network data – available at http://southtexasweather.tamu.edu – provide growers across the Valley with a variety of information for more effectively managing irrigation, including a crop evapotranspiration calculator.

Also, as part of its ongoing operational enhancements, the Harlingen Irrigation District continued to expand its use of geographic information system (GIS) technology to better manage the district as a whole, especially its water accounting process. Thanks to the software, canal riders always have up to date information on water orders and canal conditions. This enables them to police water sales throughout the District, ensuring growers are applying water to the correct parcel and buying the proper amount of water for each parcel.

For example, the use of GIS has aided in identifying fraud and inaccuracies in water orders. HID canal riders are provided with new water tickets on an almost daily basis and are able to check the ordered water against the District map to ensure the ordered water is associated correctly with the land (accounts) to which the water is being applied.

In 2013, the District added a new code to its water accounting system so that the riders are alerted to any problems with a water ticket. The ordered acre amount now is compared to the net taxable acreage for the parcel of land. If the amount of water ordered varies from this acreage by more than 10 percent, the accounting software color codes the order. As shown in Exhibit 1.5, green signifies that the order is less than 90 percent of the taxable acreage, while red signifies the order is more than 110 percent.

With this easy tool, the canal rider then can compare the water order to the GIS map and determine the nature of the problem. This capability saves canal riders a considerable amount of time, especially during the busy irrigation season.

Exhibit 1.5: Color-Coded Water Tickets Flag Potential Problems

Canal Rider's Copy Ticket Re-Print

Page 1 of 2

Re-Print 05/28/14 4:30 PM

Property ID/ Owner ID	Property Description/ Owner Name	Delivery/ Crop	Ordered/ Delivered	Rate	Amount
0001-0135-0000-01	ORIGINAL 54.90	Gravity	48.000	9.00	$432.00
006529	Abundant Life Christian	Cotton	54.140	<=PropNet	
0028-0009-0000-02	BRIGGS & COLEMAN E 11.93/W 22.39	Gravity	6.000	9.00	$54.00
001173	Alvarez;Ysrael	Cotton	10.570	<=PropNet	
0045-0007-0000-02	SURVEY 49 E-4.25	Gravity	3.000	9.00	$27.00
001498	Olivarez;Juan	Cotton	4.110	<=PropNet	
0045-0007-0000-02	SURVEY 49 E-4.25	Gravity	1.000	9.00	$9.00
001498	Olivarez;Juan	Cotton	4.110	<=PropNet	
0045-0007-0000-06	SURVEY 49 2.00 Prior Owner: Juan O	Gravity	1.300	9.00	$11.70
007529	Olivarez;James D.	Cotton	2.000	<=PropNet	
0045-0012-0000-01	SURVEY 49 N.W. 5.00	Gravity	4.000	9.00	$36.00
005933	Juarez;Juanita	Cotton	4.850	<=PropNet	
0045-0012-0000-02	SURVEY 49 N.E. 5.00 Pt. Blk 12	Gravity	3.000	9.00	$27.00
005934	Del Rio;Eva	Cotton	4.850	<=PropNet	
0045-0012-0000-04	SURVEY 49 S.E. 5.00	Gravity	5.000	9.00	$45.00
006232	Olivarez;Pamela J.	Cotton			
0045-0013-0000-01	SURVEY 49 N.W. 5.00	Gravity	5.500	9.00	$49.50
005935	Olivarez;Juan Jr.	Cotton	4.900	<=PropNet	
0045-0013-0000-02	SURVEY 49 N.E. 5.00	Gravity	4.000	9.00	$36.00
007778	Castillo;Santos	Cotton	4.670	<=PropNet	
0045-0013-0000-03	SURVEY 49 S.W. 5.00	Gravity	4.000	9.00	$36.00
005936	Garza;Julia	Cotton	4.900	<=PropNet	
0045-0013-0000-04	SURVEY 49 S.E. 5.00	Gravity	4.000	9.00	$36.00
005930	Garcia;Delia O	Cotton	4.680	<=PropNet	
0045-0017-0000-02	SURVEY 49 7.00	Gravity	7.000	9.00	$63.00
000251	Kidd;Comer	Cotton			
0045-0017-0000-04	SURVEY 49 3.50 BLK. 17 SUR. 49	Gravity	3.500	9.00	$31.50
000251	Kidd;Comer	Cotton			
	Page Totals ...		99.300		$893.70

But GIS capabilities mean much more than monitoring and managing current water deliveries. District maps are constantly being updated by HID's GIS tech, allowing for precise accounting of water use.

In 2013, HID used its accounting software to run a report comparing ordered irrigation acres to net taxable acres and found that approximately 30 percent of the taxable acres in the District had not had water ordered on them in the past year. Using the GIS system, HID created a map of those acres, allowing them to visually identify their locations. In most cases, the non-irrigated lands had been taken out of production in recent years and converted to wildlife management areas. However, some were small parcels that had been overlooked when water orders were placed. HID alerted both the growers and the water ticket clerks to the property locations, ensuring correct ordering of water amounts in the future.

Proper accounting of irrigated properties is important in the Rio Grande Valley, especially in a drought. If for some reason the District is forced to allocate water, properties that have not been irrigated in the past two years run the risk of not receiving an allocation. The GIS technology and the maps created based on the District's water accounting data have been very useful in ensuring that all properties located in the District receive the irrigation water to which they are entitled, and that growers do not suffer because of an accounting mistake.

2013 BLUE LEGACY AWARD HONORS HID & TEXAS AWE CONSERVATION EFFORTS

In December 2013, the Harlingen Irrigation District was honored with the Blue Legacy Award for its work on the Texas Project for Ag Water Efficiency. The award is bestowed by the Water Conservation Advisory Council as a way to showcase agricultural producers as effective caretakers of water resources and to honor those groups whose practices enhance conservation of water while maintaining or improving profitability.

The Council cited the District as "a leader in their community for conservation outreach," [spreading] "the news of their successful projects including presentations within the state and around the country. Through information sharing and the careful collection of its own data, the Harlingen Irrigation District – Cameron County No. 1 hopes to continue to develop and be recognized for their cutting edge technologies in water conservation."

With additional funding for Texas AWE, the District can continue the campaign to promote water-efficient irrigation practices in the Lower Rio Grande Valley. As detailed in this report, the potential is huge. Achieving that potential, however, requires ongoing outreach and training and education. After a decade of work, Texas AWE has amassed incontrovertible data, developed important partnerships and leveraged resources for promoting water efficiencies, trained a cadre of experienced cooperators eager to share their stories, and generated interest among districts in the benefits of metering: now is not the time to mothball Texas AWE and cease implementing its proven water conservation strategies. Dry conditions are predicted to continue; Texas AWE is needed, now more than ever.

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Section 2: Leveraging Texas Awe Resources

Juan Enciso, PhD, Texas A&M AgriLife Research and Extension Center, Weslaco
Tom McLemore, Harlingen Irrigation District
Shad D. Nelson, PhD, Texas A&M University-Kingsville, Citrus Center
Linda Fernandez, WaterPR

In 2013, Texas AWE moved beyond demonstrations and analyses toward implementation by leveraging its resources to support other regional projects focused on agricultural water conservation. Texas AWE activities have helped attract federal funding for two major projects aimed at implementing results of demonstration studies: (1) a USDA-NRCS grant for irrigation scheduling and management, and (2) a Bureau of Reclamation grant to put water-saving surge valves to work in Valley fields.

TEXAS A&M GRANT FOR IRRIGATION SCHEDULING TOOLS

The U.S. Department of Agriculture–Natural Resources Conservation Service awarded a $232,552 grant for "Developing Irrigation Management Strategies Under Drought Conditions in Texas." The project is led by Texas AWE partners Dr. Juan Enciso, Texas A&M AgriLife Research and Extension Center in Weslaco, and Dr. Shad Nelson, Texas A&M University–Kingsville Citrus Center. A major goal is to continue Texas AWE core activities related to irrigation scheduling and management.

The project is focused on enhancing mechanisms to guide producers in scheduling irrigations at optimum times and in precise volumes, i.e., when the plants need water and in the amount of water needed. The grant will be used to develop guidelines for managing irrigation under drought conditions and computer programs for linking weather stations with irrigation scheduling.

Important data collection for this work is supported by another grant acquired by Texas A&M University-Kingsville. The "STEP UP to USDA Career Success" grant managed by Dr. Shad Nelson is covering some $45,000 of the cost for the soil moisture sensing equipment as well as funding work on the project by a graduate student pursuing a Master of Plant and Soil Science.

The project components supporting AWE objectives include:

- Developing irrigation guidelines for sugarcane, citrus, corn, cotton, onions, cabbage, and watermelon, as well as for pastures in the Lower Rio Grande Valley. The guidelines will encompass when and how much to water these crops under both full irrigation scenarios and in limited water supply situations. In addition, irrigation priorities will be determined for these crops according to profitability and water use efficiency. This will allow growers in drought situations with reduced irrigations to better allocate available water based on critical crop growing stages.

- Enhancing the existing weather station network to provide an internet-based computer program for efficient irrigation management. The existing network has been expanded from three to five weather stations to provide more site-specific data; new additions in 2013 include stations at the Rio Grande Center for Ag Water Efficiency and in Rio Grande City. The data are accessible at southtexasweather.tamu.edu.

Each weather station has sensors that measure solar radiation, temperature, relative humidity, wind speed and direction, and other factors that correlate to water use in crops; data are reported on an hourly and daily basis. Plans also call for placing throughout the region soil moisture sensors that will use cellular technology to transmit data on real-time monitoring, allowing growers to better determine precise water needs for their crops. Growers can view the information from the sensors using the graphing chart and data provided by Decagon software, or by importing the data into other soil moisture graphing programs, such as the one offered by Irrometer.

New weather station installed May 2013, Rio Grande Center for Ag Water Efficiency.

Field days and workshops for growers will be held on the use of the weather station network and remote soil moisture sensors.

RGRWA GRANT SUBSIDIZES SURGE VALVES

The U.S. Bureau of Reclamation awarded a $155,000 WaterSMART grant to the Surge Valve Cooperative (SVC), a regional agricultural water conservation effort managed by the Rio Grande Regional Water Authority (RGRWA) with major support from Texas AWE and its partners. The project is a direct result of Dr. Juan Enciso's research for Texas AWE on the substantial water savings that can be achieved by using surge valves in furrow irrigation.

The sticking point for widespread adoption of surge has been economic: given the current low cost of water in the Lower Rio Grande Valley, there has been little financial incentive for growers to invest $2,000 in surge valve technology.

With the BOR funding, SVC is significantly subsidizing the cost of each surge valve. Participating growers pay only $300 for a valve and controller; in return, they must participate in a half-day training workshop and document their water use with the valves. The information they provide will expand considerably the database on surge valve efficiencies in the Valley collected through the Texas AWE demonstration studies.

Cooperators also are providing important peer-to-peer information throughout the agricultural community, helping kick-start the broad-scale practice of surge irrigation across the Lower Rio Grande Valley.

As part of the 50/50 match requirements, Texas AWE is providing a range of professional and support services as in-kind support:

- Training and technical assistance from Dr. Juan Enciso, Texas A&M AgriLife Research and Extension Center, Weslaco;
- Administrative services by the Harlingen Irrigation District;
- Workshop facilities at HID's Rio Grande Center for Ag Water Efficiency; and
- Outreach by WaterPR to publicize the program.

In 2013, Texas AWE coordinated and conducted two training workshops for SVC cooperators, on September 17 and 18, at the Rio Grande Center for Ag Water Efficiency.

Left: Cooperators learn to program the surge valve controller.
Below: Dr. Juan Enciso at the November Surge Valve Field Day.

The Surge Valve Coop also has received valuable support and assistance from the Texas A&M AgriLife Research Center in Weslaco, which provided facilities for and promoted two Surge Valve Field Days, on September 13 and November 14. Special thanks go to Extension staff Brad Cowan, Enrique Perez, Dr. Juan Anciso, Ashley Gregory, Rod Santa Ana, and South District Extension Administrator Ruben Saldaña.

Field day activities included live demonstrations of the surge valve presented by Texas AWE research partner Juan Enciso and Tom McLemore, and a grower testimony on practical applications and use of surge valves. Local media coverage of the event – including a KRGV-TV news segment that aired on October 25 – generated additional positive publicity for the Coop.

In 2013, 28 surge valves were provided to 14 growers for use on a variety of crops: cotton, grain sorghum, corn, sugarcane, and vegetables. Additional cooperators have joined in 2014 and Surge Valve Coop activities are continuing through the year.

Cooperators take possession of their new water-saving surge valves following training at the Rio Grande Center for Ag Water Efficiency.

Section 3: Education & Outreach on Texas AWE

Linda Fernandez, Karen Ford, and Johanna Arendt, WaterPR

In 2013, Texas AWE's communications and outreach consultant WaterPR expanded efforts begun the previous year to convey information about project results to ag producers, irrigation districts, relevant commodity groups and governmental agencies, and regional and state policy makers. The goal of all outreach activities has been to promote the easy-to-implement, low-cost water efficiency and conservation strategies for both growers and districts that the project has demonstrated and proven in the field.

Major additions to the outreach and education tool kit included:

- A reformulated attention-grabbing newsletter – the *TexasAWE Reporter* – with updates on Texas AWE findings and related programs and events. The newsletter is produced semiannually and mailed to an extensive list of producers and other interested parties; issues were published in Summer 2013 and Winter 2014.
- A new "on-farm" educational fact sheet (*Narrow Border Flood for Citrus: Saving Water While Improving Yields and Net Cash Farm Income)* and two "in-district" fact sheets (*Automated Irrigation Gates: Maximizing Water Delivery While Reducing Water Loss* and *Telemetry & SCADA: Information Technology Takes Auto-Gates to Next Level of Efficiency)*.
- Closed captioning of all Texas AWE videos produced in FY 2012, making them accessible to a broader audience.

And, of course, all these materials – plus research monographs by Texas AWE partners – are posted to TexasAWE.org along with relevant events, news clips on irrigation technologies, and other pertinent material. Printed copies of the *TexasAWE Reporter* and all fact sheets are distributed at conferences, workshops, and other events.

WaterPR also continues to coordinate Texas AWE exhibit space at relevant events, often staffing booths, and regularly promotes Texas AWE among the media.

But the biggest outreach efforts for Texas AWE in 2013 (and continuing through 2014) involve supporting the new partnerships that have developed to implement Texas AWE objectives. Chief among these is the Surge Valve Cooperative (SVC), which was awarded a U.S. Bureau of Reclamation WaterSMART grant in early FY 2013, as the 2012 Annual Report was submitted. The

Executive Summary of the grant application (written by WaterPR) was included in that report. Details on the implementation of the SVC are provided in Section 2 of this report.

WaterPR regularly posts SVC information to the AWE and RGRWA websites and the AWE Facebook page and has worked with HID to organize SVC training workshops throughout the Valley. Images of the flyer, poster, and infosheet created for the SVC are included in Exhibit 3.1.

Exhibit 3.1 also provides a full overview of education and outreach materials and activities developed during the 2013 grant year based on key outreach strategies designed and executed by WaterPR in partnership with the Harlingen Irrigation District and its Texas A&M partners in Texas AWE.

These partners have co-authored and reviewed fact sheets and newsletters and presented at workshops. They also have undertaken their own outreach and education efforts in the academic realm and in the media, as noted in other sections of this report. WaterPR thanks the entire Texas AWE team as well as the staff of the Harlingen Irrigation District for their invaluable assistance in spreading the good news of Texas AWE.

This exhibit is intended to provide only an at-a-glance summary of outreach activities; a compact disc of high-resolution files for all education and outreach materials developed in FY 2013 is included with this report.

Exhibit 3.1: Education & Outreach Activities & Results

NOTE: A compact disc enclosed with this Annual Report provides high-resolution files for all education and outreach materials developed in FY 2013, including those featured in this exhibit.

COMMUNICATION TOOLS & MATERIALS

Texas AWE Reporter newsletter launched in 2013 to provide updates on Texas AWE findings, promote conservation programs and events for producers, report on project news, and allow producers to share their experiences with water conservation practices. Issues were published in Summer 2013 and Winter 2014.

Volume 1, Issue 1 Summer 2013

TEXAS AWE REPORTER

A PUBLICATION OF THE TEXAS PROJECT FOR AG WATER EFFICIENCY

IN THIS ISSUE

SURGE VALVE COOPERATIVE

DELIVER OUR WATER NOW!

RAISED BEDS & FURROW FLOOD IRRIGATION

AG WEATHER STATION NETWORK

PRODUCER SPOTLIGHT: JIM HOFFMAN

THE GM'S REPORT: THE WHY OF AWE

The Texas Project for Ag Water Efficiency is developed and managed by the Harlingen Irrigation District with grant funding from the Texas Water Development Board.

TEXAS PROJECT FOR AG WATER EFFICIENCY

From river to farm.

"Surge Valve Cooperative" Offers Water-Saving Tool at Dirt-Cheap Price

With irrigation water in tight supply these days, smart growers are looking for cost-effective ways to make every drop count. It's time to look to the Surge Valve Cooperative.

The Cooperative is a new initiative of the Rio Grande Regional Water Authority (RGRWA) aimed at putting surge valves to work in the Lower Rio Grande Valley. The Authority was intrigued by the results of Texas AWE field demonstrations showing that the use of surge valves in furrow irrigation can reduce water consumption by as much as 52 percent.

Surge v. Furrow

Crop (Date)	Volume of Water Used/Acre (in acre-inches)		Savings with Surge
	Furrow	Surge	
Sugarcane (2005)	30.68	14.64	52%
Cotton (2005)	19.53	13.48	31%
Seed Corn (2007)	23.95	17.31	28%
Cotton (2010)	18	14	22%

Growing sugarcane in the Lower Rio Grande Valley uses some 252,000 AF of water per year, and irrigated cotton about 111,000 AF/yr. Based on Texas AWE findings, using surge valves to irrigate these crops could save around 110,000 acre-feet of water per year in the region, an amount equal to about 40 percent of current municipal demand.

The possibility of such impressive water savings is thwarted by cost. Each surge valve comes with a price tag of about $2,000, making this equipment economically unfeasible for most producers in the region.

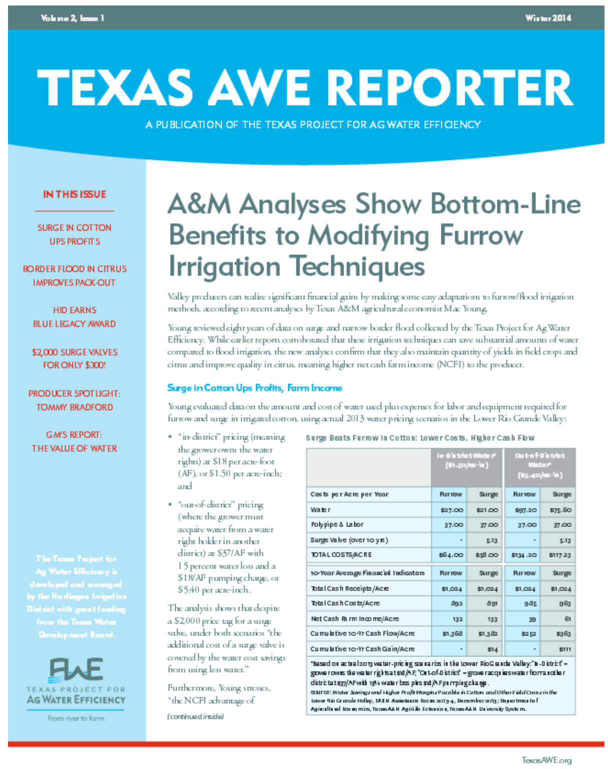
Surge Valve Co-op to the Rescue!

The RGRWA has just been awarded a WaterSMART grant from the U.S. Bureau of Reclamation that will offset the

(continued inside)

Customized surge valve with solar panel.

TexasAWE.org



Volume 2, Issue 1 Winter 2014

TEXAS AWE REPORTER

A PUBLICATION OF THE TEXAS PROJECT FOR AG WATER EFFICIENCY

IN THIS ISSUE

SURGE IN COTTON UPS PROFITS

BORDER FLOOD IN CITRUS IMPROVES PACK-OUT

HID EARNS BLUE LEGACY AWARD

$2,000 SURGE VALVES FOR ONLY $300!

PRODUCER SPOTLIGHT: TOMMY BRADFORD

GM'S REPORT: THE VALUE OF WATER

The Texas Project for Ag Water Efficiency is developed and managed by the Harlingen Irrigation District with grant funding from the Texas Water Development Board.

TEXAS PROJECT FOR AG WATER EFFICIENCY

From river to farm.

A&M Analyses Show Bottom-Line Benefits to Modifying Furrow Irrigation Techniques

Valley producers can realize significant financial gains by making some easy adaptations to furrow/flood irrigation methods, according to recent analyses by Texas A&M agricultural economist Mac Young.

Young reviewed eight years of data on surge and narrow border flood collected by the Texas Project for Ag Water Efficiency. While earlier reports corroborated that these irrigation techniques can save substantial amounts of water compared to flood irrigation, the new analyses confirm that they also maintain quantity of yields in field crops and citrus and improve quality in citrus, meaning higher net cash farm income (NCFI) to the producer.

Surge in Cotton Ups Profits, Farm Income

Young evaluated data on the amount and cost of water used plus expenses for labor and equipment required for furrow and surge in irrigated cotton, using actual 2013 water pricing scenarios in the Lower Rio Grande Valley:

- "in-district" pricing (meaning the grower owns the water rights) at $18 per acre-foot (AF), or $1.50 per acre-inch; and
- "out-of-district" pricing (where the grower must acquire water from a water right holder in another district) at $37/AF with 15 percent water loss and a $18/AF pumping charge, or $5.40 per acre-inch.

The analysis shows that despite a $2,000 price tag for a surge valve, under both scenarios "the additional cost of a surge valve is covered by the water cost savings from using less water."

Furthermore, Young stresses, "the NCFI advantage of

(continued inside)

Surge Beats Furrow in Cotton: Lower Costs, Higher Cash Flow

	In-District Water* ($1.50/ac-in)		Out-of-District Water* ($5.40/ac-in)	
Costs per Acre per Year	Furrow	Surge	Furrow	Surge
Water	$27.00	$21.00	$97.20	$75.60
Polypipe & Labor	37.00	37.00	37.00	37.00
Surge Valve (over 10 yrs)	-	5.13	-	5.13
TOTAL COSTS/ACRE	$64.00	$58.00	$134.20	$117.23
10-Year Average Financial Indicators	Furrow	Surge	Furrow	Surge
Total Cash Receipts/Acre	$1,024	$1,024	$1,024	$1,024
Total Cash Costs/Acre	892	891	985	963
Net Cash Farm Income/Acre	132	133	39	61
Cumulative 10-Yr Cash Flow/Acre	$1,368	$1,382	$252	$363
Cumulative 10-Yr Cash Gain/Acre	-	$14	-	$111

*Based on actual 2013 water-pricing scenarios in the Lower Rio Grande Valley: "In-District" = grower owns the water rights at $18/AF; "Out-of-District" = grower acquires water from another district at $37/AF with 15% water loss plus $18/AF pumping charge.

SOURCE: *Water Savings and Higher Profit Margins Possible in Cotton and Other Field Crops in the Lower Rio Grande Valley*, FARM Assistance Focus 2013-4, December 2013; Department of Agricultural Economics, Texas A&M AgriLife Extension, Texas A&M University System.

TexasAWE.org

AWEsome FACTS series continued with three new factsheets about on-farm and in-district practices:

- *Narrow Border Flood for Citrus: Saving Water While Improving Yields and Net Cash Farm Income*, co-authored by Shad Nelson, Mac Young, Steven Klose and Juan Enciso; and
- *Automated Irrigation Gates: Maximizing Water Delivery While Reducing Water Loss*, and *Telemetry & SCADA: Information Technology Takes Auto-Gates to Next Level of Efficiency*, by Dr. Al Blair with WaterPR.

TEXAS PROJECT FOR AG WATER EFFICIENCY
From river to farm.
TexasAWE.org

ON-FARM

AWESOME FACTS
on agricultural water conservation and efficiency

Narrow-Border Flood for Citrus: Saving Water While Improving Yields and Net Cash Farm Income

Narrow-border flood (NBF) irrigation of citrus orchards can save one-third the water used by traditional large-pan flood irrigation with negligible investment in equipment yet with higher yields of better quality, substantially enhancing net farm cash income.

NBF also works in other laser-leveled orchards, including most any perennial fruit or nut trees such as pecan, where flood irrigation is a common practice.

SUMMARY

For citrus, surface irrigation makes up the difference between the 24 inches of rain received on average during a growing season and the 45 inches of water needed to raise a good crop. Traditionally, growers have used large-pan flood irrigation, a method that floods the entire grove with about six inches of water, with four to eight separate irrigation events per year.

Texas AWE researchers compared the amount of water used by traditional large-pan flood, NBF, microjet sprinkler spray, and single and dual line drip irrigation

NBF proved to be a cost-effective irrigation practice and an easy-to-implement alternative for citrus growers currently using traditional flood irrigation. Growers using NBF best met the 45-inch water requirement, every other irrigation method analyzed exceeded this crop requirement. NBF used about 35 percent of the water required for traditional large pan flood. If applied uniformly throughout South Texas citrus groves, this strategy could conserve up to 49,000 acre-feet of water a year.

Above: Large-pan flood irrigation
Below: Narrow-border flood irrigation

Modifying Traditional Citrus Irrigation Method Reduces Water Use by One-Third

Irrigation Method	Inches of Water Applied		Water Savings over Large-Pan Flood		
	Min – Max	Average	Inches/Acre	AF/Acre	Potential Industry Wide
Large-Pan Flood	60 – 66	62			
Microjet Sprinkler Spray	48 – 56	51	11	0.94	26,200 AF/yr
Single & Dual Line Drip	48 – 50	48	14	1.18	33,000 AF/yr
Narrow-Border Flood	40 – 44	41	21	1.75	49,000 AF/yr

TexasAWE.org

TEXAS PROJECT FOR AG WATER EFFICIENCY
From river to farm.
TexasAWE.org

IN-DISTRICT

AWESOME FACTS
on agricultural water conservation and efficiency

Automated Irrigation Gates: Maximizing Water Delivery While Reducing Water Loss

FEATURES & BENEFITS

Surface water irrigation districts can reduce delivery losses and improve their efficiencies by adopting some low-cost techniques for automating system operations.

A good place to start is right at the gate.

As part of the Texas Project for Ag Water Efficiency, the Harlingen Irrigation District developed and tested its own prototype auto-gate made of lightweight aluminum and featuring push-button controls. The efficiencies were immediately apparent: the auto-gate was considerably easier to operate and produced results in a fraction of the time needed to manually change the original heavy wooden gates.

Since then, HID has replaced its manual gates with 37 automated gates, all custom-made and installed by district staff. The auto-gate design uses readily available, off-the-shelf components for a surprising low cost of $3,500 per gate (including actuators and controllers). Adding the full complement of supervisory control and data acquisition (SCADA) features brings the total cost to about $10,000 per gate — still well below the price tag for commercially available automatic gates.

As an added value, the time and costs for the district to build and install its own automated gate system qualified as a "local match" for cost-sharing grants from the Texas Water Development Board and the U.S. Bureau of Reclamation.

Detailed instructions for the gates, along with parts lists, drawings, and other supporting information, are posted at TexasAWE.org. HID's auto-gate plans and specifications have been adopted by El Paso Irrigation District and Lower Colorado River Authority for use in their conveyance systems.

Clockwise from top left: HID auto-gates at work; actuator; control box

TECHNICAL DETAILS

The primary sub-assemblies of the auto-gate system are the gate assembly itself and the actuator, including motor and controls for raising and lowering the gate. In addition, each gate requires a set of controls; more than one set of controls can be incorporated in each control box.

- **The gate** is constructed of 3/8-inch aluminum plate, reinforced horizontally with 2-inch x 2-inch aluminum angles bolted to the plate with 1/2-inch stainless steel bolts. The gate can slide smoothly up and down within the aluminum frame using a bearing surface and seal provided by ultra high molecular weight (UHMW) plastic strips.
- **The actuator** — the mechanism that moves the gate up and down — is a 12-volt DC off-the-shelf device similar to those used for "slide-out" room extensions on recreational vehicles. The motor operates a screw assembly that extends or retracts linearly, making it well suited to handle the movement of canal gates.

TexasAWE.org

TEXAS PROJECT FOR AG WATER EFFICIENCY
From river to farm.
TexasAWE.org

IN-DISTRICT

AWESOME FACTS
on agricultural water conservation and efficiency

Telemetry & SCADA: Information Technology Takes Auto-Gates to Next Level of Efficiency

FEATURES & BENEFITS

Surface water irrigation districts can reduce delivery losses and improve their efficiencies by adopting some low-cost techniques for automating system operations.

Automated gates are the first step; the next is networking those and other data points into a comprehensive information system that allows for real-time monitoring of canal conditions and rapid response to changing conditions.

The keys to this system are telemetry (automatic measurement and transmission of data from remote sources by wire or radio or other similar means) and SCADA (supervisory control and data acquisition).

As part of the Texas Project for Ag Water Efficiency, the Harlingen Irrigation District has networked its pumps, auto-gates, water sensors, and other components of its conveyance system by means of telemetry stations remotely controlled via SCADA. HID built its network using low-cost, off-the-shelf components. Its 37 auto-gates cost about $3,500 each; enhancing operations with the full complement of SCADA features brought the total cost to about $10,000 per gate.

HID's networked system also can compute the volume of water delivered to each individual farm, readily enabling an anticipated move to volumetric pricing. Other enhancements in the future could include notifying farmers when their irrigation cycles are complete or when tail water reaches a certain level, and even changing flow to new sets of rows in the middle of the night. Eventually, weather and soil moisture monitoring stations also will be brought into the system

TECHNICAL DETAILS

Because irrigation districts typically employ telemetry units in remote areas, units not only have to perform their intended function of gathering and transmitting data, but also must be constructed to use alternative power sources and survive inclement weather conditions.

The major components of a telemetry unit are

- **The housing/enclosure** for the electronic components and the power supply. HID fashioned its enclosures of robust materials that stand up to sunlight, rain, and variations in temperature, including UV-resistant schedule 40 PVC electrical conduit pipe and fittings.
- **A power supply system** that can work in remote areas far from electrical transmission lines. At HID, an external 10-watt solar panel recharges a 12-volt DC lead/acid battery located inside the enclosure. Between the solar panel and the battery pack is an off-the-shelf voltage regulator circuit board.
- **Electronic circuits** to read signals and transmit data. HID "piggy backed" a radio transmitter on to the reverse side of a "single-board computer" (i.e., a minicomputer complete with microprocessor, memory, and input/output features on a single circuit board). This space-saving device gathers readings from water-level sensors and then transmits them to the central data collection system

Detailed instructions and schematics for building a low-cost remote telemetry unit are available online at TexasAWE.org. Click on "Resources," then on "Technical Reports & Specs."

AUTOMATION AT WORK: The Harlingen Irrigation District moves on average about 52,000 acre-feet per year through a fully automated system integrating 40 miles of canal, 200 miles of pipeline, 37 automated gates, and 36 re-lift pump houses — all networked by telemetry stations and remotely controlled via SCADA.

By allowing real-time monitoring of operations and remote operations, the system has created real efficiencies. Thanks to sensors that monitor water levels, district staff can set the auto-gates to automatically open or close in response to changing levels, keeping the entire irrigation system charged and at an optimal performance level. The automated system also alerts staff to problems that could trigger overflows, especially in remote areas. HID estimates that by enabling rapid response and preventing overflows, the automated system saves 40 to 70 acre-feet of water per irrigation.

This secure network is accessible by canal riders and other personnel through any electronic communications device — smart phone, computer, or iPad — enabling rapid response to a variety of situations that might need attention. District personnel can check on the status of just about everything in the delivery system from just about anywhere and at any time — and they can make changes to settings whenever necessary.

TexasAWE.org

TexasAWE.org: this dedicated website, launched in FY 2012, is continually updated with current news articles, summaries of scientific studies, and information about upcoming events.

From March 1, 2013, to February 28, 2014, Texasawe.org was visited by 866 individuals with a total of 4,505 page views. This is almost three times the number of page views the site received in the October 2012 – February 2013 period reported on in the last annual report.

Visitors came to the site primarily from the United States, but Google Analytics shows that viewers also came from India, Canada, Ukraine, Egypt, Mexico, Australia, and Uganda.

Videos: Closed captioning was added to the entire video series on TexasAWE.org.

Powerpoint template, fact slides, graphics and talking points tailored for specific events and presentations.

Infosheet, flyer, and poster for the Surge Valve Cooperative.

"Surge Valve Cooperative" Offers Water-Saving Tool at a Dirt-Cheap Price

With irrigation water in tight supply these days, smart growers are looking for cost-effective ways to make every drop count.

It's time to look to the **Surge Valve Cooperative.**

The Cooperative is a new initiative of the Rio Grande Regional Water Authority (RGRWA) aimed at putting surge valves to work in the Lower Rio Grande Valley. The Authority was intrigued by the results of field demonstrations conducted by the Texas Project for Ag Water Efficiency (Texas AWE) showing that the use of surge valves in furrow irrigation can reduce water consumption by as much as 52 percent.

Texas AWE is developed and managed by the Harlingen Irrigation District (HID) with grant funds from the Texas Water Development Board.

Surge v. Furrow

Crop (Date)	Volume of Water Used/Acre (in acre-inches)		Savings with Surge
	Furrow	Surge	
Sugarcane (2005)	30.68	14.64	52%
Cotton (2005)	19.53	13.48	31%
Seed Corn (2007)	23.95	17.31	28%
Cotton (2010)	18	14	22%

Growing sugarcane in the Lower Rio Grande Valley uses some 252,000 AF of water per year, and irrigated cotton about 111,000 AF/yr. Based on Texas AWE findings, using surge valves to irrigate these crops could save around 110,000 acre-feet of water per year in the region, an amount equal to about 40 percent of current municipal demand.

The possibility of such impressive water savings is thwarted by cost. Each surge valve costs about $2,000, making this equipment economically unfeasible for most producers in the region.

Surge Valve Co-op to the Rescue!

The RGRWA has just been awarded a WaterSMART grant from the U.S. Bureau of Reclamation that will offset the cost of surge valves for up to 32 volunteer cooperators in an extended demonstration of the technology.

Cooperators will receive up to two surge valves, enabling irrigation of about 50 acres per valve, in return for an initial payment of $350 each. To receive the valves at this discounted price, cooperators must register for the project and attend a two to three hour training session conducted by Texas AWE staff on how to use the equipment for maximum irrigation efficiency.

Once surge valves are in operation, water use must be measured during actual irrigation. Texas A&M specialists will choose several cooperators for follow-up evaluations. Cooperators who participate in a final wrap-up meeting about field experiences, common issues, and problems will receive a $50 rebate on each valve—bringing total valve cost down to $300 each.

Surge valve workshops and field days will be scheduled throughout fall 2013 and early 2014, at various locals in the Rio Grande Valley. Training dates, times, and locations can be found on the websites below.

Registrations for the Surge Valve Cooperative will be taken on a first-come, first-served basis. Registration forms are available online at **www.RGRWA.org** and **www.TexasAWE.org**.

Questions? Call Heather Stock with Harlingen Irrigation District at 956-423-7015.

Why Are These Valley Growers Smiling?

They Just Got a Water-Thrifty Tool at a Dirt-Cheap Price!

What's not to like about getting a $2,000 irrigation tool for only $300, especially when that tool can produce water savings of up to 52 percent plus more efficiently deliver fertilizer?

Come find out more at the Surge Valve Field Day, Thursday, Nov. 14, 10 am to 12 noon, at the Texas A&M AgriLife Research Annex Farm, 9584 Mile 2 W in Mercedes.

If you like what you learn, sign up for the Surge Valve Coop, and get a $2,000 surge valve and controller for only $300.

Water Savings with Surge

Crop (Date)	Volume of Water Used/Acre (in acre-inches)		Savings with Surge
	Furrow	Surge	
Sugarcane (2005)	30.68	14.64	52%
Cotton (2005)	19.53	13.48	31%
Seed Corn (2007)	23.95	17.31	28%
Cotton (2010)	18	14	22%

Source: Texas Project for Ag Water Efficiency

Here's how the Coop works:

- You receive up to two surge valves for an initial payment of $350 each;
- You attend a half-day training session on how to use the equipment for maximum irrigation efficiency; and
- You meter and record your water use during actual irrigation in 2014 and turn in your results.

Cooperators who participate in a final wrap-up meeting about field experiences receive a $50 rebate per valve, bringing total valve cost down to $300 each.

Registration forms are available online at **www.RGRWA.org** and **www.TexasAWE.org** or call Heather Stock , 956.423.7015.

The Surge Valve Coop is made possible by a grant from the U.S. Bureau of Reclamation to the Rio Grande Regional Water Authority and is supported by the Texas Project for Ag Water Efficiency.

Why Are These Valley Growers Smiling?

They just got a handy irrigation tool at a dirt-cheap price!

WHAT'S NOT TO LIKE about getting a $2,000 water- and labor-saving device for only $300? Especially when it can deliver water savings of up to 52 percent, plus more efficiently deliver fertilizer and cut down on labor costs too.

With irrigation water in tight supply these days, smart growers are looking for cost-effective ways to make every drop count.

The Surge Valve Cooperative (SVC) can help.

SVC is an initiative of the Rio Grande Regional Water Authority (RGRWA) aimed at putting surge valves to work in the Lower Rio Grande Valley through a grant from the U.S. Bureau of Reclamation.

Field demonstrations and results from the Texas Project for Ag Water Efficiency (Texas AWE) have shown that the use of surge valves in furrow irrigation can reduce water consumption by as much as 52 percent.

Water Savings with Surge

Crop (Date)	Volume of Water Used/Acre (in acre-inches)		Savings with Surge
	Furrow	Surge	
Sugarcane (2005)	30.68	14.64	**52%**
Cotton (2005)	19.53	13.48	31%
Seed Corn (2007)	23.95	17.31	28%
Cotton (2010)	18	14	22%

Source: *Texas Project for Ag Water Efficiency*

Here's how the SV Coop works:

- Growers can receive up to two surge valves for an initial payment of $350 each;
- Growers must attend a half-day training session on how to use the equipment for maximum irrigation efficiency; and
- Growers must record water use during actual irrigation in 2014 and report results.

Cooperators who participate in a final wrap-up meeting about field experiences in the fall of 2014 will receive a $50 rebate per surge valve, bringing total valve cost down to $300 each.

Surge valve workshops and field days have been held throughout fall 2013 and will be scheduled in early 2014 at various locales in the Rio Grande Valley. Training dates, times and locations can be found on the websites below.

Registration forms for the SVC are available online at www.RGRWA.org and www.TexasAWE.org, or call Heather Stock at 956-423-7015.

The Surge Valve Coop is made possible by a grant from the U.S. Bureau of Reclamation to the Rio Grande Regional Water Authority and is supported by the Texas Project for Ag Water Efficiency.

RGRWA RIO GRANDE REGIONAL WATER AUTHORITY

AWE TEXAS PROJECT FOR AG WATER EFFICIENCY

RECLAMATION *Managing Water in the West*

TRAINING & OUTREACH @ THE RIO GRANDE CENTER FOR AWE

The Rio Grande Center for Ag Water Efficiency experienced a busy 2013. HID verified and calibrated some 50 meters for other districts throughout the Valley and consulted on meter installations and verified open channel meters in Rancho Vallejo MUD and Delta Lake irrigation Distinct. The Center also hosted two Surge Valve Coop workshops in the fall of 2013 and is providing space for a new Texas A&M Extension weather station.

PRESENTATIONS & EVENT OUTREACH

The HID AWE team presented project findings at several water conservation and policy venues:

Texas Ag Water Forum, Austin, February 25, 2013. Wayne Halbert and Tom McLemore presented on Texas AWE results to date and distributed materials from the AWE booth.

Rio Grande Basin Initiative San Antonio, April 16, 2013. Texas AWE partners reported to the final meeting on results of project demonstrations that had enjoyed cooperation with and support from RGBI researchers.

Law of the Rio Grande Santa Fe, New Mexico, April 24-26, 2013. Wayne presented Texas AWE videos and water conservation techniques being promoted by Texas AWE**.**

Texas Produce Convention, San Antonio, August 7-9, 2013. Tom, supported by project videos, presented on Texas AWE findings during a panel focused on water issues for agriculture.

Texas Water Conservation Association conference, San Antonio, October 23-25, 2013. WaterPR staffed the AWE information booth.

Texas Plant Protection Conference, Bryan, December 10-11, 2013. Members of the Texas AWE team highlighted accomplishments and promoted the Surge Valve Coop.

***Irrigation Leader*'s 2nd Annual Operations and Management workshop, Phoenix, Arizona, February 12-13, 2014.** Tom presented on water conservation efforts in Texas. The workshop was attended by more than 70 irrigation district managers and board members.

Promoting the Surge Valve Coop was a main focus of Texas AWE in 2013. SVC workshops were held on September 17 and 18 at the Rio Grande Center for AWE. The Texas A&M Extension Center annex in Mercedes also hosted two surge valve field days that attracted more than 20 growers. The field days included live surge valve demonstrations and prompted a news story by KRGV-TV Channel 5 as well as a radio interview on the local country station, KTEX.

AWARDS & RECOGNITIONS

Irrigation Leader magazine featured Wayne Halbert and his work with HID as the cover story for the June 2013 issue. Topics included district operations, the Texas Project for Ag Water Efficiency, and the Valley Water District Managers Association. The issue also included several articles on irrigation issues in the Lower Rio Grande Valley.

In late 2013, the Harlingen Irrigation District was honored by the Water Conservation Advisory Council with the Blue Legacy Award for Agriculture for its work on the Texas Project for Ag Water Efficiency. In December, Tom McLemore traveled to Amarillo to receive the award at the annual Texas Commodity Symposium. The Blue Legacy Award is intended to showcase agricultural producers as effective caretakers of water resources; through it, the Council honors these groups whose practices enhance conservation of water while maintaining or improving profitability.

Following is the Council's announcement of the award:

*"The Council would like to recognize the **Harlingen Irrigation District – Cameron County No. 1** for the Texas Project for Ag Water Efficiency (Texas AWE). Throughout the past eight years, the district has employed several technologies focused on water conservation including automated gates, telemetry, and supervisory control and data acquisition (SCADA). Through this project, the district has discovered what works best in water conservation efforts. One such practice involves an automated system integrating 40 miles of canal, 200 miles of pipeline, 37 automated gates, and 36 re-lift pump houses which are all on a network of telemetry stations that can be remotely controlled and monitored in real time. The information can be accessed via smart phone, computer, or tablet to check the status and control the gates on the system that delivers up to 52,000 acre-feet of water per year.*

2013 Blue Legacy Award for Agriculture

The Harlingen Irrigation District – Cameron County No. 1 is a leader in their community for conservation outreach. Through a series of 'road shows,' the district has spread the news of their successful projects including presentations within the state and around the country. Through information sharing and the careful collection of its own data, the Harlingen Irrigation District – Cameron County No. 1 hopes to continue to develop and be recognized for their cutting edge technologies in water conservation."

Section 4: Enhancing Proven Water Savings in Citrus Irrigation

Texas A&M University-Kingsville, Citrus Center
Shad D. Nelson, PhD, SDN Consulting, Inc.

In 2013, the Texas A&M University-Kingsville Citrus Center moved forward on the "North Farm," which will serve as an irrigation technology site for citrus and provide long-term assessment of alternative irrigation methodologies to traditional large-pan flood irrigation of citrus orchards. As we reported in the *2012 Annual Report* of the Texas Project for Ag Water Efficiency, the site is located in Monte Alto, TX, on land donated by Rio Queen Farms. The site is plumbed and equipped with irrigation pipe, allowing for such irrigation technologies as drip and micro-jet spray irrigation as well various forms of border flood irrigation. However, goals for 2013 were not fully realized due to the impacts of ongoing drought, including severe water restrictions for irrigated agriculture and curtailments by the Delta Lake Irrigation District, which serves the area.

Rio Queen Farms has contracted to build an underground pipeline that will provide water to trees from an alternative source with ample supplies in a nearby canal system, allowing the irrigation park to be established. The park is scheduled to be fully operational by the start of the 2015 growing season, permitting the Center to evaluate new irrigation strategies and compete for new grant funding to build on the remarkable demonstrations that have already been realized by Texas AWE.

Building on proven successes, the Citrus Center in 2013 focused on strategies and technologies that can further enhance demonstrated water-conservation achievements in citrus irrigation, including narrow border flood, drip and micro-jet systems, and soil moisture monitoring.

PARTIAL ROOT-ZONE DRYING

The practice of "partial root-zone drying" (or PRD) has shown potential to further reduce water used while maintaining fruit yield, quality, and shape under water stress conditions. In partial root-zone drying, irrigation occurs one week on one side of selected trees and on the other side the following week. Alternating irrigations so that only one half of the tree is irrigated at a time creates conditions of water stress. The roots sense these conditions, causing the tree to respond with increased stomatal closure, thus reducing transpiration.

Ways of incorporating PRD into demonstrated water-saving strategies for managing citrus irrigation are now being demonstrated at the Citrus Center's new "water deficit irrigation" site established in 2013 with grant funding from the Texas Water Development Board. The site – composed of mature, 25-year-old Rio Red citrus trees – is irrigated via micro-jet spray and dual-line drip. PRD is incorporated into these irrigation systems to evaluate not only water use but also yield and fruit quality. After one year's data, PRD on mature trees has shown up to 40 percent water savings over conventional dual-line drip and micro-jet sprinkler spray irrigation system configurations used in citrus groves.

Exhibit 4.1: Partial Root-Zone Drying Enhances Low Water Use Irrigation Systems

Irrigation Method	**Water Use** (L/yr/tree)	**Yield** (kg/tree)	**Fruit Diameter** (mm)	**Juice** (%)	**Brix*** (TSS)
micro-jet spray	**18,500 ±1,500 a**	**147.0 a**	**87.2 a**	**38.2 a**	**11.2 a**
dual-line drip	**19,000 ±2,000 a**	**144.0 a**	**87.2 a**	**39.9 a**	**11.0 a**
partial root-zone drying	**11,500 ±1,000 b**	**165.2 a**	**86.7 a**	**38.7 a**	**11.2 a**

a = no statistical difference between treatments; **b** = statistical different at the 95% confidence level
Data shown represent one year's results from replicated rows and trees for fruit quality assessment only.
Additional data are needed to evaluate impacts over multiple growing seasons.
*Sugar content expressed as total soluble solids

As shown in Exhibit 4.1, combining PRD with the two irrigation strategies further reduces water consumption without compromising fruit yield and quality. The site will continue to be evaluated throughout FY 2014.

Dual-line drip (right) and micro-jet spray (right) irrigation both work as low water use irrigation strategies in citrus, but the former can further increase water savings when irrigation events are alternated via PRD.

TRENCH FURROW FLOOD

Prior research conducted for Texas AWE conclusively demonstrated that narrow border flood – in which water is channeled via raised berms between bed rows underneath the entire tree canopy down the length of the row – uses 36 percent less water than traditional large-pan flood irrigation.

In 2013, a field site at the Citrus Center South Farm was set aside to evaluate various border flood irrigation methods as additional means of saving water during drought. Among them is a variation on NBF: the “trench furrow flood” method (TFF), in which a trench is cut on each side of the tree along the outer drip line of the tree in order to even more precisely direct the irrigation. In TFF, water is allowed to (1) run down the length of the trench to the end of the row until the trench is full of water and then (2) percolate into the soil from the trench. The trees at this location are near to the dual-line drip PRD study and of the same variety and age, enabling relevant comparisons in terms of water use efficiency.

A variety of irrigation options will be evaluated, including a PRD scenario in which irrigations are alternated between the trench on one side of the tree and the trench on the other. Results from this trial will be compared to simultaneous irrigation of both trenches. This site is scheduled to be established in the summer 2014 after a graduate student is selected to oversee the daily operations of the project.

This type of side trench PRD alternative irrigation setup may be more economically feasible for growers, compared to more expensive drip irrigation systems. It also may be more readily adaptable to mature trees accustomed to being flood irrigated. Changing a mature grove from traditional flood to narrow border flood irrigation can be stressful on tree roots that reside near the dripline of the outer tree canopy. Establishing wider berms between citrus rows can lead to improved water savings just by reducing the total acreage irrigated and reducing the time required to irrigate down the row.

One cooperating grower created his own unique wide bed shaper to sweep soil from near the tree canopy dripline toward the middle of the bed row. This equipment is best used when the trees are young; soil surfaces within established groves that have long been under traditional flood irrigation and routine agricultural practices can be challenging. In particular, disks that are angled too deeply can cause severe cuts to feeder roots during the initial bed-shaping event.


Another possible flood irrigation method involves watering within a trench along the tree canopy dripline and allowing water to distribute laterally within the soil to wet the tree rooting system. With trenches established, a grower could direct water using polypipe and irrigate in a PRD methodology.


Border flood irrigation (left photo) is created by raising a wide berm between rows (right photo).


Creating narrow borders in newly established groves (left) and mature groves (right) can assist in irrigating less land by channeling water directly under the tree canopy while simultaneously distributing fungicide, thus using water more efficiently.

Trench irrigation also is being studied on a Citrus Center site installed in 2012 to compare various crop management treatments, including raised beds versus flat ground. In early spring 2013, side trenches were created in order to irrigate in a manner similar to that of row crops. The objective was to evaluate whether trench irrigation on raised beds can save water and at the same time reduce root rot (*Phytopthora*), a predominantly soil-borne pathogen that causes tree decline and death. The fungal spores that lead to root rot are commonly spread by traditional flood irrigation practices.

Results from this work have been promising: trees planted on raised beds have shown greater tree canopy density, increased trunk diameter size, and reduced *Phytopthora* fungal spores in soil near the trunk of the citrus trees in comparison to trees planted on flat ground.


Left: flood irrigated, flat bed with black permeable tarp. Right: trench irrigated, raised bed without tarp. Raised bed plantings with and without tarp where water does not rise up over the bed and touch the tree trunks have exhibited improved tree canopy and trunk diameter growth compared to flat ground and flooded plantings.

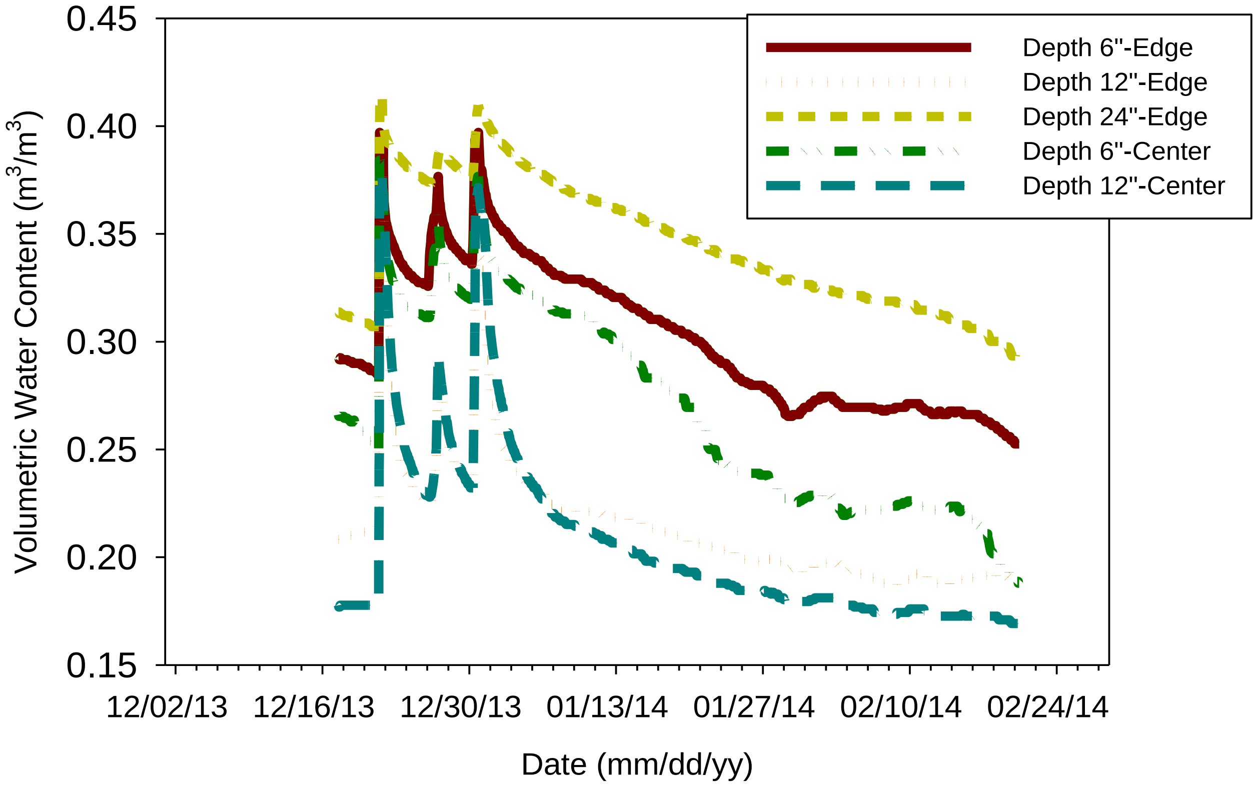
SOIL MOISTURE MONITORING

On-farm soil moisture monitoring has been an integral part of the agricultural water conservation monitoring by citrus growers involved in Texas AWE. But adopting this method is challenging for growers; basically, they must look into the past to try and determine irrigation timing in the future.

In 2013, two Texas AWE citrus collaborators with demonstration sites installed EM50 Decagon soil moisture sensors. These sensors use cellular technology to transmit to growers via the internet data on real-time monitoring. Collected data are sent six times a day to a remote server; growers can then go online to a website and, with an established password and login ID, can identify their data at their office computer and see their data within hours of the actual time.

The information from the Decagon sensors can be viewed by importing the data into a graphing program or by using the graphing chart and data provided by the Decagon software. Exhibit 4.2 shows data from a field of mature Rio Red Citrus trees irrigated using narrow border flood techniques. Soil moisture sensors are located at the outer "edge" or dripline of tree canopy at depths of 6, 12, and 24 inches and at the "center" between two tree trunks and even with the planted citrus row. The majority of citrus feeder roots are located at soil depths between 6 and12 inches; data from these depths are critical for scheduling irrigation.

Exhibit 4.2: Pawlik North Farm Decagon ECH02) soil moisture sensors



As indicated by the data presented in Exhibit 4.2, the sensors show a sharp increase in volumetric water content (VWC) after either irrigation or significant rainfall.

The field capacity level near the 6-inch soil depth is about 33 percent VWC (green and red lines), with subsequent drawdown as the soil dries out. The lighter/sandier soil near the 12-inch sensors exhibits lower VWC values of 23 percent (blue and orange lines). Around the 24-inch depth (yellow line), the higher clay content holds the water at high level (above 30 percent VWC).

In order to adequately interpret the data and make the proper decision as to irrigation scheduling, growers must spend time with the data logger information, evaluating which sensors are at or near field capacity and the significance of a rainfall event. Knowledge of soil moisture status is an essential component in the water conservation efforts and goals of Texas AWE; as growers become familiar with actual soil moisture levels within their citrus groves, they can make more informed irrigation timing decisions on when to best irrigate their crops.

At the Citrus Center, soil moisture monitoring is showing much promise as a means to assist growers with irrigation scheduling. In the partial root-zone drying site discussed above, trees are irrigated when the soil moisture level reaches a specific value, as measured by the sensors. As growers see the value of these real-time soil moisture sensors, they, as well as the scientists participating in Texas AWE, will be invaluable in promoting sensors throughout the Lower Rio Grande Valley, ideally with help from Texas A&M AgriLife Extension personnel.

Section 5: Economic Evaluation of Demonstrated Irrigation Practices and Technologies

Mac Young, Texas A&M AgriLife Extension Service FARM Assistance Program

Throughout 2013, the Financial and Risk Management Assistance (FARM Assistance) program of Texas A&M AgriLife Extension Service continued its support to the Texas Project for Ag Water Efficiency. The two primary realms of FARM Assistance activities have encompassed:

- collaborating with the project management team and coordinating FARM Assistance efforts into the project by participating in management team meetings, planning sessions, and producer meetings, and contributing to project promotional materials. Extension faculty also supports the overall project effort of recruiting project demonstrators.

- conducting economic evaluations of demonstration sites maintained by cooperating producers to calculate the financial benefit and/or viability of water conservation practices on farming operations. Individual cooperators also are offered FARM Assistance planning services for their entire operations to demonstrate the value of long-range financial planning.

Texas AWE cooperators on FARM Assistance:

"an excellent tool in helping me evaluate the direction I need to proceed with my farm operation."

"this tool gives me the confidence to expand my operation, maximize my resources, and increase my net income."

2013 ECONOMIC ANALYSES

In FY 2013, FARM Assistance specialists completed analyses for four AWE cooperators involving three whole-farm and 13 demonstration sites.

All but one of the demonstration sites involved citrus production using a variety of irrigation technologies: traditional large pan flood, narrow border flood, two-line drip, and micro-jet spray.

The non-citrus site was planted in onions (furrow irrigation) but was not an active field crop demonstration in 2013.

Demonstration site data and summaries of financial projections are provided in Exhibit 5.1, following. As in the 2012 Annual Report, data for all demonstration sites are consolidated in a single chart. This enhancement to the previous narrative reports makes it easier to compare oranges to oranges, in a manner of speaking.

The demonstration site evaluations completed in FY 2013 continue to support the major findings of economic analyses conducted of 2005-2012 field crop demonstrations and presented in previous annual reports.

In summary, field demonstrations of alternatives to using furrow in field crops have shown potential for water savings under "per event" pricing structures. Prior to 2013, savings in water did not necessarily translate into savings in cost for producers. With no significant differences in yields, the additional fixed or variable costs related to a surge valve or a drip system, for example, reduces the net returns per acre compared to furrow flood. An exception is onions, where drip technology has shown water savings as well as economic incentives.

Nevertheless, FARM Assistance analyses in 2013 indicate possible existing economic incentives for adopting conservation practices in field crops. These demonstrations have illustrated the value of water saving methods under conditions of limited water availability, water restrictions, and/or volume pricing. As reported in *FARM Assistance Focus 2013-1* (on sugar cane) and *2013-4* (on cotton), results indicate that economic incentives currently exist to invest in and adopt surge irrigation under 2013 water prices. Based on Net Cash Farm Income (NCFI), the advantage of surge over furrow now exists and improves significantly as the price for irrigation water increases. The three *FARM Assistance Focus* reports on Texas AWE results published in FY 2013 are presented in Appendix A.

Cost savings and water savings had already converged, however, in citrus production, where economic analyses of the 2005-2013 demonstrations show economic incentives to adopt alternatives to traditional large pan flood irrigation. As emphasized in the 2011 Annual Report and *Focus 2013-5* (on citrus), evaluations of differences in fruit quality and yields show clear economic incentives to adopting micro-jet spray, drip, and, in particular, narrow border flood (NBF) technologies. And given the ease with which producers can adopt narrow border flood management practices, this practice may offer the best economical option for water savings, assuming current water pricing.

As noted in earlier reports, NBF has the economic advantage over micro-jet and drip systems due to their costs and over traditional flood because it produces higher yields and pack-out quality, both of which are reflected in price.

Exhibit 5.1: Demonstration Site Economic Summaries of Financial Projections (2013-2022)

Notes:

- For all citrus sites, orchards were presumed to have mature trees.
- For all sites, prices were held constant for the 10-year period. This constant affects “10-Year Average NCFI.”
- “10-Year Average Probability of Negative NCFI” is based on risk associated with prices and yields.
- All 2013 producer costs & overhead charges are producer-estimated.

Acronyms:

- NCFI = Net Cash Farm Income
- IC = irrigation costs
- EA = expensed at
- VIC = variable irrigation costs
- ANFC = assuming no financing costs

Crop	Site #	Price/ Ton	Irrigation Technique/Acreage	10-Year Average Cash Receipts/Acre	10-Year Average Cash Costs/Acre ($/ac IC in 2013)	10-Year Average NCFI/Acre	Possible Range of NCFI/Acre	10-Year Average Probability of Negative NCFI	10-Year Average Probability of Carry-Over Debt
Rio Red grapefruit	1A	$165	**narrow border flood (48.5 ac)**	$3,300	$1,820 ($220/ac IC)	$1,480	-$268 to $3,505	7.0%	1% or less
	1C	$165	**narrow border flood (15 ac)**	$3,340	$1,820 ($220/ac IC)	$1,480	-$213 to $3,467	6.8%	1% or less
	4A	$175	**2-line drip (16.5 ac)** costing $2,081/ac (EA $208/ac per year, ANFC)	$3,850	$2,680 ($264/acre IC)	$840	-$532 to $2,798	17.3%	2.7
	4B	$175	**micro-jet spray (6 ac)** costing $2,500/ac (EA $250/ac/year, ANFC)	$3,850	$2,970 ($272/ac I)	$880	-$392 to $2,762	14.3%	1.8%
	4C	$175	**large-pan flood (14 ac)**	$3,850	$2,620 ($142/ac IC)	$1,220	-$15 to $3,168	4.7%	1% or less
	28B2	$120	**2-line drip (3 ac)** costing $1,000/ac (EA $100/ac/year, ANFC)	$2,640	$2,130 ($341/ac IC)	$510	-$1,217 to $3,400	44.9%	17.2%
	28C	$120	**micro-jet spray (8 ac)** costing $1,000/ac (EA $100/ac per year, ANFC)	$2,640	$2,130 ($341/ac IC)	$510	-$1,213 to $3,388	44.9%	17.2%
Valencia oranges	1B	$140	**narrow border flood (15 ac)**	$2,100	$1,830 ($220/ac IC)	$270	-$573 to $1,193	29.6%	10.8%
	28A	$180	**micro-jet spray (8 ac)** costing $1,000/ac (EA $100/ac/yr, ANFC)	$1,980	$2,040 ($313/ac IC)	-$60	-$1,500 to $1,250	60.5%	51.8%
Marrs oranges	28B1	$180	**2-line drip system (5 ac)** costing $1,000/ac (EA $100/ac/year, ANFC)	$2,888	$1,890 ($313/ac IC)	$980	-$380 to $3,200	12.8%	1.6%
	28D2	$180	**2-line drip system (3.5 ac)** costing $1,000/ac(EA $100/ac/year, ANFC)	$3,060/ac	$1,890 ($313/ac IC)	$1,170	-$257 to $3,400	8.3%	1.0% or less
Navel oranges	28D1	$180	**2-line drip system (3.5 ac)** costing $1,000/ac (EA $100/ac/year, ANFC)	$2,520	$1,890 ($313/ac IC)	$630	-$571 to $2,571	29.0%	6.5%
Onions	1F	--	**furrow irrigation (30 ac)**	$2,000	$1,440 ($213/ac IC)	$560	-$.33 to $1,000	1% or less	1% or less

Appendix A: Water Savings & Increased Profitability

Texas A&M AgriLife Extension Service Monographs on the Economics of Surge and Narrow Border Flood Irrigation

Furrow vs. Surge Irrigation in Sugar Cane Under Restricted Water Availability in the Lower Rio Grande Valley (FARM Assistance Focus 2013-1, May 2013)

Water Savings and Higher Profit Margins Possible in Cotton and Other Field Crops in the Lower Rio Grande Valley (FARM Assistance Focus 2013-4, December 2013)

Increased Water Use Efficiency and Profitability in Citrus Production Possible in the Lower Rio Grande Valley (FARM Assistance Focus 2013-5, December 2013)

FARM Assistance Focus

TEXAS A&M AGRILIFE EXTENSION

Furrow vs. Surge Irrigation in Sugar Cane Under Restricted Water Availability in the Lower Rio Grande Valley

Mac Young
Shad Nelson
Steven Klose
Juan Enciso
Tom McLemore

FARM Assistance Focus 2013-1

May 2013

Department of Agricultural Economics
Texas A&M AgriLife Extension Service

farmassistance.tamu.edu

Evaluating the economic viability of water conservation practices such as surge vs. furrow irrigation in field crops is necessary to identify cost-effective and efficient water delivery systems, especially in times of limited water availability.

The Lower Rio Grande Valley (LRGV) is facing water shortages and restrictions in 2013 across the four-county area for the first time since the 1999-2001 drought. The Amistad and Falcon reservoirs on the Rio Grande River have become dangerously low due to a prolonged 2011-13 drought in the U.S.-Mexico watershed. The outlook will continue to be bleak until a tropical storm in the Pacific or Gulf of Mexico changes the rainfall pattern and replenishes the reservoirs.

Agricultural producers have been notified of restrictions and/or irrigation curtailment. Many producers where possible have scrambled to buy higher-priced water to sustain field, vegetable and citrus crops. These acquisition efforts may be for naught as water supplies continue to decline and urban needs take precedence. Most producers have been informed of irrigation cut-off dates by the providing water districts.

Limited irrigation will have a significant and negative impact on area crop production and the area economy. Being perennial crops, citrus and sugar cane production will be especially affected, and possible loss of crops and trees could occur. The overall LRGV economy and population will feel the economic pinch.

Irrigation conservation and efficient use of available water supplies will likely be critical in the future, even after drought conditions are alleviated. Growing demands in Mexico and non-agricultural uses in the LRGV will pressure more efficient use of water and delivery systems. Evaluating the economic viability of water conservation practices such as surge vs. furrow irrigation in field crops is necessary to identify cost-effective and efficient water delivery systems, especially in times of limited water availability.

The Texas Project for Ag Water Efficiency (AWE) is a multi-institutuional effort involving the Texas Water Development Board, the Harlingen Irrigation District, South Texas agricultural producers, Texas A&M AgriLife Extension (Extension), Texas A&M AgriLife Research, Texas A&M University-Kingsville, and others. It is designed to demonstrate state-of-the-art water distribution network management and on-farm, cost-effective irrigation technologies to maximize surface water use efficiency. The project includes maximizing the efficiency of water diverted from the Rio Grande River for irrigation consumption by various field, vegetable and citrus crops.

Extension conducts the economic analyses of demonstration results to evaluate the potential impact of adopting alternative water conserving technologies. Extension works individually with agricultural producers using the Financial And Risk Management (FARM) Assistance financial planning model to analyze the impact and cost-effectiveness of the alternative irrigation technologies.

In 2012, a furrow vs. surge valve technology demonstration associated with the AWE project was completed to analyze potential water application and irrigation costs scenarios in sugar cane production (Table 1). Under surge irrigation, a producer potentially may apply less water, but a surge valve would be an added cost at about $2,000. The following analysis evaluates the potential financial incentives for using surge technology under restricted water supplies and volumetric water pricing. For this paper, it was assumed that water delivery was metered.

Assumptions

Table 1 provides the basic per acre water use and irrigation cost assumptions for sugar cane under furrow and surge irrigation. For the purpose of evaluating these technologies, two water pricing scenarios--in-district and out-of-district--were established. The water pricing scenarios represent actual 2013 conditions in the LRGV, where "in-district" pricing means the grower owns the water rights, and "out-of-district" means the grower must acquire and purchase water from another water right holder outside the district, thus leading to a higher water delivery cost.

The furrow and surge testing was conducted on the same 30.36-acre field. The average sugar cane price received in 2012 was $25 per ton. A 43 ton average yield per acre was assumed for both irrigation methods. Costs were derived from actual producer costs and estimates of per acre overhead charges. They are assumed to be typical for the region and were not changed for analysis purposes. The in-district price of water in scenarios 1 and

Table 1: Furrow and Surge Irrigation Cost Per Acre for Surge Cane								
Irrigation Scenario	**Water Source**	**Water Price ($/Ac In)**	**Water Applied (Ac In)**	**Water Cost/Acre**	**Poly-Pipe & Labor Cost/Acre**	**Variable Irrigation Cost/Acre**	**Surge Valve Costs/Ac/Yr (Over 10 Years)**	**Total Irrigation Costs/Acre**
1-Furrow	In-District	1.32	46.44	$61.30	$26.47	$87.77	N/A	$87.77
2-Surge	In-District	1.32	35.65	$47.06	$26.47	$73.53	$6.59	$80.12
3-Furrow	Out-of-District	5.40	46.44	$250.78	$26.47	$277.25	N/A	$277.25
4-Surge	Out-of-District	5.40	35.65	$192.57	$26.47	$219.04	$6.59	$225.63

2 was $1.32/acre inch or $16/acre foot in 2012 and $1.50/acre inch or $18/acre foot in 2013. The $5.40/acre inch price in scenarios 3 and 4 assumes out-of-district water at $37/acre foot with 15% water loss and a $18/acre foot pumping charge. Based on 10 irrigations, irrigation labor was $16.47/acre and poly-pipe $10/acre. These assumptions are meant to make the illustration relevant to a wide range of producers in the area.

The two irrigation scenarios were conducted on the same site and considered a controlled experiment for comparison purposes. Differences in soil types, rainfall and management practices did not affect irrigation water application, production costs, and yields. The surge site assumes a surge valve cost of $2,000. The surge valve expense is evenly distributed over the 10-year period ($200/year or $6.59/acre per year) with the assumption of no financing costs. For the analysis, no other major differences were assumed for the furrow and surge sites.

For each 10-year outlook projection, commodity price trends follow projections provided by the Food and Agricultural Policy Research Institute (FAPRI, at the University of Missouri) with costs adjusted for inflation over the planning horizon. Actual 2012 demonstration findings reflect no significant differences in yields between furrow and surge.

Results

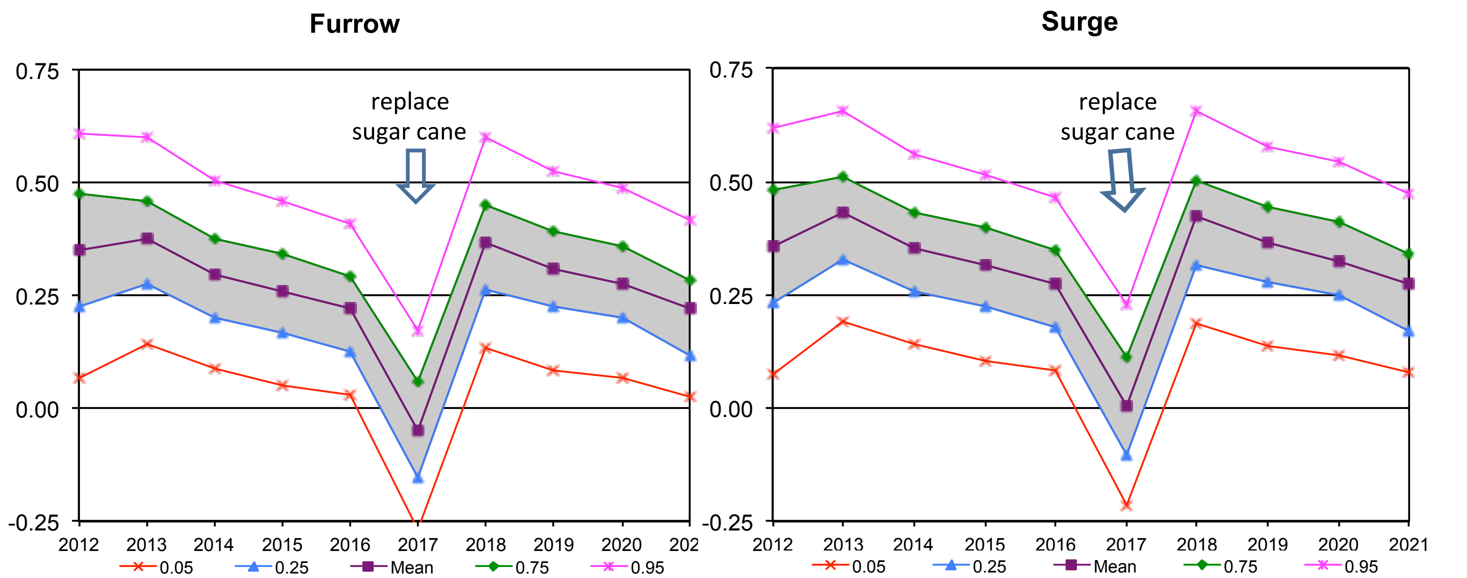
Comprehensive projections, including price and yield risk for surge irrigation, are illustrated in Table 2 and Figure 1. Table 2 presents the average outcomes for selected financial projections in all 4 scenarios. The graphical presentation in Figure 1 illustrates the full range of possibilities for net cash farm income in scenarios 3 (furrow) and 4 (surge) at the $5.40/acre inch out-of-district purchased water price. Cash receipts average $853/acre over the 10-year period for all four scenarios. Average cash costs were lower for surge under current in-district and out-of-district purchased water pricing scenarios.

Using average net cash farm income (NCFI) as a barometer, surge is more profitable than furrow (Table 2; Figure 1). In Figure 1, the dip in NCFI in 2017 for both furrow and surge reflect the costs of re-establishing the sugar cane. At both the $1.32 and $5.40 water price levels, the additional cost of a surge valve is covered by the water cost savings from using less water. The NCFI advantage under surge over furrow improves significantly as the price for irrigation water increases. The

Table 2: 10-Year Average Financial Indicators for Irrigated Sugar Cane							
			10-Year Average/Acres				
Irrigation Scenario	**Water Source**	**Water Price ($/Ac In)**	**Total Cash Receipts ($1000)**	**Total Cash Costs ($1000)**	**Net Cash Farm Income ($1000)**	**Cumulative 10-Yr Cash Flow/Acre ($1000)**	**Cumulative 10-Yr Cash Gain/Acre ($)**
1-Furrow	In-District	1.32	0.853	0.420	0.433	4.575	--
2-Surge	In-District	1.32	0.853	0.407	0.446	4.710	135
3-Furrow	Out-of-District	5.40	0.853	0.590	0.263	2.767	--
4-Surge	Out-of-District	5.40	0.853	0.541	0.312	3.293	526

Results indicate that incentives to invest and adopt surge irrigation currently exist and improve as water prices increase.

Figure 1. Projected Variability in Net Cash Farm Income Per Acre for Furrow vs. Surge Irrigation in Sugar Cane at $5.40/Acre Inch Water Cost



advantage at $1.32/acre inch is 3% and the advantage at $5.40/acre inch is 18.6%.

Liquidity or cash flow also improves with surge irrigation at current in-district and out-of-district purchased water prices (Table 2). Ending cash reserves are expected to grow to $4,710/acre for surge, $135/acre more than furrow in the in-district water pricing scenario. In the higher out-of-district price scenario, the cash flow advantage of surge is more significant at $526/acre.

Summary

Surge offers the opportunity to conserve irrigation water in sugar cane and other field crops. The incentive for producers to switch to the new technology has been minimal under current water delivery methods and past water pricing levels. Under water restrictions and current water pricing, surge is emerging as a viable irrigation method assuming metered water. Demonstration results indicate that incentives to invest and adopt surge irrigation currently exist and improve as water prices increase.

The incentives for producers to switch to surge become more substantial at higher prices for irrigation water. In drought or other high water demand situations where the availability of water is restricted or limited, economic forces will ration supplies through higher prices and water will likely be metered. Water use efficiency will then become more crucial in controlling water cost.

This case study assumes higher water prices throughout the 10-year projection period. Scenarios 1 and 2 vs. 3 and 4 represent extremes of water availability situations. If water shortages and higher prices occur only in one year then return to previous levels, producers likely will have less incentive to change to the new surge technology. However, if longer-term expectations are for tighter water supplies and higher pricing, metering to manage water supplies and delivery by irrigation districts and surge technology will likely be more widely accepted by producers as viable alternatives for the LRGV. In summary, the economic incentives for producers to switch to surge irrigation systems will likely be determined by the future availability and cost of water.

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FARM Assistance Focus

Texas A&M AgriLife Extension

Water Savings and Higher Profit Margins Possible in Cotton and Other Field Crops in the Lower Rio Grande Valley

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FARM Assistance

Planning Solutions

“Water availability in late 2013 and 2014 is uncertain which will influence future production plans.”

The 2013 crop year will be remembered for water shortages and restrictions across the four-county Lower Rio Grande Valley (LRGV). Much like 1999-2001, producers have been confronted with making planting and production decisions on depleted and limited water supplies.

Water levels in the Amistad and Falcon reservoirs on the Rio Grande River have become extremely low. A prolonged 2011-13 drought in the U.S.-Mexico watershed and new reservoirs in Mexico have diminished water flowing into the Rio Grande River. The outlook will likely continue to be bleak until rainfall from a tropical system replenishes the reservoirs.

Agricultural producers have had to cope with irrigation restrictions and curtailment by water districts. Some producers were able to purchase higher-priced, out-of-district water to sustain field, vegetable, and citrus crops early on in the spring. However, water availability in late 2013 and 2014 is uncertain which will influence future production plans.

The potential for overall crop production into 2014 may be reduced, especially citrus and sugar cane. As a result, the overall LRGV economy and population will feel the economic pinch.

The availability of water to fulfill urban and agricultural needs in the LRGV will continue to be issues in the foreseeable future. Irrigation conservation and efficient use of available water supplies will likely become more and more important, even after drought conditions are alleviated. Growing demands in Mexico and non-agricultural uses in the LRGV will encourage more efficient use of water and delivery systems. Evaluating the economic viability of water conservation practices such as surge vs. furrow irrigation in field crops is necessary to identify cost-effective and efficient water delivery systems, especially in times of limited water availability.

The Texas Project for Ag Water Efficiency (AWE) has laid the groundwork for identifying and analyzing cost-effective water conservation practices. AWE is a joint effort involving the Texas Water Development Board, the Harlingen Irrigation District, South Texas agricultural producers, Texas A&M AgriLife Extension (Extension), Texas A&M AgriLife Research, Texas A&M University-Kingsville, and others.

Between 2005-13, furrow vs. surge valve technology demonstrations associated with the AWE project have been completed analyzing potential water application and irrigation costs scenarios in cotton, sugar cane, and other field crops. These demonstrations have consistently shown that under surge irrigation a producer may potentially apply 23% less water. But a surge valve would be an added cost at about $2,000. The following analysis evaluates the potential financial incentives for using surge technology under restricted water supplies and volumetric water pricing. For this paper, it was assumed that water delivery was metered.

Assumptions

Table 1 provides the basic per acre water use and irrigation cost assumptions for cotton under furrow and surge irrigation. Irrigation application rates and yields were based on previous AWE demonstration results (Young, 2011). For the purpose of evaluating these technologies, in-district and out-of-district water pricing scenarios were established. The water pricing scenarios represent actual 2013 conditions in the LRGV, where “in-district” pricing means the grower owns the water rights, and “out-of-district” means the grower must acquire and purchase water from another water right holder outside the district, thus leading to a higher water delivery cost.

Table 1. Furrow and Surge Irrigation Cost Per Acre for Cotton

Irrigation Scenario	Water Source	Water Price (4/Acre In)	Water Applied (Acre In)	Water Cost/Acre	Poly-Pipe & Labor Cost/Acre	Variable Irrigation Cost/Acre	Surge Valve Cost/Acre/Year (Over 10 Years)	Total Irrigation Costs/Acre
1-Furrow	In-District	1.50	18.00	$27.00	$37.00	$64.00	N/A	$64.00
2-Surge	In-District	1.50	14.00	$21.00	$37.00	$58.00	$5.13	$63.13
3-Furrow	Out-of-District	5.40	18.00	$97.20	$37.00	$134.20	N/A	$134.20
4-Surge	Out-of-District	5.40	14.00	$75.60	$37.00	$112.60	$5.13	$117.73

"Average cash costs were lower for surge under current in-district and out-of-district purchased water pricing scenarios. Using average net cash farm income (NCFI) as a criterion, surge is more profitable than furrow."

Table 2. 10-Year Average Financial Indicators for Irrigated Cotton

Irrigation Scenario	Water Source	Water Price ($/Ac/In)	10-Year Averages/Acre Total Cash Receipts ($1000)	Total Cash Costs ($1000)	Net Cash Farm Income ($1000)	Cumulative 10-Yr Cash Flow/Acre ($1000)	Cumulative 10-Yr Cash Gain/Acre ($)
1-Furrow	In-District	1.50	1.024	0.892	0.132	1.368	
2-Surge	In-District	1.50	1.024	0.891	0.133	1.382	14
3-Furrow	Out-of-District	5.40	1.024	0.985	0.039	0.252	
4-Surge	Out-of-District	5.40	1.024	0.963	0.061	0.363	111

It was assumed that the furrow and surge fields were side-by-side and 19.5 acres each. The average cotton price received in 2013 was $.80 per pound. A five-year 1,000-lb. average yield per acre was assumed for both irrigation methods. Costs were derived from actual producer costs and estimates of per acre overhead charges. They are assumed to be typical for the region and were not changed for analysis purposes. The in-district price of water in scenarios 1 and 2 was $1.50/acre inch or $18/acre foot in 2013. The $5.40/acre inch price in scenarios 3 and 4 assumes out-of-district water at $37/acre foot with 15% water loss and a $18/acre foot pumping charge. Based on 3 irrigations, irrigation labor was $21/acre and poly-pipe $16/acre. These assumptions are meant to make the illustration relevant to a wide range of producers in the area.

The two irrigation scenarios were assumed to be on the same site and considered a relatively controlled case study for comparison purposes. Differences in soil types, rainfall and management practices did not affect irrigation water application, production costs, and yields. The surge site assumes a surge valve cost of $2,000. The surge valve expense is evenly distributed over the 10-year period ($200 or $10.26/acre assuming 39 acres) with the assumption of no financing costs. For the analysis, no other major differences were assumed for the furrow and surge sites.

For each 10-year outlook projection, commodity price trends follow projections provided by the Food and Agricultural Policy Research Institute (FAPRI, at the University of Missouri) with costs adjusted for inflation over the planning horizon. Actual 2005-13 demonstration findings reflect no significant differences in yields between furrow and surge.

Results

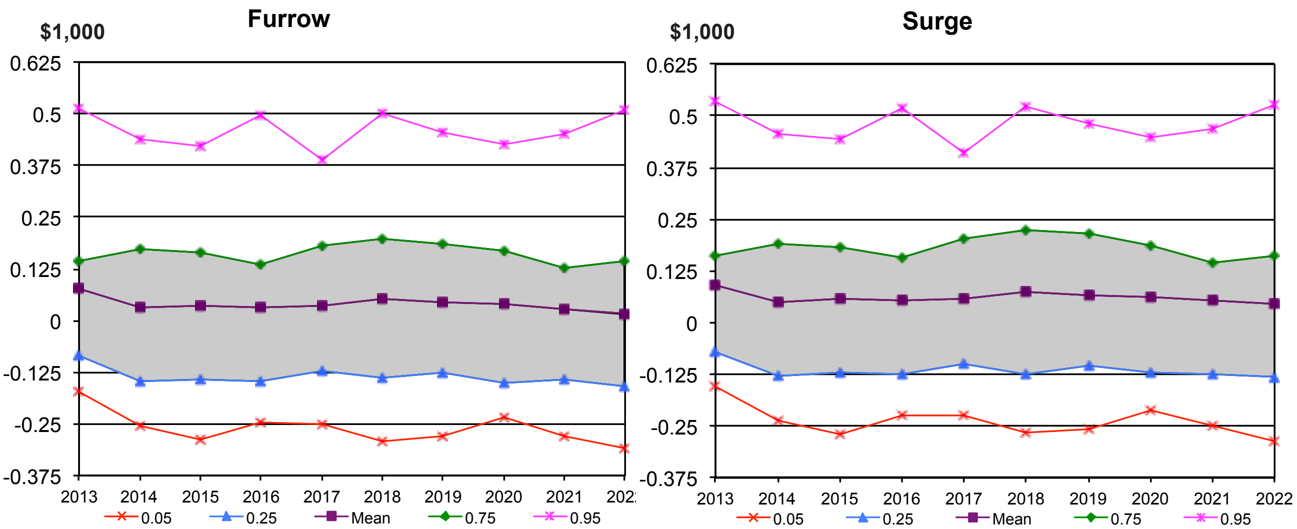
Comprehensive projections, including price and yield risk for surge irrigation, are illustrated in Table 2 and Figure 1. Table 2 presents the average outcomes for selected financial projections in the 4 scenarios. The graphical presentation in Figure 1 illustrates the full range of possibilities for net cash farm income in scenarios 3 (furrow) and 4 (surge) at the $5.40/acre inch out-of-district purchased water price. Cash receipts average $1,024/acre over the 10-year period for all four scenarios. Average cash costs were lower for surge under current in-district and out-of-district purchased water pricing scenarios.

Using average net cash farm income (NCFI) as a criterion, surge is more profitable than furrow (Table 2; Figure 1). In Figure 1, at both the $1.50 and $5.40 water price levels, the additional cost of a surge valve is covered by the water cost savings from using less water. The NCFI advantage of surge over furrow improves significantly as the price for irrigation water increases. The advantage at $1.50/acre inch is marginal, but the advantage at $5.40/acre inch is a 56% increase in NCFI/acre.

Liquidity or cash flow also improves with surge irrigation at current in-district and out-of-district purchased water prices (Table 2). Ending cash reserves are expected to grow to $1,382/acre for surge, only $14/acre more than furrow in the in-district water pricing scenario. In the higher out-of-district price scenario, the cash flow advantage of surge is more significant at $111/acre.

"Demonstration results indicate that incentives to invest and adopt surge irrigation currently exist and improve as water prices increase."

Figure 1. Projected Variability in Net Cash Farm income Per Acre for Irrigated Cotton at $5.40/Acre Inch Water Cost



Summary

Surge offers the opportunity to conserve irrigation water in cotton and other field crops. The incentive for producers to switch to the new technology has been minimal under current water delivery methods and past water pricing levels. Under water restrictions and current water pricing, surge is emerging as a viable irrigation method assuming metered water. Demonstration results indicate that incentives to invest and adopt surge irrigation currently exist and improve as water prices increase.

The incentives for producers to switch to surge become more substantial at higher prices for irrigation water. In drought or other high water demand situations where the availability of water is restricted or limited, economic forces will ration supplies through higher prices and water will likely be metered. Water use efficiency will then become more crucial in controlling water cost.

This case study assumes higher water prices throughout the 10-year projection period. Scenarios 1 and 2 vs. 3 and 4 were actual 2013 water availability and pricing situations. If water shortages and higher prices occur only in 2013 crop year and return to normal levels in 2014, producers likely will have little incentive to change to the new surge technology. However, if tighter water supplies and higher pricing persists, metering to manage water supplies and delivery by irrigation districts, and surge technology may be more widely accepted by producers as viable alternatives for the LRGV. In summary, the economic incentives for producers to switch to surge irrigation systems will likely be determined by the future availability and cost of water.

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FARM Assistance Focus

Texas A&M AgriLife Extension

Increased Water Use Efficiency and Profitability in Citrus Production Possible in the Lower Rio Grande Valley

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FARM Assistance Focus 2013-5
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FARM Assistance
Planning Solutions

"With reduced water supplies, conservation efforts to increase water use efficiency and to ensure sustainability of area production are of utmost importance."

A prolonged 2011-13 drought in the Texas-Mexico Rio Grande River watershed and new reservoirs constructed in Mexico in recent years have severely depleted water storage levels in the Amistad and Falcon reservoirs. This drought scenario is a repeat of 1999-2001. Declining water levels have culminated in farm-use restrictions imposed by water districts and higher irrigation costs in 2013. Yields and fruit quality issues are also concerns as restrictions limit the amounts and frequency of irrigation events.

Citrus production in the Lower Rio Grande Valley of Texas (LRGV) is a significant part of the area economy. It involves approximately 27,300 irrigated acres. In 2012, the estimated value of citrus production was $69.77 million and the economic impact was estimated to be $130.1 million (Robinson, 2013). Grapefruit accounts for 68% of the acreage and 80% of all citrus sales. Overall crop value is directly linked to the quantity and quality of the harvest or fresh fruit pack-out (fancy and choice) vs. juice market. As the percent of the crop grading fancy increases, so does the average sales price. Average prices decline as more choice and, especially, juice grade is produced. As a result, any analysis must include the impact on fresh pack-out vs. juice.

Table 1: Average 2005-2012 Grapefruit Pack-Out Percentages by Irrigation Method, Lower Rio Grande Valley

Irrigation Method	Category	Pack-Out Percentages		
		Average	High	Low
Flood	Fancy	45.8	53.1	37.3
	Choice	22.3	19.3	23.6
	Juice	31.9	27.6	39.1
	Total	100.00	100.00	100.00
Border Flood	Fancy	48.0	56.7	45.6
	Choice	23.9	21.2	26.9
	Juice	28.1	22.1	27.5
	Total	100.00	100.00	100.00
Drip	Fancy	47.3	51.9	42.2
	Choice	16.9	11.7	22.6
	Juice	35.8	36.4	35.2
	Total	100.00	100.00	100.00
Micro-Jet	Fancy	46.4	48.1	41.8
	Choice	17.1	13.8	21.1
	Juice	36.5	38.1	37.1
	Total	100.00	100.00	100.00
Average	Fancy	46.9	48.8	43.3
	Choice	20.00	18.3	20.8
	Juice	33.1	32.9	35.9
	Total	100.00	100.00	100.00

Irrigation supplementing annual rainfall is required to sustain grapefruit and other fruit production in the LRGV. Without irrigation, there would be no fruit production. The average annual rainfall in the LRGV is approximately 26 inches (Enciso, 2005), with normal total tree water requirements to produce a crop reaching 50 inches (Sauls, 2008). Historically, flood is the dominate irrigation method and currently accounts for 80% of all citrus.

With reduced water supplies, conservation efforts to increase water use efficiency and to ensure sustainability of area production are of utmost importance. More efficient water delivery methods, such as border flood, drip and micro-jet spray, offer the potential to save water (Young, 2010). Moreover, these irrigation methods also have other agronomic benefits such as minimizing the movement of nutrients out of the root zone and reducing pest control due to lower soil applied pesticide and fungicide loss by leaching (Nelson, 2013).

The Texas Project for Ag Water Efficiency (AWE) is a multi-faceted effort involving the Texas Water Development Board, the Harlingen Irrigation District, South Texas agricultural producers, Texas A&M AgriLife Extension (Extension), Texas A&M AgriLife Research, Texas A&M University-Kingsville, and others. The ten-year project was initiated in 2004 and was designed to demonstrate state-of-the-art water distribution network management and on-farm, cost-effective irrigation technologies to maximize surface water use efficiency. The project's scope included measuring and evaluating the efficiency of water diverted from the Rio Grande River for irrigation consumption by various field, vegetable and citrus crops.

Water use efficiency and the economics of water savings can be explained by comparing producer delivery systems. Four irrigation technologies typically used in Rio Red grapefruit production were studied as part of the AWE project—flood, border flood, micro-jet spray, and drip. These were compared to evaluate the impact on fresh pack-out and potential profitability of using various irrigation methods (Table 1). The following analysis evaluates the potential financial incentives for using the various systems. The investment costs of micro-jet spray and drip systems were also included.

"Results indicate that the highest net cash farm income (NCFI) was with border flood."

Assumptions

Table 1 provides average pack-out percentages over eight growing seasons (2005-2012) for Rio Red grapefruit by irrigation method. Pack-out percentage data for each growing season represents the average pack-out across multiple AWE participants (2 growers per irrigation method). Annual pack-out percentages were categorized (low, average or high) by the level of fruit produced. Estimated 2013 production, irrigation and systems costs were based on information provided by collaborators involved in the AWE project and was assumed to be typical for the purpose of this case analysis. Actual yields were adjusted for 'shrink' or the loss of product weight due to dust, twigs, debris, and loss of moisture. Yields were held constant and based on 2005-12 averages—flood 18.9 tons/acre, border flood 21.2 tons/acre, micro-jet 23.0 tons/acre, and drip 21.1 tons/acre.

Table 2: 10-Year Average Per Acre Financial Indicators for Grapefruit, Lower Rio Grande Valley

Pack-Out Scenario	10-Year Averages Per Acre			Cumulative 10-Yr Cash Flow/Acre ($1000)
	Total Cash Receipts ($1000)	Total Cash Costs ($1000)	Net Cash Farm Income ($1000)	
Flood-High	3.33	2.20	1.13	12.04
Flood-Average	3.01	2.20	0.81	8.55
Flood-Low	2.60	2.20	0.40	4.22
Border Flood-High	3.97	2.16	1.81	19.18
Border Flood-Average	3.53	2.16	1.36	14.46
Border Flood-Low	3.44	2.16	1.28	13.56
Drip-High	3.52	2.28	1.24	13.17
Drip-Average	3.35	2.28	1.07	11.36
Drip-Low	3.16	2.28	0.88	9.33
Micro-Jet- High	3.65	2.31	1.33	14.16
Micro-Jet-Average	3.60	2.31	1.29	13.70
Micro-Jet-Low	3.39	2.31	1.08	11.49

****Based on 2005-2012 data.**

Average crop prices—fancy $285.80/ton, choice $99.52/ton, and juice $5.44/ton—were calculated from actual 2005-12 prices received by AWE producers. These are net prices received by the collaborators, adjusted for harvest, packing, and commission charges. Average prices for all collaborators were used to minimize price differences due to tree age, harvest timing and management. Projected 2013-2022 prices were held constant at expected levels. These assumptions are intended to make the analysis relevant to typical grapefruit and citrus producers in the Lower Rio Grande Valley area.

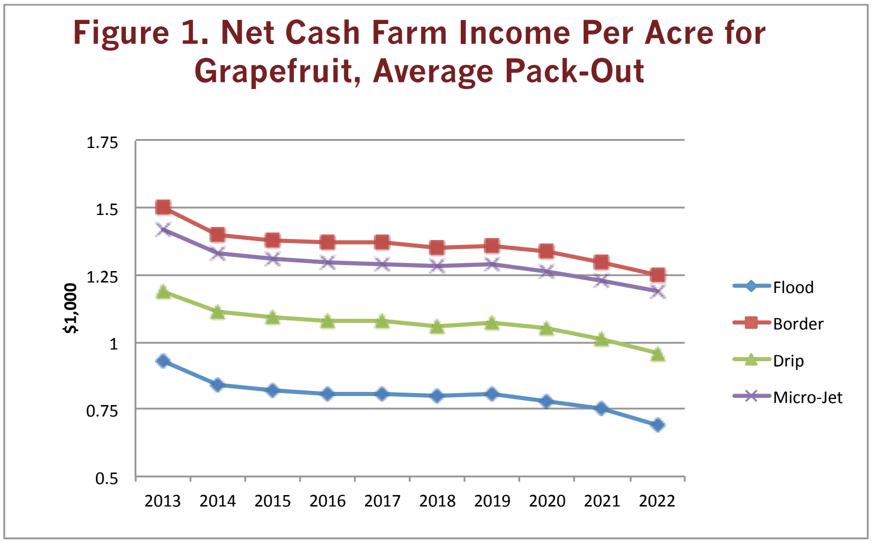
The cost, yield and price data utilized in the analysis included information from two or more ADI producers for each irrigation method. Soil types, rainfall and management practices were assumed identical, and except for irrigation costs, all input costs and management practices were assumed to be the same across irrigation scenarios. Irrigation costs by scenario were different primarily due to the amount of water applied under each irrigation method. For each 10-year outlook projection, input prices and overhead cost trends follow projections provided by the Food and Agricultural Policy Research Institute (FAPRI, at the University of Missouri).

Results

Comprehensive projections, including price and yield risk, for the four irrigation methods are illustrated in Table 2 and Figure 1. Table 2 presents the average outcomes for selected financial projections, while the graphical presentation illustrates a NCFI comparison of the four irrigation systems.

By using 8-year average pack-out percentages, yields and water use data, the results reflect the extremes in annual rainfall patterns in the LRGV ranging from consecutive years of drought (2010-2012) to excessive rainfall years, which adds more credibility to the overall findings. Results indicate that the highest net cash farm income (NCFI) was with border flood (Table 2 and Figure 1). The projected 10-year average annual NCFI for border flood was $1,360/acre, 5.4% more than micro-jet, 27.1% more than drip, and 67.9% more than flood. An assessment of high to low pack-out also reflects similar results. Border flood's advantage over conventional flood is largely reflective of higher average annual yields (21.2 tons/acre for border flood and 18.9 tons/acre for flood) and higher

"Border flood may have a NCFI or profitability advantage over flood, drip, and micro-jet irrigation systems in grapefruit production based on fresh vs. juice pack-out harvest."



average fresh pack-out. The advantage of border flood over micro-jet and drip is directly linked to higher average fresh pack-out as well as overall costs. Average cash costs were $2,040/acre for border flood, 5.6% less than drip and 6.85% less than micro-jet. The cost per acre differences largely reflects additional investment costs for drip and micro-jet systems that override water and operating cost savings. The downward NCFI trends in Figure 1 are largely due to projected prices and yields being held constant, whereas production costs increase over the 10-year period.

The NCFI advantage of border flood is also reflected in the ability to generate cash flow (Table 2). The 10-year cumulative cash flow balances illustrate the potential pre-tax cash requirements or flows generated using the four irrigation methods. Border flood, on average, generated a cumulative cash flow of 5.5% more than micro-jet, 27.3% more than drip, and 69.1% more than flood. Cumulative cash flow results assessing high and low variations in pack-out also favor border flood.

Summary

The results indicate that border flood may have a NCFI or profitability advantage over flood, drip, and micro-jet irrigation systems in grapefruit production based on fresh vs. juice pack-out harvest. Border flood's cost advantage over flood, drip and micro-jet irrigation systems is also a factor. These results reaffirm the findings in Focus 2010-4 (Young, 2010) with minor differences based on 8 years vs. 5 years of production and market history.

Actual yields and pack-out percentages vary based on rainfall, soil types, tree age, pruning, and other management practices. Eight-year averages lend credence to the results that raising borders between citrus tree rows may be the best option. However, other issues such as terrain, availability of labor, and cost of water may also play a role in deciding which system is the best fit for an individual producer.

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Nelson, Shad D., Enciso, Juan M., Perea, Hugo, Setamou, Mamoudou, Young, Mac, and Williams, Clinton. 2013. Alternative flood irrigation strategies that improve water conservation in citrus. Subtrop. Plant Sci. (65:XX-XX accepted).

Robinson, John, and Cleaver, Matthew. Texas Estimated Value of Agricultural and Related Items, 2009-2012 and 2013 Projected. Texas AgriLife Extension Service, Department of Agricultural Economics, Texas A&M University System. May 2013.

Sauls, Julian W. Citrus Water Management. Texas AgriLife Extension Service, Department of Horticulture, Texas A&M University System. Jan. 2008.

Young, Mac, Nelson, Shad, Klose, Steven, and Enciso, Juan. Assessing Irrigation Methods Based on Grapefruit Pack-Out in the Lower Rio Grande Valley. Farm Assistance Focus Series 2010-4. Texas AgriLife Extension Service, Department of Agricultural Economics, Texas A&M University System. August 2010.

Appendix B: Professional Papers and Presentations Pertaining to Texas AWE

JOURNAL PUBLICATIONS (PEER REVIEWED)

1. Perea, H., J. Enciso, J. Jifon, S. Nelson, and C. Fernandez. 2013. Performance of tensiometer and granular matrix soil moisture sensors in irrigated light, medium, and heavy textured soil. *Journal of the Subtropical Agriculture and Environments Society. 65:1-7*.
2. Perea, H., J. Enciso-Medina, V. P. Singh, D. P. Dutta and B. J. Lesikar. 2013. Statistical Analysis of Non-Pressure-Compensating and Pressure-Compensating Drip Emitters. Journal of Irrigation Drainage Engineering. J. Irrig. Drain Eng. ASCE., 139(12), 986–994.
3. Nelson, S.D., H.A. Ajwa, T. Trout, M. Stromberger, S.R. Yates and S. Sharma. 2013. Water and methyl isothiocyanate distribution in soil after drip fumigation. *J. Environ. Qual.* 42:1555-64.

AGRICULTURAL EXTENSION PUBLICATIONS

1. Young, M., Nelson, S., Klose, S., and Enciso, J. *Increased Water Use Efficiency and Profitability in Citrus Production Possible in the Lower Rio Grande Valley.* Farm Assistance Focus Series 2013-5. Texas A&M AgriLife Extension Service, Texas A&M University System. December 2013. pp. 1-3.
2. Young, M., Nelson, S., Klose, S., and Enciso, J. *Water Savings and Higher Profit Margins Possible in Cotton and Other Field Crops in the Lower Rio Grande Valley.* Farm Assistance Focus Series 2013-4. Texas A&M AgriLife Extension Service, Texas A&M University System. December 2013. pp. 1-3.
3. Young, M., Nelson, S., Klose, S., Enciso, J., and McLemore, T. *Furrow vs. Surge Irrigation in Sugar Cane Under Restricted Water Availability in the Lower Rio Grande Valley.* Farm Assistance Focus Series 2013-1. Texas A&M AgriLife Extension Service, Department of Agricultural Economics, Texas A&M University System. May 2013. pp. 1-4.

PROFESSIONAL PRESENTATIONS

Jan 2013	Texas AWE workshop, On-Farm Irrigation Advances for Producers. Rio Grande Center for Ag Water Efficiency, Los Indios, TX. January 24, 2013. Economics and Water Management. Farm Assistance staff.
Mar 2013	Texas A&M AgriLife Research, Spring Seminar Series. Crop & Water Management Strategies for Sustaining Citrus Production in South Texas. S.D. Nelson. Corpus Christi, TX. March 4, 2013. (**Invited**)

Apr 2013 Texas Citrus Showcase. Weslaco, TX. April 4, 2013. Water Conservation Techniques for Citrus: Narrow Borders. S.D. Nelson. (**Invited**)

Apr 2013 Rio Grande Basin Initiative Meeting (final meeting of the RGBI partners). San Antonio, TX. April 16, 2013. Irrigation Management Strategies for Water Conservation in the Lower Rio Grande Valley. J. Enciso Nelson, S.D. Nelson, and M. Young.

Feb 2014 68th Annual Meeting of the Subtropical Agriculture & Environments Society. Weslaco, TX**:** Contreras-Barrangan, B., A. Kusabe, J.C. Melgar, and S.D. Nelson. Partial-Rootzone Drying an Effective Water Saving Strategy in Citrus. (1st place winner).