Irrigation Water Requirements

User Manual

Version 1.0
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Download the IWR program from:
http://www.wcc.nrcs.usda.gov/nrcsirrig
under Water Management Models

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Chapter 1
Introduction

General

WELCOME to IWR, the Irrigation Water Requirements program. This program is an implementation of certain procedures for computing monthly and seasonal irrigation water requirements. The program is not capable of making daily irrigation water requirement estimates.

The procedures are as detailed in the USDA-National Resource Conservation Service (NRCS) handbook titled: National Engineering Handbook (NEH), Part 623, Chapter 2 – "Irrigation Water Requirements", September, 1993.

This document may be purchased trough: http://www.wcc.nrcs.usda.gov/nrcsirrig/ under Handbooks/Manuals

Evapotranspiration (ET) calculations are the basis from which irrigation water requirements are calculated. This program alternatively uses one of three procedures to calculate monthly average ET. The methods are the Temperature, Radiation and SCS BC-TR21 procedures. Determining which one to use will be controlled by climatic data available for use and by the characteristics of the region the procedure will be used in.

The IWR program is designed to be used for determining irrigation water requirements for individual jobs and as a tool for developing NRCS developed Irrigation Guides.

The program is intended for use by local Conservation District staff, by NRCS field staff, NRCS State staff and by consultants and others who have a need to make such calculations.

Some preparation of climatic and crop data is necessary on a statewide or project basis before this program can be used.

General design for the program was done by the NRCS Field Office Engineering Software (FOES) development team, of which the author was a member. Final program design and programming is by John Dalton, NRCS, retired.

System Requirements and Installation

System requirements

The IWR program requires Windows 95/98/NT/2000/XP. At least 17 MB of free hard disk space should be available for the program if installed from a CD-ROM. At least 30 MB should be available (Temporarily) if installing from a downloaded installation file. The space will vary depending on the amount of database data, the number of jobs archived in the job database, and whether or not the Borland database engine has previously been previously installed.

See the installation instructions below for information concerning saving local data that may previously have been saved in previous versions of the program. Remove any previous versions of IWR before installing this version.

To remove the IWR program from the computer, use the Windows *Add/Remove Programs* utility. Use only standard windows uninstall procedures, since the database registry must be properly uninstalled.

Recommended screen setting is 1024 x 768 pixels or higher. A screen setting of 800 x 600 pixels will also work, but not as well.

Installation

- **Saving previous climatic/crop data**

If you have important data that has been entered using IWR Beta 2 or 3 versions, please make a backup of the contents of the entire directory named "IWR Database Files".

Replace the entire contents of the new "*Database*" directory with the saved directory contents after the current version is installed.

As an alternative, specific parts of the database may be replaced as follows:

Climate data: replace all Climate.* and County.* files
WHR data: replace all ClimWHR.* files
Local/Job data: replace all IWRJobCrop.*, IWRCrop.* and IWRWk.crop.* files

- **General installation procedure**

Installation of the current IWR program is handled by a standard windows install procedure. Standard install procedures must be followed since the database elements of this program must be properly registered in Windows.

- **Install from CD-ROM**

If the program is distributed on CD-ROM, insert the CD-ROM. Locate the **setup.exe** file and click on it. Follow the directions on the screen. The program will be installed under the *c:\ProgramFiles\USDA\IWR* directory.

- **Download from internet and install**

If the program is downloaded from the Internet, a single executable file will be downloaded. This is a compressed file that makes the program smaller and easier to download. Click on this file to unpack the installation program. The program will be unpacked and installed in a temporary folder under *c:\Program Files\IWR Temporary*. Setup.exe will be automatically run and the program installed under the *c:\ProgramFiles\USDA\IWR* directory. If the *IWR temporary* folder is no longer needed for installation on other computers, or re-installation, it may be deleted.

Making a CD-ROM for local distribution

If further distribution of IWR is needed on other local computers, copy the files in *the IWR temporary* folder to a CD-ROM. IWR may then be installed on other computers directly from the CD-ROM.

Distribution from a CD-ROM allows distributing a version of IWR that has been tailored to local climatic/crop data. In the downloaded *Temporary* folder, go into the *Program Files/USDA/IWR* folder and replace the entire *Database* folder with one that has been updated with local climatic/crop data.

This will also allow distribution of a version where password protected defaults have been set and a unique password has been assigned.

Help Facilities

Normal Windows on-line help facilities are available.

- **Menu Bar**- From the menu bar, select the **Help** menu item. Menu items include **Contents**, **Search for Help on** and **About**. The **About** item will display information about the latest version of this program.

- **Help Buttons**- Three forms of help buttons are included.

  Located at the top of the dialog or window, this button brings up general information about using the current dialog or window.

  
  Located at various pints in dialogs, this button brings up specific information about the subject.

- **F1 key**- Context sensitive help is available at some data entry points. Click F1 when the data entry item has been selected.

- **Tips**- Pop up tips show up when certain buttons or entry points are pointed to with the mouse.

- **User Manual**- The user manual is available in the files IWRMan.doc. These are Microsoft Word, word processor files and may be loaded and printed with any word processor that can interpret that format. Nearly all material in the on-line help is contained in the manual.

Chapter 2
Program Basics

General

The program has been designed to be strictly in conformance with USDA-Natural Resource Conservation Service (NRCS) handbook, National Engineering Handbook (NEH), Part 623, Chapter 2-"Irrigation Water Requirements", dated September 1993. (Hereafter called NEH 2)

The program consists of three separate executable parts:

1. IWR program for computing irrigation water requirements.
2. Climatic database management program
3. Crop database management program

The IWR program only computes net monthly and seasonal irrigation requirements based on crop needs. It does not take into account leaching requirements, crop salt tolerance, evaporation during non-growing season, auxiliary irrigation water requirements, water table contributions or irrigation efficiencies.

Preparing ata for use in the program

Before the IWR program may be used, data must be entered in the climate and crop databases. General crop data has already been entered in the crop database. Specific crop data for local conditions must be entered. Temperature and precipitation climatic data for the local region may be downloaded from the Internet. Humidity, wind and radiation data must be researched for the local region and entered in the database.

Appendix A and B provides details on where to get the required climate and crop data and how to enter it in the databases.

The data, for a state or a particular region within a state will probably be entered by NRCS technical staff familiar with the region. Some slight modifications of the crop data may need to be done locally to reflect local crop varieties and planting/harvest dates.

Technical capabilities of program

There are three alternative computation methods available in the IWR program for use in computing monthly and seasonal evapotranspiration (ET). These are:

- **Radiation Method** developed by Doorenbos and Pruitt (1977)
- **Temperature Method** commonly referred to as the FAO-Blaney-Criddle method
- **SCS Blaney Criddle Method** as previously detailed in USDA-SCS TR21

Blaney Criddle TR21 is the least accurate of the three methods. It is the program default method for use when there is not enough climatic data to use one of the other two methods. This method may be used anywhere that monthly average temperature and precipitation data is available, which is almost everywhere.

The Temperature and Radiation methods require additional climatic data including humidity, wind and solar radiation data. This type of data is sparse and the raw data usually must be analyzed for a region to determine where it can be used.

The publication "American Society of Civil Engineers Manuals and Reports on Engineering practice-No 70, Evapotranspiration and Irrigation Water Requirements", shows a ranking of ET computation methods (Table 7.18 and 7.19). The Radiation method (FAO-24 Radiation) ranks best for arid locations. The FAO-24 Blaney Criddle (Temperature Method) ranks about the same for both arid and humid locations. The Blaney Criddle TR21 (SCS TR21) ranks below both of these methods.

The IWR program has a password-protected system default menu item, which allows setting the ET computation methods, which the user is allowed to use. This setting will allow some control by the NRCS State Engineer as to how computations will be made.

Another system default setting may be made which sets which method will be used to calculate peak monthly ET. The alternatives are shown in tables 2-54 and 2-55 of NEH2.

W. O. Pruitt, one of the authors of FAO-24, and others, recommend adjusting the ETc values for the SCS TR21 method upwards 10% for each 1000 meters above sea level. The system default settings give the option of applying this correction.

The amount of carryover soil moisture used at the beginning and end of the growing season may be controlled by setting a percentage system default value. The percentage is of a net irrigation depth entered by the user. The user has the option of directly entering a carryover amount and the amounts used at the beginning and end of the season.

Other local default values may be set by the user. These include net depth of irrigation, type of irrigation system, days between wettings, stress factor, and number and dates of hay cuttings. Setting these defaults locally reduces the number of entries needed during program execution.

Procedures for computing ETc for hay using the Radiation and Temperature methods take into account the dates of each cutting. The SCS TR21 procedure uses average ETc values for each month and ignores the differences in ET just before and after cutting.

Internally, the program computes crop coefficients (Kc) for each day and averages the results for the month. ETc is computed by multiplying the average monthly Kc by the computed ETo for the month.

For multi-crop, non-freezing areas, the program will handle planting a crop in the fall of one year and harvest in the next. It will not handle crops requiring more than 365 days. In that case, separate jobs (and crop curves) will be needed for each growth year.

General IWR program operation

Operation of the program consists of creating a ***job***. A job is based on specific climatic data for one weather station. From one to many crops may be included in a job. The job may be created for a specific farm or it may be used to create a local irrigation guide.

For the Radiation and Temperature methods, the IWR program will compute water requirements using average crop coefficients as detailed in Sections 623.024 (a) through (e) of NEH 2. This requires user input of estimated soil type and irrigation method. The SCS TR21 method does not make average crop coefficient corrections and so does not require soil type and irrigation system information.

The need for soil type and irrigation method data makes it complicated to use the Radiation and Temperature methods in preparing data for a general purpose Irrigation Guides. There will be significant advantages in using these methods for site specific computations.

Output from the program includes both normal year (50% chance) and dry year (80%chance) data.

Output from the program may be printed or saved as different type files for later incorporation in reports or technical documents. Bar graph, Etc curve and various summary reports are available and may be printed.

Chapter 3
Detailed Program Operation

Creating a new job

Entering general job data

After executing the program, click the **New Job** button. The main job entry form will appear. You may also select the **File/New Job** menu item to do the same thing.

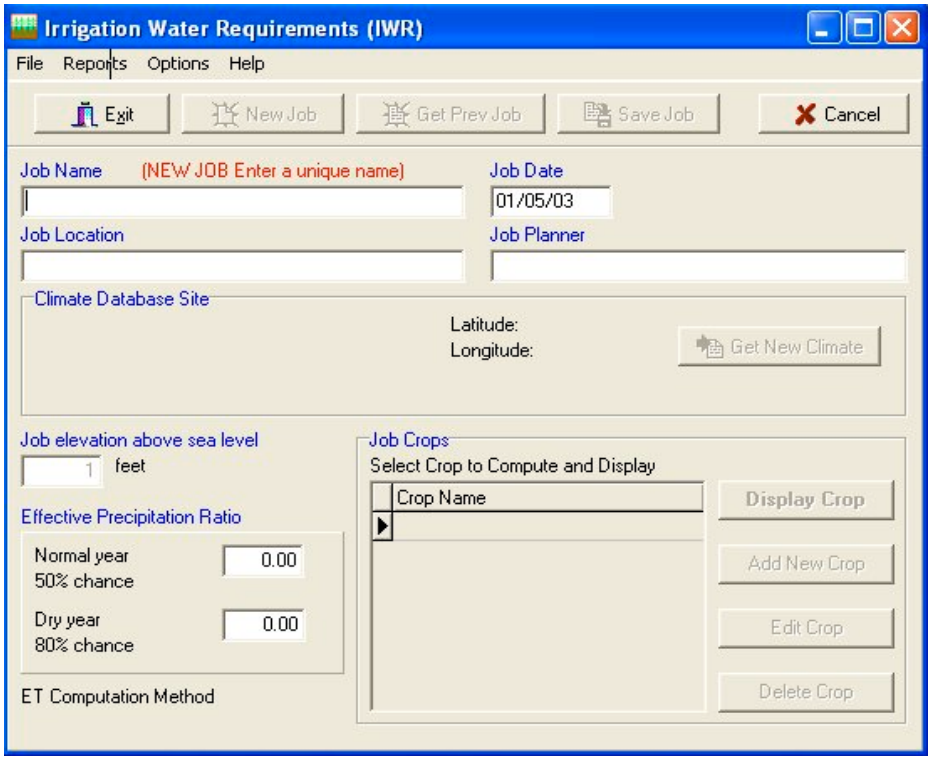


Figure 3.1
Screen after clicking "New Job" button

Enter a unique job name.
The Job date is automatically entered. This date may be overwritten.

Enter Job location and Job planner information.

Select weather station

Click the **Get New Climate** button. If Job name that was entered is the same as one previously used in a saved job, a dialog box will pop up requiring entry of a new name. Make the name change and again click the **Get New Climate** button.

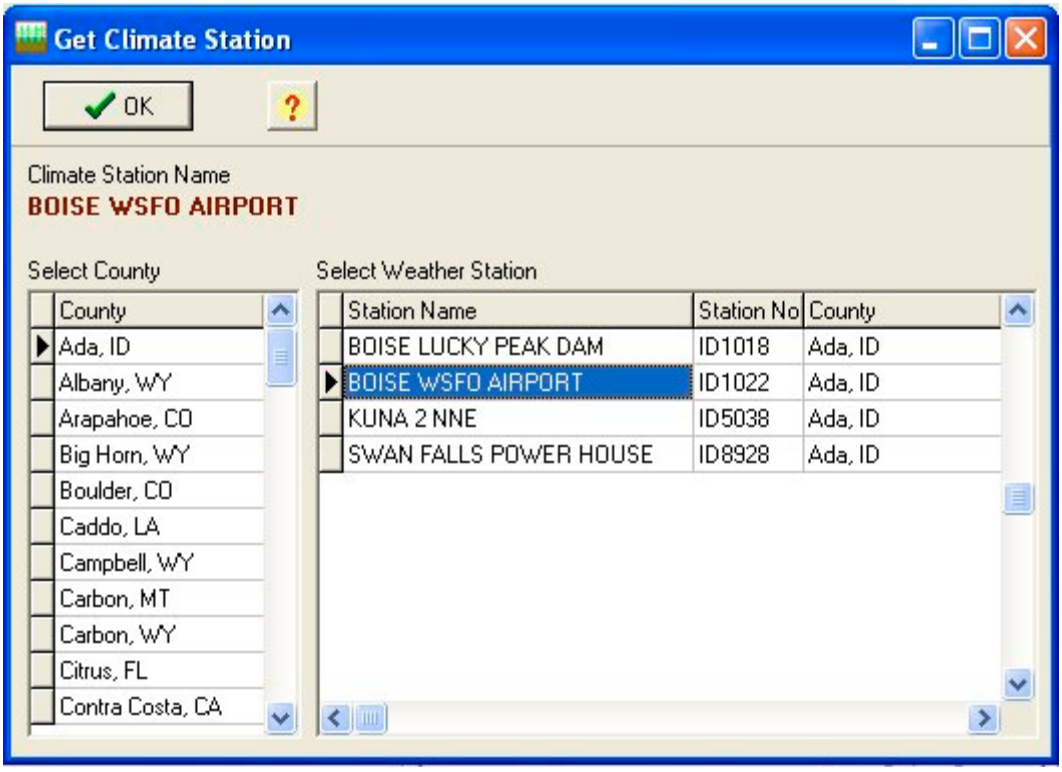


Figure 3.2
Screen when selecting new weather station

A *Get Climate Station* dialog box will pop up which displays two selection lists. From the left-hand list, select the County and state where the job is located. From the right-hand list select the weather station that you wish to base the current job on.

If the desired weather station is not available in the list, see Appendix A for details on how to create a new climate database or add stations to an existing database.

Click the **OK** button or double click the selected station when the correct station has been selected.

Depending on what the system default ET computation method settings are a pop up box (Figure 3.3) may come up allowing selection of the computation method. This will happen only if database data is available for the alternative methods, and if alternative methods are allowed. Select the desired method and click the **OK** button.

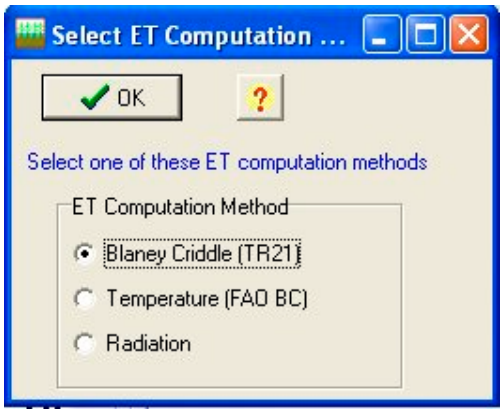


Figure 3.3
Screen while selecting Temperature (FAO BC) ET Computation Method

The program will return to the main window and a Confirm dialog (Figure 3.4) will pop up. If you wish to edit eleation or precipitation ratios, click the **Yes** button.

Figure 3.4
Pop up for editing elevation and precipitation ratios editing

Focus will be on the Job elevation above sea level input item. The default elevation is the elevation of the weather station. If the job site elevation is much different, enter the elevation at the job site. Small differences in elevation will not make much difference in irrigation requirements. In flatter parts of the country this difference can be ignored.

The effective precipitation ratios shown are calculated based on NEH 2 Table 2-43. Other methods of calculation are described in Section 623.0207 of NEH 2. These require detailed analysis of local data and would only be used where this level of detail is warranted. If a detailed analysis is made, the resulting factors may be entered in the *Effective Precipitation Ratio* data entry locations.

Crop selection

Click the **Add New Crop** button to add a crop to the job. A *Get Crop Name* dialog box will pop up.

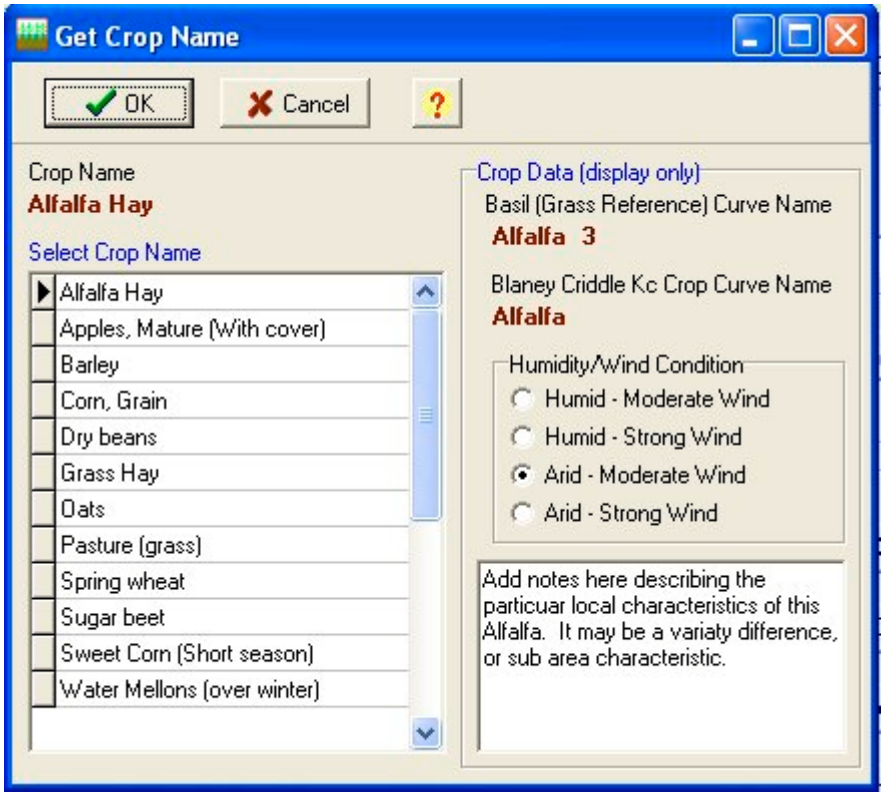


Figure 3.5
Screen on selection of new crop (Alfalfa)

On the left side of the crop selection dialog box is a selection list showing all the crops currently contained in the local crop database. For details on how to add or modify crop information in the crop database, see Appendix B. On the right side of the box are displays of certain information about the crop. This is read only information. Select the desired crop and click the **OK** button or double clicking the selected crop.

A *Job Crop Compute* dialog box will pop up which will allow changing some of the default values for the crop.

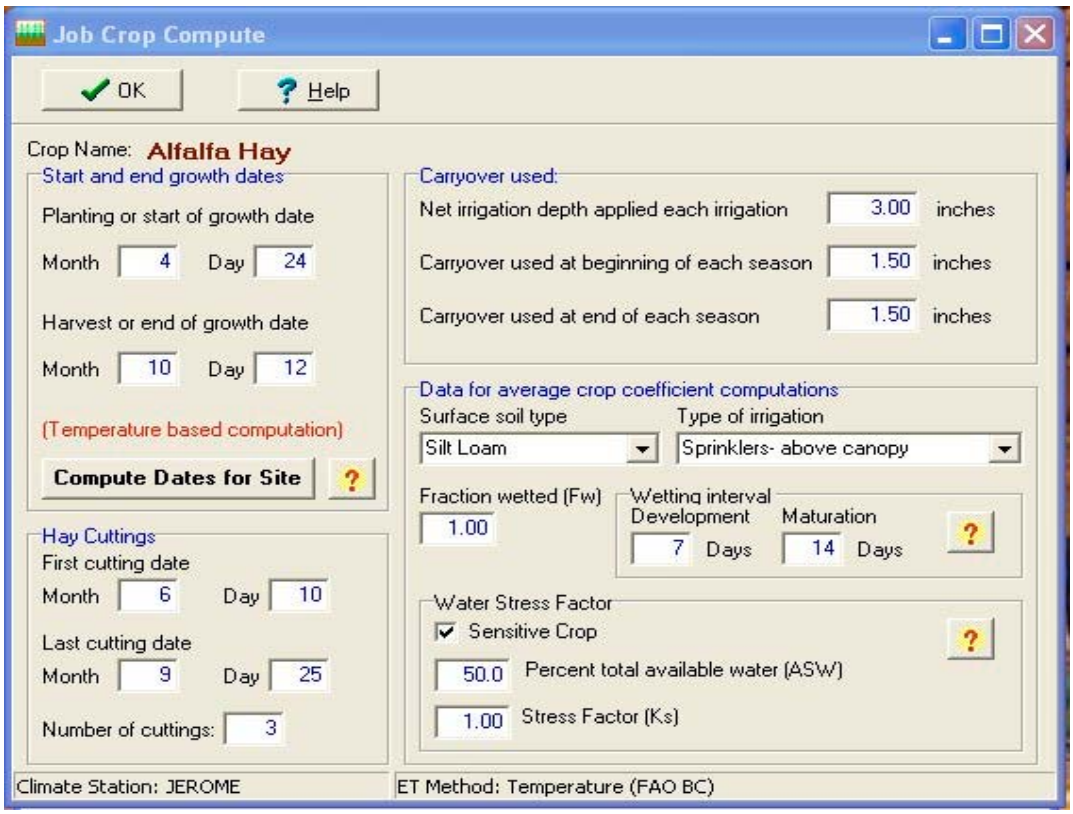


Figure 3.6
Compute screen after selecting crop (alfalfa)

Start and end growth dates

The start and end growth dates are extremely important for computing accurate irrigation water requirements. The default values are those which have been entered in the local crop database. Since these dates depend on average temperatures, accurate determination can not be made until data for the job weather station is known. In areas where there are large differences in temperatures between weather stations, it will be important to adjust default dates.

There are two ways to adjust start and end growth dates:

1. If a farmer knows specific planting and harvest dates, enter these dates directly.

2. Click the **Compute Dates for Site** button.

   Note that this tool will only work in areas where there is a dormant season. If there is no dormant season, a dialog will pop up stating that the compute dates tool can not be used.

   If there is a dormant season, a dialog box will pop up which shows temperature and minimum/maximum grow days from the local crop database and from the crop curve databases. This data is used to calculate available grow days, default grow days and revised start and end grow dates.

   If the crop requires more grow days than are available, a warning dialog will pop up. Changes may be made in grow days required, begin growth temperature, or end growth temperature, if this type of information is known. Click the **Re-Calculate** button to calculate the changed dates. New dates are

displayed in Re-calculated Start and End dates box. Clicking the **OK** button will transfer the new dates to the previous screen. Clicking the **Cancel** button will retain the default dates.

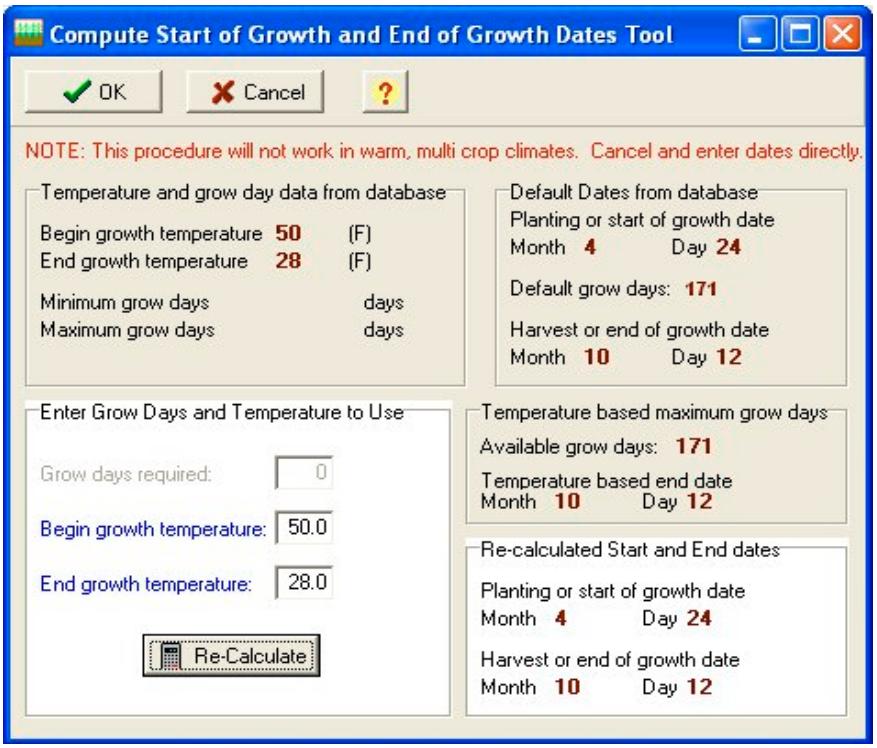


Figure 3.7
Screen showing dialog box tool for computing start growth and end growth dates

Sweet corn is an example of where changes may be needed in grow days required. Normal required grow-days for sweet corn is about 80 days. If an early variety were desired, then use the grow-days required for that variety, for example 62 days.

When corrections are made, click the **OK** button to continue. The corrected dates will now display in the *Job Compute* dialog box.

Carryover used

Carryover is the amount of available soil moisture that is available for crop use at start of growth, and that, which will be depleted at the end of growth. These amounts are deducted from irrigation requirements. Moisture available at the start of growth may be available due to non-growing season precipitation, fall irrigation, or a pre-irrigation. This is very site and region specific. Moisture available at the end of the season depends on irrigation patterns, and management practices. Default values are provided based of begin and end carryover being a percentage of a net irrigation application. In the west, a percentage value of 50% is often used. Default values for percent carryover are set in system defaults.

If the default values for net irrigation depth and carryover are not realistic, enter best estimate values.

Data for average crop coefficient computations

Only the Radiation and Temperature methods of ET computation use the average crop coefficient procedures. The SCS TR21 procedure does not make adjustments for stress factor and wet soil evaporation. The portion of the dialog box dealing with these factors will not appear if the SCS TR21 procedure is being used.

***Water Stress factor**:* See NEH 2, Section 623.0204 (c) for details concerning water stress factor (Ks). In most cases the default of 1.0 will be appropriate.

Two curves are shown in the NEH, one for sensitive crops and one for non-sensitive crops. By checking the sensitive crop box, the sensitive curve will be used to compute Ks when percent available water (ASW) is entered. If Kc is entered directly, ASW will be computed.

Soil Evaporation: See NEH 2, Section 623.0204 (d) concerning wet soil evaporation. A selection list in the dialog box allows selecting one of the irrigation methods shown in Table 1-28 of NEH 2. This sets a "fraction wetted" value. The fraction wetted can also be entered manually.

See NEH 2, Section 623.024 (e) for average crop coefficient calculations. Table 2-30 of NEH 2 is used to calculate the "average wet soil evaporation factor" (Af). This requires input of wetting recurrence intervals and a general surface soil type. Wetting intervals may be due either to irrigation or precipitation. Enter a best estimate. Both development stage and maturation stage wetting intervals must be entered.

Hay cuttings

The hay cuttings data input portion of the dialog only appears if the crop is hay or forage with cuttings, and only if the Radiation or Temperature methods of ET computation are used. The SCS TR21 procedure does not uses cutting information.

Enter the number of cuttings and the dates of the first and last cuttings. If there is only one cutting the last cutting will be blank. Intermediate cuttings will be distributed equally throughout the season.

If the crop is a pasture used for grazing, and regular cuttings or heavy rotational grazings are not performed, then the crop is treated as if there were just one cutting at the end of the season. See Appendix B on procedures for entering data in the crop database to accomplish this.

Display computed irrigation water requirements for crop

Click the **OK** button in the *Job Crop Compute* dialog box. A *Summary of Current crop for Current Job* dialog box will appear. This is display only. Use the scroll bar to see the entire form.

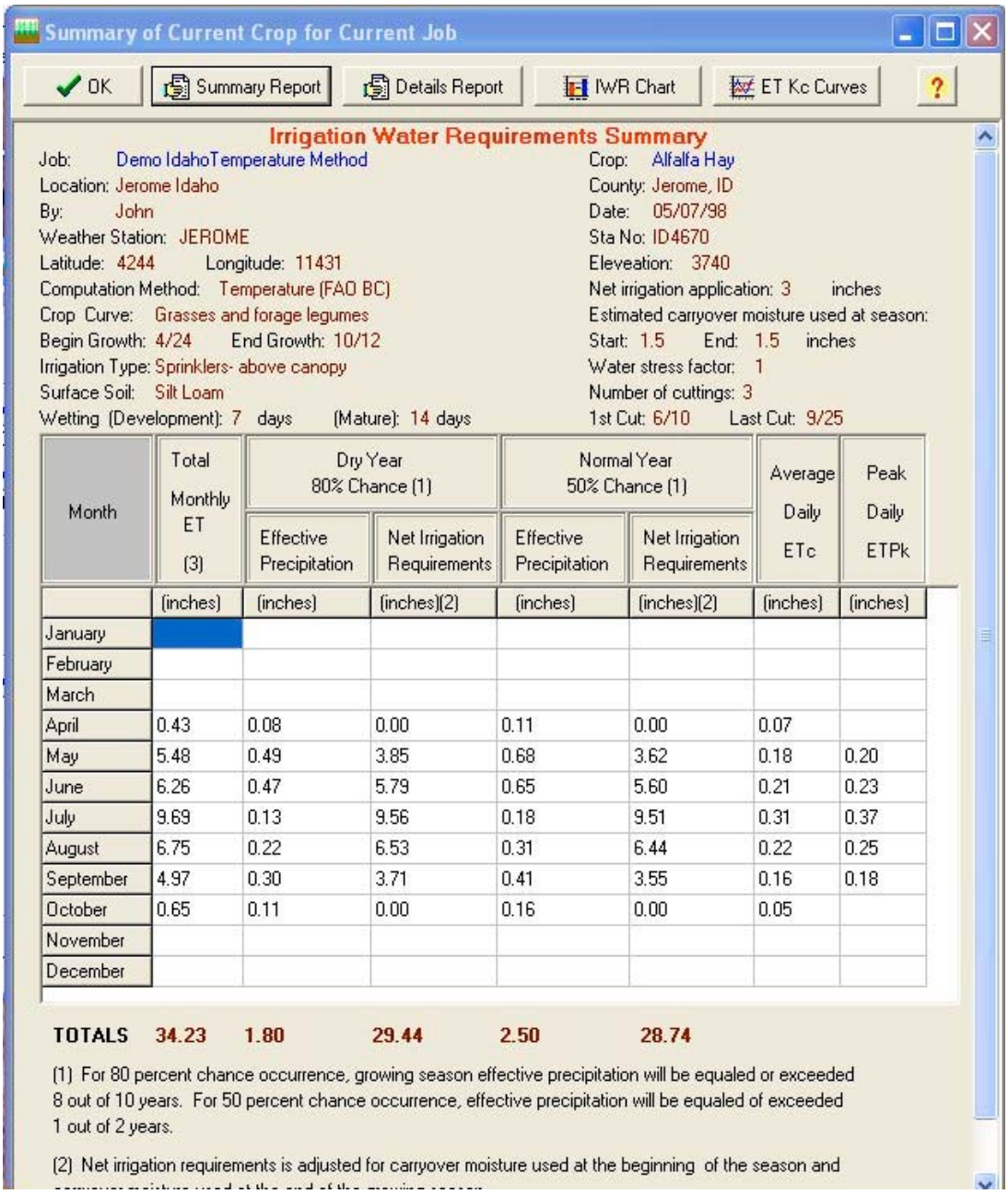


Figure 3.8
Screen showing computed output for selected job crop

Reports

• Click the **Summary Report** button to get a printable form of this display. The form may be either printed or saved to a file for future incorporation in another document.

• Click the **Details Report** button to get a printable report that displays more detail concerning the data generated during computations.

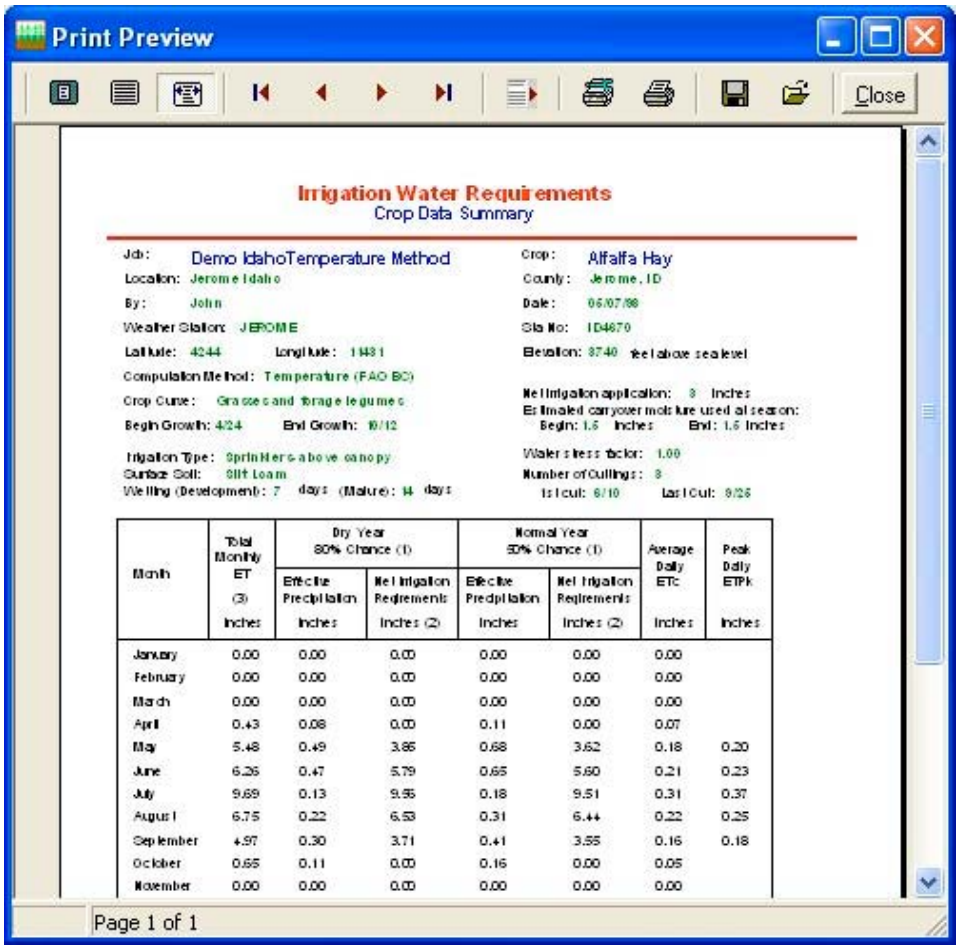


Figure 3.9
Screen showing summary report of what was shown on output screen

Select the printer icon to print the report. Select the floppy disk icon to save a report to a file.

The save as type dialog box has the following file types available:

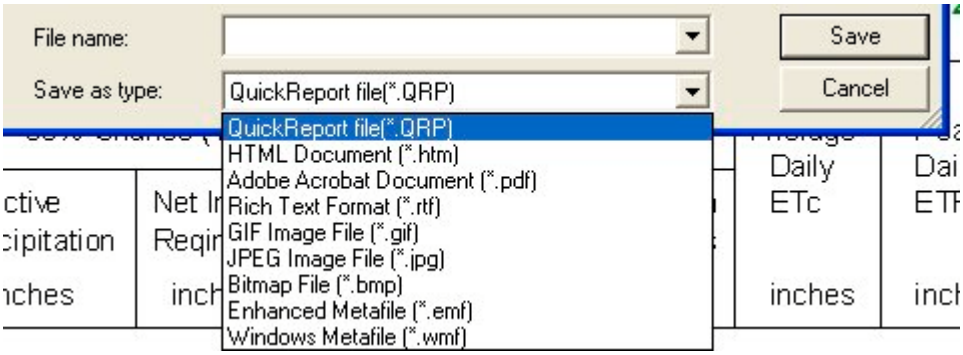


Figure 3.10
File type selection

The types of files are:

QuickReport file (*.QRP) - can only be read from a program using the same report generator used in IWR. This format works with all reports.

HTML Document (*.htm) - Can be read by a browser. Does not work reports with charts or graphs.

Adobe Acrobat document (*.pdf) - Can be read by Adobe Acrobat reader program. Does not work with reports with charts or graphs.

RTF File (*.RTF) - Formatted text file. - Can be imported to most word processors. Does not work with reports with charts or graphs.

Various graphic formats. These formats work with all reports.

• Click the **IWR Chart** button to get a bar graph of Normal year (50% chance) and Dry year (80% chance) monthly irrigation water requirements. The value in the yellow box at the top of each bar is required irrigation depth, in inches.

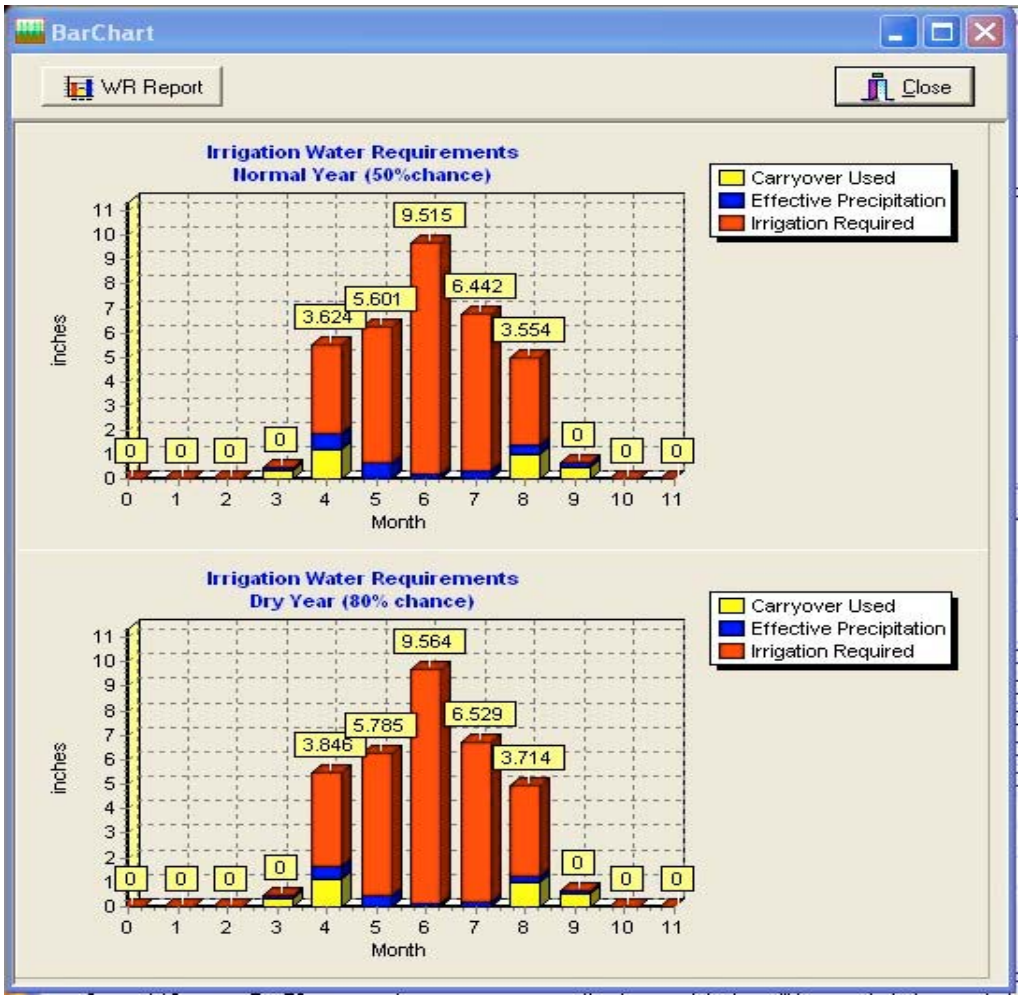


Figure 3.11
Screen showing monthly IWR bar graph output

• Click the **ET Kc curves** button to get curves for Kca and Kcb. See Section 623.0204(e) of NEH2 for an explanation of the relationship between average crop coefficient (Kca) and basal crop coefficient (Kcb). The Blaney Criddle procedure does not have average crop coefficient applied.

ETC is the computed crop evapotranspiration for the crop at this site. Etc = Eto x Kc. Eto is only computed on a monthly basis by NEH2 procedures. To get daily Etc, Eto is straight line interpolated between months.

A printable report showing the ET and Kc curves may be displayed.

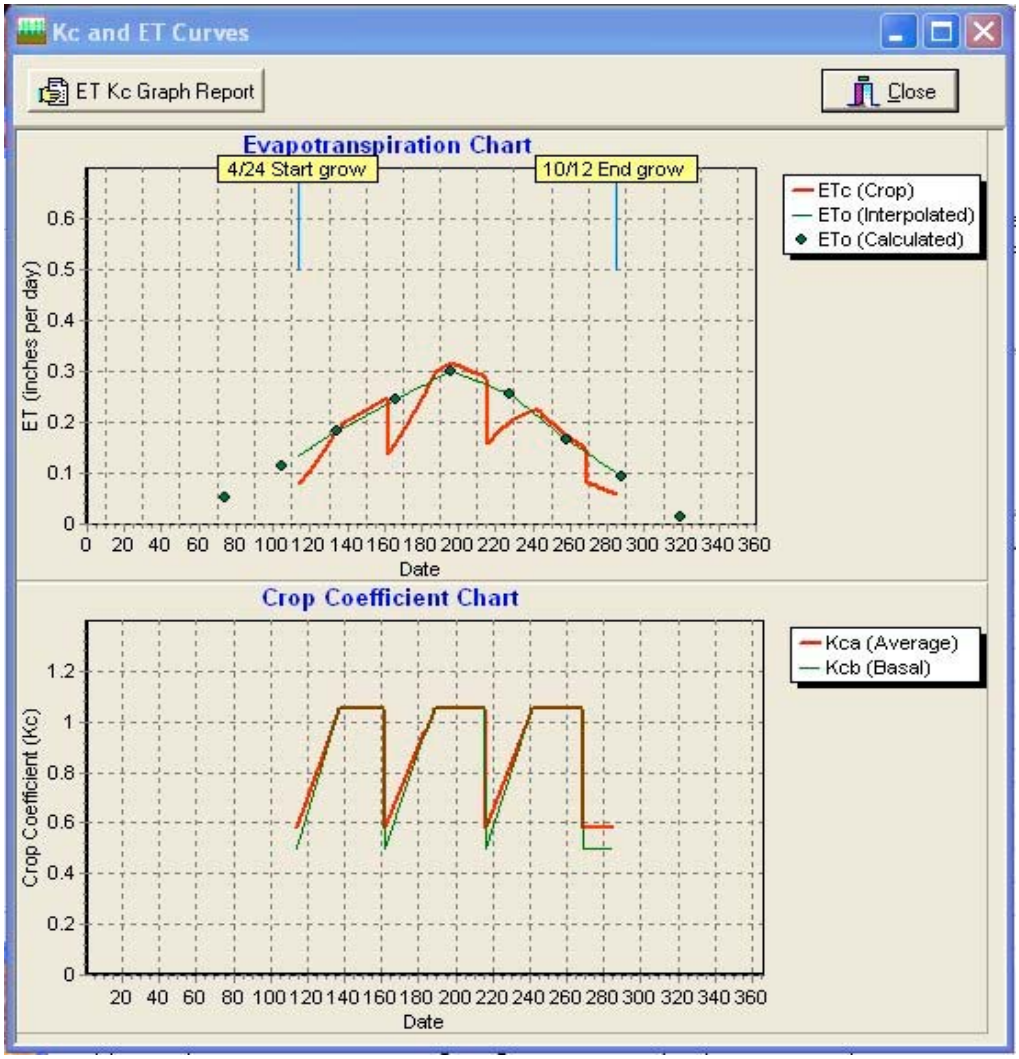


Figure 3.12
Screen showing ETKc graphic output

• Click the **OK** button to return to the main window.

Adding crops to the job

To add a new crop to the job, click the **Add New Crop** button. The *Get Crop Name* dialog box will pop up. Proceed as before. If the same crop has previously been added, a dialog box will appear stating that you can't add the same crop twice. Add a different crop. If you want to add several versions of the same crop, for example both short and long season corn, go to the crop database program and enter the different corn varieties using different descriptive names. As an alternative, make several runs of the job, making changes in the crop plant/harvest dates for each run. Re-name each version by adding a version number to the name.

Edit a job crop

To edit data for a job crop, select the crop to edit in the select crop selection box and then click the **Edit Crop** button. The *Job Crop Compute* dialog box will pop up. Make any data changes and proceed as before.

Delete a job crop

To delete a job crop, select the crop to delete in the select crop selection box and then click the **Delete Crop** button.

Display crop

To display a crop shown in the selection list, highlight the crop, then click the **Display Crop** button, or double click the crop, and the *Summary of Current Crop for current Job* dialog will appear. Proceed as before.

Other reports

The main menu **Reports** menu item allows display and printing of several reports. These reports are only available when there is an active job. An error dialog will pop up if a job is not active.

- The menu items **Single Crop Report** and **Single Crop Details** reports are for individual crops and were also available in *the Summary of current Crop for Current Job* dialog. In this case a dialog box will pop up allowing selection of a crop when one of these menu item reports are selected.

- The **Job Crop Summary** report is a summary of all crops in a job. It is in a format that might be used in an irrigation guide.

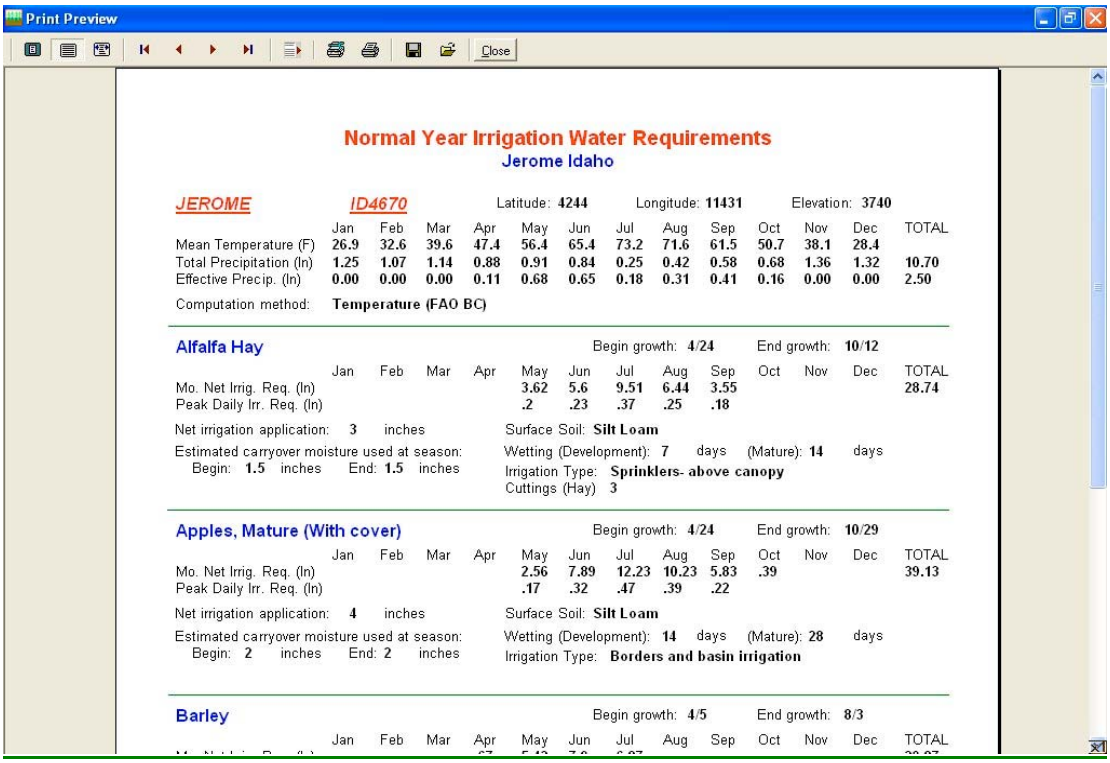


Figure 3.13
Screen showing Job Crop Summary Report as selected from the main menu

- The **List of Jobs** report is simply a listing of all jobs in the jobs database.

It is anticipated that there may be need for reports in different formats. **Report Format 1** is a placeholder for future report versions.

Saving a job to database

The program maintains previous jobs in a Paradox compatible database. Click the **Save Job** button at any time to save the current job to the database.

Reviewing or modifying a previous job

Deleting old jobs from the database

Select the **File/Maintain Job Database** menu item. A popup dialog will allow deleting jobs that are no longer required.

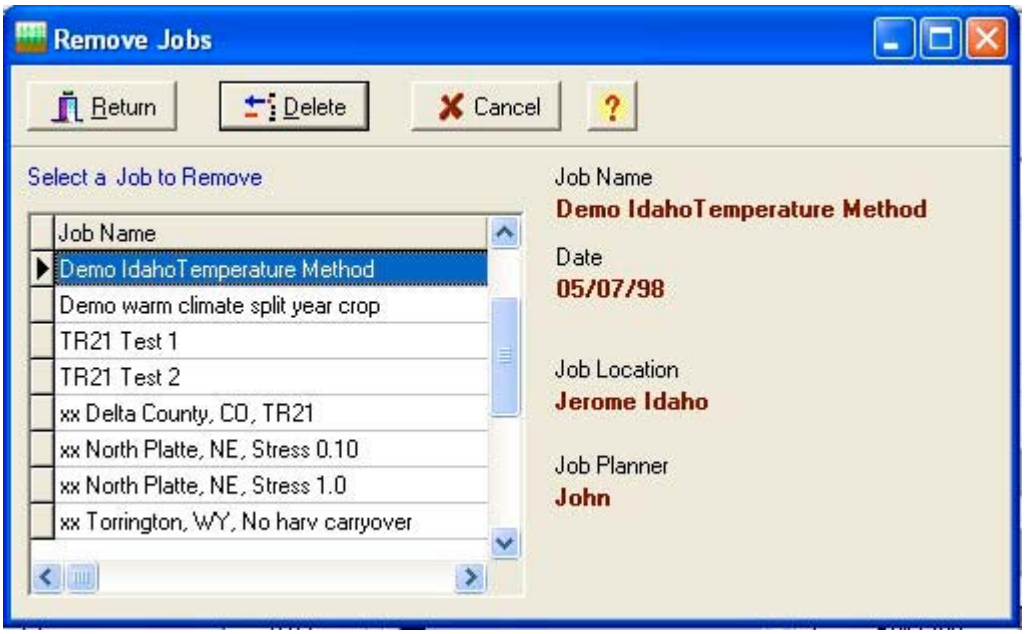


Figure 3.14
Screen showing job database management screen

Reviewing or modifying a previous job

Click the **Get Prev Job** button. A dialog box with a list of previous jobs will pop up. Select a job and click the **OK** button. The same thing can be done by selecting the main menu item **File/Review or Edit Job**.

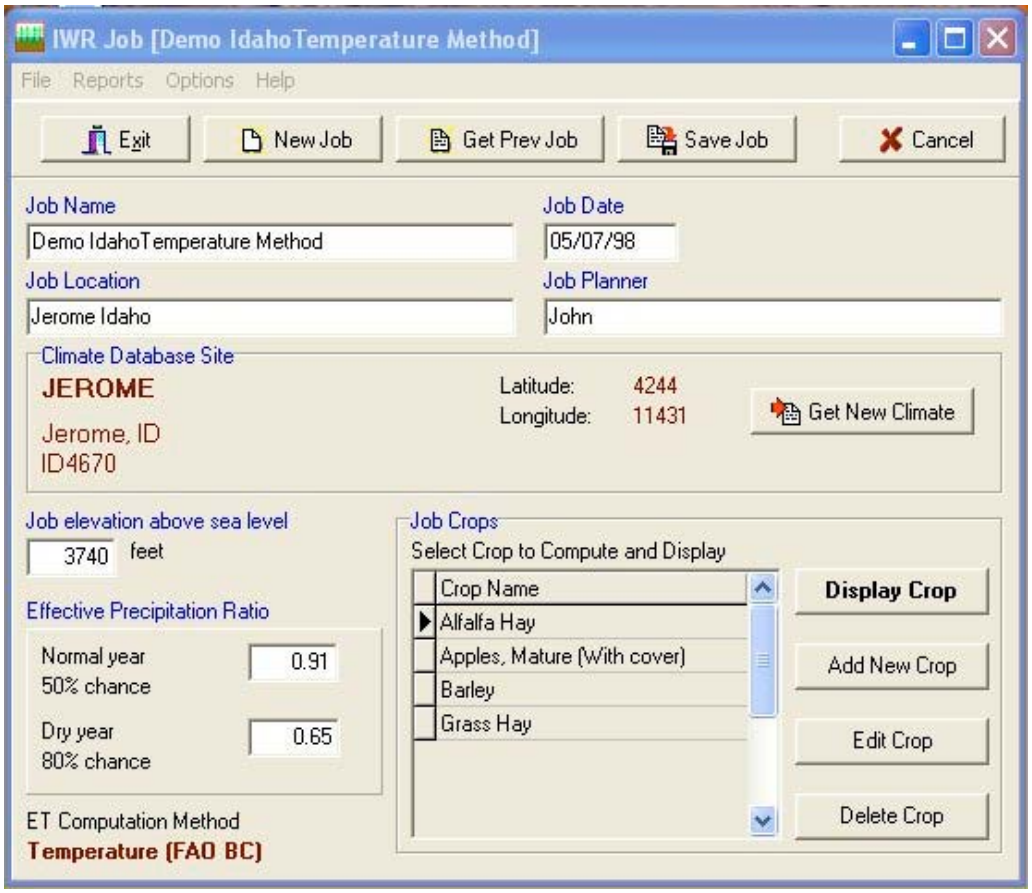


Figure 3.15
Screen showing existing job

Once displayed, you may edit or add to the crops in the normal manner. If saved, the job will contain the revised information.

If a different weather station is wanted, a new job should be created. The program is not set up to change the weather station. The reason for this is that changing the station would require re-visiting and modifying planting and harvest dates for each crop.

Chapter 4
Setting Default Values

System defaults

Select the **Options/System Defaults** main menu item. A dialog box will pop up which displays current system default values.

To change these values requires a password. Use of a password allows those distributing this program some control over how the program is used in the region. Once in the edit mode, the password may be changed.

To get in the edit mode, click the **Edit Data** button. A dialog box will pop up requesting the password.

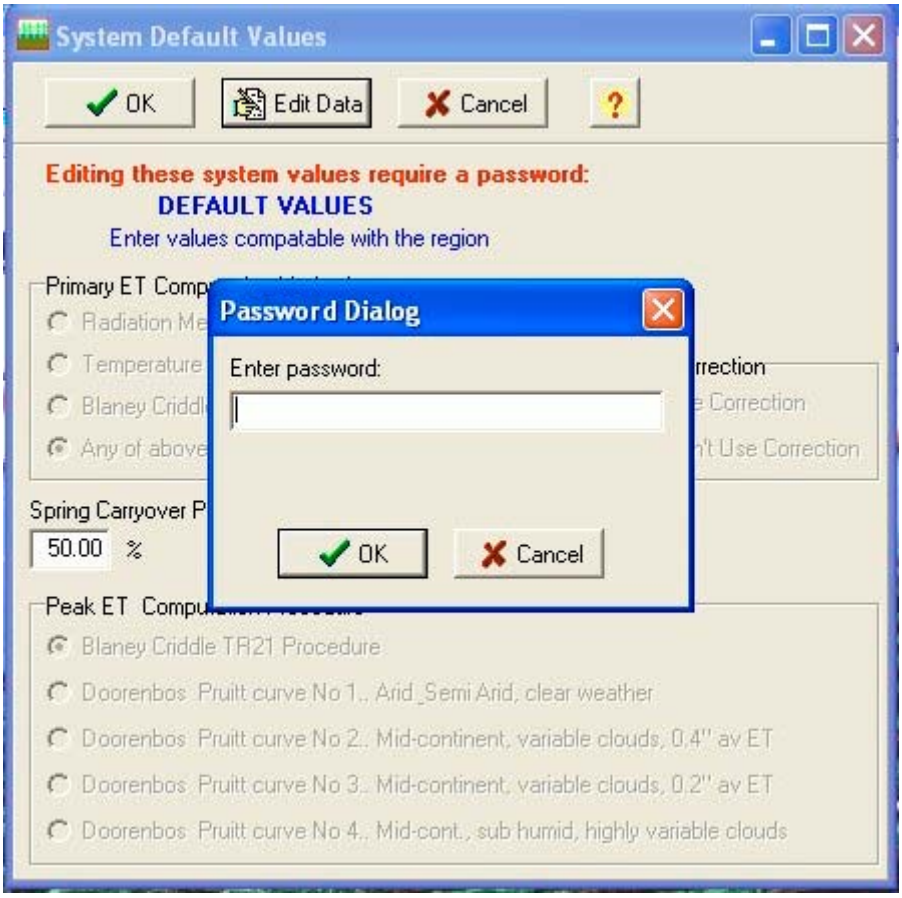


Figure 4.1
Screen showing system default dialog with password entry popup

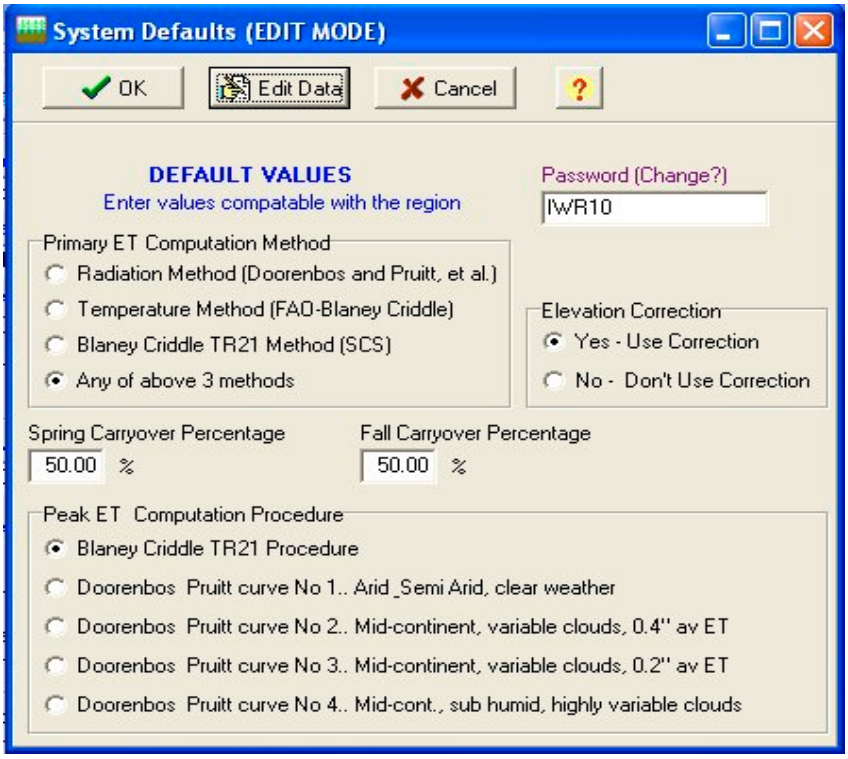


Figure 4.2
Screen showing system defaults in edit mode

- **Primary ET Computation Method** selection is as follows:

  Radiation Method (Doorenbos-Pruitt, et al.
  The Radiation method will be used unless there is not adequate climatic data in the database. In such a case the SCS TR21 method will be used. This method is the best for use in arid regions.

  Temperature Method (FAO-Blaney Criddle)
  The Temperature method will be used unless there is not adequate climatic data in the database. In such a case the SCS TR21 method will be used.

  Blaney Criddle TR21 Method (SCS)
  The SCS TR21 procedure will be used.

  Any of the above 3 methods
  Any method that has adequate climatic data in the database may be used. The user may select the method.

The SCS TR21 method is the least accurate method. It should only be used when adequate climatic data is not available for the other two methods.

- **Elevation Correction**

W.O. Pruitt, one of the authors of the FAO24 document, and others recommend that the SCS TR21 procedure irrigation requirements be increased 10% for each 1000 meters above sea level. Selecting “Yes” will make this correction to TR21 output. No correction will be made if “No” is selected. The Radiation and Temperature methods automatically include elevation correction.

• **Spring and Fall Carryover**

Enter a percentage in these input fields. Carryover percentage is a percentage of net irrigation depth. Entering zero here will mean that no default carryover will be used. (The user can still add carryover at runtime). Typical carryover percentage used in the west is 50% for both spring and fall carryover.

• **Peak ET Computation Procedure**

Two simplified methods of computing Monthly peak ET are described in NEH 2. The Doornbos and Pruitt method is shown in Figure 2-54 of NEH2. This consists of four curves for different climatic conditions. The other method is the TR21 method as shown in Table 2-55 of NEH2. Select the procedure that will be used in the program. The IWR program supports both methods. Other analysis methods are described in NEH2. They require considerable data to use and are beyond the scope of this program.

Local defaults

Local default values consist of data that is used as a starting point in data entry. They consists of typical values that are representative of the local area. The user may change any of these values at runtime to fit specific situations.

Select the **Options/Local Defaults** menu item from the main menu. A *Local Default Values* dialog box will pop up. This box is in edit mode when it appears. Enter best estimate values that fit local conditions. Only *Net Depth of Each Irrigation* is used by the SCS TR21 procedure. When SCS TR21 is used, the rest of the data is ignored.

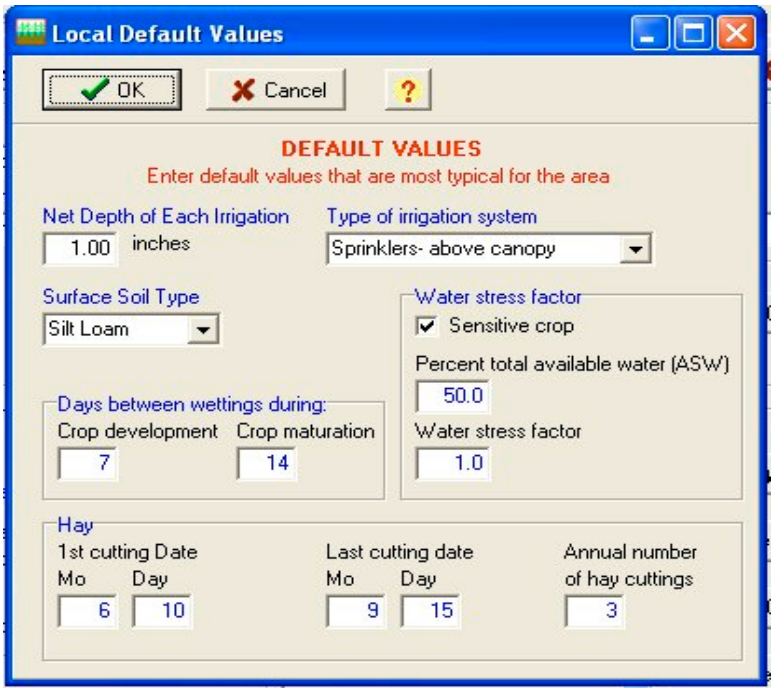


Figure 4.3
Screen showing local default dialog

- **Net Depth of Each Irrigation**

This value is dependant on several factors, including soil profile, crop, type of irrigation system and management. Enter the most typical value.

- **Type of irrigation system**

Select the most typical type of irrigation used in the area from the selection list.
See NEH 2, Section 623.0204 (d) concerning wet soil evaporation. The selection list allows selecting one of the irrigation methods shown in Table 1-28 of NEH 2. This sets a fraction wetted.

- **Surface Soil Type**

Enter a predominant soil type for the area.

- **Stress Factor**

See NEH 2, Section 623.0204 (c) for details concerning water stress factor. In most cases the default of water stress factor = 1.0 will be appropriate.

- **Days between wettings**

See NEH 2, Section 623.024 (e) for average crop coefficient calculations. Table 2-30 of NEH 2 is used to calculate the average wet soil evaporation factor (Af). This requires input of wetting recurrence intervals and a general surface soil type. Wetting intervals may be due either to irrigation or precipitation. Enter a best estimate.

- **Hay**

Enter the most typical data for the local area.

Appendix A

Preparing the climate databases with the IWRClim program

About the climate database

The Climate.db database is a Paradox compatible database file that is manipulated using database management tools in the IWRClim program. This database contains a database record for each official weather station that contains historic temperature and precipitation data, as selected by the person building the database. It also contains the latitude, longitude and elevation of each weather station. If data is found for a non-official weather station, it can be entered in the database manually.

Official weather station temperature and precipitation data can be downloaded from the Internet. Only those stations with both temperature and precipitation data are used. Some official stations have only precipitation data.

Overview of climate database for use with the IWRClim program

The IWRClim program consists of database management tools for viewing and editing climate databases used by the main Irrigation Water Management (IWR) program.

The IWR program requires several average monthly climatic factors to run. The factors needed depend on the type of procedure used to calculate evapotranspiration (ET). There are alternatively three procedures used in the IWR program. The procedure to be used will depend on availability of certain climatic data and on characteristics of the region.

Please review the following sections in USDA-Natural Resource Conservation Service (NRCS) handbook titled: National Engineering Handbook (NEH), Part 623, Chapter 2-"Irrigation Water Requirements":

623.023-c	Radiation Method
623.023-d	Temperature Method
Appendix A	Blaney Criddle Formula (SCS Technical Release 21)

The Climate.db and ClimWHR.db databases contain the climatic data that may be available. Temperature and precipitation data is usually readily available at several sites in any specific agricultural region. Wind, humidity and solar radiation data is much more limited in availability, and there will usually only be a few sites in a state or region that have this data available.

The ET calculation methods (and related irrigation water requirements) each require the following data:

	Radiation	Temperature	SCS-TR21
Latitude	X	X	X
Weather station elevation	X	X	X
Average monthly Temperature	X	X	X
1st spring date 50% chance 28 deg F	X	X	X
Last fall date 50% chance 28 deg F	X	X	X
1st spring date 50% chance 32 deg F	X	X	X
Last fall date 50% chance 32 deg F	X	X	X
Average monthly precipitation	X	X	X
Average monthly relative humidity (Rha)	X		
Mean minimum mo. relative humidity (Rhmin)		X	
Average wind run (U)	X	X	
Average day/night wind speed ration (Ur)	X	X	
Ratio of actual to possible sunshine (n/N)		X	
Incoming solar radiation (Rs)	X		

Latitude, elevation, temperature and precipitation data needed for all three methods are available at many weather station sites. The user can easily download this data from the Internet. The data is then automatically entered in the Climate.db database using the IWRClim program. The other factors needed by the radiation and temperature methods of computing ET take considerable effort to research and must be manually entered in the ClimWHR.db database.

Downloading temperature/precipitation files from the internet

The Natural Resources Conservation Service (NRCS), National Water and Climate Center, maintains WEB site on the Internet. Climatic data for use in IWR may be downloaded either by county or by state.

By County

To download individual counties go to: “Climate Analysis for Wetlands by County”. This currently may be accessed at:

http://www.wcc.nrcs.usda.gov/water/wetlands.html

Once at the site, the procedure is as follows:

- **1st screen:** Retrieval of Wetlands climate Evaluation dataset - 1. Select desired region
  Select the desired State from the list and select then “Go to County Selection”.

- **2nd screen:** Retrieval of Wetlands climate evaluation dataset - 2. Select Desired County
  Select a County and then “Go to FTP Download”

- **3rd screen:** You have chosen _____ as your state and _____ as your county.
  Select this line to receive information for ____ County from your FTP site

- The next step is to save the file to a directory on your hard disk or to a floppy.
  Select **File|Save As File** on your browser.
  An example file name is: 41057.txt (Tillamook, Oregon)

The 5 digits represent the state and county FIPS code.
Enter the file name exactly as listed when saving the file, since the IWRClim program looks for files with 5 digits and a "txt" extension.

- Now return to the 1st screen and repeat the process for as many counties as are desired for the database.

By State

To download and entire state go to: Climate Analysis for Wetlands by State. This is currently located at:

http://www.wcc.nrcs.usda.gov/water/wetstate.html

- **1st** Select the state and click on **Go to Download**
- **2nd** Click on Select **Here** to get a DOS/Windows zip file
- Download to an appropriate folder on your hard drive.
- Unzip the file and use the IWRClim program to enter appropriate counties in the IWR database.

Our recommendation is to use the entire state or split the state in two or three parts. The IWRClim program makes it easy to manage data for many weather stations.

Using downloaded files to build a new Climate.db database

- Run the IWRClim program.

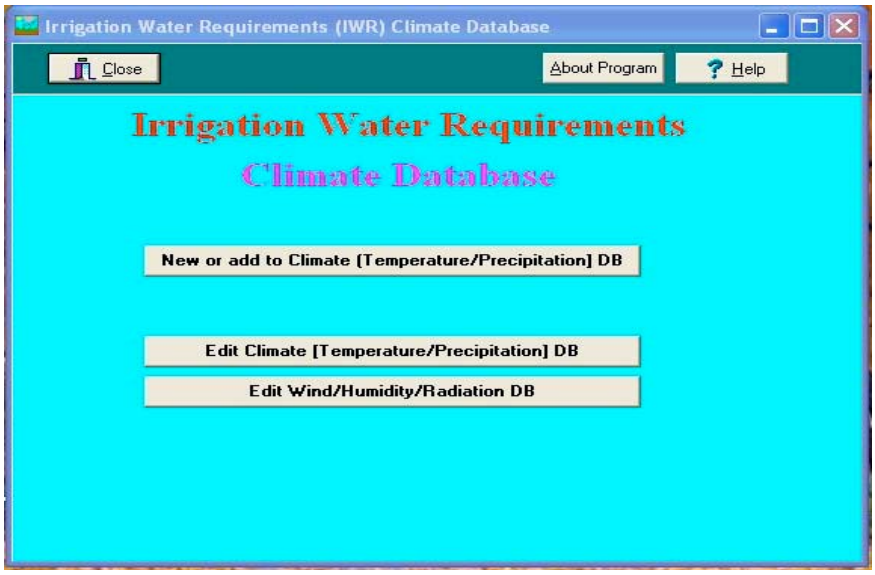


Figure A.1
Screen on entering the IWRClim program

- Select the button labeled: **New or add Climate (Temperature/Precipitation] DB**

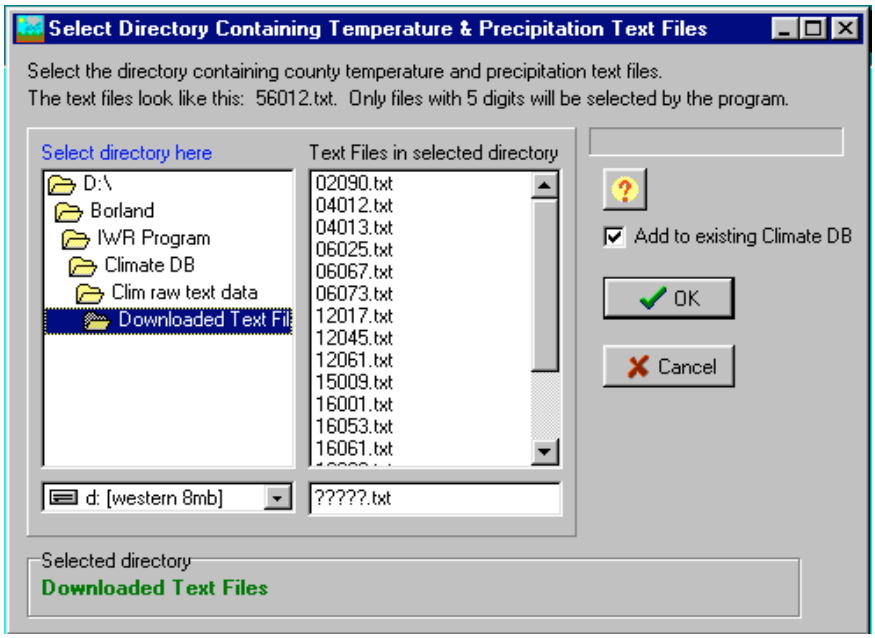


Figure A.2
Screen showing selection of directory containing climate text files

- The *Add to existing Climate DB* check box at the right side of the window is checked by default. Selected county weather data will be added to the existing climate database.

  Uncheck the check box to start a completely new climate database.
  WARNING: This action will delete all data from an existing database named Climate.db. If you are creating more than one IWR database for different regions, save the entire IWR database directory to a floppy disk for each region. Replace the entire IWR database directory for the region that the database was created for. There are many interrelationships between database files, so you must work with the entire database directory.

Selecting text file directory path

- Use the directory browser to navigate through the directories. Find the directory that contains "12345.txt" files. The first five characters are digits

  The list at the right of the screen shows only files with 5 digits or characters to the left of the ".", with a ".txt" extension. The program will sort out any files that do not have all digits in the first 5 positions. Only files in this format can be valid downloaded text files used by this program.

- When the proper directory has been found, click the **OK** button. There may be a wait while the program extracts preliminary data from the files.

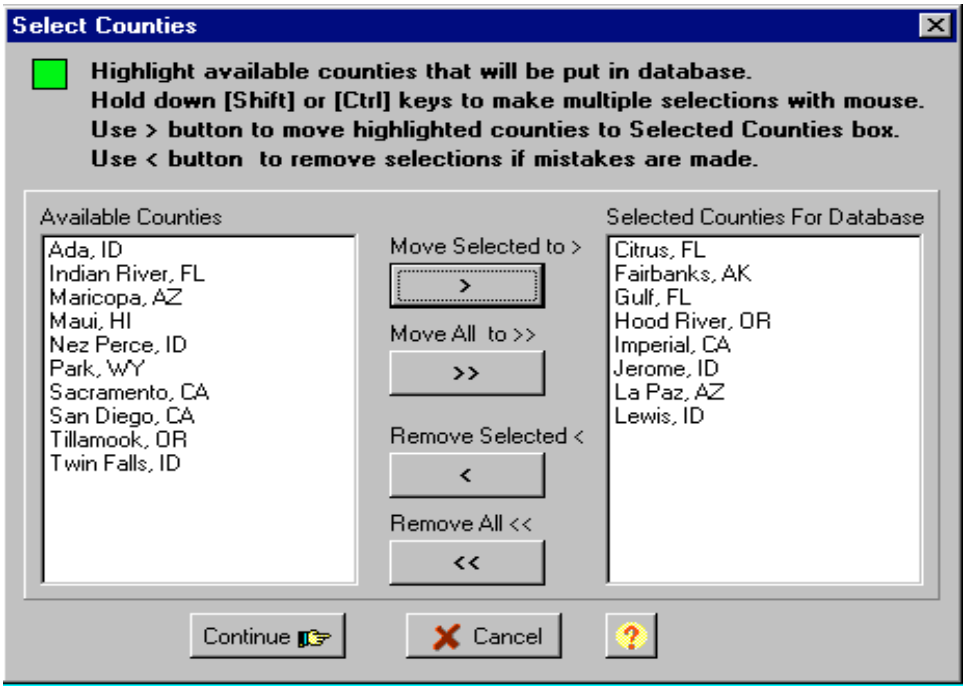


Figure A.3
Screen showing selected counties on right

Select counties to put in a database

When the "Select Counties" database comes up, a list of available counties shows on the left. You may select any or all of them for inclusion in the database. Use the **arrow keys** to select or de-select the counties. At least one county must be selected.

When the proper counties have been selected, click the **Continue** button. The program will download data for counties to the database.

The "Climate Station (Temperature and Precipitation) Database" screen will appear. You may now review the data and edit it if desired.

Climate Station (Temperature and Precipitation Database) screen

You may move through the database and view the data. You may also edit the data, but this is not recommended unless you have real knowledge of the data at the weather station.

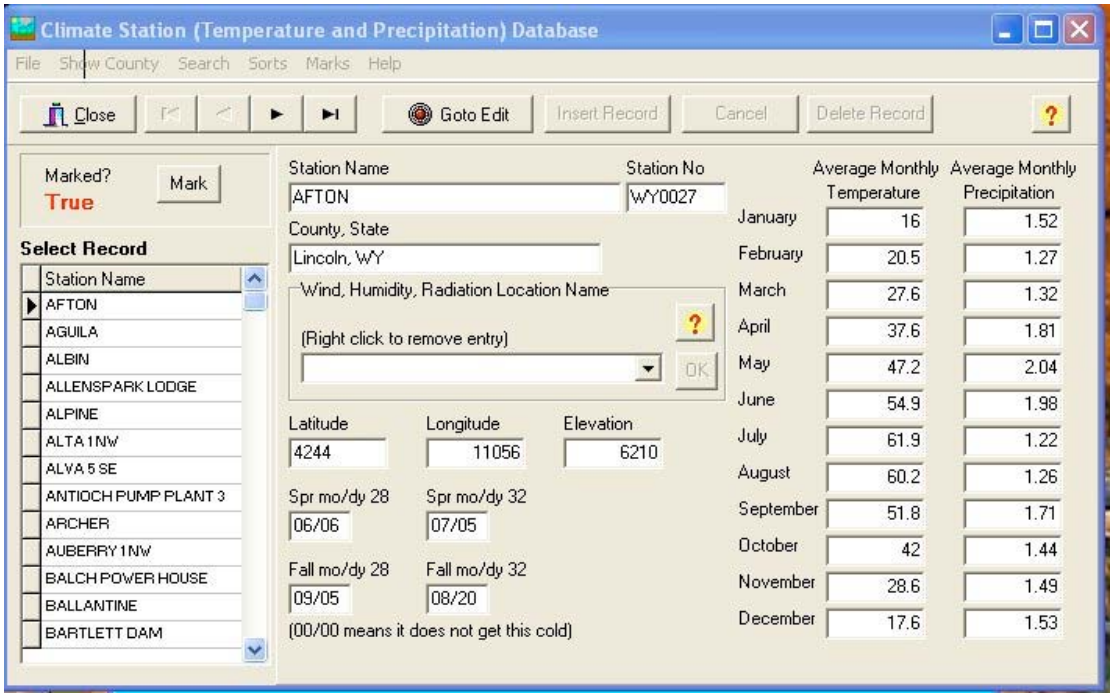


Figure A.4
Screen showing climate database editing dialog

- Delete any station records for weather for stations that obviously won't be used for agricultural or turf management purposes. For example in Park County Wyoming we will delete all those in Yellowstone National Park and all those over 7000 feet in elevation.

  To delete a station record, enter the edit mode by clicking the **Goto Edit** button. The button light will change to green and the **Insert Record**, **Cancel** and **Delete Record** buttons will become active. Take care! Once deleted, the record is gone forever.

- If you have entered data in the ClimWHR.db database for a location that is close enough to the currently selected weather station site record to be useful, then select it in the "Wind, Humidity and Radiation Location Name" field. This may be done later if desired. See *Entering a reference to "Wind, Humidity and Radiation Location Name" in a Climate.db record* for further details.

- Close the window to return to the main menu. The Climate database is complete.

NOTE: If the program does not properly retrieve data from the downloaded files, there may have been changes in the downloaded file's text format. The IWRclim program is very sensitive to text format, since it searches through the text to extract just the data needed. If this happens, please notify the program author so changes may be made in program code.

Entering a reference to "WHR Location Name" in a Climate.db record

To use either the radiation or temperature method of computing ET, then wind, humidity and radiation data must be available. Since this kind of data may be roughly similar in any given general area, the data from one weather station might apply to several weather stations that have only temperature and precipitation data. See *Selecting WHR Source data* for further details.

If there is wind, humidity and radiation (WHR) data available that is usable at the weather station site, a reference to it may be entered in the current weather station record. The appropriate WHR data must have been entered in the ClimWHR.db database. See *Entering or editing data in the WHR database* for further details

- Run the IWRClim program and select the **Edit Climate (Temperature/precipitation) DB** button.

- Move to the weather station record you that wish to associate with a WHR location.

- Enter the edit mode by clicking the **Goto Edit** button. The button light will change to green and the **Insert record**; **Cancel** and **Delete record** buttons will become active.

- Move to the "Wind Humidity, Radiation Location Name" field and click the scroll bar to pop down a list of available locations. Select the appropriate location and click the **OK** button.

IMPORTANT: If there is not an appropriate WHR location available that can be related to this temperature/precipitation site, *leave the field blank*. If this field is blank, only the BC-TR21 method of computing ET will be used.

If a WHR location is mistakenly entered for a station, right click the WHR entry box to remove it. This will work whether or not the edit mode is turned on.

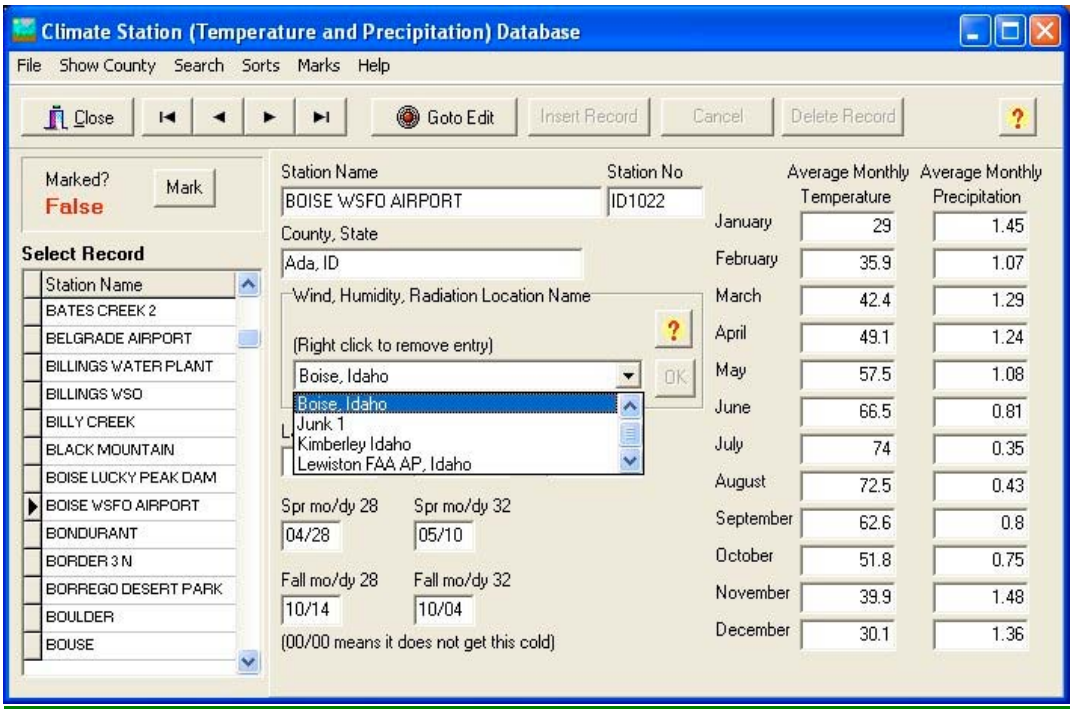


Figure A.5
Screen showing selection of the wind, humidity radiation location

Selecting WHR source data locations

In many areas, weather stations that record daily wind, humidity and solar radiation (WHR) data are far between. All of these data elements must be available to run the temperature and radiation methods of ET computation.

There are many weather stations that record daily temperature and precipitation. The approach used in the ClimWHR program is to get data wherever we can for WHR, analyze how extensive a region this data is likely to represent, and then associate it with weather stations that only have temperature and precipitation data.

IMPORTANT: This approach will need the assistance of someone who knows what he or she is doing.

The most authoritative source of this kind of help is probably a state climateologist. There is someone with this or a similar title in all states that we are familiar with. They are usually associated with a land grant university.

Another source of help may be an agricultural research station in a state where crop water requirements are being studied. Some information may also be available from the NRCS National Water and Climate Center.

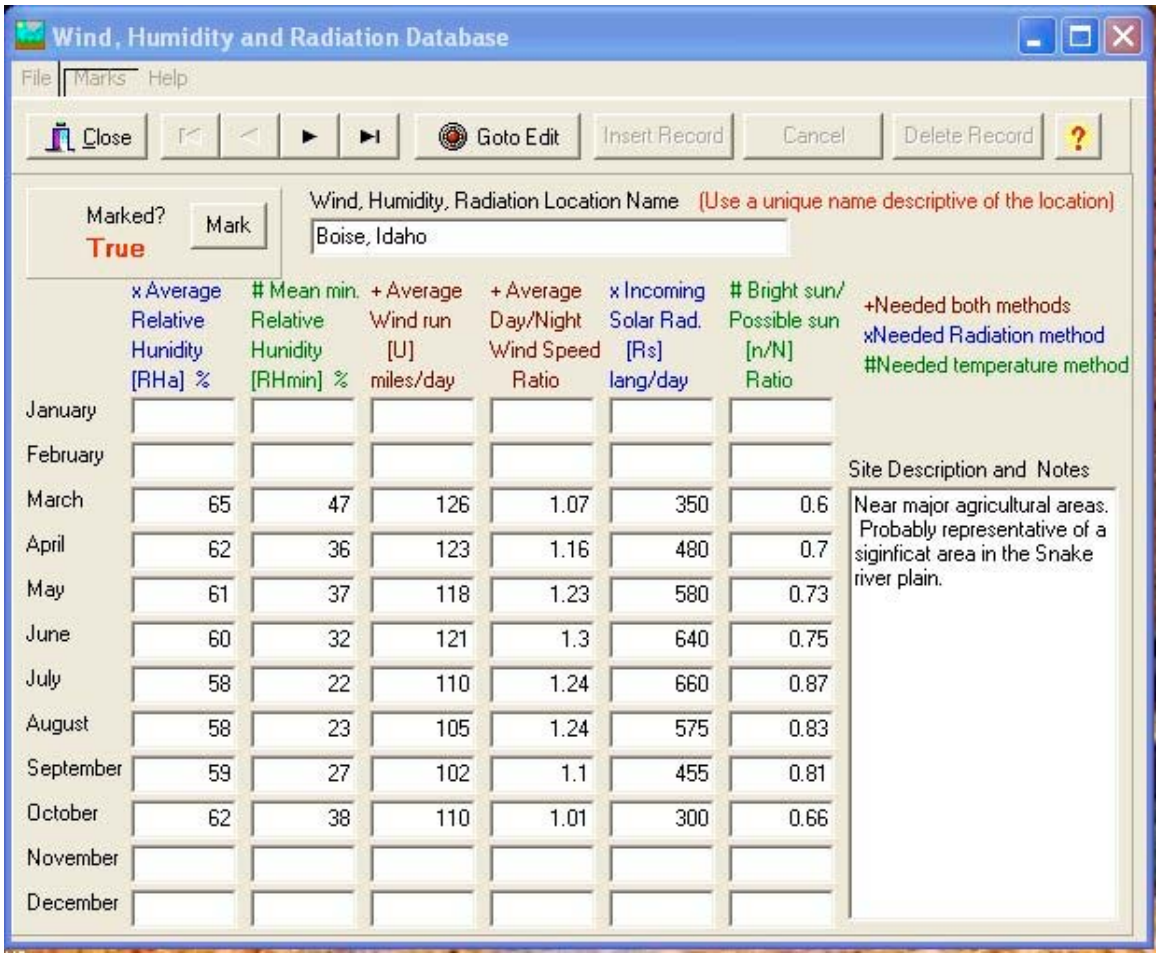
At this writing there is no known on-line source of data that will provide all of the data needed.

A suggested approach is to find weather stations with adequate historic WHR data and then have someone with appropriate technical knowledge prepare a map showing the region that could be represented by each WHR station. If all temperature precipitation stations are also plotted on the map, then it will be easy to associate these stations with an appropriate WHR site.

There are probably some regions that can not be associated with any WHR site. In these cases only the BC-TR21 method of computing EC must be used.

Entering or editing data in the WHR database

- Run the IWRClim program.
- Click the **Edit Wind/Humidity/RadiationDB** button
- The “Wind, Humidity and Radiation database” window will appear.



	x Average Relative Humidity [RHa] %	# Mean min. Relative Humidity [RHmin] %	+ Average Wind run [U] miles/day	+ Average Day/Night Wind Speed Ratio	x Incoming Solar Rad. [Rs] lang/day	# Bright sun/ Possible sun [n/N] Ratio
January						
February						
March	65	47	126	1.07	350	0.6
April	62	36	123	1.16	480	0.7
May	61	37	118	1.23	580	0.73
June	60	32	121	1.3	640	0.75
July	58	22	110	1.24	660	0.87
August	58	23	105	1.24	575	0.83
September	59	27	102	1.1	455	0.81
October	62	38	110	1.01	300	0.66
November						
December						

Figure A.6
Screen showing wind, humidity, radiation edit dialog

- To enter edit mode Click the **Goto Edit** button and the light will turn green and the **Insert record**, **Cancel** and **Delete record** buttons will become active.

- Select an existing record to edit or click the **Insert record** button to insert a new record.

Moving to another record or clicking **Insert record** again will post the current changes.

Note the “Site Description and Notes” field. A description of the weather station location and any important characteristics associated with it should be entered here. Make notes that will help determine how reliable the data is.

Humidity data

Depending on which method of computing ET will be used, the following average monthly humidity data is required:

- [Temperature method of ET computation]
  Mean minimum relative humidity (RHmin) %

- [Radiation method of ET computation]
  Average relative humidity (RHa] %

If only one of the ET computation methods will be used in the region, then only the data used by that ET method need be entered in the database.

Wind data

The IWRClim program requires that input be measured in English units. This conforms to conventions in the NEH 2, Irrigation Water Requirements reference manual. It may be necessary to convert available data from metric units before entering it in the database.

Two data items are needed for each month by both the temperature and radiation methods. These two items are used by the IWR program to compute average daytime wind speed (Ud).:

- Average wind run (U) in miles per day

- Average day/night wind speed ratio (Ur)

Solar radiation data

- Ratio between actual bright sunshine hours (n) and maximum possible sunshine hours (N)

This data is required by the temperature method of ET computation. This ratio can be estimated and may be available for average conditions in some areas. See Section 623.0202 (f) OF NEH2.

- Incoming Solar Radiation (Rs) Langleys/day
  This data is required by the radiation method of ET computation.

The IWRClim program requires that input be measured in English units. This conforms to conventions in the NEH 2, Irrigation Water Requirements reference manual. It may be necessary to convert available data from metric units before entering it in the database.

For the IWRClim program, incoming solar radiation is measured in Langleys per day. A Langley is 1 cal / sq cm or 0.0418605 mj/sq m.

This data is the rarest of all the required data. It may be possible for someone with the proper technical expertise to estimate average monthly incoming solar radiation based on observed cloud cover and other data for a region. See Section 623.0202 (f) of NEH2. This would make it possible to include a site that does not have direct observation solar radiation data but does have wind and humidity data.

Appendix B

Preparing crop databases with the IWRCrop program

Overview

The IWRCrop program consists of database management tools for constructing and maintaining a local crop database table, and for viewing, editing and adding to crop Kc curve database tables. The main Irrigation Water Management (IWR) program requires these tables.

Several crop Kc coefficient database tables are maintained by the IWRCrop program. Data contained in the following reference have been entered in the tables. Users may add data to these tables if it is available.

Please review the following sections of USDA-Natural Resources Conservation Service (NRCS) handbook titled: National Engineering Handbook (NEH) Part 623, Chapter 2- "Irrigation water Requirements":

623.0204(a) and (b)	Crop Coefficients (Basal Grass reference coefficients)
Appendix A	Blaney Criddle Formula (SCS Technical Release 21) coefficients

Separate coefficient curve database tables are required for basal (grass reference) Kc data and Blaney Criddle (BCTR21) Kc data. BCTR21 curves are not based on basal grass reference data. Three different basal grass reference databases are required because annual crops and perennial crops use a different time period base, and forage crops vary depending on the number of harvests during the year. The Kc curve database tables are as follows:

Name	**NEH 2 Reference**
Field and Vegetable Crops	Table 2-20
Annual crop Type (Sub-Table)	Table 2-20 (Fraction of season & days data)
Perennial and Specialty Crops	Tables 2-22, 2-23, 2-24, 2-25, 2-26, 2-27
Grasses and Forage Legumes	Table 2-21
BCTR21 Annual Crops	Figure 2A (various curves)
BCTR21 Perennial Crops	Figure 2A (various curves)

The data format of each of these curves varies and is interpreted and interpolated by separate special functions in the main IWR program.

Users in each regional area must construct a local crop database table. The region will usually be a portion of a state with similar growing conditions. This database will contain the following information:

Local crop name (Unique name for each crop or crop variety)
One grass reference crop curve name
One Blaney Criddle TR21 crop curve name
Default planting or start of growth date
Default harvest or end of growth date
Optional grow days and/or start/end growth temperatures for calculating start and end growth dates.

At IWR program run time, the user will choose a local crop name and all related database data will be automatically used in calculations. The user will be able to override default dates.

About the crop databases

The various crop tables are Paradox compatible database tables that are manipulated using database management tools in the IWRCrop program. All tables have separate tools for viewing or maintaining them.

In general, Kc curve data will rarely need to be added to or changed. If changes or additions are needed, it should be done in consultation from authorities familiar with local crop Kc values.

Most grass reference crop Kc curve data shown in NEH 2 tables has been entered. If local research data is available, it should be entered in the tables and used instead.

Blaney Criddle (TR21) Kc curve data has been included for all curves in Appendix A of NEH 2. These curves should only be modified or added to based on local research. The TR21 Kc values are not the same as grass reference crop Kc values.

Using the IWRCrop database tools

There are two general types of database interfaces for editing and viewing the crop database tables. A simple type is used for simple crop Kc curves that will rarely be edited and which do not have many curves. The second type is more comprehensive and will allow marking and selecting groups of database records to view and print reports for.

All database tables may be printed out in various lists or detailed formats.

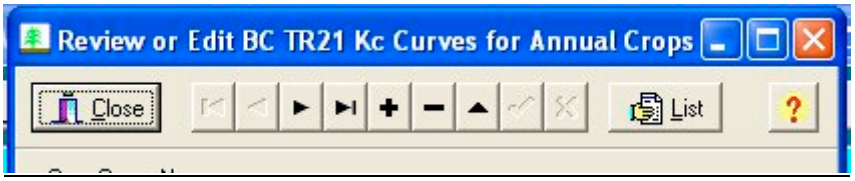


Figure B.1
Simple database interface

Use the navigation bar to move from record to record in the database, edit a record, insert a new record, or delete a record. Placing the cursor over a key will display a hint describing what the key does.

Figure B.2
More comprehensive database interface

Under the **File** menu item there are selections for two types of printed reports. One report will print the details of records that are marked.

Mark individual selected records by clicking the **Mark/Unmark** button. Under the **Marks** menu item selections will allow marking all records, unmarking all records and displaying only marked records.

Move through records by either selecting a record from the scroll list box or by using the arrow keys at the top of the form.

To edit data, insert a new record or delete a record; click the **Goto Edit** button. The button light will change to green, the caption will change to *Stop Edit*, and the **Insert Record**, **Cancel** and **Delete Record** buttons will become active.

After entering appropriate data, the data will be posted by clicking the **Stop Edit** button, moving to another record, or closing the window.

When to prepare a local crop database

A local crop database must be available in order to run the main IWR program. Data required for the local database will depend on the types of crops grown, the particular varieties of crops grown, when they are planted and harvested, climatic characteristics and cultural practices.

The boundaries of a region which can be covered by a particular local database may be a county, a valley, a portion of a state, or any geographic area where the same or very similar growing conditions apply.

It may be possible for a statewide master local database to be prepared, which then may be modified on a county by county or regional basis. The modifications would include deleting crops not grown in the area and inserting local default planting and harvest dates. It might also include inserting specialty crops only grown in the county or region.

Components of a local crop database

- **Crop name**

This is the local crop name element used by the database to tell one crop record from another. The name must be unique. For example, if you had two sweet corn varieties grown, one with 63 days between planting and harvest, and one with 82 days, the names you might assign could be:

Corn, sweet - early
Corn, sweet - late

The crop name should be as descriptive as possible of the crop's characteristics.

- **Grass reference crop curve name**

If either the radiation method or temperature method of ET computation will be used, a basal grass reference crop curve must be selected from those in the curve database. A curve as close as possible to the characteristics of the local crop should be chosen. For example, for sweet corn, if our climate were arid, moderate wind, we would choose the curve ***Corn, Sweet 3*** from the Field and vegetable crop curve table.

- **Blaney Criddle TR21 crop curve name**

A BCTR21 curve must be entered. The BCTR21 method of computing ET is the default method, which will be used if adequate climatic data is not available. Select the curve with the closest

characteristics to the crop being grown. For sweet corn we would select the BC Annual curve ***Corn, Sweet*** from the available curves.

- **Default planting or start of growth date**

Enter the month and day when this crop is planted, in the case of annual crops, or when it starts growth in the spring, in the case of a perennial crop. This is a default value. Since cultural practices may vary within the local area, the user may modify this date at run time.

- **Default harvest or end of growth date**

Enter the month and day when this crop is harvested, in the case of annual crops, or when it ends growth for the season, in the case of a perennial crop. This is a default value. Since cultural practices may vary within the local area, the user may modify this date at run time.

- **Optional data for computing start of growth and end of growth dates**

Average air temperature may be a significant factor as to when a crop starts growing and when it stops. Some of this information is available for curves in Figure 2A of NEH2. This type of data may also be available elsewhere.

Where information is available concerning average temperatures at which a crop will start growing and at which it will stop growing, that temperature data may be entered. The main IWR program will calculate start of growth and end of growth and enter it as the default rather than the default dates entered in the last item. This should result in more accurate default dates for specific sites within the region.

Length of time required for crop growth is also needed in some cases. This data may also be entered.

Even when start and end of growth dates are calculated, the user may override the default date at run time.

Creating or editing a local crop database

Start the program.

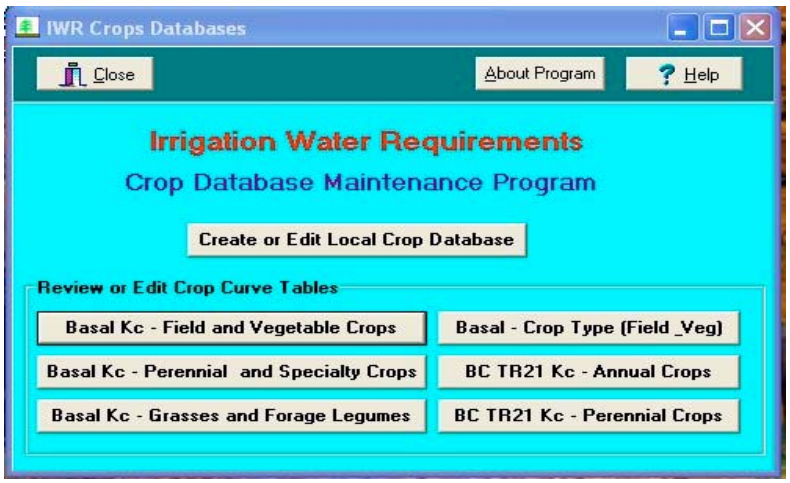


Figure B.3
Screen showing selection buttons at start if IWRCrop program

Edit mode

- Select the **Create or Edit Local Crop Database** button in the main window.
- The *Review or Edit Local Crop Database* window will appear.

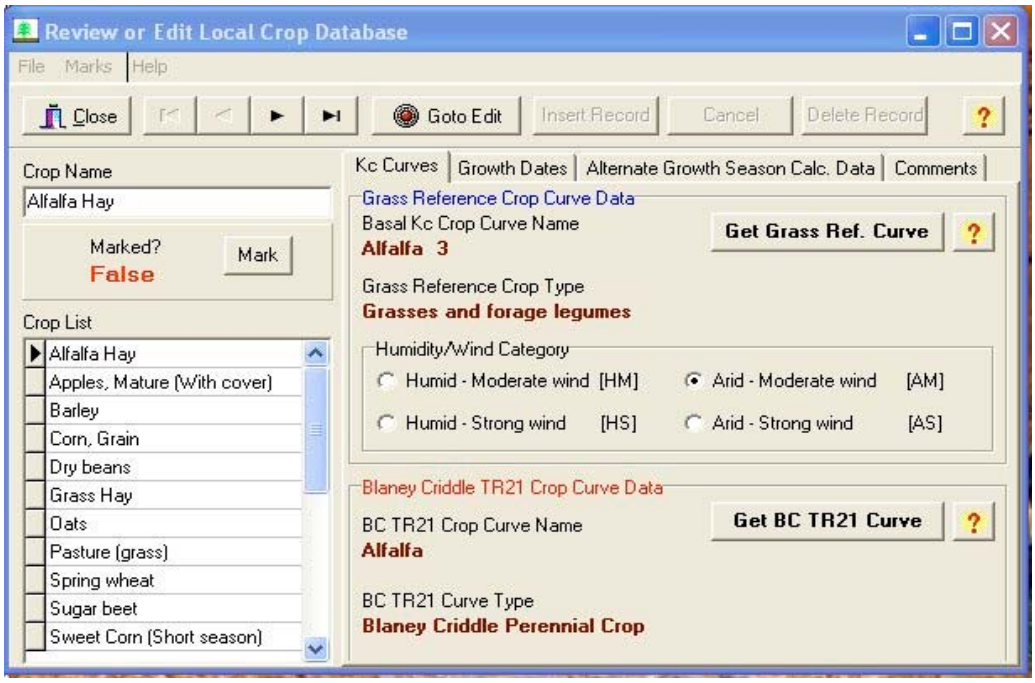


Figure B.4
Screen showing the review edit local crop database dialog

- Move through the crop name record by either selecting a crop name from the scroll list box or by using the arrow navigator keys at the top of the form. Note that there are tabs at the top of the display box at the right of the form. Click a tab to view or edit Kc Curve data, Growth Date data, Alternate Season Calc. Data, or Comments data.
- To edit data, insert a new crop record or delete a crop record, click the **Goto Edit** button. The button light will change to green, the caption will change to *Stop Edit*, and the **Insert Record**, **Cancel** and **Delete Record** buttons will become active.
- After entering appropriate data, the data will be posted by clicking the **Stop Edit** button, moving to another record, or closing the window.

Kc curves

- Click the *Kc Curves* tab.

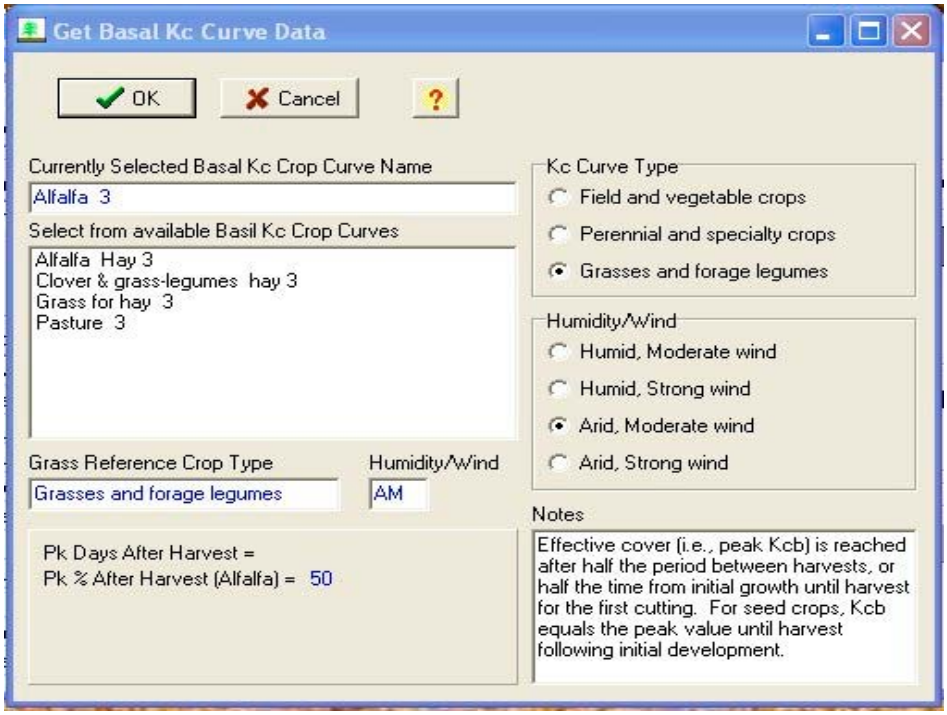


Figure B.5
Screen showing Basal crop curve selection dialog

- If either the Temperature or Radiation methods of ET computation are to be used, *Grass Reference Crop Curve Data* must be entered. Click the **Get Grass Ref. Curve** button to pop up a dialog box to enter the data. Data can not entered directly in the window display. The dialog box will be in edit mode even if you have not selected edit in the main window.

In the *Get Basal Kc Curve Data* dialog box, first select the appropriate **Kc Curve Type** and **Humidity/Wind** radio buttons. The appropriate curves will display in the *Select from available Basal Kc crop Curves* list box. Pick the appropriate crop curve name from the list. When the selection is correct, click the **OK** button. Appropriate information will now show in the window display.

Blaney Criddle curves

- A *Blaney Criddle TR21 Crop curve* must be selected. Click the **Get BC TR21 Curve** button to pop up a dialog box for entering data. You can not enter data directly in the window display. The dialog box will be in edit mode even if you have not selected edit in the main window.

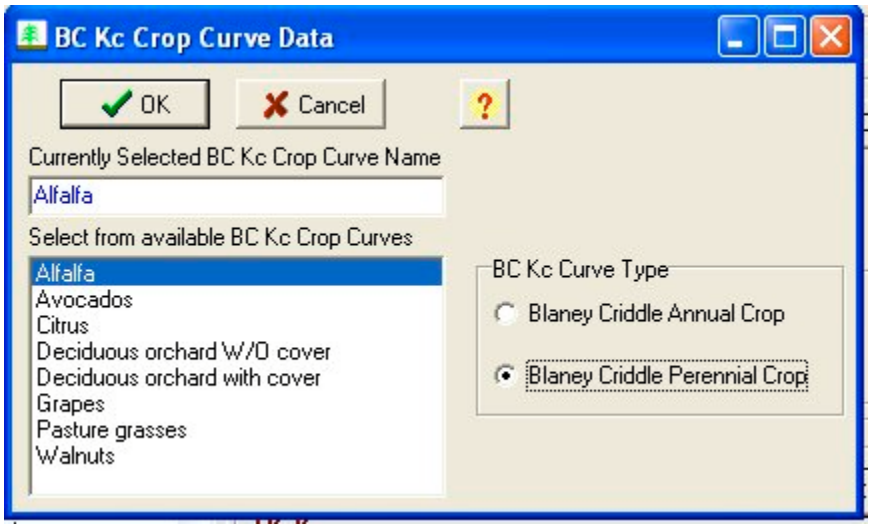


Figure B.6
Screen showing Blaney Criddle TR21 curve selection dialog

In the Get BC Kc Crop Curve Data dialog box, first select the appropriate Kc curve Type radio button. The appropriate curves will display in the *Select from available BC Kc crop Curves* list box. Pick the appropriate crop curve name from the list. When the selection is correct, click the **OK** button. Appropriate information will now show in the window display.

Growth dates

- Click *the Growth Dates* tab.

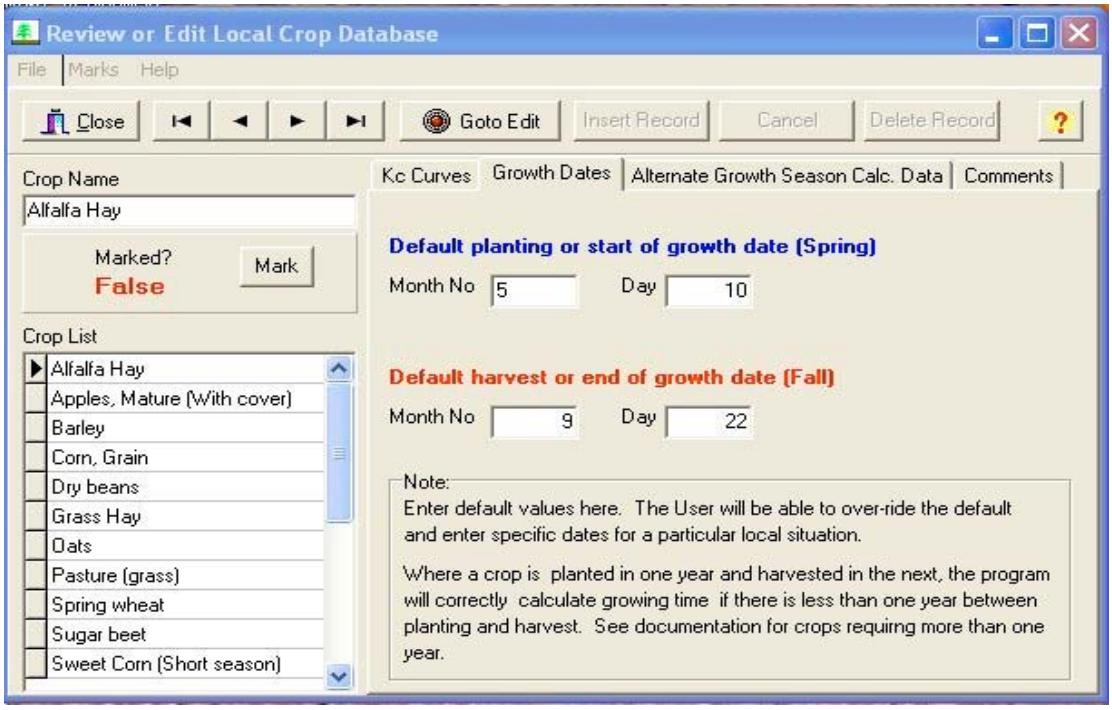


Figure B.7
Screen showing review or edit growth dates

- Enter your best estimate of the typical planting date for annual crops, or start of growth date for perennial crops. The user will have the opportunity to change this default date at run time.

- Enter your best estimate of the typical harvest date for annual crops, or end of growth date for perennial crops. The user will have the opportunity to change this default date at run time.

In warm areas, where there is not a dormant period, a crop may be planted in one year and harvested in the next. If the total growth period is 363 days or less, the IWR program will correctly calculate ET.

If a crop is multi year, separate Kc curves should be developed for each year of development. Separate IWR program should then be made for each year. This same approach should also be used for perennial crops, such as orchards, where water use is significantly different depending on the age of development of the orchard.

Where a crop is planted in one year, goes dormant, and then resumes growth in the spring, then separate Kc curves should be developed for the fall portion of growth and for the spring portion. Separate IWR runs must be made. Winter wheat is an example of this type of crop.

Alternate growth season Calc. data

- Click the *Alternate Growth Season Calc. Data* tab.
-

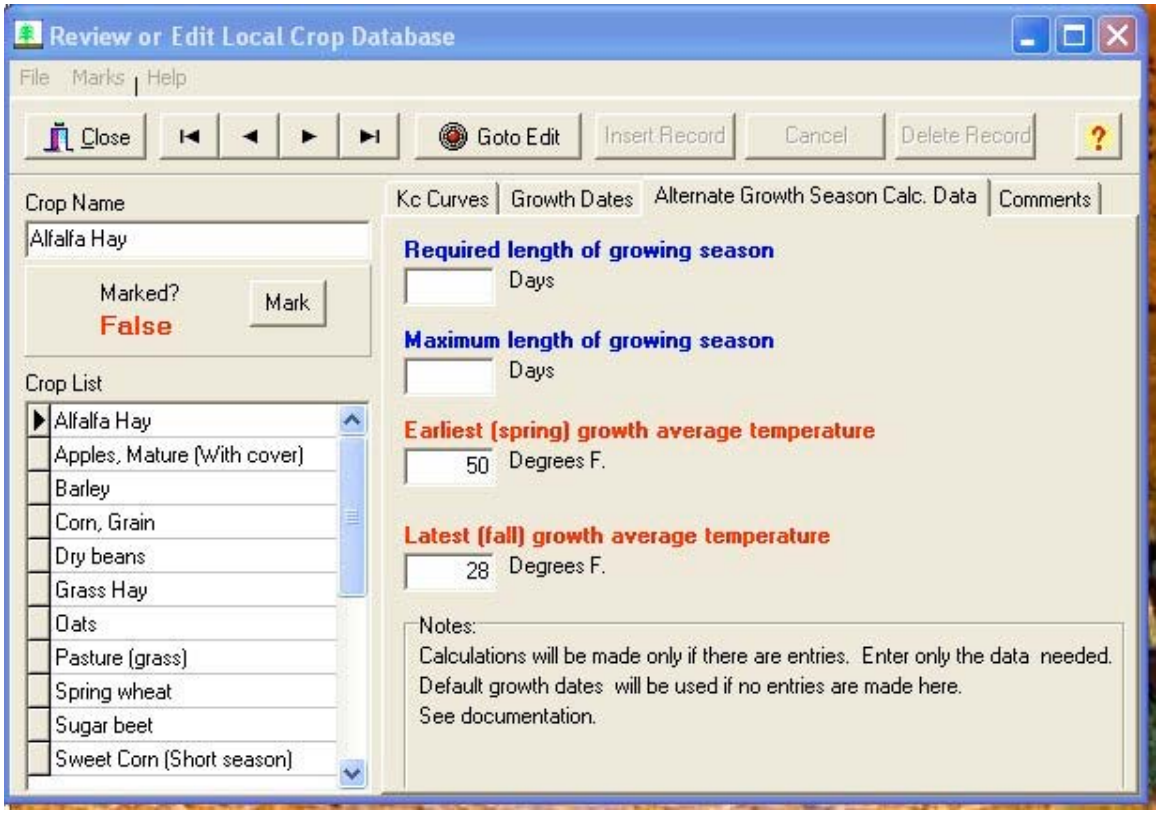


Figure B.8
Screen showing review or edit alternate growth season calc. data

- See various curves in Figure 2A, NEH2 for the data, which may be entered here. Other sources of this kind of data may be available. See *Components of a local crop database* for further details.

- Alternative calculations using this data will only be made if appropriate data is entered here. The combinations of required data are any one of the following:

  Required length of growing season + Earliest (spring) growth average temperature + Latest (fall) growth average temperature

  Earliest (spring) growth average temperature + Latest (fall) growth average temperature

  Maximum length of growing season + Earliest (spring) growth average temperature + Latest (fall) growth average temperature

Comments

- Click the *Comments* tab.

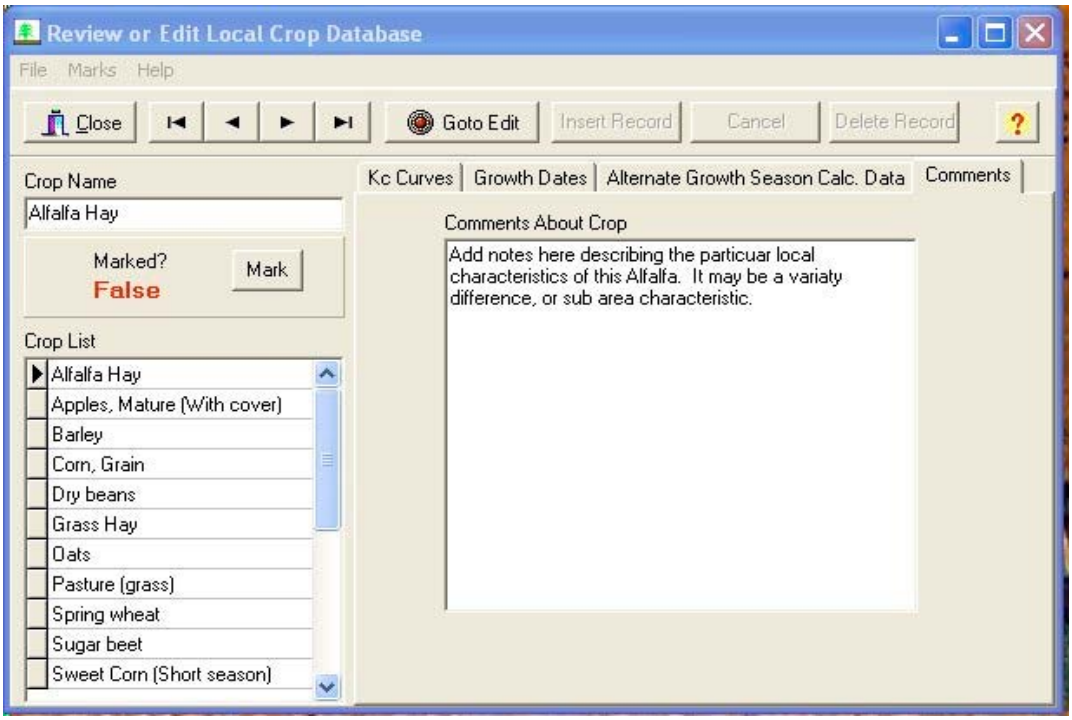


Figure B.9
Screen showing review or edit comments

- This is a place to enter comments. Comments may be any length. Enter information that pertains to the particular crop. For example, explain what geographical area the information for this local crop is applicable. List any variety or cultural information that may be of value when someone is trying to decide whether to select this crop for a calculation.

Entering or editing crop curves

Select a crop curve from the main menu.

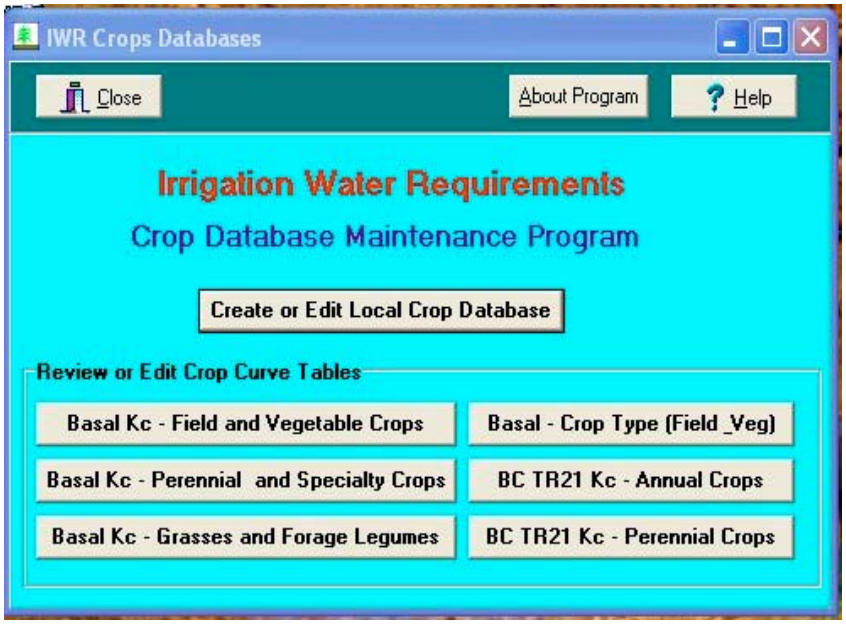


Figure B.10
Screen showing main menu buttons for selecting crop curve review or edit selections

Field and Vegetable crop curves

These curves are based on NEH2 Table 2-20. The curves are constructed in accordance with Figure 2-20. The IWR program uses the process shown in Figure 2-21 to interpolate curve Kc values. There are actually two database tables that contain the data for these curves. These are the *Field and vegetable crop curves* table and the *Field and vegetable crop type* table. The *Field and vegetable crop curves* table contains separate crop Kc coefficients for each climate category. This database refers to the *Field and vegetable crop type* table where the fractions of seasons data and days from planting until maturity data is stored.

To review or edit the crops curves table do the following:

- Select the **Basal Kc – Field and Vegetable Crops** button in the main window

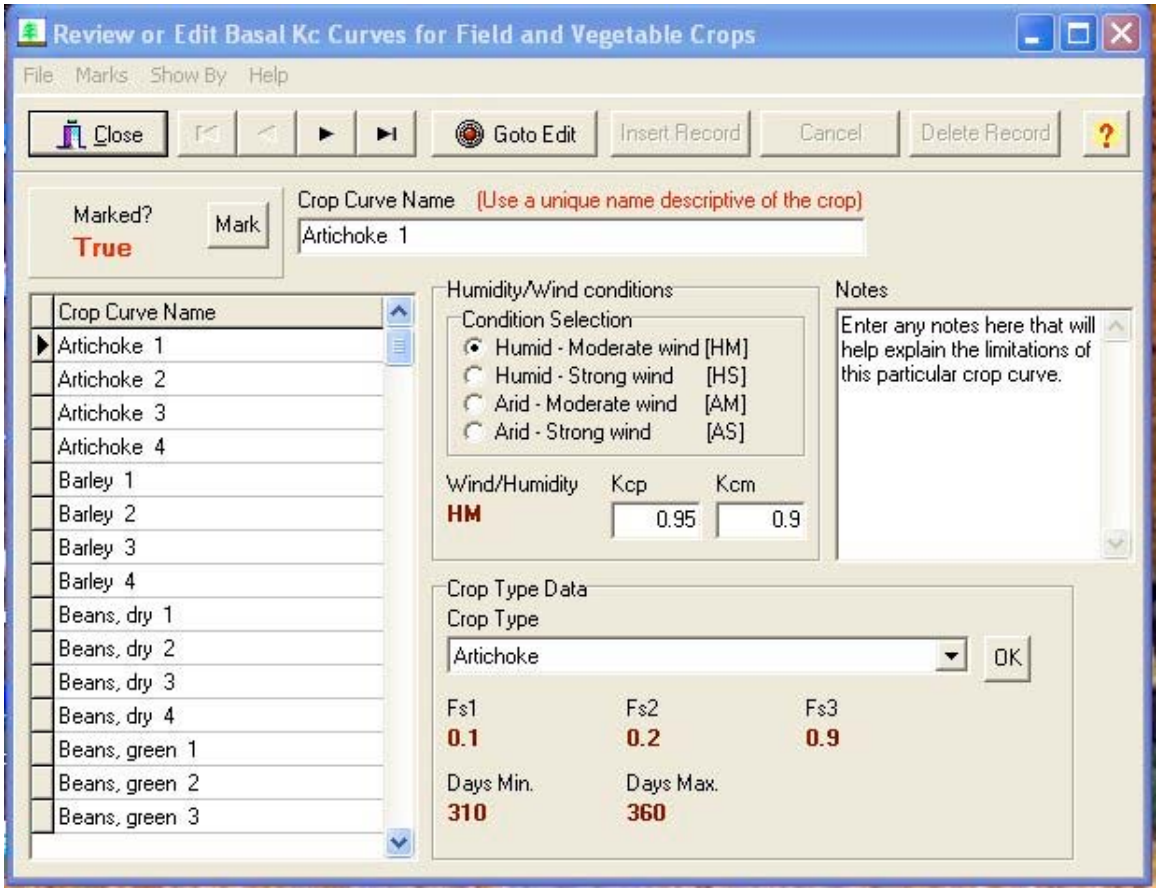


Figure B.11
Screen showing review or edit Basal Kc curves

- The *Review or Edit Basal Kc Curves for Field and Vegetable Crops* window will appear.
- Move through the Crop Curve Name records by either selecting a Crop Curve Name from the scroll list box or by using the arrow keys at the top of the form.
- To edit data, insert a new crop curve record or delete a crop curve record, click the **Goto Edit** button. The button light will change to green, the caption will change to *Stop Edit*, and the **Insert Record**, **Cancel** and **Delete Record** buttons will become active.
- After entering appropriate data, the data will be posted by clicking the **Stop Edit** button, moving to another record, or closing the window.

Selecting a crop type

A crop type must be selected from the *Field Vegetable Crop Type* database. To select the appropriate crop type, do the following:

- Enter the edit mode by clicking the Goto Edit button.
- Move to the *Crop Type* field and click on the scroll bar to pop down a list of available crop types. Select the appropriate crop type and click the OK button. The crop type data will display in appropriate fields.

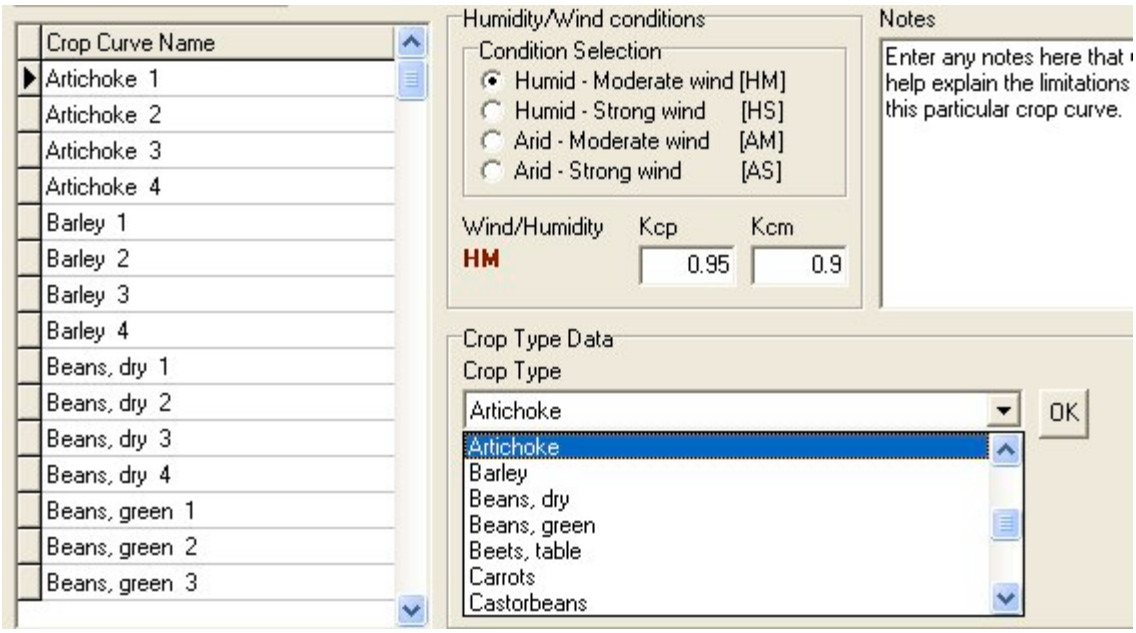


Figure B.12
Screen showing selection of crop type

Note that data can not be entered directly in the crop type data fields. Changes in crop type data must be made using the utility Field and vegetable crop type data.

Field and vegetable crop type data

To review or edit the crops type table, do the following:

- Select the **Basal – Crop Type (Field_Veg)** button in the main window
- The *Annual Crop Type DB Review or Edit* window will appear.

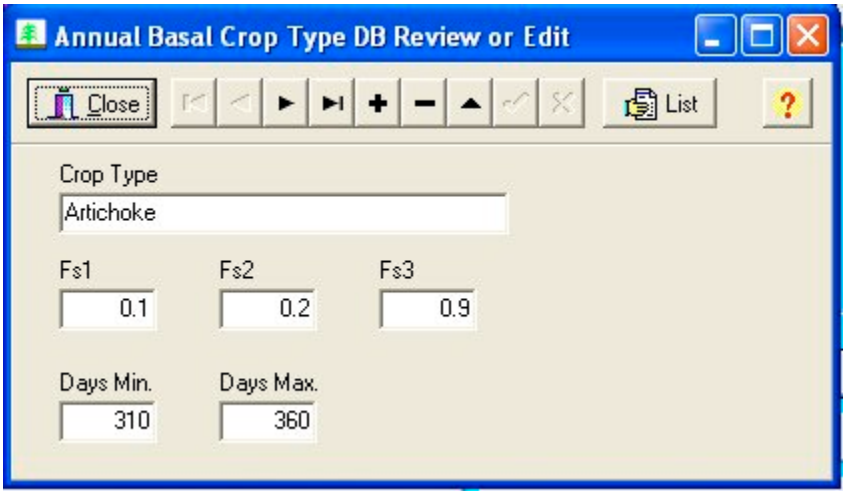


Figure B.13
Screen showing annual crop type DB review or edit

- Move through the Crop Curve Name records using the arrow keys on the button bar at the top of the form.

- Use the button bar at the top of the window to move from record to record in the database, edit a record, insert a new record, or delete a record. Placing the cursor over a key will display a hint describing what the key does.

Perennial and specialty crop curves

These curves are based on NEH2 Tables 2-22 through 2-27. These are Kc curves based on monthly Kc values. The database has Kc data inputs for all twelve months. Enter Kc values for all moths that will be used in calculating ET, even if only one day of the month is used in the calculations. If Kc data is missing from the program for a needed month, the program will use the Kc value for the nearest month.

To review or edit the crops curves table do the following:

- Select the **Basal Kc – Perennial and Specialty Crops** button in the main window

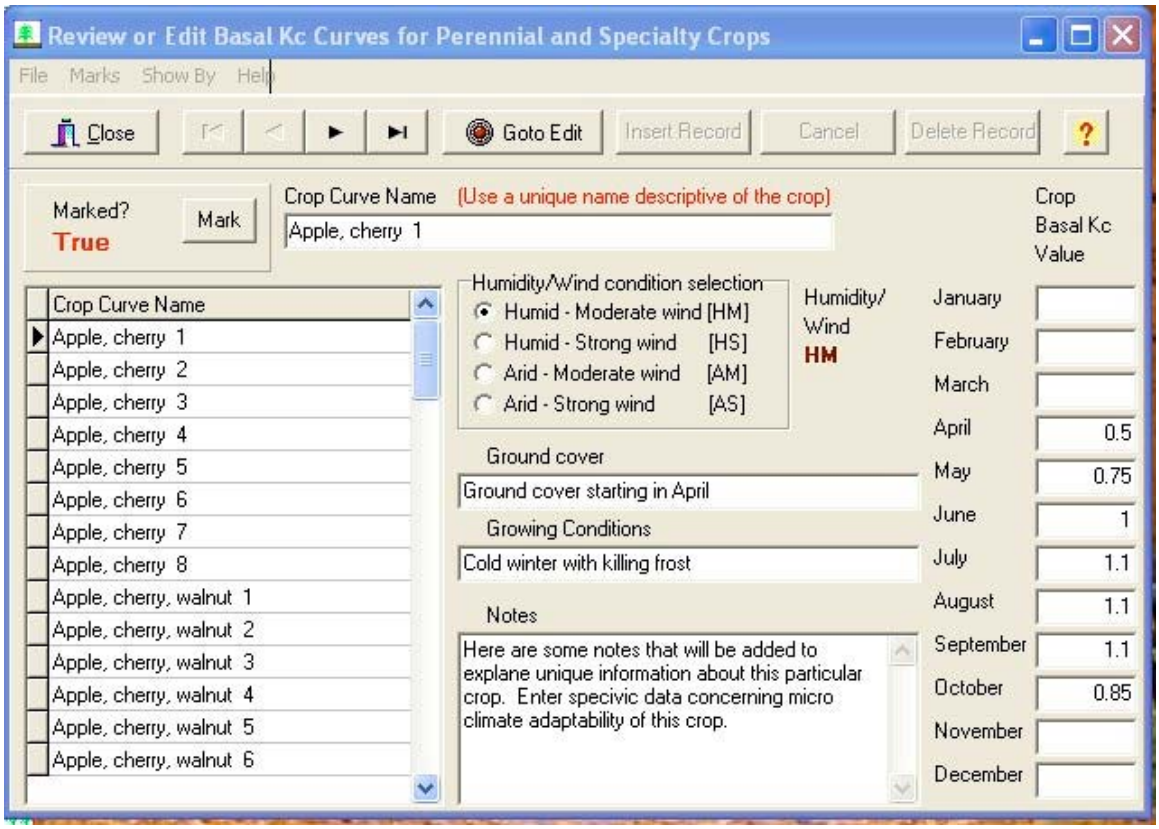


Figure B.14
Screen showing review edit basal Kc curves for perennial and specialty crops

- The *Review or Edit Basal Kc Curves for Perennial and Specialty Crops* window will appear.

- Move through the Crop Curve Name records by either selecting a Crop Curve Name from the scroll list box or by using the arrow keys at the top of the form.

- To edit data, insert a new crop curve record or delete a crop curve record, click the **Goto Edit** button. The button light will change to green, the caption will change to *Stop Edit*, and the **Insert Record**, **Cancel** and **Delete Record** buttons will become active.

- After entering appropriate data, the data will be posted by clicking the **Stop Edit** button, moving to another record, or closing the window.

Grass and forage legume crop curves

These curves are based on NEH2 Table 2-21. The Kc curves are based on low and peak Kc values. Crop coefficients for harvested grass and legumes, drop at harvest and then increase as re-growth occurs. The minimum Kc value is denoted as low and the maximum Kc value after effective cover represents the peak Kc value. Re-growth time is described in terms of percentage of the period between harvests for alfalfa and the number of days before harvest for grasses for hay.

The IWR program will require that the number of cuttings be entered at runtime, as well as the dates for first and last cuttings. The program will construct and interpolate a Kc curve at that time.

In the case of pastures that are grazed more or less continuously, or grass seed crops, there are no cut dates. The way this is handled by the IWR program, is to set only one cut date at the end of growth date. The date that peak Kc value is reached can then be adjusted by entering the number of days from end of growth to the estimated date that the pasture has reached full growth for the season. This time is entered in the *Pk. Days before Harvest (Grass)* field. Set this procedure by selecting the *Pasture/Seed (No cuttings)* radio button in the *Set to Hay or Pasture* box.

To review or edit the crops curves table do the following:

- Select the **Basal Kc – Grasses and Forage Legumes** button in the main window

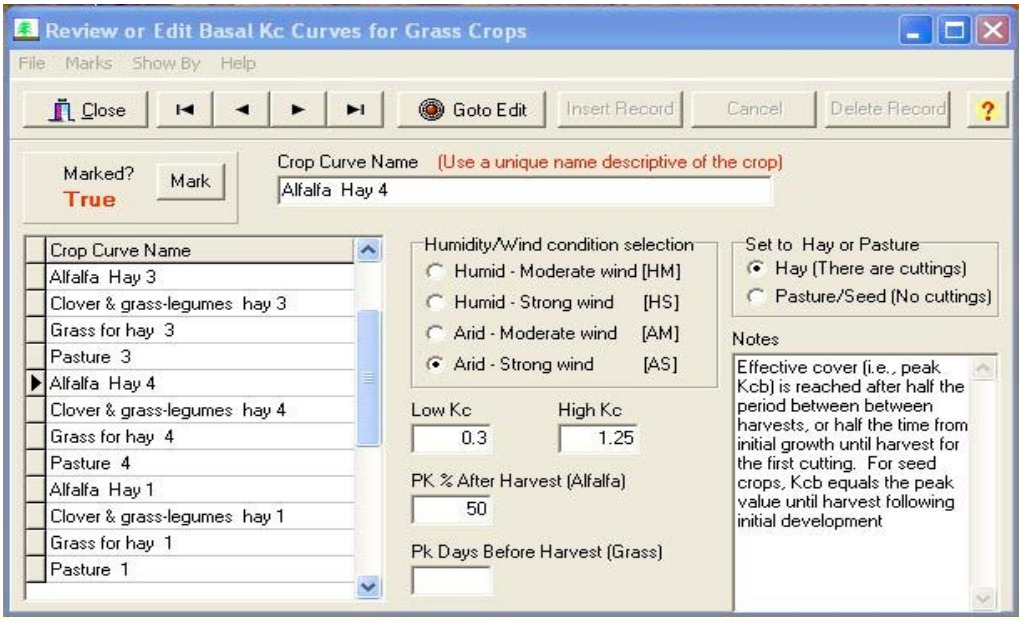


Figure B.15
Screen showing review or edit basal Kc curves for grass crops

- The *Review or Edit Basal Kc Curves for Grass Crops* window will appear.

- Move through the Crop Curve Name records by either selecting a Crop Curve Name from the scroll list box or by using the navigator arrow keys at the top of the form.

- To edit data, insert a new crop curve record or delete a crop curve record, click the **Goto Edit** button. The button light will change to green, the caption will change to *Stop Edit*, and the **Insert Record**, **Cancel** and **Delete Record** buttons will become active.

- After entering appropriate data, the data will be posted by clicking the **Stop Edit** button, moving to another record, or closing the window.

Blaney Criddle annual crop curves

To review or edit the Blaney Criddle annual curves table, do the following:

- Select the **BC TR21 Kc – Annual Crops** button in the main window

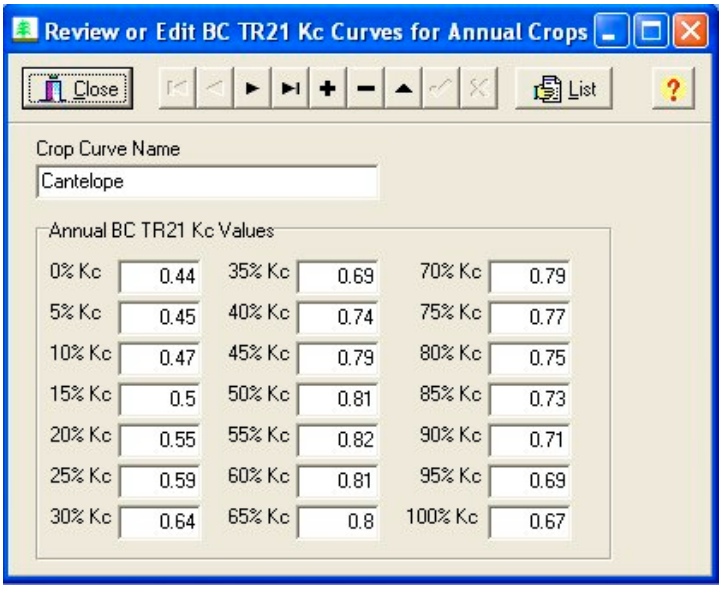


Figure B.16
Screen showing review or edit Blaney Criddle Kc curves for annual crops

- The *Review or Edit BC TR21 Kc curves for Annual Crops* window will appear.

- Move through the Crop Curve Name records using the arrow keys on the button bar at the top of the form.

- Use the button bar at the top of the window to move from record to record in the database, edit a record, insert a new record, or delete a record. Placing the cursor over a key will display a hint describing what the key does.

Blaney Criddle perennial crop curves

To review or edit the Blaney Criddle perennial curves table, do the following:

- Select the **BC TR21 Kc – Perennial Crops** button in the main window

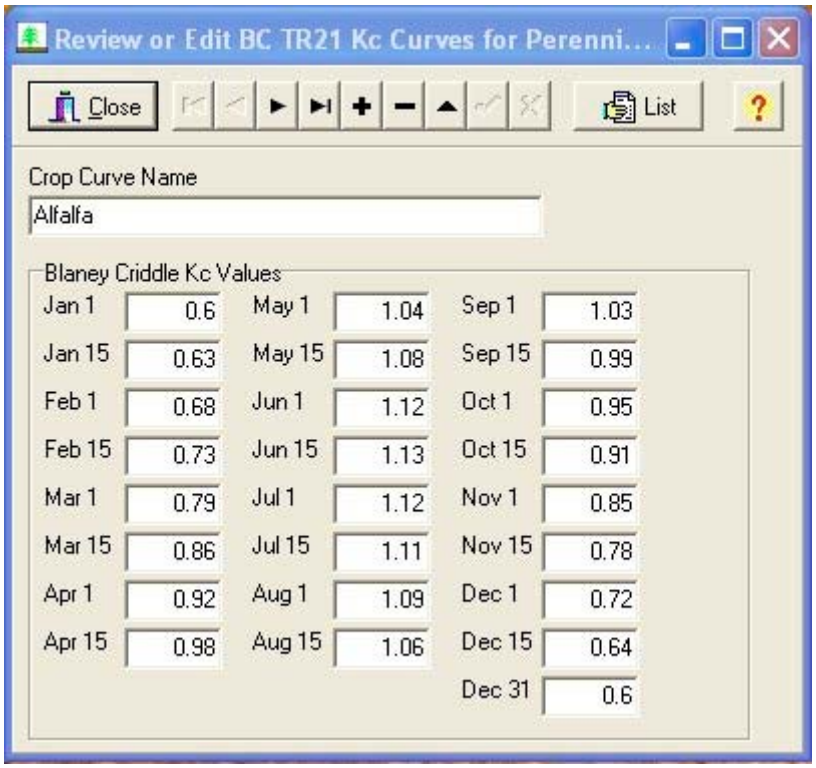


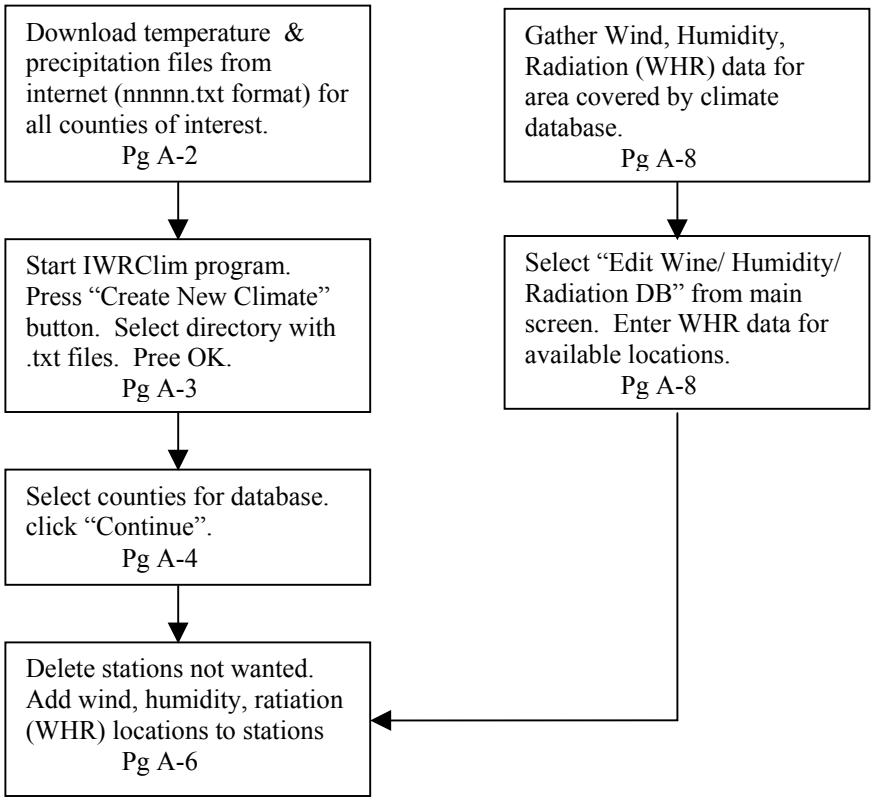
Figure B.17
Screen showing review or edit Blaney Criddle Kc curves for perennial crops

- The *Review or Edit BC TR21 Kc curves for Perennial Crops* window will appear.
- Move through the Crop Curve Name records using the arrow keys on the button bar at the top of the form.
- Use the button bar at the top of the window to move from record to record in the database, edit a record, insert a new record, or delete a record. Placing the cursor over a key will display a hint describing what the key does.

Appendix C
Program Flow Chart

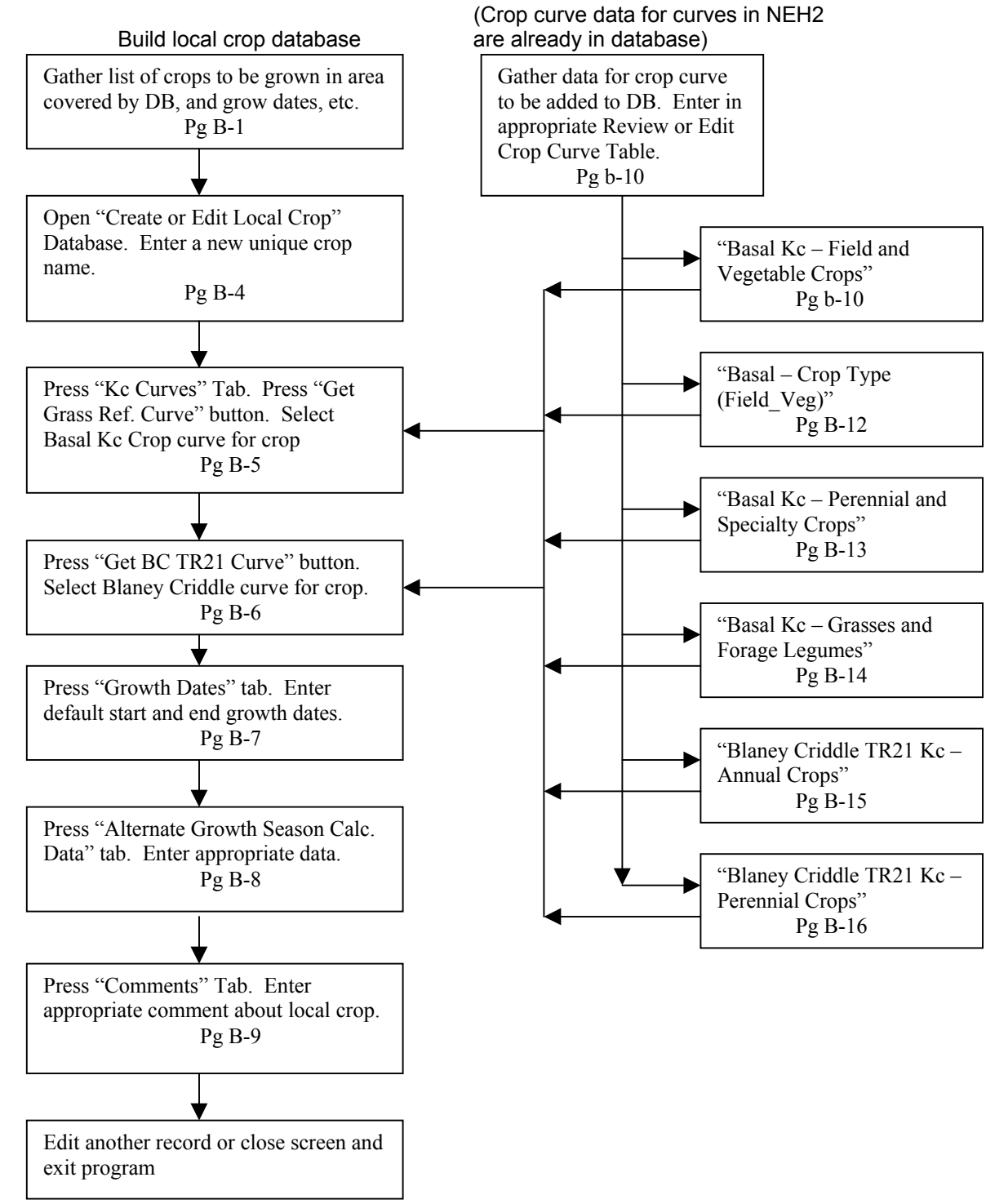
Required preparation for running IWR program (1)

Climate database program (IWRClim)



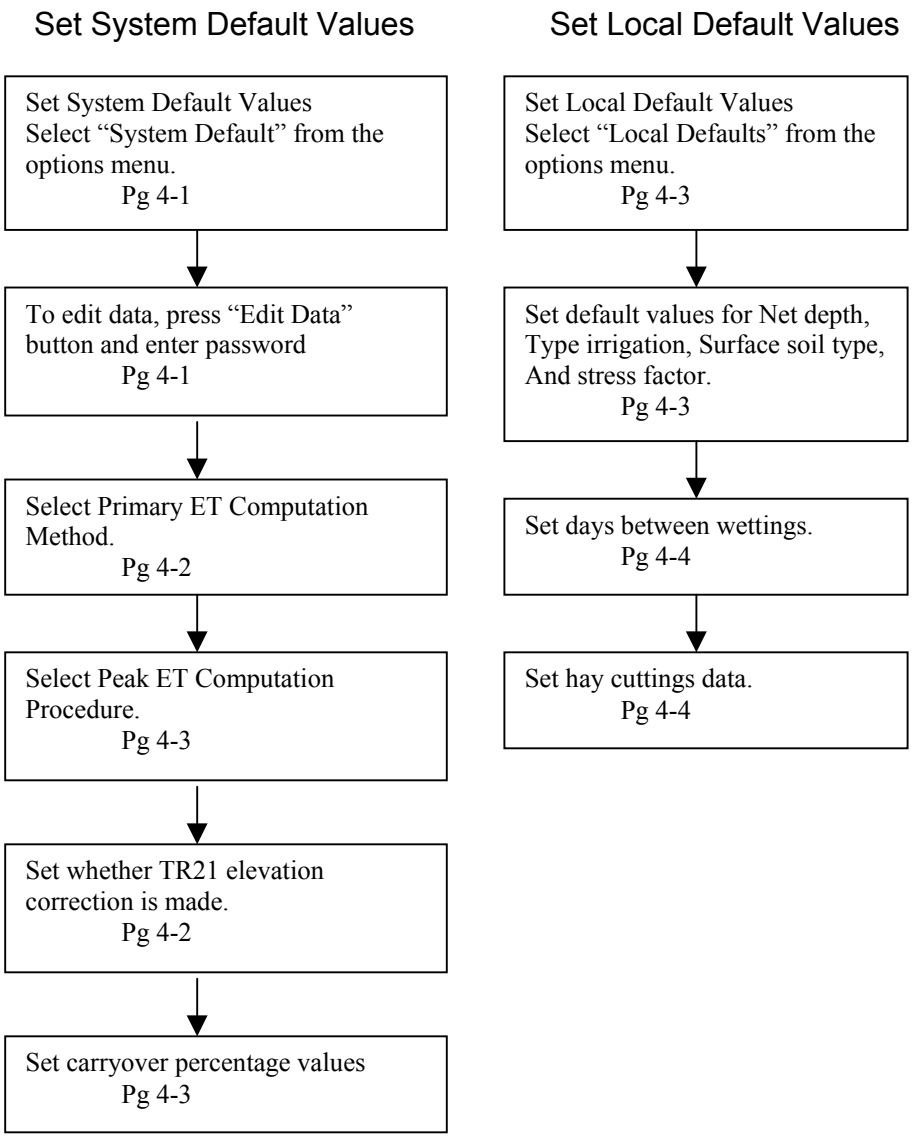
Required preparation for running IWR program (2)

Crop database program (IWRCrop)



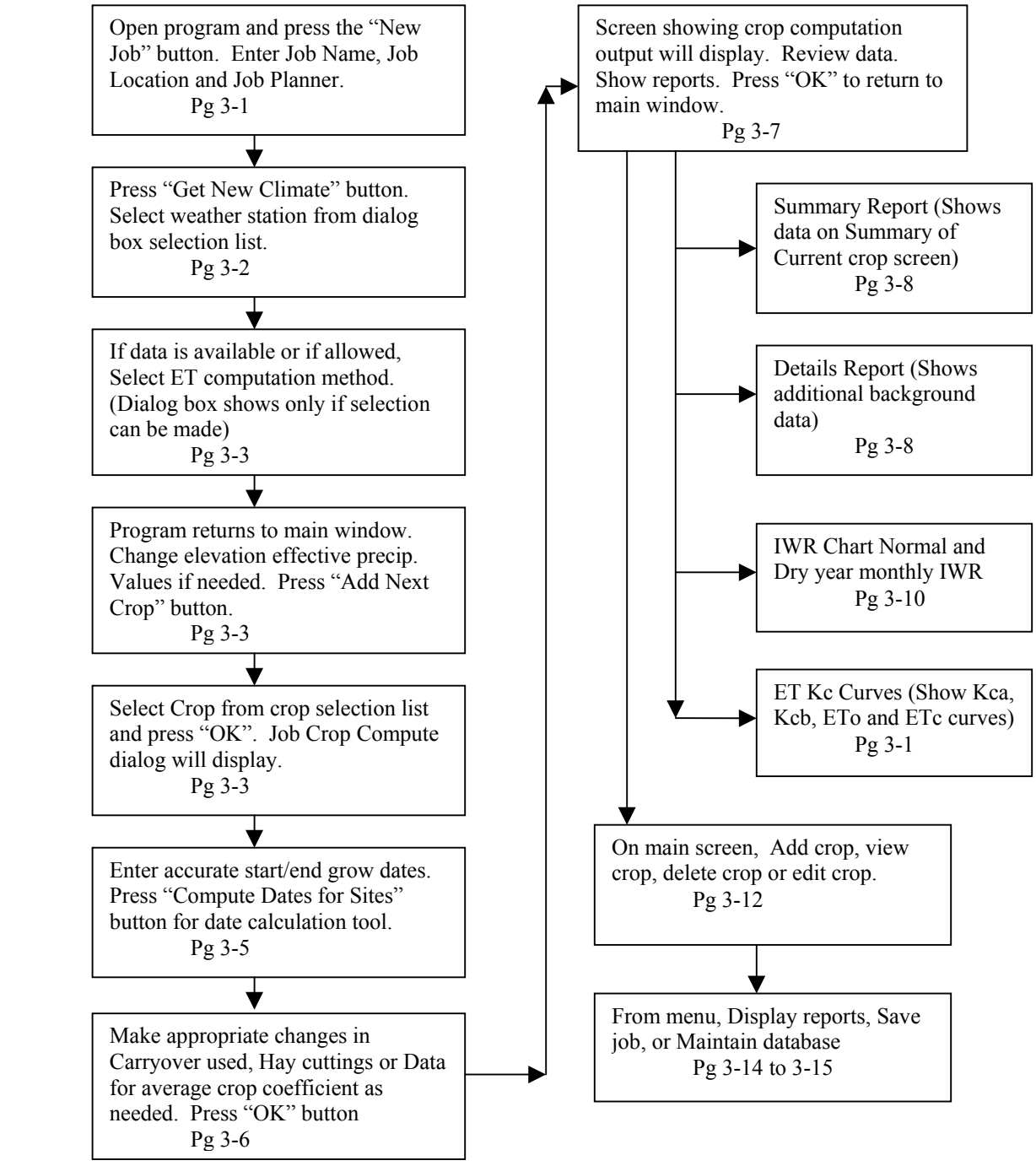
Running IWR program (Prepare program for use)

Irrigation water requirements program (IWR)



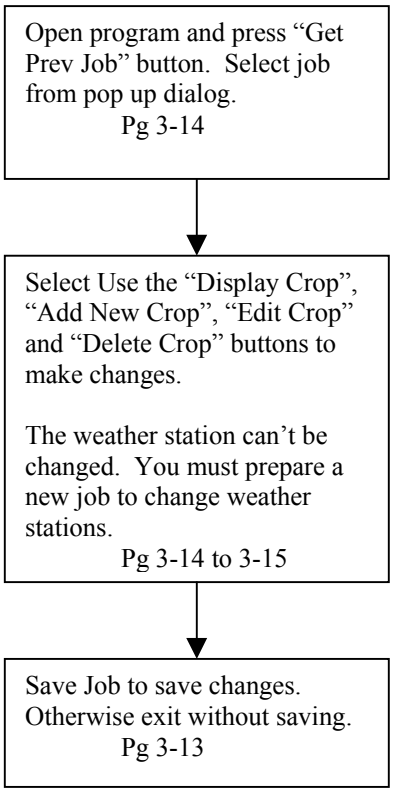
Running IWR program (New job)

Irrigation water requirements program (IWR)



Running IWR program (Old job)

Irrigation water requirements program (IWR)



Appendix D
Maintain Database Files Access

IWR program data is maintained in database files located in a single directory that is installed when IWR is installed. This directory must be separate from other directories containing database files for other programs.

The IWR programs uses the Borland Database Engine (BDE) to manage database files. The database files are non-text files of the *Paradox* database type. These files can not be read with a text editor program. The IWR programs are designed with functions to maintain these files.

The IWR program connection to database files can be broken. The procedure for re-establishing that connection is as follows.

The default location of a database directory named **"Database"** is installed under the main IWR directory. It is recommended that this directory **not** be moved from that location. Moving the directory will break the connection with IWR. Other computer glitches might also break the connection.

A *BDE Administrator* program utility is installed with IIWR (or by other programs using the Borland BDE). This program is located under the Windows *Control Panel* directory.

Click on the **BDE Administrator** button to bring up the program. Click the **Help** button for general details on how to use it.

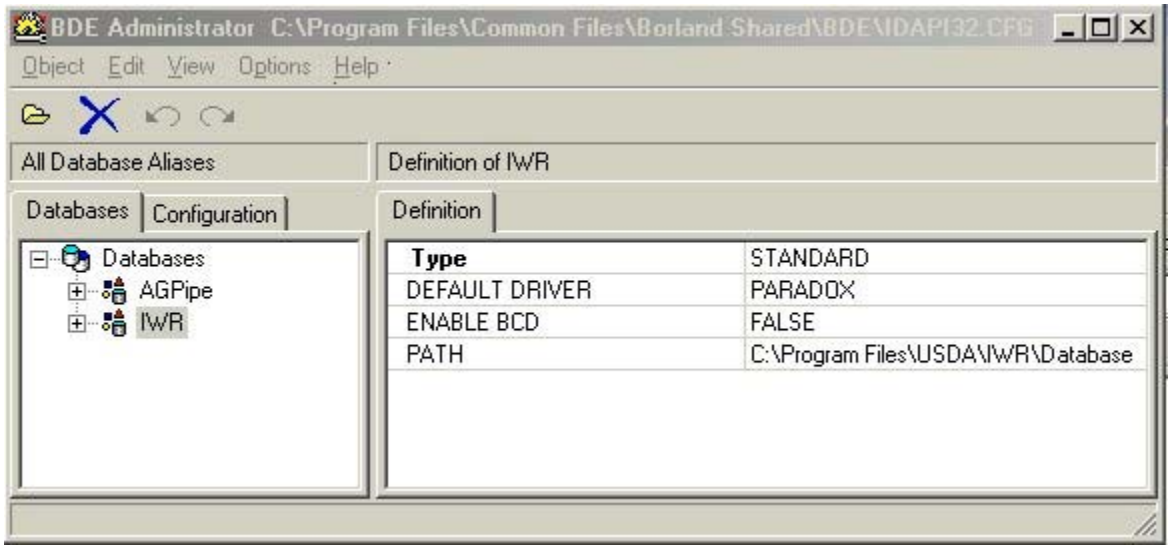


Figure D.1
Screen showing BDE Administrator and the IWR alias.

The BDE uses an ***Alias*** to keep track of where the database files are located. The alias is set with the BDE Administrator program. The alias used by the IWR program is named **IWR**. If the **IWR** alias does not show up in the list of aliases, a new one must be added. If it does show up, but is not working, the **IWR** alias must be deleted and a new one added.

To add the IWR alias:

- Click *Object* on the main menu
- Click on *new*… menu item
- A *New Data Database Alias* dialog (Figure D.1) appears. Accept the Default Database Driver Name **STANDARD**. Click OK
- Type "**IWR**" in the highlighted block. This is the name of the alias.
- Under *Definition*, do not change: Type = **STANDARD**, Default Driver = **PARADOX**, ENABLE BDE = **FALSE**.
- Click on the PATH location. Click on the [**…**] button. A Select Directory dialog will appear. Use the dialog to select the *Database* directory where IWR database files are located.
- Click on the apply button at the top of the BDE Administrator program to save the edits.
- The IWR alias should now be set and IWR should work.