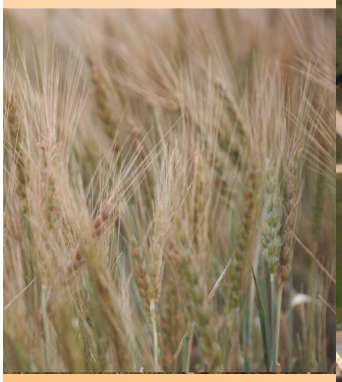
Wetting Front News



Soil and Water Management Research News

USDA-ARS Conservation and Production Research Laboratory
P.O. Drawer 10 • Bushland, Texas 79012-0010 U.S.A.
(806) 356-5724 • FAX (806) 356-5750 • 2300 Experiment Station Road

Fall / Winter 2010

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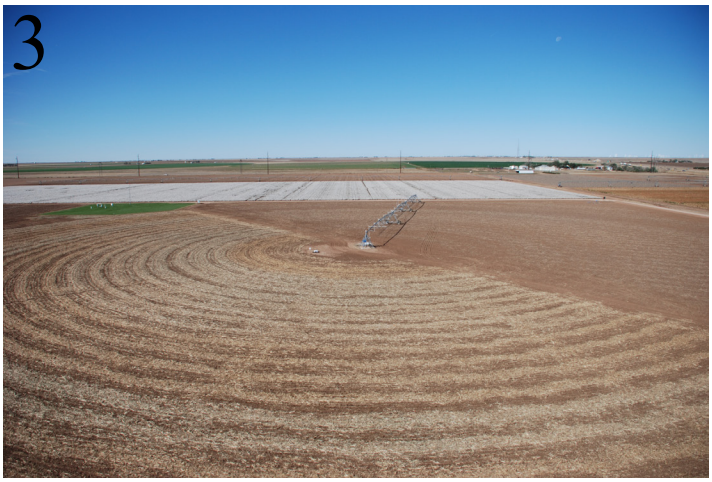
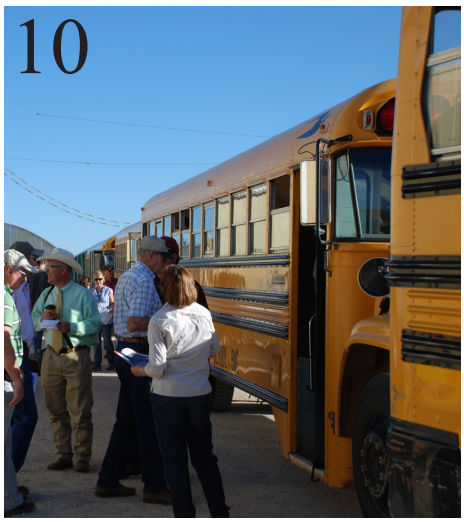
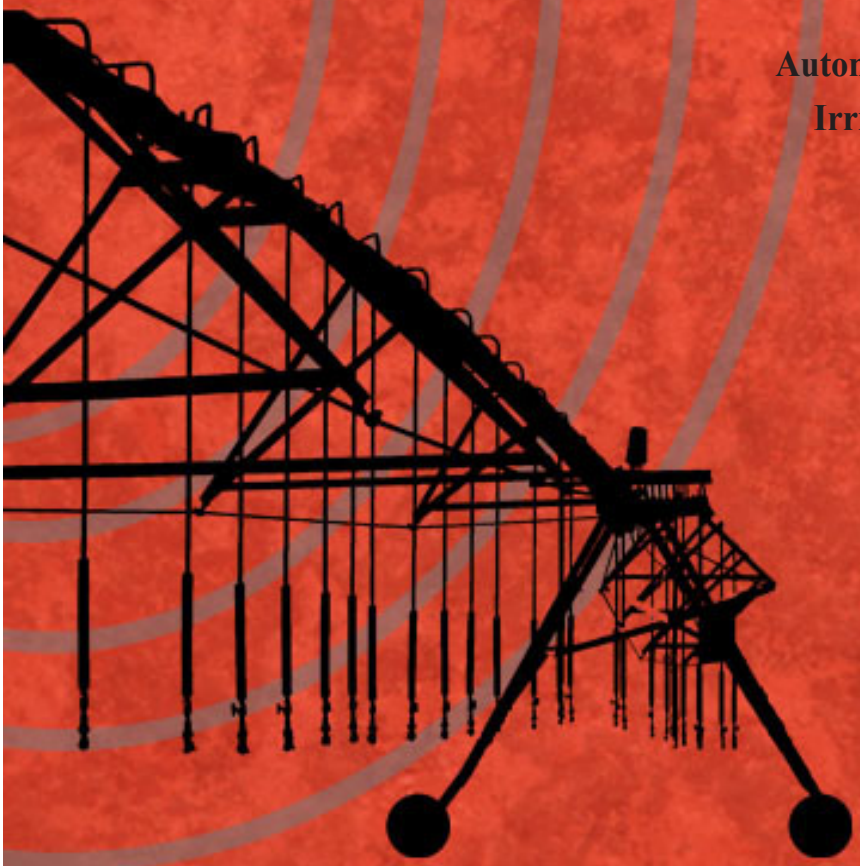




Automation and Control-Irrigation Management for the Future



Automatic Irrigation Scheduling at Deficit Irrigation Levels Controls Water Use

On a national scale, grain sorghum is grown primarily in semi-arid regions and is principally used in the United States as feed stock for cattle, swine and poultry. In the Northern High Plains region of Texas, 40% of grain sorghum is irrigated, resulting in yields double to those from dryland farming (Colaizzi et al., 2009). Because sorghum tolerates drought conditions relatively well, it is suitable for limited irrigation systems and deficit irrigation strategies (Baumhardt et al., 2007), which are important to extending the life of the Ogallala Aquifer. Our interest in irrigated grain sorghum was to: (1) evaluate the use of a thermal stress index for automatic irrigation scheduling, and (2) investigate sorghum yield response and water use efficiency across different irrigation levels.

By S.A. O'Shaughnessy, S.R. Evett, P.D. Colaizzi, and T.A. Howell

Irrigating at deficit levels requires careful consideration so as not to severely stress the crop, allowing producers to continue to meet contract requirements and sustain profitability. Sorghum is impacted by water stress at the vegetative period from planting to panicle initiation, the reproductive period from panicle initiation to flowering, and at the grain filling period (Maman et al., 2004). Visual symptoms of pre-flowering stress include leaf rolling; leaf bleaching; leaf tip and margin burn; reduction in plant height and biomass (Mastrorilli et al., 1995); delayed flowering; and reduced panicle size, seed size, and harvest indices (Prasad et al.,2008). Post-flowering drought stress is typically manifested by premature senescence, stalk lodging, stalk rot, and sometimes a significant reduction in seed size, particularly at the base of the panicle (Garrity et al., 1983; Rosenow et al., 1983; and Prasad et al., 2008).

We used the time temperature threshold (TTT) method to trigger automatic irrigations (also known at the Biologically-Identified Optimal Temperature Interactive Console, BIOTIC, patented by Upchurch et al., 1996). A number of studies have investigated the threshold yield level of irrigated grain sorghum. Colaizzi et al. (2004) showed the effects of different irrigation systems, low-energy precision applicators (LEPA), sub-surface drip irrigation (SDI), and mid-elevation spray applicators (MESA) on grain sorghum productivity in this region. These studies demonstrated the impact of different irrigation rates on grain yield for a period of three years (2000, 2001, and 2002) and showed that irrigation rates between 75% and 100% (of well-watered crop evapotranspiration) did not significantly increase sorghum grain yields for LEPA-irrigated crops grown at the Bushland Conservation and Production Research Laboratory. For this study, deficit irrigation treatments were chosen at levels of 80%, 55%, 30%, and 0% of replenishment of soil water depletion to field capacity. In addition to limited irrigation strategies, irrigation automation was investigated since automation can aid producers in achieving controlled water use efficiency and improving time management when overseeing multiple irrigation systems.

Methods

Grain sorghum (*Sorghum bicolor (L.) Moench*, Pioneer variety 84G62) was planted in concentric rows and plots under a six span center pivot sprinkler and irrigated with low elevation precision application (LEPA) drag socks (Fig. 1). The crop was seeded at a rate of 80,000 seeds ac^{-1} (197,700 seeds ha^{-1}) on day of year (DOY) 150, 2009 in 18-row plots on beds spaced 2.5 ft. (0.76 m) apart at Bushland, Texas (35° 11' N, 102° 06' W, 1174 m above mean sea level). The rows were furrowed-diked to reduce runoff. The cropped field was divided into 6 equal pie-shaped sections, three were irrigated manually on odd days of the year (DOY) and three were irrigated automatically on even DOY, if triggered by the thermal stress index. Irrigation treatments (three replications) were accomplished by nozzling and were arranged radially within each of six pie-slice-shaped sections, totaling 72 treatment plots. Manual irrigation levels were based on 80%, 55%, 30%, and 0% of replenishment of soil water depletion to field capacity as determined by neutron

Figure 1. Six-span center pivot system with wireless infrared thermometers mounted on the pivot lateral for monitoring crop canopy temperature as the pivot moves. Wireless infrared sensors are mounted in front of the drop hoses. Photo taken summer of 2009, Bushland, TX

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probe readings of soil water content taken weekly in the manual $I_{80\%M}$ treatment plots. Automatic irrigation levels were 80%, 55%, 30%, and 0% of peak water use levels (for a two-day period) established from well-watered sorghum grown on the Bushland large weighing lysimeter fields. Agronomic work is summarized in Table 1.

Table 1. Summary of Agronomics

Crop variety	**Pioneer 84G62**
Fertilize	Injected 215 lbs N ac^{-1} & 54 lbs P ac^{-1}, (DOY 64)
Planting date	May 30, 2009 (DOY 150)
Planting rate	80,000 seeds ac^{-1} (197,700 seeds ha^{-1})
Preplant irrigations	5.28 inches (134.1 mm)
Automatic irrigation scheduling dates	Jul 14 (DOY 195) – Sep 21 (DOY 264)
Plant mapping dates	Jun 23 (DOY 174), Jul 1 (DOY 182), Jul 17 (DOY 198), Aug 4 (DOY 216), Oct 7 (DOY 280)
Leaf area sampling dates	Jun 26 (DOY 177), Jul 10 (DOY 191), Jul 28 (DOY 209), Aug 14 (DOY 226), Sep 14 (DOY 257)
Herbicide application	Bicep II Magnum mixed w/Roundup (24 oz ac^{-1}), DOY 149
Pesticide application	Warhawk (1 pt. ac^{-1}) to control grasshoppers on DOY 203
Hand sample harvest dates	Oct 23-30 (DOY 296-303)

Automation:

Twenty-four wireless infrared thermometer (IRT) sensor modules and one wireless GPS unit (Fig. 2a) were deployed on the pivot arm to monitor crop canopy temperature (O'Shaughnessy and Evett, 2010). Wireless IRTs were fixed on masts in the field below to provide a reference temperature of the well-irrigated crop. Data from each sensor was transmitted every 5 minutes to an embedded computer on the pivot point. The embedded computer (Fig. 2.b) used the real-time data to schedule and control the automatic irrigations.

Figure 2. Equipment at center pivot for automation and control: (a) GPS with solar backup for in-field spatial mapping (rectangular area) and (b) embedded computer for automatic data collection.

Automatic irrigation scheduling was based on the Time Temperature Threshold (TTT) method (Evett, et al., 1996; Peters and Evett, 2008), where if the crop canopy temperature exceeded 28 °C for more than 315 minutes on an odd-numbered DOY, an irrigation was triggered for the automatic pie-slice-shaped sections. When the pivot was moving, crop canopy temperatures across the field were estimated throughout the day using one time of day scaling methods by Peters and Evett (2004).

Crop Water Use:
Crop water use or evapotranspiration (ET) was calculated using the soil water balance equation (Evett, 2002):

$$ET = P + I + F - \Delta S - R \quad [1]$$

where ET is evapotranspiration, ΔS is the change in soil water stored in the profile, R is runoff, P is precipitation (mm), I is the irrigation water applied (mm), and F is flux across the lower boundary of the control volume (taken as positive when entering the control volume), all in units of mm. Runoff and flux were assumed negligible. Water use efficiency (kg m^{-3}) was calculated as:

$$WUE = \frac{Y_g}{ET} \quad [2]$$

where Y_g is the economic yield (g m^{-2}), and ET is the crop water use (mm). Irrigation water use efficiency (IWUE, kg m^{-3}) was calculated as:

$$IWUE = \frac{\left(Y_{gi} - Y_{gd}\right)}{IRR_i} \quad [3]$$

where Y_g is the economic yield (g m^{-2}), Y_{gd} is the $I_{0\%}$ yield (g m^{-2}), and IRR is the irrigation water applied (mm) (Howell, 2002).Yield responses were analyzed using General Linear models (GLM).

RESULTS

Irrigations:
Preplant irrigations totaled 5.3 in (134 mm) and were applied due to a dry soil profile. Total post plant application depths for both irrigation methods are listed in Table 3. The mean total irrigation amount for the $I_{80\%M}$ treatment was 3.5 in. (88 mm) greater than that for the $I_{80\%A}$ treatment. After Aug 30 (DOY 242), the frequency of automatically scheduled irrigations slowed from 2- to 4-day intervals to approximately 8-day intervals. The infrequency was due mainly to the decrease in average air temperature and maximum solar irradiance in the later part of the irrigation season. Manual irrigations were discontinued after Sep 16 (DOY 259) at which time plant available soil water was approximately 6. in or 147 mm. The last automatically scheduled irrigation occurred on Sep 21 (DOY 264). Irrigations could have been terminated earlier; however, there was concern over the crop lodging prior to mechanical harvesting.

Table 2. Irrigation amounts delivered for growing season 2009 (not including pre-plant irrigation).

	Irrigation control treatment	
Irrigation Amount Treatment	Manual (mm/in.)	Automatic (mm/in.)
80%	470/19	395/16
55%	344/14	283/12
30%	218/9	190/8
0%	0	0

Biophysical measurements:
Plant heights and widths between irrigated treatments ($I_{80\%}$, $I_{55\%}$, $I_{33\%}$) were not significantly different until 66 days after planting (DAP). After 66 days, plants receiving higher irrigation rates ($I_{80\%}$ and $I_{55\%}$) grew significantly more than those irrigated to the $I_{33\%}$ and $I_{0\%}$ levels. There was no significant difference between manually and automatically irrigated plant height and width when

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comparing measurements in the same treatments. However, we observed that plant growth stages across irrigation treatments were slowed as the deficit irrigation level increased, but only by a few days. Most grain from the $I_{0\%}$ plots did not fill due to the limited amount of irrigation water and rainfall, and the same planting density as the irrigated treatments. A number of plants in the automatically irrigated plots at the $I_{55\%}$ level lodged prior to machine harvesting.

Yields:

Samples for biomass and grain yields were harvested from each of the 72 treatment plots from a 1.5 m^2 and a 10 m^2 area, respectively. Plant density was not significantly different among the $I_{80\%}$, $I_{55\%}$, and $I_{0\%}$ irrigation treatment plots. Panicle counts and biomass yields in the same treatment plots were not significantly different when compared between the manual and automatic control methods. However, biomass yield in the $I_{30\%M}$ treatment was significantly greater than yields from the $I_{30\%A}$ treatment at $p = 0.05$, (Table 3).

Table 3. Plant density, head count and biomass yields.

Irrigation Control Treatments	Irrigation Amount Treatments			
	80%	55%	30%	0%
	Plant density (# m^{-2})			
Manual	12.4 a	12.0 a	10.8 a	10.3 a
Automatic	11.5 a	11.5 a	10.1 a	11.1 a
F-statistic/p	1.33/0.27	4.12/0.06	1.0/0.33	1.48/0.24
	Panicle count (# m^{-2})			
Manual	15.36 a	14.3 a	12.5 a	9.1 a
Automatic	14.8 a	14.1 a	12.7 a	9.6 a
F-statistic/p	0.69/0.42	0.40/0.53	0.33/0.56	0.49/0.49
	Biomass yield (g m^{-2})			
Manual	2085 a	1580 a	1216 a	565 a
Automatic	2122 a	1605 a	1039 b	606 a
F-statistic/p	0.12/0.73	0.12/0.74	6.0/0.03	0.36/0.56

Values followed by the same letters in each column of irrigation treatment are not significantly different at $p \leq 0.05$.

Grain yields across irrigation amount treatments were significantly different from one another, and demonstrated a curvilinear response to the level of irrigation applied (Fig.3). These results indicated that yield increase is more responsive between irrigation levels of I_{30} and I_{55}, whereby 58% (126 mm) of additional irrigation water resulted in a 56% increase (3040 kg ha^{-1}) in grain yield, while the difference between the $I_{55\%}$ and $I_{80\%}$ treatments showed that a 37% increase in irrigation water resulted in only a 16% increase in grain yield. The differences in irrigation

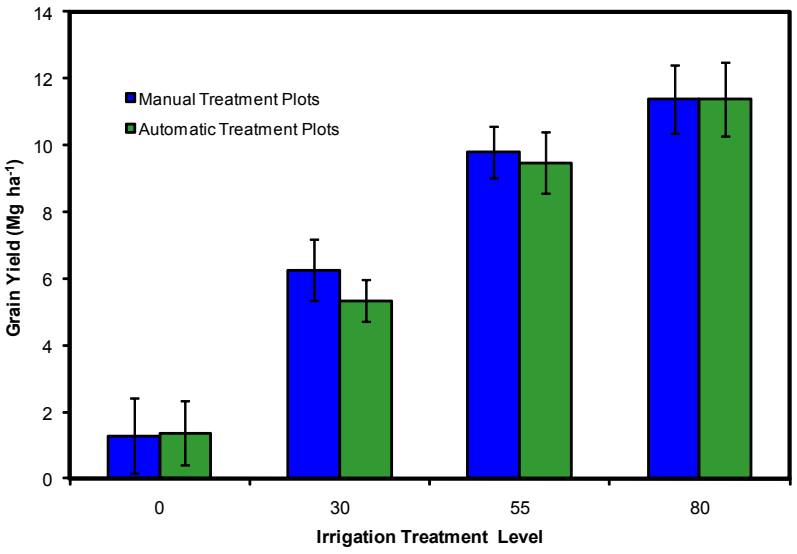


Figure 3. Average grain yield (representing 9 treatment plots) across irrigation amount treatments (80%, 55%, 30%, and 0% of replenishment of soil water depletion) and between irrigation control treatments (manual and automatic. Error bars represent standard deviation

amounts and yield between the $I_{0\%}$ and $I_{30\%}$ showed that an addition of 218 mm and 190 mm of water increased yields by 387%, and 290% in the manually and automatically controlled treatment plots, respectively.

Seed weights for the $I_{30\%M}$ plots were significantly greater than those for the $I_{30\%A}$ treatment plots. The significant difference in yield was likely due to soil water variability; four plots in the $I_{30\%M}$ treatments were initially very wet and remained wetter than plots in the $I_{30\%A}$ treatment throughout the growing season.

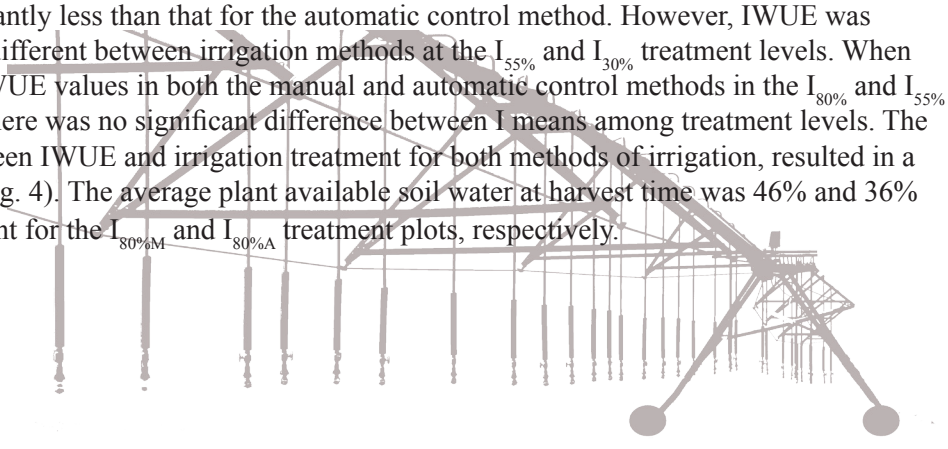
Crop ET and Water Use Efficiency:
Seasonal grain sorghum ET was calculated for the period from two weeks after planting until the crop was hand-harvested. ET was only significantly different between irrigation methods in the $I_{55\%}$ treatment level. Water use efficiency (WUE) was not significantly different between the $I_{80\%}$ and $I_{55\%}$ levels or between irrigation methods at these levels (Table 4).

Table 4. Grain sorghum evapotranspiration, water use efficiency, and irrigation water use efficiency for the 2009 growing season at Bushland, TX.

	Irrigation Levels			
Irrigation Control Treatments	80%	55%	30%	0%
	Crop ET (mm/in.)			
Manual	656/26 a	578/23 a	480/19 a	357/14 a
Automatic	641/25 a	565/22 b	479/19 a	342/13 a
F-statistic/p	1.76/0.20	5.97/0.03	0.01/0.92	0.58/0.46
	WUE (kg m^{-3})			
Manual	1.5 a	1.5 a	1.1 a	0.3 a
Automatic	1.5 a	1.4 a	0.9 b	0.3 a
F-statistic/p	0.23/0.70	0.10/0.78	7.90/0.01	0.12/0.73
	IWUE (kg m^{-3})			
Manual	1.3 b	1.4 a	1.1 a	N/A
Automatic	1.6 a	1.6 a	1.0 a	N/A
F-statistic/p	9.19/0.01	4.0/0.06	1.49/0.24	

Values followed by the same letters in each column of irrigation treatment are not significantly different at $p \leq 0.05$.

Irrigation water use efficiency (IWUE) for the manual control method in the $I_{80\%}$ treatment level was significantly less than that for the automatic control method. However, IWUE was not significantly different between irrigation methods at the $I_{55\%}$ and $I_{30\%}$ treatment levels. When considering all IWUE values in both the manual and automatic control methods in the $I_{80\%}$ and $I_{55\%}$ treatment plots, there was no significant difference between I means among treatment levels. The relationship between IWUE and irrigation treatment for both methods of irrigation, resulted in a concave curve (Fig. 4). The average plant available soil water at harvest time was 46% and 36% above wilting point for the $I_{80\%M}$ and $I_{80\%A}$ treatment plots, respectively.



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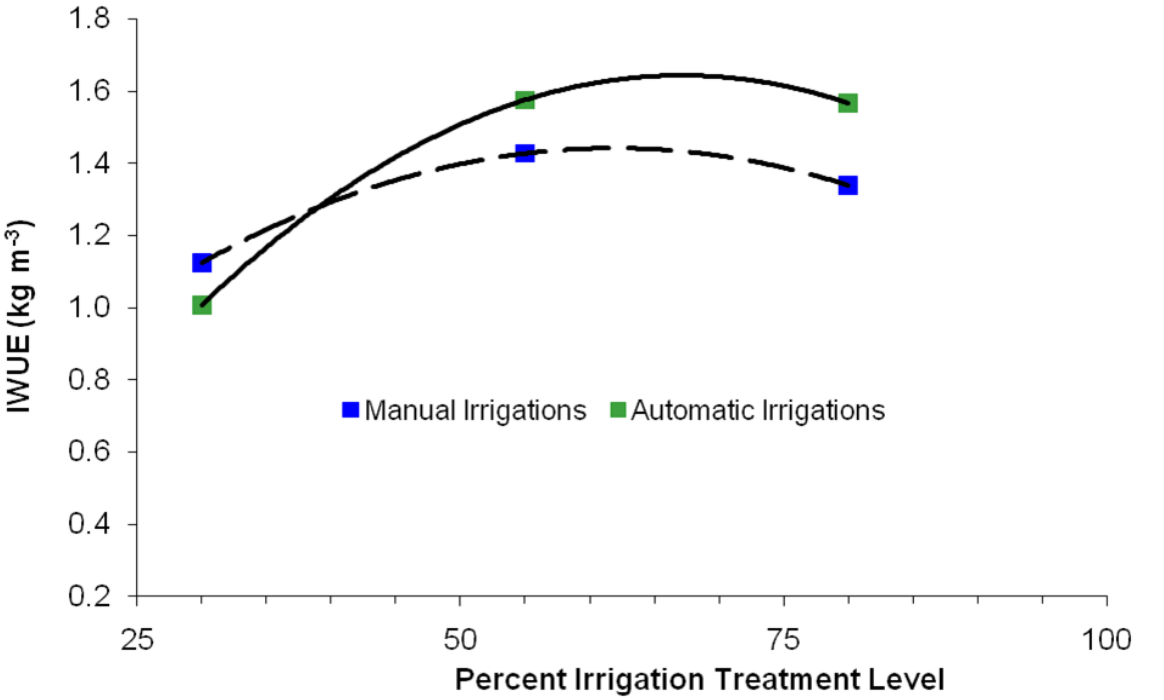

Figure 4. Relationship between irrigation water use efficiency and irrigation treatment levels for both the manual and automatic control methods.

Conclusion

The optimal irrigation rate for producing this late maturing variety of grain sorghum with maximum water use efficiency for growing season 2009 was between 50% and 75% replenishment of soil water depletion. Similar to results shown by Tolk and Howell (2003), sorghum grain yield response to irrigation was curvilinear. For this growing season, automatic irrigation scheduling resulted in water savings and could be realized as a water conservation measure if additional acreage is not committed to irrigation.

Automatic irrigation scheduling and control using the Time Temperature Threshold (TTT) method produced grain yields similar to irrigation scheduling with weekly neutron probe measurements in the $I_{80\%}$ and $I_{50\%}$ treatment plots. Irrigation water use efficiency levels were improved by automatic control in the higher irrigation treatment plots. Automation was accomplished using wireless sensor networks for spatial crop canopy monitoring and irrigation control. In addition to crop monitoring and water savings, the benefits for irrigation automation can be realized in terms of decreased management time for producers administering multiple irrigation systems without adversely impacting crop water use efficiency.

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Summer Crops Field Day

Sept. 2, 2010

Hosted by

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Above: Dr. Fred Miller, MMR Genetics Senior sorghum breeder and professor Emeritus - Texas A&M Soil and Crop Sciences Depart was the guest speaker speaking on "Sorghum's Foundation and Thoughts for the Future". Clockwise: Drs. Judy Tolk, Robert Schwartz, Susan O'Shaughnessy and Louis Baumhardt from the Soil Water Management Research Group provided information for part of the tour stops. Over 125 producers,

farmers, extension specialists, university collaborators, and staff attended this years' field day. The sessions addressed included corn pest management, sorghum weed control trials, wheat curl mite/wheat streak mosaic virus, iWheat, sorghum growth and yield comparisons, grazing in no-till wheat/ sorghum/ fallow rotation, automatic irrigation scheduling and early season water use of sorghum, herbicide technology for sorghum grass control, and forage sorghum silage and hay trials.

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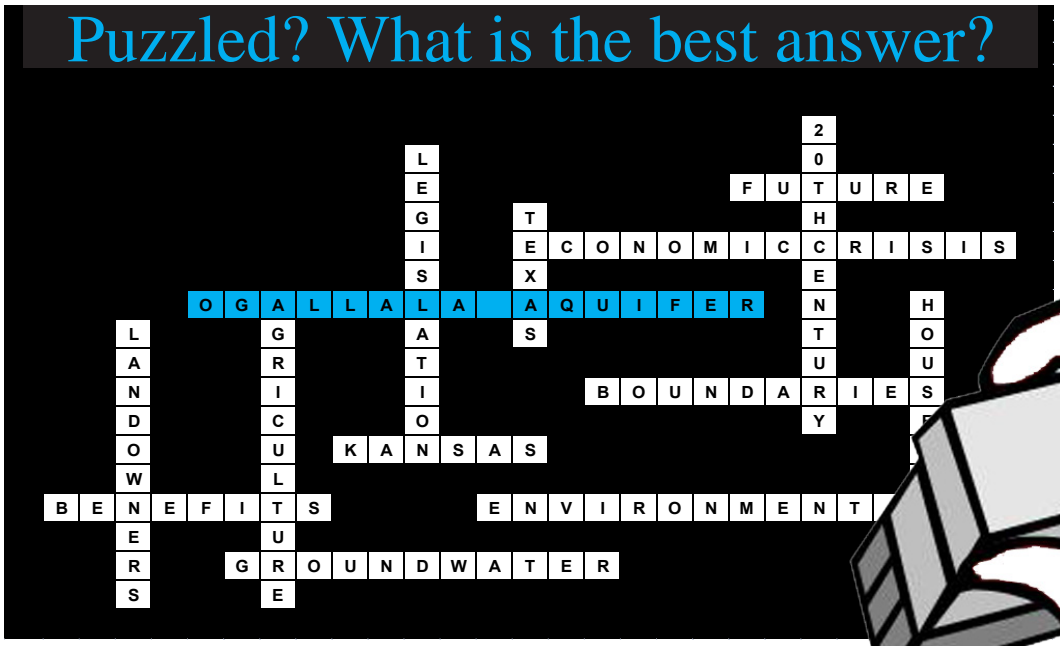

Desired Future Conditions in Texas: What is it about and why should agricultural researchers care?

By David K. Brauer

Errata and Update

The previous article described events leading to the adoption of Desired Future Condition (DFC) for the Ogallala Aquifer in GMA #1 up to November 11, 2009. A petition against the DFC adopted by GMA #1 was filed by Mesa Water LP and G&J Ranch. A hearing was held regarding the petition on November 11, 2009 in which the petitioners and representatives from GMA #1 argued in support and against the adopted DFC. Texas Water Development Board (TWDB) had a special meeting on January 21, 2010 to allow petitioners and respondents an opportunity to address points of the petition directly to the board.

CORRECTION: In the previous article of the Wetting Front, I confused some of the abbreviations for the various Groundwater Conservation Districts in the Groundwater Management Area #1 (GMA #1). To clarify: The Desired Future Condition (DFC) for the Ogallala Aquifer that was adopted by GMA #1 was: 80% remaining in 50 years for Hemphill County Underground Water Conservation District (Hemphill County UWCD); 50% in 50 years for Panhandle Groundwater Conservation District and High Plains Underground Water Conservation District #1; 40% in 50 years for the counties of Dallam, Sherman, Hartley and Moore in the North Plains Groundwater Conservation District; and 50% in 50 years for the remainder of the North Plains Groundwater Conservation District. Again my apologies for errors that were created by not proofing the article closely enough to ensure the right abbreviations were used throughout the article.

Ogallala Aquifer Program Website: http://www.ogallala.ars.usda.gov/

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On February 17, 2010, the Board Members of TWDB had a special meeting to rule that the DFC for the Ogallala Aqufier adopted by GMA #1 was not unreasonable. In their determination, the Board ruled: 1) the various groundwater districts in GMA #1 had engaged in joint planning; 2) the adopted DFC did not prohibit someone from pumping groundwater from the Ogallala Aquifer under their property; 3) county lines can be used to define geographic areas for different DFC if the aquifer uses and conditions support the use of such boundaries; 4) districts reasonably considered environmental impacts, including impacts to flows of springs; 5) the districts balanced various interests, uses and potential users; and 6) finally, the DFC was physically possible.

Certain issues in the petition were not fully resolved by the TWDB's ruling of February 17 2010. The petitioners argued that Hemphill County UWCD acted outside its authority when defining a DFC of 80% in 50 years because of the potential impact on private property rights, that is water rights and/or land values in Hemphill County. Issues related to private property rights have not been settled in the courts and TWDB believes the question was beyond the authority of the board to decide. Petitioners also argued that springs were not afforded equal protection throughout of GMA #1 because of the differences in DFC in the area. The ruling by TWDB did not address this issue directly but did rule that the potential impacts to springs and base flows to rivers were considered throughout the GMA #1 by the joint planning activities.

Learn More At:
http://www.texaswatermatters.org/
Texas Water Matters Site: Basic Info On Texas Water Issues
http://www.panhandlewater.org/
Water Planning for Texas Panhandle
http://www.twdb.state.tx.us/home/index.asp
Texas Water Development Board

Petitioners claimed that the Groundwater Conservation Districts did not quantify the socio-economic impacts of the DFC. TWDB ruled that neither the Texas Water Code nor TWDB rules require the Groundwater Conservation Districts to quantity the socio-economic impacts of the DFC. The Groundwater Conservation Districts must have considered potential socio-economic impacts in their deliberations leading to the DFC, which they did.

The saga regarding the DFC for the Ogallala Aquifer in GMA #1 has not ended with the February 17, 2010 ruling by TWDB. Mesa Water LP and G&J Ranch have sued the TWDB regarding their ruling and implementation of the DFC by the Groundwater Conservation Districts in GMA #1. At the April 28, 2010 meeting of the Panhandle Water Planning Group, lawyers that represent Mesa Water LP and other parties argued that changes to the water supply in the 2011 water plan to reflect the adopted DFC for the Ogallala Aquifer in GMA #1 were not advisable for two reasons: 1) on-going legal challenges to the TWBD ruling on DFC had not been resolved; 2) possible legislative action to chapter 36.108 under which DFC are determined may occur in the near future.

Despite these uncertainties, the Panhandle Water Planning Group and the Groundwater Conservation Districts in the Panhandle appear to be operating on the assumption that the adopted DFC for the Ogallala Aquifer will dictate its use in the foreseeable future.

American-Mexican Group Meet to Discuss Water Conservation

By David K. Brauer

A group of 10 scientists, researchers, or farmers from the state of Zacatecas in Mexico met on July 7-9, 2010 with Agricultural Research Service scientists from Bushland, Texas and El Reno, Oklahoma; scientists from the University of Georgia, Texas A&M University, Kansas State University, and the U.S. Geological Survey, along with representatives from regional ground water conservation districts, Foreign Agricultural Service-USDA, and National Resource Conservation Service-USDA. The purpose of the workshop was to discuss water conservation practices for the Calera Aquifer in Mexico, the multi-state Ogallala Aquifer, and the Rush Spring Aquifer in Oklahoma. Water for irrigation is the chief use for water in all three of these aquifers and agriculture contributes greatly to the three regional economies. This project in Mexico is an 'outgrowth' from the Ogallala Aquifer Program which consists of scientists with USDA-ARS laboratories at Bushland and Lubbock, Texas, along with scientists and research with Kansas State University, Texas AgriLife Research and Extension Service at both Amarillo and Lubbock, Texas Tech University, and West Texas A&M University. This was the third meeting of this American-Mexican group; the first two meetings were held in, Zacatecas, Mexico. The group from Mexico included scientists, water policy makers, and farmers. The farmers also were member of the local water district, COTAS.

Presentations on the first day (July 7) gave an overview of the geographic area covered by Ogallala Aquifer and the importance of the aquifer to the economy of the Texas High Plains. An overview of the available services to assist farmers with irrigation problems and increasing water application efficiency was given by representatives from the Natural Resource Conservation Service-USDA and Texas AgriLife Extension Service. These presentations addressed questions that the people from Mexico had during the second workshop held in October 2009. The last

presentations of the day were progress reports by the research team regarding efforts made by the group since the last meeting. It was noted that information regarding the hydrology of the Calera Aquifer is less developed than that for the Ogallala Aquifer.

On the second day of the workshop, the participants divided into two groups: one group discussed technical issues related to the research projects; the other visited the North Plains Ground Water Distinct in Dumas, Texas and the Texas AgriLife Research Station at Etter, Texas. Representatives of the North Plains Groundwater District discussed how their organization worked and a lively discussion occurred. Decisions regarding ground water use tend to be made by the central federal government in Mexico City and the delegates from COTAS expressed a desire to have a system more like that on the Texas High Plains in which water users and the public are more involved in making water policies. At the Texas AgriLife Research Station at Etter, the group was briefed on the economics of water conservation regarding grain production. It became apparent from this discussion that farms in Zacatecas tend to be smaller and water use is under stricter control by the federal government. Despite the differences, the group from Mexico was interested in how they could use more efficient irrigation techniques common to Texas to help them deal with a proposed 50% decrease in water appropriations in the next 10 years.

On the workshop's last day (July 9), the group toured the Conservation and Production Research Laboratory of USDA-ARS in Bushland, Texas. Presenters on the tour were chosen to feature research that may be useful to the group from Mexico to adapt to decreasing allotments of water for irrigation. Discussion on the last day culminated in an action plan for further research, which would include development of a better understanding of the hydrology of the Calera Aquifer and how much water can be saved by farmers by adopting water efficient irrigation systems.

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Technology Transfer

(Pictured Right) In August a group of 20 individuals from Australia, sponsored by 'The Australian Cottongrower' magazine who organized the tour were hosted by Conservation Production Research Laboratory in conjunction with the Texas AgriLife Research-Amarillo. The visitors were farmers and their spouses who are broad acre grain farmers, cotton growers, or irrigators. They all share an interest in new farming technology and research. While in Texas, they met with a seed company and toured an ethanol plant near Lubbock, and while in Bushland they were shown our cotton, wheat, and other irrigated research plots by Steve Evett and Paul Colaizzi (ARS) and Jacob Price, Jackie Rudd, and Qingwu Xue (AgriLife).

(Pictured Right) In May a small group of Ag Operations students (9) from Northwest College, Powell, Wyoming. Terry Howell (far left) took the group on a tour and showed them the feedlot, wind turbines, and the irrigation plots, lysimeters, rain shelter, terraces, subsurface irrigation plots, and windbreaks.

(Pictured Left) In July our laboratory hosted a visit from five members of the public relations office from Cotton, Inc. The company is considering the development of a video which examines issues related to cotton production. The objectives of their visit were (1) updates on the current water/irrigation related research in progress in west Texas;(2) identification of research gaps and funding needs; and (3) look at developing a video. The group spent two days with individuals from the ARS Lubbock laboratory and AgriLife then came to the Bushland laboratory where they met with Paul Colaizzi, Susan O'Shaughnessy, Louis Baumhardt, David Brauer and Texas AgriLife Research. They were also taken to locations around Amarillo where they met with local area cotton producers.

(Pictured Right) is USDA-ARS and Israeli researchers visit a vineyard for wine grape production in the Negev Desert, Israel, where research is being conducted on energy and water balances and water fluxes in the atmosphere to better understand water use in this arid environment.

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Planting the Seed of Science for Future Generations

Left: Soil Scientist Steve Evett's identifies the vegetables that are grown. The vegetables are taken to the High Plains Food Bank for distribution.

Right: Kindergarten Kids from nearby Bushland Elementary School admire their ornamental pumpkins they picked from the garden.

ARS - Bushland People's Garden
an effort by USDA which challenges its employees to establish a garden at USDA facilities

Above: Susan O'Shaughnessy, Agricultural Engineer, helps to convince doubting minds you can complete an electric circuit through a circle of human beings.

Below: Jourdan Bell, Biological Technician, demonstrates to the girls the properties and values of soil profiles by using cupcakes to represent different layers of soil.

Women in Science Endeavors
a community event held each fall for middle school girls to come to a hands on workshop designed to pique their interest in math and science

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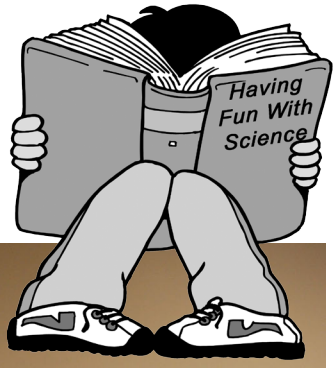
Building Adobe Houses
4th Graders at Bushland Elementary

Biological Science Technician, Jourdan Bell, and Soil Scientists, Robert Schwartz and Steve Evett worked with the fourth grade at Bushland Elementary to make miniature adobe bricks and then build miniature adobe houses (pictured left) in a project designed to teach how ancient and some contemporary peoples built with soil materials and the related soil science ideas.

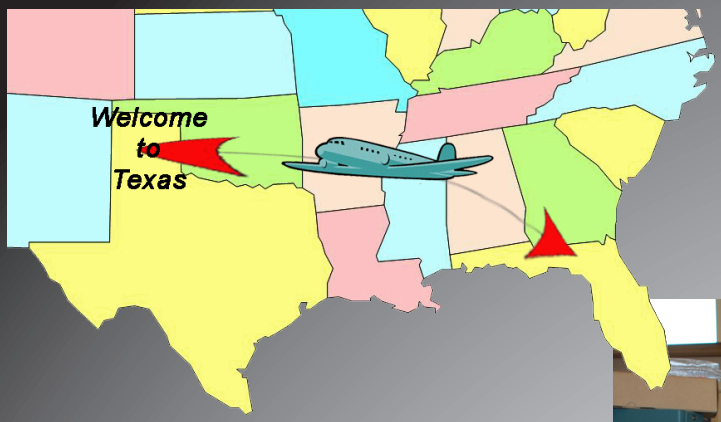
"It is not so much what is poured into the student, but what is planted that really counts."

- Unknown

Window on a Wider World
a science, arts and culture collaborative that aims to bolster education in the Panhandle



Above: Agronomist Dave Brauer demonstrates water properties and how it relates to the Ogallala Aquifer to 5th graders from area schools at the Discovery Center in Amarillo, Texas.



Meet The New Post Doc

Hi everybody! My name is Joaquin Casanova. I began work at CPRL in late May 2010 as a post-doctoral research associate for Dr. Steve Evett. I'm interested in electromagnetics, heat and mass transfer, numerical simulation, and pattern recognition. My work for Dr. Evett focuses on the design and testing of a time-domain reflectometer for sensing soil moisture.

I received the B.S. and M.S. degrees in agricultural and biological engineering from the University of Florida in 2006 and 2007, respectively, with research focusing on microwave remote sensing of soil moisture for growing sweet corn and cotton. During this research I worked on several large-scale field experiments and also worked on numerical model development. This May, I received the Ph.D. degree in electrical engineering, with research focusing on the design, optimization, and testing of wireless power systems. I'm a member of the ASABE and IEEE.

This research is a good combination of electrical and agricultural engineering, so I'm excited to get to use all of what I've learned, and to be working with such friendly people!

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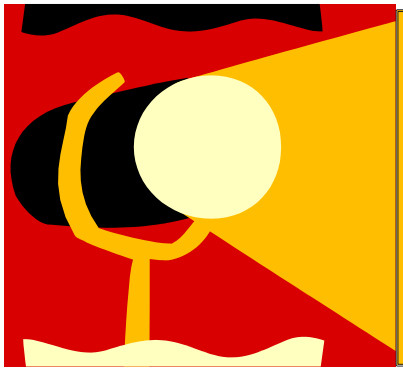

Conservation & Production Research Laboratory Shines in Excellance with 8 Awards

Texas Environmental Excellence Award (TCEQ)
Dr. Richard W. Todd, Research Soil Scientist, & Dr. N. Andy Cole, Research Animal Scientist, in collaboration with Texas AgriLife Research and Extension Service and West Texas A&M University

ASABE (American Society of Agricultural and Biological Engineers) Outstanding Paper Award
Dr. Prasanna H. Gowda, Research Agricultural Engineer - Lead Author

FLC (Federal Laboratory Consortium) Notable Technology Award
N. Andy Cole, Research Animal Scientist; Richard W. Todd, Research Soil Scientist; and Larry Fulton, Biological Science Technician, in collaboration with Texas AgriLife Research and Extension Service and West Texas A&M University

ARS (Agriculture Research Service) Post Doctoral Research Award
Dr. Prasanna Gowda, Research Agricultural Engineer co-shared with El Reno Grazinglands Research Laboratory (Dr. Daniel Moriasi, Research Hydrologist; and Dr. Jean L. Steiner, Research Soil Scientist / Laboratory Director)

Mentor Award from Women in Agronomy, Soils Crops, and Environmental Sciences
Dr. Robert C. Schwartz, Research Soil Scientist

SSSA (Soil Science Society of America) Soil Science Applied Research Award
Dr. Steven R. Evett, Research Soil Scientist

SPA (Southern Plains Area) Scientist of the Year Award
Dr. N. Andy Cole, Research Animal Scientist

A**RS (Agriculture Research Service) Outstanding Office Professional of the Year**
Beth Holt, Program Support Assistant

Notables:

SPA Francisco Salinas Safety and Health Award to **CPRL**. Presented at ARS Southern Plains Area Leadership Conference, Nov. 17-19, 2009 at Westlake, TX.

Gretchen Adams, a former Biological Science Aide with Robert Schwartz, received a B.A. and Jane Ann Stewart Dryland Agriculture Scholarship, established for Graduate students on Dr. Stewart's retirement as Director of USDA-ARS, Bushland, and in honor of his world renowned leadership in Dryland Agriculture.

Renee Allison, a Biological Science Aide with Prasanna Gowda, received two scholarships. (1) The B.A. and Jan Ann Stewart Dryland Agriculture Scholarship, established on Dr. Stewart's retirement as Director of USDA-ARS, Bushland, and in honor of his world renowned leadership in Dryland Agriculture. 2) Jimmie Green Scholarship, established in 2000 in memory of Professor Jimmie Green for outstanding Plant Science students.

Travis Allison, a Biological Science Aide with Robert Schwartz, received the C.M. Kulhman Memorial Provost's Leadership Scholarship. This scholarship was established in 2006 in memory of C.M. Kuhlman for his leadership and service to the University.

Jim Belt, a Biological Science Aide with Susan O'Shaughnessy, was awarded the Bradley Jay Rickwartz Memorial Scholarship, established in 1984 for WT students in Plant Science education.

Stephanie Schumacher, a Biological Science Aide with Susan O'Shaughnessy, received a Douglas Josserand Memorial Scholarship, established in 1991 in his memory for leadership for students in Agribusiness.

Partson Mubvumba, WTAMU graduate student (Committee members **Steve Evett and Robert Schwartz**) completed the requirements for the M.S. degree and has accepted a position at AgriLife in Vernon, TX.

Judy Tolk was elected Chair-Elect of the Climatology and Modeling Division of the American Society of Agronomy.

Louis Baumhardt was recognized as retiring SSSAJ-Associate Editor October 31, 2010.

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Employee Spirit

CFC Campaign

The Combined Federal Campaign (CFC) Kick-off began with good eating offered to employees for their donation. This year's goal of $10,000 was met and surpassed.

Collegiate Colors Day

September 3rd was declared as the 'official' WEAR YOUR COLLEGIATE COLORS DAY. CPRL Employees were invited to sing their school song.

People's Garden

The People's Garden' is an effort by USDA which challenges its employees to establish gardens at USDA facilities worldwide or help communities create gardens. By November 1st 1,790 lbs of vegetables had been donated to the High Plains Food Bank Pictured far left is Terry Howell with Marc Jansing of the Food Bank with the first pickings of the garden being weighed in at the Food Bank. Left: volunteers begin the process of preparing beds to plant.

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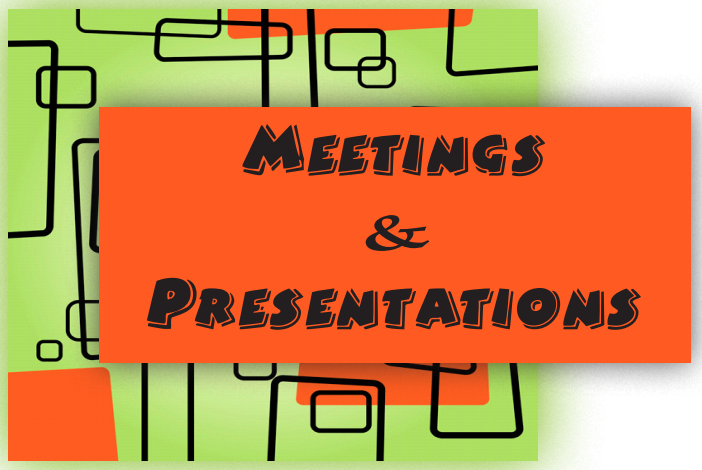

Paul Colaizzi attended the Pioneer Crop Protection Workshop, January 13, 2010 in Panhandle, TX.

Robert Schwartz presented an invited talk at the SPA Scientific Seminar, January 21, 2010 entitiled "Elucidating soil hydrological processes with accurate water content sensing at high temporal resolution: a key to optimizing the use of limited water" at the Southern Plains Area Office in College Station, TX.

Susan O'Shaughnessy, Paul Colaizzi, Judy Tolk, Jairo Hernandez, Ed Hutcherson, Don McRoberts and Luke Britten attended the High Plains Irrigation Conference on January 22, 2010.

Prasanna Gowda attended the 64th Annual Subtropical Plant Science Society Meeting, Texas A&M University-Kingsville Citrus Center, January 25, 2010, Weslaco, TX.

Conference Abstract:

***Gowda, P.H.**, J. Goolsby, T. Howell, C. Yang, and S. Basu. 2010. Application of scintillometry to estimate water use by giant weed (Arundo donax L.) – A perennial invasive weed along the Rio Grande River near Laredo, Texas.*

David Brauer, Terry Howell, and Susan O'Shaughnessy attended the planning meeting for the Ogallala Aquifer Program Workshop on February 11, 2010 in Bushland, TX.

February 19, 2010, **Steve Evett** gave an invited presentation, "Soil Water Sensors from A to Z" to a combined audience from Colorado State University, USDA-ARS at Fort Collins, CO, and consulted on soil water sensing for irrigation management and crop water use determination with USDA-ARS and university personnel.

February 25 and 26, 2010, **Steve Evett** gave invited presentations to the Monsanto "Probe Group" titled "Soil Water Sensors for Irrigation Scheduling and Crop Water Use Determination" and "Soil Water Tension and Content Control for Irrigation Scheduling and Crop Water Use Determination under Reproducible Stress Levels" in St. Louis, MO.

Prasanna Gowda attended the "It's Your Water" Showcase, U.S. Department of Agriculture-Agricultural Research Service, March 2-3, 2010, St. Louis, MO.

Conference Abstract:

***Gowda, P.H.**, and D.J. Mulla. 2010. Water quality modeling studies with the ADAPT model in the Minnesota River Basin. MO [CDROM].*

Terry Howell, Steve Evett, Robert Schwartz, Prasanna Gowda, Jairo Hernandez, David Brauer, Paul Colaizzi, Judy Tolk and Susan O'Shaughnessy attended the Ogallala Aquifer Program Workshop, March 2-4, 2010, in Amarillo, TX.

April 8, 2010, Leadership Amarillo/Canyon toured the laboratory and several scientists presented information to them.

May 2-5, 2010, **Steve Evett** presented an invited talk, "Trends in Crop Water Productivity Enhancement: Why the New Green Revolution must be Blue-Green", to the Water for Food Conference in Lincoln, NE.

Terry Howell attended the Proc. Environmental, Water Resources Institute (Am. Soc. Civil Eng.) North American Water and Environment Congress, in Providence, RI on May 16-60, 2010

Proceedings from Meeting

*Chávez, J.L., **T.A. Howell**, D. Straw, **P. Gowda**, L. Garcia, **S.R. Evett**, T. Ley, L. Simmons, M. Bartolo, P.D. Colaizzi, and A. Andales. 2010. Surface Aerodynamic Temperature derived from wind/temperature profile measurements over cotton and alfalfa in a semi-arid environment. (CD-ROM)*

Susan O'Shaughnessy, Paul Colaizzi, Jairo Hernandez and Dave Brauer attended the Wheat Field Day, May 19, 2010 in Etter, TX.

On May 28, 2010, **Steve Evett** was interviewed by KGNC Ag Radio, in Amarillo, TX, on advances in irrigation scheduling and control including crop water stress sensing and variable rate center pivot irrigation systems.

Terry Howell, Prasanna Gowda and Jairo Hernandez attended the ASABE Annual International Meeting on June 20-23, Pittsburg, PA.

Prasanna Gowda accepted a paper award with **Terry Howell** and Thomas Marek

Abstract from Meeting:

***Hernandez, J.E., P.H. Gowda**, L.K. Almas, T.H. Marek, **T.A. Howell**, and **Ha W.** Modeling Groundwater Levels in the Northern High Plains of Texas.*

Prasanna Gowda attended the Western Societies of Crop Science and Soil Science Joint Meetings, June 21-24 in Las Vegas, Nevada.

Abstracts from Meeting:

*Rangappa, U., S. Angadi, **P.H. Gowda**, M. Marsalis, A.N. Cole, S. Begna, and R. Hagevoort. 2010. Evaluation of annual forage legumes under partial and full sunlight in the Southern Great Plains.*

*Begna, S., A. Wahby, **P.H. Gowda**, M. Marsalis, A.N. Cole, R. Hagevoort, A. Sangamesh. 2010. Radiation interception, forage yield and quality of sorghum-legume intercropping systems in the Southern High Plains.*

*Taylor-Allen, M., **P.H. Gowda**, S. Angadi, A. Ghosh, and U. Rangappa. 2010. Heat unit based estimation of forage production with sorghum-legume intercropping systems in New Mexico. (Third Place in the Graduate student research competition).*

Dave Brauer, Terry Howell, Paul Colaizzi, Prasanna Gowda, Jairo Hernandez, Louis Baumhardt, Steve Evett, Susan O'Shaughnessy and Robert Schwartz participated in the meetings of Calera (Mexico) Workshop, at Bushland, TX, July 7-9, 2010.

Louis Baumhardt attended the Southern Conservation Agricultural Systems Conference, Jackson TN on July 20-22, 2010.

On July 28, 2010, **Steve Evett** presented an update of the Middle

East Regional Irrigation Management Information Systems (MERIMIS) at the office of international programs at the University of California, Davis. Dr. Evett and Dr. Ibrahim Shaqir, Director of the ARS Office of International Research Programs held discussions on weather networks for irrigation scheduling in the Middle East with UC Davis and Oregon State University personnel.

On August 18, 2010, twenty farmers from Australia toured the laboratory and discussed irrigated and dryland cropping systems and research with **Drs. Paul Colaizzi and Steve Evett**.

From August 22-25, 2010, Mr. Mustafa Natour and Dr. Fathi Abdelhadi of the Israeli NGO Elhawakeer, an Arab farmers association, visited with Dr. Steve Evett and toured research and farmers' fields in the Bushland area as well as visiting Dr. Jim Bordovsky at the Texas AgriLife Halway Research Station.

Paul Colaizzi attended the Texas High Plains Evapotranspiration Network seminar, August 26, 2010 in Bushland, TX.

The Soil Water Management Staff attended the Summer Crops Field Day, September 2, 2010, in Bushland, TX. **Judy Tolk, Louis Baumhardt, Robert Schwartz and Susan O'Shaughnessy** provided information for tour stops.

Prasanna Gowda attended the Remote Sensing and Hydrology 2010 Symposium in Jackson Hole, WY on September 27-30.

Abstracts from Meeting:

***Gowda, P.H. T.A. Howell**, S. Basu, and B.R. Scanlon. 2010. Scintillometry for ET mapping applications: A lysimetric evaluation.*

*Alfieri, J.G., W.P. Kustas, J.H. Prueger, J.L. Chavez, **S.R. Evett**, C.M.U. Neale, M.C. Anderson, L.Hipps, **K.S. Copeland**, **T.A. Howell**, A.N. French, W.P. Dulaney, and L.G. McKee. 2010. A Comparison of the Eddy Covariance and Lysimetry-based Measurements of the Surface Energy Fluxes during BEAREX08.*

*Kustas, W.P., J.G. Alfieri, M.C. Anderson, **P.D. Colaizzi**, J.H. Prueger, J.L. Chavez, L.E. Hipps, **S.R. Evett, K.S. Copeland**, and **T.A. Howell**. 2010. Utility of thermal-based dual-temperature-difference technique for surface energy balance estimation under strongly advective conditions during BEARE08.*

On September 29, 2010, **Steve Evett** was visited by Dr. David Sloane, Chief Agronomist of AquaSpy, which is a provider of soil water status information to farmers, to discuss soil water sensing methods.

Paul Colaizzi attended the Brookings Training, "Managing the Federal Employee Discipline and Performance Process," held on October 13-14, 2010, at the Southern Plains Area Office in College Station, TX.

On October 16, 2010, Scouts from Boy Scouts of America Troop 10 in Amarillo, Texas, led by Scout Alex Weaver, picked 8,325 pounds of potatoes for the Amarillo Food Bank from a research field where Drs. Charlie Rush of Texas AgriLife Research and **Steve Evett** of USDA-ARS had conducted an irrigation trial.

October 22-25, 2010, **Jourdan Bell, Robert Schwartz** and **Steve Evett** worked with the fourth grade at Bushland Elementary to make miniature adobe bricks and then build miniature adobe houses in a project designed to teach how ancient and some contemporary peoples built with soil materials and the related soil science ideas.

From October 31 to November 3, 2010, Scientists: **Terry Howell, Judy Tolk, Louis Baumhardt, Steve Evett, Susan O'Shaughnessy, Robert Schwartz, Prasanna Gowda and Jourdan Bell** from the CPRL attended the 2010 International Meetings of the Agronomy Society of America, Crop Science Society of American and Soil Science Society of America at Long Beach, CA. Steve Evett organized a symposium, "The Blue-Green Revolution: Why Water Availability and Water Management Will Be Key to Success in Bio-Energy and Environmental Security", which was chaired by Jourdan Bell. Talks given in the symposium by CPRL scientists included:

Steve Evett, "Why Water Will Be the Driving Force behind Agricultural Sustainability"

Terry Howell, "Water Use Efficiency"

Susan O'Shaughnessy, "Automation of Irrigation Systems to Control Irrigation Applications and Crop Water Use Efficiency"

Steve Evett was recognized with the Soil Science Society of America "Soil Science Applied Research Award".

Robert Schwartz received the Mentor Award from the Women in Agronomy, Crops, Soil, and Environmental Sciences (WACSES).

Abstracts from Meeting:

*Begna, S., A. Wahby, A. Marsallis, R. Hagevoort, A.N. Cole, **P.H. Gowda**, and S. Angadi. 2010. Radiation use efficiency, forage yield, and quality of sorghum-legume intercropping systems in the Southern High Plains. (CD ROM)*

***Evett, S.R., T.A. Howell, J.A. Tolk**, N. Ibragimov, N.Th. Mazahreh, and M.A. Jitan. 2010. Why water will be the driving force behind agricultural sustainability. (CD-ROM*

***Evett, S.R., S.A. O'Shaughnessy, P.D. Colaizzi, T.A. Howell**, and **R.L. Baumhardt**. 2010. Cotton evapotranspiration and yield variations with canopy temperature and irrigation deficit. (CD-ROM)*

***Gowda, P.H., T.A. Howell**, N. Rajan, J. Chavez, and S**.R. Evett**. 2010. Lysimetric evaluation of eddy covariance fluxes over irrigated sunflower in the Texas High Plains. (CD-ROM)*

***Gowda, P.H., T.A. Howell, P.D. Colaizzi**, N. Rajan, J.L. Chavez**, S.R. Evett**. 2010. Lysimetric evaluation of eddy covariance fluxes over irrigated sunflowers in the Texas High Plains. (CD ROM)*

***Howell, T.A., S.R. Evett, J.A. Tolk**, and **K.S. Copeland**. 2010. Evapotranspiration of irrigated sunflower in a semi-arid environment. (CD-ROM)*

***Howell, T.A., S.R. Evett**, and **J.A. Tolk**. 2010. Improving the blue and green water use efficiency in irrigated agriculture. (CD-ROM)*

***Howell, T.A., S.R. Evett, J.A. Tolk**, and **K.S. Copeland**. 2010. Determination of evapotranspiration of irrigated sunflower in a semi-arid environment.*

***O'Shaughnessy, S.A., S.R. Evett,** and **P.D. Colaizzi**. 2010. Irrigation automation to control irrigation scheduling and crop water use efficiency.*

*Rangappa, U., A. Sangamesh, M. Marsalis, **P.H. Gowda**, R. Hagevoort, and A.N. Cole. 2010. Effects of spatial arrangement and population density on forage yield in three different sorghum-legume intercropping systems. (CD ROM)*

***Schwartz, R.C., S.R. Evett**, and M.G. Pelletier. 2010. Column displacement experiments to evaluate electrical conductivity effects on electromagnetic soil water sensing.*

***Tolk, J.A., S.R. Evett**, and **T.A. Howell**. 2010. Lower limits of water use by cotton, maize, and grain sorghum in three great plains soils. (CD-ROM)*

From November 7-11, 2010, **Steve Evett** attended the

3rd International Conference on "Drylands, Deserts and Desertification: The Route to Restoration" at the Ben Gurion University of the Negev at Sede Boqer where he presented an invited keynote presentation in the session "Agriculture: Water and Energy" titled "Energy, water balances and fluxes in the soil-plant-atmosphere continuum: Dryland and desert cases". He also had science discussions with Drs. Alon Ben Gal, Nurit Agam, Naftali Lazarovich, Pedro Berliner, Robert Lascano, Jeff Baker and Tom Thompson regarding energy and water balance experiments on crops grown in the Negev (grapes, olives) to improve water management, increase water use efficiency and utilize brackish waters.

Abstracts from Meeting:

*Lascano, R.J., C.H.M. van Bavel, and **S.R. Evett**. 2010. Calculation of water evaporation in arid climates.*

***Steven R. Evett,** Mohammed A. Jitan, and Naem T.H. Mazahreh. 2010. Energy, water balances and fluxesin the soil-plant-atmosphere continuum: Dryland and desert cases.*

On November 17, 2010, **Steve Evett** presented "Soil Water Sensing for Water Balance, ET and WUE" at the Meeting on Water Use Efficiency – Challenges for Agriculture at the Volcani Center, Bet Dagan, Israel.

From November 21-23, 2010, **Steve Evett** attended the Middle East Regional Irrigation Management Information Systems (MERIMIS) project workshop at the Dead Sea, Jordan where he presented "Middle East Regional Irrigation Management Information Systems Project - Some Science Products" and participated in research and project planning with partners from Elhawakeer Arab Farmers Association of Israel, the Palestinian Agricultural Research Committee (PARC), Al Quds University (West Bank), the Israeli Agricultural Research Organization, and the Jordanian National Centre for Agricultural Research and Extension (NCARE).

David Brauer, Paul Colaizzi, Steve Evett, Prasanna Gowda, Wonsook Ha, Terry Howell and Susan O'Shaughnessy attended Proc. 5th Decennial National Irrigation Symposium, Am. Soc. Agr. Biol. Eng. and Irrig. Assoc., December 5-8, 2010 in Phoenix, AZ.

Prasanna Gowda accepted a paper award with Terry Howell and Thomas Marek.

Abstracts from Meeting:

***Howell, T.A., S.R. Evett, K.S. Copeland**, and **J.A. Tolk**. 2010. Forage sorghum evapotranspiration and crop coefficients.*

***Howell, T.A.**, F.R. Lamm, and **J.A. Tolk**. 2010. Irrigation management: Concepts and implementation.*

Presentations from Meeting:

***Gowda, P.H., T.A. Howell**, G. Paul, T.H. Marek, and **P.D. Colaizzi**. 2010. Surface energy balance system for estimating daily evapotranspiration rates in the Texas High Plains.*

*Allen, R.G., LS. Pereira, **T.A. Howell**, and M.E. Jensen. 2010. Recommended documentation of evapotranspiration measurements and associated weather data and a review of requirements for accuracy.*

***Colaizzi, P.D., S.R. Evett, T.A. Howell,** and **R.L. Baumhardt**. 2010. Crop production comparison with spray, LEPA, and subsurface drip irrigation in the Texas High Plains.*

***Colaizzi, P.D., S.R. Evett, T.A. Howell, P. Gowda, S.A. O'Shaughnessy, J.A. Tolk**, W.P. Kustas, and M.C. Anderson. 2010. Two source energy balance model-refinements and lysimeter tests in the Southern High Plains.*

***Gowda, P.H., T.A. Howell**, R.K. Vinukollu, **P.D. Colaizzi**, and T.H. Marek. 2010. Surface energy balance system (SEBS) for estimating hourly evapotranspiration rates in the Texas High Plains.*

*Marek, T.H., **T.A. Howell**, R.L. Snyder, D.O. Porter, T. Scherer. 2010. Crop coefficient development and application to an evapotranspiration network.*

*Marek, T.H., T. Scherer, D.O. Porter, D. Rogers, J. Henggeler, and **T.A. Howell**. 2010. What will it take to get irrigators to use advisory programs? Lessons learned from the past 10 years and beyond.*

***O'Shaughnessy, S.A., S.R. Evett, P.D. Colaizzi**, and **T.A. Howell**. 2010. Automatic irrigation scheduling of grain sorghum using a CWSI and time threshold.*

*Porter, D.O., D. Rogers, T.H. Marek, F.R. Lamm, N. Klocke, M. Alam, and **T.A. Howell**. 2010. Technology transfer: Promoting irrigation progress and best management practices.*

*Clark, R.N., and **D. Brauer**. 2010. Overview of Ogallala Aquifer Program.*

***Evett, S.R**., R.J. Lascano, **T.A. Howell, J.A. Tolk, S.A. O'Shaughnessy**, and **P.D. Colaizzi**. 2010. Single- and dual-surface implicit energy balance solutions for reference ET.*

***Evett, S.R., R.C. Schwartz**, R.J. Lascano, and M.G. Pelletier. 2010. In-soil and down-hole soil water sensors: Characteristics for irrigation management.*

*Kranz, W.L., R.G. Evans, F.R. Lamm, **S.A. O'Shaughnessy,** and T.G. Peters. 2010. A review of center pivot irrigation control and automation technologies.*

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Prasanna Gowda, Wansook Ha, Jairo Hernandez attended the 2010 AGU meeting, San Francisco, CA, December 13-17, 2010.

Poster Presented:

***W. Ha, P. H. Gowda**, T. Oommen, **T. A. Howell**, and **J. E. Hernandez**, Downscaling of Aircraft-, Landsat-, and MODIS-based Land Surface Temperature Images with Support Vector Machines.*

Proceedings:

***O'Shaughnessy, S.A., J.E. Hernandez, P.H. Gowda**, S. Basu, **P.D. Colaizzi, T.A. Howell**, and U.Schulthess. Vegetation Fraction Mapping with High Resolution Multispectral Data in the Texas High Plains.*

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Agam, N., W.P. Kustas, M.C. Anderson, J.M. Norman, **P.D. Colaizzi, T.A. Howell**, J.H. Prueger, T.P. Meyers, and T.B. Wilson, 2010. Application of the Priestley-Taylor approach in a two-source surface energy balance model. J. Hydromet. 11(2): 185-198. DOI: 10.1175/2009JHM1124.1.

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continued from page 15 - Technology Transfer

Terry Howell made the presentation on CPRL Overview to Panhandle Regional Planning Commission on January 21, 2010, in Amarillo, TX.

Terry Howell completed the training on "Managing the Federal Employee Discipline and Performance Process" by the Brookings Institute on February 2-4, 2010 at College Station, TX.

Terry Howell with Nancy Davis**,** Beth Holt, and N. Andy Cole represented CPRL at the Agribusiness is Your Business by Amarillo Chamber of commerce Ag Council at Amarillo Civic Center on May 4, 2010.

Terry Howell was interviewed by Edward Brazil with Farmer Stockman on March 15, 2010.

Terry Howell made a presentation on Deficit Irrigation and crop Production Functions at the Mini-Workshop on a Decision Tool for Optimizing Limited (Deficit) Irrigation in Colorado (ARS-Fort Collins) on May 6-7, 2010.

Louis Baumhardt made the presentation on "The what, the how, & the why of NoTill or Strip-Till Farming Practices" at the "No-Till and More Workshop" organized by the NRCS offices in Clovis, NM on March 23, 2010.

April 2,, 2010, presentations were made by CPRL scientists for the Golden Spread chapter SWCS meeting at USDA-ARS-CPRL, Bushland, TX. Louis Baumhardt - "Water conservation and yields with reduced tillage and deficit irrigation", Robert Schwartz – "Infiltration and evaporation under different tillage treatments" and Steve Evett – "Irrigation automation program".

On May 12-13, 2010, Steve Evett and Brice Ruthardt traveled to Marena, Oklahoma to work with the In Situ Soil Moisture Test Bed group for the SMAP satellite mission, installing a time domain reflectometry system for soil water content determination and a soil temperature measurement system. They have continued to collaborate with the USDA-ARS HSRL, Beltsville, Maryland and the University of Oklahoma on this project.

Terry Howell and Jairo Hernandez attended the 2010 American Society of Agricultural and Biological Engineers Meeting, May 20-23, 2010, at Pittsburgh, PA.

Terry Howell provided a tour for the North West College, Palo, WY lead by Quinn Lafollette with 10 Ag Operations students on May 20, 2010, Bushland, TX.

Paul Colaizzi conducted the annual Sealed Source Radiation Safety Training and Hazardous Materials Transport Training at Bushland, TX, May 25, 2010. There were 24 attendees from ARS, NRCS, and Texas AgriLife Research. Assisted ARS scientists at Bushland and Lubbock in obtaining sealed source radiation permits, pursuant to new USDA Radiation Safety Division rule that requires all supervisors of neutron probe users to obtain permits.

Terry Howell provided a tour at Bushland, TX, for a group of Nigerian Professors hosted by Dr. B.A. Stewart from West Texas A&M University on May 26, 2010.

Terry Howell met and toured with Monsanto Corn Group (Marcus Jones, Dr. Giovanni Piccinni, Dave Songstad, and Alice Augustine) with Steve Evett on June 3, 2010 at Bushland, TX.

July, 2010, Paul Colaizzi designed temporary surface drip system and made irrigation scheduling recommendations for BUSH(land) Gardens.

Paul Colaizzi participated in the field tour and meetings of Caldera (Mexico) Workshop, July 7-9, 2010; discussed subsurface drip irrigation research at Bushland, TX, to workshop participants.

Informative tour stops were provided by Paul Colaizzi, Steve Evett, Susan O'Shaughnessy and Robert Schwartz at the Calera Workshop at Bushland, TX, in cooperation with Mexico, Texas Water Resources Institute, and University of Georgia and ARS-El Reno on July 7-9, 2010.

Louis Baumhardt provided a part of the team "Briefing of cotton research at the USDA-ARS-CPRL" for Cotton Incorporated during their northern Texas High Plains cotton production methods tour on July 29, 2010.

Paul Colaizzi hosted representatives from Cotton, Inc. (Dr. Edward Barnes, Ric Hendee, Janet Reed) and Budline Productions (Paul Budline) on tour of the Texas Panhandle to produce a documentary on cotton production in West Texas, and to assess water, irrigation, and renewable energy research, and to identify research gaps and funding needs for irrigated and dryland cotton production. The tour included visits with three local cotton producers (Randy Darnell and Todd and Brian Vincent), and tour of cotton research and renewable energy at CPRL, July 29, 2010.

Paul Colaizzi participated in field tour and meetings for Australian producers, August 18, 2010; discussed subsurface drip irrigation research at Bushland, TX, to participants.

Terry Howell attended the North Plains Corn Irrigation Field Day at Etter, TX, on August 25, 2010. David Brauer made a presentation on the Ogallala Aquifer Program.

Paul Colaizzi contributed 256 pounds of corn that was knocked down by border disk to High Plains Food Bank in Amarillo, TX on August 27, 2010.

Louis Baumhardt made the presentation on "Grazing in a No-till Wheat/Sorghum/ Fallow Rotation" to producers and others at the USDA-ARS-CPRL Field Day tour stop, September 2, 2010, at Bushland, TX.

In September 2-3, 2010 Louis Baumhardt and Rowan Paulet, a visitor from Victoria, Australia discussed integrated crop and cattle-production in Texas and Canola farming in Australia. He was a 2010 "Nuffield Scholar and farmer of 5000+ acres.

Terry Howell and Steve Evett attended the NP-211 ARS Water Availability and Watershed Management Workshop for Stakeholders and program leaders on September 8-10, 2010, in Chicago, IL.

Terry Howell and Steve Evett hosted a visit by Dr. Visit Russell Nuti from Dawson, GA (National Peanut Research Laboratory) on October 4, 2010 at Bushland, TX.

Soil and Water Management Research Unit

http://www.cprl.ars.usda.gov

RESEARCH STAFF

Dr. Terry A. Howell, P.E.
Acting Laboratory Director
Research Leader (Agric. Engr.)
(806) 356-5746
terry.howell@ars.usda.gov

Dr. R. Louis Baumhardt
Research Soil Scientist
(806) 356-5766
r.louis.baumhardt@ars.usda.gov

Dr. David K. Brauer
Research Agronomist
(806)356-5769
david.brauer@ars.usda.gov

Dr. Joaquin Casanova
Research Electrical Engineer
(806)356-5771
joaquin.casanova@ars.usda.gov

Dr. Paul D. Colaizzi
Research Agricultural Engineer
(806) 356-5763
paul.colaizzi@ars.usda.gov

Karen S. Copeland
Soil Scientist
(806) 356-5735
karen.copeland@ars.usda.gov

Dr. Steven R. Evett
Research Soil Scientist
(806) 356-5775
steve.evett@ars.usda.gov

Dr. Prasanna Gowda
Research Agricultural Engineer
(806) 356-5730
prasanna.gowda@ars.usda.gov

Dr. Wonsook Ha
Research Agricultural Engineer
(806) 356-5717
wonsook.ha@ars.usda.gov

Dr. Jairo Hernandez
Research Agricultural Engineer
(806) 356-5718
jairo.hernandez@ars.usda.gov

Dr. Susan O'Shaughnessy
Research Agricultural Engineer
(806) 356-5770
susan.oshaughnessy@ars.usda.gov

Dr. Robert C. Schwartz
Research Soil Scientist
(806) 356-5762
robert.schwartz@ars.usda.gov

Dr. Judy A. Tolk
Research Plant Physiologist
(806) 356-5736
judy.tolk@ars.usda.gov

Dr. Paul W. Unger
Collaborator (Soil Scientist)
(806) 356-5749
pwunger@suddenlink.net

Publication Contact

The *Wetting Front* publication is designed to foster technology transfer from our research to industry and to agricultural producers in the Southern High Plains and to improve communications with our stakeholders and partners.

All issues will be sent by email or are available on the website www.cprl.ars.usda.gov/Wetting_Front_Newsletter.htm

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For actions or corrections to our email list, contact Ms. Nancy Davis by one of the following:

fax: (806) 356-5750
email: nancy.davis@ars.usda.gov
phone: (806) 356-5732
mail: USDA-ARS
P.O. Drawer 10
Bushland, TX 79012

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Editors: Dr. Terry A. Howell, P.E.
Design: Nancy Davis

USDA-ARS
P.O. Drawer 10
Bushland, TX 79012-0010

Email: terry.howell@ars.usda.gov
nancy.davis@ars.usda.gov

Phone: (806)356-5746 / (806)356-5732
Fax: (806)356-5750
Shipping: 2300 Experiment Station Road

United States Department of Agriculture
Agricultural Research Service

USDA-ARS
P.O. Drawer 10
Bushland, TX 79012-0010