Wetting Front

Water Management Research Unit Newsletter

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Conservation Landmark . . .

A historic landmark nomination commemorating the Graham-Hoeme chisel plow is being prepared by Ron Allen and Dr. Arland Schneider for an ASAE National Historical Landmark on behalf of the Texas and Oklahoma Sections of ASAE.

The chisel plow, developed by Fred Hoeme, a Hooker, Oklahoma farmer, was a major factor in controlling the wind erosion of the 1930s. Hoeme had noticed that road building scarifiers, with their heavy pointed shanks, could rip up large clods capable of stopping wind erosion. Agricultural spring tooth cultivators, then on the market, were too lightly constructed for the deeper primary tillage needed to stop wind erosion. In 1933, Hoeme began assembling a heavy, agricultural chisel using truck frames and tillage shanks made from truck springs. After testing several prototypes, he began producing the heavy-duty cultivator for sale. Heavy H-beams for frame members were supplied by the Colorado Fuel & Iron plant in Pueblo, CO, where special rolls were set up to form the H-beams. Tillage shanks made from recently developed tough manganese steel came from California.

After marketing about 2000 of the chisel plows, Hoeme sold the manufacturing and distribution rights to W. T. Graham who established a manufacturing plant in Amarillo, TX. Graham modified and strengthened the plow for higher power tractors and increased production and marketing to meet the growing demand. During the post-WWII farm equipment boom, Graham also operated plants in Colorado, Washington and Canada.

Since this chisel plow was developed in both Texas and Oklahoma, the nomination is being jointly sponsored by the two state sections of ASAE. Ron and Arland are documenting the development of the plow and will submit the nomination to ASAE's Historic Commemoration Committee. They will recommend placing the historic landmark at the Bushland Conservation and Production Research Laboratory. Starting in 1941, much of the Great Plains conservation tillage research on "stubble mulch tillage" has been conducted at this location.

by Arland Schneider

What's In a Name . . .

Irrigation technology often does not have a consistent set of terminology except that found in several lists of nomenclature that are often ignored or difficult to find such as the ASAE Engineering Practice, S526 Soil and Water Terminology. Dr. Bill Lyle used the acronym LEPA for the irrigation system that Jim Bordovsky and he developed for the Texas High Plains by the Texas Agricultural Experiment Station at Halfway. LEPA stands for low energy precision application, and according to guidelines

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and publications by Bill and Jim, the LEPA name applies as much to a management philosophy as to irrigation hardware. The LEPA name should only be used to describe application systems that either bubble water directly onto the ground or that use a drag sock arrangement with some specific tillage used to provide the needed surface storage [see ASAE Engineering Practice 531(in review) Planning, Design, Operation and Management of Low Energy Precision Application (LEPA) Irrigation Systems]. A LEPA system can operate in a spray mode or a chemigation mode, but these application modes are not the LEPA irrigation mode. A LEPA system includes a surface tillage system that enhances surface storage impounding the applied water with the goal of eliminating surface redistribution of the water. Of course, these impoundment structures can further enhance water conservation by reducing and/or eliminating surface runoff and redistributions from rainfall. In practice, a LEPA system delivers water directly to the ground (eliminating any foliage wetting or airborne droplet evaporation) in an amount designed not to exceed the surface storage volume. LEPA is used often in an alternate furrow manner, but it can be every furrow; however, additional hardware and costs are involved. Commonly, in this area, LEPA drops are 60 or 80 in. apart depending on the predominate row width (40-in. rows are often used for cotton and 30 in. are more common where mainly corn is produced). Ideally, the irrigation furrows will be "soft furrows" that have had no wheel traffic in them (tractor tires or implement gauge wheels) so compaction will be minimized and infiltration rates maximized. LEPA surface impoundment is commonly achieved by furrow diking. Furrow dike spacing will vary with implement design, but spacings from 4 to 8 ft are common. Typical dikes can hold about 1.6 to 2.0 in. of rain. So for an alternate row irrigation, this amount will be halved (i.e., 0.8 to 1.0 in.). Dammer-diker type dikes can only store about 0.25 to 0.5 in. of rain and consequently are less useful for LEPA, but they can be very useful in other sprinkler methods.

Many systems are popularly called LEPA systems, but many of them do not meet or conform to the criteria or intent of a LEPA system. Therefore, the ARS-Bushland and Amarillo-TAES and TAEX irrigation engineers have used several new acronyms – LESA and MESA to describe other similar irrigation application systems that embody the LEPA technology but don't meet one or more of the criteria to be called LEPA. All of these technologies are designed to operate either on a center-pivot or a lateral-move sprinkler machine. Figure 1 provides a schematic illustration of these irrigation methods. Exact heights differentiating LESA from MESA are not standardized. Typically, we refer to LESA as about 1 to 2 ft above the ground while MESA systems might vary from 5-10 ft above the ground. These systems have been called "in-canopy" applicators, but this terminology remains vague. Both LESA and MESA could be spaced wider than two rows (alternate furrows), but one of the main advantages for LESA is under-foliage chemigation that requires the applicator spacing to match the row spacing geometry. We have called each a "spray" applicator, but a

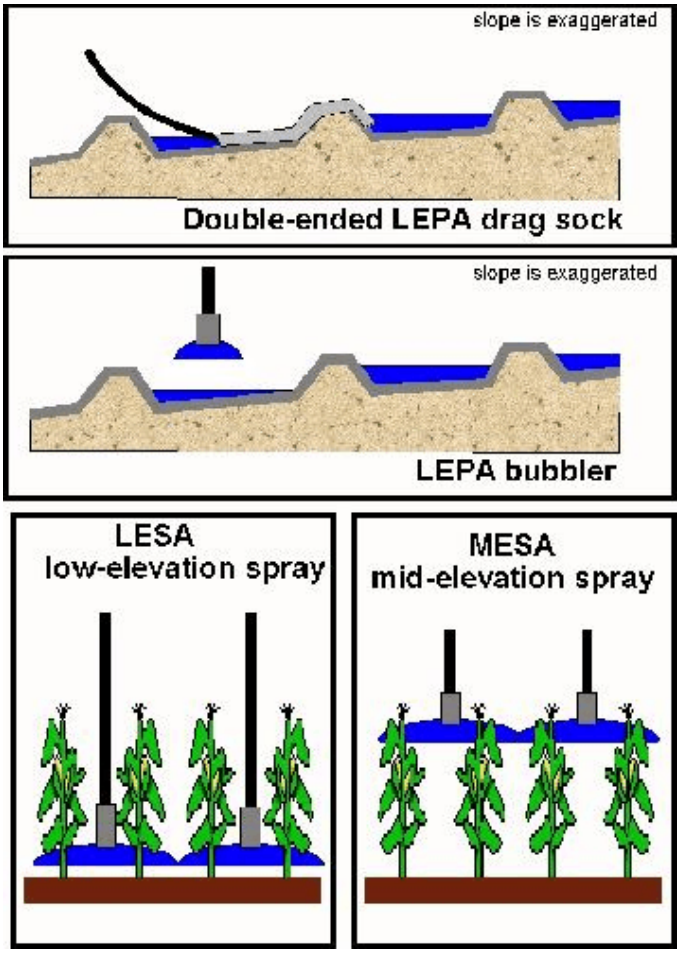

Figure 1. Illustrations of LEPA (low energy precision application) in the drag sock and bubble modes, LESA (low-elevation spray application), and MESA (mid-elevation spray application).

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rotator, spinner, or a wobbler type applicator head could be used. Many times an adapter to either a LESA or a MESA head can be used to attach a drag sock transforming it into a "true" LEPA system (if surface storage tillage is used). LESA and MESA systems names are more applicable to management systems designed to use conservation and/or ridge tillage without any furrow dikes. However, furrow dikes or dammer-diker pitting can still be used with either LESA or MESA. The main differences between LESA and MESA and LEPA is the extent of soil and crop wetting. LEPA typically only wets the soil surface of alternate furrows without any intended crop wetting. While both LESA and MESA wet the whole soil surface, LESA may not wet the foliage to the extent that MESA will. Table 1 provides a list of attributes for LEPA, LESA, and MESA irrigation technologies.

Table 1. Attributes of LEPA, LESA, and MESA irrigation systems.

Characteristic	LEPA	LESA	MESA
Applicator	Bubble Drag sock	Spray Spinner Rotator Wobbler Drag sock	Spray Spinner Rotator Wobbler Drag sock
Height	1-2 ft	1-2 ft	5-10 ft
Under-foliage chemigation	Yes	Yes	No
Over-canopy chemigation	No	No	Yes
Surface storage tillage	Yes	Option (desired)	Option
Tillage	Ridge till Fur. dikes Dam. diker	Any Conserv. till No-till	Any Conserv. till No-till
Soil wetting	Furrow only	All	All
Canopy wetting	None	All or part	All

by Terry Howell

LEPA, LESA & MESA Irrigation For Fully Irrigated Grain Crops . . .

The number of center pivot irrigation systems is rapidly increasing in the Southern High Plains, especially in the Texas High Plains region. Many of these systems are equipped with LEPA (Low Energy Precision Application) or LESA (Low Elevation Spray Application) applicators located near the ground. The LEPA devices are usually positioned over alternate furrows with an 80-in. spacing for cotton, or 60-in. spacing for grain crops in the northern part of the region. LESA spray heads are typically placed 1 to 2 ft above ground level with a spacing of 5 to 10 ft.

USDA researchers in the Water Management Research Unit compared two LEPA methods, bubble and double-ended drag sock, with LESA (Low Elevation Spray Application) and MESA (Mid Elevation Spray). Full irrigation and deficit irrigation (a percent of full irrigation) were used with all sprinkler devices. All spray and LEPA devices were nozzled for the same flow rate and were spaced 60 in. apart over alternate furrows. The LEPA and LESA devices were suspended without weights from ¾-in. plastic hose. All plots were furrow-diked to minimize surface redistribution and plot runoff.

Our results did not find any significant differences between LEPA in the drag sock or bubble modes, and these treatment yield results were averaged. With full irrigation in the two cropping years for the three crops, grain yields were slightly larger with LESA and MESA than with LEPA (Fig. 2), but the differences were not statistically significant. Two-year average grain sorghum yields were 7900 lb/ac with LEPA and 8150 lb/ac with LESA and MESA averaged. For corn, the comparable averages were 209 bu/ac with LEPA and 221 bu/ac with MESA and LESA averaged; and for wheat, the averages were 67 bu/ac with LEPA and 72 bu/ac with the MESA and LESA systems averaged. The crop yields are above average for this region but typical of those obtained by progressive producers.

With deficit irrigation, LEPA was highly efficient for grain sorghum, but for the other two crops, there was little difference between LEPA and MESA or LESA (Fig. 2). At the 50% irrigation amount with grain sorghum, two-year average grain yields were 7400 lb/ac with LEPA and 6400 lb/ac with MESA and LESA averaged. For corn, which is not a drought-tolerant crop, the 50% irrigation yields were 132 bu/ac with LEPA and 129 bu/ac with the average of the two spray methods. Wheat yields at the 33% irrigation amount were identical at 48 bu/ac. At the 67% irrigation amount, they were 61 bu/ac with LEPA and 65 bu/ac with MESA and LESA averaged.

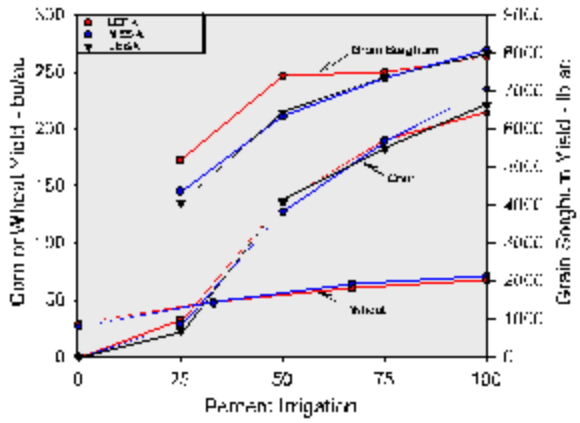

Figure 2. Grain yields of corn, wheat, and sorghum as affected by irrigation deficit and method of application.

One surprising outcome of the studies was the small grain yield differences between the LESA and MESA spray methods. For example, with the 1992 grain sorghum crop, yields averaged across all irrigation amounts were 7130 lb/ac with LESA and 7110 lb/ac with MESA. Comparable average two-year yields for corn were 109 bu/ac with LESA and 112 bu/ac with MESA. The LESA spray heads often became entangled in the crop and sprayed water onto the entire crop canopy. As a result, water losses from the crop canopy were probably similar for the two spray methods even though the spray head location was entirely different. LESA was not used with wheat because of the difficulty of using spray heads within a closely-spaced crop. Spring irrigations for corn and sorghum were minimized by seeding into previously fallowed fields. When pre-plant or emergence irrigations are necessary, LESA or LEPA will be more efficient in this environment because the application point is closer to the ground and out of the high wind and dry air.

Full irrigation was defined as sufficient irrigation to maintain soil water at a selected non-yield limiting level for each of the three crops. Deficit irrigations ranged from 0 to 75 percent of the full irrigation applications. The fully-irrigated crop received 1-in. irrigations, and deficit-irrigated crops received a percentage of the 1-in. irrigations on the same date. The grain crops were grown with cultural practices such as variety, fertility, plant population, and weed and insect control similar to those used for high-yield on-farm irrigation. Corn and grain sorghum were planted on 30-in. spaced beds, and wheat was flat-planted in 10-in. spaced rows.

by Arland Schneider and Terry Howell

Corn Water Use and Yield Response to Growing Season Mulch and Soil Differences . . .

Soil surface residue often increases crop yields by enhancing soil water storage prior to planting and by slowing soil water evaporation during the growing period. The magnitude of this reduction can depend on the amount or thickness of the mulch, frequency and amount of rain or irrigation, canopy architecture or development, or soil type.

Corn (*Zea mays* L.) is a major irrigated crop in the Southern High Plains, and it has a high seasonal water requirement for maximum yields. Most of the area's irrigation water is pumped from an aquifer that is declining. Due to increased pumping costs and limited water reserves, producers must adopt farming practices which limit evaporative losses of water needed for crop growth and that enhance water use efficiency.

The objective of this research was to evaluate the effect of a growing season mulch on the growth, water use, and yield of short season corn grown with limited water and on three soil textures representative of the Southern High Plains.

METHODS and MATERIALS

Short season corn (PIO-3737) was grown in 1994 and 1995 at Bushland, TX, USA, in a 0.25-ha field with a rain shelter facility that has 48 weighable lysimeters (Fig. 3). The lysimeters have a surface dimension of 1.0 m by 0.75 m and are 2.3 m deep. Soil types were Pullman silty clay loam from Bushland, TX; Ulysses silt loam from Garden City, KS; and Amarillo fine sandy loam from Big Spring, TX. A low plant population of 4 plants/m^2 was used. Irrigation treatments were based on the amount of rainfall which normally occurs during the growing period (200 mm). Another variable was soil moisture available to the plant at the beginning of the growing season as well as mulch mass. In 1994, irrigation treatments totaling 25% (I-25 irrigation treatment) and 75% (I-75) of normal rainfall were applied, with beginning plant available soil moisture at 270 mm, 420 mm, and 325 mm for the clay loam, silt loam, and sandy loam, respectively. In 1995, irrigation treatments were 60% (I-60) and 100% (I-100) of normal rainfall, with all soil types with 300 mm plant available soil moisture. Mulch was applied after plant emergence at a rate of 4 Mg ha^{-1} in 1994 and 6.7 Mg ha^{-1} in 1995.

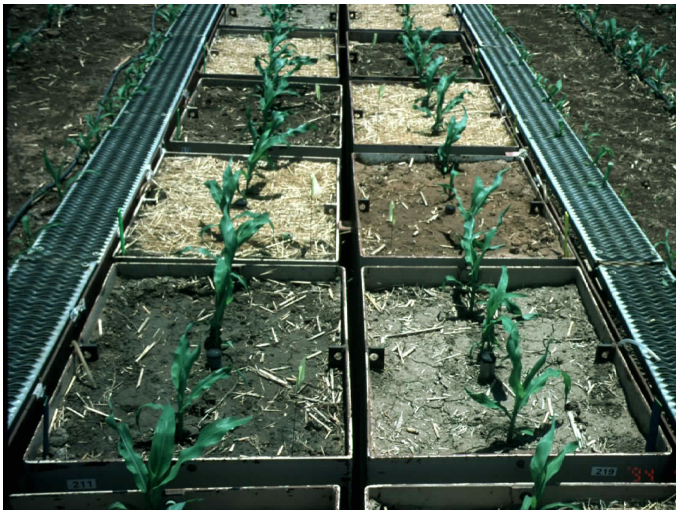

Figure 3. View of the lysimeters showing the mulch covers installed with the corn growing.

RESULTS

Yield Components and Water Use

Surface mulch of 4 Mg ha^{-1} had no effect on yield components or cumulative evapotranspiration (ET) in 1994 (Table 2). Irrigation at the I-25 level significantly reduced grain yield by 19% and ET by about 20% compared with the I-75 treatment. The corn in the silt loam produced the highest

Table 2. Cumulative evapotranspiration (ET), grain yield, and grain water use efficiency (WUE) data..

1994				1995			
Main Effect	ET	Grn. Yld.†	Grn. WUE	Main Effect	ET	Grn. Yld.	Grn. WUE
	mm	g m^{-2}	kg m^{-3}		mm	g m^{-2}	kg m^{-3}
Irrigation				Irrigation			
I-75	501a‡	772a	1.54a	I-100	405a	561a	1.38a
I-25	444b	622b	1.43a	I-60	397a	524a	1.31a
Soil Type				Soil Type			
Clay Loam	427c	616b	1.42b	Clay Loam	378b	478b	1.26b
Silt Loam	527a	806a	1.58a	Silt Loam	435a	612a	1.40a
Sandy Loam	463b	670b	1.45b	Sandy Loam	391b	538b	1.38a
Surface				Surface			
Mulch	473a	691a	1.48a	Mulch	412a	592a	1.44a
No Mulch	472a	704a	1.49a	No Mulch	391a	494b	1.26b

† Grain yield is reported at 0% moisture.
‡ Main effect means followed by a different letter are significantly different within the main effect at the 0.05 probability level.

grain yield, ET, and water use efficiency (WUE) in 1994 compared with the corn in the other two soils. Yields, WUE, and ET were lowest for the corn in the clay loam.

Surface mulch significantly increased grain yield and WUE in 1995 by at least 10% compared with those with a bare surface, but cumulative ET was similar (Table 2) for the surface treatment. Irrigation treatment did not affect grain yield or ET. Grain yield and grain WUE was again lowest for the corn in the clay loam, which had about 65 mm more available soil moisture remaining in both irrigation treatments compared to the crops in the other two soils. The limited water use by the crop in the clay loam may have been due to restricted rooting caused by a dense clay layer at about 1.15and/or the caliche layer below.

The cumulative ET of mulched and bare soil surfaces was similar each year. In 1994, mulch reduced ET rate only when irrigation occurred and when leaf area index (LAI) was less than 1.5, which was prior to anthesis. At LAI greater than 1.5, ET rate was not affected by mulch. The nearly equal ratios of mulched to bare surface ET when no irrigation occurred support the findings of Todd et al. (1991) that the crop canopy accounted for most of the evaporation reduction in dryland situations. No significant differences occurred in LAI between surface treatments in the latter part of the 1994 season.

In 1995, ET of the mulched surface treatments was generally greater than that of the bare soil surface after anthesis, possibly due to the significantly higher LAI of the mulched corn. This suggests that mulching partitioned more water use into transpiration rather than soil water evaporation, thus increasing both yield and WUE. Howell et al. (1990) pointed out the importance of improved irrigation techniques that redirected losses from evaporation, drainage, and runoff into increases in transpiration and consequently WUE.

Table 3. Cumulative evapotranspiration (ET), grain yield, total biomass, seed number, and grain water use efficiency (WUE) data by soil type and surface treatment for 1995.

Main Effect	ET	Grn. Yld.†	Tot. Bio.	Seed #	Grn. WUE
	mm	----- g m^{-2} -----		- no. m^{-2} -	- kg m^{-3} -
Clay Loam					
Mulch	395a‡	545a	1159a	2064a	1.38a
No Mulch	361a	411b	865b	1709b	1.14b
Silt Loam					
Mulch	451a	656a	1312a	2487a	1.45a
No Mulch	420a	569a	1155a	2266a	1.36a
Sandy Loam					
Mulch	390a	575a	1140a	2221a	1.48a
No Mulch	392a	501b	1023a	2134a	1.27a

† Grain yield is reported at 0% moisture.
‡ Main effect means followed by a different letter are significantly different within the main effect at the 0.05 probability level.

Soil type and mulch

No main effect interaction between mulch and soil type occurred in either year. However, an additional analysis was made on the 1995 data to examine the magnitude of the effect of mulch on the corn grown in each soil type. Mulch resulted in significant increases in grain yield, seed number, and grain WUE for the crop in the clay loam, no significant increases in the silt loam, and significant increases only in grain yield in the sandy loam (Table 3). This suggests that mulch provided just enough evaporation reduction to compensate in part for the limited use of plant available water by the crop in the clay loam.

CONCLUSIONS

Mulch mass may be the most important component for enhancing WUE with limited irrigation, but the effect is minimized as leaf area develops. Reduction in soil water evaporation due to mulch can help minimize the effects of limited water use by a crop which may have resulted from soil properties.

REFERENCES

Howell, T.A., Cuenca, R.H., and Solmon, K.H., 1990. Crop yield response. In: G.J. Hoffman, T.A. Howell, and K.H. Solomon (Editors). Management of farm irrigation systems. ASAE Mongraph, Am. Soc. Agric. Eng., St. Joseph, MI, pp. 93-122.

Todd, R.W., Klocke, N.L. Hergert, G.W., and Parkhurst, A.M., 1991. Evaporation from soil influenced by crop shading, crop residue, and wetting regime. Trans. ASAE 34(2):461-466.

By Judy Tolk, Terry Howell, and Steve Evett

Newsletter . . .

The *Wetting Front* newsletter is designed to foster technology transfer from our research to industry and to agricultural producers in the Southern High Plains. Our purpose is to improve communications with our stakeholders and partners as well. We are still updating our mailing list, so to request removal of your name from our mailing list or to request an addition, you can simply fax the information to (806) 356-5750 or send the information in an e-mail message to Mrs. Carole Perryman at <cperryma@ag.gov>. Call Mrs. Perryman at (806) 356-5749 to update your mailing information or to request removal or additions. *Wetting Front* can be found on the WWW at http://www.cprl.ars.usda.gov/wmru/wfront.htm. Any suggestions or comments are welcome too.

Awards and Recognitions . . .

Keith Brock and ***Brice Ruthardt*** received Certificates of Merit for 1996-97 performance from USDA-ARS.

Terry Howell received a 1997 ASAE Soil and Water Division Director's Award from Dr. Jim Gilley for service as Division Editor. He was recognized and received a Certificate of Merit from ASAE at the 1997 International meeting in Minneapolis, MN, in August for his four years of service as Soil and Water Division Editor.

Internet News . . .

Our new Web URL is http://www.cprl.ars.usda.gov/, but the former address will automatically forward. So please update your bookmarks. Several new features include the "News" page with information about upcoming events and seminars. Several 1997 spring seminars slide shows are published on the WWW and can be accessed from this page as well as press releases. Also, information about employment opportunities both at the CPRL and ARS can be accessed from the "News Page."

We would like to highlight the following WWW addresses that we think may interest our *Wetting Front* readers:

http://www.ars-grin.gov/ars/id
USDA-ARS Directory of Irrigation & Drainage Research
http://www.ussl.ars.usda.gov
USDA-ARS-U.S. Salinity Lab., Riverside, CA
http://agweb.tamu.edu/amarillo/index.htm
Amarillo Research & Extension Center
http://agprogram.tamu.edu/agropolis
Cyberstop for Texas A&M Univ. Agriculture Information
http://www.ttu.edu/~catt
Texas Tech Univ., Center for Agric. Technology Transfer
http://www.taia.org
Texas Agricultural Irrigation Association
http://www.hub.ofthe.net/hpwd
High Plains Under Ground Water Conservation District No. 1, Lubbock, TX
http://www.tx.nrcs.usda.gov
Texas USDA-NRCS, Temple
SURF'S UP!!!!!

Grant News . . .

PENDING PROPOSALS:

Terry Howell and Steve Evett with Leon New, Thomas Marek, B.A. Stewart, Brent Bean, and Jerry Michels, $600,000 for "Enhancing the Sustainability of Irrigation on the Texas High Plains, a REE Approach" to USDA-CSREES for the Fund for Rural America.

Coming Events and Upcoming Meetings and Presentations . . .

UPCOMING EVENTS
1998 FIELD DAYS
Check the Web page for these schedules when they become available.

UPCOMING MEETINGS & PRESENTATIONS
Dec. 2-4, 1997
Amarillo Farm Show
Amarillo, TX

Dec. 9-10, 1997
Texas Agriculture Irrigation Association Conference and Trade Show
Lubbock, TX

Feb. 17-18, 1998
Central Plains Irrigation Workshop and Exposition
North Platte, NE

June 17-20, 1998
Soil and Water Conservation Society State Meeting
Amarillo, TX
Contact Steve Evett at (806) 356-5775 or <srevett@ag.gov> for additional information.

July 12-16, 1998
American Society of Agricultural Engineers Meeting
Orlando, FL
Aug. 3-7, 1998
ASCE International Water Resources Engineering Conference & Groundwater Management Symposium
Memphis, TN

Aug. 20-26, 1998

International Soil Science Society Congress
Montpellier, FRANCE S.R. Evett

RECENT PRESENTATIONS
September 15-19, 1997
International Society of Sugar Cane Technologists
Townsville, Queensland AUSTRALIA
"Water Use Efficiency" [invited keynote] T.A. Howell

September 22-24, 1997
Bureau of Sugar Experiment Stations and growers at Burdekin, Mckay, Bundaberg, Queensland AUSTRALIA
"Water Use Efficiency" T.A. Howell

October 22-24, 1997
American Society of Agronomy/Soil Science Society of America Workshop on Characterization and Measurement of Hydraulic Properties of Unsaturated Porous Media
Riverside, CA
"Soil Characteristic Curves from Tension Infiltrometer and Laboratory Data "
S.R. Evett, F.H. Peters, O.R. Jones, and P.W. Unger

October 26-31, 1997
American Society of Agronomy and Soil Science Society of America Annual Meeting
Anaheim, CA
"Evapotranspiration of Irrigated Fescue Grass Compared with Computed Reference ET" T.A. Howell, S.R. Evett
"Alfalfa Evapotranspiration Compared with Reference ET"
S.R. Evett, T.A. Howell, J.A. Tolk, A.D. Schneider
"Corn Water Use and Yield Response to Growing Season Mulch and Soil Differences"
J.A. Tolk, T.A. Howell, and S.R. Evett

Technology Transfer News . . .

Customer/Clientele Needs:

Technical reviews of USDA Small Business Innovation Research Proposals were made by Dr. Schneider and Dr. Evett. Dr. Howell reviewed research proposals for USGS and Montana State University and PWA of ARS.

Presentation and discussion about agricultural research careers and ARS research was made to Mesa Verde Elementary School in June by Dr. Tolk. Dr. Howell presented a briefing on irrigation to the TAMU System Leadership in Higher Education group in June 1997. Three Amarillo students were advised by Dr. Tolk on science fair projects examining plant growth regulation in April-May 1997. A briefing was presented to the TAMU System Leadership in Higher Education class in April 1997 by Dr. Howell. A briefing was made to the TAMU College of Agriculture and Life Sciences and TAMU System Vice Chancellor on the irrigation research program in June 1997 by Dr. Howell. A presentation was made to the TAMU System Chancellor's 21st Century Council meeting in June 1997 on ARS-Bushland programs and collaboration with TAMU System by Dr. Howell. Presentations and tours (all day) about irrigation were made in June 1997 to the WTAMU International Workshop on Dryland Agriculture by Dr. Schneider. A tour and presentation about irrigation research was made by Dr. Evett in July 1997 to the State FFA Conference attendees.

Media Contacts:

Dr. Tolk discussed plant drought tolerant mechanisms in July 1997 with an AP reporter from Washington, DC. Daily reports on grass water use were published in the Amarillo Globe News about water savings for lawn watering guides. Daily faxes on PET were sent to local newspapers, radio stations, and TV stations. Dr. Tolk and Karen Copeland provided TV interviews on women in agricultural research careers at the Wheat Field Day in May. Dr. Schneider provided TV interviews at the Wheat Field Day.

Visitors:

On Oct. 15, 1997, Lindsay Ward from Toowoomba, QLD, Australia was hosted for consultations by O.R. Jones, Dr. Howell, Dr. Evett, and Dr. Tolk.

On Oct. 15, 1997, Chris Williams was hosted by Dr. Schneider to consult about automating lateral irrigation machines.

On Nov. 13, 1997, U.S. Congressman Larry Combest (R-Lubbock; 19th District of Texas) conferred about research programs and toured the facilities. He was hosted by Drs. Clark, Howell, Cole, and Unger.

Field Days/Conferences:

Presentations on wheat tillage, wheat planting dates, and wheat irrigations by Drs. Howell and Schneider for 1997 Wheat Field Day at Bushland in May. A SWCS technical meeting and tour on Animal Waste Management was organized by Dr. Evett and held at Clovis, NM, in May.

Seminars/Producer/Clientele Meeting Presentations:

Dr. Evett presented a lecture and led field exercises on water content measurement methods to the soil physics class at WTAMU.

Popular Magazine Articles:

The article "Put Automation in Irrigation" was published in May 1997 in Vegetable Grower based on an interview and cooperative work with Dr. Evett. The opinion article "Footprints of a Profession are Created by its Publications" was published in May in Resource [ASAE] magazine by Dr. Howell. The article "LEPA and LESA Fight It Out" was published in June in the Business and Technology magazine of the Irrigation Association by Drs. Schneider and Howell.

CRADA/Inter-Agency Collaboration:

The CRADA with Dynamax, Inc., of Houston Texas, was completed on Sept. 15. Dynamax is now marketing a time domain reflectometry (TDR) system designed by ARS for real-

time, unattended soil water content measurement. The system includes probes, coaxial multiplexers, and the TACQ computer program for automatic control of the system. The system was extended to include measurement of bulk electrical conductivity that is useful for soil salinity investigations and determination of solute transport parameters used in prediction of pollutant movement. New technology for control of AC power to the system was transferred to Dynamax. A 98-page system manual was written and transferred to Dynamax. The TACQ software and TDR system manual were posted on the CPRL WWW site (see URL http://www.cprl.ars.usda.gov/programs/) for public downloading.

Cooperative work on TDR methods was initiated with Gail Olson and Peter Gostomski of the Idaho National Engineering Laboratory to help them measure water content of composts; with Susan Phillips and Gary Gurtler of the USGS Biological Resource Division to help them measure water content of environmentally fragile cryptobiotic soil crusts in Canyonlands National Park, Utah; with Jon Wraith of Montana State University to investigate errors in TDR determined water contents due to temperature changes in soil; and, with John Fleming of the University of Idaho to measure soil water content in columns. The TACQ software was provided to these cooperators and training was conducted at Bushland or by telephone, and mail. The TACQ software was provided to several other researchers including Jim Swan of Iowa State University and Sally Logsdon of the ARS Soil Tilth Laboratory for measurement of soil bulk electrical conductivity.

Work on the residue measurement device by Dr. Evett continued under the leadership of Jim Morrison, USDA-ARS, GSWRL, Temple, TX. The CRADA partner is Opti-Sciences. A working prototype is planned for August.

Cooperative work was begun with Tom Giambelluca of the Dept. of Geography, University of Hawaii, on the use of the tension infiltrometer for measurement off road surface hydraulic properties in SE Asia.

Other Technology Transfer Activities:

Our WEB site (see URL http://www.cprl.ars.usda.gov) was updated several times and materials added about 1997 research presentations, press releases, and staff updates. Over 4,700 "primary" hits were recorded during the year.

About 100,000 faxes were sent to producers, county agents, water districts, media, irrigation companies, consultants, coops, and NRCS specialists that contained information on water use and crop development for the NP-PET network. This information was broadcast on the morning and noon farm radio programs, was published in the local newspaper, and was mentioned several times on local TV stations.

A Water Management newsletter, the *Wetting Front*, was developed, and the first issue was mailed in May to over 300 individuals and organizations and posted on the WEB (see the URL http://www.cprl.ars.usda.gov/wmru/wfront.htm). This is the second issue!

The ENWATBAL model was distributed by mail to several scientific researchers; and was posted on our WWW site (see the URL http://www.cprl.ars.usda.gov/programs/) for free download and is listed on the ARS Databases site at the URL http://www.ars.usda.gov/arsdb.html.

Recent Publications . . .

1997. Allen, R. R., and Musick, J. T. Tillage method and depth effects on furrow irrigation infiltration. Appl. Engr. Agric. 13(6):in press.

1997. Allen, R. R., and Musick, J. T. Furrow irrigation infiltration with multiple traffic and increased axle mass. Appl. Engr. Agric. 13(1):49-53.

1997. Evett, S. R., Howell, T. A., Tolk, J. A., and Schneider, A. D. Alfalfa evapotranspiration compared with reference ET. Agron. Abstr. p. 20.

1997. Evett, S. R., Peters ,F. H., Jones. O.R., and Unger, P. W. Soil characteristic curves from tension infiltrometer and laboratory data. p. 54. *In:* "Program and Abstracts of the Characterization and Measurement of the Hydraulic Properties of Unsaturated Porous Media", USDA-ARS, U.S. Salinity Lab., and Univ. of Calif., Dept. of Soil & Environ. Sci., Riverside.

1997. Howell, T. A. Footprints of a profession are created by its publications. Resource Magazine 4(5):17.

1997. Howell, T. A. and Evett, S. R. Evapotranspiration of irrigated fescue grass compared with computed reference ET. Agron. Abstr. p. 20.

1997. Howell, T. A., Schneider, A. D., and Evett, S. R. Subsurface and surface microirrigation of corn — Southern High Plains. Trans ASAE 40(3):635-641.

1997. Howell, T. A., Steiner, J. L., Schneider, A. D., Evett, S. R., and Tolk, J. A. Seasonal and maximum daily evapotranspiration of irrigated winter wheat, sorghum, and corn — Southern High Plains. Trans ASAE 40(3):623-634.

1997. Lamm, F. R., Clark, G. A., Yitayew, M., Schoneman, R. A., Mead, R. M., and Schneider, A. D. Installation issues for SDI systems. ASAE Paper No. 97-2074, Minneapolis, MN. August 10-14, 1997.

1997. Schneider, A. D., and Howell, T. A. Methods, amounts, and timing of sprinkler irrigation for winter wheat. Trans. ASAE 40(1):137-142.

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1997. Thompson, A. L., Martin, D. L., Norman, J. M., Tolk, J. A., Howell, T. A., Gilley, J. R., and Schneider, A. D. Testing of a water loss distribution model for moving sprinkler systems. Trans. ASAE 40(1):81-88.

1997. Tolk, J. A., Howell, T. A., and Evett, S. R. Corn water use and yield response to growing season mulch and soil differences. Agron. Abstr. p. 13.

1998. Howell, T. A., Tolk, J. A., Schneider, A. D. and Evett, S. R. Water use, yield, and water use efficiency of two different maturity corn hybrids. Agron. J. (accepted 14 July 1997).

1998. Tolk, J. A., Howell T. A., and Evett, S. R. Evapotranspiration and yield of corn grown in three High Plains soils. Agron. J. (in revision).

1998. Tolk, J. A., Howell, T. A., Steiner, J. L., and Evett, S. R. Grain sorghum growth, water use, and yield in contrasting soils. Agric. Water Mgmt. (accepted 22 April 1997; in press).

Personnel News . . .

Judy A. Tolk, Ph.D. was hired for our Plant Physiologist position and started work in the Water Management Research Unit on June 8. Dr. Tolk received her Ph.D. in Environmental Crop Physiology from Texas Tech University in 1992, a M.S. degree from West Texas State University (now West Texas A&M University) in 1985, and a B.J. degree from the University of Texas in 1973. She began working at Bushland in 1983 for the Texas Agricultural Experiment Station as a technician and joined ARS in 1985 as a Biological Technician. Judy works part-time on the Playa lake project in the Energy, Soil, and Animal Waste Resources Research Unit. e-mail:jtolk@ag.gov.

Richard (Rick) W. Todd, Ph.D. was hired as Research Associate in Plant Physiology and started working on August 17 with Dr. Evett on the USDA-FAS-USAID project with Egypt. Dr. Todd received his Ph.D. from the University of Nebraska-Lincoln in 1996 with a major in Agronomy. He received a B.S. degree from the University of Nebraska-Lincoln in 1979. Rick was a Research Technician and Technologist with the West Central Research and Extension at North Platte, NE, from 1977 through 1997, except in 1980-81 when he was in Fort Collins, CO, at Colorado State University in Range Science. e-mail:rtodd@ag.gov.

Lorie Boudra was hired to fill our Biological Technician vacancy and started on June 22. Lorie came to us from Arkansas where she received her B.S. from Southern Arkansas University in May of 1996. She worked for Arland Schneider on our irrigation runoff studies this summer. Unfortunately, Lorie will be leaving ARS on Nov. 21 and has accepted a position with Asgrow Seed Co. in Plainview, TX.

Jack Musick underwent surgery in April and is recovering nicely. But he has not returned full time to his "collaborator's" position yet. We're sure many of Jack's friends and colleagues may want to write him. His address is 5502 Floyd in Amarillo, TX 79106 [home phone is (806) 352-7549]. The WMRU is looking forward to Jack's return to work, even though he is supposed to be retired!

The Water Management Research Unit together with the whole Conservation and Production Research Laboratory family extend our sympathies to the **Evett family** in the recent loss of Steve's mother.

The Water Management Research Unit depends on the critical assistance provided by our summer employees. In 1997, like most years, we had an excellent group of students. First year summer employees ***Kyle Schniederjan*** (Randall High School), ***Donald Smith*** (Southern Methodist Univ. and now at Texas Tech Univ.), and ***Sara Ledbetter*** (Tascosa High School and now attending Amarillo College) joined with our experienced students – ***Gary Marek*** and ***Kevin von Netzer***, both attending WTAMU in Canyon. We really appreciated all their hard work and their attention to detail that is needed in research. Thanks to them and our dedicated support staff, we had a

great 1996-97 research season!

Water Management Research Unit

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

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