

KanSched An ET-Based Irrigation Scheduling Tool for Kansas Summer Annual Crops

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KanSched is a computer software program that is designed to help monitor the root zone soil profile water balance and schedule irrigation events on a field using evapotranspiration (ET) data. The program can also be used to monitor the soil profile water content of non-irrigated fields. ET-based irrigation scheduling is a tool that can help you determine when and how much irrigation water to apply. The basic process involves using data on crop water use (crop evapotranspiration or ETc), rainfall, and soil water storage to assess when an irrigation event is needed and how much water could be applied. KanSched was developed to be user friendly with minimal training requirements and operational inputs.

This program was developed as part of the Mobile Irrigation Lab, which is supported by a partnership between K-State Research and Extension, the Kansas Water Office with State Water Plan Funds, Kansas Water Resources Research Institute, and the Kansas Corn Commission.

General Overview

Irrigation scheduling that uses ET information is much like checkbook accounting procedures where the valued commodities are tracked. In this case, soil water, rather than money, is the valued commodity and the debit is crop water use while credits are rainfall and irrigation. One notable difference is that the water balance can be too high as well as deficient. ETc, short for crop evapotranspiration, is the amount of water that a crop withdraws from the soil water reserve. Deposits to the soil water reserve are rainfall and applied irrigation. The major goal of the accounting procedure is to help the irrigation manager keep the amount of water in reserve above a minimum soil water balance level to prevent water stress to the growing crop. The upper limit to the account is the amount of water that can be physically stored in the root zone area of the soil profile. Deposits of water, once the upper limit is exceeded, result in the water being lost as either deep percolation or surface runoff. Irrigation scheduling can help minimize deep percolation losses, although even the most rigorously followed schedule cannot prevent all losses since large rainfall events can exceed soil water storage capacity by themselves. The benefits of irrigation scheduling generally translate into increased net returns

through several possible avenues. Irrigation scheduling may also reduce irrigation labor and equipment operation pumping cost, and may also result in improved yields due to less water stress or less loss of fertilizer due to leaching.

One of the major obstacles to adoption of on-farm irrigation scheduling has been the time management problem of gathering, processing, and implementing scheduling on a daily irrigation cycle period. Computer technology presents the opportunity for information gathering, transferring, and processing to be done much more easily, efficiently, and sometimes automatically. Scheduling software, communication, and control technology exists that can provide management recommendations which could then be remotely implemented. This text will describe the basics of KanSched and illustrate some of the input windows and help screens.

The Start Screen

Each time KanSched is started the screen in Figure 1 appears and the operator has several options to choose from depending on how the program is to be used.

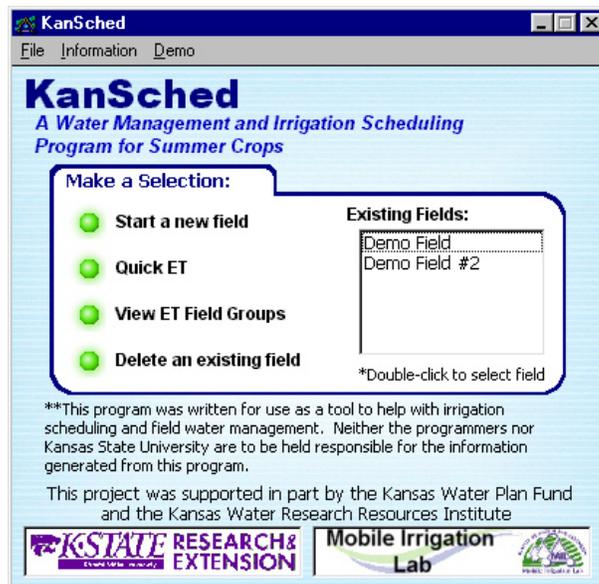


Figure 1 – The start screen of KanSched

To initialize a new field, click the green button labeled “Start a new field”. A new window will appear displaying the input boxes for the initial field information and soil information (Figure 2). The input screen will be discussed in detail later.

KanSched Demo Field Input Sheet

Monday, August 26, 2002
Current Field: Demo Field

Field Name or ID: Demo Field

Soil Available Water Holding Capacity: 0.14 (in. water/in. soil)

Soil Permanent Wilting Point: 0.09 (in. water/in. soil)

Emergence Date: 5/25/2002 (ex. 5/15/2002)

Date to Start the Water Budget: 5/30/2002 (ex. 5/20/2002)

Root Depth on the Start Date: 3 (inches)

Maximum Managed Root Zone Depth: 24 (inches)

Date the Crop Canopy Cover Exceeds 10% of the field area: 6/12/2002 (ex. 6/1/2002)

Date the Crop Canopy Cover Exceeds 70 - 80% of the field area: 7/8/2002 (ex. 6/25/2002)

Date when the Crop is at Initial Maturation: 8/30/2002 (ex. 8/1/2002)

Date of the End of the Growing Season: 9/22/2002 (ex. 8/25/2002)

The initial crop coefficient: 0.25 (ex. 0.25)

The maximum crop coefficient: 1.15 (ex. 1.10)

The final crop coefficient: 0.45 (ex. 0.65)

Management Allowed Deficit (MAD): 50 %

Initial Soil Water Availability: 100 %

Field ET Info

Select an ET field group from the list:

sadfsa

- For your convenience, all fields in this group will be updated with the same daily Reference ET value.

This field uses individual ET data

Create a new group

View groups

To enable the help options, click here ?

Start Screen

Figure 2 – The input data screen of KanSched

KanSched can be set up to allow quick entry of daily reference ET data for a group of fields that are in the same region with the use of the “Quick ET Update”. When an ET group is selected, the fields within the group can all be updated with ET values at one time.

Entering Information Into KanSched

Before KanSched can begin tracking the field’s soil water content and crop water usage, information about the soil type, growing season, and crop for each field are needed as follows. The Input Screen

The Input screen (Figure 2) requires some information that characterizes the soil type, growing season, and crop type for a field. All of the inputs on this screen must be entered before KanSched can track your field’s soil water content and crop water usage. If some of these values are unknown, simply click the question mark button  in the lower right corner of the screen to obtain a help screen. Help is available in any of the sections that become highlighted, and accessed by clicking on the question mark button associated with a section. Help screens are available for soil characteristics, crop growth characteristics, and crop coefficients.

Soil Available Water Holding Capacity and Soil Permanent Wilting Point:

The soil available water (AW) holding capacity value is a measure of the maximum amount of water a soil can hold that is usable to the crop. The soil permanent wilting point (PWP) value is the water content of the soil when the crop cannot pull the water from the soil, causing the plant to wilt. Both of these values are measured in inches of water per inch of soil. If these values are not known, simply click the help button in the lower right hand corner of the input screen to enable the help options, then select the help button in the soil characteristics section. The help screen for the soil section is

shown in Figure 3. The soil's water holding characteristic value can be selected based on the soil texture from the drop-down list at the top of the screen. The default values on this help page are from the NRCS soil characteristic database.

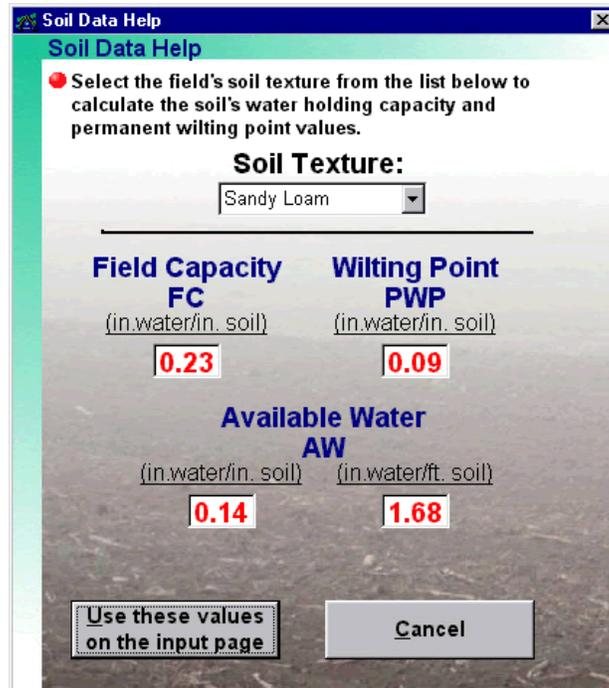


Figure 3 – The Soil Help Screen

Emergence Date:

KanSched needs to know the emergence date of the crop in order to start tracking water usage. The emergence date is simply the date your crop emerges from the ground after planting.

Date to Start the Water Budget:

The water budget start date is the date that KanSched will actually start tracking the soil water content. This date must be after the emergence date.

Root Depth on the Start Date:

KanSched tracks root growth throughout the season. In order to do this, it must know the root depth on the date it starts the water budget. This can be determined by going out to the field on the start day and dig around the crop to measure the root depth. The root depth can also be set to the desired management depth at this time as well.

Maximum Managed Root Zone:

Entering a maximum managed root zone lets KanSched calculate the maximum depth of the soil profile that your crop can draw water from. While the actual root depth may be deeper, this value is the managed depth for the crop's roots.

Normally, managed root zone depth is 3 to 4 feet unless the root-depth is limited by restrictive soils.

Date the Crop Canopy Cover Exceeds 10% of the field area, Date the Crop Canopy Cover Exceeds 70-80% of the field area, Date when the Crop is at Initial Maturation, and Date of the End of the Growing Season :

Crop Date Help

● Select the appropriate crop type, emergence date, and season length then click the "Calculate Values" button to calculate the crop canopy coverage dates and the recommended crop coefficients.

Crop Type:

Enter the season length, in days: (ex. 100)

Enter the emergence date here: (ex. 5/15/2002)

Calculate Values

Date crop canopy exceeds 10%: **6/11/2002**

Date crop canopy exceeds 70 - 80%: **7/9/2002**

Date of initial decline: **8/11/2002**

End of season date: **9/2/2002**

Use these values on the input page **Cancel**

Figure 4 – The Crop Date Help Screen

The above dates are required by KanSched in order to monitor the growth stages of the crop and to create a crop coefficient curve. Assistance with calculating these values is available using the help option in this section, shown in Figure 4. Select the crop type, enter the season length and emergence date and press the **Calculate Values** button. The calculated values are displayed at the bottom of the screen. Click the "Use these values on the input page" button to automatically enter these values on the input screen; however, they can be adjusted later if needed.

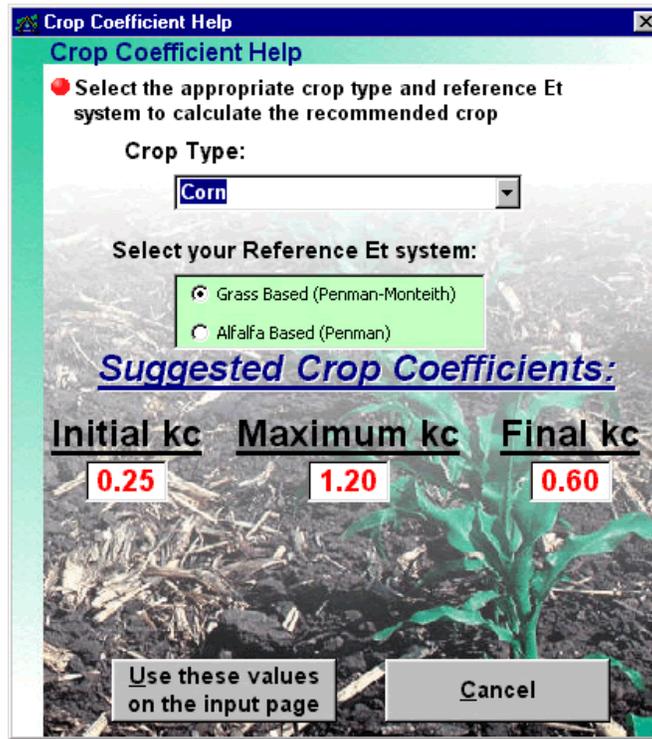


Figure 5 – The Crop Coefficient Help Screen

The Initial Crop Coefficient, The Maximum Crop Coefficient, and The Final Crop Coefficient:

To determine how much water the crop is using, KanSched uses crop coefficients. The crop coefficient changes over the season; starting very small, increasing as the crop grows, peaking at the beginning of reproduction, then declining as the plant's water usage stops with maturation. To gain assistance with calculating these values, enable the help options and click the associated question mark button. The Crop Coefficient Help screen is shown in Figure 5. Select the crop type and the reference ET system.

Management Allowed Deficit (MAD):

The Management Allowed Deficit is the guideline on the percentage of the available water in the soil that will be removed by the crop before crop water stress is likely. The MAD value will vary across different crops and according to how risk adverse a producer is a MAD of 50 percent is recommended for most row crops.

Initial Soil Water Availability:

Before KanSched starts tracking your soil water content, it must have an initial value to start with. The initial soil water availability is the percentage of available water to the crop on the budget start date entered earlier. A value of zero (0%) is associated with the permanent wilting point water content while a value of 100% represents a full profile at the field capacity level. KanSched defaults to 100%, but this value usually needs to be changed to reflect the initial soil water value.

The Budget Screen

The Budget screen (Figure 6) consists of rows of input for each day. These inputs include reference ET, rainfall, and gross irrigation. When these inputs are entered into

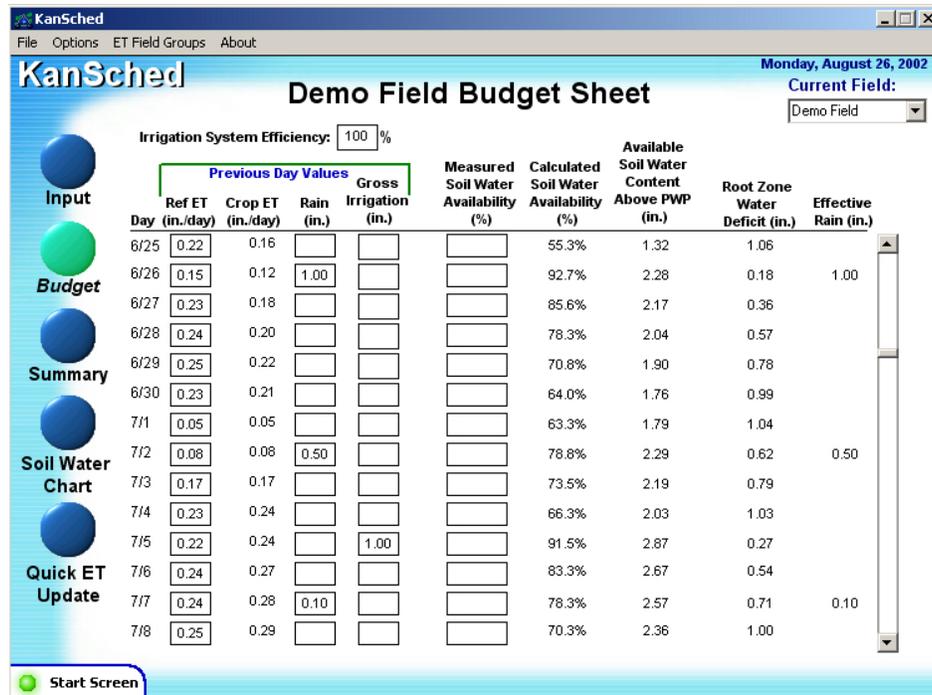


Figure 6 – The Budget Sheet

KanSched, it can track the soil water that is available to the crop. The following sections describe the individual inputs needed and the program's output.

Reference ET and Crop ET

The reference ET values can be obtained from on-site measurements or from an automated weather station in the region. This value needs to be entered for each day of the season as KanSched tracks the water content. However, ET values from several days can be entered at one time. The reference ET can also be updated using the Quick ET button from the start screen.

After the daily reference ET value is entered, KanSched will calculate and display the crop ET. This value is the amount of water (in inches) the crop used during each of the listed days. KanSched uses the crop coefficient values and the reference ET values to calculate the crop ET value.

Rain and Effective Rain

Whenever the crop receives rainfall, the value is entered for the appropriate day and it will then be used to calculate the soil's current water content.

How does KanSched handle rainfall events on a soil that is already at field capacity? Basically, when the soil profile is at field capacity, any water that is applied to the field

will either run off or be lost in the soil through deep percolation. KanSched keeps track of the soil's current profile status and will ignore any rainfall or irrigation events that occur on the soil when it has reached field capacity. This ensures that the program will not credit the soil with more water than it can hold when it receives many rainfall events (or one large rainfall event) in a short period of time.

Gross Irrigation

Input gross irrigation amounts into KanSched whenever an irrigation event occurs. At the top of the budget sheet (Figure 6) is an input box labeled *Irrigation System Efficiency*. By default, a value of 100% is entered, meaning that KanSched uses the exact value entered into the Gross Irrigation box. The estimated efficiency of the system should be entered into this box. Then, each Gross Irrigation value will be recalculated to a Net Irrigation value.

Measured Soil Water Availability

KanSched allows the option of entering a new Soil Water Availability value any time during the irrigation season. KanSched tends to be a conservative estimate of soil water. Therefore, if KanSched is indicating that the soil is drier than it actually is, simply enter a new value for the soil water availability, automatically recalibrating KanSched to the accurate field-based values.

Calculated Soil Water Availability

KanSched's calculation of the available water in the soil is displayed in the *Calculated Soil Water Availability* column. This value can be defined as the percent of water that is available for the crop to use from the available water profile. When this value drops below the MAD value, the *Calculating Soil Water Availability* numbers turn red, alerting the manager to the current situation. A value of zero (0%) represents PWP while 100% represents field capacity.

Available Soil Water Content Above PWP

Another way that KanSched interprets the soil's current water content is in the *Available Soil Water Content Above PWP* column. This is an estimate of approximately how much water is in the soil that the crop can use before it enters the permanent wilting point. Keep in mind that when the water content reaches the MAD value, crop stress is beginning to occur.

Root Zone Water Deficit

The *Root Zone Water Deficit* value displays how much water (in inches) the managed root zone soil profile needs before the water would be lost either to runoff or deep percolation.

Soil Water Chart

One of KanSched's most useful features is the Soil Water Chart, shown in Figure 7. This chart shows a visual representation of the field soil water content as it changes

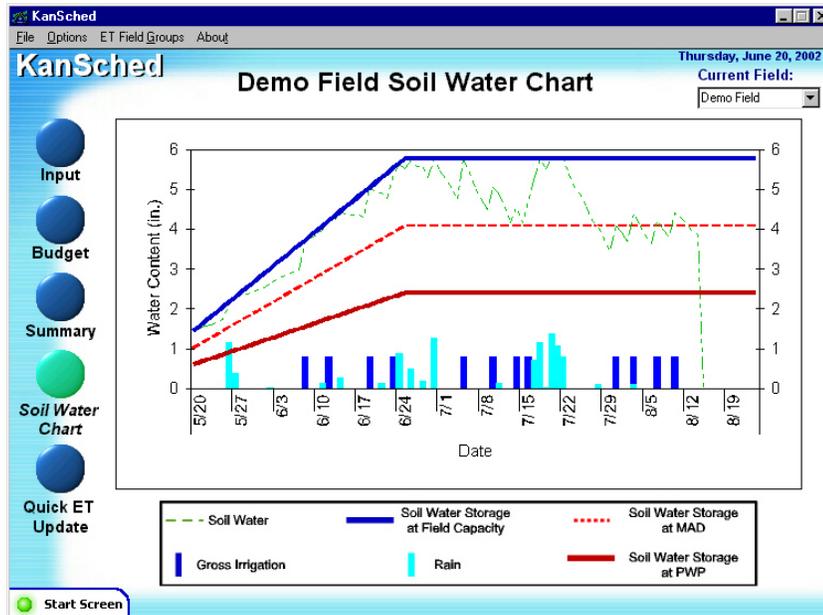


Figure 7 – Soil Water Management Chart

throughout the season. In addition, each rainfall and irrigation events are displayed at the bottom of the chart. The horizontal axis of the chart is labeled with the dates of the crop season, while the vertical axis is in units of inches of water contained within the defined soil profile. Before fully utilizing the Soil Water Chart, one must understand how to read the chart. The following section describes each component of the Soil Water Chart.

The Soil Water Chart has the ability to get detailed information about any point on the chart. Using your mouse, position the cursor arrow and click on any line or column in the chart to get information about that point. This is an easy way to see how much rain or irrigation was received on a particular day, without having to scroll through the budget page to find the information.

Soil Water Storage at Field Capacity, PWP, and MAD

The dark blue line that forms the upper boundary of the chart is called the *Soil Water Storage at Field Capacity* line. This line represents the total amount of water that your soil can hold before runoff or deep percolation occurs. This line also represents a water availability value of 100%. This value is determined using the soil characteristics from the input screen and the depth of the root zone, as are the PWP and MAD values described next.

The dark red line that forms the lower boundary of the chart is called the *Soil Water Storage at PWP* line. This line represents the moisture content of the soil where plants

are unable to pull the water from the soil, causing them to wilt and die. This line also represents a water availability value of 0%.

The dotted red line represents the MAD level that was chosen during the initial input process for the field. One way to manage a field's soil water content is to attempt to keep the dotted green line (the calculated soil water content) close to the dotted red line (the MAD value). Of course, the MAD value is only a visual representation of an individual's management preference. As the water content goes below the MAD value, plants may wilt and experience some stress. Therefore, KanSched derates or reduces crop coefficients when this occurs and simulated crop water use is reduced.

Current Soil Water-

The dotted green line represents the calculated soil water content of the soil. As the line approaches the upper dark blue line, the soil's water content is increasing. Likewise, as the dotted green line approaches the lower dark red line, the soil's water content is decreasing

Gross Irrigation-

Each irrigation event is represented by a dark blue column and is plotted on the date the irrigation was received. The height of the column reflects the amount of the irrigation event.

Rain-

Much like the irrigation events, a light blue column represents the rainfall events on the date the rainfall was received. The height of the column reflects the amount of rain received.

The Summary Screen

The summary screen (not shown) gives a snapshot of the current total season amounts for the crop of total reference ET, crop ET, rainfall, effective rainfall, gross irrigation amounts, and net irrigation amounts. A periodic check-up on this screen shows the current water-use statistics at a glance.

Extra Features in KanSched

KanSched has several built in utilities to increase the functionality of the program. The following section will describe each of these utilities that allow an individual to archive a field and export the field information to a text file. Archive a field allows the beginning of a new season for the same field without having to create a new field or delete the old data. Exporting the data allows individuals to do additional analysis of their data using spreadsheet programs.

KanSched Availability

KanShed is available via the web at www.oznet.ksu.edu/mil. CD copies are available at KanSched training meeting in Kansas and by request by contacting a Kansas County Extension Office.