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THE CROSS SECTION

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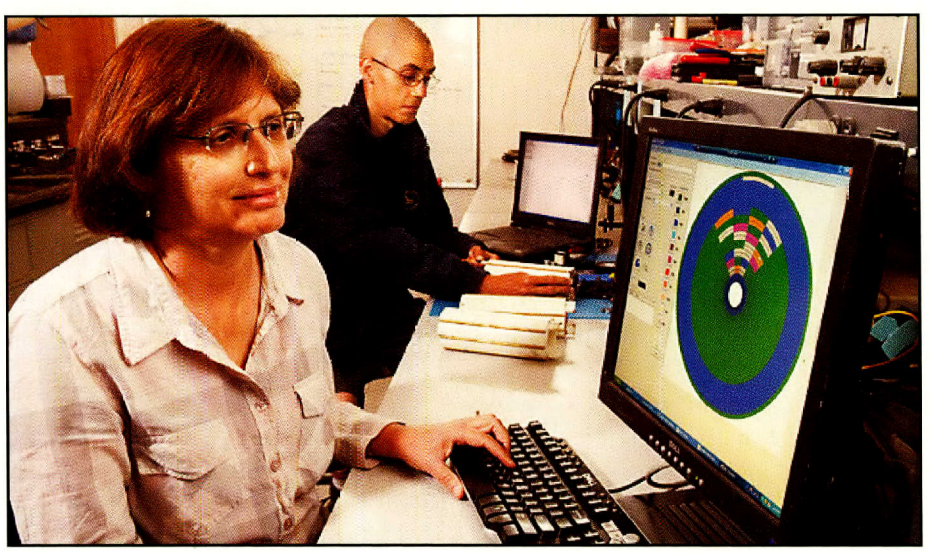
USDA-ARS researchers examine methods to optimize water productivity

EDITOR'S NOTE--The following article appeared in the April 2013 issue of *Agricultural Research* and is reprinted with permission of the USDA-ARS--**CEM.**

By Dennis O'Brien, USDA-ARS

USDA-Agricultural Research Service (USDA-ARS) researchers in Bushland, Texas, are helping farmers make the most of their water supplies in a region where they depend on the Ogallala Aquifer, a massive underground reservoir under constant threat of overuse.



Calculating Crop Water Needs

Agricultural Engineer Susan O'Shaughnessy views an irrigation prescription map constructed from data collected by an ARS wireless sensor system. The map shows variable crop water needs. Next to her, Agricultural Engineer Joaquin Casanova tests his prototype TDR (time domain reflectometry) probe. (*Photo courtesy of USDA-ARS*).

New Innovations

Steve Evett, Susan O'Shaughnessy, and their colleagues at the Conservation and Production Research Laboratory are developing and testing soil-water and plant-stress sensors and automated irrigation systems that will irrigate fields only as necessary. Automated systems are considered key to sustainable use of the aquifer and to helping growers reduce water and labor costs.

"As water becomes more precious and the costs to pump it continue to rise, we need to tap the potential of every drop used in agriculture. To do that, we need to develop the best systems possible for accurately scheduling and controlling irrigation," Evett says. The researchers are developing automated irrigation and sensor systems based on two approaches that complement each other, O'Shaughnessy says. One system applies water based on levels of crop water stress detected by wireless sensors mounted on above ground moving pipelines of commercial irrigation systems.

In the other system, the researchers are adapting sensor technology designed for urban sites so that it will work in agriculture. It triggers irrigation based on soil water content detected by sensors in fixed locations in the soil.

"Each system has advantages and disadvantages. But the combination of these two networked systems in a single field would be ideal, providing the temporal frequency and spatial coverage needed for monitoring crop water stress and robust control of irrigation," O'Shaughnessy says.

Sensing Water Needs From Above

Evett, O'Shaughnessy, and their colleagues have filed for a patent on the automated irrigation system. They verified its effectiveness in numerous field studies that compared it with manual irrigation control based on soil water monitoring with a neutron probe. The probe

See **SENSORS** Page Three

In This Issue

Bushland laboratory to celebrate 75 years of research

By Kay Ledbetter
AgriLife Today

BUSHLAND – Agricultural research entities in the High Plains will celebrate "75 Years of Southern High Plains Agricultural Advancements" on Aug. 29 at the joint U.S. Department of Agriculture-Agricultural Research Service and Texas A&M AgriLife Research facility, one-half mile west of Bushland.

The Conservation and Production Research Laboratory will celebrate 75 years of scientific advancements with field and building tours, posters and speakers who throughout the day will outline what agriculture issues have been addressed over the years and the science-based solutions found.

"Innovations in Soil, Water and Environment Management since 1938" is the theme selected for the celebration, according to Dr. Dave Brauer, USDA-ARS research agronomist and co-chair of the event.

The daylong event will begin at 9 a.m. with registration and continue through an evening meal. Dr. Bob Stewart, longtime director of the USDA facility and current director of the Dryland Agriculture Institute at West Texas A&M University, as well as other employees, past and present, will entertain and inspire with reminiscent accounts of research developments and important outcomes, said Dr. Jerry Michels, AgriLife Research entomologist and co-chair.

Morning field tours will include stops to look at integrated pest management, alternative crops,

See **ANNIVERSARY** Page Four

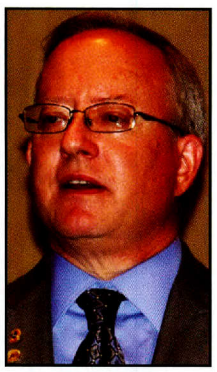
Retirements, resignation cause High Plains Water District staff changes

Several changes were made to the High Plains Underground Water Conservation District staff due to recent retirements and a resignation.

Carmon McCain Named Interim Manager

Carmon McCain was named interim manager during a special June 24 meeting of the district's Board of Directors.

"The HPWD Board of Directors appreciates Carmon's willingness to serve as interim manager following Jim Conkwright's retirement on June 30. We have confidence in his abilities," said Board President Lynn Tate of Amarillo.



McCAIN

McCain joined the HPWD staff in April 1987 as Information/Education supervisor.

Some of his duties include writing articles, editing, and layout of *The Cross Section* newsletter; writing and distributing news releases; writing and producing radio and television announcements; giving public presentations; maintaining the district's web site; and assisting students in learning the importance of water and water conservation.

He will serve in both positions until a new manager is hired.

Kathryn CdeBaca Retires As Executive Secretary

Kathryn CdeBaca retired June 30 after 21 years of service to the High Plains Water District.

She joined the district staff in April 1992 and was Executive Secretary to Manager A. Wayne Wyatt, Interim Manager Comer A. Tuck Jr., and manager Jim Conkwright.

CdeBACA

Kathryn's responsibilities included preparations for the monthly Board of Directors meeting, taking minutes of board meetings, posting meeting notices in accordance with the Texas Open Meetings Act, handling office correspondence, maintaining files regarding open wells, cave-ins, and irrigation water waste, making travel arrangements for board members and staff, answering the telephone, and greeting the public.

She also handled secretarial duties for the Llano Estacado Regional Water Planning Group for several years.

"We congratulate Kathryn on her retirement and wish her all the best as she spends more time with Jerry, their children, and grandchildren," McCain said.

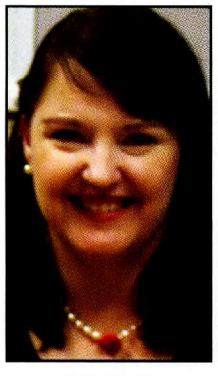
Patty Bryant Resigns As Permit Group Supervisor

Patty Bryant resigned from the HPWD staff July 15.

She joined the HPWD staff in June 2001 as secretary/receptionist.

In addition, she issued water well permits for the portion of Crosby County in the district, all of Lubbock County, and all of Lynn County.

She also processed water well permit applications and well logs for the other counties in the district.



BRYANT

Beginning in August 2002, Patty provided input to representatives of the Texas Tech Department of Economics and Geography as the district worked to develop a GIS-based application to automate/manage the water well permit process.

Patty was named Permit/Field Support Group Supervisor in 2006.

Her duties included supervising the water well permit process, maintaining the district's permit/well log files, assisting with audits of HPWD county offices, and coordinating staff investigation of water waste, uncovered water wells, and deteriorating water wells that were reported to the district.

"We thank Patty for 12 years of dedicated service to the High Plains Water District. We wish her all the best in her future endeavors," McCain said.

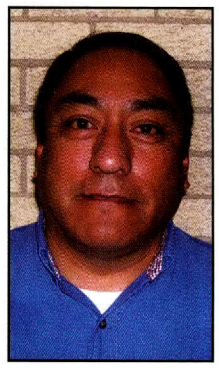
Juan Peña Named Permit Group Supervisor

Juan Peña was named Permit Group Supervisor following Patty Bryant's resignation.

Peña joined the HPWD staff in October 2006 as a field technician.

He previously worked for Fox Drilling Company at Petersburg in the early 1970s. Peña retired as a Corporal after 25 years of service with the City of Lubbock Police Department.

In addition to his supervisory duties, Peña serves as County Secretary for the portion of Crosby County within the district, all of Lubbock County, and all of Lynn County.



PENA

"The Board of Directors appreciate Juan's willingness to accept the Permit Group Supervisor duties. This is a big help as we work through the staff changes that have occurred," McCain said.

Hale County permit office relocated

The High Plains Underground Water Conservation District No. 1 (HPWD) announces the relocation of its Hale County water well permit office.

The Hale County office is now located at the Great Plains Ag Credit office, 104 North Interstate 27, in Plainview.

Daleyn Schwartz is the new Hale County Secretary. She can be reached at (806) 296-2782, or by fax at (806) 296-9351.

The Hale County office was previously located at the USDA-NRCS Plainview Service Center during the past 19 years.

"We want to express our sincere appreciation to local Hale County NRCS officials who allowed the district to keep its water well permit and drillers' log records in their office. The district's Board of Directors and staff also thank Sharon Perkins for her 19 years of dedicated service as Hale County Secretary," said Carmon McCain, HPWD interim manager.

Persons wanting to drill water wells producing more than 17.5 gallons of water per minute from the Ogallala Aquifer or Dockum ("Santa Rosa") Aquifer must first contact the High Plains Water District to obtain a permit.

In addition to Schwartz, other HPWD officials in Hale County include Precinct Five District Director Ronnie Hopper of Petersburg. He represents the portion of Floyd County within the district, all of Hale County, and all of Swisher County.

"The Water District appreciates Branch Manager Cliff Daniel and his willingness to house the district's Hale County records in their office. We look forward to working with the Great Plains Ag Credit staff," said Hopper.

Recently-appointed Hale County Advisory Committee members include Rob Bass of Plainview, Gaylord Groce of Petersburg, Jeff Harrell of Plainview, Brad Martin of Edmonson, and Jimmy Sageser of Kress.

THE CROSS SECTION

CARMON McCAIN, Editor
Information/Education Group Supervisor

Telephone: (806) 762-0181
Fax: (806) 762-1834
Web: *www.hpwd.com*
E-mail *info@hpwd.com*

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Sensors & automated systems may help producers with irrigation scheduling

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is a research standard for irrigation scheduling, but growers avoid it due to expense and regulatory burdens.

In one study, the researchers cultivated early- and late-maturing sorghum for two years. They used 16 prototype wireless sensors on a center-pivot irrigation system to monitor crop canopy temperatures.

They chose sorghum because of its importance as a cash crop in the Southern High Plains and because it withstands water stress. Even so, irrigation plays a significant role in sorghum production in the region, tripling its yields.

Crop canopy temperature was monitored during the growing season as the pivot system moved across the field. Other instruments recorded weather data.

The information was processed daily by a computer at the pivot point, which automatically scheduled and delivered irrigations when and where necessary.

"The sensor network was mounted on a six-span center pivot, but the technology could be adapted to other types of moving or static irrigation systems," O'Shaughnessy says.

An earlier system used to trigger irrigation manually was the Crop Water Stress Index. It calculated water stress based on canopy temperatures and weather factors measured at midday.

Because cloud cover and other weather changes could make once-a-day measurements irrelevant to daily water use, the researchers developed a system using continuous measurements over the course of a day and calculated an Integrated Crop Water Stress Index (iCWSI).

Irrigations were delivered automatically when and where iCWSI values exceeded a threshold established from previous data.

Besides comparing crop yields and water-use efficiency between automatic and manual control methods, the study also evaluated yields at "deficit irrigation" levels. This was important since growers in the region sometimes increase profits by irrigating less, which saves on water and pumping costs.

The study results, published in 2012 in *Agricultural Water Management,* showed that the automated method of irrigation scheduling was just as effective as the manual method at both the full and deficit irrigation levels, producing similar grain yields and water-use efficiency levels.

Through a cooperative research and development agreement (CRADA), Evett and his colleagues are modifying Nebraska-based Valmont Industries' commercial irrigation systems in ways that will make them more useful to growers.

The research team is integrating the ARS-developed sensor networks and irrigation-control system with the company's variable-rate and center-pivot irrigation systems.

ARS researchers in Florence, South Carolina; Maricopa, Arizona; Portageville, Missouri; and Stoneville, Mississippi are working with Evett and Valmont on the CRADA as part of an ARS multi-location research plan. The scientists are also developing sensor technology that will allow irrigation levels to be set based on site-specific data, which can be updated based on changing weather conditions.

Sensing Water Status Below the Soil Surface

For the automated irrigation system using underground sensors, Evett and his colleagues established a CRADA with Acclima, Inc., of Meridian, Idaho, to create a soil-water sensor designed to measure deeply and accurately. Evett and Bushland researchers Robert Schwartz and Joaquin Casanova are co-inventors of the system.

Acclima makes sensor-based irrigation control systems with probes that use time-domain transmission technology, which measures the time required for an electromagnetic pulse to travel along an electrode embedded in the soil.

Water slows the signal's travel, and the recorded speed is an accurate representation of the amount of water in the soil. A computer automatically activates water pumps and/or valves at predetermined soil water content levels.

Because Acclima's sensors are designed to control irrigation on tracts of grass, shrubs, and ornamentals, they only need to monitor water content to depths of about 4 to 6 inches.

For use in agriculture, the probes need to be installed at depths of 50 inches or more and take readings at multiple depths.

Evett and his Acclima partners are developing new technology that uses time-domain reflectometry. They are using hollow, non-conductive, plastic tubes that can be drilled deeper into the soil.

The tubes are divided into segments that attach to each other so they can be drilled down to any desired depth.

Prototype designs tested in water and test fluids, in clay and loam soils, and in the field have shown the feasibility of the approach, Evett says.

ARS and Acclima have filed for a patent on the technology, which also includes the ability to assess soil salinity.

A new generation of relatively inexpensive wireless sensors is likely to make sensor network systems affordable in the near future, O'Shaughnessy says.

Combining these sensor systems and improving and testing control algorithms based on years of data will increase the robustness and effectiveness of the irrigation automation solution.

Technology Transfer

Dr. Steve Evett (at right) discusses recent developments in soil moisture monitoring technology with a visitor during the March 2013 Ogallala Aquifer Program workshop in Amarillo.

"This is the future of irrigation, getting water where it is needed when it is needed, and limiting water use to the exact amount that is needed," Evett says.

Nine ways to waste water with an automatic lawn sprinkler system & what to do about them

PROBLEM	CAUSE	SOLUTION
Spray heads misting	Pressure too high at nozzle.	Reduce nozzle pressure to 30 psi with pressure regulators installed on or downstream of valves or install pressure compensating nozzles or heads.
Drift	Wind.	Operate system early in morning. 3-7 a.m. is very good; 4-6 a.m. is even better.
Evaporation	Wind/Solar radiation.	Operate system early in morning.
Runoff	Exceeding soil infiltration rate.	Water in short cycles giving the water time to soak in or convert to equipment with a lower precipitation rate.
Leaching	Overwatering to the point that water moves below the target root zone and is unavailable to the plants.	Know your soil, plant water requirements (ET), and how fast your system puts out water. Take advantage of rainfall by using rain sensors or shutting off system when raining. Adjust your timer to the season. Help your lawn develop a deeper root zone by watering less frequently.
Poor application uniformity	Interference, poor spacing.	Ensure sprinkler heads are spaced according to the manufacturer's recommendations. Raise or replace heads that don't clear vegetation.
Overspray	Poor adjustment of nozzles.	Adjust nozzles to keep spray off non-landscaped areas.
Geysers or puddling	Broken or stuck heads.	Regular maintenance.
Poor timer management	Thinking all zones are alike--they're not!!	Know the precipitation rate for each zone and adjust them according to each zone's water needs.
Used with permission	Randall Merriott , Irrigation Dynamics	Lubbock, TX

Anniversary program to highlight past, current, and future research

Continued From Page One

irrigation technologies and management, conservation tillage, wind erosion prevention and chemical control for fallow.

The lunch program will feature leadership from both the state and federal agencies discussing the importance of the High Plains' facility.

The afternoon program will move indoors for historical presentations on other programs, such as wheat breeding, cattle production, air quality and a panel discussion with representatives of the agriculture industry on what might dominate research for the next 25 years.

Specialized tours will be arranged for individuals wanting to view the cattle research facilities and feedyard, the AgriLife Research Bush Farm located north of Bushland, and various greenhouses and laboratories.

Additionally, posters depicting the timeline of the key research program areas and the individuals and projects involved will be placed throughout the facilities.

The evening meal is open to anyone interested in hearing about the facilities, how they have grown over the years and the trials and successes celebrated there, Brauer said.

The research facilities demonstrate the active and productive partnership between the Agricultural Research Service, USDA's chief scientific research agency, and the Texas A&M University System including AgriLife Research, Texas A&M AgriLife Extension Service and West Texas A&M University.

"Over the years, scientists, regardless of agency or university affiliation, have established high producing teams that have advanced scientific knowledge and produced enduring benefits to mankind in this region and beyond," said Dr. John Sweeten, AgriLife Research director at Amarillo.

"One of the messages we want to convey is this lab has a long history of agricultural-related research that has benefitted Amarillo and the surrounding communities through not only the research results that have supported agriculture, but also the many opportunities it has offered in training young people who have become leaders and contributors to the area," said Dr. Steve Evett, acting research leader of the soil and water management unit for the Agricultural Research Service.

According to historical accounts, Congress first began working on legislation to support the laboratory in 1934 amid the Dust Bowl issues. By 1936, federal funding for wind erosion research in the Texas Panhandle was in place.

The land was purchased in Potter and Randall counties, chosen because it represented the fine-textured soils of the southern Great Plains and was severely eroded.

A local committee formed to set up the facility was composed of H.H. Finnell, Denny Hill and Dr. Horace Grub from the USDA Soil Conservation Service and assisted by U.S. Rep. Marvin Jones, Extension agent Art Bralley of Potter County, and Dr. C.J. Whitfield of the USDA-Soil Conservation Service in Dalhart. The first experiments were conducted at the laboratory in 1938.

The site was first named the Amarillo Experiment Station and was staffed by Whitfield, who served as director; and researchers Hugh Porterfield, soil erosion; C.E. Van Doren, dryland production; and Dr. David Reid, small grains breeder.

President Eisenhower signed legislation creating the Agricultural Research Service in 1953, and brought most of USDA's research functions into a single agency.

In 1959, an Amarillo Business Men's Committee worked to secure funds to expand facilities at Bushland.

A new office and laboratory building was completed in 1961. Later expansions have included a plant and soil processing building and water laboratory.

Also added were a 350-head research feedlot, the Kenneth Porter wheat seed processing and greenhouse complex, environmental quality laboratories and other facilities to house emerging research projects.

The laboratory has been at the forefront of many of the research achievements in dryland farming practices, irrigation engineering and management, water conservation and management, small grain breeding, grain sorghum improvement, sunflower improvement, sugar beet production, soil fertility and beef cattle nutrition and health.

Also groundwater recharge, grass establishment, weed control, conjunctive management of plant insects/diseases, entomology, climate, conservation tillage and residue management, crop water use, crop stress physiology, plant pathology, dust and ammonia emissions from feed yards, and renewable energy technologies.

THE CROSS SECTION *(USPS 564-920)*
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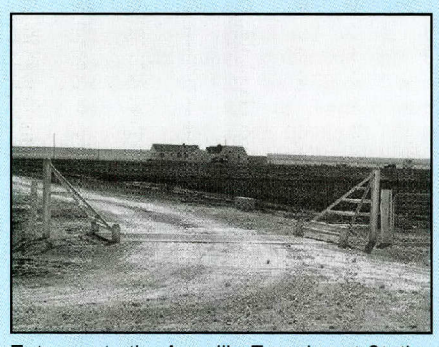
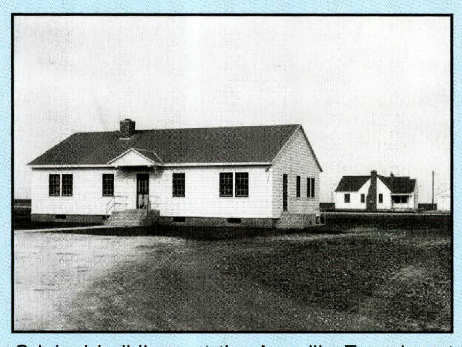
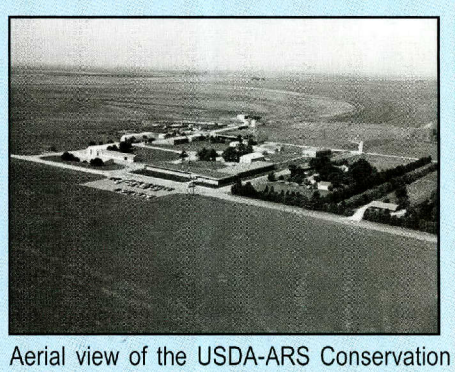
A look back at the USDA-ARS CPRL at Bushland TX



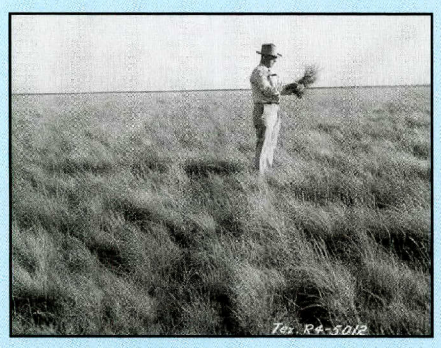
Entrance to the Amarillo Experiment Station in December 1938.



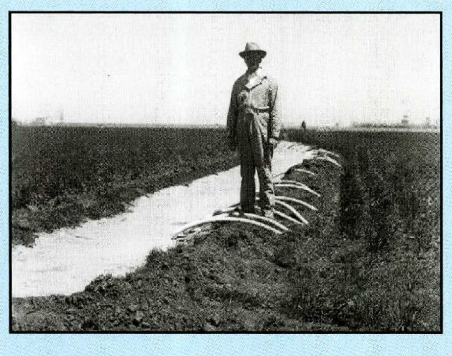
Original buildings at the Amarillo Experiment Station circa 1940.



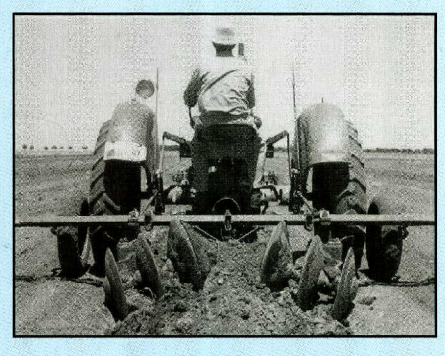
Aerial view of the USDA-ARS Conservation and Production Research Laboratory in 1960s.



May 1941 planting of blue grama, buffalograss, side-oats grama, and western wheatgrass.



Winter wheat irrigation in March 1949.



Constructing an irrigation border in June 1949 with a disk attachment on the tractor tool bar.