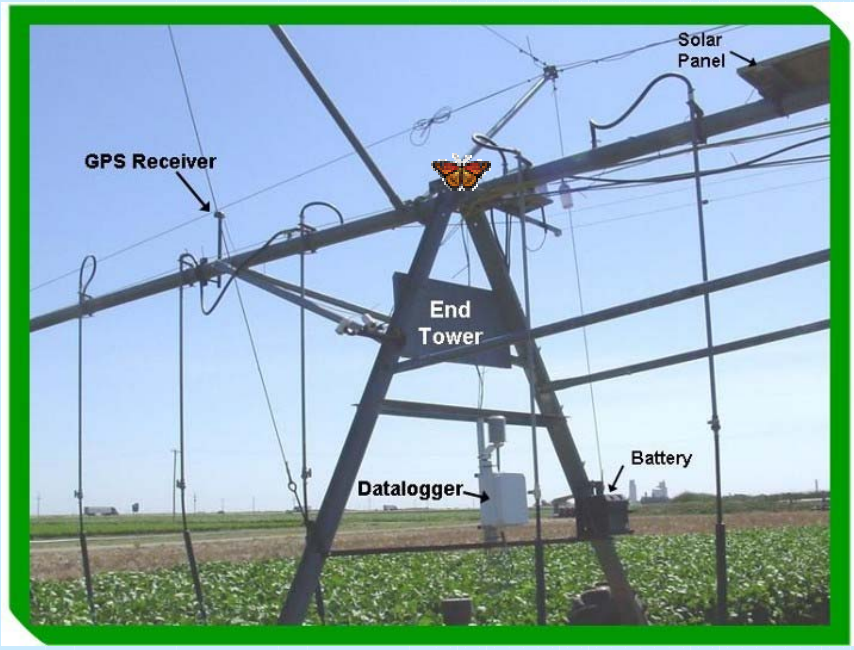
SOIL AND WATER MANAGEMENT RESEARCH UNIT NEWSLETTER

WETTING FRONT

Vol. 6, No. 2 | USDA-ARS Conservation and Production Research Laboratory | November 2004
P.O. Drawer 10 • Bushland, Texas 79012-0010 U.S.A.
(806)356-5724 · FAX (806)356-5750 · 2300 Experiment Station Road

Using GPS for Determining Center Pivot Angular Position

by R. Troy Peters



Introduction

Precision or site-specific irrigation with mechanical move irrigation systems (center pivot or lateral-move) requires accurate information on the system's location within a field. Global positioning system (GPS) technology can offer the measurement and positional accuracy (a few meters or less) to pin-point irrigation applications to specific crop needs that may vary with crop conditions or soil properties within a field.

In 1994, the U.S. Department of Defense developed and deployed a global positioning system (GPS) composed of 24 satellites for military purposes. Civilian uses were permitted but with degraded accuracy by periodically shifting "reported" satellite positions or randomly switching off satellite signals briefly. In May of 2000, President Clinton announced the removal of selective availability which increased the accuracy of publicly available GPS positioning from about 45 meters to 6 meters. In July of 2003, the Wide-Area Augmentation System (WAAS) was certified by the Federal Aviation Administration (FAA) to meet the basic requirements for aviation navigation, making available a free method for differentially correcting GPS signals to further increase accuracy to less than three meters. Along with increased accuracy, the cost of differentially corrected GPS receivers has been decreasing, making their use in many additional applications a possibility. One such application includes precision farming where GPS systems are used to guide tractors and to create field yield maps. There has been additional interest in using GPS technology for center pivot positioning for precision or site-specific irrigation work.

Most modern center pivots use an instrument called a resolver-located at the pivot's "fixed" center point to report the angular position. However, these are subject to errors due to the instrument being bumped or inaccuracies in the resolver itself. A major limitation of using resolvers for precision irrigation work is that resolvers can only report the position of the first tower from the center point. Center pivots often have a slight bow in them to help minimize the forces on the pivot point, and the intermittent movement of interior towers results in position errors as the end tower moves far more often than the first interior tower. The resolver-reported angular position at the center point for the angle from the pivot point to the first tower may not translate into an accurate representation of the location of the end tower. Other precision irrigation

(Continued on page 2)

Table of Contents

1…**Using GPS for Determining Center Pivot Angular Position**
4…**An Evapotranspiration Research Facility for Soil-Plant-Environment Interactions**
6…**Events, Meetings & Presentations since last Newsletter**
6…**Upcoming Events, Meetings, and Presentations**
7…**Technology Transfer News**
7…**New Publications**
8…**Research Staff**
8…**Newsletter Contact**

(Continued from page 1)

researchers have found errors in the reported resolver angle and had to use correction algorithms to get accurate field positions (e.g. Sadler et al., 2002). Although these errors are not a cause for concern for most irrigators, knowing the correct pivot position is important for precision-application, or site-specific irrigation. The use of a low cost GPS receiver mounted near the end of the pivot could provide a more accurate representation of the pivot's position. The GPS receiver could also be used as a safeguard or backup for the resolver-reported angular position. The objective of this research project was to evaluate the fitness of low-cost GPS receivers for reporting center pivot angular position.

Materials and Methods

A survey grade GPS receiver (Trimble GPS Pathfinder Pro XRS) with sub-meter accuracy was mounted on the very end of a three-span experimental center pivot to evaluate the resolver angular accuracy. A data logger mounted on the center pivot measured the center pivot status and resolver position every minute. The details of this setup are given by Peters and Evett (2004). The center pivot control panel clock was synchronized with the GPS clock, and the pivot was sent around in a complete circle while logging both the center pivot angular position as reported by the resolver and the end point position as reported by the Trimble GPS receiver. These data were used to determine the accuracy of the resolver angle.

In a separate test, a low cost (~$169) GPS receiver (Garmin, model 16HVS) was mounted approximately 6 m beyond the last tower of a three tower, 127-m long center pivot system. This receiver was WAAS enabled and had a reported position accuracy of 95% less than 3 m when differentially corrected and 95% less than 15 m if not differentially corrected. The output NMEA (National Marine Electronics Association) sentence, which used the RS-232 protocol, was recorded by a solar powered datalogger (Campbell Scientific CR10X) mounted on the last tower. The datalogger parsed the data from the comma delimited sentences and logged the key data on one minute intervals.

Two separate trials were run in the spring of 2004 in which the pivot was left in a stationary position for an extended period of time and the variability in the measurements was analyzed. The first trial ran for almost 63 hours beginning on day-of-year (DOY) 96 at 1645 h and ending on DOY 99 at 738 h. The second trial ran for almost 137 hours beginning on DOY 119 at 1608 h and ended on DOY 125 at 854 h. The two trials were not done in the same area of the field.

GPS receivers report global position in terms of longitude and latitude. A series of equations as described by Carlson (1999) were used to convert the GPS reading into X and Y points on a theoretical field level grid with the pivot center point as the origin. These points were trigonometrically translated into angular position.

Results and Discussion

The resolver position error was determined using the survey-grade, sub-meter-accuracy GPS receiver mounted on the end of the center pivot for an entire revolution (Fig. 1). The resolver error changed as the pivot moved around the circle. The error was as large as five degrees. This is unacceptably large for precision or site-specific irrigation research even on a short three-tower center pivot. The error in the end tower position estimate using the resolver angle would be worse if the pivot was longer.

Least squares regression was used to fit a sine curve to the error

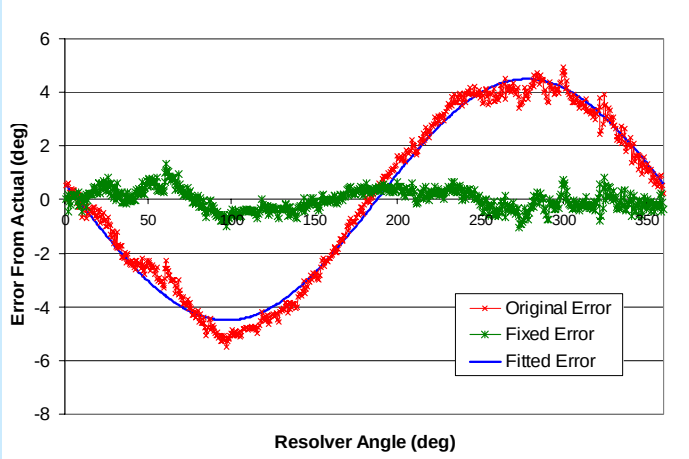


Figure 1. The center pivot resolver error as determined by a survey grade, sub-meter GPS receiver mounted on the end of the pivot for an entire revolution. Also shown is the fitted error curve, which was then used to correct the resolver reported angle to give the fixed error.

(Fig. 1). The resolver angle was then corrected by subtracting this error from the reported resolver angle to yield an error much closer to the zero-error line (Fig. 1).

The data collected from both trials of the low-cost GPS receiver are shown in Figs. 2 and 3. During both trials all points were differentially (WAAS) corrected. The X and Y position is the GPS receiver position in the field level grid with the pivot center point as the origin. The mean point is shown in each of these graphs along with the circle that includes 95% of all of the points collected. This circle radius was 2.07 m for trial-1 (Fig 2) and 1.42 m for trial-2 (Fig. 3). From these plots it can be seen that, although most points are within the stated

(Continued on page 3)

Wetting Front is published semi-annually and distributed by the USDA-ARS, Conservation and Production Research Laboratory, Soil and Water Management Research Unit, P.O. Drawer 10, Bushland, TX 79012-0010.
Mention of trade or manufacturer names is provided for information only and does not imply an endorsement, recommendation, or exclusion by USDA-Agricultural Research Service.
The United States Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).
To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence Avenue, SW, Washington, DC 20250-9410 or call 202-720-5964 (voice or TDD). USDA is an equal opportunity provider and employer.
Any material in this newsletter may be freely copied and distributed in part of whole if due credit is given to the authors.

Editors: Dr. Terry A. Howell, P.E./Nancy Davis
USDA-ARS
P.O. Drawer 10
Bushland, TX 79012-0010

email: tahowell@cprl.ars.usda.gov / ndavis@cprl.ars.usda.gov
Phone: (806)356-5746 / (806)356-5732
Fax: (806)356-5750
Shipping: 2300 Experiment Station Road

(Continued from page 2)

tolerance of 95% which was less than three m, the points that do go outside tend to go far out. Points further than six m away from the mean were measured.

The effect that these outlying points had on the calculated

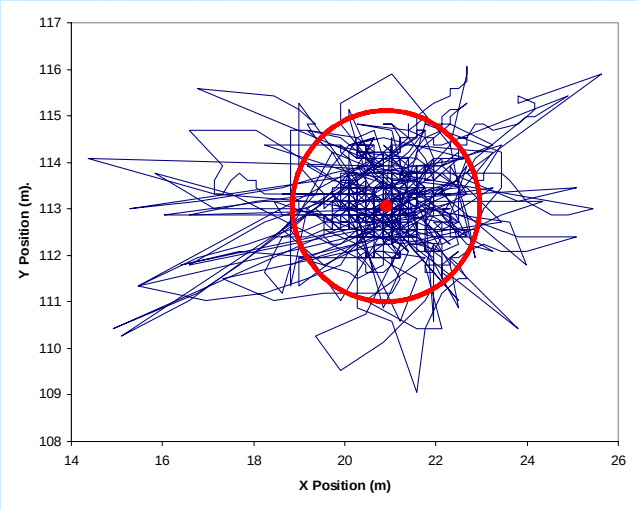


Figure 2. A plot of the points recorded by the low-cost GPS receiver in trial-1. The mean position is plotted and a circle enclosing 95% of the position readings is also shown.

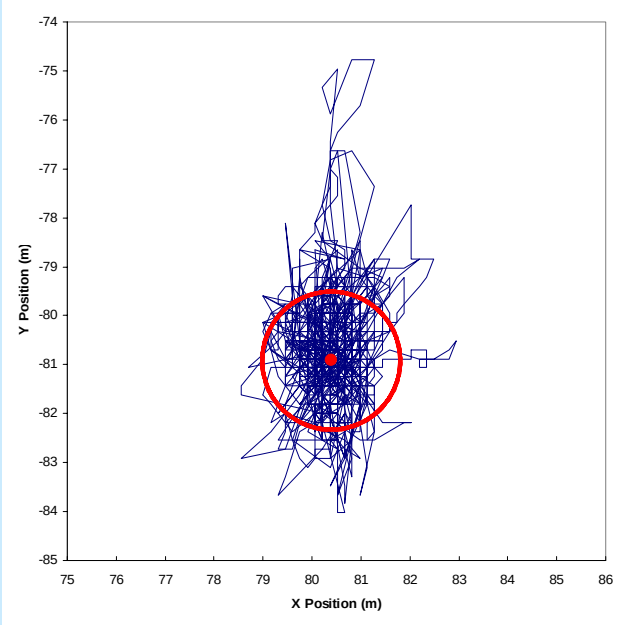


Figure 3. A plot of the points recorded by the low-cost GPS receiver in trial-2. The mean position is plotted and a circle enclosing 95% of the position readings is also shown.

center pivot angular position for trial-1 can be seen in Fig. 4. The plot for trial-2 was similar. Although 95% of the points were within a range of 1.55° for trial-1 and 1.08° for trial-2, the outliers created a range of errors of 5.55° for trial-1 and 3.94° for trial-2. These angular position errors are larger for the short, three-tower center pivot that was used for this experiment than what would be calculated on a more typical, longer center pivot. As an example, on a more typical seven tower, 400-m (1/4 mile) center pivot these errors would translate to a 95% range of 0.49° for trial-1 (Fig. 5) and 0.34° for trial-2, and a maximum range of 1.77° for trial-1 and 1.25° for trial-2. For longer pivots the angular position errors would be reduced further.

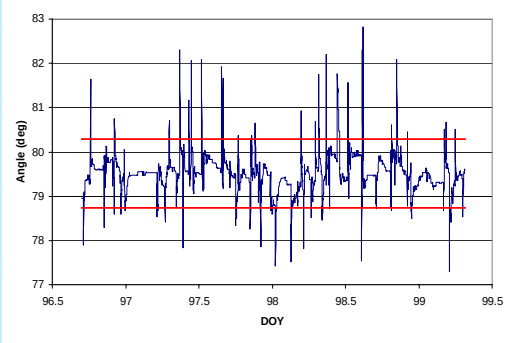


Figure 4. Calculated angular position of the center pivot over the time period of trial-1. The upper 97.5 percentile and lower 2.5 percentile lines are shown such that 95% of all measurements are between the two lines. The difference between these two lines represents the 95% error range.

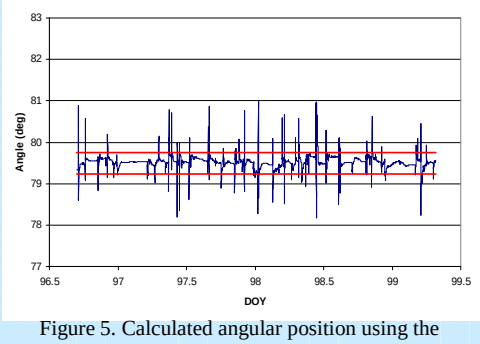


Figure 5. Calculated angular position using the same data as in Fig. 4 but on a more typical 400 m (¼ mile pivot). The upper and lower percentile lines are shown such that 95% of all measurements are between the boundaries.

Although 95% of the position measurements were within about 2 m, the remaining 5% of measurements were as high as 6.6 m. This is a significant concern if accurate position is always required as tends to be the case in precision control of moving center pivots. Rolling averaging schemes would provide little help since the pivot may need to respond immediately as it moves over the field, and because most GPS errors are caused by atmospheric interferences (Garmin, 2004), which tend to change slowly. This can be seen in Fig. 2, but more clearly in Fig. 3. The outlying points tend to follow each other in time. The probable causes for GPS position error include interferences in the ionosphere, the ephemeris and the troposphere, as well as multi-path errors and problems with the GPS clock and receiver. Because of these many possible error sources, it is difficult to know exactly what caused the error differences between trial-1 and trial-2.

(Continued on page 6)

An Evapotranspiration Research Facility for Soil-Plant-Environment Interactions

by Judy A. Tolk, Terry A. Howell, and Steven R. Evett

Lysimeters have become standard tools for evapotranspiration (ET) research and, in conjunction with rain shelters, can enhance the evaluation of plant water stress in soil-plant-water interaction studies. This poster describes recent improvements to the Soil-Plant-Environment Research (SPER) facility at the USDA-ARS facility in Bushland, TX. These improvements addressed several problems at the facility and involved the addition of a fourth soil type, conversion of the 48 lysimeters from weighable to weighing through the installation of deck scales, and use of a pressure-compensating drip irrigation system that allows simple, accurate irrigation application to each lysimeter.

The SPER Facility

The SPER facility, located at the USDA-Agricultural Research Service Conservation and Production Research Laboratory at Bushland, TX, was first described by Schneider et al. (1993). It had 48 weighable lysimeters with a 0.75-m x 1.00-m surface area and 2.30-m depth. Each lysimeter contained a monolithic soil core of one of three Great Plains benchmark soils.

The 13-m x 18-m x 2.7-m high rain shelter contained a top-running, double-bridge gantry crane used for moving the lysimeters, as well as weighing them for the weekly measurement of ET using a load cell and data acquisition system. The lysimeters were arranged in two concrete pits, each pit containing two side-by-side rows of 12 lysimeters each.

The soil monoliths were collected with the hydraulic pulldown procedure described by Schneider et al. (1988). The soil series were the Amarillo fine sandy loam (fine-loamy, mixed, thermic Aridic Paleustalfs) collected at Big Spring, TX; Pullman clay loam (fine, mixed, superactive, thermic Torrertic Paleustolls) from Bushland, TX; and Ulysses clay loam (fine-silty, mixed, superactive, mesic Aridic Haplustolls) from Garden City, KS.

The facility has been in operation since 1990.

Soil Monolith Collection

The Amarillo, Pullman, and Ulysses soil series are major agricultural soils of the Great Plains. A fourth soil was needed to contrast with these soils in permeability, fertility, water holding capacity, and the presence of a calcic horizon. A fourth soil also was needed for an even number of soil monolith replicates at the facility. The Vingo fine sand (coarse-loamy, mixed, mesic Aridic Paleustalfs) is a moderately rapidly draining soil formed in sandy materials of eolian origin. At the monolith collection site, the profile contained an average of 86 percent sand, with a buried B horizon beginning at 1.7 m which contained about 15 percent clay. A calcic horizon was not present in the 2.3-m profile that was collected.

The monoliths were collected using static weights similar to procedures outlined by Tackett et al. (1965). A frame was constructed which was used to move the empty lysimeter boxes into position, and center and hold the weights on the lysimeter box as it was pushed into the soil (see left).

The weights were stackable crane counterweights provided by the crane service which assisted in the collection and transport of the lysimeters. A forklift maintained lysimeter vertical alignment, and controlled the speed of downward movement of the lysimeter box into the soil (see right).

The crane moved successive weights into position . Fourteen monoliths were to be collected. But even with the total available force of 577 kN (130,000 lbs), the target monolith depth of 2.3 m could not be achieved for two monoliths.

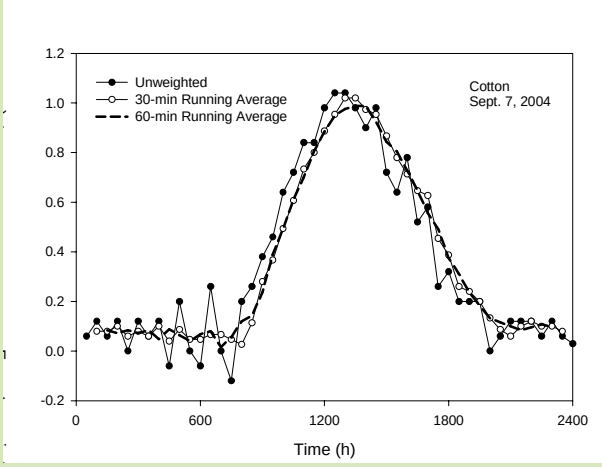
Conversion to Weighing Lysimeters

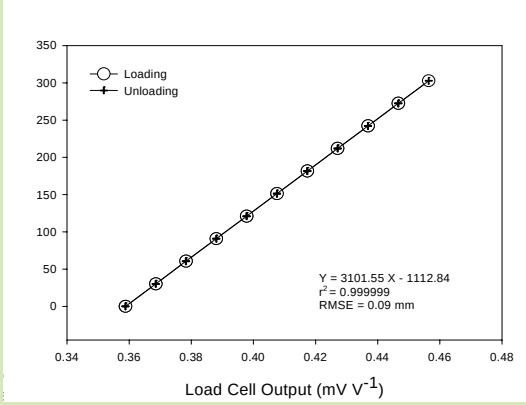
The first installation of four deck scales (model DS30x40-10K, Weigh-Tronix, Fairmont, MN[1]) was in 1995. Successive installations converted one-half of the lysimeters to weighing lysimeters by 2000. The installation of all 48 deck scales was completed in 2004.

The deck scale is of steel construction, and consists of a base structure, four load beams with individual suspension assemblies, a suspended platform, horizontal movement checks, overload stops, and junction box (shown left). The scale dimensions are 1 m x 0.75 m x 0.2 m. To maintain level and provide stability, the scales were mounted on 3 m x 1.5 m tubular steel frames positioned on the bottom of the concrete pits.

The deck scales are excited and measured by a Campbell Scientific, Inc. CR-7X data acquisition system with a 15-bit resolution, using a 6-wire full bridge program instruction which compensates for lead wire resistance. Excitation voltage from the data acquisition system is 2 V, keeping the excitation current below the 50 mA maximum source current of the data logger.

Deck scale output converted to ET of cotton grown in the Pullman soil is shown right. The ET rate appears "noisy" in the unsmoothed data, while the 30- and 60-min equally weighted averages (three and five 30-min averages, respectively) are considerably more stable. Typical measured standard deviations of the signal voltages were 30 to 40 microvolts, corresponding to 0.09 to 0.12 mm.





The figure above shows a typical calibration in 2004 of a deck scale in use since 1995. The root mean square error of the calibration was 0.09 mm. The calibration slope has varied less than 1 percent since calibration in 1996. Of the 48 deck scales calibrated in 2004, the smallest coefficient of determination was 0.999996 with a RMSE of 0.2 mm.

[1]Mention of trade or manufacturer products in this poster is solely for the purpose of providing specific information and does not imply recommendation or endorsement by USDA.

(Continued from page 4)

Drip Irrigation System

Initially, each set of 12 lysimeters was irrigated using a single drip line with in-line emitters whose flow was regulated using a pressure regulator. The accuracy in irrigation application amounts was variable. To increase accuracy, later irrigations were measured and applied by hand which proved very time-consuming. The improved system used six pressure compensating point source drippers (model WPC20, Netafim USA, Fresno, CA) on each lysimeter, with a cutoff valve to the 17-mm OD water distribution line so that each box could be irrigated independently. The drippers have internal check valves to prevent drainage.

References

Schneider, A.D., T.A. Howell, and J.L. Steiner. 1993. An evapotranspiration research facility using monolithic lysimeters from three soils. Appl. Eng. Agric. 9:227-235.

Schneider, A.D., T.H. Marek, L.L. Ebeling, T.A. Howell, and J.L. Steiner. 1988. Hydraulic pulldown procedure for collecting large soil monoliths. Trans. ASAE 31:1092-1097.

Tackett, J.L., E. Burnett, and D.W. Fryear. 1965. A rapid procedure for securing large, undisturbed soil cores. SSSA Proc. 29:218-220.

Events, Meetings & Presentations since last newsletter. . .

Louis Baumhardt presented a paper about "Deficit irrigation, seeding practices, and cultivar maturity effects on simulated grain sorghum yield" with Terry Howell on March 8-10 at the Biological Systems Simulation Conference in Gainesville FL.

Steve Evett and Bill (Charles) Purdy traveled to Uzbekistan for two weeks in April and May in support of a joint research project on crop water use, irrigation scheduling and irrigation water quality funded by USDA through the Science and Technology Center Ukraine. They worked with colleagues at the Uzbekistan National Cotton Growing Research Institute and the Veterinary Institute of Uzbekistan.

Paul Colaizzi, Troy Peters, and Terry Howell met on June 2nd with the Ogallala Aquifer Initiative team on Irrigation Systems and Technology at Etter, TX to plan FY-05 & 06 research.

Troy Peters and Terry Howell attended SAS I&II programming training at Lubbock, TX, June 18th-20th.

Louis Baumhardt and Terry Howell attended the field day on June 18th at New Deal, TX, on the Cropping Systems research being conducted by Texas Tech University, Texas A&M University, USDA-ARS Lubbock, and the High Plains Underground Water Conservation District at Lubbock.

Terry Howell, Vivien Allen, and Bill Payne met on June 22nd at Halfway, TX, to review and finalize FY-05 & 06 Production Systems proposals for the Ogallala Aquifer Initiative.

Paul Colaizzi and Terry Howell attended the ASCE/EWRI Conference June 30th - July 1st at Salt Lake City, UT. Paul attended the On-Farm Irrigation Committee meeting, and Terry attended the ET in Irrigation and Hydrology Committee meeting and its Reference ET Standardization, Update for ASCE Manual 70, Crop Coefficients Task Committee meetings and other Irrigation and Drainage Council Committees as the Council Chair. Paul also assumed Position of Secretary for the EWRI On-farm Irrigation Systems Task Committee.

Steve Evett presented "Water use in irrigation: prospects for increased water use efficiency through cooperation in the Middle East" at the Workshop Promoting Cooperation in Agricultural Research and Development in the Middle East Region, July 5th-7th, at Koc University, Turkey.

In July, Steve Evett met with scientists of the National Center for Agricultural Research and Technology Transfer in Amman, Jordan in order to develop plans for weather station siting and for a weighing lysimeter for crop water use determinations. Later, he met with scientists in Israel and the Palestine Authority to work on water management research plans and learn about work underway there. This travel was organized under the USDA-OIRP Project titled Irrigation Management Information Systems for the Middle East.

Carole Perryman attended the Southern Plains Area Advisory Council for Office Professionals in Weslaco, TX. She was nominated for and accepted the position of "Training Coordinator", July 13th-15th.

On July 20th, Nolan Clark and Terry Howell presented the interactive FY-05 unit and laboratory ARMPS (Agricultural Research Management Plan) review to the ARS Southern Plains Area Director's office staff and the Director.

Troy Peters attended the annual international meeting of the ASAE in Ottawa, Canada, August 1st-4th and presented the paper, "Complete Center Pivot Automation Using the Temperature-Time Threshold Method of Irrigation Scheduling".

On August 2nd Louis Baumhardt, Paul Unger, and Bill Payne traveled to Colorado Springs, CO, where they locked themselves in a conference room for 3 days with Gary Peterson (Colorado State Univ.) and Randy Anderson (USDA-ARS Brookings, SD) to develop a summary chapter for the revised ASA Monograph on Dryland Agriculture to be published in 2005.

Paul Colaizzi presented a paper "Comparison of Radiometric and Aerodynamic Surface Temperature Using Precision Weighing Lysimeters" (By Colaizzi, Evett, Howell, and Tolk) in Denver, CO, at the International Symposium on Optical Science and Technology (SPIE, the International Society for Optical Engineering, 49th Annual Meeting) Sub-conference Remote Sensing & Modeling of Ecosystems for Sustainability, August 2nd-6th.

Terry Howell attended the retirement celebration for Dr. Edward A. Hiler, Vice Chancellor for Agriculture and Dean of Agriculture at Texas A&M University, Director of the Texas Agricultural Experiment Station, and Director of the Texas Cooperative Extension on August 9th at the George H.W. Bush Presidential Library in College Station, TX.

Paul Colaizzi, Steve Evett, and Troy Peters attended a Statistical Analysis Workshop on Multiple Comparisons and Multiple Tests, held in Lubbock, TX, August 11th-12th.

Carole Perryman attended Travel Training for the Southern Plains Area in Weslaco, Texas, August 16th-20th, 2004. Domestic and international travel training was presented by Freida Williams, Transportation Assistant for the SPA.

Terry Howell and Thomas Marek attended the 2004 meeting on August 17th and 18th of the WCC-202 CSREES technical committee on Crop Coefficients at Boise, ID.

Paul Colaizzi spoke at the CPRL Field Crops Day August 31st, on two on-going field experiments involving

(Continued on page 8)

Upcoming Events, Meetings, and Presentations. . .

Troy Peters will present a paper November 14th-16th on "Comparison of Scaled Canopy Temperatures with Measured Results under Center Pivot Irrigation" at the 2004 Irrigation Association (IA) technical conference in Tampa, FL.

Paul Colaizzi will present a paper "Comparison of SDI, LEPA, and Spray Irrigation Performance for Cotton in the North Texas High Plains" (By Colaizzi, Evett, and Howell) at the Irrigation Association Annual Meeting and Exposition this November in Tampa, Florida.

Steve Evett will present a paper "Profile Water Content Measurement for Soil Water Balance: Systems Compared" at the 2004 joint international meeting of the Soil Science Society of America and the Canadian Society of Soil Science in Seattle, WA. He is co-author on "Neutron Moisture Meter Calibration in Soils of Uzbekistan" and "Soil Water Balance of Wheat and Cotton in Uzbekistan by Neutron Probe" with Bakhtiyor Kamilov and Nazirbay Ibragimov of the Uzbekistan National Cotton Growing Research Institute. He will preside over the oral session titled "Soil Water Content Sensing Methods: Comparisons and Calibrations".

Louis Baumhardt will present a paper about "Integrating Cattle Grazing into a Dryland Wheat Sorghum Fallow Rotation" at the High Plains Groundwater Resources: Challenges and Opportunities Conference in Lubbock, TX, this December.

(Continued from page 3)

Conclusions

On the center pivot that was tested, the resolver angle had to be corrected to give angular position of sufficient accuracy for precision or site-specific irrigation. The low-cost GPS receiver that was tested conformed to the stated specifications of an accuracy of 95% of points less than 3 m. In fact, an accuracy of 95% less than 2.1 m was measured. However, the remaining 5% of points showed errors as large as 6.6 m. This is cause for concern when using GPS for pivot or lateral-move positioning under precision or site-specific irrigation. An advantage of the GPS receiver is that it can show the location of the center pivot end point while resolvers can only indicate the location of the first tower. This advantage becomes more pronounced with longer center pivots.

References

Carlson, C.G. 1999. What do latitude and longitude readings form a DGPS receiver mean? Available at: http://www.abs.sdstate.edu/abs/precisionfarm/EARTHMO1.html. Accessed Oct. 2003.

Garmin Inc. 2004. Differential GPS. Available at: http://www.gpsinformation.org/dale/dgps.htm. Accessed Sept. 2004.

Peters, R.T., and S.R. Evett. 2004. Complete center pivot automation using the temperature-time-threshold method of irrigation scheduling. Paper #042096, 2004 ASAE annual irrigation meeting

Sadler, E.J., C.R. Camp, D.E. Evans, and J.A. Millen. 2002. Corn canopy temperatures measured with a moving infrared thermometer array. *Trans. ASAE*. 45(3): 531-591

Technology Transfer News. .

On March 31, Steve Evett was interviewed by KGNC Radio on international cooperation in agricultural research, including joint research projects underway on cotton and winter wheat water use and irrigation scheduling in Uzbekistan, similar work undertaken by the SWMRU in Egypt in the 1990s and work underway in Israel, Jordan and the Palestine Authority on water use and water resource management.

In April, a group of engineers and scientists from Colorado State University and the Colorado Department of Water Resources met with unit scientists to discuss weighing lysimeters and to tour the Bushland facilities.

In April, Nolan Clark participated in a project review of Texas Water Development Board grant proposals for the Texas A&M University Agricultural Research & Extension Center at Amarillo.

May 6th, Nolan Clark and Terry Howell meet with Texas A&M University, West Texas A&M University, and, Texas Tech University administrators and faculty at Halfway, TX, to discuss Texas Water Development Board research and demonstration projects.

On May 12th, Terry Howell recorded a CREET Beat interview for KGNC 710 AM radio for the Friday May 14th Agricultural News on the "Use of the Penman-Monteith Equation in Estimating Crop Water Use and Water Rights Transfers".

On May 26, Bill Purdy and Steven Evett delivered a presentation on people and customs of Uzbekistan to the fourth grade class at Bushland Elementary.

On June 8, Steve Evett and Brice Ruthardt delivered radiation safety training for nuclear moisture/density meters and hazardous materials transport training for radioactive materials to participants from Texas A&M University, West Texas A&M University, and USDA locations at Bushland and Lubbock, TX and El Reno and Woodward, OK.

In July, Terry Howell presented "Trends in Water Use Efficiency: Producing More, Using Less" and "Rural versus Urban: Who Needs the Water More?" to the Confronting Water Scarcity Conference in Lethbridge, Alberta, Canada.

Paul Colaizzi and Judy Tolk provided a field tour and discussed agricultural research issues on July 20 with members of the West Texas A&M University environment education class taught by Drs. Bob Stewart and Jim Rodgers.

On July 28th, Troy Peters recorded a CREET Beat interview for KGNC 710 AM radio for the Friday July 30th Agricultural News on “Center Pivot Automation Using Leaf Temperatures”.

In August, Terry Howell presented "Evapotranspiration of Corn - Southern High Plains" at the 2004 ASAE/ CSAE International meeting at Ottawa, Ontario, Canada.

In August, Steve Evett met with Scientist Bobbie McMichaels and Technician Jill Booker at the USDA-ARS Laboratory in Lubbock to help configure a time domain reflectometry system for soil water content measurement. Later, Jill Booker visited the SWMRU at Bushland for training in TDR system configuration.

Faculty from the Biological Systems Engineering Department at the University of Nebraska (Derrel Martin, Suat Irmak, and Jose Payero) met with SWMRU staff from ARS Bushland on August 19th to discuss research and to tour research facilities.

On August 31st, Louis Baumhardt, Paul Colaizzi, Steve Evett, and Troy Peters presented research highlights on field tours for the 2004 Bushland Field Day. Robert Schwartz was co-chair and Steve Evett was a member of the field day planning committee. Special thanks to all SWMRU staff for registering visitors, bus hosting, and setting up and cleaning up for the activities that made this event a success and the opportunity to show the public and local producers our research results in the field.

James Herring (Friona Industries) a member of the Texas Water Development Board visited the NP ET team at Bushland on September 17th to tour and discuss ET and weather information provided to the Texas High Plains and surrounding regions of the state.

Articles on the irrigation automation work of Troy Peters and Steve Evett appeared in the Southwest Farm Press (16 September 2003) and the Southern Idaho Ag Weekly (11 September 2004). This project is for developing a center pivot irrigation automation system using data on crop leaf temperatures obtained using infrared thermometers.

Steve Evett led a seminar on 17 September 2004 at West Texas A&M University in Canyon for the class: PSES 8301 - Advanced Plant and Soil Management. The discussion involved soil water measurement, crop water use, and water use efficiency, with related discussions on water resource issues relative to the southern High Plains and Ogallala aquifer.

On 24 September 2004, Steve Evett led a tour of ARS Bushland field research on crop water use, including viewing and discussing weighing lysimeters. He concluded the tour, for the West Texas A&M class: PSES 8301 - Advanced Plant and Soil Management, with the presentation: "Overview of Soil Water Studies Under Rainfed and Irrigated Agriculture".

New Publications. . .

2004. Baumhardt, R.L., Unger, P.W., and Dao, T.H. Seedbed surface geometry effects on soil crusting and seedling emergence. Agron. J. 96:1112-1117.

2004. Colaizzi, P. D., Schneider, A. D., Evett, S. R., and Howell, T. A. 2004. Comparison of SDI, LEPA, and spray irrigation performance for grain sorghum. Trans. ASAE. 47(5):1477-1492

2004. Colaizzi, P.D., Evett, S.R., and Howell, T.A. 2004. Comparison of aerodynamic and radiometric surface temperature. International Symp. Optical Sci. Tech., The International Society for Optical Engineering 49th Annual Meeting, 2-6 August 2004, Denver, CO. (Invited)

Evett, S.R. 2004. Water use in irrigation: prospects for increased water use efficiency through cooperation in the Middle East. Proc. Workshop Promoting Cooperation in Agricultural Research and Development in the Middle East Region. 5-7 July 2004, Koc University, Turkey. BARD, Bet Dagan, Israel. (Abstract)

Howell, T.A., Evett, S.R., Tolk, J.A. and Schneider, A.D. 2004. Evapotranspiration of full- deficit-irrigated, and dryland cotton on the Northern Texas High Plains. J. Irrig. Drain. Engr. (ASCE) 130(4):277-285.

Howell, T.A., and Evett, S.R. 2004. The Penman-Monteith Method. Section 3 in Evapotranspiration: Determination of Consumptive Use in Water Rights Proceedings. Continuing Legal Education in Colorado, Inc. Denver, CO.

Peters, R.T., and Evett, S.R. 2004. Complete center pivot automation using the temperature-time threshold method of irrigation scheduling. ASAE/CSAE Meeting Paper No. 042196. St. Joseph, Mich. American Society of Agricultural Engineers.

van Donk, S., Tollner, E.W., Steiner, J.L. and Evett, S.R. Soil temperature under a dormant bermuda grass mulch: Simulation and measurement. Transactions of the ASAE. Vol. 47(1) 91-98.

Soil and Water Management Research Unit

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

RESEARCH STAFF

Dr. Terry A. Howell, P.E.
Research Leader (Agric. Engr.)
(806) 356-5746
tahowell@cprl.ars.usda.gov

Dr. R. Nolan Clark
Laboratory Director (Agric. Engr.)
(806) 356-5734
rnclark@cprl.ars.usda.gov

Dr. R. Louis Baumhardt
Soil Scientist
(806) 356-5766
rlbaumhardt@cprl.ars.usda.gov

Dr. Paul D. Colaizzi
Agricultural Engineer
(806) 356-5763
pcolaizzi@cprl.ars.usda.gov

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

Dr. Steven R. Evett
Soil Scientist
(806) 356-5775
srevett@cprl.ars.usda.gov

Dr. Robert C. Schwartz
Soil Scientist
(806) 356-5762
rschwart@cprl.ars.usda.gov

Dr. Judy A. Tolk
Plant Physiologist
(806) 356-5736
jtolk@cprl.ars.usda.gov

Dr. R. Troy Peters
Agricultural Engineer
(806)356-5770
tpeters@cprl.ars.usda.gov

Donald A. Dusek
Collaborator (Agronomist)
(806) 356-5747
ddusek@cprl.ars.usda.gov

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

Newsletter Contact . . .

The *Wetting Front* newsletter 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.

For actions or corrections to our mailing list, contact Mrs. Carole Perryman by one of the following:

fax: (806)356-5750
email: cperryman@cprl.ars.usda.gov
phone: (806)356-5749
mail: USDA-ARS, P.O. Drawer 10, Bushland, TX 79012

(Continued from page 6)

subsurface drip irrigation: 1) Comparison of SDI, LEPA, and Spray Irrigation Performance for Early Maturity Cotton; 2) SDI Designs for Better Crop Establishment.

Louis Baumhardt discussed planting population, cultivar, date, and row spacing effects on simulated dryland grain sorghum yields at the CPRL Summer Crops Field Day August 31st.

Paul Colaizzi attended the US Committee on Irrigation and Drainage Meeting on Water Rights and Related Water Supply Issues held October 13th -15th, in Salt Lake City, UT.

Poster presentations at the 2004 ASA/CSSA/SSSA meeting in Seattle, WA will be "Furrow Irrigated Cotton-Sorghum Rotation for the Texas Northern Plains" by Howell, Tolk, and Evett; "Contrasting Effects Of Seeding Practices on Simulated Grain Sorghum Yield" by Baumhardt, Howell, and Tolk; "An Evapotranspiration Research Facility for Soil-plant-environment Interactions" by Tolk, Howell, and Evett; and "Planting Rate Effects on Yield and Water Use of Irrigated Corn Hybrids with

Download at **http://www.cprl.ars.usda.gov/wmru/wmpubs.htm**

United States Department of Agriculture

Agricultural Research Service

POSTMASTER: Send address changes to *Wetting Front*, USDA-ARS, P.O. Drawer 10 Bushland, TX 79012-0010.

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