DECISION SUPPORT SYSTEMS:
Tools for Implementing Water Conservation
Best Management Practices in Texas

EM 100
August 2007
Precision Irrigators Network

Funded by
Texas Water Development Board
Contract # 2005-358-023

Authors:
Josh Bynum, Graduate Student, Department of Soil and Crop Sciences
Tom Cothren, Professor, Department of Soil and Crop Sciences
Tom Marek, Amarillo Research and Extension Center
Giovanni Piccinni, Crop Physiologist, Uvalde Agricultural Research and Extension Center

Editing and Formatting:
Danielle Supercinski, Communications Coordinator & Project Manager, Texas Water Resources Institute
Cecilia Wagner, Project Manager, Texas Water Resources Institute

Edited and published by the
Texas Water Resources Institute
1500 Research Parkway, Suite A240
2118 TAMU
College Station, TX 77843-2118

Texas Agricultural Experiment Station, Texas A&M University
Texas A&M Agricultural Research and Extension Center, Uvalde, TX 78801
  http://uvalde.tamu.edu/
  Ph: 830.278.9151    Fax: 830.278.1570
Texas A&M Agricultural Research and Extension Center, Amarillo, TX 79106
  http://amarillo.tamu.edu/
  Ph: 806.677.5600    Fax: 806.677.5644
Department of Soil and Crop Sciences, College Station, TX 77843
  http://soilcrop.tamu.edu/
  Ph: 979.845.0360    Fax: 979.845.0456
Texas Water Resources Institute, College Station, TX 77843
  http://twri.tamu.edu
  Ph: 979.845.1851    Fax: 979.845.8554
Table of Contents

Introduction .....................................................................................................................................1

Most Currently Developed DSS .....................................................................................................2
   TXHPET ........................................................................................................................................2
   PIN .............................................................................................................................................3
   CroPMa ......................................................................................................................................3

Potential Cost and Water Savings from Adopting and Implementing a DSS .........................3

How to Use DSS .............................................................................................................................5
   Case 1 – TXHPET ......................................................................................................................5
   Case 2 – PIN ...............................................................................................................................6
   Case 3 – CroPMa .......................................................................................................................8

Conclusion .....................................................................................................................................10

References ....................................................................................................................................11
DECISION SUPPORT SYSTEMS:

Introduction
Identifying best management practices (BMPs) promoting greater water use efficiency while maintaining crop yields is essential to the future of Texas cropping systems. Available water for irrigated crops is vital for sustaining crop production throughout the state. However, the availability of this water for irrigation is diminishing through competition by urban development and, in some regions such as the Edwards Aquifer, is falling under state regulation. The awareness and improvement of efficient irrigation and best management practices to conserve water while maintaining crop production will help preserve the aquifer levels and increase water savings to producers.

One component of BMPs for conserving water use is the application of decision support systems (DSS) that are used as tools for implementing irrigation BMPs. This DSS guide was developed as a complement to TWDB Report 362, “Water Conservation Best Management Practices Guide,” which is a more comprehensive report on water conservation including an “Agricultural Irrigation Water Use Management” BMPs section. The full TWDB Report 362 can be found at: http://www.twdb.state.tx.us/assistance/conservation/consindex.asp.

DSS include the Texas High Plains Evapotranspiration Network (TXHPET), the Precision Irrigators Network (PIN) and the Crop Production Management (CroPMan) model. These DSS strive to promote grower awareness of water conservation strategies. Irrigation conservation strategies are proposed to result in savings of approximately 1.4 million acre-feet per year by 2060 (TWDB and TWRI).

TXHPET operates 18 meteorological stations located in 15 counties across the Texas North Plains and Texas South Plains. The regional coverage of TXHPET is estimated at 4 million irrigated acres. The network offers insight to evapotranspiration (ET)-based crop water use that producers and agricultural consultants can reference when making decisions on when and how much to irrigate their crops. This information is available to data users via fax or online (http://txhighplainset.tamu.edu) and currently results in approximately 300,000 downloads or faxes annually.

The PIN program was formed in 2004 with a goal of saving millions of gallons of water annually by reducing irrigation water use by as much as 20 percent over several years and currently supports several crops (corn, cotton, sorghum, wheat) in seven counties of South Central Texas. Cooperation of the PIN programs consists of area producers, Texas Agricultural Experiment Station researchers, Texas Cooperative Extension personnel, San Antonio Water System, Edwards Aquifer Authority, Texas Water Resources Institute, Texas Water Development Board, Uvalde County Underground Water Conservation District and Wintergarden Water Conservation District. The PIN database will allow producers to gain historical and real-time information for better management of irrigation scheduling. The PIN program estimates that when all irrigators in the Edwards Aquifer region implement limited irrigation scheduling, approximately 50,000 to 60,000 acre-feet of water can be saved per year and made available for purposes other than agriculture.
CroPMan is a computer model designed to aid producers and agricultural consultants in optimizing crop management and maximizing production and profit through a production-risk approach. CroPMan will help growers identify limitations to crop yield, assist in making replant decisions and help recognize management practices that reduce the impact of agriculture on soil erosion and water quality. CroPMan is a Windows-based application program that can be downloaded from the CroPMan Web site (http://cropman.brc.tamus.edu).

**Most Currently Developed DSS**

**TXHPET**

Total crop water demand can be estimated by ET. ET represents the combination of water lost through evaporation of moist soil and wet surfaces, and the water lost through plant leaves by transpiration. Data collected from the 18 weather stations that make up the TXHPET are used to calculate daily reference crop (well-watered grass or alfalfa) ET. Based on the ET of the reference crop, specific ET values for individual crops are then produced.

For example, when using TXHPET, sum up the daily ET values from the nearest weather station for your crop of interest for a week. If no rainfall occurred during the week to replenish the crop water demand, the summation of ET is the amount of irrigation required to prevent crop stress. The use of TXHPET allows producers the ability to make in-season irrigation decisions.

![Figure 1. PET networks across Texas provide regional data to guide producers’ irrigation decisions.](image)
**PIN**
The formation of PIN has greatly impacted producer awareness of water conserving strategies. The increasing value of water in the Edwards Aquifer region has challenged PIN to search for management practices allowing efficient crop water use. Data in the Edwards Aquifer region suggests that ET overestimates the amount of irrigation needed (Falkenberg et al., 2006). Water savings in this region are possible without depletion of yield when only 75 percent of the ET is replenished with irrigation. The PIN program allows producers to precisely manage their irrigation scheduling in-season in a way that maximizes their returns and ensures irrigation water for coming years.

**CroPMan**
CroPMan is a Windows-based computer application model that can simulate crop management practices and climatic and edaphic conditions allowing producers to see the impact on crop yield, soil properties, soil erosion, profitability and nutrient/pesticide fate. CroPMan permits agricultural consultants and producers to form strategic assessments over years for best management practices and also allows them to run real-time analysis to determine the amount and timing of irrigation. Of the DSS discussed, CroPMan is the only system that allows producers the advantage of long-term planning for the future.

**Potential Cost and Water Savings from Adopting and Implementing a DSS**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Current mean water usage</th>
<th>Simulated water usage to maintain yield at current water usage under varying irrigation types</th>
<th>Irrigated crop acreage in region</th>
<th>Potential water savings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>inches/acre/year</td>
<td>inches/acre/year</td>
<td>Acres</td>
<td>acre-ft/year</td>
</tr>
<tr>
<td></td>
<td>Furrow</td>
<td>Sprinkler-LAPA</td>
<td>Buried Drip (12&quot;)</td>
<td>Furow</td>
</tr>
<tr>
<td>Corn</td>
<td>24</td>
<td>14</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>21</td>
<td>19</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Grain</td>
<td>18</td>
<td>10</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Sorghum</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>30</td>
<td>24</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Data collected from the NASS 2005 census data in Cameron, Willacy, Hidalgo and Starr counties.
2 Water savings for each irrigation type is based on total acreage of crop.

Table 1. Potential water savings while maintaining yield from implementing decision support systems.
Figure 2. Probabilities for net returns associated with the percent of total irrigation water available applied to either cotton, corn or grain sorghum.

Figure 2 indicates the probability of net returns based on the percentage of acres planted to cotton, corn and/or grain sorghum based on 2 acre-feet per year of available irrigation. The red indicates the probability that net returns will be less than $0.000 per acre, yellow indicates net returns ranging from $0.000 to $100.000 per acre, and green indicates the probability of net returns exceeding $100.000 per acre. The first bar represents a farmer placing all his/her acres in cotton production. The second bar displays the probability for returns if a producer chooses to grow corn on all his/her acres. The third bar corresponds to the probability of net returns per acre if all the acres are planted to grain sorghum. The rest of the bars indicate the probability of net returns if producers’ acres are split into cotton, corn and grain sorghum. The numbers on the x-axis below each bar represent the percent of total acres planted to cotton, corn or grain sorghum. For example, the bar on the far right is the probability of net returns when 60 percent of the acres are planted to cotton, 20 percent are planted to corn and 20 percent are planted to grain sorghum.
How to Use a DSS

Case 1 – TXHPET

Steps:

1. To look at daily water use and other climatic factors for your region, go to http://txhighplainset.tamu.edu.
2. From the homepage (Figure 3) click on the Weather Data tab.

3. Once weather data has been selected, click on “Daily” to receive daily readings.
4. The Daily Weather Page (Figure 4) will open and ask the user to select a location, type of data (i.e. crop water use), dates for viewing, units of measurement and how the users want to view the data.
5. After the information is submitted a data report will be generated. For example, Figure 5 is the result of selecting Dalhart as the location, water use for short-season corn during the time range of May 1, 2007 through May 13, 2007. The units selected are English and the report is in table format.

Figure 3. Homepage of the Texas High Plains Evapotranspiration Network (http://txhighplainset.tamu.edu).

Figure 4. Options for daily reading data.

Figure 5. Short-season corn water use in Dalhart, Texas, for May 1 through May 13, 2007.
When using tables such as that in Figure 5 as a guide for making irrigation decisions, sum the water-use column and subtract the amount of rainfall received by the farm of interest. If the number is less than zero, no irrigation is needed. If the number is above zero, that is the amount of irrigation needed to prevent crop-water stress.

**Case 2 – PIN**
Precise calculation of ET is crucial to meeting the proper water demand by the crop. Figure 6 illustrates several methods and their calculation of ET throughout part of the corn growing season.

**Steps:**
1. To calculate or determine ET, go to the Texas A&M University Agricultural Research and Extension Center at Uvalde homepage at [http://uvalde.tamu.edu](http://uvalde.tamu.edu).
2. On the homepage (Figure 7), click PET and select the county nearest your location of interest. For example if your farm is located in Uvalde County, click on Uvalde.

3. Click on the date of interest to identify the crop-water use and climate for that date. In the example below, May 17, 2007, was selected for determination of cotton water use.

![Figure 8. Water use table for cotton selected for May 17, 2007.](image)

When reading the table as in Figure 8, users should choose the date that most closely approximates their planting date. The “Growth Stage” column should be close to the maturity of the user’s crop. The “Day” column represents the amount of ET lost by the crop for May 17. The “3 day” and “7 day” columns are the average daily ET for the previous 3 and 7 days, respectively. The “Seas. in.” column reports the total water lost through ET for the growing season up to May 17.

When making irrigation decisions, sum the amount of daily ET for a given number of days. If the amount of daily ET is not replenished by rainfall, then that is the amount of irrigation required to prevent crop water stress.
Case 3 – CroPMan
Implementing CroPMan must first begin with calibration to the user’s region. Ongoing research is being conducted to validate CroPMan in all regions of Texas. The validation procedure uses actual measured yield points in comparison with CroPMan simulated yields. An example of sugarcane yield validation in the Lower Rio Grande Valley can be seen in Figure 9.

![CroPMan Validation of Sugarcane in the LRGV](image)

Figure 9. Validation of CroPMan for sugarcane yields using research data.

![CroPMan homepage](image)

Figure 10. The CroPMan homepage at [http://cropman.brc.tamus.edu](http://cropman.brc.tamus.edu).
Steps:
1. From the homepage (Figure 10), click on “Decision Aids” and then select “IRRIG-AID.”
   The irrigation strategy worksheet (Figure 11) will appear.
2. When all the necessary worksheets are filled in a profit analysis of irrigated crops spreadsheet (Figure 12) is generated to guide producers in the best management decision for their crop.

### Figure 11. Irrigation strategy worksheet for Lower Rio Grande Valley irrigators.
Conclusion

Producers must begin exercising best management practices to ensure the sustainability of their farm for future years. The above mentioned DSS will aid producers in managing their production risk, while maintaining profitable yields and conserving irrigation water. By implementing the above DSS, producers will be making educated, economically sound decisions on which crop to plant, how much and when to apply irrigation, and other crop management decisions in an effort to maximize water use efficiency and profits.

Figure 12. Profit analysis of irrigated crops.
**References**


