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International Research Cooperation at the Conservation & Production Research Laboratory

by S.R. Evett, Soil Scientist/Lead Scientist Irrigation and Crop Water Use Team

International cooperation has long been recognized as essential for the steady advance of science and technology in service to our citizens. This is true as much for the agricultural sciences as it is for sciences that are more visible to the public at large. Since European settlers brought plants and agricultural techniques to the east coast of the Americas, and returned to Europe with such important crops as corn, potatoes, and cocoa, the exchange of agricultural information and seed stock has had great impact on economies around the world.

Visitors to the USDA-ARS Conservation & Production Research Laboratory (CPRL) are often surprised by the amount and depth of international work in which our scientists and engineers are involved. Stakeholders may legitimately ask why we spend time on international projects and where the resources for these projects come from. What follows is a short explanation of how our international cooperation has enhanced agricultural research findings and outcomes beneficial to farmers in the Great Plains and United States.

From left to right, are: Naem Mazahrih (Jordan), Nedal Katbeh-Bader (Palestine), and Brice Ruthardt (Bushland, TX) who are testing a capacitance type soil water content sensor in a California pepper field.

Overseas work by scientists located at Bushland extends back to work done more than 20 years ago; but an outstanding example of cooperation is the 1988 International Conference on Dryland Farming held to commemorate the more than 50 years of research by the CPRL and Texas Agricultural Experiment Station at Bushland. The 460 conference attendees were from 52 countries and 36 of the United States. Research at Bushland was important to practices that contributed to ending the "Dust Bowl" of the 1930s, and much of that research was presented in the 282 papers published in the proceedings, "Challenges in Dryland Agriculture – A Global Perspective" (Unger et al., 1988). However, more than half the papers reported on dryland farming conditions, techniques and outcomes in semi-arid areas in other countries. Dr. Paul Unger, the senior editor of the proceedings, visited more than 20 countries during his tenure with USDA-ARS at Bushland. The conference was supported by, and involved participation of, such diverse entities as the United Nations Food and Agriculture Organization, the World Bank, and the U.S. Agency for International

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Development (USAID). A majority of the papers presented information on agricultural problems relevant to the Great Plains, including erosion control; corn, cotton, millet, sorghum, and winter wheat production practices; soil and water conserving tillage practices; effective use of rainfall; farming strategies in risky environments; and many other topics. The strong participation of the Texas Agricultural Experiment Station in the conference organization was guarantee of the effective transfer of knowledge from around the world. Others active in early international work at Bushland, and some still active to this day, include former Laboratory Director Bob Stewart, now Director of the Dryland Agriculture Institute at West Texas A&M University; Reggie Jones, former Soil Scientist with the CPRL, and several others.

In the 1990s, cooperative research was continued with a series of visiting scientists and students working with CPRL scientists, including Dr. Attila Yazar from Turkey [work on corn irrigation scheduling (Howell et al., 1995; Yazar et al., 1999)], Dr. Zhu Zixi of the Henan Institute of Meteorology in China, and several students from China, most of whom were working with winter wheat under similar climates as we experience on the High Plains. In 1993 through 1995, Dr. Terry Howell led the USAID/USDA-FAS funded project "Water conservation with improved irrigation methods and management", which involved building weighing lysimeters in Egypt and the first subsurface drip irrigation research facility at Bushland. Under this project, Dr. Arland Schneider developed novel, low-cost weighing lysimeter designs for developing countries, which were used in Brazil and Egypt, Uvalde, TX and Rocky Ford, CO and some elements of which were included in lysimeters installed at Bushland and at the USDA-ARS Laboratory at Parlier, CA (Schneider et al., 1998). Subsurface drip irrigation research begun under this project has continued at Bushland to this day, an important jump start from an international research project.

A second project with the Egyptian Soil, Water, and Environment Research Institute was funded by USAID/USDA-FAS from 1997 through 2000, and led by Dr. Steve Evett. Under this project, cooperative work at the CPRL and in Egypt was conducted on reference crop water use of alfalfa (and of grass at Bushland); and the Penman-Monteith method of estimating reference crop water use was shown to predict well for alfalfa, but not as well for grass. This was an important finding relative to evapotranspiration (ET) networks used to predict crop water use for irrigation scheduling both in the Texas High Plains and in other States. Installation of a state-of-the-art, solar-powered system for automated measurement of deep soil water content in Egypt was a key test of technology, developed at Bushland for determination of water content by time domain reflectometry, and made available to the public through commercialization by a Texas company. The second Egypt project also funded continued research on surface and subsurface drip irrigation, and allowed thorough testing of an automatic irrigation scheduling and control system based on crop leaf temperature measurements. Discussions are now underway on commercialization of this technology. These studies established crop water use and water savings knowledge for corn and soybeans under drip irrigation on the High Plains.

In 1999, the International Atomic Energy Agency (IAEA) and Food and Agricultural Organization Joint Division of the United Nations asked Dr. Evett to travel to Uzbekistan in Central Asia. The trip's purpose was to train scientists in that country's National Cotton Growing

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Research Institute in the use of the neutron probe for measurement of soil water content and crop water use. The visit led to three subsequent grants, one from the IAEA and two funded by the U.S. Department of State, to study water use and irrigation scheduling of cotton, corn, winter wheat, and sugar beet. Because climates and soils are similar in the great plains and Uzbekistan, this work provided important checks on methods and knowledge developed at the CPRL on these crops. For example, improvements in corn and cotton water use efficiency under drip irrigation were similar in both regions, lending support and credibility to the results. Also, methods for calibrating and using the neutron probe based on CPRL research were tested and proved suitable under conditions in Uzbekistan. Recently, Dr. Charles Purdy (DVM at CPRL) has become involved in studying quality of irrigation waters in Uzbekistan; and the cooperation has provided useful and safe work for former weapons scientists in that country – a key U.S. objective in foreign policy. Several visits to the United States to scientists from Uzbekistan, and return visits by our scientists to that country, have broadened international understanding and cemented relationships.

Work now being completed at Bushland has reached a broad audience of users of soil water content sensors, both in the USA and internationally (Charlesworth, 2005). Research into the suitability of different sensors for determining crop water use and irrigation scheduling had begun at the CPRL in the early 1990s, but was recognized in 2000 by an invitation from the IAEA to join an international team of scientists in comparisons and fundamental studies of a wide variety of soil water content sensors. Results of the studies, which spanned five continents, are compiled in a seven-chapter book to be released by the IAEA, and in a special section of a scientific journal (Evett and Parkin, 2005: Evett et al., 2005). Interim results have had important effects on sensor manufacturers' designs, and have identified the major problems with existing sensors – the first step to improved designs. The IAEA book, titled *A Practical Guide to Soil Water Sensing*, will serve as a useful guide to irrigation managers and scientists both in the USA and abroad. This work led to a four-month sabbatical with the IAEA in Vienna, Austria where preparatory work for the IAEA book was done in 2003, and where Dr. Evett was invited to teach a course on Soil Water Measurement for Water Balance Studies and Irrigation at the Universität für Bodenkultur. While in Austria, Dr. Evett was also chief instructor for a four-week IAEA training course for scientists from 19 countries – the FAO/IAEA Interregional Training Course on the Use of Nuclear and Related Techniques to Increase Water Use Efficiency in Rainfed and Irrigated Agriculture.

International cooperation in the Middle East was renewed in 2002 with the initiation of the Middle East Regional Irrigation Management Information System (MERIMIS), which includes participants from Jordan, Israel, the Palestine Authority, and two USDA-ARS laboratories: The CPRL at Bushland, and the San Joaquin Valley Agricultural Sciences Center at Parlier, California. Coordination between ARS and MERIMIS is accomplished through the laboratory at Bushland. Objectives of MERIMIS include:

- "Improve water management in the Middle East by developing a regional database system for dissemination of agro-meteorological information, providing data for scheduling irrigation and other crop management decisions to increase irrigation efficiency in the region.

- Install automated weather stations and lysimeters to develop and improve water management models and irrigation scheduling practices at both the field and watershed scale in the Middle East and the United States.

- Apply irrigation scheduling methodology in farmer's fields; and through interaction with farmers, farm advisors and extension personnel, promote the implementation of the MERIMIS system to ensure wide acceptance and sustainability".

To date, three weather stations have been installed in Jordan, two in Israel, and three in the Palestine Authority. A site has been chosen for a weighing lysimeter in the Jordan Valley to measure water use of horticultural crops – also an important research topic at the Parlier Laboratory. Planning continues on that project, which is in conjunction with the National Center for Agricultural Research and Technology Transfer of Jordan. In 2004, visiting scientists from Jordan and the Palestine Authority came to spend a year at the ARS Laboratory at Parlier, with a visit to Bushland to learn soil water sensing techniques. The scientists, Naem Mazahrih and Nedal Katbeh-Bader, then performed in 2005 a field comparison of spatial variability and accuracy of soil water sensors in California that lent strong support to results from Bushland. Future work is aimed to improve irrigation scheduling of horticultural and fruit crops in all participating countries, thus saving water and fertilizers and improving harvest quality.

Other international activities include recent participation in conferences and workshops in Australia, Canada, China, France, Mexico, and Turkey by CPRL scientists and engineers. In summary, international collaborations improve relations between countries, allow testing of methods and techniques developed by CPRL scientists in a broad range of environments, and enhance the exchange of knowledge both from and to our shores.

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Technology Transfer News. . .

On July 5, 2005, Steve Evett was interviewed on KGNC Agricultural Radio's CREET Beat program on the subject of crop germination problems with subsurface drip irrigation and research at Bushland aimed at solving those problems.

On July 28, 2005, Paul Colaizzi and Steve Evett hosted visiting scientist Alberto Mora of Brazil for discussion and a field tour on microirrigation of cotton.

On August 16, 2005, Graham Harris visited the SWMRU. He is the Senior Development Extension Officer for Irrigation, Department of Primary Industries and Fisheries, Toowoomba, Australia. He is the Swire Group Churchill Fellow for 2004.

September 1-20, 2005, Steve Evett was detailed to a U.S. Forest Service/U.S. Agency for International Development Disaster Assistance Response Team (DART) in northeast Mali, West Africa. Steve served as the water resources expert on a multi-person team examining the effects of drought, including livestock losses and famine, on the agro-pastoralists and nomadic herders of the region, which includes the semi-arid Sahel and mountainous parts of the Sahara Desert. The team made recommendations for immediate assistance to prevent short-term loss of life in the region.

On September 28-31, 2005, Steve Evett visited the USDA-ARS Laboratory at Parlier, CA to work with scientist Jim Ayars and visiting scientists Naem Mazahrih and Nedal Katbeh-Bader on an experiment comparing soil profile water content sensors in a field on the west side of the San Joaquin Valley.

October 31 through November 5, 2005, Steve Evett and Troy Peters hosted two scientists from the Uzbekistan National Cotton Growing Research Institute on a tour of irrigation, winter wheat and sugar beet production in northern Utah and southern Idaho, visiting Utah State University; Campbell Scientific, Inc.; AMS Inc., makers of soil coring equipment; the Twin Falls Tract Irrigation District; and the USDA-ARS Northwest Soils and Irrigation Laboratory at Kimberly, Idaho.

On November 17, 2005, David Wigginton, Research Engineer at the National Centre for Engineering in Agriculture, University of Southern Queensland, Toowoomba, Australia visited Paul Colaizzi, Steve Evett and Terry Howell to discuss irrigation research in Australia and the United States.

Troy Peters recorded a CREET Beat interview which aired November 25, 2005 titled: “New Technologies for Center Pivot Irrigation.”

MAPPING TILLAGE PRACTICES IN THE TEXAS PANHANDLE WITH LANDSAT THEMATIC MAPPER (TM) DATA

By Prasanna H. Gowda, R. Troy Peters and Terry A. Howell

Introduction

Environmental models require information on tillage management practices to predict water holding capacity, evapotranspiration, carbon sequestration, and soil losses due to wind and water erosion from agricultural lands. Collecting this information can be time consuming, labor intensive, costly and can involve destructive sampling. Moreover, field data are limited because they provide point, rather than area information. Remote sensing techniques show promise in providing spatial data over a large area in a time and cost-effective manner.

Conventional methods of mapping tillage practices over a large area include field survey and manual interpretation of film-products derived from sensors mounted on aerial or satellite platforms. In a 5-year study, DeGloria et al. (1986) manually interpreted the Landsat Multi Spectral Scanner (MSS) data for identifying land under conventional and conservation tillage practices in the central coastal region of California. They achieved an overall classification accuracy of 81 percent. However, accuracy of their map was a function of a human interpreter's ability to identify tillage patterns on the image. Motsch et al. (1990) derived a crop residue map showing four tillage categories from Landsat TM data for Seneca County, Ohio and reported an accuracy of 68 percent. For the same study area, van Deventer et al. (1997) developed a set of Landsat TM-based probability models to identify tillage practices. Models classified 93 percent of the tillage attributes correctly when they were tested with independent data from 15 fields. Similar levels of accuracy may not be achieved when these models are applied to a different geographic region. Spectral models that contain ratio and orthogonal indices are sensitive to soil types and water conditions (Huete et al., 1985). Therefore, spectral indices developed and evaluated for one geographic location must be re-evaluated if they are to be applied in another geographic location. The objective of this study is to evaluate a set of Landsat TM-based logistic regression models proposed by van Deventer et al. (1997) for their ability to identify tillage management practices in the Texas High Plains.

Study Area

Ochiltree County is located in the Texas Panhandle underlain by the diminishing Ogallala aquifer. The county area is about 234,911 ha with more than 70 percent of the land under row crop production. Annual average precipitation is about 562 mm and about 66 percent of the crop land is irrigated with Ogallala water. Sorghum, wheat and corn are the major crops in the county. Silty Clay Sherm soils with nearly level to gently sloping fields occupy nearly all of the crop land.

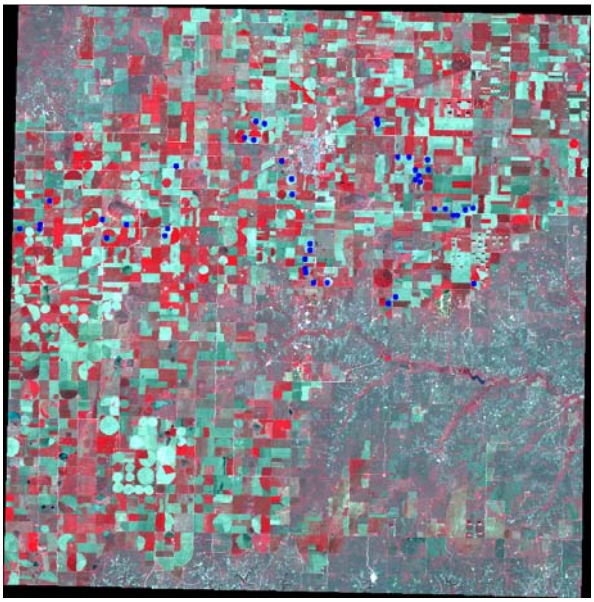

Figure 1. Landsat TM imagery of Ochiltree County acquired on May 10, 2005 for mapping tillage practices.

Materials and Methods

The Landsat TM imagery was acquired on May 10, 2005 for mapping tillage practices in the Ochiltree County. A set of six TM based logistic regression models proposed by van Deventer et al. (1997) (Table 1) was used to identify tillage practices. Mapping of tillage practices and the accuracy assessment consisted of three steps: 1) ground-truth data collection, 2) applying logistic regression models to determine tillage probability values for each pixel in the imagery, and 3) determining statistical measures of map accuracy, i.e., *percent correct* and *kappa (k)* values. Ground-truth data were collected from 41 randomly selected fields in Ochiltree County on the day of the satellite overpass. Ground-truth data included geographic coordinates using a handheld Global Position System (GPS), infrared and digital pictures for residue cover estimation, soil water content using the time-domain

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Table 1. Landsat TM-based logistic regression models proposed by van Deventer et al. (1997)[1].

Model	Band or Index[2]	Intercept	Slope	Cut-off Tillage Probability
I	TM5	10.215	-0.072	0.62
II	R15	-19.404	29.949	0.56
III	M15	8.785	40.947	0.56
IV	D35	10.931	0.135	0.44
V	STI	45.218	-23.998	0.64
VI	NDTI	30.464	-99.483	0.62

[1] Intercept and slope terms are for each logit equation. For example, logit(p) = 45.218 - 23.998 STI.
[2] R15 = (Band 1 / Band 5), M15 = (Band 1 - Band 5) / (Band 1 + Band 5), D35 = Band 3 - Band 5, STI = (Band 5 / Band 7) NDTI = (Band 5 - Band 7) / (Band 5 + Band 7).

reflectometry, and soil samples for particle size distribution.

The Landsat TM-based logistic regression models (SAS, 1990) used in this study have the form:

$$\log it(p) = \ln\left[\frac{p}{1-p}\right] = \alpha + \beta X$$

(1)

where p is the response probability for a specific tillage management practice, X is an independent response variable based on reflectance, α is the intercept parameter, and p is a vector of slope parameters. In this study, p is the conventional tillage probability and varies between 0 and 1. The ideal p values for 100% conservation and 100% conventional tillage are 0 and 1, respectively. The p value, expressed as a fraction, is:

$$p = \frac{e^{\log it(p)}}{1 + e^{\log it(p)}}$$

(2)

Logistic regression models require users to specify a cut-off response probability to classify the outcome of an event occurring. For example, in this study, whenever the tillage probability of a pixel was less than the cut-off tillage probability value, the pixel was classified as conservation tillage. Selection of a cut-off response probability will normally depend on the application.

Six models were used with different values for X in Eq. (1). Model I was derived from TM band 5. Model II was based on the ratio of TM bands 1 and 5 (R15 index). Model III was based on the normalized difference between TM bands 3 and 5 (M15 index). Model IV was based on the difference between TM bands 3 and 5 (D35 index). Model V was based on the ratio of TM bands 5 and 7 (Simple Tillage Index -STI). Model VI was based on the normalized difference between TM bands 5 and 7 (Normalized Difference Tillage Index - NDTI).

The ERDAS Imagine®, image processing software was used to extract brightness values for each of the ground-truth locations. The ground-truth locations on the image were identified using the geographic coordinates recorded during the field visit. A tillage probability value for each location was calculated using a spreadsheet and ranked for further analysis. The crop residue cover was estimated by classifying the infrared images using Multispec®, an image processing software developed by the Purdue Research Foundation. Cut-off probability values were determined by comparing ground-truth data with calculated tillage probability values to maximize mapping accuracy.

Error matrices (Campbell, 1987) were developed for all regression models to determine overall classification accuracy (*percent correct*) and *kappa (k)* values. *Percent correct* is calculated by dividing the sum of correctly classified fields by the total number of fields examined. The "*k* value is a measure of the difference between two maps and the agreement that might be contributed solely by chance matching of the two maps" (Campbell, 1987). The *k* value is calculated using:

$$k = \frac{Observed - Expected}{1 - Expected}$$

(3)

where, "observed" is the *percent correct* and "expected" is an estimate of the chance agreement to the "observed." A *k* value of +1.0 indicates perfect accuracy of the classification.

Results and Discussions

Table 2 presents tillage and crop residue types from 41 randomly selected ground-truth data locations in Ochiltree County during the 2005 planting season. Out of 41 fields, conservation tillage was found in 19 fields and about 53% of these fields had wheat residue. Conventional tillage was found in 22 fields, and only 18% these had wheat residue. About 37% of the conservation and 36% of conventionally tilled fields had sorghum residue. Soybean fields accounted for 32% of the conventionally tilled fields and none under conservation tillage.

Table 3 presents the best cut-off probability for each

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tillage model and resulting overall classification accuracy and k values.

Table 2. Tillage and crop residue characteristics of randomly selected fields for ground-truth data in Ochiltree County.

Tillage	N[1]	Crop residue				
		Sorghum	Soybean	Corn	Wheat	Others
Conservation	19	7	0	2	10	0
Conventional	22	8	7	2	4	1
Total	41	15	7	4	14	1

[1] N - Number of ground truth data fields.

Table 3. *Percentage Correct* and kappa (*k)* values for tillage management practice maps derived using TM based logistic regression models.

Model	Band or Index	Cut-off Probability[1]	Percent Correct	Kappa Value (*k*)
I	TM5	0.10	71	0.52
II	R15	0.10	83	0.73
III	M15	0.10	83	0.73
IV	D35	0.10	80	0.69
V	STI	0.99	61	0.03
VI	NDTI	0.99	61	0.02

[1] *Cut-off probability values associated with maximum percent correct* and *k* values

The regression models that use TM bands 1 and 5 (Model II and III) gave the highest *percent correct* and *k* values followed by the regression model that uses differences between TM bands 3 and 5 (Model IV). Models II and III performed equally and gave *percent correct* and k values of 83% and 0.73, respectively. Similar values were found with model IV. The TM band 3 is present in all three models indicating that reflectance values in the mid-infrared spectral range (1.55 - 1.75 µm) are sensitive to crop residue, and generally show higher reflectance in conservation tillage fields than in conventionally tilled fields.

Models V and VI performed more poorly than all other models. This may be due to the fact that TM Bands 5 and 7 are sensitive to organic matter content and soil water conditions. In Ochiltree County, a majority of soils are silty clay texture, and soil water content is usually low compared to that in northern Ohio. Also, models V and VI are ratio-based models that are generally sensitive to soil background (Huete et al., 1985). For this reason, the ratio of TM bands 5 and 7 in model V was smaller (< 1.7) than the range of values (1.7 to 2.1) reported in van Deventer (1997). As a result, models V and VI achieved their maximum *percent correct* and *k* values at a cut-off probability of 0.99.

Conclusions

Tillage information is crucial in environmental modeling as it has a direct impact on soil erosion and water holding capacity of agricultural soils. A remote sensing approach is promising for the rapid collection of tillage information on individual fields over large areas. In this study, six Thematic Mapper (TM)-based logistic regression models proposed by van Deventer et al. (1997) were used to distinguish conventional and conservation tillage practices in Ochiltree County located in the Texas Panhandle. Accuracy assessments of tillage maps derived from Landsat 5 TM data were made using field data collected during the 2005 planting season. Logistic regression models were easy to use, cost and time effective, and produced reasonably accurate tillage maps. The “percent correct” and kappa (k) values varied from 61-83% and 0.02-0.73, respectively, with best values for logistic regression models that use TM bands 1, 3 and 5 images. This approach is promising for the rapid collection of tillage information on individual fields over large areas.

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Historic Tree Row Restoration

By J.A. Tolk

The establishment of our research station as a Soil Conservation Service location in 1938 was soon followed by the installation in 1939 of an extensive windbreak. The windbreak planting used a diverse array of trees and shrubs such as ponderosa pine, locust, ash, juniper, snowberry, and osage orange that numbered well over 6000 plants. The windbreak, which included multiple N-S and E-W plantings, sheltered the initial few offices and related buildings. Expansion of the facilities, drought, and inevitable aging has greatly reduced tree and shrub numbers.

Restoration of the historic windbreak began in 2005 with the assistance of Brian Scott, Texas Forest Service, whose job includes helping farmers and ranchers establish and rehabilitate Great Plains windbreaks. Phase 1 in 2005 consisted of E-W plantings of aromatic sumac, Rocky Mountain juniper, eastern red cedar, and lacebark elms. Phase 2 in 2006 will be N-S plantings of bur oak and Austrian pine, with additional plantings of juniper and sumac at the Soil-Plant-Environment Research field facility for snow capture.

Once the ground was prepared, the trees and bushes were dropped by hand by Brian riding a specially designed furrow opener. This was followed by a machine which laid down landscape fabric which we slit to pull the plants through. The fabric helps to control weeds and preserve soil moisture. Screens protected the junipers from wind damage, and plastic tubes continue to protect the elms from gnawing damage by rabbits and rodents. A drip system will be installed to water the old and new windbreaks.

Our first installation of about 500 plants made us appreciate the effort it must have taken for the planting and especially the maintenance of the first 6000 trees and shrubs! The weeding alone must have taken a tremendous amount of time. We are extremely grateful for specialized equipment and modern landscaping tools.

Top picture: Brian Scott, Texas Forest Service, planting trees.
Center picture: Jim Cresap, USDA-ARS, laying landscape fabric
Bottom picture: Three months of growth

Meetings & Presentations. . .

Steve Evett presented the seminar "Soil Moisture Monitoring Systems Compared" to USDA-ARS and Colorado State University scientists at Fort Collins, CO, February 18, 2005.

Steve Evett worked with Mike Duniway at the Jornada Experimental Range and New Mexico State University in April 6-8, 2005, on Mike's experiment using TDR to measure soil water in various soils, including calcic and petrocalcic layers, and on questions of neutron moisture meter use and calibration.

Steve Evett presented "Comparing Soil Water Sensing Systems in Soil Columns and Field Soils" to USDA-ARS and New Mexico State University, Las Cruces, NM, April 7, 2005; to USDA-ARS, Beltsville Agricultural Research Center, Beltsville, MD, April 13, 2005; and to the Department of Soil and Crop Sciences, Texas A&M University, College Station, TX, April 28, 2005.

Students from West Texas A&M University in the Plant, Soils, and Environmental Sciences (PSES) Department toured the SWMRU weighing lysimeters and grassed weather station and were given a lecture on Soil Profile Water Content Sensing for Spatial ET Calculation by Soil Water Balance by Steve Evett for PSES courses 4331 and 5331 on April 27, 2005.

Louis Baumhardt, Paul Colaizzi, Terry Howell, Troy Peters, Robert Schwartz, and Judy Tolk attended the statistical training in Repeated Measures Analysis, May 3-5, 2005, Bushland, TX.

Paul Coaizzi and Terry Howell attended the EWRI World Water & Environmental Resources Congress, May 15-19, 2005, Anchorage, AK. Paul Colaizzi presented the paper: "Lysimetric evaluation of one- and two-source energy balance models for alfalfa, grain sorghum, and cotton in the Southern High Plains." He also attended two committee meetings (On-Farm Irrigation and Crop Coefficients), where presently he serves as Secretary for the On-Farm Irrigation Committee. Terry Howell presented “Enhancing WUEin Irrigated Agriculture” and “Reference Evapotranspiration of Grass-Southern High Plains” and was the Irrrigation & Drainage Concil Track Chair.

Nolan Clark, Paul Colaizzi, Steve Evett, Prasanna Gowda, Terry Howell, Troy Peters, and Judy Tolk attended the USDA-ARS National Program 201 Workshop in Denver, CO, June 8-10, 2005. National Program 201, titled Water Quality and Management, concerns ARS research

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Software (on our web site)

Note that the web site has changed since the last newsletter; and this is a newer version of the ISDfit software.

IDSfit

Ver. 2.0, July 2005 Inverse estimation of soil hydraulic parameters using outflow data obtained from tension disc infiltrometers, water retention data, soil core water contents, and TDR water contents. Also permits the separate fit of water retention data using the van Genuchten relationship. Includes a Microsoft Windows based graphical user interface with data entry forms, an extensive Microsoft Windows Help file, example input files, and the 2-D water flow and fitting routines written in FORTRAN. System Requirements: Windows 9x, Me, 2000, or XP; 32 Mb RAM, 20 Mb free hard disk space. Recommended: Pentium processor running at clock speeds greater than 1.5 GHz.

Download at: http://www.cprl.ars.usda.gov/programs/index.htm

TACQ beta software for Time Domain Reflectometry

Version uploaded 17 November 2005 (Beta 02-03-2005, 16:46:45) The new version of TACQBeta.EXE outputs data needed for effective frequency calculations as detailed in "Evett, S.R., J.A. Tolk, and T.A. Howell. 2005. TDR laboratory calibration in travel time, bulk electrical conductivity, and effective frequency. Vadose Zone J. 4:10201029". In the file "yeardoyW.xxx", each output line has been augmented with six additional data values:

Mod32 - slope of a line tangent to the waveform before the first inflection (zero),
Mod28 - Slope of the first inflection in the waveform (rising limb of 1st peak),
LowD - minimum value of the 1st derivative of the waveform,
Slope2 - slope of line tangent to the waveform just before the 2nd inflection,
Slope - maximum slope of rising limb of 2nd inflection (used in effective frequency),
NSecPerUnit - time (ns) between each waveform datum and the next (used in effective frequency calculation - usually constant, but changes with Vp and Dist/Div).

The file name is "year" - a four-digit value, "doy" - the three-digit value of the serial day of the year (e.g., 001 for 1 January), "W" - indicating that this file contains water content estimates, and "xxx" - a three-character suffix chosen by the user. The user may use the sequential to parallel conversion facility of TACQ to read in file "yeardoyW.xxx" and create output files containing, 1) the travel time, and 2) the Slope of the 2nd inflection, and 3) if necessary, a file with values of NSecPerUnit, if the propagation velocity and/or Dist/Div settings were variable across probes. Using bulk electrical conductivity data output by TACQ and user-measured probe constant(s), the user may create a third file of BEC data. Following Evett et al. (2005), these may be combined to estimate water contents using a common calibration equation in travel time, effective frequency and BEC (from Evett et al. (2005) or a user-defined calibration).

Download at: http://www.cprl.ars.usda.gov/programs/index.htm

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programs in irrigation, drainage, water quality, watershed management, water reuse, and erosion. The workshop's purpose was to begin planning the next five-year cycle of research while soliciting input and comment from the over 100 stakeholders present, and through contacts with producer and commodity organizations, the irrigation industry, water and irrigation districts, underground water conservation districts, and action agencies at the Federal and State levels. Steve Evett was named one of the co-leaders of the writing team for research problem area 2: Irrigation Water Management and Security.

The SWMRU Irrigation and Crop Water Use research team hosted a delegation of senior level officials and scientists from Uzbekistan and Kazakhstan on June 24, 2005. SWMRU scientists presented a field tour and presentations on irrigation systems, deficit irrigation, irrigation scheduling of cotton and winter wheat, and renewable energy systems for water pumping and remote electric power.

Paul Colaizzi hosted meetings with scientists on June 30, 2005 from the USDA-ARS Water Conservation Laboratory, Remote Sensing Research Unit, Phoenix, AZ, to plan collaborative research in ET remote sensing between ARS locations in Phoenix, AZ, Bushland, TX, and Beltsville, MD.

Terry Howell attended the ENVIROWATER 2005 CIGR Conference in Arlington, TX, July 2-5. He met and served as a Board member on Section I "Land and Water Engineering".

Paul Colaizzi, Terry Howell and Troy Peters attended American Society of Agricultural and Biological Engineers International Annual Meeting, July 17-20, 2005 Tampa, FL. Paul presented the paper "Comparison of Five Models to Scale Daily Evapotranspiration from One-Time-of-Day Measurements"

Terry Howell attended the USDA-NRCS Sprinkler Irrigation Standard Meeting, August 9, 2005 in Denver, CO

Terry Howell and Thomas Marek from TAES-Amarillo attended the WERA 202 Project Meeting, August 23-24, 2005 in Phoenix, AZ.

Paul Colaizzi was invited to present a seminar at the Department of Agricultural and Biosystems Engineering, University of Arizona, on "Irrigation and Evapotranspiration Research at the USDA-ARS in the Southern High Plains," September 12, 2005, Tucson, AZ.

Louis Baumhardt, Nolan Clark, Paul Colaizzi, Steve Evett, Prasanna Gowda, Terry Howell, Troy Peters, Robert Schwartz, and Judy Tolk attended meetings with Drs. Allan Jones and Gary Riskowski, Texas A&M Irrigation Research & Extension September 19-22, 2005 in Amarillo, TX.

On September 23 and October 3, 2005, Steve Evett presented seminars to USDA-ARS and Texas A&M staff and to the International Agriculture class from West Texas A&M University on water problems in the country of Mali in West Africa.

On September 26, 2005 Freddie Lamm of Kansas State University and Gerard Arbat, visiting scientist from Spain, visited Paul Colaizzi, Steve Evett, and Terry Howell for discussions of current research efforts and needs in subsurface drip irrigation..

Nolan Clark, Terry Howell, Lynnette Lott and Carole Perryman attended Business Operations Short Course October 6, 2005 in College Station, TX.

Nolan Clark and Terry Howell attended Texas Section ASABE 41st Annual Meeting in Grapevine, TX on October 12-13, 2005.

Paul Colaizzi attended the W-1128 Meeting (Removing Barriers to the Adoption of Microirrigation), and presented research findings and activities at Bushland to collaborate with other scientists and engineers on future research directions in subsurface drip irrigation, November 2-4, 2005, Tempe, AZ.

Terry Howell and Paul Colaizzi attended the Irrigation Association Annual Meeting and Show. Paul Colaizzi presented a paper "Cotton production with SDI, LEPA, and spray irrigation in a thermally-limited climate," participated in attending the ARS booth exhibit at the IA Show, and attended Common Interest Group Meetings, November 6-8, 2005. Terry Howell was Technical Program Committee vice-chair.

Louis Baumhardt, Steve Evett, Prasanna Gowda, Troy Peters, Robert Schwartz, and Judy Tolk attended the 2005 ASA-CSSA-SSSA International Annual Meetings in Salt Lake City, UT, November 6-10, 2005. Presentations were:

Cattle Grazing Effects on Dryland Cropping System Productivity and Soil Properties. R. Louis Baumhardt, L. Wayne Greene, and Robert C. Schwartz.

Growing Dryland Grain Sorghum in Clumps to Reduce Tillers and Early Season Water Use and Increase Yield and Harvest Index. Varaprasad Bandura, B.A. Stewart, Louis Baumhardt, Satish Ambati, C.A. Robinson, and Alan Schlegel.

Mapping Tillage Practices in Southern High Plains of Texas with Landsat Thematic Mapper Data. Prasanna H. Gowda, Troy Peters, Terry A. Howell, and Leon New.

Nighttime evapotranspiration from alfalfa and cotton in a semiarid environment. Judy Tolk, Steven R. Evett, and Terry A. Howell.

Tillage effects on near surface soil water dynamics. Robert C. Schwartz, R. Louis Baumhardt, and Steven R. Evett.

Time Dependent Bioactive Phosphorus Extractability in Calcium- and Iron-Treated Soils. Thanh H. Dao, Eton E. Codling, and Robert C. Schwartz.

Time domain reflectometry calibration in terms of travel time, bulk electrical conductivity, and effective frequency. Steven Evett, Terry Howell, and Judy Tolk.

Water use of maize for two irrigation methods and two scheduling methods. Ibragimov Nazirbay, Steven Evett, Yusupbek Esanbekov, and Bakhtiyor Kamilov.

Water use of winter wheat for two irrigation and scheduling methods in uzbekistan. Bakhtiyor Kamilov, Steven Evett, Nazirbay Ibragimov, German Bezborodov, Yusupbek Esanbekov, and John Lamers.

Nolan Clark and Terry Howell attended the SPA Executive Leadership Conference in College Station, TX on November 29-30, 2005.

Nolan Clark, Steve Evett and Terry Howell attended the Western ARS/NRCS Irrigation Research Meeting December 1-2, 2005 in Riverside CA.

Check it out:
Texas High Plains ET Network
http://txhighplainset.tamu.edu/

New Publications...

Allen, R.G., Pruitt, W.O., Wright, J.L, **Howell, T.A**, Ventura, F., Snyder, R., Itenfisu, D., Steduto, P., Berengena, J., Yrisarry, J.B., Smith, M., Pereira, L.S., Raes, D., Perrier, A., Alves, I., Walter, I., and Elliott, R. 2005. Standardized Surface Resistance for Hourly Calculation of Reference ET_o by the FAO56 Penman-Monteith Method. Agricultural Water Management. (in press).

Burt, C.M, Mutziger, A.J., Allen, R.G., and **Howell, T.A.** 2005. Evaporation Research – A Review and Interpretation. J. Irrigation and Drainage Engineering (ASCE) 131(1):37-58.

Colaizzi, P.D., Evett, S.R. and **Howell, T.A**. 2005. Comparison of spray, LEPA, and SDI for cotton and grain sorghum in the Texas Panhandle. In 17th Annual Central Plains Irrigation Association Conference and Exposition Proceedings, 16-17 Feb., Sterling, CO. Central Plains Irrigation Association, pp. 123-136. (Invited).

Colaizzi, P.D., Evett, S.R., Howell, T.A. and **Tolk, J.A.** 2005. Lysimetric evaluation of single- and two-source energy balance models for alfalfa, grain sorghum, and cotton in the Southern High Plains. In Proc. ASCE-EWRI World Water and Environmental Resources Congress 2005, 15-19 May, Anchorage, AK.

Colaizzi, P.D., Evett, S.R., Howell, T.A. and **Tolk, J.A**. 2005. Comparison of Five Models to Scale Daily Evapotranspiration from One-Time-of-Day Measurements. Paper Number: 052002. 2005 ASAE Annual International Meeting, Sponsored by American Society of Agricultural Engineers, 17-20 July, Tampa, FL.

Colaizzi, P.D., Evett, S.R. and **Howell, T.A.** 2005. Cotton production with SDI, LEPA, and spray irrigation in a thermally-limited climate. CD-ROM. Irrigation Association Annual Meeting, 6-8 Nov, Phoenix, AZ

Encisco, J.M., **Colaizzi, P.D.**, and Multer, W.L. 2005. Economic Analysis of subsurface drip irrigation lateral spacing and installation depth for cotton. Trans. ASAE. Vol. 48(1):197-204.

Evett, S.R. 2005. International Soil Moisture Sensor Comparison. In Irrigation Insights No. 1, Second Edition, SOIL WATER MONITORING, P. Charlesworth (ed.). Land & Water Australia, Braddon, Australia. Pp. 68-71. (Chapter)

Evett, S.R. and Parkin, G.W. 2005. Advances in Soil Water Content Sensing: The Continuing Maturation of Technology and Theory. Vadose Zone Journal 4: 986-991. Special Section: Soil Water Sensing. doi:10.2136/vzj2005.0099

Evett, S.R., Colaizzi, P.D. and **Howell, T.A.** 2005. Drip and Evaporation. In 17th Annual Central Plains Irrigation Association Conference and Exposition Proceedings, 16-17 Feb., Sterling, CO. Central Plains Irrigation Association, pp. 33-39. (Invited).

Evett, S.R., Tolk, J.A. and **Howell, T.A.**. 2005. TDR laboratory calibration in travel time, bulk electrical conductivity, and effective frequency. Vadose Zone Journal 4:1020-1029. Special Section: Soil Water Sensing. doi:10.2136/vzj2005.0046

Gowda, P.H. and Mulla, D.J. 2005. Environmental benefits of precision farming - A modeling case study. Paper No. 05-1042, ASAE Annual International Meeting, July 17-20, Tampa, FL, 8p.

Gowda, P. H., Peters, T. and **Howell, T.A**. 2005. Mapping tillage practices in high plains of Texas with Landsat Thematic Mapper data. ASA-CSSA, SSSA Annual Meeting, November 6-10, Salt Lake City, UT.

Gowda P. H. and Mulla, D.J. 2005. Evaluating feasibility of nitrate TMDLs on two agricultural watersheds in southern Minnesota. Mississippi River Basin Nutrients Science Workshop sponsored by the Office of Water, U.S. Environmental Protection Agency, Washington D.C., October 4-6, St. Louis, MO.

Hauser, V.C., Gimon, D., Bonta, J.V., **Howell, T.A**., Malone, R.W. and Williams, J.R. 2005 Models for Hydrologic Design of Evapotranspiration Landfill Covers. Environ. Sci. Technol., 39 (18), 7226 -7233

Irmak, S., **Howell, T.A.**, Allen, R.G., Payero, J.O., and Martin, D.L. 2005. Standardized ASCE Penman-Monteith: impact of sum-of-hourly vs. 24-hour timestep computations at reference weather station sites. Trans ASAE 48(3):1063-1077.

Nangia, V., **Gowda, P.H.,** Mulla, D.J. and Sands, G. 2005. Modeling water quality for nitrate losses in response to changes in tile drain spacing or depth. Paper No. 05-2022, ASAE Annual International Meeting, July 17-20, Tampa, FL, 12 p.

Nangia, V., **Gowda, P.H**., Mulla, D.J. and Kuehner, K. 2005. Evaluation of water quality trends due to long term climatic variability and changes in landscape management. Paper No. 05-2226, ASAE Annual International Meeting, July 17-20, Tampa, FL, 12p.

Peters, R.T., Heermann, D.F, and Stahl, K.M. 2005. The use of low-cost, differentially corrected GPS for reporting field position of self-propelled irrigation systems. In: Proceedings of the Irrigation Association 26th Annual International Irrigation Show. Nov. 6-8, 2005. Phoenix, AZ. CDROM

Peters, R.T. and Hill, R.W. 2005. Simulation of Grass/Legume Pasture Yield as Influenced by Soil Water, Temperature and Nitrogen. In: Abstracts of the 2005 ASA-CSSA-SSA International Annual Meetings. Nov. 6-10, 2005. Salt Lake City, UT. CDROM

Peters, R.T. and Evett, S.R. 2005. Using low-cost GPS receivers for determining field position of mechanized irrigation systems. Applied Engineering in Agriculture, 21(5): 841-845.

Peters, R.T. and Evett, S.R. 2005. Mechanized irrigation system positioning using two inexpensive GPS receivers. Proceedings of the ASAE/CSAE Annual International Meeting. July 17-20, 2005, Tampa, Florida. CDROM.

Petrolia, D.R., **Gowda, P.H**. and Mulla, D.J. 2005. Agricultural Drainage and Gulf of Hypoxia: Economic targeting of farmland to reduce nitrogen loads in a Minnesota watershed. Selected paper for the American Agricultural Economics Association Annual Meeting, July 24-27, Providence, MA.

Petrolia, D. R. and **Gowda, P.H**. 2005. Missing the Boat: Midwest farm drainage and Gulf of Mexico Hypoxia. Review of Agricultural Economics (Accepted for publication).

Piccinni, G., Leskovar, D.I., Kolenda, K.A., Marek, T.H., Dusek, D.A. and **Howell, T.A.** 2005. Development of Phenological-Stage-Specific Crop Coefficients (Kc) to Manage Deficit Irrigation in Agricultural Production Systems. INTERDROUGHT-II, The 2nd International Conference on Integrated Approaches to Sustain and Improve Plant Production Under Drought Stress; Rome, Italy, September 24-28, 2005. [Abstract]. http://www.plantstress.com/id2/Abstract%20book%20updated.pdf.

Porter, D., Marek, T., **Howell, T.** and New, N. 2005. The Texas High Plains Evapotranspiration Network (TXHPET) User Manual. AREC 05-37, Amarillo Research and Extension Center, Texas Agricultural Experiment Station, Amarillo, TX. 34 p.

Tolk, J.A., Howell, T.A. and **Evett, S.R.** 2005. An evapotranspiration research facility for soil-plant-environment interactions. Applied Engineering in Agriculture, 21(6): 993-998.

Extension Publications

Petrolia, D.R., Gowda, P.H. and Mulla, D.J. 2005. Targeting agricultural drainage to reduce nitrogen losses in a Minnesota watershed. Staff Paper P05-2, Department of Applied Economics, University of Minnesota, St. Paul, MN. http://agecon.lib.umn.edu/mn/p05-02.pdf

Book Review

P. H. Gowda. 2005. Book review of "Scales in Hydrology and Water Management", a joint IAHS/IHP-UNESCO Publication Edited by Ioulia Tchigririnskaia, Mike Bonell and Hubert. IAHS Publication 287 ISSN 0144-7815. Journal of the American Water Resources Association, 41(4):1000-1001.

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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.

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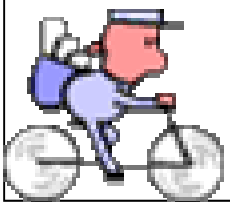
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