Extension Portal for Higher Integration Networking for Coordination of Training, Information and Research

Final Project Report

For the Completion of
TWDB Contract No. 1213581481
by

Thomas Marek, M.S., P.E.
Senior Research Engineer
Texas AgriLife Research
Amarillo, TX

Dana Porter, **Ph.D., P.E.**
Associate Professor & Extension Irrigation Engineer
Texas AgriLife Research and Extension Service
Lubbock, TX

submitted to the

Texas Water Development Board
P.O. Box 13231, Capitol Station
Austin, Texas 78711-3231
July 2015

This page is intentionally blank.

Acknowledgements

This resource is made available through partial support from the **Texas Water Development Board** (Contract #**1213581481**, "**Extension Portal for Higher Integration Networking for Coordination of Training, Information and Research**") and the **USDA-ARS Ogallala Aquifer Program**.

The authors appreciate the opportunity to serve the stakeholders in the State of Texas, especially the Texas High Plains through projects such as this that collectively support improved water management. Special thanks are extended to **Kyle Ingham, Joseph Price**, and **Julie Lyles, Panhandle Regional Planning Commission** for their guidance, collaboration and administration of this contract and to **Cameron Turner**, **Texas Water Development Board**, for his assistance and guidance in this project. Special thanks also are extended to **Dr. David Brauer, United Stated Department of Agriculture-Agricultural Research Service Conservation and Production Research Laboratory**, for his support of the Texas High Plains Evapotranspiration Network and related programs through the Ogallala Aquifer Program. Finally the authors express appreciation to Texas A&M University Sponsored Research Services and Texas A&M AgriLife Research support staff, including Kathy Wingate, Daniel Holman, Don Dusek and others, who assisted in accounting, programming, reporting and network operations.

Glossary of Acronyms and Abbreviations

Ac = acre

ET = Evapotranspiration

ETc = Crop Evapotranspiration

PRPC = Panhandle Regional Planning Commission

TDA = Texas Department of Agriculture

TXHPET = Texas High Plains Evapotranspiration Network

TWDB = Texas Water Development Board

USDA = United States Department of Agriculture

USDA-ARS = USDA Agricultural Research Service

USDA-ARS-OAP = USDA-ARS Ogallala Aquifer Program

USDA-NRCS = USDA Natural Resources Conservation Service

USDA-RMS = USDA Risk Management Agency

Extension Portal for Higher Integration Networking for Coordination of Training, Information and Research

1. Executive summary

Growing demand for limited and declining water resources in Texas is one of the most critical issues of concern for all water user sectors, including agricultural irrigators. The economic importance of irrigated agriculture warrants careful consideration of water management options, as optimizing rainfall and irrigation management are key to achieving high water use efficiency and maintaining acceptable crop yields and quality.

Irrigation accounts for approximately 90% of the total water use in the Texas High Plains, where an estimated 4.5 million acre-feet (1.47 trillion gallons) of irrigation water is applied annually. Regional water planning analysis (Panhandle Region, or Region A) has indicated that use of evapotranspiration (ET) based irrigation scheduling using data from agriculturally sited weather station networks (ET Networks) has been determined to be one of the most cost-effective water conservation strategies identified.

End users of the Texas High Plains ET (TXHPET) Network information include agricultural irrigators; **a**gricultural, environmental and other research programs; **w**ater resources managers/agencies; **c**rop insurance companies and agencies (TDA, USDA-Risk Management Agency); municipalities, turf managers, homeowners; environmental consultants and researchers; and educators. As new audiences adopt water conservation strategies and applications of the data evolve, there is an ongoing need for education to support appropriate application/interpretation of the information.

The "Extension Portal" supported through this project serves as a public gateway to information available from the Texas High Plains Evapotranspiration (TXHPET) Network. Internet access to crop water use estimates, an online irrigation scheduling tool, information and educational resources are provided through this gateway. While the tools and resource materials are broadly applicable to a wide range of audiences and conditions, the crop water use data are regionally focused in the Texas High Plains (Panhandle and South Plains) where the majority of irrigation water in the state is used, as well as portions of the Rolling Plains and West Texas. The products of this effort support Regional Water Planning agricultural water conservation strategies.

The objectives of this project were to leverage the Texas High Plains ET Network resources by 1) providing public access to agriculturally appropriate weather data and crop water use estimates; and 2) promoting proficient use of the data through educational programs.

Users of the data available from this Network could save 0.5 to 2.0 ac-inches/irrigated acre. Data associated with this project impact the Texas High Plains region an estimated value of $22

million annually in reduced water pumping costs and equipment use as well as conservation of limited groundwater resources of the Ogallala aquifer.

Educational programs reached diverse audiences through face-to-face Extension meetings, presentations, and workshops. These events promoted availability of the Extension Portal resources and demonstrated utility of the information in context of efficient water management.

2. Introduction and Background

Growing demand for limited and declining water resources in Texas has emerged as one of the most critical issues of concern for large urban centers and rural communities, as well as agriculture, manufacturing, power generation and environmental concerns. The record drought of 2010-2014 has highlighted the critical nature of this issue, and has greatly increased public interest in water's role in the future of Texas. The State Water Plan's water supply and demand projections consistently indicate expected increases in water supply shortfalls. Increasing demand for water for increasing population is expected to require diversion of water from other uses – particularly from irrigated agriculture (by far the greatest water user statewide). The economic importance of irrigated agriculture warrants careful consideration of options. Optimizing rainfall and irrigation management will be key to achieving high water use efficiency and maintaining acceptable crop yields and quality.

Irrigation accounts for nearly 90% of the total water use in each of the two largest groundwater districts in the northern region of the state of Texas. It is estimated that over 4.5 million acre-feet (1.47 trillion gallons) of irrigation water is applied annually in the region. Regional water planning analysis (Panhandle Region, or Region A) has indicated that use of evapotranspiration (ET) based irrigation scheduling using data from agriculturally sited weather station networks (ET Networks) has been determined to be one of the most economically viable conservation strategies available, and the benefits far outweigh the costs of network implementation and operation. In fact, the 2010 Regional Water Plan for the Panhandle Water planning area projected an implementation cost of $8.99 per acre-foot of groundwater saved. (That implementation cost is equivalent to 2.76 cents per 1,000 gallons). In addition, the use of irrigation scheduling has been shown to be effective in terms of water conservation and in preventing the over application of applied water for crop production.

The use of the Texas High Plains ET network also enhances the effectiveness and implementation of 5 of the 8 water management strategies in the Region A plan. These other strategies include changes in crop type and variety, changes in irrigation equipment type (irrigation method), implementing conservation tillage and adoption of biotechnology crops. Recent research related to the timing of limited water applications also has proven to provide the most cost effective production with updated crop production functions (yield response to crop water use). Through improved irrigation management (including irrigation scheduling) and efficient advanced irrigation technologies, improved crop genetics and overall integrated crop and pest management, water use efficiency (crop yield per volume of water used) has increased tremendously in recent years. Progress producers using advanced irrigation technologies and management are producing as much corn grain on 40 percent (60% less) of irrigation water as they did in the 1980's and with only 10 percent (or 90% less) of the energy requirements. In

Region A, corn production uses nearly 53 percent of all irrigation water pumped. The need for sustained and up-to-date ET-based crop water demand data for irrigation scheduling is essential to Texas High Plains producers to minimize pumping withdrawals and costs while avoiding yield loss, and in general to make better informed decisions in crop water management.

Resources and capabilities in Texas, including internationally recognized agricultural research, education and extension/outreach programs (state universities, USDA-ARS, and industry-based), continue to improve upon irrigation technologies and best management practices, crop production systems, crop varieties, and integrated crop/pest management. These programs depend upon availability of quality agriculturally based weather data and accurate crop water demand estimates.

Evapotranspiration (ET) Networks such as the Texas High Plains ET (TXHPET) Network collect weather data in agriculturally-representative conditions. They use the data in research-derived models to provide estimates of crop water demand, used in agricultural research programs, production agriculture and other applications. The data from the TXHPET network are unique in that they are ground-truthed to weighing lysimeters planted with crops produced under field conditions and operated by the USDA-Agricultural Research Service at Bushland.

End users and applications of TXHPET Network information represent a range of interests and technical levels. Agricultural producers and crop consultants use evapotranspiration-based crop water use estimates in optimizing irrigation scheduling to achieve high water use efficiency with acceptable crop yields/quality. The difficult decision of whether to irrigate or forego and irrigation application is easier with reliable crop water use information to support the decision. Agricultural, environmental and other research programs in the public sector (universities, AgriLife, USDA-ARS) and private sector (seed companies, etc.) use the crop water use estimates and other local agricultural meteorological information from the network for irrigation management, environmental conditions (rainfall, temperatures, wind, etc. for interpretation of experimental results, etc.), ground-truthing data for remote sensing research and related applications. Water resources managers/agencies use the information for estimating water requirements for crops, water planning and permitting. Crop insurance companies and state agencies (TDA, USDA-Risk Management Agency), as well as seed companies use the information for determining crop water requirements vs. rainfall and departures from normal. This is essential for interpreting context of "normal" and "extreme" weather conditions, and are useful in explaining crop performance (or lack of performance). Municipalities, turf managers, and homeowners use the turf grass water use estimates to determine irrigation needs for lawns, sports fields, as well as promotion of water conservation through education of homeowners and landscape irrigation professionals. Environmental consultants and researchers use water balance and weather conditions for various applications related to groundwater, surface water and air quality projects. TXHPET Network information also is used in a variety of education applications, including university courses and Extension outreach programs.

There is an ongoing need for education to support appropriate application/interpretation of evapotranspiration information from this and other sources that otherwise is frequently mis-applied or mis-interpreted due to poor understanding. New end-users in **all** categories need additional and ongoing technical and educational support. Educational resources developed

through this project (and those made more easily accessible through this website) are expected to remain relevant for the foreseeable future. Therefore continued educational programs and availability of the educational content will remain a priority of the project team. The team also will continue to advocate for stable funding and technical support for a statewide evapotranspiration network, preferably under the direction of the Texas Water Development Board.

This project has provided data access and educational support through an "Extension Portal" that serves as a gateway to information available from the Texas High Plains Evapotranspiration (TXHPET) Network. Internet access to weather-driven crop water use estimates, user-friendly online irrigation scheduling tools, information and educational resources, are provided through this gateway. For efficiency, this effort integrated previously developed resources and was conducted by an experienced team, thereby increasing impact of these resources for water conservation. Extension-based delivery focused upon incorporating user-friendly formats and customary "layman" terminology and units, and upon promoting awareness of the availability of the resource.

This conservation / irrigation management educational project has regional applicability focused on the Texas High Plains (Panhandle and South Plains) where the majority of irrigation water in the state is used, as well as portions of the Rolling Plains and West Texas (shaded area in the figure below). The effort represents a target area exceeding 50 counties representing the primary irrigated agricultural production regions of Texas. The project target area (Figure 1) includes Region A (Panhandle) and Region O (Llano Estacado) Water Planning Groups, as well as portions of Regions B, G, and F; all or portions of Groundwater Management Areas 1, 2, 3, 6 and 7; and several groundwater conservation districts, including North Plains Groundwater Conservation District, Panhandle Groundwater Conservation District, High Plains Underground Water Conservation District No. 1, Gateway Groundwater Conservation District, and several single county groundwater conservation districts.

Figure 1. Target area of the Texas High Plains Evapotranspiration (TXHPET) Network portal project.

Relevance to Water Management Strategy in most recent plan

This project addresses needs of Regional Water Planning efforts, particularly for agricultural water conservation. The agricultural water conservation strategy this effort addresses is the use of the TXHPET network to schedule irrigation and conserve groundwater. This strategy also underpins several other strategies that complement effective irrigation water use.

3. Project Objectives

The objectives of this project were to leverage the Texas High Plains ET Network resources by

1. Providing public access to agriculturally appropriate weather data and crop water use estimates to improve irrigation scheduling, thereby supporting water conservation without sacrificing crop yield and profitability;
2. Promoting proficient use of the data through educational programs (presentations, workshops, and publications).

4. Tasks and Methodology

The major tasks necessary to meet the objectives of this project included: 1) development and operation of Internet site for access to information, tools and educational resources, including data available from the Texas High Plains ET Network; 2) identification, adaptation, integration and promotion of tool and resources; 3) training of key stakeholders and educators; and 4) project administration to ensure compliance with the terms of the contract.

Task 1: Development and operation of Internet site for access to information, tools and educational resources

Internet access to information, tools, and educational resources will be achieved through the development, posting, and maintenance of a website that will be linked to the TXHPET data for the purpose of agricultural water conservation in the Texas Panhandle…

Internet access to information, tools and educational resources were achieved through a website (**watermgmt.tamu.edu**) linked to TXHPET data. The Texas High Plains Water Management website also provides convenient access to other reliable, credible, and practical water management and conservation information. **Screen shots from the website showing information available are included in Appendix A of this report.**

A significant effort was dedicated to upgrades of Internet server equipment, updates and software and data security protocols to ensure compliance with Texas A&M University System policy. Programming efforts included conversion of codes for compatibility with new software. To ensure compatibility with other resources and to support the program, site development (computer programming) and ongoing maintenance of the website and network were supervised by Texas A&M AgriLife personnel (subcontractor). TWDB funds were used primarily to support salaries and fringes of programming and data management support staff; other funds, including USDA-ARS Ogallala Aquifer Program funds and Texas A&M AgriLife funds were used to address the remaining staffing, travel and computer / Internet server associated educational expenses. To improve recruitment and retention of qualified personnel, partial reimbursement of tuition, fees, reference materials and related costs were included as part of the compensation

package for the programming staff (graduate students). Since appropriate source funds were not secured for this expense, project leaders paid these expenses from other designated program funds.

During the course of the project, there were intermittent telecommunications issues with some of the weather stations, requiring significant time and expense for necessary corrective measures and equipment replacements. Losses of land-based telephone lines due to agency conversion of "landlines" to "internet-based phone service"; discontinuation of support for "2G" cellular service by the cellular provider; and even termination of agreements with owners of some sites have posed serious challenges in maintaining operations of the weather station network, and have resulted in loss of some weather stations from the network, and intermittent down time for others. While continuing to support access to remaining weather station data, the team has been working (on other projects funded by other sources) with collaborators to investigate the feasibility of using other data sources, while promoting the use of irrigation scheduling tools available on the Extension portal.

Task 2: Identification, adaptation, integration and promotion of tools and resources

Under this task, useful available information (including crop water use data available from the TXHPET Network and other sources), practical irrigation scheduling tools, and appropriate relevant educational materials will be identified, adapted as needed and integrated for delivery through the Extension Portal and website….

Under this task, useful available information (including crop water use data available from the TXHPET Network and other sources), practical irrigation scheduling tools, and appropriate, relevant educational materials were identified, adapted as needed, and integrated for delivery through the Extension Portal. Examples of tools and information are included in Appendix A (screen shots from the watermgmt.tamu.edu website showing links to educational videos, reports and other materials) and Appendix B (summarizing the Soil Moisture User Profile irrigation scheduling tool developed under a previous, separate project) of this report. In planning for ongoing efforts beyond this project, contingent upon future funding availability, needs for new educational materials and programs to meet evolving and emerging stakeholder needs were identified.

Information gaps and educational needs: As computer and technology capabilities and stakeholder demands continue to evolve over time, higher level of integration of new and available tools is needed. The ever-increasing array of public-domain and commercially available resources offer both excellent tools for improved water management and increasing risk of "information overload", confusion and even mis-information. Educational events and resources (addressed in Task 3) were developed for target audiences with differing needs (general interest to specific applications of data; low to higher level technical level).

To ensure quality and straightforwardness of information and products provided, this task was conducted by experienced extension and applied research personnel. A high level of understanding of the background science and online tool capabilities, as well as familiarity with stakeholder/end-user needs was absolutely essential to success of this important task. This effort was accomplished with significant and ongoing focus and commitment of program faculty.

Task 3: Training of key stakeholders and educators

Conduct a concerted educational effort promoting the availability of the products and provide training opportunities for end-users/stakeholders… A minimum of six trainings will be conducted by AgriLife staff in the Panhandle Region…

To maximize adoption of the technologies and application of the tools and data, a concerted educational effort promoted the availability of the products and provided training opportunities for end-users/stakeholders. Primary target audiences included extension educators (county extension agents with significant irrigation acreages in their counties), crop consultants, agricultural producers, agricultural industry/agribusiness professionals, groundwater conservation district personnel, and research personnel (research associates, graduate students, faculty, and others involved in project management and water use information interpretation from research programs). **Educational activities are summarized in Appendix C of this report.**

The Extension Portal and associated TXHPET data, supporting information and tools were presented in at least 28 educational programs and events. Events and presentations specifically targeting Panhandle water concerns. At least 5 events, including 4 in-person meetings and one highly focused "ET and Irrigation Scheduling" webinar were conducted to train Texas A&M AgriLife Extension Service County Agents (agriculture and Integrated Pest Management agents) in the AgriLife North Plains (Panhandle and High Plains) region.

The Extension Portal website and materials were presented and promoted in meetings of the Boards of Directors of the North Plains Groundwater Conservation District, Panhandle Groundwater Conservation District, and the Panhandle Regional Water Planning Group (Region A). The resource was promoted in visits with staff of the High Plains Underground Water Conservation District and through a guest article in the Cross Section, published by the High Plains District. Other venues in which the resources were promoted to Panhandle audiences include the Groundwater Symposium in Amarillo, the Commodity Symposium in conjunction with the Amarillo Farm and Ranch Show, the High Plains Irrigation Conference in Amarillo, and in county-based AgriLife Extension meetings in Deaf Smith, Lipscomb, and other area counties. Meetings outside the Panhandle region included Panhandle stakeholders; examples include an invited irrigation workshop at the Beltwide Cotton Conference in San Antonio, TX, and invited presentations educational meetings for the Texas Seed Trade Association and the National Crop Insurance Services in Austin, TX. **Agendas for selected meetings are included in Appendix C. A summary of educational events (locations, dates, audiences, and subject matter focus) is presented in a table in Appendix C.**

Task 4: Project administration

Submission of activities and budgetary reports on a quarterly basis…AgriLife shall submit quarterly reports to PRPC…

Project administration was led by the Panhandle Regional Planning Commission project management staff with support from subcontractor Texas A&M AgriLife Research-Amarillo and the Texas A&M Office of Sponsored Research Services. Project administration included accounting management, intermediate (quarterly) reporting, project team meetings (PRPC and

AgriLife participants), and other accountability operations. AgriLife staff prepared quarterly reports for PRPC for submission to Texas Water Development Board.

5. Results

The Texas High Plains ET Network Water Management Website (Extension Portal) has provided convenient access to timely, pertinent, summarized and interpreted weather data and crop water use estimates to support improved irrigation water management.

Users of the data available from this Network could save 0.5 to 2.0 ac-inches/irrigated acre, depending upon level of adoption and well capacity and crops produced, with higher potential savings in areas with greater irrigation capacity such as in the Panhandle and Northern Texas High Plains. Data associated with this project impact the Texas High Plains region an estimated value of $22 million annually in reduced water pumping costs and equipment use as well as conservation of limited groundwater resources of the Ogallala aquifer. Data from this project continue to be used in regional and state (Texas) water planning efforts to estimate 50-year projected water demand for irrigated agriculture. These data inform development of regulations by groundwater conservation districts throughout the Texas High Plains, and the methodologies are used throughout the state

Educational programs reached over 1,969 individuals through face-to-face Extension meetings. These events are summarized in Appendix A. Examples of meeting agendas, presentation materials, and other related materials are included also in Appendix A. To gage program effectiveness and stakeholder response to these activities, evaluation surveys were used at events (where appropriate). In addition to these more formal evaluations, the project team received valuable feedback from stakeholders through individual contacts.

Figure 2. Participants at educational events represented a wide geographic distribution, with greater representation in the target area, Texas High Plains.

Water savings associated with this project

The computed water savings directly attributable to this project was determined from input and feedback from producers at the extension based educational meetings over the project duration. Corn production had the most conservation impact, as it is the most water sensitive (highest irrigation application) crop grown with the northern Texas High Plains region. In the southern Texas High Plains, cotton is the most prevalent crop, and it generally uses generally less water than corn; however, there is a significant amount of sorghum silage produced in both regions that is used to support the dairy industry.

The amount of groundwater conserved attributable by implementation and access to crop ET data from this project was determined to average 6.8% of that which would have otherwise been applied without the use of the ET data. The application reduction equates to 260,569 acre-feet less groundwater pumped than otherwise would have been used by irrigated producers within the two regions. The total pumped water for irrigated crops was computed to 3.816 million acre-feet in Regions A and O.

Total water savings are not computed for water savings associated with use of ET related data from other (including some commercial) regional ET providers that have adopted the concept of crop ET estimations developed by the Texas High Plains ET Network. While these alternative data providers readily admit their estimates are not as accurate as the data provided through this project, data from these providers is viewed as valued and contributing to water efficiency improvement and groundwater conservation.

This page is intentionally blank.

Appendix A

Texas High Plains ET Network
Water Management Website

Home | My Profile | Weather Data | Educational | Partners & Credits | Help

Welcome to Water Management

What is Water Management?

Purpose:

Water Management is a new website dedicated to water conservation and management in the Texas High Plains. It has been established to provide management programs and application tools for irrigation scheduling and water management information. This website is maintained and operated by the Texas AgriLife Research and Extension Service and supported in part by the USDA-ARS and the Ogallala Aquifer Program.

The *Water Management* website provides educational information and online tools to assist the public, producers, consultants, and researchers with irrigation scheduling and water management in the Texas High Plains. These tools include an irrigation scheduler to assist producers to manage irrigation applications and timing on individual farms/fields. A user can create a personalized profile to obtain detailed information to their specific operation. Parameters can be entered to create a customized irrigation scheduler to assist with production.

Background:

The Texas High Plains is the most intensively irrigated region in the state. Relying largely on the Ogallala Aquifer for this water, it is important to utilize the best management practices available to ensure the continuing availability of this resource.

Irrigation scheduling is economically beneficial to producers as it helps better manage the available water and increase water use efficiency while reducing pumping costs. Applying only the amount of water needed for a particular crop can reduce inputs without sacrificing production. In addition, over application of water can potentially limit crop root growth and reduce yield.

Water Management tools available on this website are useful to everyone who uses water on a daily basis for a variety of purposes. This website is also devoted to providing educational information to the general public.

Organization and Operation

The *Water Management* website is run in a collaboration between engineers and scientists of the Texas AgriLife Research and Extension Service in Amarillo, TX and Lubbock, TX. The site depends upon agricultural research and extension personnel to provide the best estimates of water use for reference and crops grown within the region. The website is maintained and supported internally by the Texas AgriLife Research and Extension Service. This information is made available principally for agricultural irrigation scheduling purposes. However, many other applications and user groups have utilized the data.

Data Users

Data on this site are currently utilized by a variety of clientele for many uses. Our primary purpose is to provide irrigation scheduling tools and information for use in agricultural irrigation

Water Management User Profile

E-mail Address

Password

Login

Sign Up | Forgot Password

Recent Weather Summary

Bushland (ARS)	Bushland (JBF)
Chillicothe	Etter
Halfway	Lamesa
Lubbock	Pecos
Vernon	W.T. Feedlot

More Weather Data

External Links

Ogallala Aquifer Program
USDA-ARS-Conservation & Production Research Laboratory
Texas Water Development Board
Texas A&M AgriLife Research & Extension - Amarillo
Texas A&M AgriLife Research & Extension - Lubbock
More Links

Featured Video

Strategic Irrigation Management Using C-Probe Part 1 of 2

Main page of the Water Management Website. From this Extension Portal, users can access weather data, tools, and other information.

Texas High Plains ET Network Weather Station, Bushland (ARS),TX

Date	ETo	Temperatures (F) Air Max	Air Min	Soil Min 2in.	Soil Min 6in.	Prec. in.	Growing Degrees Days (F) Crn	Srg	Pnt	Cot	Soy	Wht
	in.											
09/04/2014	.32	88	65	77	77	0.00	25	27	0	17	29	40
09/05/2014	.10	76	52	69	67	0.07	14	14	0	4	18	32
09/06/2014	.08	63	50	64	62	0.06	7	7	0	0	11	25
10-day avg min soil temp				74	73	Wind	6.9	mph from 278 deg.				

CORN Seed Date	Acc GDD	Short Season Var. Water Use Growth Stage	Day -----in/d-----	3day	7day	Seas. in.	Long Season Var. Water Use Growth Stage	Day -----in/d-----	3day	7day	Seas. in.
04/01	3014	Harvest	.00	.00	.00	34.3	Blk lyr	.05	.14	.23	38.8
04/15	2872	Harvest	.00	.00	.13	33.1	1/2 mat	.07	.15	.24	36.0
05/01	2686	Blk lyr	.05	.12	.18	30.6	Dent	.08	.17	.26	32.7
05/15	2499	1/2 mat	.07	.15	.23	27.9	Dough	.09	.20	.31	29.4

SORGHUM Seed Date	Acc GDD	Short Season Var. Water Use Growth Stage	Day -----in/d----	3day	7day	Seas. in.	Long Season Var. Water Use Growth Stage	Day -----in/d----	3day	7day	Seas. in.
05/01	2896	Blk lyr	.06	.14	.22	27.0	H Dough	.07	.15	.24	26.2
05/15	2693	Blk lyr	.06	.15	.23	23.9	S Dough	.07	.16	.24	23.1
06/01	2382	S Dough	.07	.16	.24	20.1	S Dough	.07	.16	.25	19.2
06/15	2084	Flower	.08	.17	.26	16.5	Flower	.08	.17	.27	15.7

COTTON Seed Date	Acc GDD	Texas High Plains Area Water Use Growth Stage	Day -----in/d----	3day	7day	Seas. in.	South Plains Area Water Use Growth Stage	Day -----in/d----	3day	7day	Seas. in.
05/01	1599	Max Blom	.08	.18	.28	24.4	Max Blom	.08	.17	.26	15.4
05/15	1537	Max Blom	.08	.18	.29	22.0	Max Blom	.08	.17	.26	13.6
06/01	1404	1st Blom	.09	.19	.30	18.8	1st Blom	.08	.17	.26	11.3
06/15	1247	1st Blom	.09	.19	.30	15.2	1st Blom	.08	.17	.26	8.4

SOYBEANS Seed Date	Acc GDD	Late Group 4-Var. Water Use Growth Stage	Day -----in/d----	3day	7day	Seas. in.
05/15	2953	R_6	.08	.17	.26	27.1
06/01	2591	R_6	.09	.19	.29	21.2
06/15	2262	R_5	.09	.19	.29	18.5
07/01	1828	R_4	.08	.19	.29	13.4

WHEAT Seed Date	Acc GDD	Growth Stage	Water Use Day -----in/d----	3day	7day	Seas. in.
08/15	871	Emerged	.04	.09	.14	2.8

Fescue/Bluegrass lawn water use 0.07 inch
Bermuda grass lawn water use 0.06 inch
Buffalo grass lawn water use 0.04 inch

Daily crop weather data summary available from the Water Management Website. Crop water use estimates for major crops grown in the region are reported by crop and planting date. Daily turf grass water use estimates are also provided, increasing value of the information for non-agricultural audiences.

Home | My Profile | Weather Data | **Educational** | Partners & Credits | Help

Education

What is ET?

Evapotranspiration is a term that describes crop water demand by combining evaporation and transpiration. Evaporation is the process through which water is removed from moist soil and wet surfaces (such as dew on leaves). Transpiration is the process through which water is drawn up through the plant (roots extract water from the soil, and water is eventually removed through stomata on the leaves.)
More Information

Videos

The Water Cycle
Nicholas Kenny
Texas A&M AgriLife Extension Service
Amarillo, TX

Agriculture in the State of Texas
Nicholas Kenny
Texas A&M AgriLife Extension Service
Amarillo, TX

The Importance of Agricultural Research in Production Agriculture
Part 1 of 2
Thomas Marek
Texas A&M AgriLife Research
High Plains Irrigation Conference
Amarillo, TX
High Plains Irrigation Conference

More Videos

Reports

Research Reports
Lysimetry and Water-Use Measurement.pdf

Irrigation Technologies and Management
IrrigationwithSalineWater.pdf

More Reports

The Water Management Website provides convenient access to research reports, fact sheets, educational videos, and other information.

Appendix B

Examples of Tools and Resources Accessible through the Extension Portal

(Note: These were developed under previous contracts through various funding sources.)

The Water Management User Profile Tool

Home | My Profile | My Farms | Manage Farms | Weather Data | Sign Out

User Profile: Dana Porter

My Farms : SFF

SFF Details

Current Profile Plant Available Water:	0.0 in.
Field Capacity:	5.76 in.
Irrigation Trigger:	3.0 in.

Create Report Show Graph Show Table

SFF Furrow Details

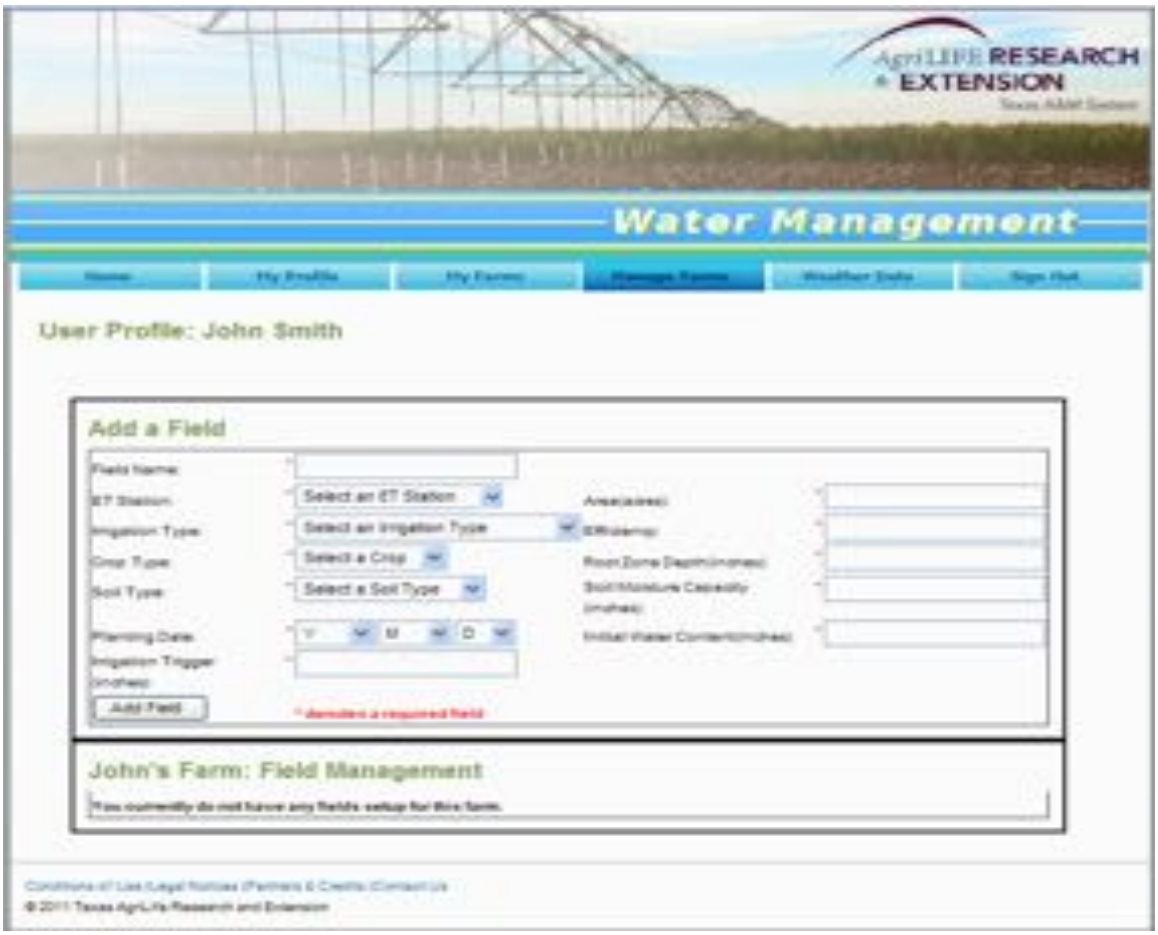
Current Profile Plant Available Water:	0.0 in.
Field Capacity:	5.76 in.
Irrigation Trigger:	3.0 in.

Create Report Show Graph Show Table

SFF SDI Details

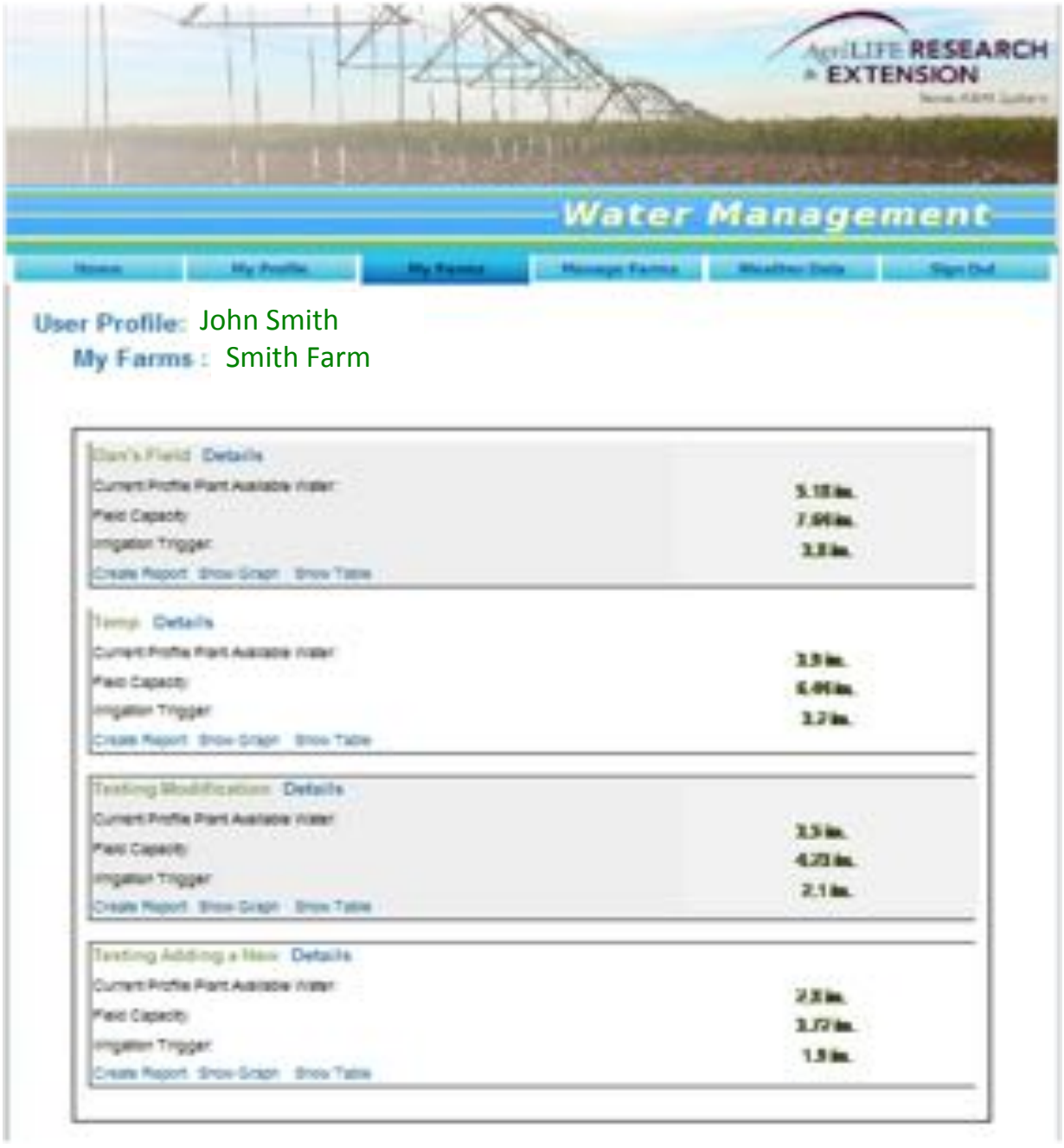
Current Profile Plant Available Water:	0.0 in.
Field Capacity:	5.76 in.
Irrigation Trigger:	3.0 in.

Create Report Show Graph Show Table

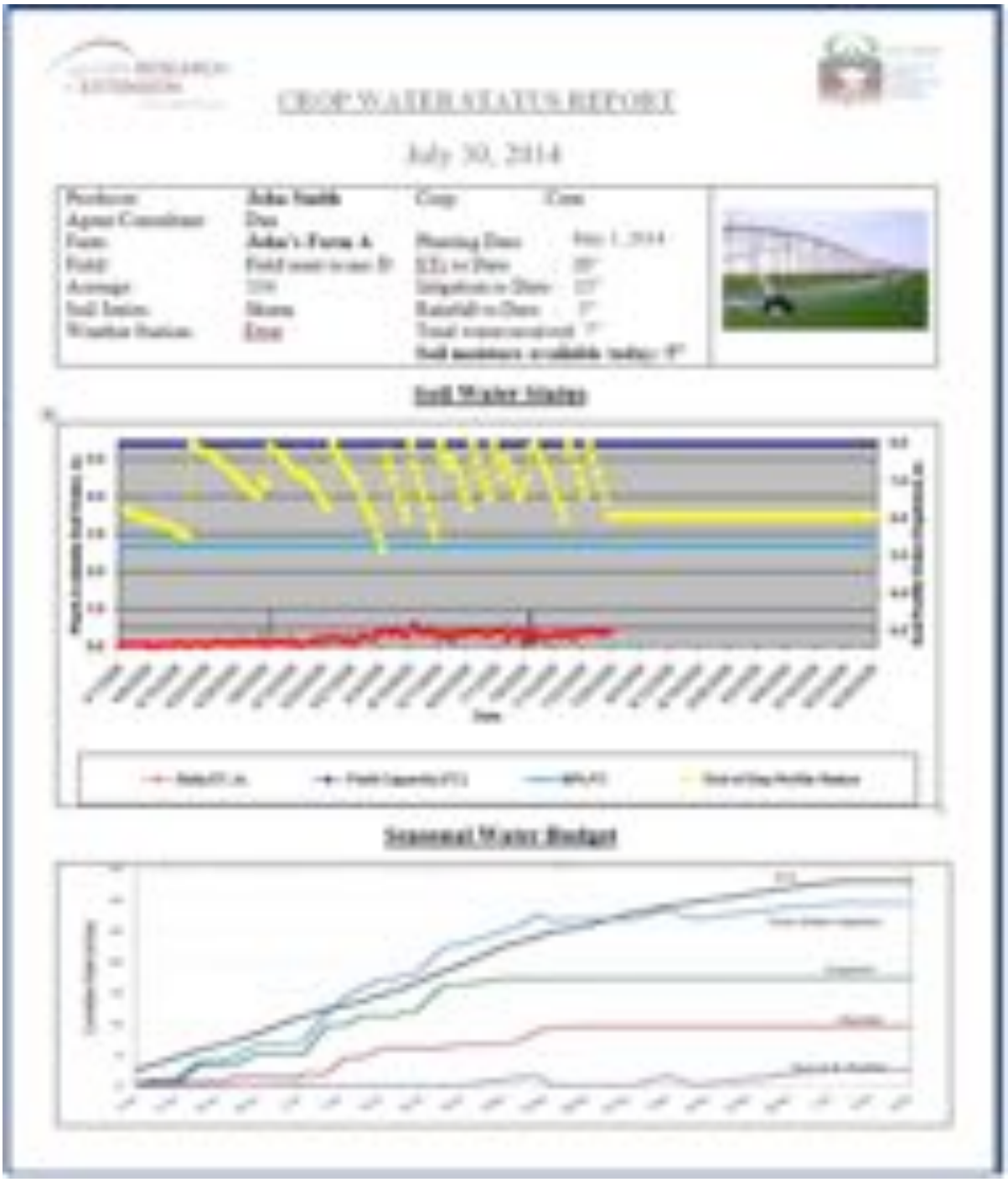


Screen shot from the User Profile Tool showing field management information input utility.

Screen shot from the User Profile Tool showing field management information input utility.



Screen shot from the User Profile Tool showing soil moisture thresholds for each field.



The User Profile Tool output summary page.

Guide to Crop Water Use Estimates from the Texas High Plains Evapotranspiration Network: Water Management Website

Dana Porter and Thomas Marek
Texas A&M AgriLife Research and Extension Centers – Lubbock and Amarillo

INTRODUCTION

Growing demand for limited and declining water resources in Texas has emerged as one of the most critical issues of concern for large urban centers and rural communities; agriculture, manufacturing, power generation and environmental concerns. The recent and ongoing drought has highlighted the critical nature of this issue, and has greatly increased public interest in water's role in the future of Texas. The State Water Plan's water supply and demand projections consistently indicate expected increases in water supply shortfalls. Increasing demand for water for increasing population is expected to increase diversion of water from irrigated agriculture (the largest water use sector statewide). However, the economic importance of irrigated agriculture to the state warrants careful consideration of the diversion options. To sustain agricultural productivity, optimizing rainfall and irrigation management will be key to achieving high water use efficiency and maintaining acceptable crop yields and quality.

Water resources and management capabilities in Texas, including internationally recognized agricultural research, education and extension/outreach programs (state universities, USDA-ARS, and industry-based), continue to improve irrigation tools, and technologies and enhancement of best management practices, crop production systems, crop varieties, and integrated crop/pest management. Evapotranspiration (ET) Networks such as the Texas High Plains ET (TXHPET) Network collect weather data in agriculturally-representative conditions. They then use the data in research-derived models to provide accurate estimates of crop water demand, used in production agriculture, agricultural research programs, water resource planning efforts, and other applications. The use of ET networks has been shown to be one the most economic water conservation strategies in the several regional water plans.

End users and applications of the TXHPET Network information include:

- Agricultural producers: optimizing irrigation scheduling to achieve high water use efficiency with acceptable crop yields/quality;
- Agricultural, environmental and other research programs (universities, AgriLife, USDA-ARS, industry (including seed companies): irrigation management, environmental conditions (rainfall, temperatures, wind, etc.) for interpretation of

experimental results, ground-truthing data for remote sensing research and applications;

- Water resources managers/agencies: estimating water requirements for crops, water planning and permitting;
- Industry (crop insurance companies, seed companies) and agencies (Texas Department of Agriculture, USDA-Risk Management Agency):crop water requirements vs. rainfall and departures from normal;
- Municipalities, turf managers, homeowners: irrigation needs for lawns, sports fields, as well as water conservation education programs for homeowners and landscape irrigation professionals;
- Environmental consultants and researchers: water balance and weather conditions for various applications related to groundwater, surface water and air quality;
- Remote sensing researchers, consulting hydrology engineers; and
- Educational organizations, agencies and schools: university courses and Extension outreach.

The Texas High Plains Evapotranspiration Network (TXHPET) has provided crop water use and related agricultural meteorology data and technical support since 2001, when it was formed of the partnership between the South Plains ET Network and the North Plains ET Network. Over time the TXHPET Network has developed a variety of user friendly online tools and data delivery formats. This "Service Portal for Higher Integration Networking for Coordination of Training, Information, and Research" is a digital gateway to information available from the Texas High Plains Evapotranspiration (TXHPET) Network. It provides a concise and convenient summary of the pertinent information needed for in-season irrigation management for the entire Texas High Plains and to adjacent area outside the state of Texas.

SERVICE PORTAL FOR HIGHER INTEGRATION NETWORKING FOR COORDINATION OF TRAINING, INFORMATION, AND RESEARCH ON THE WATER MANAGEMENT WEBSITE

The Water Management website home page is shown in Figure 1. This page includes links to a variety of irrigation and water management information, including crop water use estimates.

Figure 1. The Water Management Website (watermgmt.tamu.edu) home page.

Crop water use (weather data) may be accessed through the "Weather Data" tab near the top of the page, or through the "Recent Weather Summary" links in the box on the right side of the page. These links are indicated by maroon boxes in Figure 2.

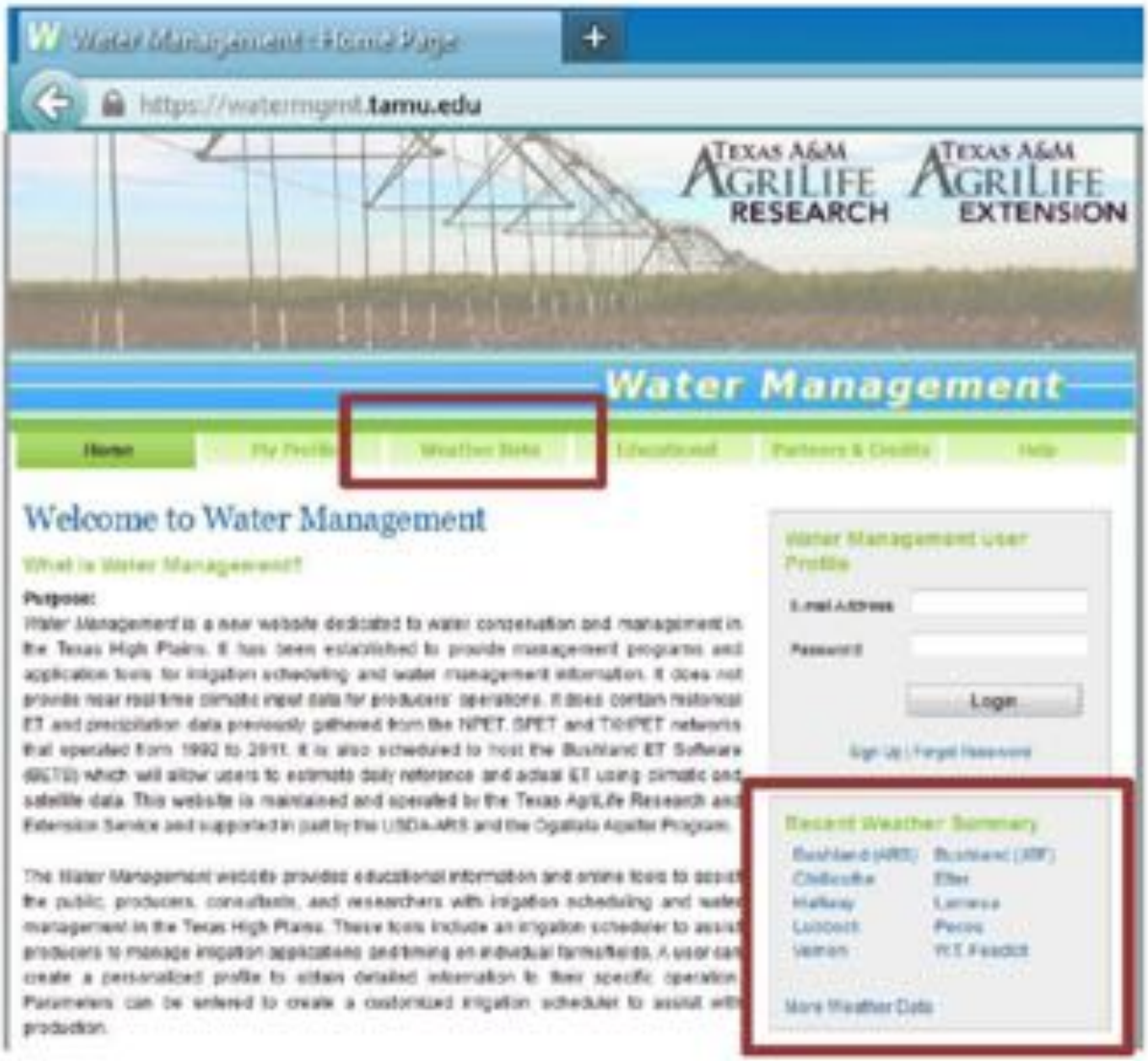


Figure 2. Locations of the "Weather Data" and "Recent Weather Summary" links on the Water Management website.

Clicking on the "Weather Data" tab directs the user to the "Weather Data" page (Figure 3). There is a pull-down menu that helps the user to "Select a Station" (Figure 4).

Figure 3. Weather Data page.

Figure 4. Pull-down menu to aid the user in selecting a weather station location.

Selecting a weather station directs the user to crop weather and water use estimates for the most recent 30 days (Figure 5).

Figure 5. Access to the most recent 30 days of crop weather information and water use estimates.

Selecting a date will direct the user to the crop weather and crop water use estimate summary page (Figure 6). The format of this page presents pertinent data concisely. Crop water use for major crops at the location, as well as reference crop ET (ETo), maximum and minimum air temperatures, soil temperatures at 2-inch and 6-inch depths, precipitation, and heat unit accumulations are all indicated on one page.

Texas High Plains ET Network Weather Station, Lubbock, TX

Date	ETo	Temperatures (F) ---Air-- Max	Min	Soil Min 2in.	6in.	Prec. in.	Growing Degrees Days (F) Cra	Grg	Pnt	Cot	Soy	Wht
	in.											
07/05/13	.41	94	66	74	76	0.00	26	30	0	20	30	0
07/06/13	.43	95	71	78	79	0.00	29	33	0	23	33	0
07/07/13	.35	94	67	79	80	0.00	26	31	0	21	30	0

10-day avg min soil temp 76 77 Wind 8.3 mph from 154 deg.

CORN Seed Date	Acc GDD	Short Season Growth Stage	Var. Water Use Day	3day	7day	Seas. in.	Long Season Growth Stage	Var. Water Use Day	3day	7day	Seas. in.
			-----in/d-----					-----in/d-----			
04/01	1934	Dough	.42	.49	.42	25.4	Blister	.45	.51	.43	25.2
04/15	1768	Milk	.45	.51	.43	21.9	Silk,	.45	.51	.43	21.6
05/01	1544	Blister	.45	.51	.43	17.1	14-leaf	.43	.49	.41	16.9
05/15	1358	Silk,	.45	.51	.42	13.6	14-leaf	.42	.49	.40	13.5

SORGHUM Seed Date	Acc GDD	Short Season Growth Stage	Var. Water Use Day	3day	7day	Seas. in.	Long Season Growth Stage	Var. Water Use Day	3day	7day	Seas. in.
			-----in/d----					-----in/d----			
05/01	1734	Boot	.38	.39	.32	14.8	Flag	.33	.37	.31	13.7
05/15	1545	Flag	.33	.37	.31	12.1	Flag	.33	.35	.28	11.0
06/01	1072	GPD	.28	.32	.26	6.9	5-leaf	.24	.28	.23	6.5
06/15	697	5-leaf	.24	.25	.20	3.6	4-leaf	.21	.24	.19	3.6

COTTON Seed Date	Acc GDD	North Plains Area Water Use Growth Stage	Day	3day	7day	Seas. in.	South Plains Area Water Use Growth Stage	Day	3day	7day	Seas. in.
			-----in/d----					-----in/d----			
05/01	1062	1st Sqr	.34	.39	.32	12.9	1st Sqr	.34	.39	.32	12.6
05/15	1015	1st Sqr	.34	.39	.32	11.5	1st Sqr	.34	.39	.32	11.2
06/01	710	1st Sqr	.34	.39	.27	6.0	1st Sqr	.34	.32	.22	5.7
06/15	474	Emerged	.17	.20	.16	3.1	Emerged	.17	.20	.16	3.1

Corn Rootworm Estimated Adult Emergence 75.7%
Fescue/Bluegrass lawn water use 0.34 inch
Bermuda grass lawn water use 0.26 inch
Buffalo grass lawn water use 0.17 inch

Figure 6. Crop weather information and crop water use estimates summary page.

Crop water use estimates are provided for major crops grown in the area (Figure 7). Information is summarized for multiple planting dates of the crop. In the highlighted area in Figure 7, information for short season corn is presented for four planting dates (April 1, April 15, May 1 and May 15). Heat unit accumulation and estimated growth stage are presented. For instance, corn planted April 15 has an accumulated 1768 growing degree days (heat units), and according to the heat-unit driven model, the corn should be at "milk stage" in its development. For a corn at this stage, it was estimated that the crop water demand was 0.45 in/day for the previous day; it averaged 0.51 in/day over the last 3 days, and it averaged 0.43 in/day in the last 7 days. The seasonal water use to date was estimated to be 21.9 inches. The one-day, three-day and 7-day intervals are based upon common irrigation scheduling time frames.

		Temperatures (F)										
Date	ETo	---Air--		Soil Min		Prec.	Growing Degrees Days (F)					
	in.	Max	Min	2in.	6in.	in.	Crn	Srg	Pnt	Cot	Soy	Wht
07/05/13	.41	94	66	74	76	0.00	26	30	0	20	30	0
07/06/13	.43	95	71	78	79	0.00	29	33	0	23	33	0
07/07/13	.35	94	67	79	80	0.00	26	31	0	21	30	0
10-day avg min soil temp				76	77	Wind	8.3	mph from 154 deg.				

CORN		Short Season Var. Water Use				Long Season Var. Water Use				
Seed	Acc	Growth	Day	3day	7day	Seas	Growth	Day	3day	7day	Seas.
Date	GDD	Stage	-----in/d-----			in.	Stage	-----in/d-----			in.
04/01	1934	Dough	.42	.49	.42	25.4	Blister	.45	.51	.43	25.2
04/15	1768	Milk	.45	.51	.43	21.9	Silk,	.45	.51	.43	21.6
05/01	1544	Blister	.45	.51	.43	17.1	14-leaf	.43	.49	.41	16.9
05/15	1358	Silk,	.45	.51	.42	13.6	14-leaf	.43	.49	.40	13.5

SORGHUM		Short Season Var. Water Use				Long Season Var. Water Use				
Seed	Acc	Growth	Day	3day	7day	Seas.	Growth	Day	3day	7day	Seas.
Date	GDD	Stage	-----in/d----			in.	Stage	-----in/d----			in.
05/01	1734	Boot	.38	.39	.32	14.8	Flag	.33	.37	.31	13.7
05/15	1545	Flag	.33	.37	.31	12.1	Flag	.33	.35	.28	11.0
06/01	1072	GPD	.28	.32	.26	6.9	5-leaf	.24	.28	.23	6.5
06/15	697	5-leaf	.24	.25	.20	3.6	4-leaf	.21	.24	.19	3.6

COTTON		North Plains Area Water Use				South Plains Area Water Use				
Seed	Acc	Growth	Day	3day	7day	Seas.	Growth	Day	3day	7day	Seas.
Date	GDD	Stage	-----in/d----			in.	Stage	-----in/d----			in.
05/01	1062	1st Sqr	.34	.39	.32	12.9	1st Sqr	.34	.39	.32	12.6
05/15	1015	1st Sqr	.34	.39	.32	11.5	1st Sqr	.34	.39	.32	11.2
06/01	710	1st Sqr	.34	.39	.27	6.0	1st Sqr	.34	.32	.22	5.7
06/15	474	Emerged	.17	.20	.16	3.1	Emerged	.17	.20	.16	3.1

Corn Rootworm Estimated Adult Emergence 75.7%
Fescue/Bluegrass lawn water use 0.34 inch
Bermuda grass lawn water use 0.26 inch
Buffalo grass lawn water use 0.17 inch

Figure 7. Crop weather information and crop water use estimates summary page with information for short season corn highlighted.

Since the reference crop used in estimating crop water use is an idealized cool-season grass, the information is easily adapted to use in lawn and turf irrigation applications. In Figure 8, lawn water use estimates are highlighted. For instance, in the last day, fescue or bluegrass lawns would have used approximately 0.34 inch of water; Bermuda grass lawns would have used approximately 0.26 inch of water, and buffalo grass would have used approximately 0.17 inch of water.

		Temperatures (F)					Growing Degrees Days (F)					
Date	ETo	---Air--		Soil Min		Prec.						
	in.	Max	Min	2in.	6in.	in.	Crn	Srg	Pnt	Cot	Soy	Wht
07/05/13	.41	94	66	74	76	0.00	26	30	0	20	30	0
07/06/13	.43	95	71	78	79	0.00	29	33	0	23	33	0
07/07/13	.35	94	67	79	80	0.00	26	31	0	21	30	0
10-day avg min soil temp				76	77	Wind	8.3	mph from 154 deg.				

CORN		Short Season Var. Water Use				Long Season Var. Water Use				
Seed	Acc	Growth	Day	3day	7day	Seas.	Growth	Day	3day	7day	Seas.
Date	GDD	Stage	-----in/d-----			in.	Stage	-----in/d-----			in.
04/01	1934	Dough	.42	.49	.42	25.4	Blister	.45	.51	.43	25.2
04/15	1768	Milk	.45	.51	.43	21.9	Silk,	.45	.51	.43	21.6
05/01	1544	Blister	.45	.51	.43	17.1	14-leaf	.43	.49	.41	16.9
05/15	1358	Silk,	.45	.51	.42	13.6	14-leaf	.43	.49	.40	13.5

SORGHUM		Short Season Var. Water Use				Long Season Var. Water Use				
Seed	Acc	Growth	Day	3day	7day	Seas.	Growth	Day	3day	7day	Seas.
Date	GDD	Stage	-----in/d----			in.	Stage	-----in/d----			in.
05/01	1734	Boot	.38	.39	.32	14.8	Flag	.33	.37	.31	13.7
05/15	1545	Flag	.33	.37	.31	12.1	Flag	.33	.35	.28	11.0
06/01	1072	GPD	.28	.32	.26	6.9	5-leaf	.24	.28	.23	6.5
06/15	697	5-leaf	.24	.25	.20	3.6	4-leaf	.21	.24	.19	3.6

COTTON		North Plains Area Water Use				South Plains Area Water Use				
Seed	Acc	Growth	Day	3day	7day	Seas.	Growth	Day	3day	7day	Seas.
Date	GDD	Stage	-----in/d----			in.	Stage	-----in/d----			in.
05/01	1062	1st Sqr	.34	.39	.32	12.9	1st Sqr	.34	.39	.32	12.6
05/15	1015	1st Sqr	.34	.39	.32	11.5	1st Sqr	.34	.39	.32	11.2
06/01	710	1st Sqr	.34	.39	.27	6.0	1st Sqr	.34	.32	.22	5.7
06/15	474	Emerged	.17	.20	.16	3.1	Emerged	.17	.20	.16	3.1

[redacted] 75.7%

Fescue/Bluegrass lawn water use 0.34 inch
Bermuda grass lawn water use 0.26 inch
Buffalo grass lawn water use 0.17 inch

Figure 8. Crop weather information and crop water use estimates summary page with lawn water use information highlighted.

ADDITIONAL INFORMATION: EVAPOTRANSPIRATION AND USING CROP WATER USE ESTIMATES TO MANAGE IRRIGATION

What is evapotranspiration (ET)?

Evapotranspiration is a term that describes crop water demand by combining evaporation and transpiration. Evaporation is the process through which water is removed from moist soil and wet surfaces (such as dew on leaves). Transpiration is the process through which water is drawn up through the plant (roots extract water from the soil, and water is eventually removed through stomata on the leaves.)

What is Reference ET (ETo)?

Reference crop evapotranspiration (ETo) is an estimate of water requirement for a well watered reference crop. This reference crop (grass or alfalfa) is essentially an idealized crop used as a basis for the ET model. Reference ET is calculated by applying climate data (air temperature, solar radiation, wind, humidity) in a model (equation). It is helpful to note that reference ET is only an estimate of the water demand for this idealized crop, based upon weather station data at a given location.

How is Crop Evapotranspiration calculated?

Crop-specific ET is estimated by multiplying the Reference ET by a crop coefficient.

Crop ET = Reference ET x Crop Coefficient

The crop coefficient takes into account the crop's water use (at a given growth stage) compared with the reference crop. For instance, seedling corn does not use as much water as the idealized grass reference crop, but during silking the corn can use more water than the grass reference crop. The crop coefficient is understood to follow a pattern (curve) of the general shape shown below. Each crop (wheat, sorghum, etc.) will have its own crop coefficient curve (Figure 9). The crop coefficient curve for an annual crop reflects that crop water use is typically low during crop establishment; it increases through the vegetative growth period to a peak water use stage (usually full canopy or fruiting stages), and then it declines through the maturation stage.

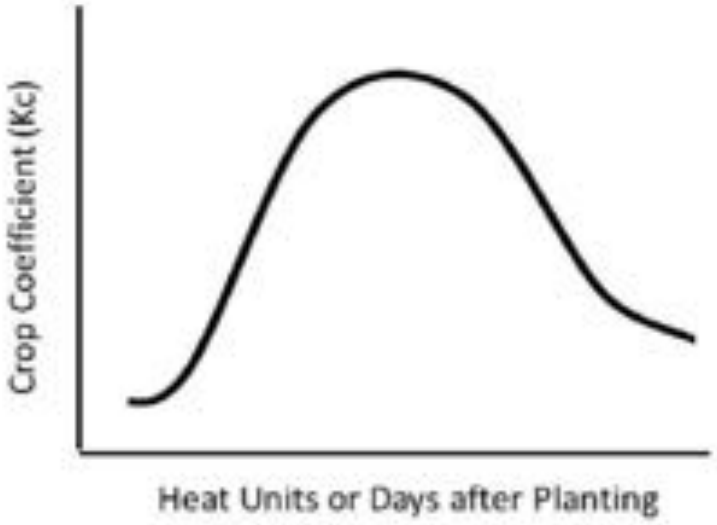


Figure 9. Generalized crop coefficient curve.

The reference crop ET model and the crop coefficient curves were developed from long-term research at various locations. ***Actual crop water demand can be affected by many factors, including soil moisture available, health of the crop, management and likely by plant populations and crop variety traits.*** These factors are not taken into account by the generalized (average) models. Hence, ET data provided by on-line networks are probably best used as ***guidelines*** for irrigation scheduling, and (where applicable) integrated pest management and integrated crop management. The predicted growth stage and estimated water use should be verified with field observations. The actual crop water use may be less than the predicted value due to less than optimal field conditions.

How is estimated ET used to schedule irrigation?

There are a variety of irrigation scheduling methods, models and tools available. Many are essentially based upon a "checkbook" approach: Water stored in the soil (in the crop's root zone) is withdrawn by evapotranspiration and deposited back into the soil through precipitation and irrigation. When soil moisture storage falls below a given threshold value, irrigation should be applied to restore the moisture. The threshold value may be determined by crop drought sensitivity, by irrigation system capabilities, or other farm-level criteria.

Acknowledgements:

The Watermgmt.tamu.edu website, crop water use estimates and related information, and this user guide are made possible through partial support from the USDA-ARS Ogallala Aquifer Program and from Texas Water Development Board and the Panhandle Regional Planning Commission through TWDB Contract #1213581481, "Service Portal for Higher Integration Networking for Coordination of Training, Information, and Research". The project team appreciates the participation and guidance from Mr. Kyle Ingham, PRPC Economic Development and Local Government Services Director, and Mr. Cameron Turner, TWDB Team Leader, Agricultural Water Conservation Programs, Agricultural Demonstration Initiatives. The team also extends special thanks to Mr. Daniel Holman for programming support and website maintenance.

Panhandle Regional Planning Commission

Ogallala Aquifer

TEXAS WATER DEVELOPMENT BOARD

TEXAS A&M AGRILIFE RESEARCH

TEXAS A&M AGRILIFE EXTENSION

APPENDIX C

Educational Events Promoting Availability and Application of Evapotranspiration Data and Related Information Available through the Watermgmt.tamu.edu Portal

Event	Location & Date	Audience	Attendance	Focus or application of TXHPET data and Watermgmt.tamu.edu
Commodity Symposium at the Amarillo Farm and Ranch Show	Amarillo, Texas 11/28/12	Agricultural producers; landowners; agribusiness professionals; local, state and federal agency personnel	260	Irrigation management for Texas High Plains production systems.
Lamar County Irrigation Symposium	Paris, TX 12/04/12	Agricultural producers; farm managers; agribusiness, professionals; USDA-NRCS personnel; and irrigation professionals.	45	ET-based irrigation scheduling tools; soil moisture; crop water requirements; best management practices; information sources available; crop water requirements; and irrigation methods/technologies
Innovations in Cotton Irrigation Management: Irrigation Workshop at the Beltwide Cotton Conferences	San Antonio, TX 01/08/13	Irrigation professionals; cotton producers; certified crop advisers; Extension educators; agricultural research scientists; and agribusiness professionals	118	Irrigation management for cotton production, including irrigation scheduling.100% of survey respondents reported increased understanding of irrigation scheduling.
Southern Mesa Ag Conference	Lamesa, TX 01/23/13	Agricultural producers; farm managers; agribusiness, professionals; USDA-NRCS personnel; and irrigation professionals	98	Managing limited irrigation water – using available information to optimize limited irrigation resources.
Caprock Cotton Conference	Muncy, TX 01/24/13	Agricultural producers; farm managers; agribusiness, professionals; USDA-NRCS personnel; and irrigation professionals	130	Irrigation Management for Texas High Plains Production Systems
Cochran County Crops Conference	Morton, TX 01/21/13	Agricultural producers; farm managers; agribusiness, professionals; and irrigation professionals	18	Irrigation Management for Texas High Plains Production Systems

Event	Location & Date	Audience	Attendance	Focus or application of TXHPET data and Watermgmt.tamu.edu
Parmer County Subsurface Drip Irrigation Meeting	Farwell, TX 01/21/13	Agricultural producers; farm managers; agribusiness, professionals; and irrigation professionals.	13	Irrigation Management for Texas High Plains Production Systems
National Crop Insurance Services Annual Southwest Regional Meeting	San Antonio, TX 02/01/13	Crop insurance professionals and USDA-Risk Management Agency personnel	25	Irrigation technologies and management strategies; information sources; application of information to optimize irrigation resources.
Texas Seed Trade Association Annual Meeting	Austin, TX 02/04/13	Agribusiness professionals (seed companies and associated research programs)	25	Irrigation technologies and management strategies; information sources; application of information to optimize irrigation resources.
Sandy Land Ag Conference	Seminole, TX 02/28/13	Agricultural producers, agribusiness professionals, agency personnel and groundwater conservation district managers, staff and board members.	159	Efficient Irrigation Technologies & Management
Comanche County Irrigation Symposium	Comanche, TX 02/26/13	Agricultural producers, agribusiness professionals, agency personnel and groundwater conservation district managers, staff and board members.	21	Irrigation scheduling, crop water requirements, information sources available.
USDA-ARS Ogallala Aquifer Program Annual Meeting and Public Educational Resources Exhibit	Amarillo, TX 03/07/13	Master Gardeners, agricultural producers, commodity leaders, research personnel, and others.	21	Information available and application of the information to improving irrigation management.

Event	Location & Date	Audience	Attendance	Focus or application of TXHPET data and Watermgmt.tamu.edu
Hockley County Ag and Business Expo	Levelland, TX 03/26/13	Local news media and educators	12	Efficient Irrigation Technologies and Management and Efficient Irrigation Management in Lawns and Landscapes
Mitchell County Water Meeting	Colorado City, TX 05/02/13	Homeowners, landowners, agricultural producers, Extension educators	6	Water issues (in general); management of water in agricultural production and in lawns and landscapes; rainwater harvesting
Extension Agent Training (Cotton 101)	Lubbock, TX 08/20/13	County Extension Agents – Agriculture and Integrated Pest Management	19	Irrigation management for cotton production; information resources and applying available information to optimize irrigation management
Netafim Global Commodity Workshop	Lubbock, TX 09/30/13	Netafim leadership and product managers	41	Optimizing management of microirrigation technologies
High Plains Ag Conference	Lubbock, TX 12/13/13	Agricultural producers, agency personnel and groundwater conservation district staff	27	Irrigation Management Resources, Tools, and Updates
Texas A&M AgriLife Extension County Extension Agent Training	Lubbock 05/08/13; Vernon 05/09/13; Amarillo 05/14/13	County Extension Agents – Agriculture and Integrated Pest Management	33	Update and training on watermgmt.tamu.edu; ET-based irrigation scheduling; information and tools available to support local Extension education and demonstration programs
High Plains Irrigation Conference	Amarillo, TX 01/16/14	Agricultural producers; landowners; irrigation and agribusiness professionals; agency personnel; local news media	115	Irrigation technologies and management; tools and information resources available; water issues in agriculture
Southern Mesa Ag Conference	Lamesa, TX 01/22/14	Agricultural producers; agribusiness professionals; USDA-NRCS personnel; and irrigation professionals	89	Irrigation management strategies for optimizing limited irrigation resources

Event	Location & Date	Audience	Attendance	Focus or application of TXHPET data and Watermgmt.tamu.edu
Lamb County Ag Conference	Littlefield, TX 01/22/14	Agricultural producers; agribusiness professionals; commodity representatives	37	Managing Cotton Irrigation in Drought Conditions
High Plains Dairy Conference	Lubbock, TX 03/05/14	Dairy producers and associated agribusiness professionals	304	Water issues and water management in High Plains Dairies
Groundwater Symposium – Agriculture Breakout Session	Amarillo, TX 02/12/14	Agricultural producers, landowners, agribusiness and irrigation professionals, agency personnel, groundwater conservation district staff and board members	198	Considerations in selecting and managing microirrigation
Deaf Smith County Cotton Conference	Hereford, TX 02/14/14	Agricultural producers, landowners, crop consultants and agribusiness professionals	37	Irrigation management for cotton production
Lipscomb County Irrigation Technology Conference	Lipscomb, TX 02/18/14	Agricultural producers, landowners and agribusiness professionals	13	Applying available information resources to optimize irrigation management
Hale County Master Gardeners Class	Plainview, TX 03/27/14	Master Gardeners	13	Fundamentals of efficient irrigation in lawns and landscapes; information available and application of the information to improving irrigation management.
Texas A&M AgriLife Extension Agent Training Webinar	North Region – Lubbock 05/21/14	County Extension Agents – Agriculture and Integrated Pest Management	13	ET and Water Management: focused training on how to access and use available information
Panhandle Regional Water Planning Group Meeting	Amarillo, TX 05/20/14	Panhandle Regional Water Planning Group members and interested public	34	Fundamentals of ET for irrigation scheduling and provided an orientation to the Water Management Website

International audiences

Event	Location & Date	Audience	Attendance	Focus or application of TXHPET data and Watermgmt.tamu.edu
Holambra Agricola	09/16/13	Agricultural producers from Brazil	39	Cotton irrigation in the Texas High Plains
Cochran Fellowship Program, hosted by the Texas A&M University Borlaug Institute	Lubbock, TX 04/01/14	Agricultural leaders from Pakistan	6	Water Use Efficiency and Water Capture Available for Agriculture (Water issues in Texas High Plains agriculture)

Example Educational Program:

High Plains Irrigation Conference

The High Plains Irrigation Conference and Trade Show is based upon a long-standing tradition and cooperation between Texas A&M AgriLife Extension Service and the Texas Agricultural Irrigation Association (TAIA). Dr. Dana Porter has been the TAIA Educational Advisor since 1999, and she has assisted in several workshops and conferences throughout the state since that time. The technical / educational program featured special invited guest speakers to address water issues of general (and mass media) interest; Texas A&M AgriLife Extension Risk Management specialists to address farm-level (producer and off-farm) decision makers; and applied research and extension professionals to address "nuts and bolts" practical on-farm management of irrigation resources. All commercial presentations were reserved for the separate, but co-located trade show, and ample time was allowed for attendees to visit with vendors. Continuing Education Units were offered for Irrigation Association Certified Irrigation Designers and Certified Agricultural Irrigation Specialists, as well as Certified Crop Advisers.

Approximately 115 attendees at the 2014 High Plains Irrigation Conference and Trade Show included agricultural producers, landowners, irrigation professionals, research and extension professionals (including county agents who received professional development credit for attending), and crop consultants. An evaluation survey was distributed to gauge knowledge gained and to seek additional feedback from the audience. Of the survey respondents, 90% indicated increased understanding of regional and state water issues, planning and programs; 69% indicated increased understanding of risk management considerations and tools; 72% indicated increased understanding of crop-specific water management considerations; 83% indicated increased understanding of information resources, research programs and expertise available; 64% indicated increased understanding of efficient irrigation strategies and technologies; and 61% indicated increased understanding of irrigation products and services available. All (100%) of respondents indicated that the information provided in the program would be helpful in their irrigation decisions. Several indicated specific technologies and/or practices they would implement as a result of what they learned in the program.

While in-person attendees benefitted from interactions with others at the conference and had opportunities to visit with speakers and vendors, extensive local media coverage promoted highlights of the event throughout the region. Radio stations (KVOP AgriPlex Report; KFLP All Ag All Day, which aired the conference live; KGNC-Golden Spread AgriBusiness Hour) and television stations (Fox 34 Lubbock; KVII (ABC affiliate), KFDA (CBS affiliate), and KAMR (NBC affiliate) in Amarillo) covered the event, and aired on-camera interviews with Dr. Porter and other key speakers in Amarillo, Lubbock and surrounding areas. Kay Ledbetter, Texas A&M AgriLife Research and Extension Service Communications Specialist, developed news releases that were widely distributed through local and regional media outlets, and she coordinated with Amarillo area television stations to cover the event.

Program agenda and a presentation addressing the Water Management Website tools and other irrigation management information are included below. Addition program agendas included provide a representation of the venues (and target audiences, contexts) in which the information was presented.

Trade Show Exhibitors

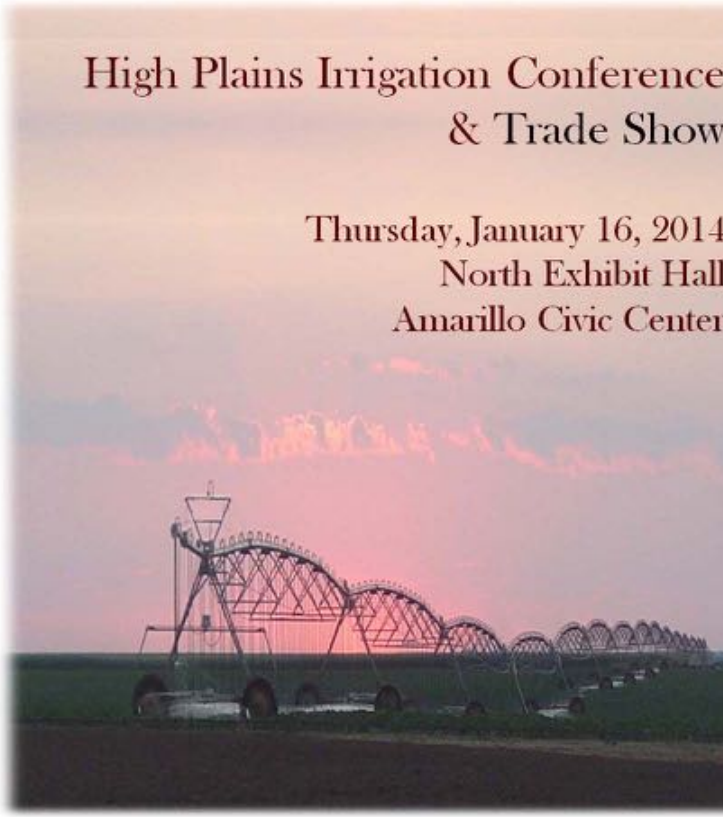
AquaPlanner
BROWN
DSI
ECO-DRIP
Subsurface Drip Irrigation
EQUIPMENT SUPPLY CO., INC.
Eurodrip U.S.A., Inc.
InTerra
JAIN Irrigation Inc
Kroy
LINDSAY CORPORATION
McCROMETER GREAT PLAINS
NELSON
netirrigate
NRCS
PivoTrac Monitoring
Reinke
MORE RIGHT THAN RAIN
Senninger Irrigation Inc.
TAWC
USB
Texas Water Development Board
T-L
VALLEY
WATERMASTER IRRIGATION SUPPLY INC.

Texas Agricultural Irrigation Association

TEXAS A&M AGRILIFE EXTENSION

High Plains Irrigation Conference & Trade Show

Thursday, January 16, 2014
North Exhibit Hall
Amarillo Civic Center



Irrigation Association CID ● (5.0 CEUs)
Certified Crop Advisor ● (5.5 CEUs) 4.5 SW & 1 CM CEUs

$30 Registration Fee (Includes Lunch)

2014 High Plains Irrigation Conference

8:00 Registration and Trade Show (Sponsor slide show)

8:30 Welcome and Introductions by *Dana Porter*, Texas A&M AgriLife Extension Service

AM Session

8:45 Regional Water Planning in Texas: Past, Present & Future – *Kyle Ingham*

9:15 Texas Water Development Board Programs: SWIFT Updates and Agricultural and Rural Water Conservation – *Randall Rakowitz*

9:45 Trends in Agricultural Irrigation – *Kevin Wagner*

10:15 ***Break / Trade-show***

10:45 Crop Insurance and Irrigation BMPs – *Jay Yates*

11:20 Risk Management Tools for Limited Irrigation – *DeDe Jones*

12:00 ***Lunch – Included with $30 Registration Fee***
Sponsors Acknowledgement
Comments from TAIA President
Exhibit visitations

PM Session

1:15 Applied Research Panel: Irrigation Management Strategies for High Plains Crops – *Qingwu Xue, Thomas Marek, Jim Bordovsky*

2:30 ***Break / Trade-show***

3:00 Pumps and Wells – *Dana Porter*

3:30 Irrigation Management Tools and Information Resources – *Dana Porter*

4:15 Wrap-up/Q&A, Evaluation and CEU distribution

Featured Speakers

Kyle Ingham, Economic Development Director, Local Government Services Direct Regional Water Planning Director, Panhandle Regional Planning Commission.

Randall Rakowitz, TWDB Ag Conservation Education Programs, Texas Water Development Board, Austin

Kevin Wagner, Ph.D., Associate Director, Texas Water Resources Institute

Jay Yates, M.S., Extension Economist- Risk Management, Texas A&M AgriLife Extension Service, Lubbock

DeDe Jones, MBA, Extension Program Specialist- Risk Management, Texas A&M AgriLife Extension Service, Amarillo

Qingwu Xue, Ph.D. Assistant Professor, Crop Stress Physiology, Texas A&M AgriLife Research, Amarillo

Thomas Marek, M.S., P.E., Senior Research Engineer and Superintendent, North Research Field, Etter, Texas A&M AgriLife Research, Amarillo

James P. (Jim) Bordovsky, M.S., P.E., Research Scientist and Agricultural Engineer Texas A&M AgriLife Research, Halfway / Lubbock

Dana Porter, Ph.D., P.E., Associate Professor and Extension Agricultural Engineer, Texas A&M AgriLife Research and Extension Service, Lubbock

*******Many thanks to HPIC 2014 Sponsors!!!*******

Irrigation Management Tools & Information Resources

Dana O. Porter, PhD, PE
Research and Extension Agricultural Engineer

Texas A&M AgriLife Research and Extension Center – Lubbock
Department of Biological and Agricultural Engineering

Agricultural Irrigation Challenges, Opportunities and Observations

Why have advanced irrigation technologies been so widely adopted in the Texas High Plains?

1. Water capacity is the primary limiting factor
2. Agricultural producers are progressive, relatively rapid adopters of technology
3. The technologies are "good fits" for farm operations in the Texas High Plains
4. Excellent applied research programs in the area
5. Well-qualified and experienced irrigation dealers, designers, installers
   = ready access to products, technical expertise and support
6. Cost-share and low interest loan programs to help with high capital costs
7. Good collaboration among research, extension, industry, agricultural producers

Efficient advanced irrigation technologies are widely used in the High Plains, especially in areas where well capacities have long been a limiting factor.

Important considerations:

- suitability or adaptability of a technology to local production systems and conditions
- economic feasibility
- availability of irrigation industry, research and educational infrastructure and resources to support applications in the field

Successful application of irrigation technologies requires good design, installation, maintenance, and management.

Precautions for End-Users in Interpreting Research and Demonstrations

Consider variability in climate conditions

Consider crop rotations, markets, crop insurance, policy…

Consider farm specific factors: management, labor, water quality (salinity), soil characteristics, IPM concerns

Consider limitations in research and demonstrations: applicability, experimental design and interpretation of results

Irrigation in Context: Integrated Production Systems

Goals: Crop yield, quality

Production efficiency
- Water, Nitrogen, and Energy Efficiency
- Efficiency and efficacy of all inputs

Manage the overall system for high return
- Optimal response to inputs
- Understanding limiting factors
- Reducing losses and unnecessary inputs

Nutrient management
Variety selection
IPM
Water management (irrigation, rainfall, soil moisture)

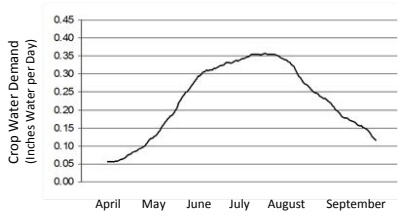
Plant Water Requirements

Important Crop-Specific Information:

Critical growth stage(s) during which drought stress will have most impact on the crop.

Peak consumptive water use rate.

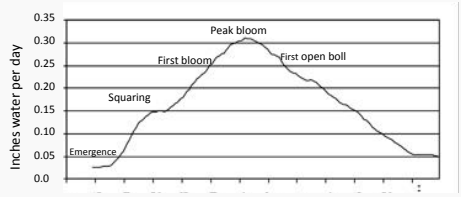
Crop Water Demand for Corn
Etter, Texas
Average from Crop Seasons 2000 - 2008



Average season crop water demand: 36.8 inches

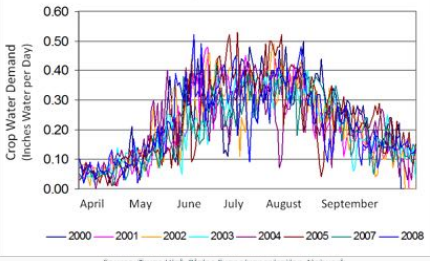
Source: Texas High Plains Evapotranspiration Network http://txhighplainset.tamu.edu

Cotton Water Demand



Long-term average cotton crop water demand at Lubbock, Texas
(Texas High Plains ET Network, 1998 - 2008)

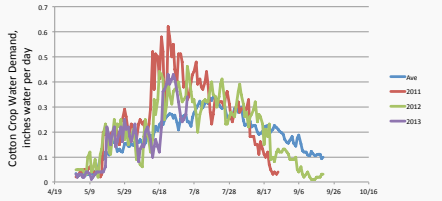
Crop Water Demand Estimates (ETc) for Corn
Etter, Texas
Crop seasons 2000 - 2008



Source: Texas High Plains Evapotranspiration Network
http://txhighplainset.tamu.edu

Comparing 2011, 2012 and 2013 Crop Seasons to Previous 10-Year Average

Daily Cotton Crop Water Demand at Lubbock



Relating irrigation system capacity to depth of application
(Gallons per minute per acre to inches per day or inches per week)

GPM/Acre	Inches/Day	Inches/Week
1	0.053	0.37
2	0.11	0.74
3	0.16	1.11
4	0.21	1.48
4.5	0.24	1.68
5	0.27	1.86
6	0.32	2.23
7	0.37	2.60
8	0.42	2.97
9	0.48	3.34

Note: these values do not take into account irrigation efficiency.

The Root Zone

Soil moisture profile (moist, but not saturated area), plow pans, caliche layers, etc. often limits the effective root zone depth.

The root zone is the effective area for available soil moisture, accessible nutrients, etc.
Nutrients are taken up with water.

Shallow-rooted crops are more susceptible to drought stress and related problems.

Effective root zone depths reported for agronomic crops

Cotton	2.6 – 5.6 ft.
Alfalfa	3.3 – 6.6+ ft.
Corn	2.6 – 5.6 ft.
Sorghum	3.3 – 6.6 ft.
Peanuts	up to 3.3 ft

Most vegetable crops 1 – 3 ft.

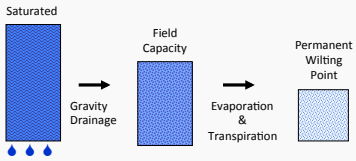
Managing the Root Zone

Effective root zone of many agronomic crops can be as deep as 5-6 feet, if soil conditions allow.

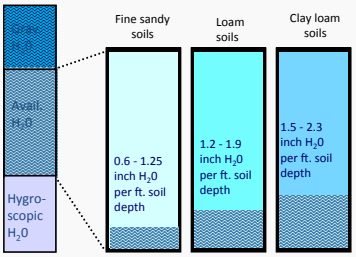
Most of the water used is extracted from the top 1-2-3 feet of soil.

Irrigation management is more critical for shallow-rooted crops.

Soil Moisture Terminology

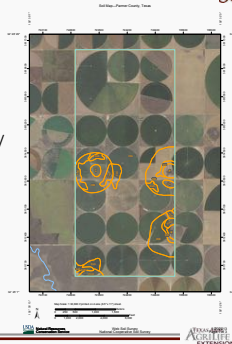


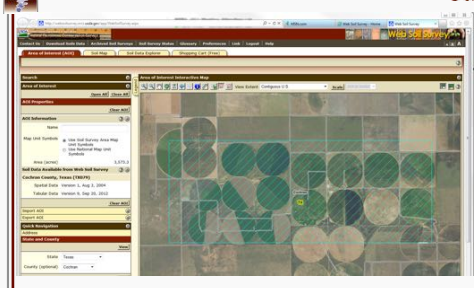
Available Water Storage by Soil Type



USDA-NRCS Web Soil Survey

http://websoilsurvey.nrcs.usda.gov/





Report – Physical Soil Properties

Cochran County, Texas

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*
AmB—Amarillo loamy fine sand, 0 to 3 percent slopes							
Amarillo	0-12	-84-	- 7-	5-10-15	1.40-1.60	14.00-42.00	0.06-0.10
	12-56	-55-	-17-	20-28-35	1.30-1.65	4.00-14.00	0.14-0.18
	56-80	-55-	-17-	20-28-35	1.40-1.80	4.00-14.00	0.10-0.15

Plant Available Water Storage Capacity
Amarillo Loamy Fine Sand

		Approx. Plant Available Water by Depth of Root Zone (inches water)				
Depth from Soil Surface	Plant Avail. Water (in/in)	1 Ft Soil	2 Ft Soil	3 Ft Soil	4 Ft Soil	5 Ft Soil
0 - 12	0.06 – 0.10	0.7 – 1.2	2.4 – 3.4	4.1 – 5.5	5.8 – 7.7	7.3 – 9.7
12 - 56	0.14 – 0.18	**1.0**	**2.9**	**4.8**	**6.7**	**8.5**
56 - 80	0.10 – 0.15					

Approximate plant available water holding capacity
(Texas High Plains area)

Soil Series	Available H2O (inches)			50% MAD (inches water)		
	1 ft. soil	2 ft. soil	3 ft. soil	1 ft. soil	2 ft. soil	3 ft. soil
Acuff	1.9	3.8	5.7	0.9	1.9	2.8
Amarillo	1.7	3.6	5.5	0.9	1.8	2.7
Brownfield	1.2	2.4	3.6	0.6	1.2	1.8
Olton	2.0	4.1	6.1	1.0	2.0	3.0
Pullman	1.9	3.8	5.7	0.9	1.9	2.8
Sherm	2.0	3.9	5.7	1.0	2.0	2.9

Source: USDA-NRCS Web Soil Survey http://websoilsurvey.nrcs.usda.gov/

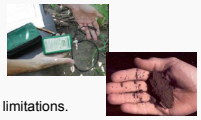
Stored soil moisture can be especially important during high water demand periods when irrigation system capacity is not sufficient to meet crop needs fully.

Shallow soil moisture is often used first. An extensive feeder root system and availability of deeper moisture can help to mitigate irrigation capacity limitations.

Estimating Soil Moisture

Methods

- Gravimetric - "gold standard" used to calibrate other methods
- Electrical resistance methods
- Capacitance sensors
- Tensiometers
- Soil feel and appearance



Each method has advantages and limitations.

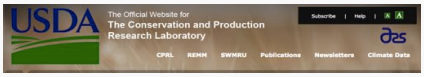
They vary in cost, accuracy, ease of use, and applicability to local conditions (soils, moisture ranges, etc.).

Most require calibration for accurate moisture measurement.

Proficiency of use and in interpreting information results from practice and experience under given field conditions.

USDA-ARS
Conservation & Production Research Laboratory (CPRL)
Bushland, Texas
http://www.cprl.ars.usda.gov/

http://www.cprl.ars.usda.gov/swmru-publications.php



Dr. Steve Evett has evaluated and compared soil moisture measurement technologies. These and other publications are available free of charge on this website.

Other topics:

- Time-Temperature Thresholds for plant-based irrigation scheduling
- Evaluations and comparisons of irrigation technologies
- Crop water demand
- Remote sensing methods
- Residue management

Researchers and authors: Susan O'Shaughnessy, Paul Colaizzi, Louis Baumhardt, Prasanna Gowda, Terry Howell, Judy Tolk, Karen Copeland, Steve Evett and others at the CPRL, with collaborators from industry, agencies and universities

http://ogallala.ars.usda.gov/irrigation.php

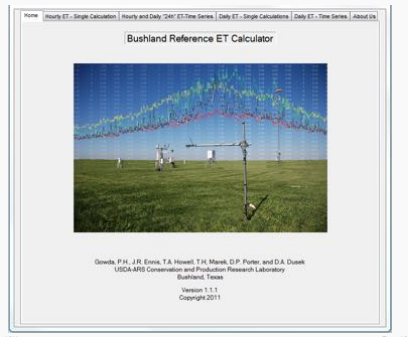
Bushland Reference Evapotranspiration (ET) Calculator

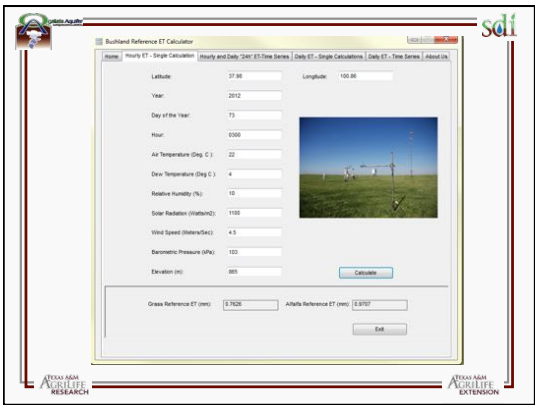
Prasanna Gowda, Terry Howell, Jerry Ennis, and Don Dusek
USDA-ARS Conservation and Production Research Laboratory – Bushland, TX

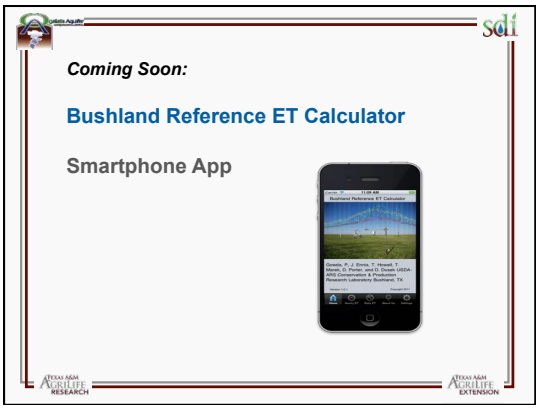
Daniel Holman, Thomas Marek and Dana Porter
Texas AgriLife Research and Extension Service – Amarillo and Lubbock

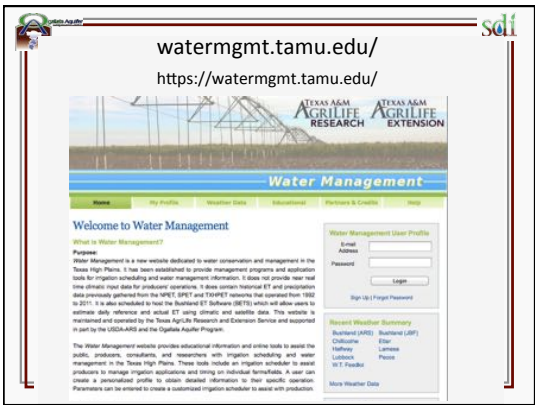
USDA-ARS Conservation and Production Research Laboratory
http://www.cprl.ars.usda.gov

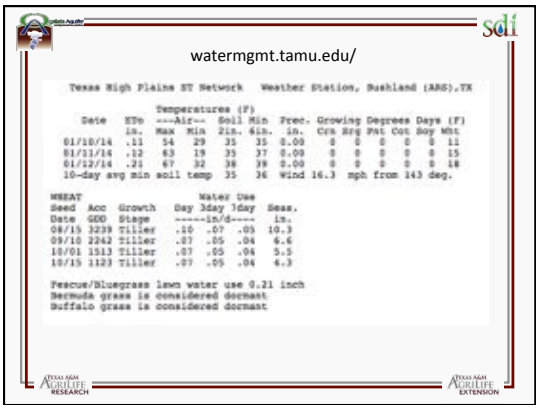
USDA-ARS Conservation and Production Research Laboratory
http://www.cprl.ars.usda.gov/swmru-software.php

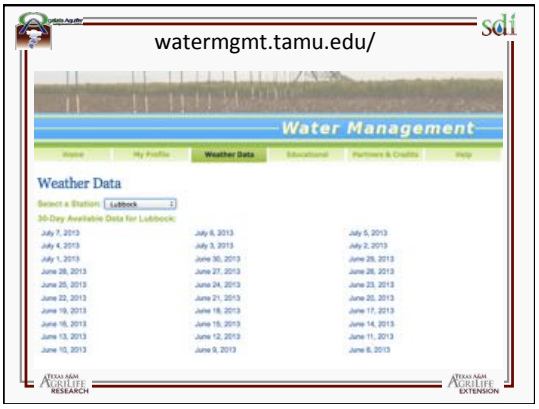


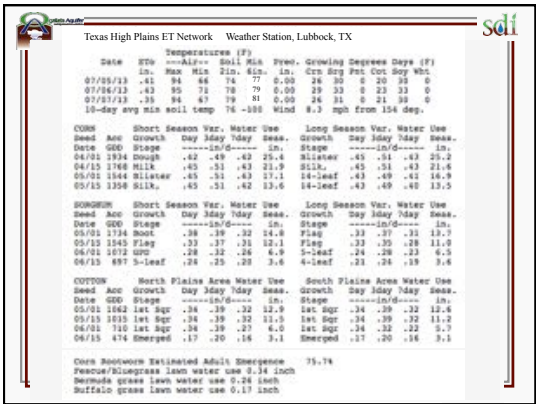

Bushland Reference ET Calculator


Coming Soon:
Bushland Reference ET Calculator
Smartphone App


watermgmt.tamu.edu/
https://watermgmt.tamu.edu/
Water Management
Welcome to Water Management


watermgmt.tamu.edu/
Texas High Plains ET Network Weather Station, Bushland (ARS),TX


watermgmt.tamu.edu/
Water Management
Weather Data

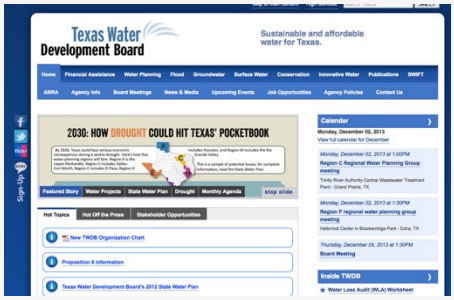

Texas High Plains ET Network Weather Station, Lubbock, TX

I.

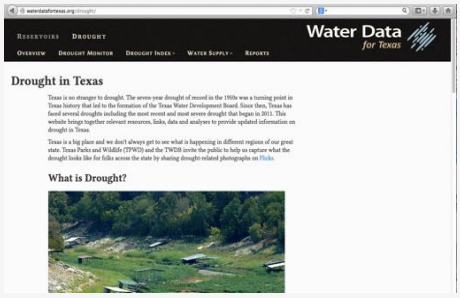
watermgmt.tamu.edu/

Texas A&M AgriLife Research and Extension Service
Water.tamu.edu

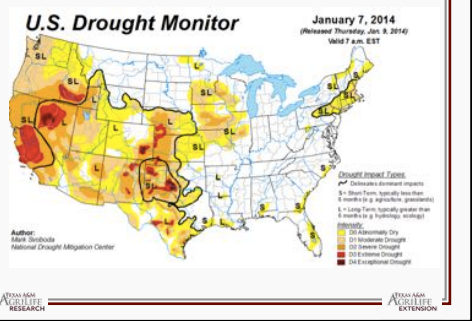
Texas Water Development Board
http://www.twdb.state.tx.us/



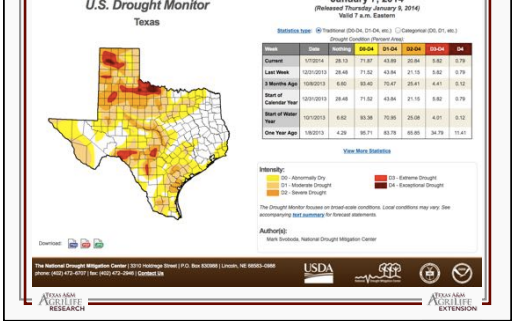
http://waterdatafortexas.org/



http://droughtmonitor.unl.edu/

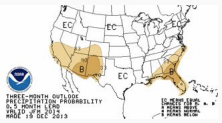


droughtmonitor.unl.edu/

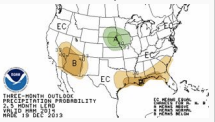


http://www.cpc.ncep.noaa.gov/

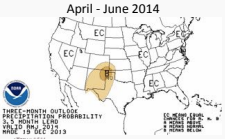
January - March 2014



March - May 2014



April - June 2014



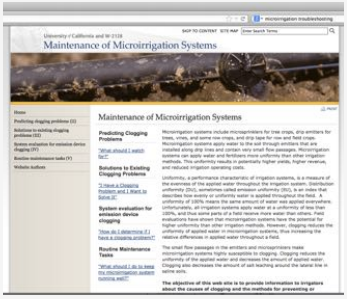
May - July 2014

USDA-ARS Ogallala Aquifer Program
Irrigation Systems and Technology
SDI working group, with participants primarily from
Kansas State University
Texas A&M AgriLife Research and Extension
USDA-ARS Bushland

Microirrigation Research Group:
Kansas State University
University of California
Texas A&M AgriLife Research and Extension
University of Wyoming
Oregon State University
University of Idaho
University of Nebraska
New Mexico State University
University of Florida
Other Land Grant Universities

Kansas State University Mobile Irrigation Lab
www.ksre.ksu.edu/mil

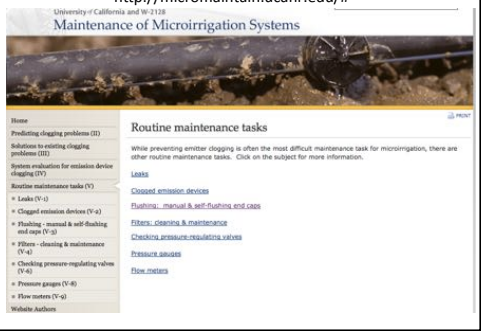
Maintenance of Microirrigation Systems
http://micromaintain.ucanr.edu/#

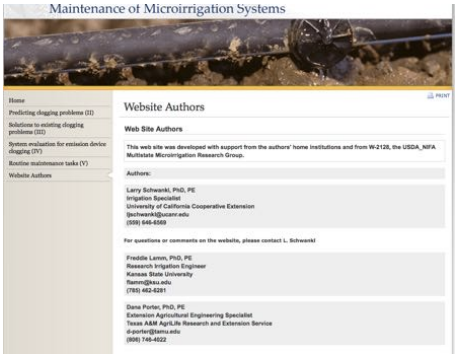


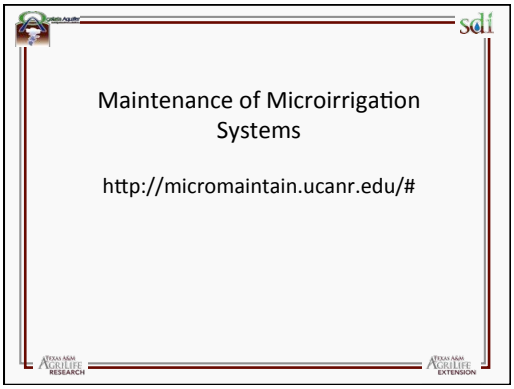
Maintenance of Microirrigation Systems
http://micromaintain.ucanr.edu/#

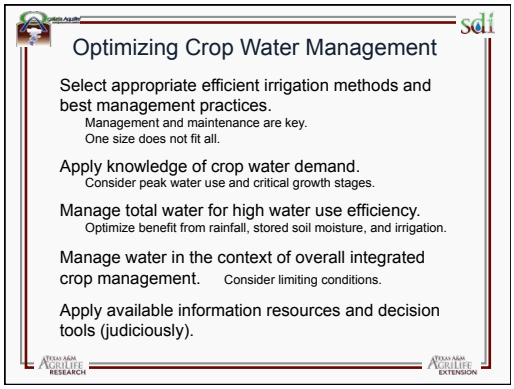
Maintenance of Microirrigation Systems
http://micromaintain.ucanr.edu/#

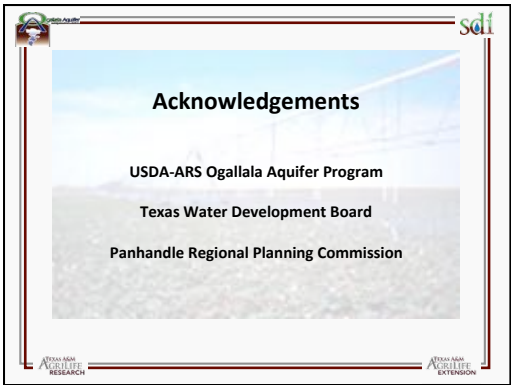
Maintenance of Microirrigation Systems
http://micromaintain.ucanr.edu/#











Thursday, March 7, 2013

7:00 - 8:00 a.m.	**Breakfast (Provided by the Ambassador for hotel guests only)**
9:00 - Noon	**Water Conservation Technologies Session** Concurrent Presentations **Soil Water Sensors** S.R. Evett **Evapotranspiration Calculator** J. Moorhead & J. Ennis **Irrigation Scheduling** D. Rogers **Cotton Irrigation** S. Mauget **Water Budgeting / Allocation** J. Aguilar **Irrigation Education Resources** D. Porter

Institutional Contacts for Ogallala Aquifer Program

David Brauer, ARS-Bushland, Texas
Terry Howell, ARS-Bushland, Texas
Robert Lascano, ARS-Lubbock, Texas
Dan Devlin, Kansas State University
Roel Lopez, Texas A&M University
Sukant Misra, Texas Tech University
Don Topliff, West Texas A&M University

For additional information about the Ogallala Aquifer Program, visit us at http://www.ogallala.ars.usda.gov/

Ogallala Aquifer

Funded by USDA ARS Research Initiative

A Research Consortium Between
USDA-Agricultural Research Service
Kansas State University
Texas A&M AgriLife Research and Extension Service
Texas Tech University
West Texas A & M University

2013 Workshop
Ogallala Aquifer Program
March 5 – 7, 2013
Amarillo, Texas

PANHANDLE
REGIONAL
PLANNING
COMMISSION

NOTICE OF MEETING

The Panhandle Water Planning Group (Region A) will hold a rescheduled public meeting on Tuesday, May 20, 2014, at 1:30 PM in the Boardroom of the Panhandle Regional Planning Commission, 415 W. 8th Avenue, Amarillo, Potter County, Texas.

AGENDA

1. **Call To Order and Welcoming Remarks.**
   C.E. Williams, Chairman.
2. **Roll Call of members to establish quorum and acknowledgement of any designated alternates.**
3. **Consider - the minutes from the regular meeting held on February 21, 2014.**
4. **Consider – the minutes from the Agriculture Committee meeting held on March 27, 2014**
5. **Consider – the minutes from the Executive Committee meetings held on March 27, 2014 and April 11, 2014 Respectively**
6. **Discuss and Action as Appropriate - Review and Consider the Current Financial Reports.**
7. **Update – Texas Water Development Board from Director Bech Brunn.**
8. **Discuss and Action as Appropriate – Sending PWPG Representation to the Agriculture Water Planning Summit in San Marcos on June 23 and/or the Lone Star Water Summit in Austin from June 24 to 25.**
9. **Discuss and Action as Appropriate – Prioritization and prioritization methodology for Water Management Strategies included in the 2011 Panhandle Regional Water Plan and 2012 Texas State Water Plan for Region A. Including the approval of a draft prioritization list.**
10. **Discuss and Action as Appropriate – Process for the development of prioritization methodology for Water Management Strategies to be included in the 2016 Panhandle Regional Water Plan.**
11. **Discuss and Action as Appropriate – Projected water deficits over 50 year horizon to be considered for 2016 Panhandle Regional Water Plan based on water supply and water demand projections.**

415 West Eighth Avenue
P.O. Box 9257
Amarillo, Texas 79105
(806) 372-3381

12. **Discuss and Action as Appropriate – Process for the development of Potentially Feasible Water Management Strategies**

    a. **Municipal**
    b. **Agriculture**
    c. **County Other**
    d. **Other Water Management Strategies**

13. **Discuss and Action as Appropriate – Chapter 7: Drought – Regional Triggers**

14. **Discuss and Action as Appropriate – Development of Region A Technical Memorandum by Freese & Nichols Inc. for submission to the Texas Water Development Board. Including the ratification of the technical memo at the next Full meeting of the PWPG.**

15. **Presentation from Texas A&M AgriLife Research – Amarillo on the current status of the High Plains Evapotranspiration Network.**

16. **Regional Reports – Region B and Region O**

17. **Report or Comments from TWDB Personnel**

18. **Other business, closing comments from Chairman and Board members.**

19. **Public Comment Relating to PWPG Activities**

20. **Adjourn.**

PUBLIC NOTICE

This notice complies with Texas Government Code Chapter 551, Open Meetings Act, Section 551.041 (Notice of Meeting Requirements); Section 551.042 (Time and Accessibility of Notice Requirements; and Section 551.053 (Notice Requirements of a Political Subdivision Extending Into Four or More Counties). The notice has been filed at least 72 hours before the scheduled time of the meeting with the Secretary of State's Office, the Potter County Clerk's Office, and the Administrative Office of the Panhandle Regional Planning Commission in Amarillo, Texas and the remaining County Clerk's offices in the remaining 20 counties of the Region A Water Planning Group.

Posted this 7th day of May, 2014 at 415 West Eighth Avenue, Amarillo, Texas, at 5:00 P.M.

_____

Kyle G. Ingham

You're invited to the

2nd Biennial Texas Panhandle-High Plains Water Conservation Symposium: The Dollars and $ense of Water Conservation

WEDNESDAY, FEBRUARY 12, 2014

8:30 A.M.—4:30 P.M. • AMARILLO CIVIC CENTER
NORTH EXHIBIT HALL

With Speakers including:

Carlos Rubinstein, ***Chairman Texas Water Development Board, Austin***
"Now that Proposition 6 Passed, What Opportunities are Available?"

Mary Ann Dickinson, ***Executive Director of Alliance for Water Efficiency, Chicago***
"The Value of Water"

Texas State Representative Four Price, ***District 87, Amarillo***
"Quenching Texas Thirst - Interim Charges for Next Session"

Texas State Representative Lyle Larson, ***District 87, San Antonio***
"The Roll Brackish Groundwater and Aquifer Storage and Recovery will have in Meeting Texas Water Needs"

Edward C. Small, ***Jackson Walker L.L.P., Austin***
"Statewide Perspective of Agriculture Water Conservation"

Kristin Scotten, ***National Weather Service, Amarillo***
"What's in Store for 2014?"

Tickets are $35 each, lunch included.
Register at The Texas Water Foundation: **http://www.texaswater.org.**
For more information, call the Panhandle Groundwater Conservation District at 806-883-2501.

Afternoon Breakout Sessions

Agriculture Breakout

Danny Krienke, ***Board member North Plains GCD, Perryton***
"Ag Water Conservation, Past, Present and Future"

Rick Kellison, ***Texas Alliance for Water Conservation, Lubbock***
"Conservation and Economic Opportunities"

Jourdan Bell, ***USDA Agricultural Research Service, Amarillo***
"Irrigation Strategies with Limited Water"

Dana Porter, ***Texas AgriLife Extension Service, Lubbock***
"When is the right time to consider drip irrigation?"

Public Breakout

Denise Hickey, ***Education Director North Texas Water District, Wylie***
"Understanding the Benefits and Quantifying Water Conservation Education"

Jason Hodges, ***Prairie Workshop LLC, Lubbock***
"Water Efficient Landscaping"

Lance Kieth, ***West Texas A&M University, Canyon***
"Importance of Water Conservation Education"

Billy Kniffen, ***Formerly with Texas AgriLife Extension Service, Wylie***
"The Benefits and Opportunities of Rainwater Harvesting"

Municipal Breakout

John Simms, ***Alan Plummer Associates Inc, Ft. Worth***
"Industrial Water Audits"

Mark Mathis, ***WLProspecting, Austin***
"Municipal Water Audits"

Rick Gibson, ***Xcel Energy, Amarillo***
"The Multiple Opportunities of Water Re-Use"

Emmett Autrey, ***City of Amarillo, Amarillo***
"Municipal Water Conservation"