Educational Enhancements to the Texas High Plains Evapotranspiration (ET) Network

Final Project Report
for completion of

TWDB Contract No. 0903580956

submitted to the

Texas Water Development Board
Austin, Texas

by

Thomas Marek, P.E.
Senior Research Engineer and Superintendent, NPRF
Texas AgriLife Research
Amarillo, Texas

Dr. Dana Porter, P.E.
Associate Professor and Extension Agricultural Engineering Specialist
Texas AgriLife Research and Extension
Lubbock, Texas

Nicholas Kenny, P.E.
Extension Program Specialist – Agricultural Engineer
Texas AgriLife Extension Service
Amarillo, Texas

Dr. Prasanna Gowda, MBA
Agricultural Engineer
USDA ARS Bushland, Texas

Dr. Terry Howell, P.E., D. WRE
Research Leader & Agricultural Engineer
USDA ARS, Bushland, Texas

and

Jerry Moorhead
Technician II
Texas AgriLife Research
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AREC 2011-8

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Cover background photo:
ET lysimeter research on grain sorghum at the USDA-ARS facility at Bushland, Texas.
(photo courtesy of Dr. Terry Howell)

Texas Water Development Board Project Managers:
Mrs. Whitney Milberger-Laird and Mr. Cameron Turner

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Nomenclature and Abbreviations

ET	general term used to refer to evapotranspiration (does not specify type or reference)
ET_c	crop evapotranspiration, mm/d or mm/h (in/d or in/h)
PWPG	Panhandle Regional Planning Group-(TWDB Region A)
RFA	Request for application(s)
TXHPET	Texas High Plains Evapotranspiration (ET) Network
TWDB	Texas Water Development Board

Educational Enhancements to the Texas High Plains Evapotranspiration (ET) Network

T.H. Marek, D.P. Porter, N.P. Kenny, P.H. Gowda, T.A. Howell and J.E. Moorhead[1]

Executive Summary

This educational enhancement project was awarded to develop an irrigation scheduling and management tool for addressing large acreage, multiple field irrigated farms, particularly those in the Texas High Plains regions (Regions A & O – see TWDB figure 1), where the primary source of irrigation water is the vast but declining Ogallala Aquifer. This tool, while providing in-season ET use data, can also be used as a seasonal planning tool for evaluating alternative water management production strategies and scenarios. A simplified, stand-alone version of the tool representing a single field, with a well watered condition status, irrigation scheduler was also developed in Microsoft Excel® for use in a Windows® operating system environment. As with the website, default field values are suggested from workbook information tabs and can be easily adjusted per user input. The web-based user profile tool can handle multiple fields per farm(s) per producer and thus lends itself useful to crop consultants, who manage multiple fields for multiple producers within a given production area. While the original intent of the project was proposed to integrate the tool into the Texas High Plains ET (TXHPET) network, an alternate website had to be developed (http://watermgmt.tamu.edu) due to the unforeseen shutdown of the TXHPET network as of September 1, 2010, due to the lack of funding support. To facilitate data input requirements of the newly developed scheduling tool, average based crop parameters were computed and integrated into the tool, which can be overwritten with custom input data values (i.e. user can provide from a representative meteorological source). Since crop ET data are no longer available in near real time from TXHPET, long term average based daily data were computed and are provided for average based irrigation scheduling purposes. The tool developed has value and application in practice and in educational applications and can result in reduced water use where over-application practice occurs.

Multiple videos were developed through this project to support educational efforts in irrigation water management for general audiences, as well as experienced irrigation personnel. These included addressing the reasons irrigation is needed and practiced, the profitability of irrigated crop production, the importance of correct soil moisture measurement in scheduling, the potential of limited irrigation production and the value of irrigation and research in agricultural production. The videos are entitled: "Irrigation Profitability in Grain Corn", "Profit Based Irrigation in Cotton", "Capacitance Probe Case Study", "Strategic Irrigation Management using C-Probes", "12-200 Corn Project" and "Practical Value of Irrigation Research". Additionally, five videos targeted for youth audiences were developed and are entitled: "The Water Cycle",

[1] Senior Research Engineer and Superintendent, North Plains Research Field, Texas AgriLife Research, Amarillo, Texas; Associate Professor & Extension Irrigation Engineer, Texas AgriLife Research and Extension Service, Lubbock, Texas; Irrigation Specialist, Texas AgriLife Extension Service, Amarillo, Texas; Agricultural Engineer, USDA ARS Bushland, Texas; Research Leader & Agricultural Engineer, USDA ARS Bushland, Texas and Technician II, Texas AgriLife Research, Amarillo, Texas.

“Agriculture in the State of Texas”, “Diminishing Water Resources”, “What Is Drip Irrigation” and “Determining Soil Bulk Density.

Outreach events through workshops and seminars promoted this project’s efforts and developed resources with appropriate credit of support from the Texas Water Development Board (TWDB). The outreach efforts were conducted at over 30 educational events including the Texas High Plains Irrigation Conference in Amarillo, TX, the Ochiltree County Cotton Conference in Perryton, TX, the South Texas Irrigation Conference in Uvalde, TX, a meeting with Biological and Agricultural Engineering water educators in College Station, TX and a meeting with Amarillo agricultural and science educators in Amarillo, TX. The majority of the audience at these targeted outreach activities were practicing irrigators, wherein the overwhelming majority of the water resource is utilized for crop production purposes, and in turn provides economic stability to much of the rural production areas of the Texas High Plains.

While the deliverable requirements of this contract were achieved within the project timelines, the opportunity to initiate development of these type educational materials is viewed as a start and is envisioned to continue to further enhance and develop resources to educate producers on the importance and benefit of proper irrigation water management. As with previous projects this team has completed with support from the TWDB, appropriate credit of support will be given going forward indicating that “we are all working together in water” toward the common goal to conserve the precious water resources of the state and using advanced management technologies to sustain the agricultural production viability of Texas.

Introduction and Background

The Texas High Plains is the most intensively irrigated region in the state. In Region A (see figure 1), it is estimated that 1.47 million acre-feet (ac-ft) of water is used annually for agriculture (irrigation plus livestock – PWPG, 2010). Of this water demand, 1.43 million ac-ft (466 billion gallons) are used for irrigated crop production. It has been estimated that Region O uses approximately twice this amount. Thus, irrigation is huge indeed within the regions and contributes significantly to both regions' rural economies.

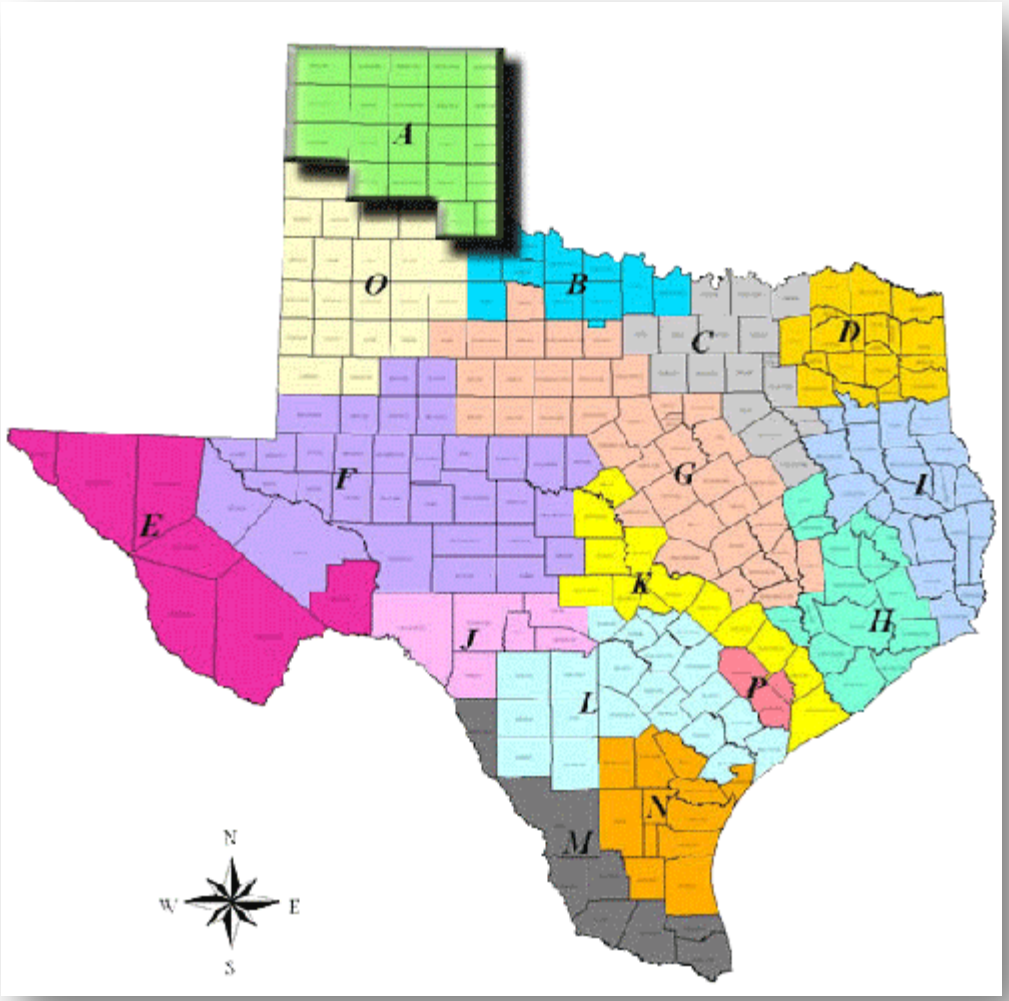


Figure 1. The Texas Panhandle water planning area defined as Region A (TWDB, 2010).

Nonetheless, research has shown that over-irrigation reduces crop yields (see figure 2). The use of irrigation scheduling tools has generally proven to be effective in preventing the over-application of irrigation water to crops. Crop evapotranspiration (ET_c) can be estimated and utilized to plan irrigation applications. Water savings can be gained through the use of irrigation scheduling based on accurate and representative evapotranspiration (ET) data. While there are many producers currently scheduling irrigations based on ET, or use a crop consultant who does,

many others do not. The Texas High Plains ET (TXHPET) Network (Marek and Porter, 2009) has provided ET data (in the past) to support efficient irrigation management and economic viability. This network provided accurate and representative ET data for the management of irrigation for major crops within the region, but did not provide an actual scheduler. Generally water savings can be attained through the adoption of ET based irrigation scheduling (Kisekka et al., 2009). Electronic, web-based delivery can provide easier access and utilization of these type decision support system (DSS) tools, since version and product updates are more seamless and transparent from the users' standpoint and problems with differing operating systems and software compatibility issues are avoided. This project targeted the development and utilization of a web-based irrigation scheduler to provide wise water information to current irrigators as well as targeting the youth that will become tomorrow's water managers.

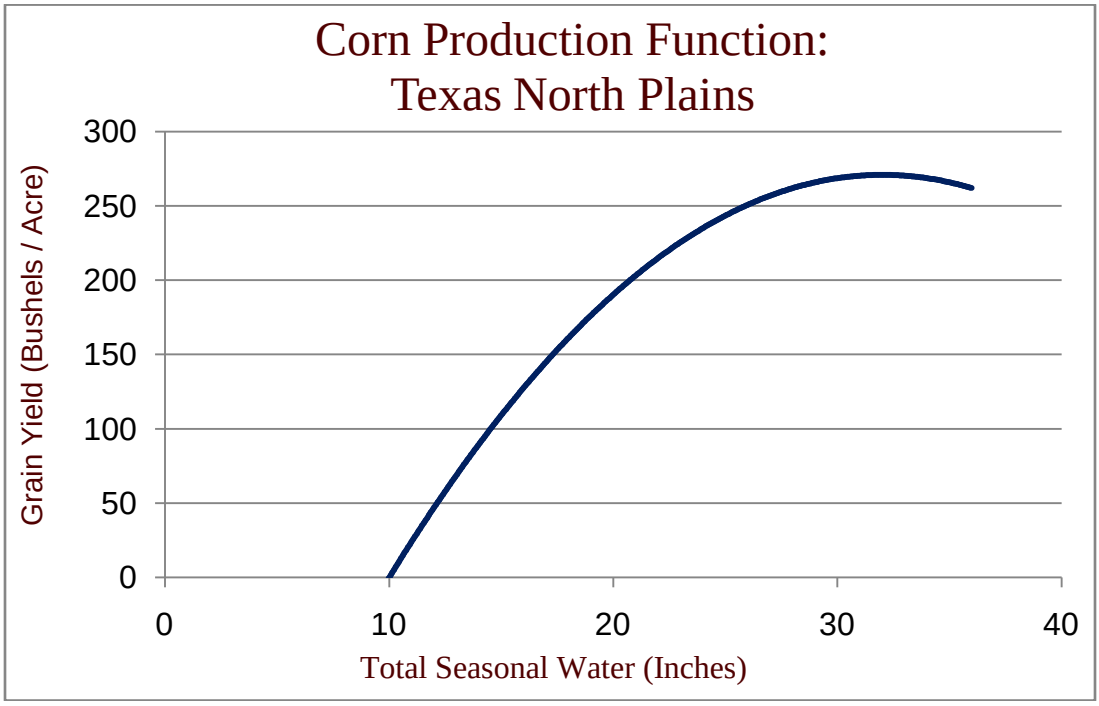


Figure 2. Corn production function for the Texas North Plains.

Objective

The objective of this educational enhancement effort was to improve the Texas High Plains Evapotranspiration Network (TXHPET) that addresses the item declared in the 2009 Texas Water Development Board (TWDB) RFA. Due to the lack of funding in mid 2010, the decision was made to shut down public access to the TXHPET network, thus a secondary "Water Management" website had to be created to accomplish the goals of this project. The user profile, irrigation scheduling tool and educational content will be made available through this new website located at http://watermgmt.tamu.edu and is envisioned more encompassing in terms of all water related subject matter.

The objective of this project was accomplished through performance of the following tasks:

1) Develop an integrated, user based, farm/field irrigation scheduling profile site for use with the Texas High Plains ET (TXHPET) network (which could be adapted by other ET networks in the state), which is to be replaced with public access at the Water Management website. Also, a spreadsheet version of the irrigation scheduling tool is provided for individual user offline, single field use,

2) Develop a set of electronic irrigation scheduling and irrigation water management video clips that are targeted toward existing Texas High Plains irrigators,

3) Develop a set of electronic informational irrigation based video clips that are targeted toward the youth of Texas promoting water literacy, efficient irrigation and water conservation information and education, and,

4) Integrate the above into the TXHPET network system (replaced by the new Water Management) website and provide the unveiling of the new tools at a minimum of three (3) educational workshops/seminars throughout Texas for irrigation producers and three (3) workshops/seminars for the youth/children groups, which could include 4-H type youth events and extension activities, and one (1) project seminar in Austin for the Texas Water Development Board (TWDB).

Project Methods

Task 1: Development of an integrated Water Management user profile system

Task 1 was accomplished through the multi-agency team collaboration resulting in the new Water Management website and the integrated, web based, user profile tool whereby a producer can use the scheduling tool without having to maintain the processes outside the disseminating Water Management servers. In this manner, records of performance could also be maintained and monitored to assist cooperating producers in using the enhanced features to gain increased insight as to their particular farm/field site soil moisture condition and in-season status. For producers who have severely limited irrigation capacity, conversion to other lower water use crops can be detailed as per the specific status records. (Water Management site and utilization records information pertaining to the identity of any specific producer(s) is deemed confidential and data will be compiled for website usage statistics and impact reporting and related purposes activity only.)

Task 2: Development of producer targeted videos and materials

Task 2 was to address existing irrigated producers through the development of educational video clips and materials. The digital media content was to include presentations and/or tutorials on the Water Management website navigation and utilization; basic knowledge of irrigation scheduling based on ET; pumping plant efficiency and costs; and irrigation system design, operation and maintenance, including pivot, sprinkler and drip (surface and sub-surface) systems.

The target audience for this portion of the informational media consisted of agricultural water users, consultants/advisors and others interested in irrigation management.

Task 3: Develop youth based videos and materials

Task 3 was to address young, potentially future agricultural producers and other youth water users through the development of educational video clips and materials. An additional primary target audience consisted of elementary school age children who have generally had very limited exposure to water use topics. The digital media content for this group was to begin with basic water literacy, introduction to climatic conditions that affect water usage and availability, an introduction to irrigation, practical water saving methods and an overall exposure to current and future water use issues. Five short length videos were targeted under this heading. It was anticipated that the task content would reach a much broader demographic of those desiring basic knowledge concerning current water use topics. The media content would primarily be delivered online, but would also be made available on a DVD format for point specific distribution (such as Texas AgriLife Extension Service and 4-H programs).

Task 4: Integrate profile and conduct trainings throughout Texas

Task 4 was completed through the integration of programmed additions to the Water Management and other Texas High Plains water related websites. Additionally, links to the new tool sites were added to all existing agriculture based and Texas AgriLife High Plains sites. Materials were presented at a variety of educational events.

Task 1

Development of an integrated Water Management user profile system

ET data have been utilized for nearly 20 years in the Texas High Plains for irrigation scheduling. Problems can arise, however, when ET data or irrigation scheduling are not completely understood. Many producers have been managing their farms and irrigations for many years and believe that they have the necessary knowledge to plan irrigation events without assistance from computer scheduling programs. Even experienced irrigators, however, can benefit from improved irrigation scheduling and better applications of research-based knowledge. Adoption and utilization of a web based irrigation scheduler can be beneficial to producers and promote conservation of water resources. It has been established that over-watering a crop can actually reduce yield (Piccinni et al., 2009; Evans et al., 1996 - see right portion of curve in figure 2) as much as under-watering a crop (left portion of curve in figure 2). To further assist producers with their scheduling needs and reduce over-irrigation, a “user profile” was developed on the Water Management website (http://watermgmt.tamu.edu) that customizes an irrigation scheduler to site-specific conditions (see figure 3 - figure 5). Specific farm data can be entered to personalize each farm setup. For producers and consultants who manage multiple farms and fields, the profile tool accommodates multiple farms with multiple fields with differing (or similar) characteristics, all under a given user profile (see figure 6). Within each farm, multiple fields can be set up to provide specific information for each particular field.

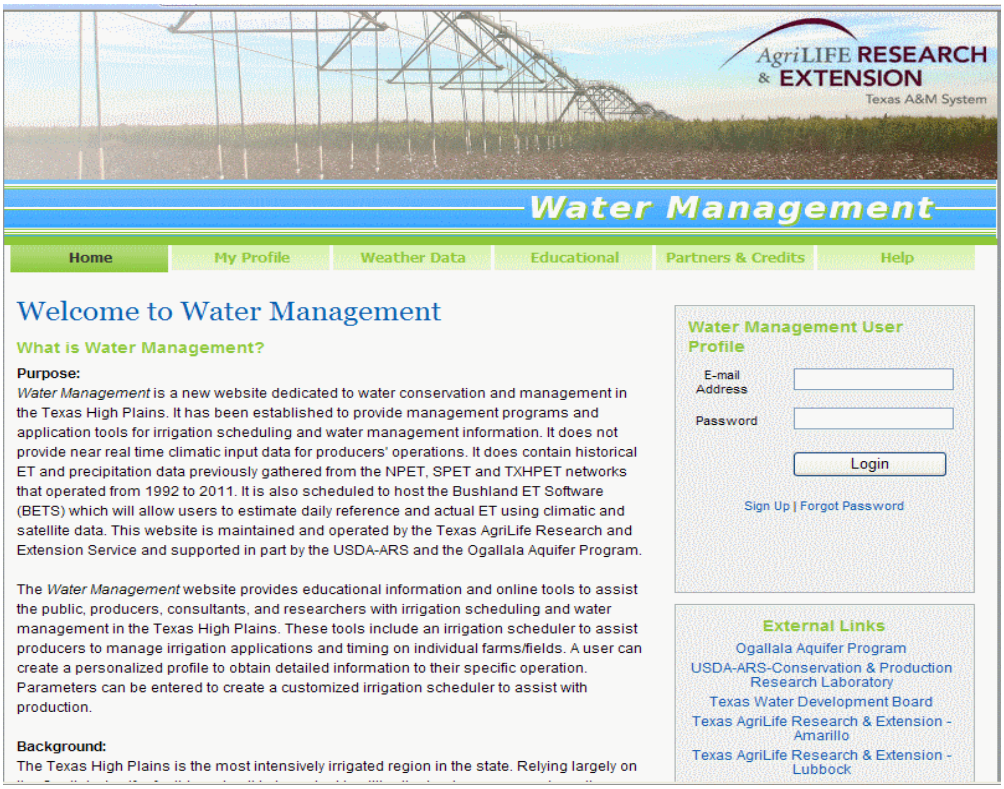


Figure 3. Water Management website homepage.

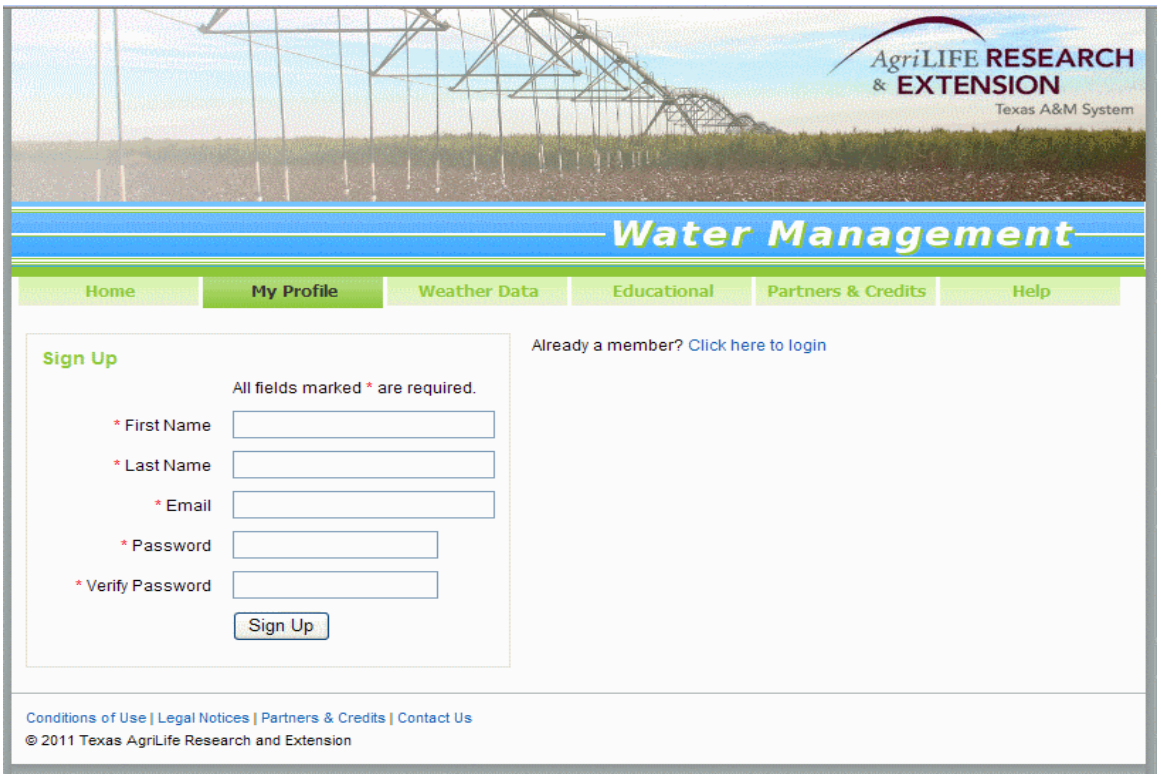


Figure 4. Water Management user profile sign up webpage.

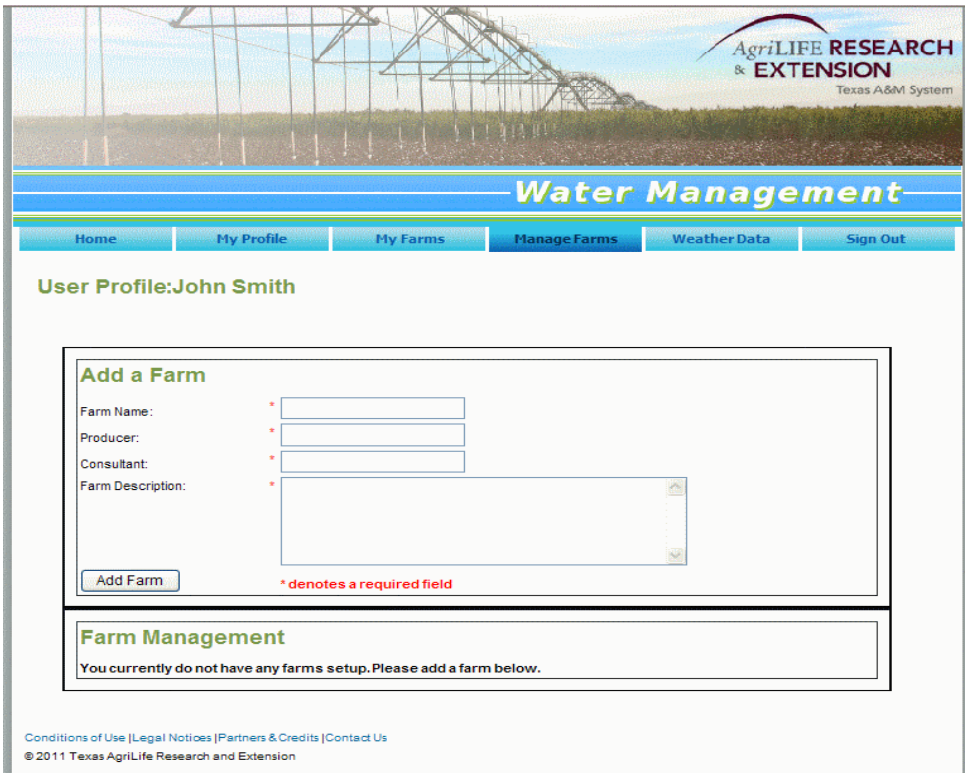


Figure 5. Water Management "Add a Farm" webpage.

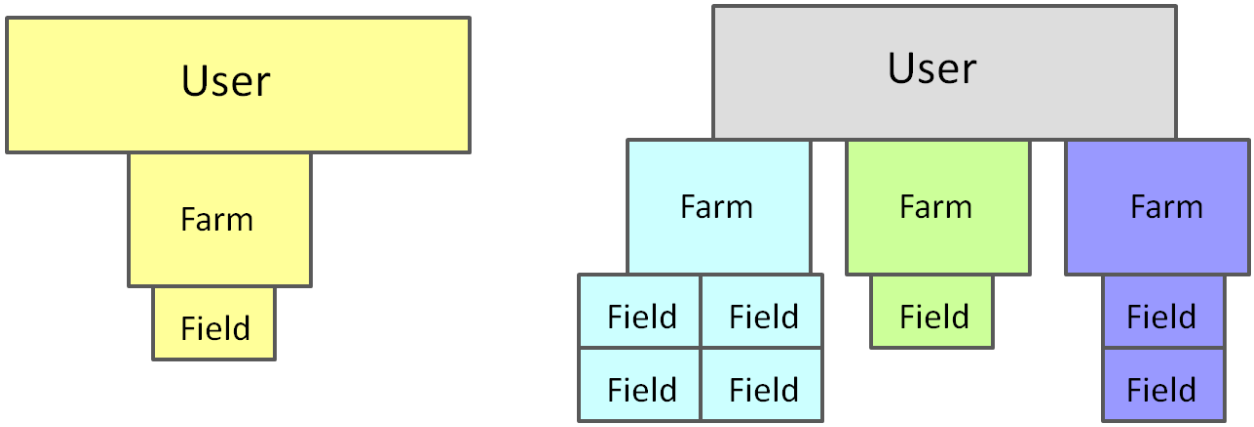


Figure 6. Flowchart depicting the ability to set up a single farm and field or multiple farms and fields within the Water Management website.

The data inputs required for each field include the field name, irrigation type (center pivot, subsurface drip, etc.), ET station (location selected from long term average values), crop type, soil type, planting date, root zone depth (in inches), initial water content (in inches), soil moisture capacity (in inches), irrigation trigger (in inches), irrigated area (in acres) and irrigation system efficiency (see figure 7). The field name is entered by the user and can be referenced by a name understood by the user or client. The irrigation system type is selected from a drop down

menu and each irrigation system type has an associated default efficiency. If the actual system efficiency differs from the default value, the user can enter a custom system efficiency value (however the program checks to see that it is within a realistic range). The ET station is then selected from a drop down menu which allows for selection of one of the TXHPET weather station sites and automatic entry of the default average values computed from nearly 20 years of data for some stations (new data are not being collected from these sites, however past data have been used to calculate a long term average at each station site). This long term average value can thus be used for crop ET data, or the user can input their own crop ET values. The crop type, soil type and planting date are also selected from the respective drop down menus. The root zone depth is (by default) populated based on the crop selected. Soil moisture capacity is populated based on the selected soil type. Initial water content, irrigation event triggering (percent of soil water depleted) and field area are all entered by the user.

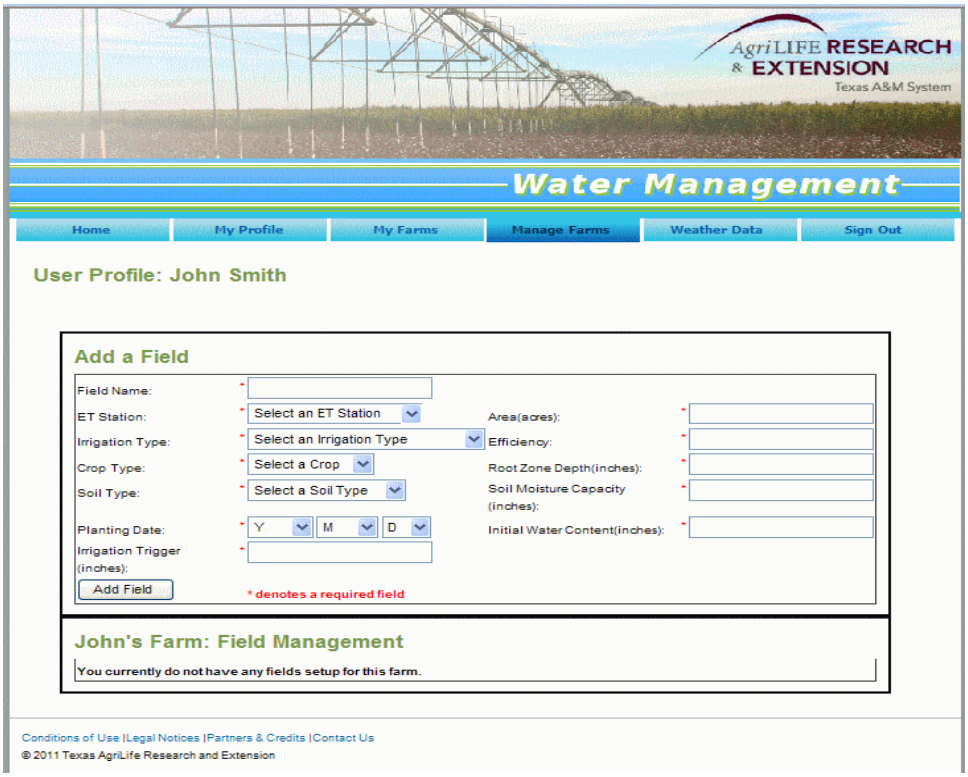


Figure 7. Water Management "Add a Field" webpage.

Once a field is added, the user has the option to add another field or view fields previously entered. The fields that have been entered (per the created farm) display all the respective attribute data that was entered when the field was added (see figure 8). Selecting the details link located next to the field name will direct the user to a webpage that displays the planting date, current profile plant available water, field capacity, irrigation trigger level, total irrigation to date and total rainfall to date.

It is on this page that a user can input an irrigation or rain event (see figure 9). This page also contains a field ending date to indicate when the field was harvested. This water input is

necessary and is used to update the stored soil moisture status within the soil profile on a daily basis. The soil profile can be displayed either in table or graphical format. There is also an option to create a PDF event report page suitable as a crop consultant's report to a client (see figure 10). This PDF is entitled appropriately as a "Crop Water Status Report" and includes the producer's name, the agent/consultant's name, farm name, field name, acreage, soil series, weather station, crop, planting date, crop ET to date, irrigation to date, rainfall to date, total water received and soil moisture available up to today's date or the field ending date.

This report also displays a graph of the soil profile water status since the planting date. This graph illustrates both the increases and decreases of soil water content as irrigation and rain events added soil water and crop ET decreased the amount of water within the soil. The graphical output displays the soil water status for the time period beginning on the planting date and ending either at the current date or the ending date of field production as specified by the user. This soil water status graph has a line indicating the soil water status each day with solid horizontal lines corresponding to field capacity and the user specified irrigation trigger level. Below the soil water status graph, a chart displaying the crop ET is presented.

Another two graphs included in this output (not shown in figure 10) include precipitation and irrigation events and cumulative crop growing degree days. These different graphs are generated due to the potential "data congestion" created when all data are included on a single graph.

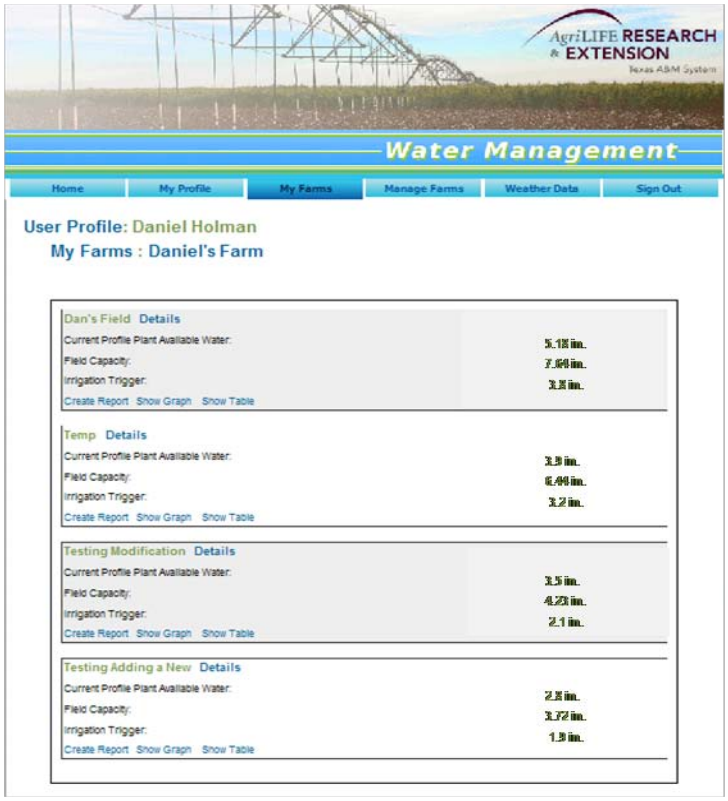


Figure 8. Screenshot displaying fields within a farm.

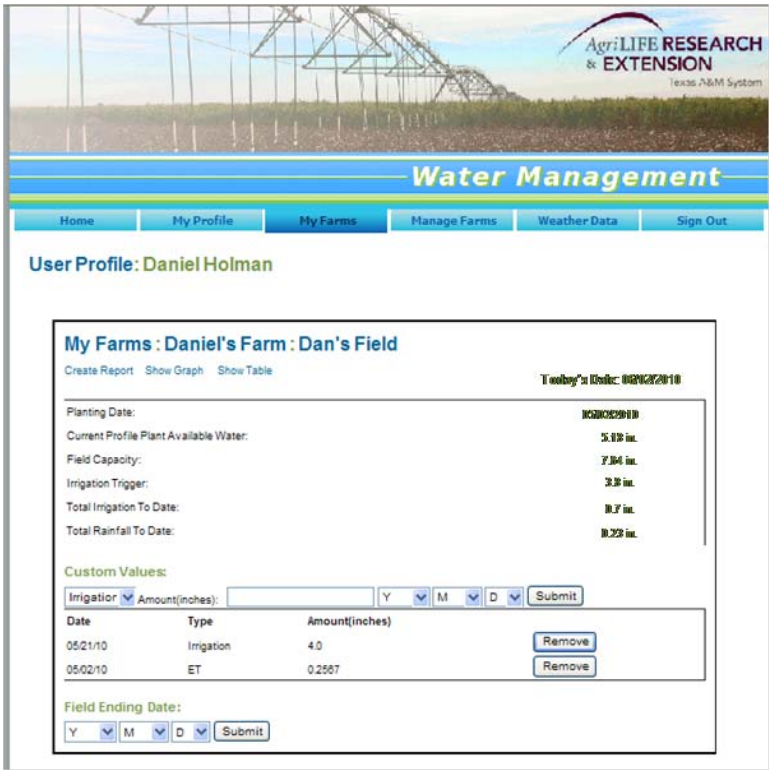


Figure 9. Field details for a user defined field.

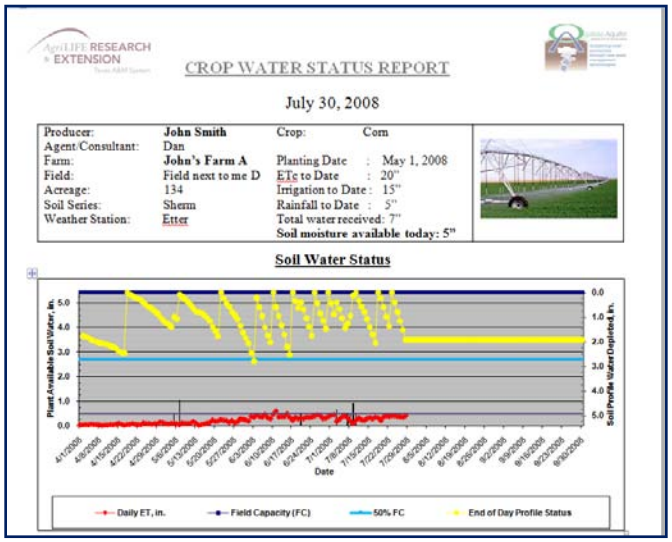


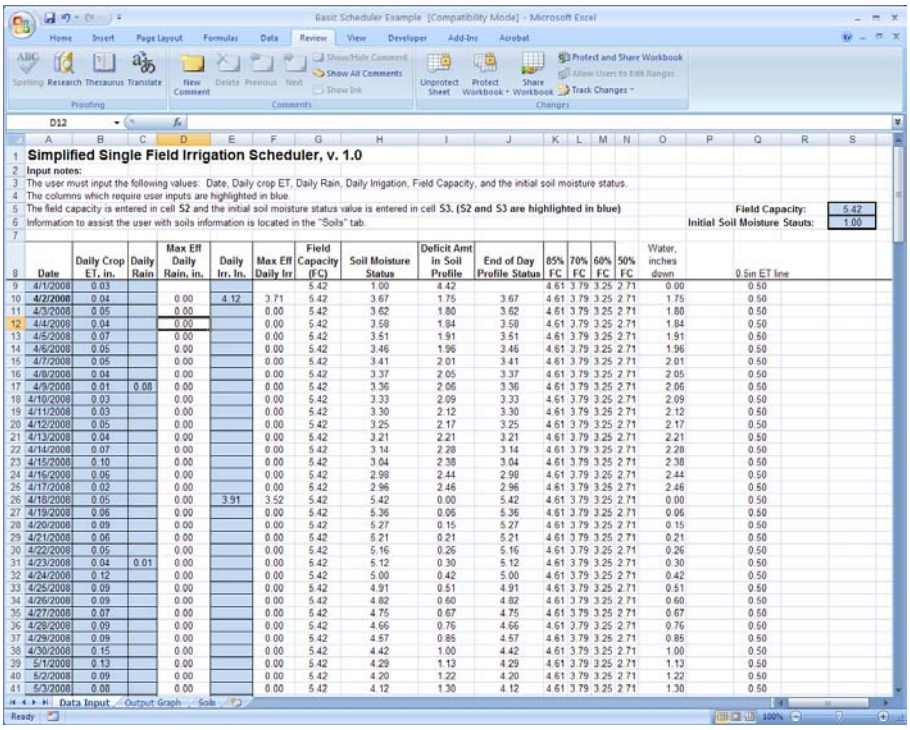
Figure 10. Example of PDF field report available from the Water Management website.

The table output also contains selected parameters from the irrigation scheduler model on the Water Management Internet server. The table displays the date, growing degree days, crop ET, rain and irrigation events and end of day available soil water. The end-of-season values for total crop growing degree days, total crop ET, total rain and total irrigation are included at the bottom of the table. This scheduler takes the user's inputs to calculate a suggestion of when and how much irrigation should be applied to achieve field capacity. The scheduler operates by utilizing

the inputs of soil moisture content, crop ET, effective rainfall and effective irrigation to compute the water stored in the soil profile at the end of each day. Based on water content in the profile, the user can interpret how much water is currently available within the soil and how much, if any, irrigation is needed to attain field capacity.

Again, the inputs required with this scheduler are initial soil moisture content, crop ET, effective rainfall and effective irrigation. Effective rainfall and effective irrigation are used (programmatically truncated) due to the fact that not all water applied through irrigation or rain will become plant available water, as applications exceeding the soil's moisture storage capacity will be lost through deep percolation, runoff and/or evaporation. A minimum effective rainfall algorithm and irrigation system efficiency are used by the scheduler to automatically calculate effective rainfall or irrigation using the understanding that plant available water cannot exceed the soil's storage capacity (and as experienced from applied research-based information). Initial soil moisture is used to determine a starting point for the soil water content model. The soil water content is updated daily to provide a timely, accurate soil moisture value to the user on a daily basis.

A stand-alone, basic, ET based scheduler (see figure 11) is available for download through the Water Management website. This scheduler is run in Microsoft Excel®. This program only requires the inputs of field capacity, initial soil moisture status, planting date, daily crop ET, daily rain and daily irrigation. The scheduler will calculate effective rain and effective irrigation from the user inputs of rain and irrigation, respectively. Through calculations run in the background, this program updates the current soil moisture status and displays the "deficit" water amount in the soil and the current amount of water stored in the profile. Depending on the desired irrigation trigger, the user can know how much water is available and can make a more informed decision on when, and how much, to irrigate. For ease of use, these values are displayed in a graph in another tab of the scheduler (see figure 12). This assists the user in visualizing the water content of the soil profile and makes the irrigation decision process easier. For users unfamiliar with their field capacity, a "Soils" tab is available with some basic information on soil moisture capacity for general soil types.



Simplified Single Field Irrigation Scheduler, v. 1.0

Input notes:

The user must input the following values: Date, Daily crop ET, Daily Rain, Daily Irrigation, Field Capacity, and the initial soil moisture status.

The columns which require user inputs are highlighted in blue.

The field capacity is entered in cell S2 and the initial soil moisture status value is entered in cell S3. (S2 and S3 are highlighted in blue)

Information to assist the user with soils information is located in the "Soils" tab.

Field Capacity: 5.42

Initial Soil Moisture Stauts: 1.00

Date	Daily Crop ET, in.	Daily Rain	Max Eff Daily Rain, in.	Daily Irr, In.	Max Eff Daily Irr	Field Capacity (FC)	Soil Moisture Status	Deficit Amt in Soil Profile	End of Day Profile Status	85% FC	70% FC	60% FC	50% FC	Water, inches down	0.5in ET line
4/1/2008	0.03					5.42	1.00	4.42		4.61	3.79	3.25	2.71	0.00	0.50
4/2/2008	0.04		0.00	4.12	3.71	5.42	3.67	1.75	3.67	4.61	3.79	3.25	2.71	1.75	0.50
4/3/2008	0.05		0.00		0.00	5.42	3.62	1.80	3.62	4.61	3.79	3.25	2.71	1.80	0.50
4/4/2008	0.04		0.00		0.00	5.42	3.58	1.84	3.58	4.61	3.79	3.25	2.71	1.84	0.50
4/5/2008	0.07		0.00		0.00	5.42	3.51	1.91	3.51	4.61	3.79	3.25	2.71	1.91	0.50
4/6/2008	0.05		0.00		0.00	5.42	3.46	1.96	3.46	4.61	3.79	3.25	2.71	1.96	0.50
4/7/2008	0.05		0.00		0.00	5.42	3.41	2.01	3.41	4.61	3.79	3.25	2.71	2.01	0.50
4/8/2008	0.04		0.00		0.00	5.42	3.37	2.05	3.37	4.61	3.79	3.25	2.71	2.05	0.50
4/9/2008	0.01	0.08	0.00		0.00	5.42	3.36	2.06	3.36	4.61	3.79	3.25	2.71	2.06	0.50
4/10/2008	0.03		0.00		0.00	5.42	3.33	2.09	3.33	4.61	3.79	3.25	2.71	2.09	0.50
4/11/2008	0.03		0.00		0.00	5.42	3.30	2.12	3.30	4.61	3.79	3.25	2.71	2.12	0.50
4/12/2008	0.05		0.00		0.00	5.42	3.25	2.17	3.25	4.61	3.79	3.25	2.71	2.17	0.50
4/13/2008	0.04		0.00		0.00	5.42	3.21	2.21	3.21	4.61	3.79	3.25	2.71	2.21	0.50
4/14/2008	0.07		0.00		0.00	5.42	3.14	2.28	3.14	4.61	3.79	3.25	2.71	2.28	0.50
4/15/2008	0.10		0.00		0.00	5.42	3.04	2.38	3.04	4.61	3.79	3.25	2.71	2.38	0.50
4/16/2008	0.06		0.00		0.00	5.42	2.98	2.44	2.98	4.61	3.79	3.25	2.71	2.44	0.50
4/17/2008	0.02		0.00		0.00	5.42	2.96	2.46	2.96	4.61	3.79	3.25	2.71	2.46	0.50
4/18/2008	0.05		0.00	3.91	3.52	5.42	5.42	0.00	5.42	4.61	3.79	3.25	2.71	0.00	0.50
4/19/2008	0.06		0.00		0.00	5.42	5.36	0.06	5.36	4.61	3.79	3.25	2.71	0.06	0.50
4/20/2008	0.09		0.00		0.00	5.42	5.27	0.15	5.27	4.61	3.79	3.25	2.71	0.15	0.50
4/21/2008	0.06		0.00		0.00	5.42	5.21	0.21	5.21	4.61	3.79	3.25	2.71	0.21	0.50
4/22/2008	0.05		0.00		0.00	5.42	5.16	0.26	5.16	4.61	3.79	3.25	2.71	0.26	0.50
4/23/2008	0.04	0.01	0.00		0.00	5.42	5.12	0.30	5.12	4.61	3.79	3.25	2.71	0.30	0.50
4/24/2008	0.12		0.00		0.00	5.42	5.00	0.42	5.00	4.61	3.79	3.25	2.71	0.42	0.50
4/25/2008	0.09		0.00		0.00	5.42	4.91	0.51	4.91	4.61	3.79	3.25	2.71	0.51	0.50
4/26/2008	0.09		0.00		0.00	5.42	4.82	0.60	4.82	4.61	3.79	3.25	2.71	0.60	0.50
4/27/2008	0.07		0.00		0.00	5.42	4.75	0.67	4.75	4.61	3.79	3.25	2.71	0.67	0.50
4/28/2008	0.09		0.00		0.00	5.42	4.66	0.76	4.66	4.61	3.79	3.25	2.71	0.76	0.50
4/29/2008	0.09		0.00		0.00	5.42	4.57	0.85	4.57	4.61	3.79	3.25	2.71	0.85	0.50
4/30/2008	0.15		0.00		0.00	5.42	4.42	1.00	4.42	4.61	3.79	3.25	2.71	1.00	0.50
5/1/2008	0.13		0.00		0.00	5.42	4.29	1.13	4.29	4.61	3.79	3.25	2.71	1.13	0.50
5/2/2008	0.09		0.00		0.00	5.42	4.20	1.22	4.20	4.61	3.79	3.25	2.71	1.22	0.50
5/3/2008	0.08		0.00		0.00	5.42	4.12	1.30	4.12	4.61	3.79	3.25	2.71	1.30	0.50

Figure 11. Example of the stand-alone basic irrigation scheduler.

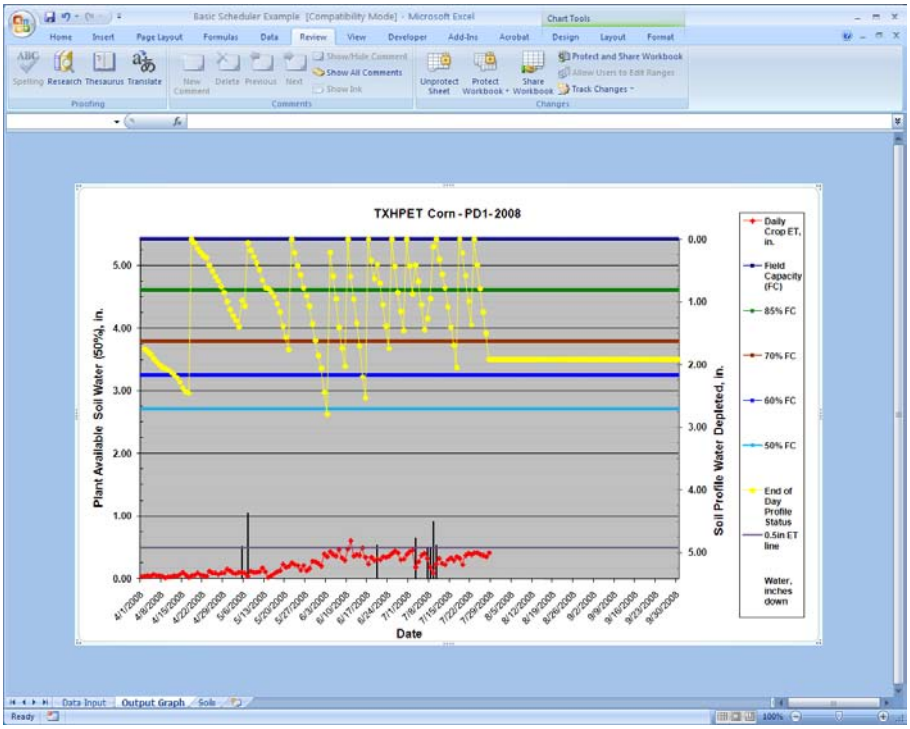


Figure 12. Example of the graphical output of the stand-alone basic irrigation scheduler.

Task 2

Develop producer targeted videos and materials

This task was targeted toward existing irrigators to provide information on irrigation systems, efficiencies and scheduling. The goal of this task was to assist irrigators in better meeting crop water requirements, while reducing the risk of over-irrigation. (Recent groundwater conservation district records indicate that some over-irrigation still occurs in field practice (Walthour, 2009). The videos also promote the concept that "more is not necessarily better - or profitable." This task provides developed videos to inform users of more efficient irrigation systems and best management practices. To allow personnel of this project the necessary tools to capture, edit and produce videos, the necessary equipment and software was procured with the use of this grant. Several months were spent capturing and editing video footage as well as becoming familiar and proficient with the video editing software.

Six videos were created, entitled: "Irrigation Profitability in Grain Corn", "Profit Based Irrigation in Cotton", "Capacitance Probe Case Study", "Practical Value of Irrigation Research", "12-200 Corn Project" and "Strategic Irrigation Management Using C-Probes".

The "Practical Value of Irrigation Research" video (see figure 13) details some of the past accomplishments and future plans of research in agriculture and irrigation. This video illustrates the need for and value of research in these areas and the benefits obtained from that research. It also reflects advances in irrigated production technologies over the last 30 years.

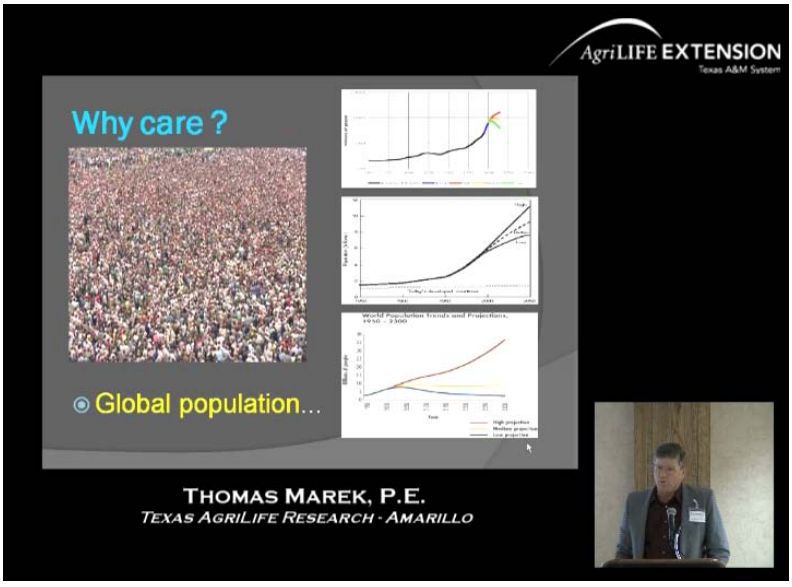


Figure 13. Snapshot of the "Practical Value of Irrigation Research" video.

The "Profit Based Irrigation in Cotton" video (see figure 14) illustrates the theory behind scheduling irrigations based on crop production and net profit. (Realize that cotton is a drought tolerant crop and must be water stressed to produce lint - a condition dissimilar to other grain type crops). This video demonstrates that increasing irrigation does not always increase net

income and can actually decrease yield and profits. This video provides the viewer some background information on crop production functions and estimating net income returns per acre based on inputs and expected yield. (Cotton in the northern Texas High Plains is an extremely important crop because net income can be maintained or exceeded with 40 to 50% less irrigation water than corn, the major produced crop within the area)

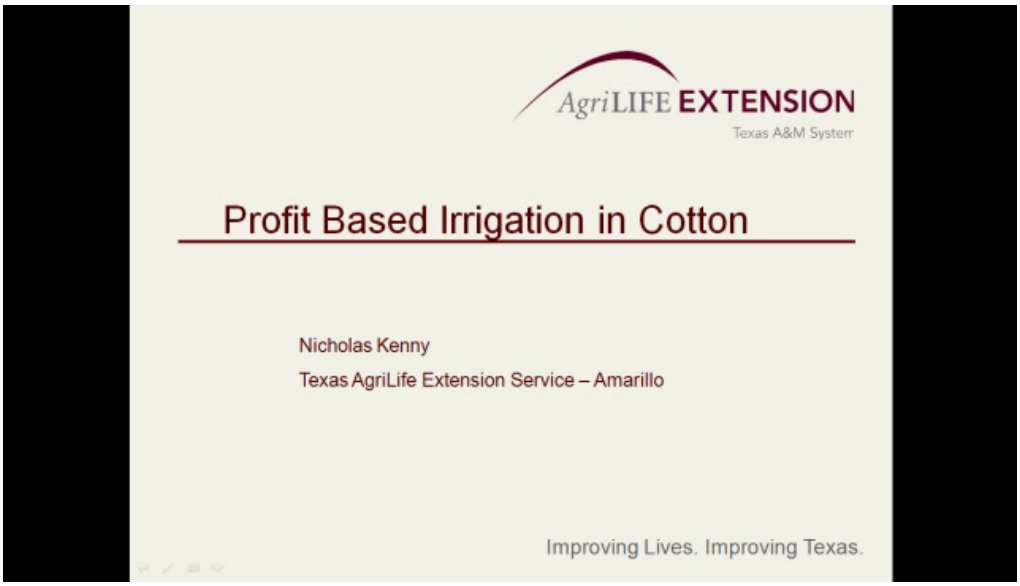


Figure 14. Snapshot of the "Profit Based Irrigation in Cotton" video.

The “Irrigation Profitability in Grain Corn” video (see figure 15) is similar to the profit based irrigation in cotton video. The grain corn production function differs from the cotton production function as do seasonal inputs and water demands. This video also provides an explanation of different measures of efficiency for irrigation. (Corn is addressed in the video series because it uses 53% of all the agricultural water resources within Region A).

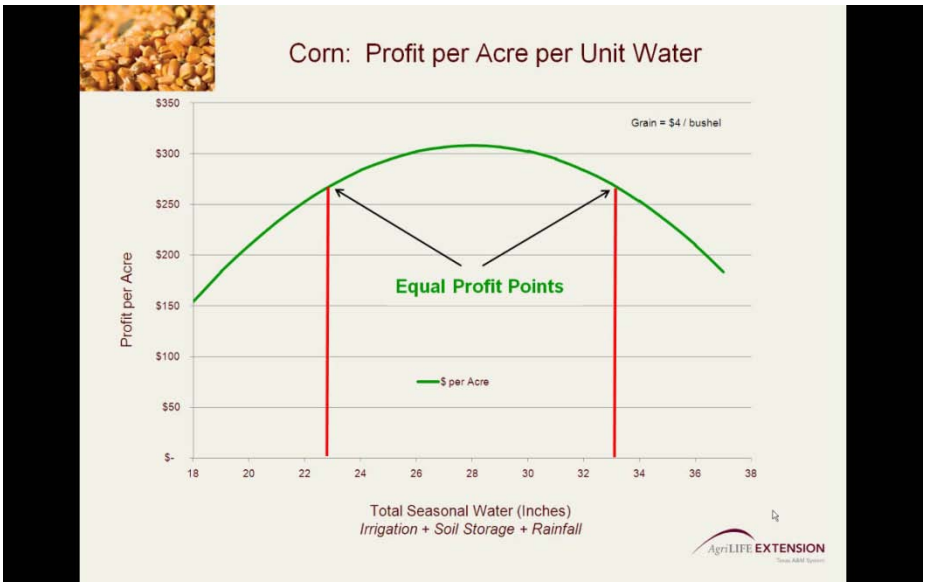


Figure 15. Snapshot of the "Irrigation Profitability in Grain Corn" video.

The “12-200 Corn Project” video (see figure 16) details information obtained from a study cooperatively conducted by the North Plains Research Field (north of Dumas, Texas; Marek et al., 2011) and the North Plains Groundwater Conservation District Board where the goal was to assess whether 200 bushel per acre corn yield is possible using no more than 12 inches of pumped irrigation water. This trial was conducted on a field scale under center pivot irrigation and was also performed by cooperating, irrigated District Board members.

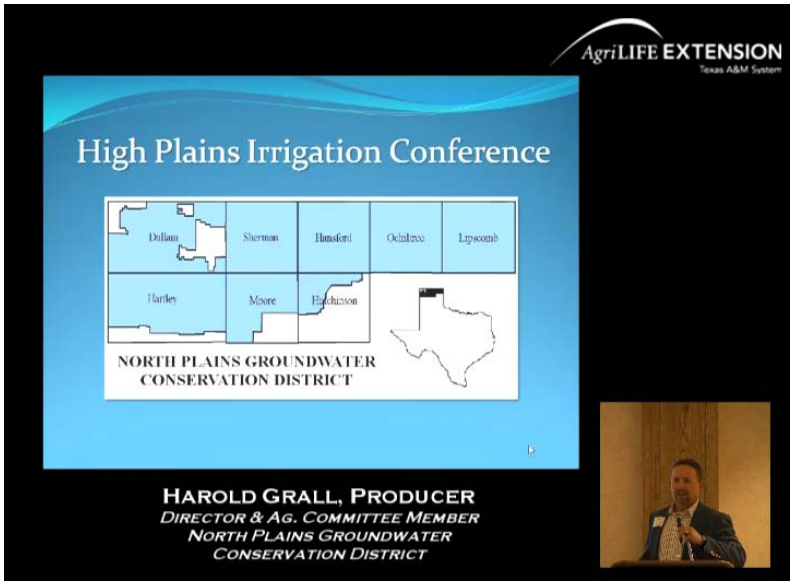


Figure 16. Snapshot of the "12-200 Corn Project" video.

As soil profile moisture is important and key to successful irrigation scheduling and crop production, a video on this subject was developed. The “Capacitance Probe Case Study” video (see figure 17) details results of a case study performed to analyze the effectiveness and accuracy of two commercially available capacitance probes. These probes can be used during the crop growing season to measure soil water content and to aid in scheduling irrigations accordingly. This video provides the results from the study which show that using this technology can improve water use efficiency and maximize profit by reducing inputs while maintaining yield.

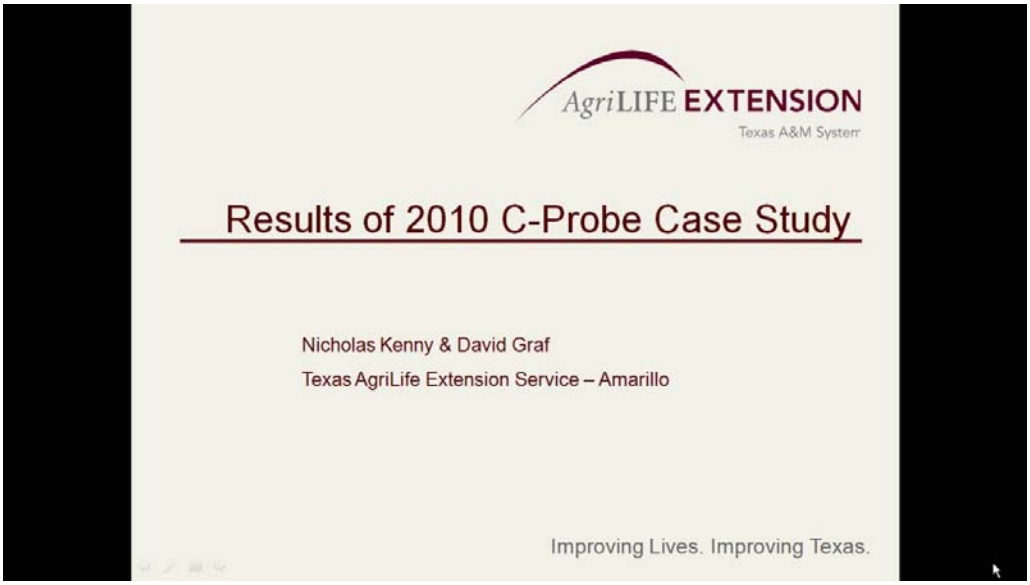


Figure 17. Snapshot of the "Capacitance Probe Case Study" video.

The “Strategic Irrigation Management Using C-Probes” video (see figure 18) provides another example of how capacitance probes can be useful to producers in managing their irrigations. This video also provides additional information on how scheduling and timing can play a large role in production and maximum yields. This video provides real examples from multiple trials using commercially available equipment.

Figure 18. Snapshot of the "Strategic Irrigation Management Using C-Probes" video.

Task 3

Develop youth based videos and materials

Today's youth do not have the knowledge of agriculture that was common to past generations. The videos in this task aim to educate and inform today's youth of the water demand agriculture has and the value gained from its use of that water. For those more familiar with agricultural production, the goal is to provide additional information for more efficient use of water resources.

Five videos were created and targeted for the youth audience: "Agriculture in the State of Texas", "Diminishing Water Resources", "The Water Cycle", "What is Drip Irrigation" and "Determining Soil Bulk Density".

The goal of "Agriculture in the State of Texas" (see figure 19) is to highlight the importance of agriculture. This video shows four of the major crops grown in Texas and includes corn, cotton, wheat and sorghum. It provides some basic information about each crop including the crop's rank in production acreage, rank in water consumption and a few uses for each crop.

Figure 19. Screenshot of the "Agriculture in the State of Texas" video.

The “Diminishing Water Resources” video (see figure 20) addresses this issue of concern in many areas of Texas. This video describes the uses of water, where water comes from, major and minor aquifers, future water availability projections and the need for conservation and management.

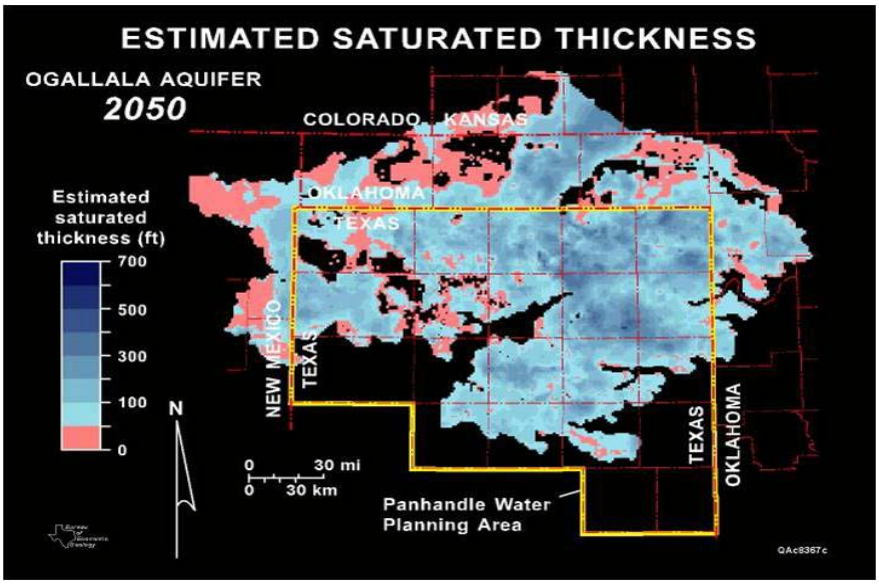


Figure 20. Screenshot of the "Diminishing Water Resources" video.

“The Water Cycle” video (see figure 21) describes natural water cycle processes, including what happens to water molecules. This video only includes the stages of evaporation, condensation and precipitation.

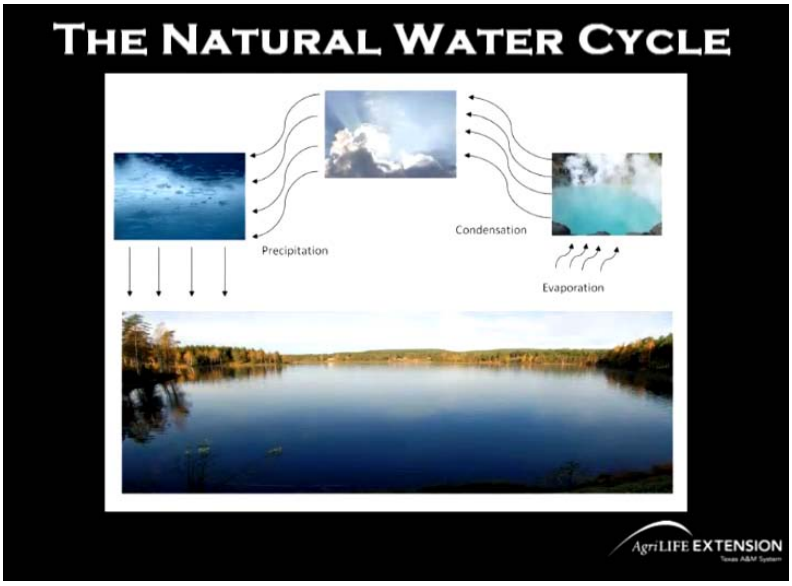


Figure 21. Screenshot of "The Water Cycle" video.

The video “What is Drip Irrigation” (see figure 22) is a general look at drip irrigation systems. It explains the components of a typical drip irrigation system, explains some of the differences between a center pivot irrigation system and drip irrigation and provides a few benefits of drip irrigation. This video was produced to promote efficient irrigation systems to future irrigators.

Figure 22. Snapshot of the "What is Drip Irrigation" video.

The video "Determining Soil Bulk Density" (see figure 23) provides a step by step guide to determining soil bulk density. This video illustrates the tools and equipment needed, the method and calculations necessary. Along with this information, video footage is shown of each step of the process. This process includes taking the soil sample, drying the sample and calculating the results. This video demonstrates how to determine soil bulk density, which is necessary to determine soil moisture content. Knowing soil moisture content is essential for accurate irrigation scheduling and seasonal water usage.

Figure 23. Snapshot of the "Determining Soil Bulk Density" video.

Task 4

Integrate profile and conduct trainings

The web based irrigation scheduler developed in this project was integrated as part of and into the new Water Management website (http://watermgmt.tamu.edu), as exhibited in Task 1, made necessary due to the shutdown of the Texas High Plains ET network. The Water Management website was named according to its targeted goal of not only addressing production topics for benefit to irrigators and producers, but to all water users. The website aims to deliver production information and useful tools to assist in water conservation and management for all water users. (Note: This website is functioning with ongoing development at the time of this report submission, and will be fully operational and publicly accessible by the time of this project's completion date.)

The homepage of the Water Management website contains a brief description of the website and how it is utilized, the organization and operation of the site and the anticipated data users (target audience - see figure 3). The homepage contains links at the top of the page to navigate to the user's profile, weather data, educational content, a partners and credits links page and a help

section. On the right side of the homepage is a login section, or if the user is already logged in to their profile, it will display their name with links to their profile or to sign out. Below the homepage's login section there is an "external links" section that provides the user links to additional water related websites, including the TWDB website. Below these links is the "video of the day" section. This section displays a small image of a single, randomly selected video available for viewing. This video is rotated on a daily basis (to prevent site stagnation). There is also a link below the video image to additional water related educational and information videos located within the website (see later in figure 27).

The "My Profile" tab (see figure 24) processes the user to their user profile (which the user previously defined), if signed in. If the user is not signed in, it takes the user to a log in, or sign up page. If the user is logged in, the page displays the user's information, which includes the user's name and email. There are "Configure" and "Password" buttons located within the user information section. The "Configure" button allows the user to change their profile first name, last name, or email address, as desired. The "Password" button allows the user to change their password. The user's old password is required to be input before the user can change to a new password.

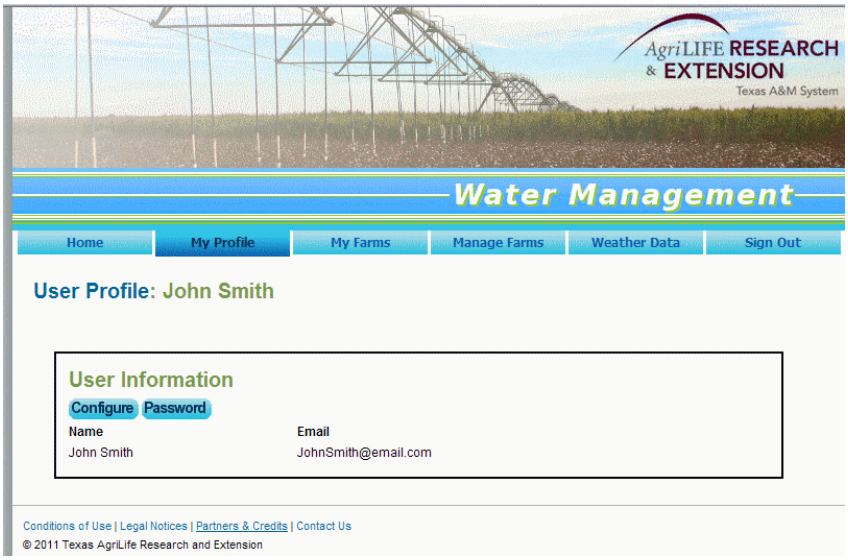


Figure 24. My Profile tab of the Water Management website.

The "My Farms" tab (see figure 25) displays a list of the user's farms with the farm name and description in separate columns. This page allows the user to select a farm to view and/or modify the fields within that farm. Using the mouse, hovering over the "My Farms" tab will display a drop down menu that lists the farms and allows the user to skip the "My Farms" section and go directly to an individual farm. Selecting a farm from the "My Farms" tab or from the page itself displays a page listing the fields within the farm and will allow the user to access data outputs or input rainfall or irrigation events related to that field.

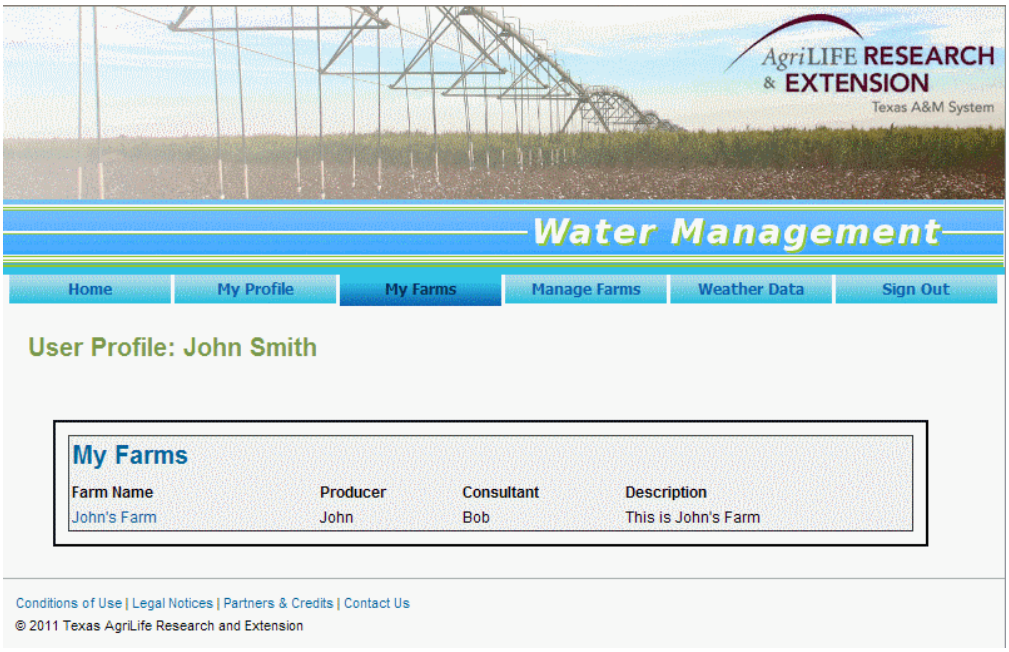


Figure 25. My Farms tab of the Water Management website.

The "Manage Farms" tab (see figure 26) displays a page that allows the user to add a new farm, modify an existing farm, or remove an existing farm. Selecting the "Modify" button will allow the user to modify a farm. The modifications allowed are the farm name, producer, consultant and farm description.

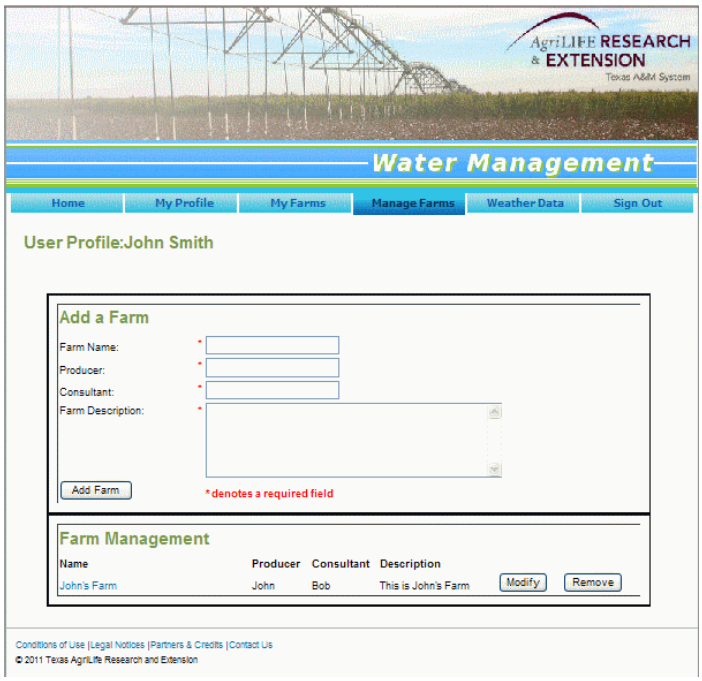


Figure 26. Manage Farms tab of the Water Management website.

The “Weather Data” tab displays the long term mean values of weather data parameters. Future plans are to develop the capability to include probability based values of the weather data parameters (as determined from ~20 years of records from the Texas High Plains ET Network) and will be added accordingly.

The “Sign Out” tab will log the user out of their profile and return them to the home page.

The “Weather Data” tab requires the user to be logged in to access the data. If the user is not logged in, they will be directed to a login screen. If logged in, the user will be directed to the weather data page that displays long term mean and probability based values for weather parameters.

The “Educational” tab (see figure 27) takes the user to a page that provides access to background information to support efficient irrigation management and proficient use of data and tools; videos for agricultural, youth and general audiences; and PDF format fact sheets and other publications.

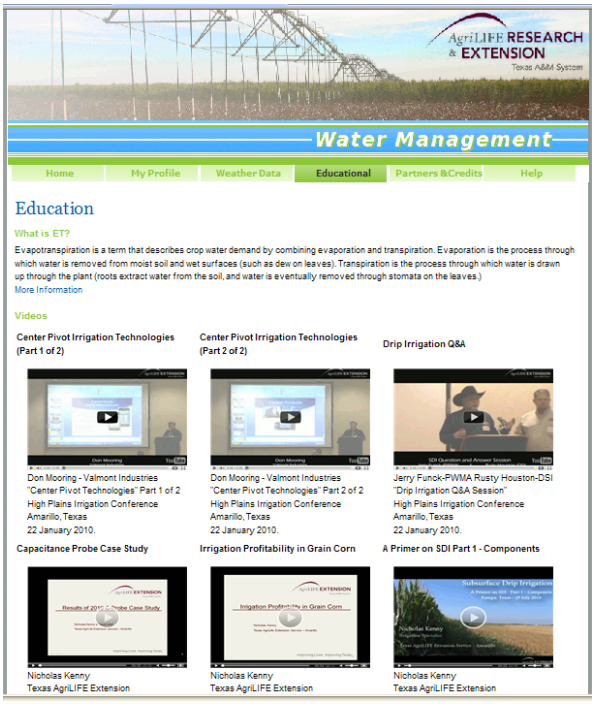


Figure 27. Educational tab of the Water Management website.

The “Help” tab provides the user with links to a sitemap, frequently asked questions and a website user manual.

Outreach and Dissemination

Details of this project, its goal and tasks and the new Water Management website were introduced to producers, researchers, extension agents and the general public at several meetings throughout the state of Texas.

The first of these meetings was at the Texas Agricultural Irrigation Association's High Plains Irrigation Conference (Amarillo Civic Center) in Amarillo on January 13, 2011. This was a full day conference featuring industry, research and agency speakers and a trade show to demonstrate new and current irrigation products and companies. A presentation overview of this project and website was given at this conference to inform those in attendance of the upcoming features and information they would be able to access through the internet. Other events where the Educational Enhancements were featured included the Ochiltree County Cotton Conference in Perryton, TX (January 19, 2011) and at the South Texas Irrigation Conference (see figure 28 and figure 29) in Uvalde, TX (February 2, 2011). The preliminary project report and new website were presented to the Texas Water Development Board-Agricultural Water Conservation Division in Austin, TX on February 18, 2011. Youth materials were presented at a Biological and Agricultural Engineering Department meeting with educators, on February 17, 2011 in College Station, TX and in a meeting with agricultural and science educators in Amarillo, TX on February 21, 2011. The effort has also been mentioned and discussed at several national irrigation related steering committee meetings by team members. In total, it is estimated that 400 persons have been exposed to this effort and its output to date.

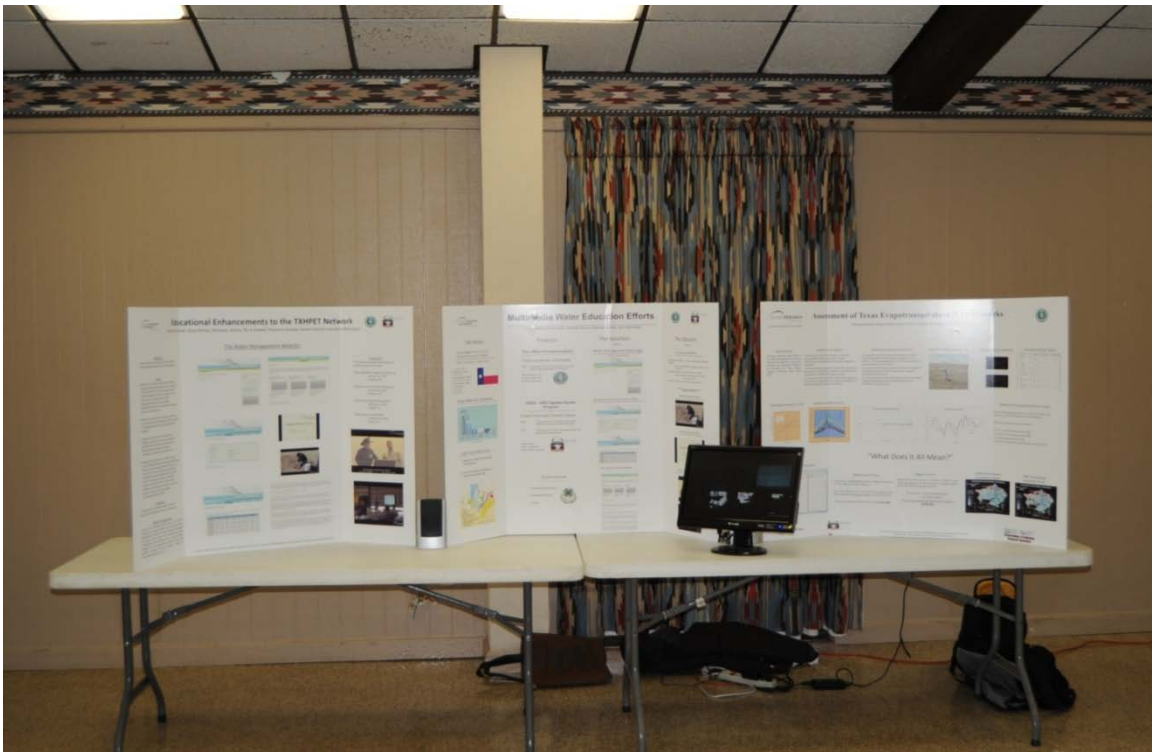


Figure 28. Texas AgriLife at Amarillo display at the South Texas Irrigation Conference. (These posters also included results of the recently completed Texas ET Assessment study conducted by Texas AgriLife and supported by the TWDB).

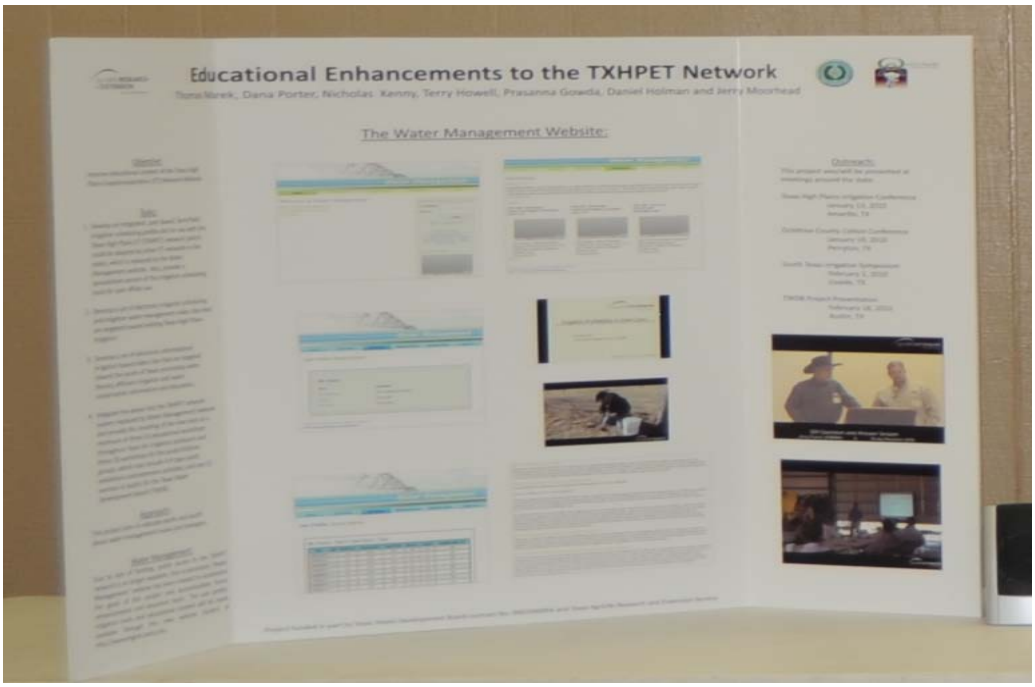


Figure 29. Educational Enhancements project poster displayed at the South Texas Irrigation Conference.

Delivering news and information about this project and development of the new website was highly important and deemed essential by the team members of this project. The new website will house water related information and provide valuable tools to all visitors. Educational content will be available to the general public and youth audiences to provide continuing information about agriculture and the necessity and value of irrigation. Many people do not realize how water is used for irrigation and how vital that irrigation is to farm production and agricultural products they consume. Also, most folks are unaware that local, regional and national food production is paramount to sustaining a national security issue of an adequate food supply. This new website addresses many of these issues with hope to enlighten all visitors to water management and conservation issues beneficial to all the citizens of the state of Texas.

Conclusions

An enhanced farm level, multiple field capable irrigation scheduling tool has been created for use by producers and crop consultants to reduce over-watering and improve irrigation efficiencies for the promotion of water conservation in Texas. This versatile tool has been programmed into a new Water Management website where diverse water related and educational information can be accessed. The action of creating a new website was necessary after shutdown of the Texas High Plains ET (TXHPET) network due to a lack of operational and maintenance funding. Although the website uses long term average values as defaults to allow the scheduler profile to run, the user can input custom ET and soil values as desired.

A set of both producer-based and youth oriented videos were developed to educate agricultural producers as well as young irrigators of tomorrow. It is viewed by the project team members that these educational efforts will be continued well past the project fulfillment with additional educational materials and videos to support improved water conservation and management.

Recommendations

It is recommended that as the current economic conditions warrant reduction and cutbacks in program efforts, including water conservation, that electronic outreach such as both informational and how-to videos continue to be developed and shared (or linked) among the numerous water conservation agencies. This effort will potentially lead to enhanced educational capabilities and efficiencies in production and save the State's water resources.

Additionally, as recommended in a previous project report by Marek et al. (2010) that the development of a plan for sustained ET data be developed and structured through sustained ET network operations. A mechanism or contract for data network support needs to be developed and agreed upon by the participating member, and the TWDB, as the State's water agency, should consider possession of the funding and coordination responsibilities. Additionally, a statewide database of accurate data should be electronically warehoused and made readily available for use in research, education and water planning. It appears the Texas Natural Resources Information System (TNRIS), the TWDB clearinghouse for natural resources and GIS data, would be an ideal warehouse location for such data. However, given the fiscal shortfall of the state, this will be a challenging task but one that should be addressed for the water resources of the citizens of Texas.

Water Savings

The water conservation benefits of this project cannot be measured directly in terms of water applied. However, data in the future from producer use of the online user profile should lead to records of application and improvements in water use efficiency and potential reductions in pumpage. Additionally, the impact of the educational videos and fact sheets can be assessed by tabulation of pages downloaded from the Water Management website logs.

An estimate of the impact derived from this effort, given that it is a short period after development, can be calculated assuming that irrigated producers, particularly large acreage

producers of the Texas Panhandle can benefit by reducing irrigation levels of 0.5 inches per acre from this information. Assuming 100 such producers with a mean irrigated farm acreage total of 3,500 acres results in a conservative water savings estimate impact of 175,000 acre inches (4.75 billion gallons) or nearly 15,000 acre feet of groundwater resources.

Attachment 1

TWDB Contract # 0903580956
"Educational Enhancement to the Texas High Plains Evapo-Transpiration Network"
Draft Final Report Comments

Page 5. Executive Summary

• Due to the unavailability of actual ET data, please describe in further detail the potential usefulness of "averaged based crop parameters". Will this result in actual water savings?

Page 8. Objective

• Please address the situation about the Texas High Plains ET network http://txhighplainset.tamu.edu and explain why the primary objective to enhance this network was not achieved according to the original scope of work.

• Please provide open access to the newly created website at http://watermgmt.tamu.edu. Currently, this is password protected and thus not available to the public.

Rebuttal response and comments:

Page 5 Executive Summary

Due to the unavailability of actual ET data, please describe in further detail the potential usefulness of "averaged based crop parameters". Will this result in actual water savings?

It is well established that near real time crop water demand estimates (crop ET, or ETc) based upon current reference ET (ETo) calculations are extremely valuable in scheduling irrigation. Irrigation replacement of soil water reduces the risk of over-irrigation (effectively a water waste), while minimizing the risk of crop loss due to excessive drought stress. Since real-time ETo and ETc are no longer available, long-term, average based crop water use estimates will provide a reasonable estimate of crop water use that can be used in irrigation planning, crop rotation

planning (according to water requirements of different crops) and even for in-season irrigation scheduling, provided the current weather patterns are near normal (i.e., not excessively hot/dry or cool/wet). In many cases, even the average based values are an improvement over other irrigation scheduling practices of growers. Furthermore, the average crop water use information provides users the necessary inputs to utilize the user tool developed in this project so that they may become familiar with its capabilities. Users can also input "real-time" data from alternative sources, where available.
Average based data will also be useful in teaching and training applications. Water savings are expected to result from better management and scheduling of irrigation as a result of knowledge gained in these teaching/training opportunities.

A statement was added to the executive summary regarding the concern of application.

Page 8 Objective

Please address the situation about the Texas High Plains ET network http://txhighplainset.tamu.edu/ and explain why the primary objective to enhance this network was not achieved according to the original scope of work.

The objective to develop an integrated irrigation scheduling tool for the Texas High Plains ET Network was achieved and the tool's source code is being provided to the TWDB with this final report. Thus, the primary objective was effectively achieved. However, exhaustive and sustained efforts by the project team have failed to secure the required funding for continued operation of the Texas High Plains ET (TXHPET) Network, particularly as the state and associated agencies have experienced significant budget reductions with more anticipated for the next biennium (or beyond). At the time of the project proposal and initiation, the action to shut down the Texas High Plains ET network was not envisioned. Subsequently, recommendations in this report (and others) for the TWDB to manage support of state ET networks was proposed to provide critical ET data continuity going forward as the data have significant usage and value in both operational and planning venues.

References

Evans, Robert, R.E. Sneed and D.K. Cassel. 1996. Irrigation scheduling to improve water and energy use efficiencies. North Carolina Cooperative Extension Service. Publication Number: AG 452-4. Available at: www.bae.ncsu.edu/programs/extension/evans/ag452-4.html. Accessed 2/22/2011.

Kisekka, Isaya, Kati W Migliaccio, Bruce Schaffer, Jonathan H Crane, Michael D Dukes. 2009. Evaluation of Evapotranspiration-Based Irrigation Controllers in a Tropical Fruit Orchard in Southern Florida. ASABE Paper No. 095701. American Society of Agricultural and Biological Engineers, St. Joseph, Michigan.

Marek, T.H. and D.O. Porter. 2009. The Texas High Plains ET (TXHPET) Network . Proceedings of the 21st Annual Central Plains Irrigation Conference, Colby Kansas, February 24-25, 2009.

Marek, Thomas H., Dana O. Porter, Prasanna Gowda, Terry A. Howell and Jerry E. Moorhead. 2010. Assessment of Texas Evapotranspiration (ET) Networks. Technical Report for Contract #0903580904 to the Texas Water Development Board, Austin, Texas. Texas AgriLife Research, Amarillo, Texas. AREC publication 201011-12. 379p.

Marek, Thomas, Wenwei Xu, Qingwu Xue, Brent Bean, G.J. Michels, S.H. Amosson, J. Moorhead, N.P. Kenny, J.M. Sweeten, T.A. Howell, P.D. Colaizzi and P. Gowda. 2011. 2010 North Plains Research Field 12-200 Limited Irrigation Corn Production Study. Texas AgriLife Research at Amarillo. AREC 2011-2. 57p.

Piccinni, G. D. Leskovar. W.L. Harman, T.H. Marek and B.L. Harris. 2009. Precision Irrigators Network: On-Farm Research Demonstration to Evaluate Irrigation Scheduling Tools in the Wintergarden and Texas High Plains. TWDB contract 0602580596. Texas Water Resources Institute, College Station, TX. 92p.

PWPG. 2010. Panhandle Water Planning Group Regional Water Plan Main Report. September 2010. Available at: www.panhandlewater.org/2011_adopted_plan.html. Accessed 1/4/2011.

TWDB. 2010. Texas Water Development Board. Available at: www.twdb.state.tx.us/wrpi/rwp/3rdround/2011RWP.asp. Accessed 2/22/2010.

Walthour, Steve, 2009. North Plans Groundwater Conservation District, Dumas, TX. (Personal communication.)

This report may be referenced as follows:
Marek, T.H., D.P. Porter, N.P. Kenny, P.H. Gowda, T.A. Howell and J.E. Moorhead. 2011. Educational Enhancements to the Texas High Plains Evapotranspiration (ET) Network. Technical Report for Contract #0903580956 to the Texas Water Development Board, Austin, Texas. Texas AgriLife Research, Amarillo, Texas. AREC publication 2011-8. 34p.