



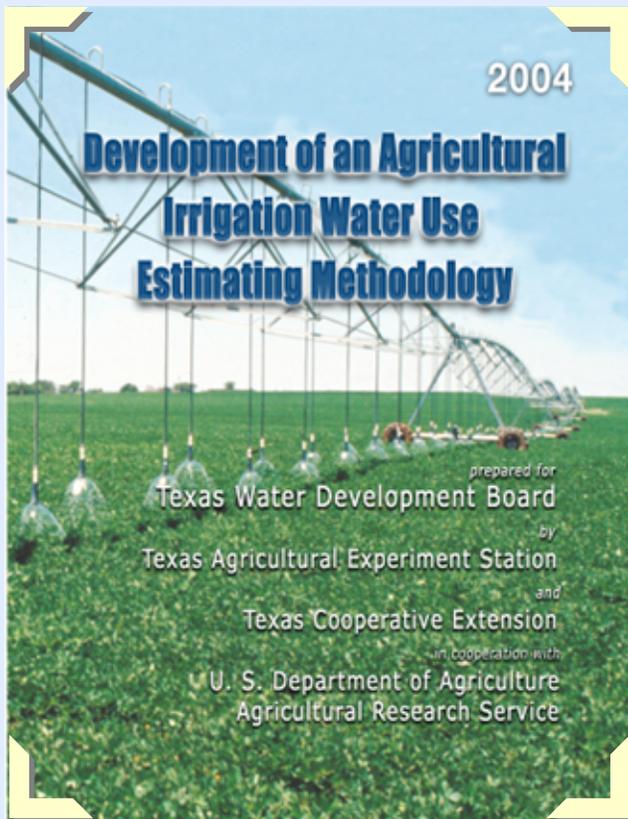
# WETTING FRONT

Spring 2005

USDA-ARS Conservation and Production Research Laboratory  
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## Development of an Agricultural Irrigation Water Use Estimating Methodology

By Terry A. Howell



The future of Texas may very well depend on its water supplies. Projected population in Texas is expected to more than double by 2060, making effective water planning critical. The centerpiece of any planning effort must be irrigated crop production, which accounted for 61 percent of total water use in the state during 2002. Eighty-six percent of the water used for irrigation comes from underground water sources, mainly aquifers. The slow recharge rate of many of these aquifers makes them basically a non-renewable resource, thus the accurate estimation of irrigation use is imperative.

“...86% of the water used for irrigation comes from underground water sources...”

A study was conducted by the Texas Agricultural Experiment Station (TAES), Texas Cooperative Extension (TCE), West Texas A&M University (WTAMU), and USDA-ARS and funded by the Texas Water Development Board (TWDB) [contract number 2003483009] to develop and recommend a Statewide strategy for estimating irrigation use in Texas. Specific objectives of the project were to identify and analyze data requirements

necessary for estimating irrigation use; and identify and assess the feasibility of the most promising methodologies for projecting irrigation use. The study was led by Thomas Marek (TAES-Amarillo) and Stephen Amosson (TCE-Amarillo) with Co-PIs Ranjan Muttiah (formerly TAES-Temple now with Texas Christian University, Fort Worth), Lal Almas (WTAMU-Canyon), Leon New (TCE-Amarillo), and Terry Howell (ARS-Bushland). Fran Bretz (TAES-Amarillo), Bridget Guerrero (TCE-Amarillo), and Nick Simpson (formerly TAES-Amarillo) were principle project support personnel.

Evapotranspiration (ET) based modeling was selected as the recommended strategy for estimating irrigation use in the state. It is the most commonly used methodology, the simplest from a modeling standpoint, requires the least

(Continued on page 2)

### Table of Contents

1. ...Development of an Agricultural Irrigation Water Use Estimating Methodology
- 2.... Phosphorus Extractabilities in Manure Amended Soils
- 3.... Meetings & Presentations
- 4.... NEW SWMRU SCIENTIST
- 4.... Technology Transfer News
- 5.... New Publications
- 6.... Research Staff
- 6.... Newsletter Contact

(Continued from page 1)

amount of data, and is the most accurate in estimating irrigation use among the current methodologies available. It is expected to take 12 to 18 months to develop ET based models for all major irrigation regions of Texas at an estimated cost of \$300,000 assuming involvement of expertise already developed in the state. The cost of maintaining the required databases and analytical capabilities is estimated at \$100,000 annually. Initially, the ET based models could be developed using improved specific crop acreage estimates with approximations of the remaining required data coming from existing sources in the state water planning regions.

Long-term investments in demonstrations and an agricultural weather network are essential to developing more reliable, improved estimates of irrigation use in the future. Demonstration work must be expanded and standardized with respect to data collected and location. A total of 250 to 350 demonstration sites strategically placed in the irrigated areas of the state are projected to provide sufficient coverage to insure dependable estimates of water use by crop. This would result in a total estimated annual expense of \$375,000 to \$700,000 annually. Most meteorological stations in Texas do not meet the necessary agricultural related standards with respect to site location, data generated and quality assurance/quality control (QA/QC) requirements to provide a reliable source of data. The development cost for establishing an adequate statewide evapotranspiration (ET) station network (minimum of 53 stations) is estimated at \$950,000. However, this cost could be reduced by contracting with the appropriate existing weather networks given that these stations and networks are brought up to the required standards, where necessary. The annual cost to operate and maintain a statewide ET network is estimated at \$600,000.

A GAM (ground water availability model) and ET based model operating independently will result in overestimating future water use. An interface model needs to be developed that considers changes in ground water availability emanating from the GAM models and other relevant factors to project modifications in the amount and/or crop composition for use in the decadal projection by the ET Irrigation Water Use model.

The developed methodology will improve and standardize irrigation water use estimates for all regions of the State involved in current water planning for future water needs in Texas.

This was excerpted from the Executive Summary of the report published in October 2004 and prepared for the TWDB. The complete report is available electronically (15.2 MB) at [http://www.twdb.state.tx.us/RWPG/rpgm\\_rpts/2003483009.pdf](http://www.twdb.state.tx.us/RWPG/rpgm_rpts/2003483009.pdf).

## Meetings & Presentations. . .

The Irrigation Association Meeting was attended by Paul Colaizzi, Troy Peters, November 14-16, in Tampa, FL. Presentation was on Comparison of Scaled Canopy Temperatures with Measured Results under Center Pivot Irrigation.

The SWCS High Plains Groundwater Resources Conference in Lubbock held December 8-10, was attended by Paul Colaizzi, Nolan Clark, Louis Baumhardt, Steve Evett, Prasanna Gowda, Terry Howell and Robert Schwartz. Paul Colaizzi and Nolan Clark presented papers, Louis Baumhardt presented a poster, and Robert Schwartz presided at a technical session.

A 3-day training class on Visual Basic at Spellman and Assoc. was attended by Judy Tolk, Brice Ruthardt, and Jourdan Bell on January 5-7, Amarillo, TX

A Pioneer Crops Seminar and Workshop held January 14<sup>th</sup>, in Panhandle, Texas was attended by Terry Howell.

The "Evaporation from Remote Sensing using Surface Energy Balance" workshop was attended by Prasanna Gowda on February 7-8. Hosted by R.G. Allen, University of Idaho at USDA-ARS in Ft. Collins, CO.

The Bureau of Reclamation ET Workshop: State-of-the-Art Review of Evapotranspiration (ET) Remote Sensing Science and Technology by the U.S. Bureau of Reclamation at USDA-ARS, Fort Collins, CO, February 8-10, was attended by Prasanna Gowda.

The Central Plains Irrigation Association, February 16-17, in Sterling, CO, was attended by Paul Colaizzi, Steve Evett, and Terry Howell and each presented papers.

The NP 202 (Soil Management) planning meeting on February 22-25, in Dallas, TX, was attended by Louis Baumhardt, Terry Howell, and Robert Schwartz.

West Texas A&M University Career Expo was held to recruit student employees for the summer on March 3, attendees were Paul Colaizzi, Judy Tolk, and Prasanna Gowda.

"Cotton and Grain Sorghum Rotations" was discussed on KGNC Radio's agribusiness news as part of CREET beat March 4, by Judy Tolk.

The Ogallala Aquifer initiative workshop attended by The SWMRU scientists met on March 8-10, in Garden City, KS.

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.

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## Phosphorus Extractabilities in Manure Amended Soils

R.C. Schwartz and J.M. Bell

**S**oils are most often the resource used in the final assimilation of many agricultural waste products. The application of manure can have a beneficial influence on the soil condition by improving aggregation, increasing organic matter content, and supplying nutrients for plant growth. However, manures should be applied to soils so that constituents in the waste do not exceed the soils capacity to adsorb or store them. Phosphorus in manure tends to be the most restrictive constituent because of the relatively large concentrations found in manure and because it is not very mobile in the soil which leads to surface accumulation and subject to offsite transport by runoff. Typically agronomic soil tests (e.g. Mehlich 3, sodium bicarbonate extractions) are used to make nutrient management recommendations and assess risks associated with offsite P transport.

A study (Schwartz, 2004; Schwartz and Dao, 2005) was carried out at the USDA-ARS Conservation and Production Research Laboratory to investigate the influence of soil characteristics, manure characteristics, and fertilizer application rates on the extractability of phosphorus in soils. The Mehlich 3, sodium bicarbonate ( $\text{NaHCO}_3$ ), and Texas A&M (TAM) agronomic soil phosphorus tests were examined in this study because these extractants are used by the state extension soil testing laboratories of Oklahoma, New Mexico, and Texas, respectively, for making nutrient management recommendations. Water extractable P in amended soils was also examined because it is an important quantity when considering offsite movement of P with runoff.

The increase in extractable P in soils amended with manures and synthetic fertilizers varied considerably with respect to P source, incubation time, extractant, and soil characteristics. Most notably, the relationship between agronomic extractable P with water extractable P differed depending on if the soil was amended with a synthetic or manure fertilizer source (Fig. 1). As a consequence, common agronomic soil extractants in the region cannot always be used to make reliable inferences about water extractable P, an important quantity when considering risks associated with the offsite movement of P in runoff. For the five soils investigated in this study, nutrient management decisions based on agronomic soil test P may tend to overestimate risks with recent beef manure applications

and underestimate risks with recent synthetic fertilizer applications. These inconsistencies could be overcome by applying both an agronomic and environmental soil test to P indexing systems. An environmental soil test, such as water extractable P, would only need to be considered if the agronomic soil test value is “exceedingly” high. The results of this study combined with further field research will allow for improved P management and permit more flexibility in planning manure applications thereby increasing its perceived and real value as a fertilizer.

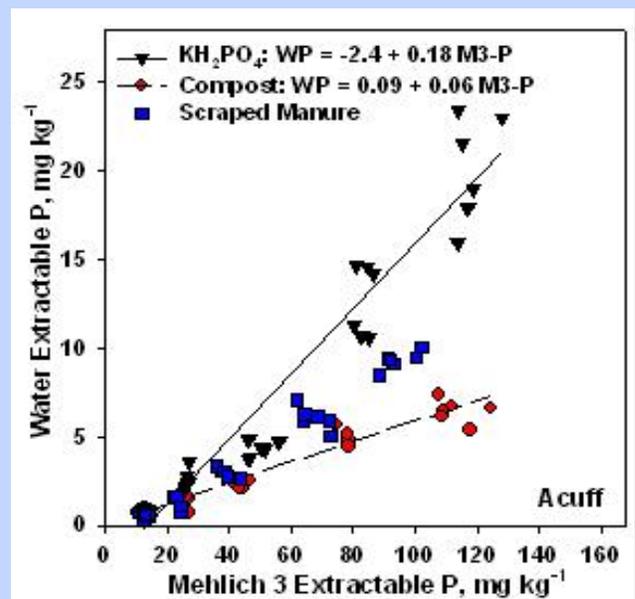
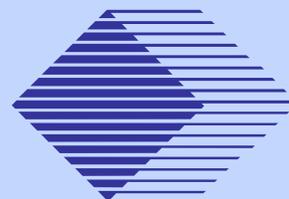


Fig. 1. Trends in Mehlich 3 extractable P (M3-P) with water extractable P (WP) for different fertilizer sources in the Acuff soil. Linear regression equations are shown for  $\text{KH}_2\text{PO}_4$  and composted manure P sources.

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## NEW SWMRU SCIENTIST...

Hello Everybody! My name is Prasanna Gowda. I joined the Soil and Water Management Research Unit in January 2005, as an agricultural engineer. Before that, I was a senior research associate and an adjunct faculty in the Soil, Water, and Climate Department, University of Minnesota, St. Paul, MN. My research interests and background include hydrologic and water quality modeling and application of Geographic Information Systems (GIS) and remote sensing in water resources management. I have a Ph.D. in Agricultural Engineering from the Ohio State University in Columbus, Ohio, a master's degree in City and Regional Planning and a postgraduate diploma in Environmental Planning from Mysore University, India and a bachelor's degree in Civil Engineering from Bangalore University, India.

My Ph.D. research included development and evaluation of a spatial process-based watershed modeling methodology that couples two newly developed routing programs with a field scale water table management model and uses GIS and remote sensing technologies. I also developed and evaluated a novel remote sensing technique to identify contrasting tillage practices at a regional scale. After graduating with a Ph.D. in 1996, I joined the GIS Division of Upper Midwest Environmental Sciences Center, U.S. Geological Survey in Onalaska, Wisconsin, as an associate researcher. There I worked on mapping floodplain vegetation in the Upper Mississippi River System with HYDICE (Hyperspectral Digital Imagery Collection Experiment) and AVIRIS (Airborne Visible/Infrared Imaging Spectrometer) hyperspectral remote sensing data.

In 1998, I joined the University of Minnesota and worked on several water quality modeling projects at plot, field, watershed and regional scales. There, I closely worked with farmers, Natural Resources Conservation Service, Minnesota Pollution Control Agency, Twin Cities Metropolitan Council and numerous non-profit stakeholders' groups to develop alternative farming practices to reduce soil erosion and nutrient loadings to Minnesota and Upper Mississippi Rivers. During this time, I had the privilege to work closely with several farmers and understand first hand why farmers' do their business the way they do. I lead a multidisciplinary collaborative research project that involved researchers from Ohio State University and University of Wisconsin. Also, I served as a member on the Twin Cities Metropolitan Council's Total Maximum Daily Load (TMDL) Technical Committee. Our study on the phosphorous index has led to a ban of the use of phosphorus in lawn fertilizer in Minnesota.

My initial work at CPRL includes use of data from previous evapotranspiration experiments and GIS and remote sensing models to predict crop water use, and then to predict groundwater use for irrigation across the High Plains region of the Ogallala aquifer. As part of this work, I am planning to conduct a comprehensive ground-truth survey to collect data on crop residue cover and plant growth parameters (leaf area index, biomass, plant height and yield) in about 80-100 commercial fields in Ochiltree, Moore and Ochiltree counties during the 2005 cropping season. I look forward to working with you all. Thank you very much.

## Technology Transfer News...

Terry Howell attended a working committee meeting on the revision of ASCE Manual No. 70 on Nov 8-9, 2004 at Loveland, CO, at the Northern Colorado Water Conservancy District office.

Terry Howell team taught a graduate class [PSES 8301 Advanced Plant and Soil Management] at West Texas A&M University on water conservation in irrigated agriculture November 18, 2004.

Paul Colazzi provided Sealed Source Radiation Safety Training to Dr. Ted Zobeck (Soil Scientist) and Mr. Dean Holder (Biological Technician) of the USDA-ARS Cropping Systems Research Laboratory, Lubbock, TX. on December 9, 2004.

Terry Howell and Nolan Clark met with Dan Upchurch on the Ogallala Aquifer Initiative on January 11, 2005.

Paul Colazzi drilled and installed a new irrigation well January 21, 2005. The pipeline and power line remain to be installed.

Louis Baumhardt, Terry Howell, and Robert Schwartz participated in the joint CREET research discussions and planning meeting at Bushland, TX, on January 28, 2005.

Terry Howell participated as an advisory member for the USDA-CSREES NRI project with Oregon State University February 11-13, 2005 in San Francisco, CA.

Terry Howell participated in the EWRI/ASCE leadership conference weekend at Atlanta, GA, on February 25-27, 2005.

Louis Baumhardt and Robert Schwartz selected projects entered in the High Plains Regional Science Fair as winners of the Golden Spread Soil and Water Conservation Society award for individual projects about Conservation and Stewardship of Soil, Water, Air, Plant, and Animal Resources on March 5, 2005.

Louis Baumhardt was interviewed on the KNGC 710 AM radio Agribusiness news Program CREET-BEAT about "Producing Cotton Panhandle Style" when he discussed results from cotton row spacing, population, and fertility tests on March 21, 2005.

Louis Baumhardt hosted Soil and Water Conservation classes from West Texas A&M University. They obtained practical experience estimating residue cover for various crops grown in rotations and or as monocultures on March 23, 2005.

Terry Howell participated in a web site review for the North Plains and South Plains ET Network at Lubbock, TX, on March 25, 2005.

Terry Howell presented an overview of irrigation water use to the Sustainable Water Resources Roundtable at Ann Arbor, MI, on April 5-6, 2005.

Louis Baumhardt presented a talk on "What, When & Where to Plant Dryland Grain Sorghum" at the Randall County Sorghum Meeting sponsored by the Texas Sorghum Producers. He discussed grain sorghum research comparing cultivar, planting date, population, and row spacing effects on yield on April 19, 2005.

Prasanna Gowda gave a seminar titled "Modeling the effect of precision agriculture: A GIS application" to the AGRI 8303 class at WTAMU, Canyon, TX, on April 5, 2005.

Troy Peters hosted a class from WTAMU, April 20, 2005, discussing irrigation efficiency, irrigation uniformity and irrigation management strategies. As an exercise a center pivot evaluation was performed on the small research center pivot on site.

Terry Howell, Troy Peters, Judy Tolk, Robert Schwartz, Louis Baumhardt, and Jourdan Bell attended SAS training on repeated measures at Bushland, TX, on May 3-5, 2005.

(Continued on page 6)

## New Publications...

- Ambati, S., Payne, W.A., Stewart, B.A., Bronson, K.F., and Baumhardt, R.L. 2004. Water use efficiency studies on continuous dryland grain sorghum in response to planting date and geometry. [CD-ROM]. ASA-CSSA-SSSA, Seattle, WA. Annual Meetings Abstracts 2004.
- Baumhardt, R.L. and Greene, L.W. 2004. Integrating cattle grazing into a dryland wheat sorghum fallow rotation. In: Rainwater, K.A. editor. 2004 High Plains Groundwater Resources: Challenges and Opportunities, December 7-9, 2004, Lubbock, Texas. p. 1-5.
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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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(Continued from page 4 - Technology Transfer News)

### Software

**IDSfit Ver. 2.0.** IDSfit implements the 2-D simulation of infiltration using Richards' Equation in cylindrical coordinates and permits the inverse fitting of soil hydraulic parameters using field measured tension disc infiltrometer and ponded infiltration data. The new version includes improvements in the numerical method and a new graphical user interface written in Visual Basic 6. This application is compatible with Microsoft Windows 95/98/2000/XP. Download at <http://www.cpri.ars.usda.gov/wmru/software/idsfit/idsfit.html>

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