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Revised Wind Erosion Equation

by
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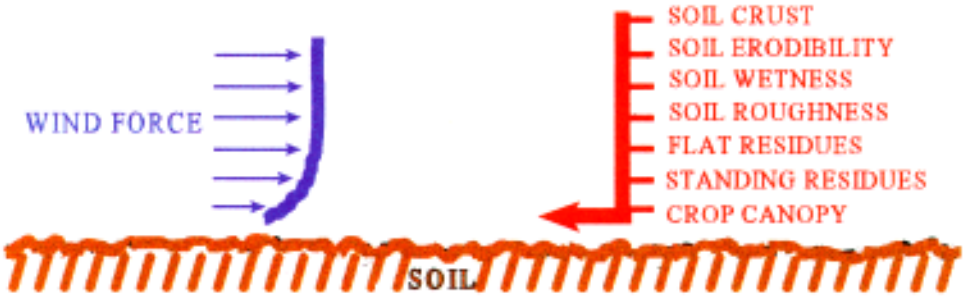

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APPENDICES

PREFACE

The Revised Wind Erosion Equation (RWEQ) uses mathematical equations and associated parameter values needed to compute estimates of soil eroded and transported by wind for that portion of sediment that moves between the soil surface up to a height of two meters. This documentation has been peer reviewed and administratively approved according to standard practice of the USDA-Agricultural Research Service (ARS) when it authorizes scientific information to be published and publicly released.

The ultimate objective for RWEQ is that it be used as a tool in operational programs by the USDA-Natural Resources Conservation Service (NRCS), other federal, state, and local agencies, and private consultants and organizations. This version of RWEQ, however, has not been fully tested and evaluated for that purpose. The United States Department of Agriculture and the Agricultural Research Service accept no liability or responsibility of any kind to any user, other person, or entity as a result of installation or operation of this software. The software is provided "AS IS," and you, its user, assume all risks when using it.

RWEQ is in the public domain and you are free to use it. ARS would appreciate your comments on the model's capabilities and limitations, especially if you conduct field validation tests on the model. Please send comments to Dr. Ted M. Zobeck (tzobeck@lbk.ars.usda.gov).

If the executable code of the current version is downloaded and used within a larger software package, please acknowledge the source and include this preface.

To reference this manual use the following citation:
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Internet address:
http://www.csrl.ars.usda.gov/wewc/rweq/readme.htm

1. INTRODUCTION

Technology currently not being used to estimate wind erosion has been incorporated into a Revised Wind Erosion Equation (RWEQ) which estimates soil eroded and transported by wind between the soil surface and a height of two meters. Fine sediment is transported as suspended load and travels much greater distances than the coarse sediment transported as creep and saltation. Thus, RWEQ is not applicable for those problems where suspended, fine sediment above two meters is the concern. RWEQ is most applicable for problems of erosion from the field but also provides information on erosion rate effects within the field. This revision improves estimates of erosion, allows more flexibility in inputs, and enhances output. The basic assumption of RWEQ is that wind limits total erosion. A general diagram of RWEQ is illustrated in Figure 1.

RWEQ utilizes monthly weather data, soil and field data, and management inputs. The management inputs include cropping systems, tillage and operation dates, windbarrier descriptions, and, where applicable, irrigation information. Time periods from the management input file are used to partition the weather factor for each 1-15 day time period. The dominant wind direction for each period is determined, and the wind factor is computed for four directions based on preponderance and positive parallel ratio values from the weather files. Adjustments are made in wind for hill and wind barrier effects, snow cover, and soil wetness. Operation dates are also used to determine time periods for computations of residue decay, soil roughness decline, and soil erosion. Residue decomposition is computed for each period based on weather conditions and accumulated decomposition days since crop harvest. Soil roughness is decayed for each time period based on rainfall characteristics and clay content.

Whenever tillage operations are performed, standing residues are flattened according to the standing retained coefficient. The mass going from standing to flat is added to the existing flat mass pool and buried according to the flat retained coefficient.

Tillage roughness, both random (clods) and oriented (ridges), varies between geographic regions, soil conditions, and operator experience. No single value is equally suited for all regions of the country. The residue and soil roughness values at the end of each 1-15 day period are used to estimate transport mass for the time period. The transport mass (between soil surface and a height of 6.6 feet) is divided by the length of eroding field to determine the average soil erosion for that field length.

To validate RWEQ, transport mass samples of eroded soil were collected from twenty-two sites in 11 states. These sites represent major wind erosion regions of the United States. The majority of the data are from standard 6.5-acre circular fields. Limited erosion data from 320-acre rectangular, 160-acre square and 130-acre circular fields are included in the validation tests.

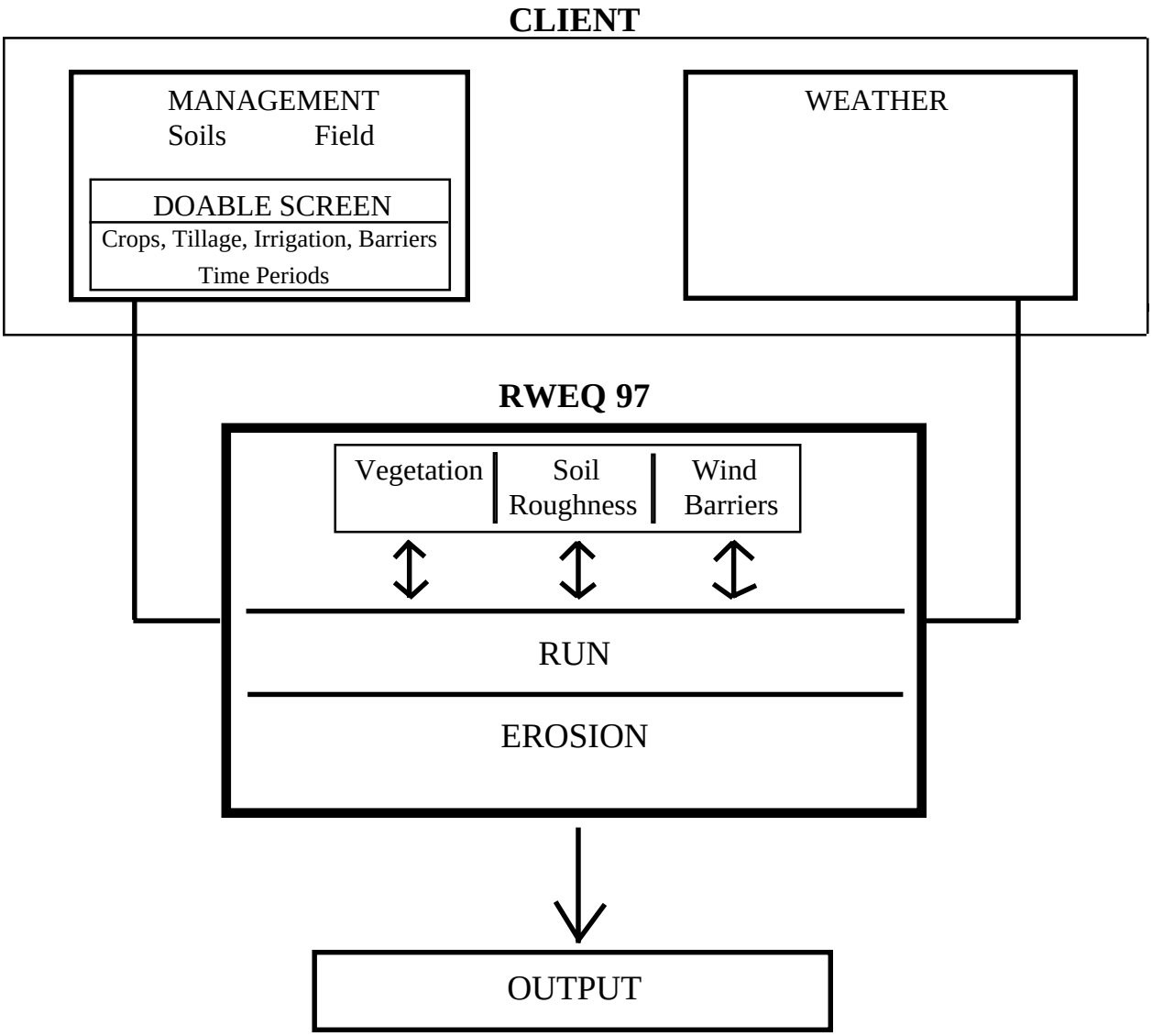
To expedite file development, input information can be saved under a CLIENT filename. The CLIENT file can be brought into the RWEQ program, modified to represent a different field and saved under a new CLIENT filename. This facilitates developing a management template that

Fryrear, D.W., Ali Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, and T.M. Zobeck. 1998. Revised Wind Erosion Equation (RWEQ). Wind Erosion and Water Conservation Research Unit, USDA-ARS, Southern Plains Area Cropping Systems Research Laboratory. Technical Bulletin No. 1. Internet address: http://www.csrl.ars.usda.gov/wewc/rweq/readme.htm

can be tested with different crops, tillage dates, types of tillage operations, or any other modifications of the basic input data.

RWEQ is not intended for time intervals shorter than one day. Routines are not available to describe the relationships between transport mass and fine dust emissions. Routines are not included to modify soil roughness or adjust erodibility due to freeze/thaw effects.

Figure 1. Generalized flow diagram of RWEQ.



1.1 GETTING STARTED

1.1.1 Loading RWEQ

The RWEQ program and 602 weather data files are on a single computer diskette.

Turn the computer on! At the C:\>prompt, type **MD RWEQ97** to create a subdirectory for RWEQ. At the C:\> prompt, type **CD RWEQ97** to move to the new subdirectory.

Insert the RWEQ program diskette in the proper drive (*e.g*. A:). At the C:\ RWEQ97> prompt, type **COPY A:*.*** to copy the RWEQ program and associated files from the diskette to the RWEQ97 subdirectory. At the C:\RWEQ97> prompt, type **INSTWE** to install the program and weather files.

1.1.2 Running RWEQ

Anytime after the RWEQ program has been loaded and installed, simply go to the RWEQ97 subdirectory to run RWEQ. At the C:\> prompt, type **CD RWEQ97**. At the C:\RWEQ97> prompt type **RWEQ** to begin the program.

1.2 RWEQ INPUT FILES AND DATA

In the RWEQ program, the user is prompted for client, weather, management, soil, field, crop, tillage, and barrier information that is essential to estimating soil erosion. The input data may be saved in RWEQ which minimizes data input time and maximizes flexibility in evaluating wind erosion control strategies.

1.2.1 Client

Use of a client file is not essential; however, it is convenient. The client file contains the names of a management file and a weather data file. The client filename can be any combination of characters (up to 8 with an optional extension of 3 characters) that identifies the specific field being evaluated. For example, farmer Smith may have several different fields. The fields may be identified as Smith1, Smith2, Smith3, etc. Each client file may contain different weather, field, crop, soil, and/or tillage system data.

1.2.2 Weather

The weather input file contains the monthly climatic data that includes the wind, rainfall, solar radiation, temperature, and snow cover data. Weather files are provided for 602 sites. The weather filenames and locations are listed in APPENDIX-D. They carry a “.DAT” filename extension in the C:\RWEQ97\W subdirectory.

1.2.3 **Management**

A management file contains the soil properties, field geometry, farming operations and dates, and data for field roughness, irrigation, windbarriers, and soil cover (bare, growing crop, residue crop, or a combination of these). A management file may be a multiple year rotation system or a combination of one year in irrigation and the next year dryland. The main function of the management file is to input decisions the farmer can make that impact erosion. Because of the extreme variability in crops and operations, it is impossible to provide management files for all combinations of crops, soils, and tillage practices. Examples of field management systems are provided in Section 4.3.

1.2.3.1 **Soil properties** In RWEQ, generic files are provided for 12 soil textures. (See listing in APPENDIX E-3.) These files provide percent sand, silt, organic matter, calcium carbonate, and rock cover to estimate erodible fraction. Soil properties data can be changed within the program. RWEQ does not modify the soil's physical properties with long-term crop rotation systems. **NOTE:** Rock cover is combined with residue cover to compute a soil loss ratio coefficient for flat nonerodible elements.

1.2.3.2 **Field geometry** To estimate soil erosion the size, shape, and orientation of the field must be entered. Data on slope gradient and slope length are used to quantify the effect of hills on wind speeds and soil erosion. Until more complex input data systems are available, a hill starts at the upwind boundary of the field. If this is not the case, the field should be divided and the erosion from the hill calculated separately.

1.2.3.3 **DOABLE SCREEN** Operating decisions that are "doable" are entered in this screen. These decisions include tillage dates and operations, residue crops, growing crops, irrigation, and windbarriers.

1.2.3.3.1 **Vegetation data:** In addition to economic yields most crops produce residues that remain in the field after harvest. RWEQ computes residue cover and silhouette area of standing stubble from yield, crop and harvest heights, and stem number.

In RWEQ, residues are expressed as flat or standing. Within each crop file are residue decomposition coefficients (APPENDIX B-1) that decay residues based on air temperatures and soil wetness. While available for a limited number of crops, additional research is underway to develop coefficients for essential crops.

When crops are planted, the crop canopy development routine is initialized. The crop canopy coefficients (APPENDIX B-2) reflect the effect of a developing crop canopy on soil erosion as a function of "days after planting". Canopy effects continue until the crop is harvested.

CAUTION! Flat residue cover is normally calculated from crop yield data. Flat residues may be added through the "Flat Residue Cover" input in the **`Residue and Growing Crop Information`** window.

1.2.3.3.2 **Operation/Event [Tillage] data:** The effects of farm tillage operations are expressed with coefficients for soil ridge roughness and random roughness. Each operation that disturbs the soil surface destroys the soil crust. In addition, tillage operations also bury and flatten crop residues (APPENDIX C-1). Since burial or flattening is dependent upon soil texture, residue type, implement used, and moisture condition operators should customize tillage files for their specific region.

1.2.3.3.2.1 **Irrigation data:** The impact of irrigation water is included in the decomposition of plant residues, the decay of soil roughness, and the development of soil crust. All irrigation systems are assumed to have an effect similar to natural rainfall or sprinkler irrigation.

1.2.3.3.3 **Barrier data:** For each line in the **`DOABLE SCREEN`** the operator describes a vegetated barrier if one has been established. At this time RWEQ does not *grow* a barrier. Height, density, spacing and orientation changes must be entered for each line.

Barriers are described with optical density. The protected zone downwind is related to barrier characteristics, wind speed and soil surface conditions.

1.3 WATCH YOUR STEP!

When editing a file from DOS remember that filenames are limited to no more than 8 characters with an optional 3 character extension after the period. In RWEQ management files have ".MAN" extensions; output, ".OUT"; original weather files, ".DAT"; and modified weather files, ".W1"; There are no file extensions for soils, tillage and crop files - the filenames are listed in the second columns of APPENDICES E-3, C-1, B-1 and B-2.

Use of an arrow key after a value has been changed gives the appearance of a changed value; however, the new value is *not entered into the program* unless the <enter> key is used.

1.3.1 Vegetation

In the **`Residue and Growing Crop`** window it is important to understand that residue may be introduced into the program in two ways. The first uses economic yield, stem number, crop height before harvest and height of standing residue after harvest as inputs to the RWEQ program to estimate flat and standing residue masses. The second uses measured, observed, or estimated percent of flat residue cover as an input.

1.3.1.1 **Residues from harvested crops** This first method is usually for residue producing crops. Select the residue crop name from the F2 choice list. RWEQ brings in coefficients associated with that crop to distribute and decompose crop residue (APPENDIX B-1). The economic yield of the harvested crop entered at the "Yield" prompt and the stem number are used to determine the mass of flat and/or standing residue after harvest. When stem number is entered, the program computes silhouette based on crop harvest height and stem number.

1.3.1.2 **Adding flat residue cover** The second method is usually for residues that are hauled into the field. Estimated residue cover from a harvested crop can be input in lieu of yield and stem number. At the Crop prompt under "Residue" select a crop from the F2 choice list. The crop decomposition coefficients are called into the program. Do not enter a value for yield. Proceed to the "Flat Residue Cover" prompt and enter the percent of the surface covered with residue. Only enter a value for "Flat Residue Cover" when the residues are added to the field. All residues added are considered *flat* residues.

1.3.1.3 **Choosing the growing crop** At the Crop prompt under "Growing Crop", if NONE is chosen from the F2 choice list a "No" is automatically entered next to the Growing Crop prompt. If a crop is selected from the F2 choice list a "Yes" is automatically entered and the canopy development coefficients are brought into the program.

At the Growing crop prompt a "Yes" initializes the canopy development routine at planting. It should remain "Yes" during the entire growing season. It should be "No" at harvest or whenever there is no growing crop.

1.3.2 Operation/Event

When the operation or event is highlighted and flashing under "**`Operation/Event`**, press F9 to access the **`Operation/Irrigation Data`** window. Press F2 to see a choice list of tillage operations. Highlight the desired operation and press <enter>. If there is no operation, choose NONE. *NEVER* leave the operation name blank.

Selecting a tillage operation brings generic values for random roughness, for ridge height and spacing, and for residue burial and flattening coefficients into the F9 screen. These generic values may be changed if a "yes" is answered for "Operation Modifies Roughness". A "yes" indicates that an operation destroys the soil surface crust and initializes the soil crust development routine.

If a "Yes" is answered to "Kill Crop", the canopy development routine is terminated and the residue decomposition routine is initialized. Normally answer "Yes" at harvest.

1.3.3 Output

"Total Erosion" is the sum of the erosion values in the "Period Erosion" column of the **`DOABLE SCREEN`**. For example, the erosion period may be for months or years depending on the management system.

1.4 SPECIAL FUNCTION KEYS

In the RWEQ program there are special function keys that enable the operator to develop or modify the management file and expedite estimates of erosion.

1.4.1 F1 Field Help

Brings in specific help for the current position of the cursor. Press F1 a second time for a second help screen describing the special function keys. To return to the first help screen, press <Esc>. To return to the program from the first help screen, press <Esc>.

From either the first or second of these help screens press Alt-F1 to view a larger window. Press Alt-F1 again to return to the smaller window.

1.4.2 Shift-F1 General Help

Accesses a general help menu with a choice of descriptions of the variables in the tabular output, of the special function keys, or of the RWEQ program and its authors. Make a selection and press F1. As in the field help menus, press Alt-F1 to view a larger window and Alt-F1 to return to the smaller window.

1.4.3 F2 Choice List

Brings in a choice list available to the operator from the **Soils Properties**, **Field Geometry**, **Residue and Growing Crop Information**, or **Operation/ Irrigation Data** windows. Additional options can be added to these choice lists following the "Adding to choice list" instruction with each input file.

1.4.4 F3 DOS Edit

Press while in the RWEQ program to go to the DOS editor to modify, edit or generate an input file. To return to RWEQ from DOS, press Alt, F, and X. Reboot the system for file to be in the program.

1.4.5 F4 Graphs

After erosion has been calculated and the output has been saved, the operator can view a graphic display of the erosion, soil roughness, vegetation and weather factor by time periods. Selecting the PRINT option allows the operator to print a graph of these variables. To exit the graphics screen press Ctrl/C.

1.4.6 F5 Save and Exit

When pop-up screen *default* values are correct, the operator may save the information and exit the pop-up screen by pressing F5.

1.4.7 Shift-F5 Insert line in DOABLE SCREEN

While in the **DOABLE SCREEN**, to insert a new data line within an existing *saved* management file, move the cursor to the extreme left of the "date start" column on the line with the date that should *follow* the new date. Press Shift-F5. RWEQ creates a blank line beginning with the same

date as the following line. Type over the date and complete the vegetation, operation, and barrier inputs.

1.4.8 **F6** **Input/Output Save**

If a client file was named at the beginning, the name is automatically recalled in the "Saving Input/Output Files" window. To accept the name press <enter> or type a new client name.

The management filename is automatically recalled in the "Saving Input/Output Files" window. To accept the name press <enter> or type a new management filename if you want to save the changes as a separate file. DO NOT use the same name for both management and client files without the filename extension of ".man" to distinguish a management file. When prompted, press <Esc> to advance to output file.

If erosion has been estimated, the operator may save the output by naming the output file. Again, a different filename extension (*e.g.* ".out") is suggested to distinguish an output file.

1.4.9 **Shift-F6** **Delete line in DOABLE SCREEN**

While in the **DOABLE SCREEN**, to delete a line of data from an existing *saved* management file, move the cursor to the extreme left of the "Date Start" column of the line to be deleted. Press Shift-F6. **WARNING**: When Shift-F6 is pressed, the line is immediately deleted from the management file. It cannot be undeleted or recalled!

1.4.10 **F7** **Previous Input**

This key enables the operator to move "backward" through the input information screens.

1.4.11 **F9** **Pop-up Windows**

Pop-up windows are available to input data for soil properties, field geometry, vegetation, operations, or barriers. Press <enter> to advance through the window.

1.4.12 **F10** **Run Menu**

Press F10 key and select "Compute Erosion" to compute erosion for the entire management period or "Tabular output" to view the output of erosion and input coefficients for each time period in table form. If "Compute Erosion" is chosen, erosion is calculated. Press <Esc> to transfer the results to the DOABLE SCREEN. In the tabular output or the DOABLE SCREEN the arrow keys are used to move up and down..

1.4.13 **Esc** **Exit**

To exit the program press <Esc> and answer yes ("y") to the question at the bottom of the screen.

1.4.14 **Ctrl-Break** **Exit**

Press this key combination and <enter> to exit the program from anywhere in the program. Type **CLS** to clear the screen.

2. RWEQ INPUT FILE DEVELOPMENT

Input files can be developed and/or modified within the RWEQ program. Guides for preparing a new file, saving the new file, and adding the file to the choice list are presented. These guides are not intended to explain all the routines in RWEQ but are intended to provide sufficient information to enable a computer novice to successfully utilize the capabilities of the RWEQ program.

2.1 CLIENT

The CLIENT in RWEQ is the name assigned to the two line file that contains the names of the management and weather files for a particular farm unit.

2.1.1 Existing client file

An existing client file can be recalled by typing the filename at the **`CLIENT`** prompt or by using the F2 key to call the choice list, using the arrow to select the file and pressing <enter>.

2.1.2 New client file

A new CLIENT file is developed in RWEQ from the weather and management input filenames. Use the RWEQ INPUT FORM (APPENDIX A-2) as a worksheet to assemble the necessary inputs.

To develop a new file, at the **`CLIENT`** prompt, type a new name for the CLIENT file and press <enter>, OR at the **`CLIENT`** prompt, simply press <enter> to leave the CLIENT filename blank and continue. Select a weather file from the F2 choice list or type a weather filename. Press <enter> to advance to the **`Man. File`** prompt. Select a management file from the F2 choice list or type an existing management filename. Press <enter> to advance through the **`Soil Properties`** and **`Field Geometry`** windows and to the **`DOABLE SCREEN`**.

For example to create a CLIENT file for a bare field at Big Spring, Texas, advance to the weather file prompt using the <enter> key. Type **W\TX23005.DAT** for the weather data file for Big Spring and press <enter>. From **`Man. File:`** press F2 for the choice list, select BSTBARE.MAN using the arrow keys and press <enter> to continue. Press <enter> to advance through and accept default values in **`Soil Properties`** and **`Field Geometry`** windows.

2.1.3 Saving a new client file

From the DOABLE SCREEN, press F6 to enter the **`Saving Input/Output File`** window. To the right of **`Save Client File:`** enter the new CLIENT filename (*e.g.* **BSTBARE**). Press <enter>. RWEQ saves the weather filename (TX23005.DAT) and management file (BSTBARE.MAN) under the name assigned to the CLIENT file (BSTBARE).

2.1.4 Adding a client file to the choice list

RWEQ automatically adds the filename to the choice list (in alphabetical order if the first letter is capitalized) when the file is saved with the F6 key.

2.2 WEATHER

The present weather files contain monthly total or average values for all the weather parameters required by RWEQ. The weather files were assembled by using WERIS (Wind Energy Resource Information System) data bases and computing values for all parameters (Skidmore and Tatarko, 1990).

2.2.1 Existing file

If the desired weather file already exists, it may be called into the RWEQ program by typing the filename at the weather prompt. If the filename is in the choice list, at the weather prompt press F2, use the arrow key to highlight the filename, and press <enter> . (For example, W\TX23005.DAT brings in the Big Spring, Texas weather file.)

2.2.2 Modifying existing file

An existing weather file may be modified in the DOS editor. At the C:\RWEQ97> prompt, type **EDIT W\TX23005.DAT** to bring in the Big Spring, Texas file. Any of the data may be overwritten. The number of decimal places is not critical, but there must be at least one space between monthly data on same line. If for example, the RWEQ operator has rainfall data (or any weather data) for a site not included in these 602 sites, the weather file for an adjacent site may be modified file with new rainfall data.

2.2.3 Saving a new weather file

After making the necessary modifications, select SAVE AS from the FILE menu (press ALT, F, and A). Type the name of the new weather file (*e.g.* **W\TX_BIGSP.DAT**) and press <enter>. Select EXIT from the FILE menu to exit the editor (press ALT, F, and X).

2.2.4 Adding to the choice list

A new weather file may be added to the choice list from DOS. At the C:\RWEQ97> prompt type **EDIT RWEQ.CLS**. A portion of this file appears below. Find "*climate"in the listing. At the end of this line press <enter> to create a blank line below "climate". Type the name of the new weather file on this blank line. The line immediately under "*climate" appears first in the F2 choice list. Select SAVE from the FILE menu to save the new version of RWEQ.CLS (press ALT, F, and S). Select EXIT from the FILE menu to exit the editor (press ALT, F, and X).

```
SWEEPS_2
SWEEPS_3
*climate
AC88.W1
AC89.W1
AC90.W1
BST90.W1
BST91.W1
```

2.3 MANAGEMENT

The management file includes soil properties, field geometry, crop, tillage, irrigation, and barrier data. A new management file may be developed using the RWEQ program or the DOS editor. Either method may be used to customize crops and tillage operations for a specific region.

As a management file is developed in RWEQ default values are called into the program for soil, residue and growing crops and tillage. These generic values may be overwritten to better describe a specific management system. Any new values (with the exception of soil erodible fraction, EF) are saved in the management file when the management file is saved.

When prompted for a management filename the choices are

(1) to type the name of a previously developed and saved management file,
(2) to press F2, highlight a previously developed and saved management file from the choice list, and press <enter>,
(3) to type the name of a new management file, or
(4) to press <enter> twice to continue without a filename.

2.3.1 Developing and saving a new management file using RWEQ

The easiest way to develop a new management file is to use the RWEQ program. From **`Man. File:`** type a new management filename and press <enter> or just press <enter> to advance without naming the new file. A warning screen indicates that the file cannot be found. Press <enter> to continue. Enter soil properties and field geometry data. Enter vegetation and operation data into the **`DOABLE SCREEN`** .

For example, the information for Big Spring in 1990 is shown in the RWEQ INPUT FORM below (Table 2.3.1). When all data have been entered into the **`DOABLE SCREEN`** , the F6 key is used to save the new management file. To the right of **`Save Client File:`** type **BST90** to name the client file and press <enter> and advance to the Save Man. File prompt. To the right of **`Save Man. File:`** type the name for the new management file just developed (**BST90.MAN**). The ".MAN" for the filename extension distinguishes it as a management file. Press <enter> and <Esc>. The filename is automatically added to the choice list.

Table 2.3.1

RWEQ INPUT FORM

CLIENT: BST90 WEATHER FILE: BST90. W1 MANAGEMENT FILE: BST90. MAN

Soil Properties:
soil texture _____ OR sand 83.6 %
silt 8.4 %
organic matter 0.29 %
calcium carbonate 0 %
rock cover 0 %

Field Geometry: shape (circular) or rectangular
area 6.5 acres
orientation – ° from north
length_N – feet
slope gradient –
slope length – feet

Longitude 101° 29.19' Latitude 32° 16.21' Elevation 2690'(820m) Annual Rainfall 18.5"(470mm)

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov	# Stems	Growing Crop	Implement	Mod Rough	RR	Ridge Spac.	Ridge Ht	Ridge Orient	Kill Crop	% Flat	% Stand	Amt.	Rate	# Days	Ht.	Dt	Spac.	Orient
1/5/90	COTTON	0	4	0	NONE	PLANE	Y	0.1	200	1.0	0	Y	100	100							
4/16/90	COTTON	0	0	0	NONE	CHI-STR	Y	0.9	12	2	0	N	70	70							
5/4/90	COTTON	0	0	0	NONE	NONE	N	0	0	0	0	N	100	100							

Figure 2.3.1

```
#File Creation Date: 02/18/98
#File Creation Time: 14:14:24
#New Mangement File   : BST90.MAN


01/05/1990
+       Plane
+       NONE
+       R_Cotton  0.000000  4.000000  400.000000          9.250000  2.000000
+       0.000000  1.800000  0.200000
+       100.000000          100.000000
+       0.001000  0.010000  0.000100
+       -0.000250 4.000000  45.000000
+       1         0.100000  200.000000          1.000000  0.000000
+       1         0         0.000000  0.000000
+       0.000000  0.000000  0.000000  0.000000
+       0.000000  0.000000  0.000000
+       83.600000 8.400000  0.300000  0.000000  0.000000
+       0         6.500000  0.000000  0.000000  0.000000  0.000000

04/16/1990
+       CHI_STR
+       NONE
+       R_Cotton  0.000000  0.000000  400.000000          9.250000  2.000000
+       0.000000  1.800000  0.200000
+       70.000000 70.000000
+       0.001000  0.010000  0.000100
+       -0.000250 4.000000  45.000000
+       1         0.900000  12.000000 2.000000  0.000000
+       0         0         0.000000  0.000000
+       0.000000  0.000000  0.000000  0.000000
+       0.000000  0.000000  0.000000

05/04/1990
+       NONE
+       NONE
+       R_Cotton  0.000000  0.000000  400.000000          9.250000  2.000000
+       0.000000  1.800000  0.200000
+       100.000000          100.000000
+       0.001000  0.010000  0.000100
+       -0.000250 4.000000  45.000000
+       0         0.000000  0.000000  0.000000  0.000000
+       0         0         0.000000  0.000000
+       0.000000  0.000000  0.000000  0.000000
+       0.000000  0.000000  0.000000

12/31/1990
```

2.3.1.1 **Inserting or deleting an operation/event in a management file** To insert a new data line within an existing *saved* management file while in the **`DOABLE SCREEN`**, move the cursor to the **`Date Start`** column on the line with the date that should *follow* the new date. Press Shift/F5. RWEQ creates a blank line with a date which duplicates the date on the next line. Type over the date and complete the vegetation, operation, and barrier inputs.

To delete a line of data from an existing *saved* management file while in the **`DOABLE SCREEN`**, move the cursor to **`Date Start`** of the line to be deleted. Press Shift-F6. **WARNING:** After pressing Shift-F6, the line is deleted immediately from the management file. It may *not* be undeleted or recalled.

A modified file may be saved by using the F6 key. The original file is overwritten when the changes are saved to the original filename or when a line is deleted using Shift/F6.

To create a new version of a management file and keep the original file intact, first save the original file to a *new* filename using the F6 key. Go back to the **`Man. File:`** prompt in the main screen and enter the new filename. When a line is deleted in the DOABLE SCREEN using the Shift-F6 key, the changes are immediately saved to the new filename. Other changes made in the management file may be saved to the new filename using the F6 key.

2.3.1.2 **Adding a management file to the choice list**

When a new management file is developed, named, and saved in RWEQ using the F6 key, the filename is automatically added to the choice list.

2.4 SOIL

Soil texture and soil crust conditions are extremely important in controlling wind erosion.

The RWEQ program accepts generic soil data or data for a specific soil can be manually entered in the RWEQ program through the **Soil Properties** window. Physical and chemical properties for 12 different soil textures are available in RWEQ (APPENDIX E-3). These files are called into RWEQ when a soil texture is selected from the F2 choice list in the **Soil Properties** window. If data are available for the soil in a specific field, the default values for sand, silt, organic matter, $CaCO_3$, and rock cover may be overwritten. Regardless of the source of the data, the values accepted or entered in the **Soils Properties** window are saved as a part of the management file.

Soils data are used to estimate erodible fraction, soil crust, and the degradation by weathering of tillage roughness.

The clay content and soil crust factor are not input but are computed. Erodible fraction is computed but may be overwritten if soil sieving data are available. WARNING: An erodible fraction value that is overwritten is NOT saved in the management file.

On some Soil Interpretation Records rock cover may not be available. When rock cover is available and entered with other soil properties, RWEQ assumes a constant rock cover for the field. Rock cover is added to the flat residue cover to produce a single cover value for nonerodible elements; therefore, the flat cover is never less than the rock cover. The effect of a rock cover appears in the *V* column in the DOABLE SCREEN after erosion is calculated.

2.4.1 Customizing soil inputs within RWEQ

In the **Soils Properties** window with the cursor to the right of **Soil Texture:**, the F2 key is pressed to show the choice list of 12 files. When one is selected, default values are called into the program. Any of the properties may be overwritten to develop a unique soil file. The soil input file for a loamy sand (APPENDIX E-3) is shown below.

Percent sand	**84**
Percent silt	**10**
Percent organic matter	**0.5**
Percent $CaCO_3$	**2.0**
Percent rock	**0**

This soil file may be changed by using the DOS editor and asssigning the soil file a new name or may be changed for a single field by overwriting the soils values in the **Soil Properties** window.

2.4.2 **Adding a soils file to the choice list**

To add a new soils filename to the RWEQ choice list you *must* exit the RWEQ program. A new file of soils data can be added to the choice list from DOS. At the C:\RWEQ97> prompt type **EDIT RWEQ.CLS**. A portion of this file appears below. Scroll down to find "*soil" in the listing. At the end of this line press <enter> to create a blank line below "*soil". Type the name of the new soil file. The line immediately under "*soil" appears first in the F2 choice list. Select SAVE from the FILE menu to save the new version of RWEQ.CLS (press ALT, F, S). Select EXIT from the FILE menu to exit the editor (press ALT, F, X).

```
YBTX95B.MAN
YETX95E.MAN
*soil
clay
clay_loam
loam
loamy_sand
sand
```

2.5 FIELD

The only field shapes available in RWEQ are circular and rectangular. If you select circular, RWEQ assumes circular rows and you do not have the option of putting in row orientation. For rectangular fields, enter the length of the north side. (See APPENDIX F-2.) RWEQ computes the length of the remaining side.

2.6 RESIDUE INPUT FILE

2.6.1 Developing and saving a residue crop file

Presently RWEQ has nine residue crop files. Research is being conducted on additional crops, but until these data are available, the RWEQ user may develop a new crop file based on knowledge of similar crops.

A file of residue data for a crop not in the choice list can be developed in DOS. For illustration purposes, the creation of a residue crop data file for kenaf follows. Kenaf is a fiber crop in the same family as cotton. The growth rate of kenaf is equivalent to or better than sorghum. Plant cover (canopy) estimates are assumed to be the same as sorghum.

Residue crop data files are designated with "R_". For kenaf the residue crop data file is "R_kenaf". At the C:\RWEQ97> prompt type **EDIT R_KENAF**. For the kenaf residue crop data file use the following values. The data file must have one value (bolded below) on each line (11 lines for the file). The file*name* identifies the data. The file itself contains only one column of 11 numbers.

Yield intercept - *pounds/acre* (same as corn) (See APPENDIX B-1.)	**3000**
Yield slope - (same as corn)	**1.5**
Crop height - *feet* (assume dryland)	**6.0**
Stem diameter - *inches* (assume dryland)	**0.7**
After harvest height - *feet* (cut entire plant for fiber)	**0.3**
Standing mass loss coefficient - (assume same as cotton)	**0.0010**
Flat mass loss coefficient - (assume same as cotton)	**0.010**
Stem number decline coefficient - (assume same as cotton)	**0.0001**
Mass/cover conversion coefficient - *ha/kg* (assume same as cotton)	**-0.00025**
Takeoff factor - (assume same as corn)	**1.0**
Stem number threshold decomposition days - (assume same as cotton)	**45**

After all coefficients have been entered, SAVE the file (press ALT, F, S) and EXIT the editor (press ALT, F, X).

Crop yield, % flat residue cover, and stem number are not part of the crop data file but are input by the operator in the RWEQ97 program as residue information.

2.6.2 **Adding a residue crop to choice list**

To add a new residue crop filename to the RWEQ choice list you *must* exit the RWEQ program. A new file of residue crop data can be added to the choice list from DOS. At the C:\RWEQ97> prompt type **EDIT RWEQ.CLS**. A portion of this file appears below. Scroll down to find "*rcrop" in the listing. At the end of this line press <enter> to create a blank line below "*rcrop". Type the name of the new file (*e.g*. **R_KENAF**). The line immediately under "*rcrop" appears first in the F2 choice list. Select SAVE from the FILE menu to save the new version of RWEQ.CLS (press ALT, F, S). Select EXIT from the FILE menu to exit the editor (press ALT, F, X).

```
silty_clay
silty_clay_loam
*rcrop
NONE
R_Corn
R_Cotton
R_Grass
```

2.7 GROWING CROP INPUT FILE

Crop growth data are available for winter wheat, spring wheat, cotton, soybeans, corn, and sorghum. The RWEQ operator must select one with growth characteristics similar to the new crop. For kenaf, forage sorghum would be a good example.

When a crop is planted, the crop canopy development routine is initialized by the toggle "yes" in the "Growing Crop" query in the "**`Residue and Growing Crop Information`**" window.

2.7.1 Developing a growing crop input file

To create a growing crop input file for kenaf, at the C:\RWEQ97> prompt type **EDIT G_KENAF**. Since the canopy development of kenaf is similar to sorghum, use the plant growth coefficients given for sorghum in APPENDIX B-2.

Plant growth coefficient "a", *pgca* **0.408**
Plant growth coefficient "b", *pgcb* **-2273.16**

There are only two numbers in a growing crop input file. Choose SAVE from the FILE menu (press ALT, F, S). Select EXIT from the FILE menu to exit the editor (press ALT, F, X).

2.7.2 Adding a growing crop input file to the choice list

To add a new growing crop filename to the RWEQ choice list you *must* exit the RWEQ program. A new file of growing crop data can be added to the choice list from DOS. At the C:\RWEQ97> prompt type **EDIT RWEQ.CLS**. A portion of this file appears below. Scroll down to find "*gcrop" in the listing. At the end of this line press <enter> to create a blank line below "*gcrop". Type the name of the new file (*e.g*. **G_KENAF**). The line immediately under "*gcrop" appears first in the F2 choice list. Select SAVE from the FILE menu to save the new version of RWEQ.CLS (press ALT, F, S). Select EXIT from the FILE menu to exit the editor (press ALT, F, X).

```
R_WBarley
R_WWheat
*gcrop
G_Corn
G_Cotton
G_Grass
G_SWheat
```

2.8 TILLAGE INPUT FILE

The input files for tillage implements may be modified to fit different regions of the country. To develop a file for an implement not listed, you must know the effect of the implement on soil surface characteristics in that region.

Terminology for describing tillage implements varies for different regions of the country. In RWEQ the RUSLE tillage data files are used to minimize variations within tillage implements.

Residue burial and decomposition in RWEQ are based on mass, not percent cover. In RWEQ buried residues remain buried and are not brought to the surface with tillage.

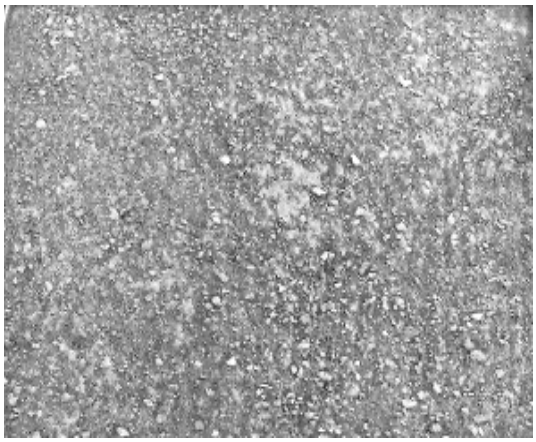
New tillage operations can be added by selecting values similar to other tillage operations. The generic values assigned to tillage implements for random roughness, ridge height, ridge spacing, % standing retained and % flat retained are in APPENDIX C-1. These values reflect Southern Plains conditions and may be modified for other regions of the country.

2.8.1 Determining soil roughness

A variety of roughness measuring methods have been developed. The optimum method depends on the intended use of the results. Because of the dynamic nature of the wind erosion process combined with the effect of rainfall, a simple method that allows many measurements across a field is preferred. A visual estimate is the cheapest but it may not provide reproducible estimates. The chain method (Saleh, 1993) does provide an economical and simple method of measuring soil roughness (APPENDIX H-2). The chain method (Saleh, 1993) can be expressed as random roughness (Allmaras *et al*., 1966) using APPENDIX H-1.

Photographs of field surfaces with the corresponding random roughness are in Figure 2.8.1.

Figure 2.8.1



RR = 0.23

RR = 0.53

RR = 0.95

RR = 1.14

RR = 2.52

2.8.2 **Developing and saving a tillage input file**

For illustration purposes the creation of a tillage input file for a rotary hoe follows. This implement is used on moist soils to roughen the soil surface or to aid seedling emergence. The implement has minimal effect on ridge roughness. If the previous implement was a deep furrow drill with the rows 14" apart and ridges 3" high, the rotary hoe may leave ridges 14" apart and 2.5" high. You would have to keep a record of ridge height and spacing of the previous implement to properly input the rotary hoe. The random roughness is similar to a spike harrow (RR=0.4), but this may vary for different regions of the country. The rotary hoe is normally not used when large quantities of residue are on the surface or when residues are standing.

From DOS at the C:\RWEQ97> prompt type **EDIT ROTARY_H**. (There is an 8 character limit on the file name.) The file consists of 5 values (bolded) as shown below. The data file should have one value on each line (5 lines for the file). The filename identifies the data. The file itself contains only one column of 5 numbers.

Random roughness, *inches*	**0.4**
Ridge spacing, *inches* (previous implement- deep furrow drill)	**14**
Ridge height, *inches*	**2.5**
% Standing retained after harvest (assume rodweeder - plain)	**90**
% Flat retained after harvest (assume rodweeder - plain)	**50**

% Standing is that portion of the original standing residue that is not flattened by the tillage operation. % Flat retained is that portion of the flat mass residue not buried by the tillage operation.

After all of the data are entered, select SAVE from the FILE menu (press ALT, F, S) and then EXIT the editor (press ALT, F, X).

2.8.3 **Adding a tillage file to the choice list**

To add a new growing crop filename to the RWEQ choice list you *must* exit the RWEQ program. A new file of growing crop data can be added to the choice list from DOS. At the C:\RWEQ97> prompt type **EDIT RWEQ.CLS**. A portion of this file appears below. Scroll down to find "*Operation" in the listing. At the end of this line press <enter> to create a blank line below "*Operation". Type the name of the new file (*e.g.* **ROTARY_H**). The line immediately under "*Operation" appears first in the F2 choice list. Select SAVE from the FILE menu to save the new version of RWEQ.CLS (press ALT, F, S). Select EXIT from the FILE menu to exit the editor (press ALT, F, X).

```
Circular
Rectangular
*Operation
CHI_STR
CHI_TWI
```

2.9 IRRIGATION

The application of irrigation water degrades soil roughness, increases soil wetness, and aids in decomposition of surface residues. Until data are available on the effect of different irrigation systems, *i.e.* furrow, flood, or sprinkler irrigation, they are all treated as equivalent to rainfall. Irrigation data from a specific period are input at the *beginning* of the period.

2.10 BARRIER INPUT DATA

2.10.1 Photos of optical density

To provide guidelines for optical density, photographs illustrating *OD* for annual crop barriers are in Figure 2.10.1 and for perennial evergreens are in Figure 2.10.2. Barriers are never uniform in height, configuration, or density; therefore, the best estimate should be used in place of measured values. Optical density normally reflects the density of the first row of a multirow barrier. Expressions are being evaluated that may permit the computation of density of each row and combining all rows into an optical density factor. Until this development is completed the photographs can be used.

2.11 OUTPUT

2.11.1 Saving and printing output in the DOABLE SCREEN

After erosion has been calculated (F10) and the <Esc> key is pressed, the soil loss by periods appears in the **`DOABLE SCREEN`** and may be printed using the PRINT SCREEN key. This output may also be saved to a file which may be printed. To save an output file press F6. Use the arrow key to move down to **`Save Output File`**. Enter a name for the output file to the right of **`Save Output File:`** and press <enter>. Press ESC to return to the main screen.

2.11.2 Viewing the tabular output

View the tabular output file by pressing F10 and selecting “Tabular Output”. The “Erosion Computation Summary” presents the erosion data by time periods. Use the arrow key to scroll down through the entire season. Press ESC to return to the “Run Menu” and press ESC again to return to the main screen.

2.11.3 Graphics

The output from RWEQ can be viewed graphically by pressing F4 after the output file has been saved with the F6 key. The estimated erosion, soil roughness, vegetation coefficient, and weather factor are graphed by 15 day periods. This allows the RWEQ operator to see when erosion is a problem. To return to program press CTRL/C.

NOTE: The graphics program incorporated in RWEQ is COPYRIGHTED and LICENSED SOFTWARE. It may *not* be reproduced in any way or used outside the RWEQ program. See APPENDIX M for software agreement.

Figure 2.10.1

Optical Density - 16 %

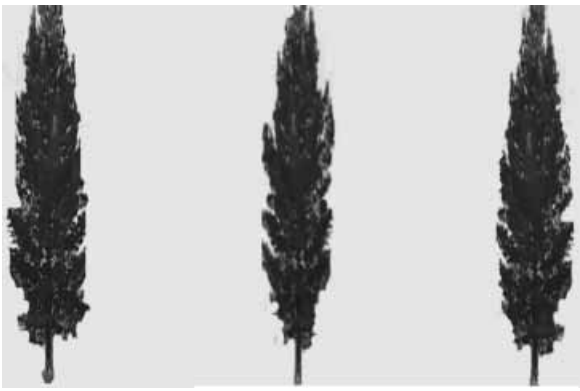
Optical Density - 42 %

Optical Density - 56 %

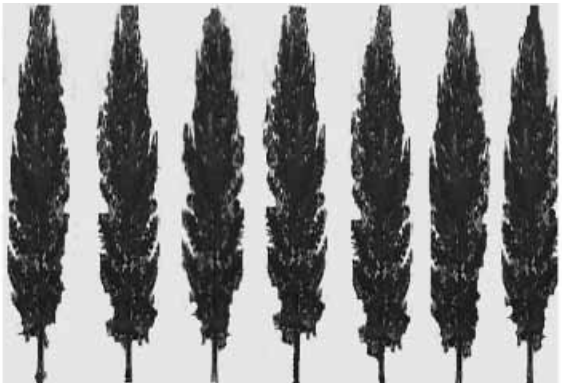
Optical Density - 61 %

Optical Density - 63 %

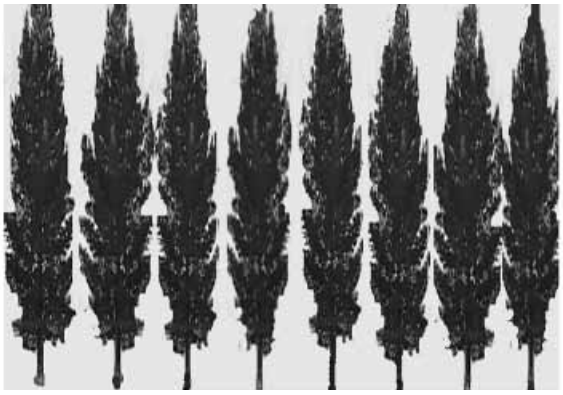
Figure 2.10.2



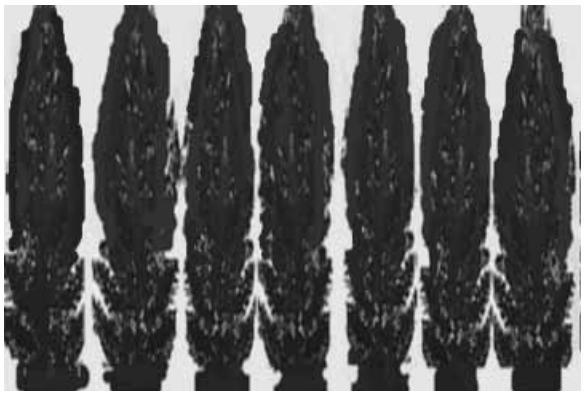
Optical Density = 25 %



Optical Density = 50 %



Optical Density = 60 %



Optical Density = 75 %

Optical Density = 100 %

3. PARAMETERS AND EQUATIONS

This section describes the research and equations used in RWEQ, which estimates soil eroded and transported by wind between the soil surface and a height of two meters. Fine sediment is transported as suspended load and travels much greater distances than the coarse sediment transported as creep and saltation. Thus, RWEQ is not applicable for those problems where suspended, fine sediment above two meters is the concern. RWEQ is most applicable for problems of erosion from the field, but can also provide information on erosion rate effects within the field and abrasion of plants by wind blown sediment. The intent of this section is to discuss the equation used to estimate transport mass and the equations used to input weather, soils, crops, and tillage data into the RWEQ model. In addition, the computations of erosion from validation sites in several states are included to compare measured erosion under a variety of conditions with RWEQ estimated erosion.

3.1 TRANSPORT MASS EQUATION

The heart of any wind erosion model is the equation for computing the mass transport of wind-eroded material. Mass transport (Q) varies with soil texture, soil surface, field length, and climatic conditions (Fryrear and Saleh, 1996; Stout and Zobeck, 1996). Transport equations have been developed and applied to the movement of agricultural soils (Gregory and Borelli, 1986; Stout, 1990; Hagen and Armbrust, 1994), desert sands, and windblown snow (Greeley and Iversen, 1985). One common feature of these equations is the assumption that the horizontal flux is proportional to the difference between the maximum transport and the actual transport at a point within the field.

Horizontal mass transport across an eroding surface has been measured by Bagnold (1943), Chepil (1945), Fryrear *et al.* (1991), Fryrear and Saleh (1996), and Stout (1990). The basic equation that defines the horizontal distribution of transport mass $Q(x)$ is

$$b(x)\frac{dQ(x)}{dx} + Q(x) - Q_{max}(x) + S_r(x) = 0 \qquad \textbf{[1]}$$

where

$Q(x)$	=	mass transport at downwind distance x, kg/meter-width
$Q_{max}(x)$	=	maximum transport, kg/meter-width
$S_r(x)$	=	surface retention coefficient
x	=	distance from the upwind edge of the field, meters
$b(x)$	=	field length scale, meters.

Fryrear, D.W., Ali Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, and T.M. Zobeck. 1998. Revised Wind Erosion Equation (RWEQ). Wind Erosion and Water Conservation Research Unit, USDA-ARS, Southern Plains Area Cropping Systems Research Laboratory. Technical Bulletin No. 1. Internet address: http://www.csrl.ars.usda.gov/wewc/rweq/readme.htm

In RWEQ, $S_r(x)$ is set to zero and thus equation **[1]** may be rewritten as

$$\frac{dQ(x)}{dx} = \frac{Q_{max}(x) - Q(x)}{b(x)} \quad . \qquad \textbf{[2]}$$

Equation **[2]** can be solved analytically in a few special cases. For the special case where Q_{max} and b are constant (the simple field assumption), the solution of equation **[2]** is simply

$$\frac{Q(x)}{Q_{max}} = 1 - e^{-\left(\frac{x}{b}\right)} \quad . \qquad \textbf{[3]}$$

On the other hand, if we assume that the length scale b varies with distance across the field or $b=b(x)$ then there are many other possible solutions. For example, if we assume that

$$b(x) = \frac{s(x)^2}{2x} \qquad \textbf{[4]}$$

where $s(x)$ is a field length scale, then equation **[2]** becomes

$$\frac{dQ(x)}{dx} = \frac{2x}{s(x)^2}\left(Q_{max}(x) - Q(x)\right) \qquad \textbf{[5]}$$

which is the governing equation used in RWEQ. For the special case where Q_{max} and s are constant, we obtain the sigmoidal form:

$$\frac{Q(x)}{Q_{max}} = 1 - e^{-\left(\frac{x}{s}\right)^2} \quad . \qquad \textbf{[6]}$$

Note from equation **[6]**, when $x = s$ and s is the critical field length, $Q(s)$ = 63.2% of Q_{max}.

The first derivative of $Q(x)$ with respect to x defines the soil loss at each point across a wind-eroding surface. From equation **[5]** we find that

$$soil\ loss = \frac{dQ(x)}{dx} = \frac{2x}{s(x)^2}\left(Q_{max}(x) - Q(x)\right) \quad . \qquad \textbf{[7]}$$

In equation **[8]** we can combine equations **[5]** and **[6]** to obtain soil loss for the special case where Q_{max} and s are constant (not functions of x).

$$soil\ loss = \frac{2x}{s^2} Q_{max} e^{-\left(\frac{x}{s}\right)^2} \qquad \textbf{[8]}$$

Where soil roughness is the same upwind and within the field of interest, equation **[3]** appears to best describe measured data. However, few actual fields fit the ideal, thus, equation **[6]** often has smaller residual sums of squares than equation **[3]** when fit to measured data. Beyond a distance x greater than s, the two equations give almost identical results, especially when fit to experimental data where field length extends beyond the distance s. However, if the field length is less than s, then the appropriate equation depends on upwind conditions. In particular, if surface conditions upwind of a field have increased roughness or vegetative cover and the erosivity of the wind is dramatically reduced, then equation **[6]** is often found to better describe measured data.

Although equation **[5]** can be solved analytically in a few special cases, in RWEQ it is solved numerically. First, we approximate the mass transport gradient in finite difference form as

$$\frac{dQ(x)}{dx} \approx \frac{Q(x+\Delta x) - Q(x)}{\Delta x} \quad . \qquad \textbf{[9]}$$

Combining equations **[5]** and **[9]** yields the finite difference equation which is used in RWEQ:

$$Q(x+\Delta x) = Q(x) + \left(\frac{Q_{max}(x) - Q(x)}{s(x)}\right)\left(\frac{2x}{s(x)}\right)\Delta x \quad . \qquad \textbf{[10]}$$

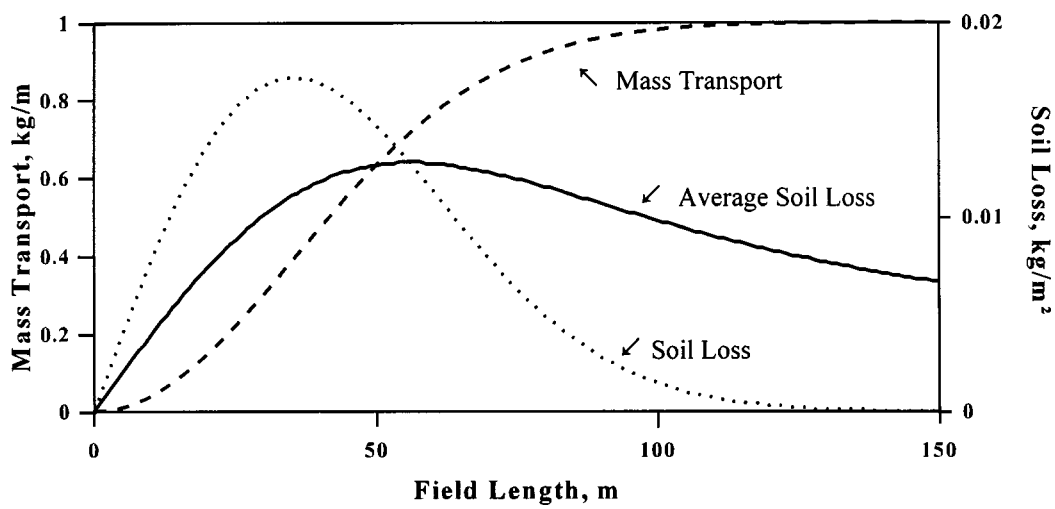
An example plot of soil loss across a field with s = 50 meters is shown in Figure 3.1. The maximum soil loss occurs at a downwind distance of $x = s/\sqrt{2}$ or in this case at x = 35.4 m. Soil loss approaches zero as mass transport approaches the maximum mass transport Q_{max}; in this example, this occurs at a downwind distance of around 150 m.

To express erosion in terms that can be compared to the output from WEQ, average soil loss is defined as mass transport at field length x or $Q(x)$ divided by distance x. In this example, maximum average soil loss occurs at a downwind distance equal to 55 m. After reaching a maximum, average soil loss decreases with increasing field length and is 0.0067 kg/m^2 at a field length of 150 m.

Variations in transport mass within large fields may be due to different residue levels, tillage roughness conditions or erodibility of the soil surface (Chepil, 1957) (Fryrear and Saleh, 1996). The mass of eroded soil material being transported by wind depends on the magnitude and duration of the wind speed, soil erodibility, orientation and quantity of crop residues, and the

type, timing and number of tillage operations. In the following sections the coefficients for weather, soils, crops, and tillage used to calculate Q_{max} and s are described.

Figure 3.1 Relationship between mass transport, soil loss, and average soil loss from RWEQ using $s = 50$ m and $Q_{max} = 1.0$ kg/m.



3.2 WEATHER EQUATIONS

3.2.1 Wind value (W)

Wind is the basic driving force in RWEQ. To estimate soil erosion an accurate input of the wind is required. Bagnold (1943) and Zingg (1953) used the friction speed cubed to describe the relationship between wind speed and mass transported. Ten mass transport equations using friction speed cubed and four mass transport equations using wind speed cubed are listed in Greeley and Iverson's Table 3.5 (1985). To compute friction speed the roughness of the surface must be described. Since soil roughness, residue levels, wind barriers and soil texture are highly variable, a reference wind speed above the immediate surface boundary was used. The field measurements are from relatively smooth surfaces; therefore, the instrumented reference height is 2 meters.

RWEQ expresses the wind in a form that uses wind speed minus the threshold speed. The equation for calculating the wind value is

$$W = \sum_{i=1}^{N} U_2 (U_2 - U_t)^2 \qquad \textbf{[11]}$$

where

W	=	wind value, $(m/sec)^3$
U_2	=	wind speed at 2 meters, m/sec
U_t	=	threshold wind speed at 2 meters (assumed 5 m/sec)
N	=	number of wind speed observations (i) in a time period of 1-15 days.

Combinations of wind speed (U_2) and threshold wind speed (U_t) that were considered for use in RWEQ gave the following wind values.

	$U_2^2(U_2-U_t)$	$U_2(U_2^2-U_t^2)$	$\mathbf{U_2(U_2-U_t)^2}$	$(U_2-U_t)U_t^2$
W when U_2 = 6 m/sec	36	66	**6**	25
W when U_2 = 20 m/sec	6000	7500	**4500**	375
ratio of W when U_2 = 20 to W when U_2 = 6	167	114	**750**	15

The bolded expression was chosen because it gives the largest range of wind values (W) when U_2 varies from 6 to 20 m/sec.

3.2.2 **Wind factor (*Wf*)**

Over 600 weather data files were assembled for RWEQ using procedures described by Skidmore and Tatarko (1990; Appendix Q). In these weather files, the wind is described with Weibull coefficients *k* and *c*, percent calm, and the cumulative probability distribution. The RWEQ program divides the probability values that range from 0 and 0.999 into 500 uniformly distributed probability values. These probability values are used with the Weibull coefficients and percent calm to compute 500 wind speeds for each period. These computed 10-meter wind speeds are converted to the equivalent 2-meter wind speeds, then the wind factor (Wf) is computed.

The total wind factor (Wf) for each period is determined by dividing the total wind value for each period by 500 and multiplying by the number of days in the period.

$$Wf = \frac{W}{500} \times N_d \qquad \textbf{[12]}$$

where

Wf	=	wind factor, $(m/sec)^3$
W	=	wind value, $(m/sec)^3$
N_d	=	number of days in the period.

The selection of 500 for the number of uniformly distributed probability values was based on the minimal difference in *Wf* when 10 to 10,000 uniformly distributed probability values are used to compute the wind factor in equation **[12]**.

Number of probability values	10	50	100	300	500	750	1,000	10,000
Wf, *(m/sec)*^{3}	119	233	218	248	238	241	240	241

Integration of the wind speed probability distribution equation would provide a single wind factor for each time period. However, a single wind factor excludes the computation of wind speeds for expressing windbarrier and hill effects. See equations **[30]** and **[31]**.

3.2.3 **Weather factor (*WF*)**

Wf is combined with terms for soil wetness (*SW*) and snow cover (*SD*) to produce a weather factor (*WF*).

$$WF = Wf \frac{\rho}{g} (SW) SD \qquad \textbf{[13]}$$

where

WF	=	weather factor, kg/m
Wf	=	wind factor, (m/sec)^3
ρ	=	air density, kg/m^3
g	=	acceleration due to gravity, m/sec/sec
SW	=	soil wetness, dimensionless
SD	=	snow cover factor.

WF is then partitioned according to the preponderance and positive parallel ratio values from the weather file (Skidmore and Tatarko, 1990; Skidmore *et al.*, 1995). While *WF* has the same terms as the climatic factor in WEQ, *WF* also contains terms for threshold speeds and snow cover.

3.2.3.1 **Soil wetness (*SW*)**

The wetness of the surface influences the wind speed required to erode the soil (Chepil, 1956; Saleh and Fryrear, 1995). The duration of the benefits from a wet soil surface depends on evaporative demand of the atmosphere, but wind erosion can follow rainstorms within a few minutes.

The soil wetness factor developed for RWEQ is

$$SW = \frac{ET_p - (R + I)\frac{R_d}{N_d}}{ET_p} \qquad \textbf{[14]}$$

where

SW	=	soil wetness factor
ET_p	=	potential relative evapotranspiration, mm
R_d	=	number of rainfall and/or irrigation days
$R+I$	=	rainfall and irrigation, mm
N_d	=	number of days (normally 15).

The equation for computing ET_p reported by Samani and Pessarakli (1986) is

$$ET_p = 0.0162\left(\frac{SR}{58.5}\right)(DT + 17.8) \qquad \textbf{[15]}$$

where

SR	=	total solar radiation for the time period, cal/cm^2
DT	=	average temperature, degrees centigrade.

Soil wetness increases the resistance of the soil surface to wind erosion. If there is more rain or irrigation than solar radiation can evaporate, then the soil wetness factor is zero and there is no erosion for that period. With no rain or irrigation, the soil wetness factor is 1.0 for that period regardless of the previous period's conditions.

The influence of soil wetness on a fine sandy loam soil was evaluated in the 1990 wind erosion season at Big Spring. The soil surface was flat and the roughness and residue levels did not change for several weeks. There were 30 rainfall events that wet the soil surface and 33 wind erosion events. APPENDICES J-2 through J-6 are the monthly weather data summaries for Big Spring for the 1990 season. The measured erosion was 18.6 kg/m^2 and estimated erosion with RWEQ97 was 17.1 kg/m^2. Without corrections for soil wetness (zero rain days) the estimated erosion was 20.0 kg/m^2.

3.2.3.2 **Snow cover (*SD*)**

The snow cover factor is equal to 1 minus the probability of snow depth greater than 25.4 mm. Monthly snow probability values are in the weather data files. If the soil is covered with snow, there is no erosion and the *SD* = 0. If 50% of the time in a month the soil is covered with snow, the *SD* = 0.5 and the *WF* is 50% the normal *WF* without snow.

3.3 SOILS EQUATIONS

3.3.1 Soil erodible fraction (*EF*)

The erodible fraction is that fraction of the surface 25 mm of soil that is smaller than 0.84 mm in diameter as determined by a standard compact rotary sieve (Chepil, 1962). The preferred method for determining *EF* is to collect and sieve a sample of the surface soil each month for three years. From a soil sieving data base, the highest value for *EF* during a year for each site was correlated with basic soil physical and chemical properties (Fryrear *et al.*, 1994). The formula developed from this study follows.

$$EF = \frac{29.09 + 0.31Sa + 0.17Si + 0.33Sa/Cl - 2.59OM - 0.95CaCO_3}{100} \qquad \textbf{[16]}$$

$$r^2 = 0.67$$

where

Sa	=	sand content, %	(5.5 to 93.6)
Si	=	silt content, %	(0.5 to 69.5)
Sa/Cl	=	sand to clay ratio	(1.2 to 53.0)
OM	=	organic matter, %	(0.18 to 4.79)
$CaCO_3$	=	calcium carbonate, %	(0.0 to 25.2).

The range of values in the data set are given in parenthesis above. Equation **[16]** has not been verified for values outside these limits.

3.3.2 Soil crust factor (*SCF*)

When raindrops impact the soil surface, there is a redistribution of soil particles and a formation of surface crust. The resulting soil surface can be extremely hard or very fragile and may decrease or increase wind erosion potential (Zobeck, 1991). For sandy soils or for soils with a significant percentage of sand, a layer of loose, erodible sand grains forms on the top of the smooth crust. These sand grains are easily eroded by wind because the rain-impacted soil surface is aerodynamically smoother than the cloddy surface before the rain.

In WEQ a fully crusted soil was assumed to have soil losses 1/6 of the noncrusted soil (Woodruff and Siddoway, 1965). This may be reasonable for silt loam soils but does not represent sandy loam soils.

The *SCF* equation in RWEQ (equation **[17]**) was developed by regressing *SCF*, as determined from the abrasion coefficient, on clay and organic matter content. This *SCF* was developed using laboratory wind tunnel tests on resistance of soil aggregates and crusts to windblown sand (Hagen *et al.*, 1992)(Table 3.3.2).

$$SCF = \frac{1}{1 + 0.0066(Cl)^2 + 0.021(OM)^2} \qquad \textbf{[17]}$$

where

Cl	=	clay content, %	(5.0 to 39.3)
OM	=	organic matter, %	(0.32 to 4.74).

The limits of equation **[17]** are in parentheses. The coefficient of variation between *SCF* from the abrasive coefficient test and the *SCF* computed using equation **[17]** is 0.887.

In RWEQ, when accumulated rain equals or exceeds 12 mm since the last tillage operation, a soil crust factor is computed. Whenever clay content is less than 5% or immediately after a tillage operation when there is no surface crust, the *SCF* is set at one. The effects of *SCF* are evident in mass transport and critical field length equations.

Table 3.3.2. Development of empirical coefficients for SCF (equation **[17]**) using abrasive coefficient data base of Hagen *et al.* (1992).

Soil Series	Clay %	Organic Matter %	Abrasion Coefficient	Normalized Abrasion Factor*	SCF from Eq. **[17]**
Carr sandy loam	5.5	0.86	0.0732	1.000	0.823
Acuff fine sandy loam	12.2	2.53	0.0483	0.660	0.472
Alliance fine silty loam	21.1	0.56	0.0106	0.145	0.253
Amarillo fine sandy loam	11.3	0.47	0.0346	0.473	0.541
Amarillo fine sandy loam	14.8	0.34	0.0255	0.348	0.408
Amarillo loamy fine sand	8.5	4.74	0.0595	0.813	0.513
Barnes clay loam	31.6	1.10	0.0122	0.167	0.131
Cherry silt clay	26.0	2.25	0.0151	0.206	0.180
Drake fine sandy loam	11.2	0.32	0.0390	0.533	0.546
Gilford fine sandy loam	5.0	3.38	0.0523	0.714	0.712
Haynie silt loam	8.7	1.90	0.0372	0.508	0.635
Inavale loamy sand	5.9	0.80	0.0690	0.942	0.804
Kimo silty clay loam	36.0	2.20	0.0019	0.026	0.104
New Cambria silty clay	39.3	2.60	0.0016	0.022	0.088
Pullman clay loam	31.6	0.85	0.0086	0.117	0.131
Reading silt loam	23.6	2.30	0.0051	0.070	0.209
Reagan silt clay loam	29.4	2.02	0.0065	0.089	0.147

* Abrasion factor = Abrasion coefficient / 0.0732

3.4 RESIDUE and CROPS EQUATIONS

The quantity and orientation of crop residues in the field can have a significant impact on soil erosion by wind (Chepil, 1944; Englehorn *et al.*, 1952; Fryrear and Armburst, 1968; Siddoway *et al.*, 1965; Skidmore *et al.*, 1966). To quantify the effect of growing crops and residues on wind erosion, the fraction of the soil surface covered with nonerodible plant material, the plant silhouette from standing plant residues, and growing crop canopies are used (Bilbro and Fryrear, 1994). These factors were developed from laboratory wind tunnel studies.

3.4.1 Flat residues (SLR_f)

In RWEQ, the effect of flat residues (any lying on the soil surface) is described with a soil loss ratio coefficient (SLR_f) that was developed from numerous field and laboratory wind tunnel studies (APPENDIX G-1). In RWEQ, SLR_f is estimated from the decomposition routine or percent soil cover can be input if residues are added to a field.

Soil cover can be measured using the line transect method (Laflen *et al*., 1981)(APPENDIX G-1.1) or it can be estimated from a photograph or field observation. To convert SLR_f coefficients to percent cover APPENDIX G-1 can be used. From the tests to date, the diameter, density, or type of material is not as important as the percent of the soil surface that is covered (Bilbro and Fryrear, 1994).

$$SLR_f = e^{-0.0438(SC)} \qquad \textbf{[18]}$$

where

SLR_f = soil loss ratio coefficient for flat cover
SC = soil surface covered with flat residues, %.

If rock cover is present, it is added to the soil covered with *flat* residues. Rock cover is *not* decayed.

3.4.2 Standing residues (SLR_s)

Standing plant residues reduce the wind speed close to the soil surface. Laboratory wind tunnel studies on number, height, and diameter of standing material have been summarized into a soil loss ratio coefficient that reflects the silhouette of the standing material (SLR_s)(Bilbro and Fryrear, 1994). To determine the silhouette area, the height (harvest height), diameter, and number of standing stalks in a square meter area are used (APPENDIX B-1). The silhouette area value is related to the SLR_s with the following equation for a wind speed of 16 m/sec (Bilbro and Fryrear, 1994)(APPENDIX G-2).

$$SLR_s = e^{-0.0344\left(SA^{0.6413}\right)} \qquad \textbf{[19]}$$

where

SLR_s = soil loss ratio for plant silhouette

SA = silhouette area computed by multiplying the number of standing stalks in 1 m^2 times average diameter (cm) times stalk height (cm).

Average stalk height can be estimated from harvest height of the crop. If stalks are leaning after a tillage operation, the height of the stalk above the ground is used, not the total length of the stalk.

3.4.3 Crop residue decomposition

Decomposition of flat and standing residues is initialized by a harvest operation. Flat and standing crop residues are decayed with different coefficients. Research supports that temperature and number of rain-days can be used to compute the decomposition of plant residues. The parameters which should be regionally adjusted include economic yield level, plant population (plant or head number), crop height at harvest, and harvest height. These variables are used to estimate above ground residue and to partition residue mass into standing and flat pools (Schomberg and Steiner, 1997; Steiner *et al.*, 1994).

The percent soil cover (SC) is calculated using the flat residue mass (M_f) and the mass cover conversion factor (mcf)(APPENDIX B-1).

$$SC = 100\left(1 - e^{mcf(M_f)}\right) \quad \textbf{[20]}$$

Decomposition coefficients are available for 10 crops and studies are underway to expand the data base.

3.4.4 Crop canopy (SLR_c)

Emerging crop seedlings and subsequent larger plants provide a partial canopy cover over the soil. Field data have been collected to describe the canopy of several crops. From these data, a curve was developed for each crop that predicts the soil loss ratio due to canopy effects (SLR_c)(APPENDIX G-3).

The crop canopy coefficient is not used unless green living plants are in the field. The development of a crop canopy is initiated with a planting operation in the management input file. It is possible for ground cover, plant silhouette, and crop canopy to be present in the field at the same time.

To convert the influence of crop canopy to soil loss ratio the following equation is used

$$SLR_c = e^{-5.614\left(cc^{0.7366}\right)} \quad \textbf{[21]}$$

where

SLR_c = soil loss ratio for growing crop canopy
cc = fraction of soil surface covered with crop canopy.

Fractions of the land surface covered by growing crop canopies at various days after planting are presently available for six crops. The crop canopy data from RUSLE were used to develop crop canopy coefficients (APPENDIX B-2). The crop coefficients were developed for the first 60 days of crop growth, except for small grains which were for 75 days. The coefficients permit the computation of canopy cover every day or every 15 days. From this regression analysis two coefficients are developed for each crop. The equation form is

$$cc = e^{pgca + \left(\frac{pgcb}{P_d{}^2}\right)} \qquad \textbf{[22]}$$

where

cc	=	fraction of soil surface covered with crop canopy
P_d	=	days after planting
pgca	=	plant growth coefficient "a"
pgcb	=	plant growth coefficient "b".

For example, the file for soybeans is named "G_SOYBEA". The two values in the soybean growing crop file are bolded below.

Plant Growth Coefficient	"a", pgca	**0.542**
Plant Growth Coefficient	"b", pgcb	**-3162.92**

3.5 TILLAGE ROUGHNESS

Tillage roughness may be oriented (ridges and furrows) and/or random (soil clods). Roughness is formed by tillage and degraded by weather. Tillage operations modify the soil surface roughness and flatten and bury crop residues (Nelson *et al.*, 1993). The surface roughness immediately after tillage depends on the implement used, residue levels, soil texture, soil moisture, and the previous operation.

Successful estimates of soil erosion require accurate descriptions of soil surface conditions produced by tillage operations and degraded by weather. For example, Chepil and Woodruff (1954) estimated soil erosion for a smooth soil could be reduced from 5.6 to 0.056 kg/m^2 with a single listing operation. In RWEQ the effect of roughness generated by tillage operations on soil erosion is input with the relationships developed by Fryrear (1984) and Saleh and Fryrear (1997).

3.5.1 Soil roughness

Soil surface roughness due to aggregates can be measured and expressed using a pin meter (Potter and Zobeck, 1990), the chain method (Saleh, 1993) or the Allmaras *et al.* (1966) random

roughness index (*RR*). The following equation is used in RWEQ to convert *RR* in inches to chain random roughness (C_{rr})(Saleh, 1997).

$$C_{rr} = 17.46\,RR^{0.738} \qquad \textbf{[23]}$$

Soil ridge roughness (Zingg and Woodruff, 1951) is computed with the equation:

$$K_r = 4\,\frac{(RH)^2}{RS} \qquad \textbf{[24]}$$

where

K_r = soil ridge roughness, cm
RH = ridge height, cm
RS = ridge spacing, cm.

Soil ridge roughness and random roughness parallel to the dominant wind direction are expressed in the single soil roughness factor (*K'*). When the wind is parallel to the soil ridges, *K'* includes only the random roughness (Allmaras *et al.*,1966; Zobeck and Onstad, 1987); when the wind is perpendicular to the soil ridges, *K'* includes both ridge (K_r) and random roughness (C_{rr}). In RWEQ *K'* is calculated as follows:

$$K' = e^{(1.86\,K_{rmod} - 2.41\,K_{rmod}^{0.934} - 0.124\,C_{rr})} \qquad \textbf{[25]}$$

where

K_{rmod} = $R_c\,(K_r)$ which corrects K_r for wind angle when
R_c = rotational coefficient calculated in equation **[26]**.

This rotational coefficient is necessary if the wind is at an angle to the ridges. In RWEQ the following equation makes an adjustment for roughness based on the attack angle of the wind (Saleh, 1994).

$$R_c = 1 - 0.00032\,A - 0.000349\,A^2 + 0.00000258\,A^3 \qquad \textbf{[26]}$$

where

A = wind angle (0 if perpendicular, 90 if parallel), degrees.

3.5.2 **Degradation of soil roughness**

Zobeck and Popham (1997) computed degradation of soil aggregate roughness for an Acuff sandy clay loam using rainfall amount and intensity. However for RWEQ, the degradation of ridges and aggregates needs to be computed for *any* soil texture. Saleh (APPENDIX O) developed equations **[27]** and **[28]** to use percent clay, cumulative rainfall, and cumulative storm erosivity index to compute degradation of ridges for any soil texture.

$$ORR = e^{\left[DF\left(-0.025\left(CUMEI^{0.31}\right) - 0.0085\left(CUMR^{0.567}\right)\right)\right]} \qquad \textbf{[27]}$$

$$r^2 = 0.99, \quad P < 0.001$$

where

ORR	=	ratio of K_r after rainfall to K_r before rainfall
CUMEI	=	cumulative storm erosivity index, MJ-mm/ha-h
CUMR	=	cumulative rainfall, mm
DF	=	decay factor

where the decay factor is computed as

$$DF = e^{\left(0.943 - 0.07Cl + 0.0011\left(Cl^2\right) - 0.674OM + 0.12\left(OM^2\right)\right)} \quad . \qquad \textbf{[28]}$$

In RWEQ, equation **[29]** is used to degrade aggregate or random roughness.

$$RRR = e^{\left[DF\left(-0.0009CUMEI - 0.0007CUMR\right)\right]} \qquad \textbf{[29]}$$

$$r^2 = 0.95, \quad P < 0.001$$

where

RRR = ratio of C_{rr} after rainfall to C_{rr} before rainfall.

3.6 WINDBARRIERS/SHELTERBELTS

Before RWEQ, windbarriers were assumed to protect the downwind field for a distance equal to ten times the height of the barrier. The method for describing the effect of windbarriers on leeward wind speeds was developed from analysis of published results. Dr. Bilbro assembled published data on reduction patterns as a function of wind speed, optical density, and distance downwind (Sturrock, 1969, 1972). The data from Sturrock's publications are listed in Table 3.6.1. (It was assumed that when optical density = 0, PUV at the downwind H's was 100.)

Many equations can be used to describe the relationships. In RWEQ the equation is

$$PUV = 100e^{-(OD)^{0.423}(DD)^{-1.098}} \qquad \textbf{[30]}$$

$$r^2 = 0.86$$

where

PUV = percent of upwind velocity
OD = optical density (range 28 to 100%)
DD = distance downwind in barrier heights, H.

The limitations are no *PUV* greater than 100 and protected distance no greater than 30 times the barrier height.

Table 3.6.1. Wind reduction (*PUV*) data used to develop the wind barrier model from optical density (*OD*) and downwind distance (*DD*). Data are from Sturrock (1969, 1972).

Optical Density	Downwind Distance	*PUV*	Optical Density	Downwind Distance	*PUV*	Optical Density	Downwind Distance	*PUV*
28	5	57	63	15	63	74	10	56
28	10	75	63	15	66	74	10	65
28	15	90	63	20	73	74	15	76
28	20	96	63	20	71	74	15	78
28	25	98	63	25	75	74	20	81
28	30	99	63	30	76	74	20	86
33	5	38	65	5	48	74	25	87
33	10	62	65	10	57	74	25	89
33	15	76	65	15	75	74	30	92
33	20	78	66	5	27	74	30	91
49	5	58	66	10	59	88	5	27
49	10	70	66	15	77	88	10	64
49	15	88	66	20	86	88	15	78
49	20	91	66	25	87	88	20	82
49	25	92	66	30	91	91	5	33
49	30	93	67	5	49	91	10	42
52	5	55	67	10	59	91	15	64
52	10	54	67	15	73	91	20	78
52	15	63	67	20	84	91	25	87
52	20	70	67	25	89	91	30	93
52	25	75	68	5	33	100	5	45
55	5	60	68	10	40	100	5	35
55	10	66	68	15	68	100	5	40
55	15	79	68	20	76	100	10	53
55	20	88	68	25	82	100	10	60
55	25	90	71	5	30	100	10	50
55	30	93	71	10	54	100	15	75
56	5	28	71	15	72	100	15	70
56	10	57	71	20	82	100	15	66
56	15	75	72	5	38	100	20	81
56	20	85	72	10	49	100	20	80
56	25	90	72	15	72	100	20	84
56	30	93	72	20	78	100	25	84
63	5	25	72	25	85	100	25	88
63	5	29	72	30	90	100	25	86
63	10	43	74	5	30	100	30	91
63	10	55	74	5	43	100	30	93

3.7 HILLS

Hill slope gradient and slope length are used to express the effect of hills on wind speeds. RWEQ assumes that the hill extends perpendicular to the wind and that the upwind toe of the hill is at the upwind edge of the field.

The equation to describe the wind speed over a hill was adapted from Queney (1948). His equation was designed to estimate wind speed over low, gently sloping, smooth-profiled, narrow mountains where the effects of the earth's rotation and tropopause are negligible and the height does not exceed 10% of the base (Figure 3.7.1). Equation **[31]** computes the 2-meter- high wind speed at various points along the slope.

$$U(x) = U\left[1 + \left[\frac{H_H \times a}{a^2 + (x')^2} * \frac{a^2 - (x')^2}{a^2 + (x')^2}\right]\right] \qquad \textbf{[31]}$$

where

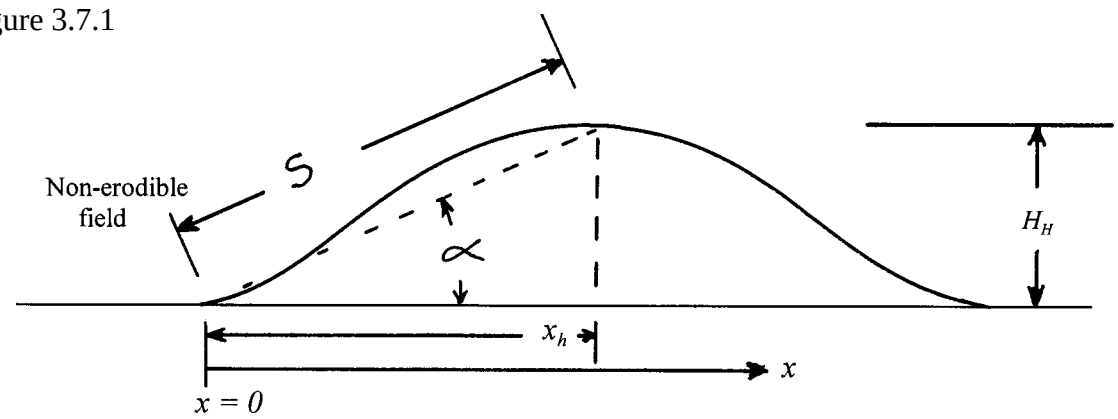
$U(x)$	=	2-meter wind speed at distance x from upwind edge of field, m/sec
U	=	open wind speed for flat surface, m/sec
H_H	=	height of hill, meters or $H_H = S \div sin$
a	=	characteristic ½ width of hill which is ½ distance from toe of hill to peak, meters or $a = cos\ (½\ S)$
x'	=	horizontal distance from center of hill, meters or $x' = x - x_h$

where

α	=	angle of slope, degrees
S	=	slope length, meters
G	=	slope gradient or $G = tan\ = H_H \div x_h$
x	=	distance from upwind edge of field, meters
x_h	=	distance from edge of field to center of hill, meters.

In RWEQ97 a is assumed equal to x_h. The slope length (S) and slope gradient (G) are inputs to describe the hill.

Figure 3.7.1



3.8 COMPUTING MAXIMUM TRANSPORT CAPACITY (Q_{max})

To estimate transport mass for any field the coefficients (Q_{max} and s) must be computed from known field conditions.

The measured Q_{max} for individual events in instrumented fields was determined from 9 transport mass (total airborne mass from soil surface to height of 2 meters) and field length data values using least square analysis procedure with equation **[6]**. For single events *EF*, *SCF*, *K'*, *COG*, *SW* and *SD* are assumed constant. Equation **[32]** was obtained by regressing measured input of *WF*, *EF*, *SCF*, *K'*, and *COG* from instrumented field sites with the measured Q_{max} value from single events (Table 3.8.1).

$$Q_{max} = 109.8\,(WF \times EF \times SCF \times K' \times COG) \qquad [32]$$

$$r^2 = 0.84$$

where

Q_{max}	=	maximum transport capacity, kg/meter-width
EF	=	erodible fraction
SCF	=	soil crust factor
K'	=	soil roughness factor
COG	=	combined crop factors ($SLR_f \times SLR_s \times SLR_c$)
WF	=	weather factor, kg/m.

3.9 COMPUTING CRITICAL FIELD LENGTH (s)

The capacity of the wind to erode and transport soil limits the increase in transport mass when field length is greater than the critical field length, *s*. Critical field lengths for individual events were computed with equation **[6]** using least square analysis of the transport mass field length data (Table 3.8.1).

The regression of computed field length *s* and wind, soil, and crop parameters gives

$$s = 150.71(WF \times EF \times SCF \times K' \times COG)^{-0.3711} \qquad [33]$$

$$r^2 = 0.46 \quad .$$

Table 3.8.1 Date of erosion event, wind factor (*WF*), soil erodible fraction (*EF*), soil crust factor (*SCF*), soil roughness (*K'*), flat and standing residues (*COG*), measured soil loss (*MSL*), estimated soil loss (*ESL*), maximum transport capacity (Q_{max}), and critical field length (*s*) for selected erosion events. Sites are coded Big Spring, Texas (BS); Mabton, Washington (MW); Elkhart, Kansas (EK); Kennett, Missouri (KM); and Eads, Colorado (EC).

Site	Date	----------Factors----------					Soil Loss		Q_{max}	*s*
		WF	*EF*	*SCF*	*K'*	*COG*	*MSL*	*ESL*		
							----kg/m^2----		kg/m	m
BS	1-27-90*	2.3	.64	.77	.95	.90	.55	.57	106	153
BS	1-29-90	2.8	.64	.77	.95	.90	.80	.70	130	142
BS	2-08-90	0.6	.64	.77	.95	.90	.15	.15	28	251
BS	3-06-90	2.8	.64	.77	.95	.90	.93	.70	130	142
BS	3-29-93**	3.6	.77	.77	1.00	.96	2.46	1.21	225	116
MW	4-02-91	8.4	.79	.91	.82	.43	1.14	1.25	234	114
EK	3-09-92	41.9	.70	.65	.91	.65	8.03	6.64	1238	61
KM	3-13-93	15.3	.85	.90	.85	1.00	4.05	5.86	1092	64
EC	3-12-91	179.9	.26	.21	.80	.48	2.14	2.22	414	92

* Includes January 27th and 28th, 1990 wind data.

** Includes March 28th and 29th, 1993 wind data.

3.10 DEFINITION OF SYMBOLS

α	=	angle of slope, degrees
ρ	=	air density, kg/m^3
a	=	characteristic ½ width of hill, meters
A	=	wind angle (0 if perpendicular, 90 if parallel), degrees
$b(x)$	=	field length scale, meters
$CaCO_3$	=	calcium carbonate, %
cc	=	fraction of soil surface covered with crop canopy
Cl	=	clay content, %
COG	=	combined crop factors ($SLR_f \times SLR_s \times SLR_c$)
C_{rr}	=	chain random roughness
$CUMEI$	=	cumulative storm erosivity index, MJ-mm/ha-h
$CUMR$	=	cumulative rainfall, mm
DD	=	distance downwind in barrier heights
DF	=	decay factor
DT	=	average temperature, degrees centigrade
EF	=	erodible fraction (portion less than 0.84 mm in diameter)
ESL	=	estimated soil loss, kg/m^2
ET_p	=	potential relative evapotranspiration, mm
G	=	slope gradient
g	=	acceleration due to gravity, m/sec/sec
H	=	barrier height
H_H	=	height of hill, meters
K'	=	soil roughness factor
K_r	=	soil ridge roughness, cm
K_{rmod}	=	soil ridge roughness corrected for wind angle, cm
mcf	=	mass cover conversion factor
M_f	=	surface flat residue, kg/ha
MSL	=	measured soil loss, kg/m^2
N	=	number of wind speed observations
N_d	=	number of days
OD	=	optical density, %
OM	=	organic matter, %
ORR	=	ratio of K_r after rainfall to K_r before rainfall
$pgca$	=	plant growth coefficient “a”
$pgcb$	=	plant growth coefficient “b”
P_d	=	days after planting
PUV	=	percent of upwind velocity
Q	=	transport mass, kg/meter-width
$Q_{max}(x)$	=	maximum transport, kg/meter-width
$Q(x)$	=	mass transport at downwind distance x, kg/meter-width
R_c	=	rotational coefficient
R_d	=	number of rainfall and/or irrigation days

$R+I$	=	rainfall and irrigation, mm
RH	=	ridge height, cm
RR	=	random roughness index, inches
RRR	=	ratio of C_{rr} after rainfall to C_{rr} before rainfall
RS	=	ridge spacing, cm
s	=	critical field length where $Q(s)$ is equal to 63.2% of Q_{max}
S	=	slope length, meters
Sa	=	sand content, %
SA	=	silhouette area per unit soil area, cm^2/m^2
Sa/Cl	=	sand to clay ratio
SC	=	soil surface covered with flat residues, %
SCF	=	soil crust factor
SD	=	snow cover factor
Si	=	silt content, %
SLR_c	=	soil loss ratio for growing crop canopy
SLR_f	=	soil loss ratio for flat cover
SLR_s	=	soil loss ratio for plant silhouette
SR	=	solar radiation, cal/cm^2
$S_r(x)$	=	surface retention coefficient
SW	=	soil wetness factor
U	=	open wind speed for flat surface, m/sec
U_2	=	wind speed at 2 meters, m/sec
U_t	=	threshold wind speed at 2 meters, assumed 5 m/sec
$U(x)$	=	2-meter wind speed at x distance from upwind edge of field, m/sec
W	=	wind value, $(m/sec)^3$
Wf	=	wind factor, $(m/sec)^3$
WF	=	weather factor, kg/m
x	=	distance from upwind edge of field, meters
x_h	=	distance from edge of field to center of hill, meters
x'	=	horizontal distance from center of hill, meters

4. MODEL VALIDATION

In RWEQ soil loss is defined as soil removed from a field. The relationship between transport mass, field length, and soil loss is basic to a clear understanding of this definition. Using this definition, the transport mass continues to increase as the field length increases. When transport mass at a point within a field is divided by the upwind field length along the path of the wind, the result is the average soil loss for the upwind field. Appendix I-1 illustrates the relationship between transport mass, field length, and soil loss. As the field length increases to the critical field length (*s*), the transport rate and average soil loss (*ASL*) both increase (APPENDIX I-1). However, once the field length exceeds the critical field length, the capacity of the wind to detach and transport particles approaches Q_{max} and *ASL* begins to decrease. The transport mass approaches the capacity of the wind and essentially remains constant. The average soil loss must decline as field length continues to increase.

4.1 MEASURED SOIL EROSION

The most accurate method of measuring soil loss is to collect all of the eroded material leaving a field boundary. To collect all eroded material may be possible in a laboratory wind tunnel but is not possible for field erosion conditions. An alternative is to sample the entire vertical profile of the dust cloud. Again for small plots this may be feasible, but for the 2.5 ha standard circles or larger fields this is not feasible.

Vertical mass samples were collected to a height of 1 meter. Vertical distribution was projected to a height of 2 meters for integration purposes. This technique works for sandy textured soils (Fryrear and Saleh, 1993). Data from Nickling (1978) supports this technique. In RWEQ the average soil loss is based on the computed total transport mass from the soil surface to a height of 2 meters.

To calculate transport mass for a circular instrumented site, the circle is divided into 20 equal width strips. The average length of each strip and maximum transport capacity are used in equation **[6]** to compute transport mass in kg/m-width. Transport mass for average field length of each segment is computed. See APPENDIX L-1 for a detailed explanation. Since there are 2-10 m wide strips with this length, the transport mass in kg/unit-width is multiplied times 20 meters to yield the total kg of soil lost from the 2 strips. The kg loss for all strips are added and the total mass is divided by the area of the circle to give average soil erosion in kg/m^2 from the entire circle. Soil loss from a field can be determined by dividing transport mass at the downwind edge of the field by the upwind field length parallel to the prevailing wind direction.

For many eroding fields the depth of the suspension cloud continues to increase as field length increases. The suspension component represents much less mass than the saltation/creep component even though the clouds of dust are readily visible. The lack of data to develop and verify routines to estimate the total suspension component for various soil textures, field length, and surface conditions prohibits the inclusion of a suspension component in RWEQ97.

4.2 ESTIMATED SOIL EROSION

When mass transport is estimated every 15 days or less for the entire erosion or management period, routines for soil wetness from rainfall or irrigation, degradation of tillage roughness, decay of crop residues, and growth of crop canopy must be included. The single event coefficients from equations **[32]** and **[33]** are used in equation **[10]** for the entire erosion season. *SW* and *SD* may be less than 1 for portions of the erosion season.

The residue level, tillage roughness value, and/or crop canopy at the end of each period are used to compute erosion for that period. The weather factor, tillage roughness, SLR_f , SLR_s , and SLR_c coefficients are output in the tabular output. They can also be viewed graphically.

RWEQ divides the field into 200 equal width strips and the field length of each strip is computed for four wind directions according to the preponderance and positive parallel ratio values. The *Q(x)* for the average field length is divided by average field length to estimate average soil loss for the field. Erosion estimates for each wind direction are based on the transport for the average field length of the 200 strips in each of four directions.

4.2.1 Weather

At each of the instrumented validation sites, wind speeds and wind direction were recorded every minute. Solar radiation, air temperatures, and rainfall were recorded every 10 minutes. Average daily maximum and minimum temperatures, % calm, and the wind Weibull coefficients, total precipitation, number of rainfall events, *EI* and total solar radiation were determined for each month.

Monthly weather data files were created for each instrumented location. The WERIS data file closest to the instrumented location was used for weather data not measured at the instrumented site. The Weibull coefficients (*c* and *k*), % calm, the average maximum and minimum temperatures, solar radiation, precipitation, days with rain and the *EI* in the WERIS file were replaced with data from the instrumented site.

4.2.2 Management

To organize the input data for the validation sites, the original RWEQ INPUT FORM (APPENDIX A-2) was modified to create APPENDIX A-4. The headings SOIL and CROP show *measured* values for *EF*, *K*, silhouette, and canopy cover. These measured values were included for comparison with values computed by RWEQ.

Modified RWEQ INPUT FORMs (APPENDIX A-4) for each site-year are listed in APPENDIX K1-51. The first entry line provides crop and tillage input data to describe field conditions at the beginning of the management period. Operations listed on the RWEQ INPUT FORM are entered by dates in the DOABLE screen.

4.2.3 **Output**

RWEQ model estimates were compared to *measured* soil loss values from instrumented sites. RWEQ estimates were made using weather data files that had been customized for the validation site and time period. The management files describe the soil, field, crops and tillage operations for the validation site.

The agreement between measured and estimated erosion values for 51 site/years from 11 states is shown in Figure 4.2.3 and Table 4.2.3. There is no adjustment for freeze-thaw effects. Freeze/ thaw is a major factor at Montana, Nebraska, Colorado, Indiana, Minnesota, and Washington. The effect of freeze-thaw may increase or decrease erosion and would depend on soil texture.

Considering the variety of erosion and surface measurements required to quantify the soil, crop, and surface conditions, the agreement in Figure 4.2.3 and Table 4.2.3 is good ($R^2 = 0.805$).

Figure 4.2.3 Measured soil losses plotted against estimated soil losses with RWEQ97.

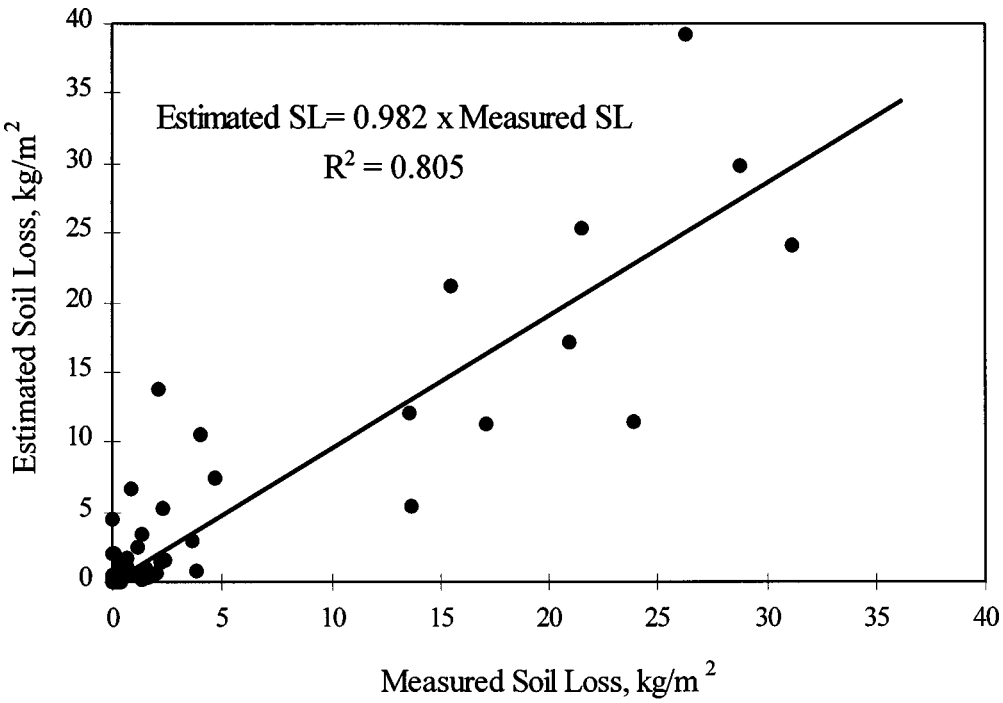


Table 4.2.3 Comparison of measured and estimated soil erosion from instrumented sites for various time periods. The * indicates those sites with erosion events included in the development of "Q_{max}" and "s" coefficients Table 3.8.1.

CLIENT	SITE	TIME		SOIL LOSS	
				----------*kg/m²*----------	
		Start	Stop	Measured	Estimated
AC89	Akron, CO	10/27/88	05/26/89	0.83	6.70
AC90	Akron, CO	10/20/89	04/26/90	1.10	0.38
EC91*	Eads, CO	10/30/90	05/07/91	2.43	1.57
EC92	Eads, CO	09/15/91	04/15/92	0.67	0.81
CPI90	Crown Point, IN	01/10/90	12/31/90	31.21	23.42
CPI91	Crown Point, IN	01/01/91	12/31/91	23.95	11.23
CPI92	Crown Point, IN	01/01/92	06/04/92	0.42	0.67
EKS90	Elkhart, KS	02/27/90	12/30/90	0.29	0.63
EKS91	Elkhart, KS	01/01/91	12/30/91	1.32	3.41
EKS92*	Elkhart, KS	01/01/92	10/15/92	15.50	20.73
EKS93	Elkhart, KS	01/01/93	05/25/93	2.06	13.72
CM89	Crookston, MN	11/07/88	12/31/89	0.21	0.00
CM90	Crookston, MN	11/27/89	05/06/90	0.32	0.00
SLM91	Swan Lake, MN	04/11/91	12/31/91	1.14	2.51
SLM92	Swan Lake, MN	01/01/92	12/31/92	0.13	0.04
SLM93	Swan Lake, MN	01/01/93	12/31/93	0.00	0.00
KM93*	Kennett, MO	12/02/92	06/17/93	13.73	5.42
KM94	Kennett, MO	11/18/93	05/05/94	0.64	1.75
HM93	Havre, MT	10/28/92	05/05/93	0.01	4.44
HM94	Havre, MT	10/19/93	03/30/94	0.01	0.52
LM91	Lindsey, MT	10/18/90	05/21/91	0.03	1.97
LM92	Lindsey, MT	10/08/91	04/08/92	0.09	2.02
SM89	Scobey, MT	10/03/88	05/10/89	4.68	7.37
SM90F	Scobey MT Fallow	10/04/89	04/21/90	1.34	0.07
SM90S	Scobey, MT Stubble	10/04/89	04/21/90	0.39	0.00
SN89	Sidney, NE	10/25/88	05/24/89	0.52	0.52
SN90	Sidney, NE	10/24/89	04/24/90	0.38	0.04
SIDNEYB	Sidney, NE	10/31/90	05/07/91	2.29	4.44
PORTALES	Portales, NM	11/24/94	04/06/95	0.01	0.09
FND95	Fargo, ND	12/06/94	05/07/95	0.00	0.00
FND96	Fargo, ND	10/24/95	05/07/96	0.00	0.00
FND97	Fargo, ND	10/29/96	05/15/97	0.00	0.00
BST89	Big Spring, TX	01/12/89	05/03/89	21.54	25.26
BST90*	Big Spring, TX	01/05/90	05/04/90	20.96	17.06
BST91	Big Spring, TX	01/25/91	05/15/91	0.10	0.11
BST93*	Big Spring, TX	03/16/93	06/01/93	28.78	29.85
BST94	Big Spring, TX	01/06/94	05/18/94	17.16	11.23
BST95	Big Spring, TX	01/11/95	05/15/95	26.29	39.15
BST96	Big Spring, TX	01/12/96	05/16/96	3.99	10.51
BST97	Big Spring, TX	01/23/97	05/23/97	13.63	11.99
TEXAS2	Martin-C, TX #2	01/24/95	06/06/95	0.30	0.20
TEXAS3	Martin-C, TX #3	01/11/95	05/23/95	0.80	0.52
TEXAS4	Martin-C, TX #4	02/11/95	05/11/95	0.30	0.43
PLAINSE	Plains E, TX	11/15/94	06/03/95	2.20	1.82
PLAINSB	Plains B, TX	12/13/94	05/24/95	1.60	0.36
PTE96	Plains, TX E	12/12/95	06/04/96	3.83	0.61
PTX96B8	Plains, TX B (800m)	12/13/95	05/29/96	2.02	0.22
PTX96B16	Plains, TX B (1600m)	12/13/95	05/29/96	1.55	0.54
MABTON*	Mabton, WA	12/13/90	04/28/91	3.68	2.98
PROSSER1	Prosser, WA #1	12/03/91	03/25/92	0.17	0.13
PROSSER2	Prosser, WA #2	06/10/92	06/15/93	0.32	1.05

4.3 **EXAMPLES OF FIELD MANAGEMENT SYSTEMS**

To test RWEQ in different regions of the country the following management systems were evaluated. A brief description and discussion of the the estimated erosion are included. The weather files used with these systems are from the closest WERIS site. Weather data files were not modified except for the sites in Washington. The weather file, the RWEQ Input Form, and the DOABLE screen showing the estimated erosion are included with each example.

4.3.1	Dryland winter wheat at Akron, Colorado
4.3.2	Dryland cotton at Big Spring, Texas
4.3.3	Corn-soybeans at Crown Point, Indiana
4.3.4	Winter Wheat at Horse Heaven Hills, Washington
4.3.5	Cotton at Kennett, Missouri
4.3.6	Winter Wheat-sorghum-fallow at Scott County, Kansas
4.3.7	Winter wheat-fallow at Moses Lake, Washington
4.3.8	Winter wheat-sunflower-fallow in Northeast Colorado.

These systems are not intended to reflect all possible cropping systems used in the country. These systems do provide examples of typical systems and the potential wind erosion from these systems for each region. In most cases, the generic soil, crop, and tillage coefficients are used. When input deviates from the generic values the new input value is used, not the generic value. These client, weather, and management files are included in the F2 choice lists.

4.3.1 **Dryland winter wheat**

This example is a typical dryland winter wheat-fallow system at Akron, Colorado. Between harvest and planting, 6 tillage operations are performed. The initial tillage operation after harvest is chemical weed control. This operation does not modify soil roughness. Some farmers observe that chemical herbicides promote residue decomposition, but this is not a factor in the current decomposition parameters.

In the DOABLE SCREEN the total soil loss for this two-year rotation is 1.7 t/ac or an annual average of 0.85 t/ac/yr. The majority of the erosion occurs after wheat planting or just prior to planting in September. For more detailed information on erosion by periods, view the tabular output.

With this system, wind erosion is not a problem unless soil moisture is not sufficient for good canopy cover after wheat planting. When dry fall conditions limit crop canopy development, the wind erosion problem can intensify in the winter and result in considerable erosion in the late winter/early spring. The *V* coefficient, reflecting residue levels on 9/20/1992, is 0.76 at wheat planting which is not sufficient to provide protection without the crop canopy.

Weather File: **CO24015.DAT**

```
# 24015 USA CO AKRON
  40 07 N 103 10 W 1399 19480101 19541231 ARF  60 64
   6.98   7.11 7.97   7.74   7.23   6.69   6.61 6.38   6.78    6.61   7.41   7.31
   2.56   2.44   2.32   2.36   2.40   2.37   2.43   2.41   2.34   2.44   2.49   2.51
   1.11   1.10   1.09   1.06   1.05   1.02   1.01   1.02   1.03   1.06   1.09   1.10
    315    338    315    338    338    338    158    158    158    338    337    315
    2.9    3.4    3.8    4.1    3.7    2.6    1.9    1.7    2.6    3.1    5.8    3.1
   0.95   0.93   0.93   0.63   0.50   0.60   0.71   0.59   0.69   0.63   0.95   0.96
    3.1    3.1    2.7    2.5    3.7    3.9    3.5    4.1    4.3    4.6    3.0    2.9
    3.7    6.3    9.5   15.8   21.1   27.2   31.4   30.5   25.5   19.0    9.9    5.3
  -10.6   -8.3   -5.4    0.1    5.7   11.0   14.7   13.8    8.5    2.2   -5.0   -8.9
  -10.9   -8.4   -7.5   -3.1    3.0    7.5   10.1    9.4    4.2   -1.4   -6.6   -9.2
    261    315    509    568    612    671    696    589    517    402    393    234
      9      7     25     33     78     67     70     46     32     21     14     10
    4.5    4.1    7.5    7.3   10.9    9.7    9.6    7.8    5.5    4.6    4.3    3.8
   31.3   24.2   10.5    0.0    0.0    0.0    0.0    0.0    0.0    0.0    3.8   18.6
      0      7     68     71     29     37    115    297    209     83     81     19
    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0
  40 6 N 103 9 W 2.3 CO AKRON CAA AP
```

RWEQ INPUT FORM

CLIENT: AKCOLO WEATHER FILE: W\CO24015.DAT MANAGEMENT FILE: AKCOLO.MAN

Soil Properties:
soil texture Sandy loam OR sand 64 %
silt 26 %
organic matter 0.5 %
calcium carbonate 3 %
rock cover 0 %

Field Geometry: shape circular or rectangular
area 160, acres
orientation 0, ° from north
length_N 2640, feet
slope gradient —
slope length —, feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
4/20/90	NONE	0		0	WWHEAT	DRILL-HO	Y	0.8	12	2	0	N	50	40							
7/1/91	WWHEAT	2000		100	NONE	HARVEST	N	0	0	0	0	Y	100	100							
8/15/91	WWHEAT	0		0	NONE	CHEM WEED	N	0	0	0	0	N	100	100							
5/1/92	WWHEAT	0		0	NONE	CHISEL STR	Y	1.5	12	2	0	N	70	70							
6/1/92	WWHEAT	0		0	NONE	SWEEP-3	Y	0.5	36	2	0	N	90	45							
7/1/92	WWHEAT	0		0	NONE	CULT-30"	Y	0.7	24	1	0	N	70	90							
8/1/92	WWHEAT	0		0	NONE	CULT-30"	Y	0.7	24	1	0	N	70	90							
9/1/92	WWHEAT	0		0	NONE	CULT-30"	Y	0.7	24	1	0	N	70	90							
9/20/92	WWHEAT	0		0	WWHEAT	DRILL-HO	Y	0.8	12	2	0	N	50	40							

```
=================REVISED WIND EROSION EQUATION=================

 Client: AKCOLO                    Weather File: w/CO24015.DAT
                            Man. File:AKCOLO.MAN

       Soil                  Field        EF: 0.51        SCF: 0.6024
                            DOABLE SCREEN
   Date                                                              Period
  Start       Vegetation     Operation/Event  Barrier  K'   K''  V   Erosion
09/20/1990 G_WWheat        DRILL_HO            No    0.18 0.14 0.95    0.0
07/01/1991 R_WWheat        HARVEST             No    0.38 0.36 0.00    0.9
08/15/1991 R_WWheat        CHEMWEED            No    0.49 0.48 0.00    0.0
05/01/1992 R_WWheat        CHI_STR             No    0.05 0.04 0.03    0.0
06/01/1992 R_WWheat        SWEEPS_3            No    0.26 0.22 0.05    0.0
07/01/1992 R_WWheat        CULT_30             No    0.20 0.19 0.11    0.0
08/01/1992 R_WWheat        CULT_30             No    0.21 0.20 0.28    0.0
09/01/1992 R_WWheat        CULT_30             No    0.20 0.19 0.51    0.3
09/20/1992 G_WWheat        DRILL_HO            No    0.14 0.10 0.76    0.5

                                   Total Erosion (t/ac):          1.7
                              RWEQ 97

      Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Accept or enter the operation date (MM/DD/YEAR)
```

4.3.2 **Dryland cotton**

Dryland cotton at Big Spring, Texas is the major cash crop for about 4 million acres. The traditional system consists of tilling the soil as soon as possible after each major rainfall. However, it is difficult to illustrate this timing in a period erosion model.

This example is a typical dryland cotton system. It consists of 10 operations between harvests. Some years it is not unusual for the farmer to till 6 to 8 additional times to control wind erosion, but these are not included in this example. There is some erosion between harvest and the first operation, but most of the erosion occurs in the months of February, March, April, and May. Based on field observations and measurements the estimated erosion of 8.0 t/ac/yr is excessive. For more detailed information on erosion by periods, view the tabular output.

Another concern is the weather file TX23005.DAT. When the management file in this example is used with *measured* weather data for the years of 1989, 1990, 1991, 1993, 1994, 1995, 1996, and 1997, the estimated erosion is 8.4, 6.2, 6.1, 10.0, 5.7, 8.0, 7.2, and 8.0 t/ac/yr. Only one of these years had as much erosion as the WERIS file for Big Spring, Texas.

The vegetative levels look about right for this type of system. The soil roughness values look good except for the fact that the timing of the tillage operations in the real world immediately follows a rain event.

Weather file: **TX23005.DAT**

```
# 23005 USA TX BIG_SPRING
  32 14 N 101 30 W 784 19590507 19701231 AGA  95 91
   5.91  6.50  7.30  7.25  7.05  6.80  5.97  5.52  5.68  5.93  5.83  5.70
   2.13  2.15  2.35  2.47  2.65  2.68  2.82  2.61  2.47  2.26  2.15  2.12
   1.17  1.15  1.13  1.10  1.09  1.08  1.07  1.08  1.09  1.11  1.14  1.16
    247    45   247   225   180   180   180   180   180   180   180   225
    1.3   1.5   1.2   1.0   2.1   5.1   3.7   1.6   3.5   3.6   2.1   1.5
   0.70  0.56  0.71  0.79  0.86  0.93  0.96  0.85  0.75  0.80  0.64  0.60
    8.0   6.6   3.3   3.6   3.2   3.8   4.0   4.7   6.1   7.2   7.8   9.5
   13.6  16.3  20.8  25.9  29.8  33.7  34.7  34.2  30.6  25.7  19.0  15.3
   -1.3   1.1   4.8  10.3  15.2  19.5  21.6  20.9  17.3  11.4   4.5   0.4
   -3.1  -1.3  -1.0   4.0  10.5  14.9  16.0  15.2  13.7   8.5   1.9  -1.6
    378   442   612   699   810   844   845   766   668   527   411   357
     17    15    17    35    76    49    47    45    67    42    16    14
    3.5   3.2   2.7   3.8   6.2   4.6   4.8   5.0   5.5   4.5   2.9   2.7
    0.7   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.5
      0     0    16    16   226   371   226   226   226   226    64    16
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  32 13 N 101 30 W 1.9 TX BIG SPRING WB AP
```

RWEQ INPUT FORM

CLIENT: BIGTEX WEATHER FILE: W\TX23005.DAT MANAGEMENT FILE: BIGTEX.MAN

Soil Properties:
soil texture SANDY LOAM OR
sand 64 %
silt 26 %
organic matter 0.5 %
calcium carbonate 3 %
rock cover 0 %

Field Geometry:
shape circular or rectangular
area 320, acres
orientation 0, ° from north
length_N 2640, feet
slope gradient 0
slope length 0, feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
11/15/91	COTTON	400		10	NONE	HARVEST	N	0	0	0	0	Y	100	100							
1/1/92	COTTON	0		0	NONE	CHISEL-STR	Y	0.4	12	3	0	N	70	70							
2/1/92	COTTON	0		0	NONE	MOLDB-8*	Y	1.9	10	3	0	N	5	0							
3/1/92	COTTON	0		0	NONE	FERT-L (Herb-Inc)	Y	0.8	12	3	0	N	80	50							
3/15/92	COTTON	0		0	NONE	LISTER	Y	1.0	40	10	0	N	20	0							
4/15/92	COTTON	0		0	NONE	KNIFE	Y	0.6	40	7	0	N	20	0							
5/10/92	COTTON	0		0	NONE	KNIFE	Y	0.5	40	6	0	N	20	0							
5/30/92	COTTON	0		0	COTTON	PLAN_ROW	Y	0.4	40	4	0	N	20	0							
6/25/92	COTTON	0		0	COTTON	CULT-6	Y	0.3	40	2	0	N	20	0							
7/20/92	COTTON	0		0	COTTON	CULT-6	Y	0.2	40	1.5	0	N	20	0							
8/15/92	COTTON	0		0	COTTON	CULT-6	Y	0.2	40	1	0	N	20	0							
11/15/92	COTTON	400		10	NONE	HARVEST	N	0.0	40	0	0	Y	100	100							

```
=================================REVISED WIND EROSION EQUATION=================

 Client: BIGTEX                        Weather File: W\TX23005.DAT
                                   Man. File:BIGTEX.MAN

      Soil                    Field          EF: 0.51          SCF: 0.6024
=================================DOABLE SCREEN=================================
   Date                                                                   Period
  Start       Vegetation        Operation/Event   Barrier  K'    K''   V   Erosion
11/15/1991 R_Cotton          HARVEST                 No    1.00  1.00  0.21   0.0
01/01/1992 R_Cotton          CHI_STR                 No    0.07  0.19  0.18   1.5
02/01/1992 R_Cotton          MOLDB8                  No    0.01  0.01  0.90   0.0
03/01/1992 R_Cotton          FERT_L                  No    0.05  0.11  0.92   0.4
03/15/1992 R_Cotton          LISTER                  No    0.02  0.05  0.98   0.0
04/15/1992 R_Cotton          KNIFE                   No    0.08  0.08  1.00   0.5
05/10/1992 R_Cotton          KNIFE                   No    0.26  0.09  1.00   0.9
05/30/1992 G_Cotton          PLAN_ROW                No    0.38  0.27  1.00   2.6
06/25/1992 G_Cotton          CULT_6                  No    0.41  0.32  0.63   1.1
07/20/1992 G_Cotton          CULT_6                  No    0.53  0.47  0.01   0.0
08/15/1992 G_Cotton          CULT_6                  No    0.54  0.52         0.0
                                                   Total Erosion (t/ac):      8.0
=================================RWEQ 97=======================================

      Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Accept or enter the operation date (MM/DD/YEAR)
```

4.3.3 **Corn-soybeans**

A typical corn-soybean system for the Midwest was supplied by Niki McClain, NRCS at Lake County, Indiana.

Excluding harvesting and planting, there are 2 tillage operations. With the high rainfall at Crown Point, the residue levels from these two crops are sufficient to protect the land from wind erosion. The total erosion is 1.9 t/ac for two years or an average of 0.95 t/ac/yr. The erosion that does occur is immediately after corn planting. This is when vegetative cover from the decaying soybeans is at a minimum. Soil roughening is not a major factor in protecting the soils because the high rainfall degrades soil roughness.

In this region, wind erosion should not be a problem unless dry weather or other unusual phenomena destroy the crop. If for some reason, the residue is removed after harvest (for fuel, feed, or building material), the wind erosion problem will be considerably different. Tillage would not be a recommended procedure because of the high rainfall. Cover crops or windbarriers might be options to minimize wind erosion under adverse conditions.

Weather file: **IL14834.DAT**

```
# 14834 USA IL JOLIET
  41 30 N 88 10 W 181 19460101 19521231 ARW  150 101
   6.46  6.18  6.49  6.38  5.54  5.04  4.16  3.88  4.50  4.95  6.13  5.82
   2.25  2.09  2.09  2.11  2.22  2.06  2.13  2.15  2.13  2.16  2.18  2.15
   1.29  1.29  1.26  1.23  1.20  1.18  1.17  1.18  1.20  1.22  1.25  1.28
    225   247   203   203   203   203   225   225   203   203   203   225
    1.9   1.7   1.8   1.6   2.0   2.5   3.5   2.1   2.0   6.7   1.7   2.3
   0.91  0.93  0.84  0.89  0.87  0.95  0.96  0.92  0.97  0.96  0.90  0.97
    1.8   2.3   3.6   2.1   2.1   3.4   5.3   6.4   4.7   5.2   2.5   4.0
   -0.7   1.1   7.7  15.3  21.7  26.9  29.5  28.3  24.2  17.8   9.0   1.3
  -10.4  -8.7  -2.9   2.8   8.4  13.7  16.3  15.4  11.2   5.0  -1.3  -7.6
   -8.8  -7.1  -3.5   2.2   8.4  13.6  16.4  16.3  11.9   6.2  -0.6  -5.5
    151   205   332   442   574   608   615   550   419   298   175   123
     44    36    64    85    95   108    88    89    92    63    57    50
    8.3   7.0   9.3   9.9  10.7  10.1   8.1   8.3   8.2   7.6   7.8   8.1
   45.0  14.6   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  22.5  32.5
      0    25    51    76   204   357   612   510   382   178   102    51
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  41 45 N 88 19 W 30.5 IL AURORA COLLEGE
```

RWEQ INPUT FORM

CLIENT: CROWNPIN WEATHER FILE: W\IL14834.DAT MANAGEMENT FILE: CROWNPIN.MAN

Soil Properties:
soil texture SANDY LOAM OR
sand 64 %
silt 26 %
organic matter 0.5 %
calcium carbonate 3 %
rock cover 0 %

Field Geometry:
shape circular or rectangular
area 80 , acres
orientation 90 , ° from north
length_N 2640 , feet
slope gradient 0
slope length 0 , feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
4/20/92	NONE	0		0	NONE	DISK_TAN	Y	0.8	12	1	0	N	50	20							
5/1/92	NONE	0		0	CORN	PLANT_ROW	Y	0.4	30	3	0	N	90	50							
10/20/92	CORN	9000		15	NONE	HARVEST	N	0	0	0	0	Y	100	100							
5/1/92	CORN	0		0	NONE	DISK_TAN	Y	0.8	12	1	0	N	50	20							
5/10/92	CORN	0		0	SOYBEAN	DRILL_NOH	Y	0.3	12	1	0	N	90	40							
10/1/93	SOYBEAN	3000		100	NONE	HARVEST	N	0	0	0	0	Y	100	100							
4/20/94	SOYBEAN	0		0	NONE	DISK_TAN	Y	0.8	12	1	0	N	50	20							

```
=================REVISED WIND EROSION EQUATION=================

 Client: CROWNPIN                 Weather File: w/IL14834.DAT
                          Man. File:CROWNPIN.MAN

       Soil                 Field        EF: 0.51        SCF: 0.6024
                            DOABLE SCREEN

   Date                                                          Period
  Start       Vegetation     Operation/Event  Barrier  K'   K''  V    Erosion
04/20/1992 R_Soybea         DISK_TAN            No    0.17 0.15 1.00    0.0
05/01/1992 G_Corn           PLAN_ROW            No    0.30 0.22 1.00    1.0
10/20/1992 R_Corn           HARVEST             No    0.90 0.90 0.00    0.8
05/01/1993 R_Corn           DISK_TAN            No    0.18 0.16 0.01    0.0
05/10/1993 G_Soybea         DRIL_NOH            No    0.41 0.36 0.02    0.0
10/01/1993 R_Soybea         HARVEST             No    0.91 0.91 0.00    0.0
04/20/1994 R_Soybea         DISK_TAN            No    0.16 0.14 0.01    0.0
  /  /                                          No    0.00 0.00 0.00    0.0

                                   Total Erosion (t/ac):          1.9
                          RWEQ 97

       Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
```

Accept or enter the operation date (MM/DD/YEAR)

4.3.4 **Winter wheat**

Horse Heaven Hills is that region of south central Washington State west of the Yakima River and north of the Columbia River. It is characterized by dry weather with infrequent but very strong winds. This dryland winter wheat-fallow management system has 6 tillage operations and one application of herbicide.

With this system the total wind erosion is 0.0 t/ac. From the 0.88 *V* value at planting (8-30-93) there is insufficient residue on the land to protect the soil if high winds should occur. Measurements and observation agree that this is a critical erosion period. The total erosion is relatively small, but this volcanic ash soil is subject to long distance transport. Any soil eroded is transported hundreds of miles before being deposited.

Cover crops are not an option because of the lack of rainfall. Windbarriers are of limited value because of the undulating topography. The soil texture is not conducive to roughening, but the potential may warrant additional research. Other options would include soil amendments for critical problem areas, or acceptance that this level of erosion will not degrade the soil resources over extended periods of time. This is probably true except during those exceptional events when high speed winds blow through the region.

HOWEVER, during extended droughts, the residue levels will be even lower and erosion can be considerably greater. Because of the impact on air quality, alternative systems and techniques may deserve additional research.

Weather file: **P2WA9293.W1**

```
# 24243 USA WA YAKIMA    modified for PROSSER2    JUN 92 to MAR 93
  46 34 N 120 32 W 326 19620119 19781231 AGW  5 10
   3.50  3.95  4.19  4.89  4.82  4.78  4.38  4.26  4.82  3.45  3.06  5.28
   1.47  1.32  1.97  2.03  2.18  2.25  2.55  2.56  1.60  1.69  1.78  1.92
   1.26  1.24  1.22  1.20  1.18  1.16  1.15  1.16  1.18  1.21  1.23  1.25
    270   247   292   292   315   293   315   292   292   270   225   180
    1.9   1.6   1.1   2.0   1.9   3.2   2.3   1.3   2.1   1.4   1.2   2.3
   0.96  0.93  0.94  0.99  0.91  1.00  0.97  1.00  0.99  1.00  1.00  0.95
   18.3  12.7  13.2   2.9   2.0   1.9   2.3   2.5   8.4  10.4  24.4   8.9
   -2.1   2.0   9.4  17.5  22.7  30.6  30.4  33.8  10.5  18.3   7.2   2.0
   -8.3  -4.5   0.4   1.4   5.8  15.3  14.3  15.2   0.1   5.2   0.9  -3.3
   -7.1  -2.6  -1.1   0.7   4.4   7.1   8.1   8.5   6.8   4.3   0.6  -2.2
    132   228   319   532   671   694   662   611   222   282   131   106
     16     7    27    11    12    29    37     8     6    22    29     6
      6     8    13   4.3   4.9     6    10   2.8     5     7    11     5
   44.3   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   6.1  25.2
     29     3    20     7     8    16    53     7     2     7    10    .2
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  46 33 N 120 31 W 2.2 WA YAKIMA WB AP D
```

RWEQ INPUT FORM

CLIENT: HORSEHH-WA WEATHER FILE: P2WA9293.W1 MANAGEMENT FILE: HORSEHH.MAN

Soil Properties:
soil texture SANDY LOAM OR sand 64 %
silt 26 %
organic matter 0.5 %
calcium carbonate 3 %
rock cover 0 %

Field Geometry: shape circular or rectangular
area 160, acres
orientation 0, ° from north
length_N 3640, feet
slope gradient 0
slope length 0, feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
7/15/92	WWHEAT	1800		70	NONE	HARVEST	N	0	0	0	0	Y	100	100							
9/1/92	WWHEAT	0		0	NONE	SWEEP-Z	Y	0.6	36	2	0	N	15	55							
4/10/93	WWHEAT	0		0	NONE	FERT-L (HERBICIDE)	Y	0.4	0	0	0	N	80	50							
5/21/93	WWHEAT	0		0	NONE	CULT-30	Y	0.7	24	1	0	N	70	90							
5/22/93	WWHEAT	0		0	NONE	ROD-PLA	Y	0.4	0	0	0	N	90	50							
6/1/93	WWHEAT	0		0	NONE	FERT-L	Y	0.4	0	0	0	N	80	50							
6/15/93	WWHEAT	0		0	NONE	ROD-PLA	Y	0.4	0	0	0	N	90	50							
8/1/93	WWHEAT	0		0	NONE	ROD-PLA	Y	0.4	0	0	0	N	90	50							
8/30/93	WWHEAT	0		0	WWHEAT	DRILL-HO	Y	0.8	16	3	0	N	50	40							
7/15/94	WWHEAT	1800		70	NONE	HARVEST	N	0	0	0	0	Y	100	100							

REVISED WIND EROSION EQUATION

Client: HORSEHH Weather File: P2WA9293.W1
Man. File:HORSEHH.MAN

Soil Field EF: 0.51 SCF: 0.6024
DOABLE SCREEN

Date Start	Vegetation	Operation/Event	Barrier	K'	K''	V	Period Erosion
07/15/1992	R_WWheat	HARVEST	No	1.00	1.00		0.0
09/01/1992	R_WWheat	SWEEPS_2	No	0.15	0.21	0.06	0.0
04/10/1993	R_WWheat	FERT_L	No	0.33	0.33	0.13	0.0
05/21/1993	R_WWheat	CULT_30	No	0.16	0.17	0.17	0.0
05/22/1993	R_WWheat	ROD_PLA	No	0.33	0.33	0.27	0.0
06/01/1993	R_WWheat	FERT_L	No	0.34	0.34	0.43	0.0
06/15/1993	R_WWheat	ROD_PLA	No	0.34	0.34	0.61	0.0
08/01/1993	R_WWheat	ROD_PLA	No	0.33	0.33	0.70	0.0
08/30/1993	G_WWheat	DRILL_HO	No	0.05	0.11	0.88	0.0
07/15/1994	R_WWheat	HARVEST	No	0.20	0.21	0.00	0.0

Total Erosion (t/ac): 0.0

RWEQ 97

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Accept or enter the operation date (MM/DD/YEAR)

4.3.5 **Cotton**

This system of cotton at Kennett, Missouri was provided by Phil Gurley, NRCS, Kennett, Missouri. This is the "Boot Heel" region of extreme Southeast Missouri. The fields are relatively flat but may have trees on the boundaries. In this system, the winter wheat is used as a cover crop and is not harvested. Tillage terminology (hipped and doall) are not common to West Texas; therefore, values for soil ridges and random roughness have been assumed.

Most of the erosion occurs at cotton planting. Experience and measurements agree that February, March and April are the critical months. The total erosion is 0.6 t/ac/yr. This is minimal, but if excessive winds occur during the critical period, such as the period immediately before cotton planting, erosion can be much greater. While infrequent, severe dust storms do occur filling road ditches and closing highways.

This region is ideally suited for windbarriers or cover crops. Soil roughening is not effective because of the numerous rainfall events. Residue management is possible, but high residue crops would need to be a part of the system. From these data, wind erosion is not a problem except in those years with a unique combination of high winds at cotton planting time.

Weather file: **KM93.W1**

```
# 13814 USA AR BLYTHEVILLE MODIFIED FOR KENNETT DEC 92 THRU JUN 93
  35 58 N 89 57 W 80 19600501 19701231 AGA  280 106
   5.24  4.22  5.63  6.15  4.31  3.54  3.45  1.72  3.14  3.90  4.49  4.90
   2.59  2.35  1.98  1.95  1.87  1.56  1.60  1.14  1.64  2.00  2.11  1.88
   1.28  1.27  1.24  1.21  1.19  1.18  1.17  1.18  1.19  1.22  1.25  1.27
    180   180   202   202   180   180     0    45     0   180   180   180
    5.9   3.4   2.2   2.7   3.3   3.3   8.5   5.9   6.7   5.5   4.2   2.9
   0.54  0.57  0.73  0.95  0.83  0.89  0.79  0.79  0.79  0.77  0.84  0.71
   13.8  15.7   7.9  13.9  10.7  16.5  15.6  44.1  24.4  20.3  21.2  10.6
    5.8  10.1  13.2  18.9  26.3  31.2  35.5  33.9  26.8  21.0  13.4  10.5
   -0.3  -1.5   3.8   8.0  14.1  19.2  22.6  20.3  14.1   7.8   2.5   0.1
   -0.0   1.0   3.1   8.7  14.7  18.8  20.5  19.9  16.4   9.6   3.3   0.3
    102   261   300   359   471   492   600   476   386   296   198   204
    135   111   138 128.8  65.3 110.2  45.5  82.3    90    71  38.1   122
   10.2   9.1  10.5  16.0  18.0  13.0   4.0   6.0   7.1   6.5   3.0   9.3
    8.2   4.7   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   7.0
    143   285   381   225    97   709   368   667    50   285   100   333
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  35 32 N 89 39 W 55.3 TN COVINGTON
```

RWEQ INPUT FORM

CLIENT: KENNMO WEATHER FILE: KM93.W1 MANAGEMENT FILE: KENNMO.MAN

Soil Properties:
soil texture_____ OR sand 87.3 %
silt 9.7 %
organic matter 0.4 %
calcium carbonate 0.2 %
rock cover 0 %

Field Geometry: shape circular or rectangular
area 80 acres
orientation 90 ° from north
length_N 1300 feet
slope gradient 0
slope length 0 feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
10/15/91	COTTON	1250		0	NONE	HARVEST	N	0	0	0	0	Y	100	100							
11/1/91	COTTON	0		0	NONE	LISTER (HIPPED)	Y	1.0	38	10	0	N	20	0							
11/5/91	COTTON	0		0	WWHEAT	DRILL-DD (OVERSEEDED)	N	0	0	0	0	N	100	100							
4/1/92	COTTON	0		0	NONE	LISTER (DOALL)	Y	0.8	38	6	0	N	20	0							
4/30/92	COTTON	0		0	COTTON	PLAN_ROW	Y	0.2	38	4	0	N	90	50							
5/20/92	COTTON	0		0	COTTON	CULT-12	Y	0.3	38	3	0	N	75	50							
6/20/92	COTTON	0		0	COTTON	CULT-12	Y	0.3	38	1	0	N	75	50							
7/30/92	COTTON	0		0	COTTON	CULT-12	Y	0.3	38	1	0	N	75	50							
10/15/92	COTTON	0		0	NONE	HARVEST	N	0	0	0	0	Y	100	100							

```
=================REVISED WIND EROSION EQUATION=================

 Client: KENNMO                    Weather File: KM93.W1
                          Man. File:KENNMO.MAN

       Soil                 Field        EF: 0.66        SCF: 0.9439
                            DOABLE SCREEN

   Date                                                          Period
  Start      Vegetation      Operation/Event   Barrier  K'   K''  V    Erosion
 10/15/1991 R_Cotton        HARVEST              No    1.00 1.00 0.09    0.0
 11/01/1991 R_Cotton        LISTER               No    0.13 0.06 0.24    0.0
 11/15/1991 G_WWheat        DRILL_DD             No    0.17 0.11 0.27    0.0
 04/01/1992 R_Cotton        LISTER               No    0.21 0.19 0.24    0.2
 04/30/1992 G_Cotton        PLAN_ROW             No    0.55 0.45 0.27    0.4
 05/20/1992 G_Cotton        CULT_12              No    0.43 0.36 0.25    0.0
 06/20/1992 G_Cotton        CULT_12              No    0.51 0.50 0.01    0.0
 07/30/1992 G_Cotton        CULT_12              No    0.57 0.57         0.0
 10/15/1992 R_Cotton        HARVEST              No    0.88 0.88 0.02    0.0

                                        Total Erosion (t/ac):        0.6
                              RWEQ 97

       Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
```

Accept or enter the operation date (MM/DD/YEAR)

4.3.6 **Winter wheat-sorghum-fallow**

This example is a winter wheat-sorghum-fallow system at Scott County, Kansas. This system is the same as used by NRCS in their training material for WEQ.

The critical period is between sorghum harvest and wheat planting. Total erosion from this three year rotation is 14.4 t/ac or an annual average of 4.8 t/ac/yr. The greatest opportunity to reduce erosion is between sorghum harvest and the first tillage operation the following April. Options may include chemical weed control, soil roughening with chiseling in March, using tillage that produces larger ridges and furrows, or possibly using windbarriers. The dominate wind direction during the erosion problem periods will determine if ridge tillage or barriers are an effective option. Only 9 tillage operations are performed in this three-year rotation. Planting and harvesting operations are not counted.

Weather file: **KS23065.DAT**

```
# 23065 USA KS GOODLAND
  39 22 N 101 42 W 1112 19500609 19640322 ARW  70 88
   6.15  6.43  7.35  7.34  6.93  6.88  6.17  6.02  6.34  6.17  6.40  6.24
   2.60  2.45  2.34  2.44  2.50  2.54  2.59  2.56  2.55  2.56  2.49  2.57
   1.15  1.13  1.12  1.10  1.07  1.05  1.04  1.05  1.07  1.09  1.12  1.14
    338   338   338   338   158   180   158   158   180   338   337   337
    3.3   3.8   3.4   3.6   2.3   2.4   2.1   2.9   3.2   3.6   3.6   4.4
   0.94  0.88  0.87  0.66  0.63  0.83  0.79  0.85  0.69  0.52  0.83  0.92
    2.4   2.8   2.6   2.2   2.5   2.4   3.7   3.5   3.3   2.9   3.1   3.1
    4.5   7.6  11.6  18.1  23.4  29.3  33.2  32.2  27.0  20.8  11.4   6.6
   -9.9  -7.3  -3.5   2.2   8.1  13.5  16.9  15.7  10.4   3.9  -3.4  -7.7
   -9.5  -6.3  -5.7  -0.4   6.3  11.9  14.1  13.5   8.1   1.9  -4.4  -7.6
    256   313   478   544   637   684   728   620   510   394   359   221
     12    14    37    43    87    89    71    49    39    30    19    12
    3.9   4.7   7.2   7.4   9.5   9.5   7.8   6.9   5.5   4.4   4.2   3.7
   22.9  26.2  10.4   0.0   0.0   0.0   0.0   0.0   0.0   0.0   6.7  17.6
      0     0    11    23   119   285   285   202   154    59    35    11
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  39 46 N 101 22 W 52.9 KS MC DONALD C
```

RWEQ INPUT FORM

CLIENT: SCOTKS WEATHER FILE: W\KS23065.DAT MANAGEMENT FILE: SCOTKS.MAN

Soil Properties:
soil texture FINE SANDY LOAM OR
sand 64 %
silt 26 %
organic matter 0.5 %
calcium carbonate 3 %
rock cover 1 %

Field Geometry:
shape circular or rectangular
area 160, acres
orientation 0, ° from north
length_N 2640, feet
slope gradient 0
slope length 0, feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
6/15/91	WWHEAT	1800		100	NONE	HARVEST	N	0	0	0	0	Y	100	100							
4/1/92	WWHEAT	0		0	NONE	DISK-TAN	Y	0.8	12	1	0	N	50	20							
5/1/92	WWHEAT	0		0	NONE	CULT-30	Y	0.7	24	1	0	N	70	90							
5/14/92	WWHEAT	0		0	NONE	CULT-30	Y	0.7	24	1	0	N	70	90							
5/15/92	WWHEAT	0		0	SORGHUM	PLAN-ROW	Y	0.2	36	2	0	N	90	50							
10/15/92	SORGHUM	3900		10	NONE	HARVEST	N	0	0	0	0	Y	100	100							
4/1/93	SORGHUM	0		0	NONE	SWEEP-2	Y	0.6	36	2	0	N	85	45							
5/15/93	SORGHUM	0		0	NONE	SWEEP-2	Y	0.6	36	2	0	N	85	45							
7/15/93	SORGHUM	0		0	NONE	SWEEP-2	Y	0.6	36	2	0	N	85	45							
8/15/93	SORGHUM	0		0	NONE	SWEEP-2	Y	0.6	36	2	0	N	85	45							
9/10/93	SORGHUM	0		0	NONE	ROD-PLA	Y	0.4	0	0	0	N	90	50							
9/15/93	SORGHUM	0		0	WWHEAT	DRILL-HO	Y	0.8	14	2	0	N	50	40							
6/15/94	WWHEAT	1800		100	NONE	HARVEST	N	0	0	0	0	Y	100	100							

REVISED WIND EROSION EQUATION

Client: SCOTKS Weather File: w/KS23065.DAT
Man. File:SCOTKS.MAN

Soil Field EF: 0.51 SCF: 0.6024

DOABLE SCREEN

Date Start	Vegetation	Operation/Event	Barrier	K'	K''	V	Period Erosion
06/15/1991	R_WWheat	HARVEST	No	1.00	1.00		0.0
04/01/1992	R_WWheat	DISK_TAN	No	0.15	0.13	0.07	0.0
05/01/1992	R_WWheat	CULT_30	No	0.20	0.19	0.15	0.0
05/14/1992	R_WWheat	CULT_30	No	0.18	0.16	0.27	0.0
05/15/1992	G_Sorghu	PLAN_ROW	No	0.51	0.45	0.38	0.6
10/15/1992	R_Sorghu	HARVEST	No	0.83	0.82	0.22	0.5
04/01/1993	R_Sorghu	SWEEPS_2	No	0.21	0.16	0.34	7.0
05/15/1993	R_Sorghu	SWEEPS_2	No	0.22	0.19	0.49	1.6
07/15/1993	R_Sorghu	SWEEPS_2	No	0.23	0.20	0.70	2.5
08/15/1993	R_Sorghu	SWEEPS_2	No	0.22	0.18	0.90	0.8
09/10/1993	R_Sorghu	ROD_PLA	No	0.34	0.34	1.00	1.1
09/15/1993	G_WWheat	DRILL_HO	No	0.16	0.08	1.00	0.0
06/15/1994	R_WWheat	HARVEST	No	0.44	0.43	0.00	0.4

Total Erosion (t/ac): 14.4

RWEQ 97

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Accept or enter the operation date (MM/DD/YEAR)

4.3.7 **Winter wheat-fallow**

This dryland winter wheat-fallow system at Moses Lake, Washington was provided by Mike Klugland, NRCS, Washington. Using the WERIS weather file, there is no estimated erosion with this system. The crop yields are sufficient to produce excellent ground cover and standing silhouette. The very small *V* values are evidence that for normal conditions, wind erosion is not a problem in this region with this weather file.

Observations have shown that very fine dust is generated from some fields without any saltating movement (personal communication with Dr. Keith Saxton). The problem is modeling the infrequent but intense winds that are responsible for erosion in this region. From the three erosion measurement sites instrumented, there is good agreement between measured and estimated erosion. However, these estimates are made using measured wind and weather conditions. The weather conditions in the WERIS files may not include these infrequent but severe wind conditions.

Weather file: **WA24110.DAT**

```
# 24110 USA WA MOSES LAKE
  47 11 N 119 20 W 361 19570501 19660530 AGA  5 10
   3.78  4.02  4.64  4.97  4.58  4.50  4.24  4.16  4.14  3.73  3.82  3.70
   1.89  1.89  1.92  2.07  2.21  2.24  2.29  2.32  2.00  1.86  1.81  1.91
   1.25  1.23  1.21  1.19  1.17  1.15  1.14  1.15  1.17  1.20  1.23  1.24
      0     0   247   270   270   247   247   270     0   203   203   180
    6.4   1.8   1.3   2.3   3.3   1.7   1.9   3.3   2.6   4.9   1.9   2.9
   0.85  0.63  0.67  0.99  0.99  0.90  0.94  1.00  0.90  0.97  0.90  0.55
   31.8  28.6  17.8  14.5  18.0  17.3  20.7  23.2  27.3  31.9  32.5  35.5
    0.2   5.3  11.2  16.8  22.5  26.9  31.4  30.5  25.4  17.0   7.1   1.9
   -6.8  -2.9   0.0   3.8   8.8  13.0  16.5  15.8  11.0   4.6  -1.0  -4.7
   -8.6  -4.3  -3.0  -0.9   2.7   5.7   6.9   7.4   5.4   2.7  -1.0  -3.8
    132   210   382   556   698   727   825   671   470   280   157   100
     23    18    17    13    13    14     6     7     8    13    26    30
    8.9   7.1   6.0   4.7   5.1   4.2   2.0   2.7   3.4   5.2   8.6   9.9
   57.3   8.4   0.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0  11.7  34.6
      0     0     2     7     8    14     7     7     8     8    13     5
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  47 17 N 119 31 W 17.8 WA EPHRATA CAA AP P
```

RWEQ INPUT FORM

CLIENT: WASHWHEAT WEATHER FILE: W\WA24110.DAT MANAGEMENT FILE: WASHWHEA.MAN

Soil Properties:
soil texture SANDY LOAM OR sand 64 %
silt 26 %
organic matter 0.5 %
calcium carbonate 1 %
rock cover 0 %

Field Geometry: shape circular or rectangular
area 160, acres
orientation 0, ° from north
length_N 2640, feet
slope gradient 0
slope length 0, feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
8/1/91	WWHEAT	2500		100	NONE	HARVEST	N	0	0	0	0	Y	100	100							
9/1/91	WWHEAT	0		0	NONE	CHISEL-STR	Y	1.0	12	2	0	N	70	70							
3/1/92	WWHEAT	0		0	NONE	SWEEP-3	Y	0.5	36	2	0	N	90	45							
4/1/92	WWHEAT	0		0	NONE	ROD-PLA	Y	0.4	0	0	0	N	90	50							
5/20/92	WWHEAT	0		0	NONE	ROD-PLA	Y	0.4	0	0	0	N	90	50							
6/15/92	WWHEAT	0		0	NONE	ROD-PLA	Y	0.4	0	0	0	N	90	50							
7/30/92	WWHEAT	0		0	NONE	ROD-PLA	Y	0.4	0	0	0	N	90	50							
7/1/92	WWHEAT	0		0	WWHEAT	DRILL-HO	Y	0.8	16	4	0	N	50	40							
8/1/93	WWHEAT	2500		100	NONE	HARVEST	N	0	0	0	0	Y	100	100							

REVISED WIND EROSION EQUATION

Client: WASHWHEAT Weather File: W\WA24110.DAT
Man. File:WASHWHEA.MAN

Soil Field EF: 0.53 SCF: 0.6024
DOABLE SCREEN

Date Start	Vegetation	Operation/Event	Barrier	K'	K''	V	Period Erosion
08/01/1991	R_WWheat	HARVEST	No	1.00	1.00		0.0
09/01/1991	R_WWheat	CHI_STR	No	0.11	0.05		0.0
03/01/1992	R_WWheat	SWEEPS_3	No	0.19	0.25	0.01	0.0
04/01/1992	R_WWheat	ROD_PLA	No	0.33	0.33	0.01	0.0
05/01/1992	R_WWheat	ROD_PLA	No	0.33	0.33	0.02	0.0
06/15/1992	R_WWheat	ROD_PLA	No	0.34	0.34	0.03	0.0
07/30/1992	R_WWheat	ROD_PLA	No	0.33	0.33	0.04	0.0
09/01/1992	G_WWheat	DRILL_HO	No	0.14	0.03	0.17	0.0
08/01/1993	R_WWheat	HARVEST	No	0.14	0.22	0.00	0.0

Total Erosion (t/ac): 0.0

RWEQ 97

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Accept or enter the operation date (MM/DD/YEAR)

4.3.8 **Winter wheat-sunflower-fallow**

A three year rotation of winter wheat-sunflowers-fallow in Northeast Colorado was provided by Richard Fryrear, a farmer (B.Sci., Chemical Engineering, Colorado School of Mines) from Haxtun, Colorado. With this system the total erosion is 1.5 t/ac, and the average erosion is 0.5 t/ac/yr. This is little erosion for the sandy loam soils of this region.

Farmers comment that they see some erosion in the spring after the sunflowers are harvested. With this system there is considerable carry over of the flat wheat residue. When supplemented with the sunflower stalks, the *V* value is 0.13 which is very effective in controlling wind erosion.

This system would be very effective in controlling wind erosion unless there is a crop failure due to drought, a severe hail that destroys the surface residue, or winter temperatures that damage the winter wheat.

NOTE: There are no plant canopy coefficients for sunflowers; therefore, cotton is used for the planted crop in June, 1992 in this example.

Weather file: **CO24015.DAT**

```
# 24015 USA CO AKRON
  40 07 N 103 10 W 1399 19480101 19541231 ARF  60 64
   6.98  7.11  7.97  7.74  7.23  6.69  6.61  6.38  6.78  6.61  7.41  7.31
   2.56  2.44  2.32  2.36  2.40  2.37  2.43  2.41  2.34  2.44  2.49  2.51
   1.11  1.10  1.09  1.06  1.05  1.02  1.01  1.02  1.03  1.06  1.09  1.10
    315   338   315   338   338   338   158   158   158   338   337   315
    2.9   3.4   3.8   4.1   3.7   2.6   1.9   1.7   2.6   3.1   5.8   3.1
   0.95  0.93  0.93  0.63  0.50  0.60  0.71  0.59  0.69  0.63  0.95  0.96
    3.1   3.1   2.7   2.5   3.7   3.9   3.5   4.1   4.3   4.6   3.0   2.9
    3.7   6.3   9.5  15.8  21.1  27.2  31.4  30.5  25.5  19.0   9.9   5.3
  -10.6  -8.3  -5.4   0.1   5.7  11.0  14.7  13.8   8.5   2.2  -5.0  -8.9
  -10.9  -8.4  -7.5  -3.1   3.0   7.5  10.1   9.4   4.2  -1.4  -6.6  -9.2
    261   315   509   568   612   671   696   589   517   402   393   234
      9     7    25    33    78    67    70    46    32    21    14    10
    4.5   4.1   7.5   7.3  10.9   9.7   9.6   7.8   5.5   4.6   4.3   3.8
   31.3  24.2  10.5   0.0   0.0   0.0   0.0   0.0   0.0   0.0   3.8  18.6
      0     7    68    71    29    37   115   297   209    83    81    19
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  40 6 N 103 9 W 2.3 CO AKRON CAA AP
```

RWEQ INPUT FORM

CLIENT: WHSUNFAL WEATHER FILE: W\CO24015.DAT MANAGEMENT FILE: WHSUNFAL.MAN

Soil Properties:
soil texture SANDY LOAM OR sand 64 %
silt 26 %
organic matter 0.5 %
calcium carbonate 3 %
rock cover 0 %

Field Geometry: shape circular or rectangular
area 160, acres
orientation 0, ° from north
length_N 2640, feet
slope gradient 0
slope length 0, feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
9/10/90	NONE	0		0	WWHEAT	DRILL-HO	Y	0.8	14	2	0	N	50	40							
7/1/91	WWHEAT	2640		150	NONE	HARVEST	N	0	0	0	0	Y	100	90							
4/15/92	WWHEAT	0		0	NONE	DISK-OS	Y	1.9	0	0	0	N	50	15							
5/1/92	WWHEAT	0		0	NONE	CHISEL-STR	Y	1.2	12	2	0	N	70	70							
6/1/92	WWHEAT	0		0	SUNFLOW	PLAN-ROW	Y	0.2	36	2	0	N	90	50							
10/1/92	SUNFLOWER	800		6	NONE	HARVEST	N	0	0	0	0	Y	100	100							
5/15/93	SUNFLOWER	0		0	NONE	DISK-OS	Y	1.9	0	0	0	N	50	15							
6/15/93	SUNFLOWER	0		0	NONE	CHISEL-STR	Y	1.2	12	2	0	N	70	70							
9/10/93	SUNFLOWER	0		0	WWHEAT	DRILL-HO	Y	0.8	14	2	0	N	50	40							

REVISED WIND EROSION EQUATION

Client: WHSUNFAL Weather File: W/CO24015.DAT
Man. File:WHSUNFAL.MAN

Soil Field EF: 0.51 SCF: 0.6024
DOABLE SCREEN

Date Start	Vegetation	Operation/Event	Barrier	K'	K''	V	Period Erosion
09/10/1990	G_WWheat	DRILL_HO	No	0.18	0.14	0.95	0.0
07/01/1991	R_WWheat	HARVEST	No	0.40	0.38	0.00	0.9
04/15/1992	R_WWheat	DISK_OS	No	0.03	0.03	0.04	0.0
05/01/1992	R_WWheat	CHI_STR	No	0.06	0.04	0.09	0.0
06/01/1992	G_Cotton	PLAN_ROW	No	0.50	0.43	0.15	0.3
10/01/1992	R_Sunflower	HARVEST	No	0.74	0.72	0.00	0.0
05/15/1993	R_Sunflower	DISK_OS	No	0.03	0.03	0.05	0.0
06/15/1993	R_Sunflower	CHI_STR	No	0.08	0.05	0.09	0.0

Total Erosion (t/ac): 1.5

RWEQ 97

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Accept or enter the operation date (MM/DD/YEAR)

5. EXAMPLES

To illustrate the flexibility and utility of RWEQ, examples of the response of RWEQ to input limits of each parameter are presented. They are not intended to cover the entire range of potential use of RWEQ. They do provide an illustration of RWEQ and methods of developing or modifying input files. In each subsection the development of the input file is illustrated.

5.1 CREATING AND EDITING MANAGEMENT FILES

A management file may be created within the RWEQ program or through the DOS editor. Instructions are given for both methods.

5.1.1 A simple management file using RWEQ

To create a management file it is not necessary to assign a client name, but it is necessary to enter a weather filename. When prompted for a management filename, pressing <enter> without entering a filename or entering a *new* filename gives blank **`Soils Properties`** and **`Field Geometry`** windows and a blank **`DOABLE SCREEN`**.

The example below is based on information given in the RWEQ INPUT FORM in Table 5.1.1. This form insures that you have the essential input data for the development of a management system.

NOTE: APPENDIX A-2 is a blank RWEQ INPUT FORM. The entries that are color coded blue are the minimum required input.

In this example the client filename TEST, the weather filename W\TX23005.DAT, and the management filename TEST.MAN are entered. The soil properties and field geometry are entered before advancing to the DOABLE SCREEN. In this simple file there is no vegetation, no tillage, and no barriers. Dates are entered for the beginning and end of the year.

A.	At the C:\RWEQ97> prompt	type **RWEQ** and press <enter>.
B.	At the **`Client`** prompt	type **TEST** and press <enter>.
C.	At the **`Weather File`** prompt	type **W\TX23005.DAT** for the Big Spring, Texas weather file. Press <enter>.
D.	At the **`Man. File`** prompt	type **TEST.MAN** (Figure 5.1.1.1) and press <enter>. (Because this is a new management file, a warning screen appears to indicate that the file cannot be found. See Figure 5.1.1.2.) Press <enter> to continue.

Fryrear, D.W., Ali Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, and T.M. Zobeck. 1998. Revised Wind Erosion Equation (RWEQ). Wind Erosion and Water Conservation Research Unit, USDA-ARS, Southern Plains Area Cropping Systems Research Laboratory. Technical Bulletin No. 1. Internet address: http://www.csrl.ars.usda.gov/wewc/rweq/readme.htm

Table 5.1.1

RWEQ INPUT FORM

CLIENT: TEST WEATHER FILE: W\TX23005.DAT MANAGEMENT FILE: TEST.MAN

Soil Properties:
soil texture SANDY LOAM OR sand 64 %
silt 26 %
organic matter 0.5 %
calcium carbonate 3 %
rock cover 0 %

Field Geometry: shape (circular) or rectangular
area 10, acres
orientation –, ° from north
length_N –, feet
slope gradient –
slope length –, feet

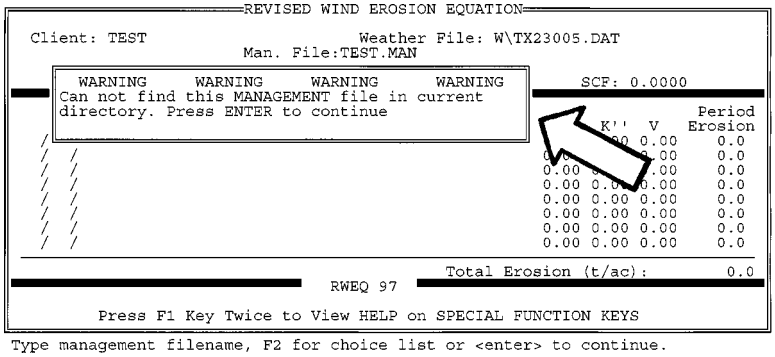
Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
1/1/90	NONE	0	0	0	NONE	NONE	N	0	0	0	0	N	0	0	–	–	–	–	–	–	–
12/31/90	NONE	0	0	0	NONE	NONE	N	0	0	0	0	N	0	0	–	–	–	–	–	–	–

Figure 5.1.1.1

```
                    REVISED WIND EROSION EQUATI
Client: TEST                    Weather          TX23005.DAT
                        Man. File:TEST.MAN

      Soil                  Field        EF: 0.00          SCF: 0.0000
                            DOABLE SCREEN

   Date                                                          Period
  Start      Vegetation     Operation/Event  Barrier  K'   K''  V    Erosion
 /  /                                                0.00 0.00 0.00    0.0
 /  /                                                0.00 0.00 0.00    0.0
 /  /                                                0.00 0.00 0.00    0.0
 /  /                                                0.00 0.00 0.00    0.0
 /  /                                                0.00 0.00 0.00    0.0
 /  /                                                0.00 0.00 0.00    0.0
 /  /                                                0.00 0.00 0.00    0.0
 /  /                                                0.00 0.00 0.00    0.0

                                        Total Erosion (t/ac):          0.0
                          RWEQ 97

      Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Type weather filename or press F2 for choice list.
```

Figure 5.1.1.2



E.	At the **`Soil Texture`** prompt	press F2, use the arrow key to highlight *sandy_loam* (Figure 5.1.1.3), and press <enter> to select. Note that the values for sand, silt, OM, $CaCO_3$, and rock are brought into the screen. The clay remains 100 (the default) until <enter> is pressed and the value 10 is calculated for clay. See Figure 5.1.1.4. Press <enter> five times to advance through the **`Soil Properties`** window and accept the default values for a sandy loam soil.
	At the flashing **`Soil`** prompt	press <enter> to advance to **`Field Geometry`** window. See Figure 5.1.1.5.
F.	At the **`Shape`** prompt	press F2 and use the arrow key if necessary to highlight *circular*. Press <enter> to select.
	At the **`Area`** prompt	type **10** and press <enter>.
	At the **`Orientation`** prompt	press <enter> to accept the default value (0.00).
	At the **`Diameter`** prompt	745 is the computed diameter of the 10 acre circular field. Press <enter> to continue.
	At the **`Slope Length`** prompt	press <enter> to accept 0.0 which means no hill.
	At the **`Slope %`** prompt	(Figure 5.1.1.6) press <enter> to accept the 0.0 and exit the **`Field Geometry`** window.
	At the flashing **`Field`** prompt	press <enter> to advance to **`EF`**.

Figure 5.1.1.3

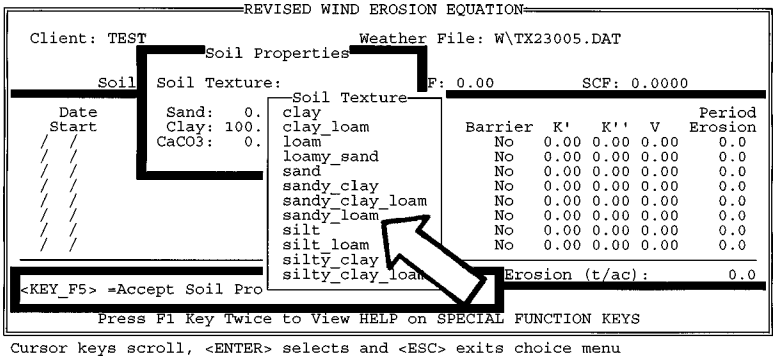


Figure 5.1.1.4

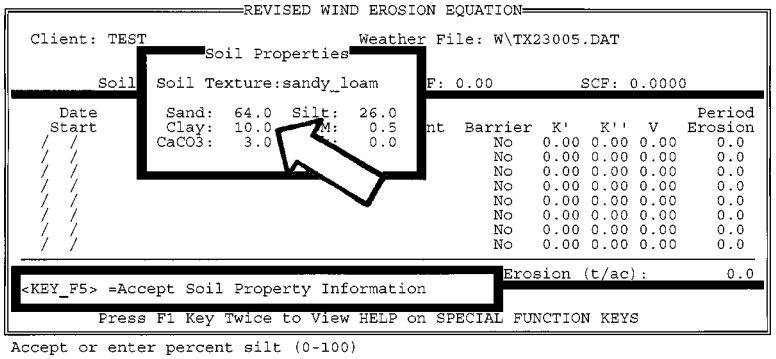


Figure 5.1.1.5

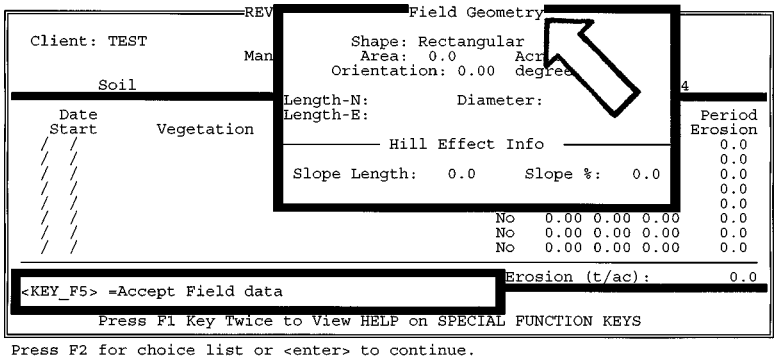
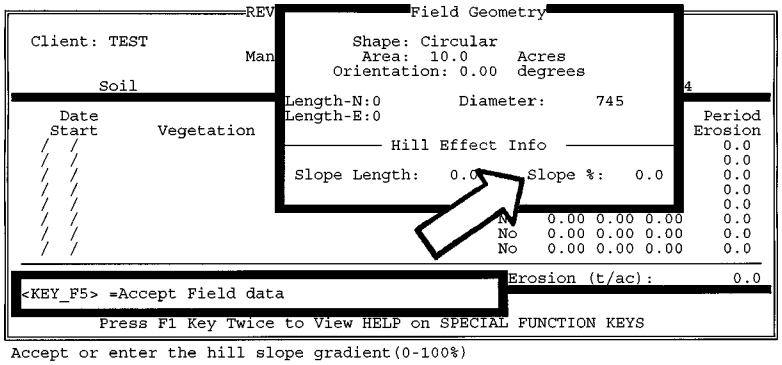


Figure 5.1.1.6



G. At the **EF** prompt — press <enter> to accept the computed value (0.51).

SCF is for information only. It may not be changed. The cursor skips **SCF** and goes directly from **EF** to the **DOABLE SCREEN**.

H. In the **DOABLE SCREEN** under **Date Start** — type **01 01 1990** . See Figure 5.1.1.7

I. Under **Vegetation** — press F9 to enter the **Residue and Growing Crop Information** window.

At the **Crop** prompt — press F2, use the arrow key if necessary to highlight *NONE*, and press <enter> to select.

At the **Yield** prompt — press <enter> to accept the default value (0.0).

At the **Flat Residue Cover** prompt — press <enter> to accept the default value (0.0).

At the **Stem Number** prompt — press <enter> to accept the default value (0).

At the **Crop Ht.** prompt — press <enter> to accept the default value (0.00).

At the **Harvest Ht.** prompt — press <enter> to accept the default value (0.00).

At the **Crop** prompt — press F2, use the arrow key to highlight *NONE*, and press <enter> to select.

At the **Growing Crop** prompt — (Figure 5.1.1.8) press <enter> to accept No and to exit the **Residue and Growing Crop Information** window.

At the flashing **NONE** — press <enter> to advance to **Operation/Event**.

Figure 5.1.1.7

```
REVISED WIND EROSION EQUATION
Client: TEST                    Weather File: W\TX23005.DAT
                          Man. File:TEST.MAN
Soil                Field        EF: 0.51          SCF: 0.6024
                    DOABLE SCREEN
  Date                                                          Period
 Start      Vegetation     Operation/Event  Barrier  K'   K''  V   Erosion
01/01/1990                                    No    0.00 0.00 0.00    0.0
 /  /                                         No    0.00 0.00 0.00    0.0
 /  /                                         No    0.00 0.00 0.00    0.0
 /  /                                         No    0.00 0.00 0.00    0.0
 /  /                                         No    0.00 0.00 0.00    0.0
 /  /                                         No    0.00 0.00 0.00    0.0
 /  /                                         No    0.00 0.00 0.00    0.0
 /  /                                         No    0.00 0.00 0.00    0.0
                                     Total Erosion (t/ac):            0.0
                         RWEQ 97
Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Press F9 for Crop Information window or <enter> to continue.
```

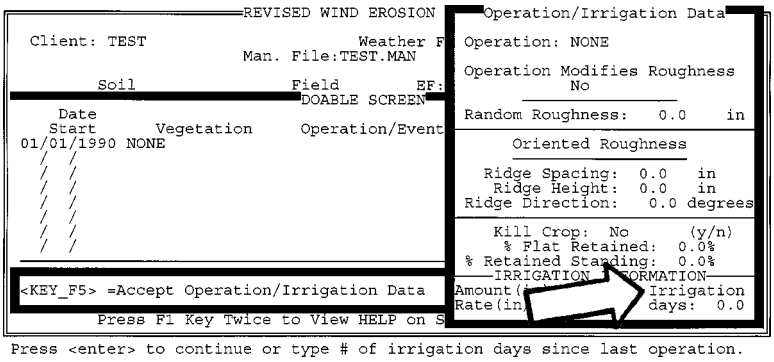
Figure 5.1.1.8

```
REVISED WIND EROSION EQUATION
Client: TEST                    Weather File: W\TX23005.DAT
                          Man. File:TEST.MAN
Soil                Field        EF: 0.51          SCF: 0.6024
        Residue and Growing Crop Information
                    Residue                                   Period
                                                   V        Erosion
                Crop: NONE                        0.00        0.0
   Yield:     0.0 lbs/ac    Flat Residue Cover:   0.00        0.0
                                                   0.00        0.0
            Stem Number:        0/1600 in2         0.00        0.0
                                                   0.00        0.0
   Crop Ht:   0.00  ft       Harvest Ht:  0.00  ft 0.00        0.0
                                                   0.00        0.0
                    Growing Crop                   0.00        0.0
                Crop: NONE                        ):           0.0
            Growing Crop: No   (y/n)
Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Toggle "yes" or "no" using SPACE BAR (yes at planting or when canopy exists).
```

J.	Under **`Operation/Event`**	press F9 to enter the **`Operation/Irrigation Data`** window.
	At the **`Operation`** prompt	press F2, use the arrow key if necessary to highlight *NONE*, and press <enter> to select.
	Under **`Operation Modifies Roughness`**	toggle No with space bar and press <enter>.
	At the **`Random Roughness`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Spacing`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Height`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Direction`** prompt	press <enter> to accept the default value (0.0).
	At the **`Kill Crop`** prompt	press <enter> to accept the default value (No).

At the **% Flat Retained** prompt	press <enter> to accept the default value (0.0).
At the **% Retained Standing** prompt	press <enter> to accept the default value (0.0).
For irrigation information	
At the **Amount (in)** prompt	press <enter> to accept the default value (0.0).
At the **Rate (in/hr)** prompt	press <enter> to accept the default value (0.0).
At the **Irrigation days** prompt	(Figure 5.1.1.9) press <enter> to accept the default value (0.0) and exit **Operation/Irrigation Data** window.
At the flashing **NONE**	press <enter> to advance to **Barrier**.

Figure 5.1.1.9



K.	At the flashing **No** under **Barrier**	press <enter> which finishes the first line in the **DOABLE SCREEN**.
L.	For the second line in the **DOABLE SCREEN**	
	Under **Date Start**	type **12 31 1990** .
	Repeat I, J, and K.	See Figure 5.1.1.10 for the 2 complete lines in the **DOABLE SCREEN**.
M.	To save this management file	press F6.
	At the **Save Client File** prompt	press <enter> to accept TEST. The client filename is automatically added to the client F2 choice list.
	At the **Save Man. File** prompt	(Figure 5.1.1.11) press <enter> to accept **TEST.MAN**. The management filename is automatically added to the management F2 choice list. Press <Esc> when prompted.

Figure 5.1.1.10

```
REVISED WIND EROSION EQUATION
Client: TEST                    Weather File: W\TX23005.DAT
                          Man. File:TEST.MAN
      Soil                Field        EF: 0.51        SCF: 0.6024
                          DOABLE SCREEN
   Date                                                          Period
  Start      Vegetation     Operation/Event  Barrier  K'   K''  V   Erosion
01/01/1990 NONE           NONE                  No   0.00 0.00 0.00    0.0
12/31/1990 NONE           NONE                  No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
                                        Total Erosion (t/ac):          0.0
                        RWEQ 97
      Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Press F9 for Operation/Irrigation Data window or <enter> to continue.
```

Figure 5.1.1.11

```
REVISED WIND EROSION EQUATION
Client: TEST                    Weather File: W\TX23005.DAT
                          Man. File:TEST.MAN
                          Saving Input/Output Files
                     Save Client File:TEST                SCF: 0.6024
                       Save Man. File:TEST.MAN
                     Save Output File:
   Date                                                          Period
  Start      Veg                                  '   K''  V   Erosion
01/01/1990 NONE           NONE                  No   0.00 0.00 0.00    0.0
12/31/1990 NONE           NONE                  No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
                                        Total Erosion (t/ac):          0.0
                        RWEQ 97
      Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Enter the new "client filename" to be saved.
```

At the **`Save Output File`** prompt

press <enter> to exit the **`Saving Input/Output Files`** window. (In this example erosion has not been computed and therefore no output has been generated that needs to be saved.)

5.1.2 **A complex management file using RWEQ**

To illustrate the basic input requirements, a complex management file is created for a three-year rotation of winter wheat, sunflower, and fallow in Akron, Colorado. The soil is a sandy loam; the field is square. This is a dryland system with no barriers or irrigation. Step-by-step instructions are given to create a management file based on the assembled information in Table 5.1.2.1. The same information is available in the RWEQ INPUT FORM shown in Table 5.1.2.2

Table 5.1.2.1

Farmer:		Mahon
Location:		Akron, Colorado
Field:		160 acres, square
Closest weather file:		W\CO24015.DAT (from APPENDIX D)
Soil:		sandy loam
System:		
	9/10/1990	drill winter wheat
	7/01/1991	harvest winter wheat
		2640 lb/acre (44 bu/acre)
		150 stalks in 40" by 40" square (1 meter^2)
	4/15/1992	offset disk
	5/01/1992	straight chisel
	6/01/1992	row plant sunflowers
	10/01/1992	harvest sunflowers
		800 lb/acre
		6 stalks in 40" by 40" square (1 meter^2)
	5/15/1993	disk
	6/15/1993	chisel
	9/10/1993	drill winter wheat

Table 5.1.2.2

RWEQ INPUT FORM

CLIENT: WHSUNFAL WEATHER FILE: W\CO24015.DAT MANAGEMENT FILE: WHSUNFAL.MAN

Soil Properties:
soil texture SANDYLOAM OR sand 64 %
silt 26 %
organic matter 0.5 %
calcium carbonate 3 %
rock cover 0 %

Field Geometry: shape circular or rectangular
area 160, acres
orientation 0, ° from north
length_N 2640, feet
slope gradient 0
slope length 0, feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									IRRIGATION			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
9/10/90	NONE	0		0	WWHEAT	DRILL-HO	Y	0.8	14	2	0	N	50	40							
7/1/91	WWHEAT	2640		150	NONE	HARVEST	N	0	0	0	0	Y	100	90							
4/15/92	WWHEAT	0		0	NONE	DISK-OS	Y	1.9	0	0	0	N	50	15							
5/1/92	WWHEAT	0		0	NONE	CHISEL-STR	Y	1.2	12	2	0	N	70	70							
6/1/92	WWHEAT	0		0	SUNFLOW	PLAN-ROW	Y	0.2	36	2	0	N	90	50							
10/1/92	SUNFLOWER	800		6	NONE	HARVEST	N	0	0	0	0	Y	100	100							
5/15/93	SUNFLOWER	0		0	NONE	DISK-OS	Y	1.9	0	0	0	N	50	15							
6/15/93	SUNFLOWER	0		0	NONE	CHISEL-STR	Y	1.2	12	2	0	N	70	70							
9/10/93	SUNFLOWER	0		0	WWHEAT	DRILL-HO	Y	0.8	14	2	0	N	50	40							

A.	At the **`Client`** prompt	type **WHSUNFAL** and press <enter>.
B.	At the **`Weather File`** prompt	type **W\CO24015.DAT** for the Akron, Colorado weather file.
C.	At the **`Man. File`** prompt	type **WHSUNFAL.MAN.** (Because this is a new management file, a warning screen appears to indicate that the file cannot be found.) See Figure 5.1.2.1. Press <enter> to advance to **`Soil Properties`** window.
D.	At the **`Soil Texture`** prompt	press F2, use the arrow key to highlight *sandy loam* and press <enter> to select. Note that the values for sand, silt, OM, $CaCO_3$, and rock are brought into the screen. The clay remains 100 (the default) until <enter> is pressed and the value 10 is calculated for clay. See Figure 5.1.2.2. Press <enter> five times to accept the default values for a sandy loam and advance through **`Soil Properties`** window.

Figure 5.1.2.1

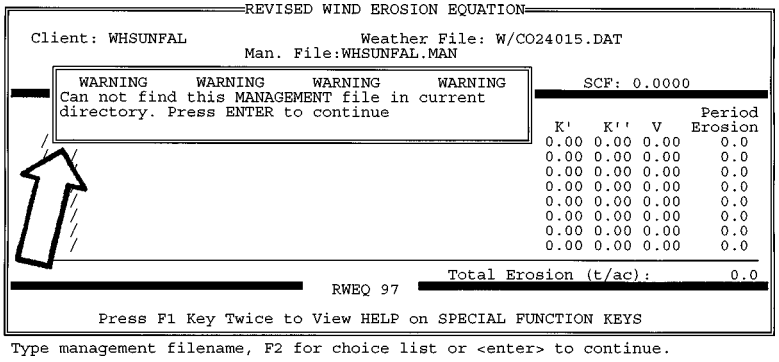
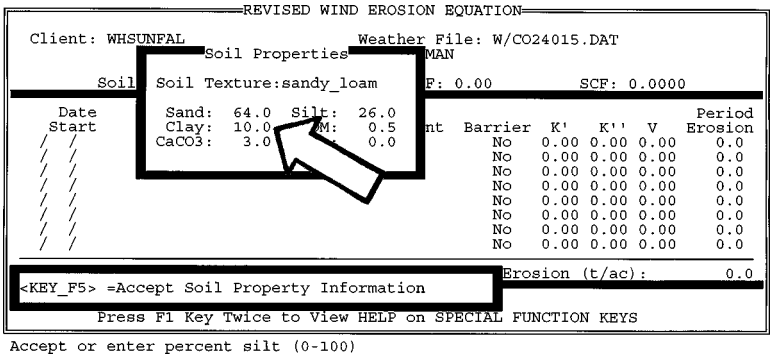


Figure 5.1.2.2

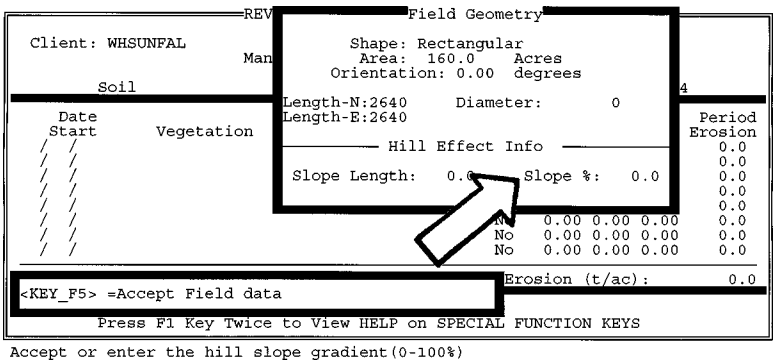


	At the flashing **Soil** prompt	press <enter> to advance to **Field Geometry** window.
E.	At the **Shape** prompt	press F2, use the arrow key if necessary to highlight *rectangular* for the square field, and press <enter> to select.
	At the **Area** prompt	type **160** and press <enter>.
	At the **Orientation** prompt	press <enter> to accept the default value (0.00).
	At the **Length-N** prompt	type **2640** and press <enter>.

Length-E is automatically calculated for a field of a given area when the **Length-N** is entered. The cursor skips directly to **Hill Effect Info**.

At the **Slope Length** prompt	press <enter> to accept the default value (0.0).
At the **Slope %** prompt	(Figure 5.1.2.3) press <enter> to accept the default value (0.0) and exit the **Field Geometry** window.
At the flashing **Field** prompt	press <enter> to advance to **EF**.

Figure 5.1.2.3



F.	At the **EF** prompt	press <enter> to accept the computed value (0.51).

SCF is for information only. It may not be changed. The cursor skips **SCF** and goes directly from **EF** to the **DOABLE SCREEN**.

G.	In the **DOABLE SCREEN** under **Date Start**	type **09 10 1990** .
I.	Under **Vegetation**	press F9 to enter the **Residue and Growing Crop Information** window.

	At the **`Crop`** prompt	press F2, use the arrow key if necessary to highlight *NONE*, and press <enter> to select.
	At the **`Yield`** prompt	press <enter> to accept the default value (0.0).
	At the **`Flat Residue Cover`** prompt	press <enter> to accept the default value (0.0).
	At the **`Stem Number`** prompt	press <enter> to accept the default value (0).
	At the **`Crop Ht.`** prompt	press <enter> to accept the default value (0.00).
	At the **`Harvest Ht.`** prompt	press <enter> to accept the default value (0.00).
	At the **`Crop`** prompt	press F2, use the arrow key if necessary to highlight *G_WWheat*, and press <enter>.
	At the **`Growing Crop`** prompt	(Figure 5.1.2.4) press <enter> to accept Yes and exit the **`Residue and Growing Crop Information`** window.
	At the flashing **`G_WWheat`**	press <enter> to advance to **`Operation/Event`**.
J.	Under **`Operation/Event`**	press F9 to enter the **`Operation/Irrigation Data`** window.
	At the **`Operation`** prompt	press F2 and use the arrow key if necessary to highlight *Drill_HO*. See Figure 5.1.2.5. Press <enter> to select.
	Under **`Operation Modifies Roughness`**	toggle Yes if necessary with space bar and press <enter>.

Figure 5.1.2.4

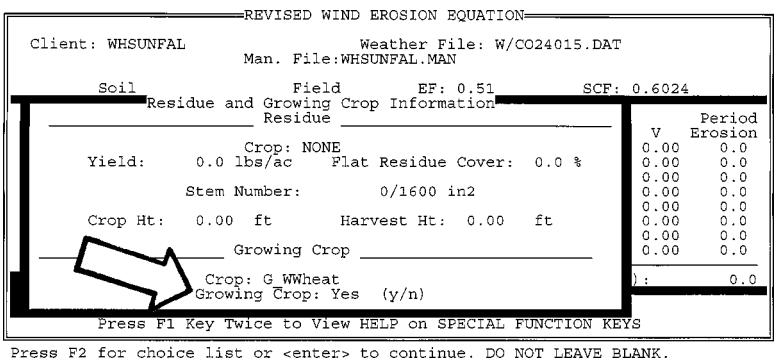
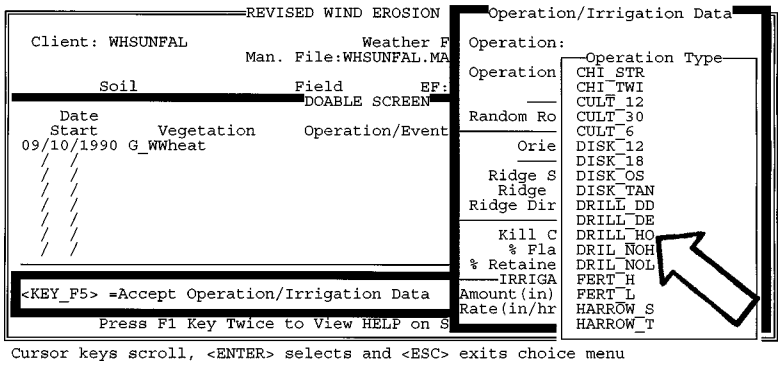
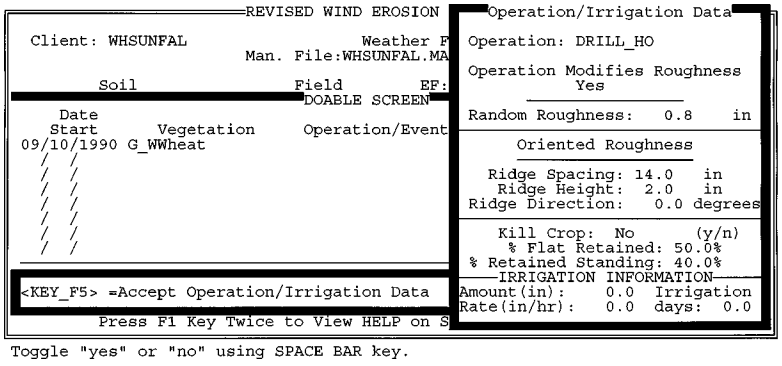


Figure 5.1.2.5



The drill hoe generic values for **`Random Roughness`**, **`Ridge Height`**, and **`% Flat`** are called into the program (Figure 5.1.2.6).

Figure 5.1.2.6



At the **`Random Roughness`** prompt	press <enter> to accept the default value (0.8).
At the **`Ridge Spacing`** prompt	press <enter> to accept the default value (14.0).
At the **`Ridge Height`** prompt	press <enter> to accept the default value (2.0).
At the **`Ridge Direction`** prompt	press <enter> to accept the default value (0.0).
At the **`Kill Crop`** prompt	press <enter> to accept the default value (No).
At the **`% Flat Retained`** prompt	press <enter> to accept the default value (50).

	At the **% Retained Standing** prompt	press <enter> to accept the default value (40).
	For irrigation information	
	At the **Amount (in)** prompt	press <enter> to accept the default value (0.0).
	At the **Rate (in/hr)** prompt	press <enter> to accept the default value (0.0).
	At the **Irrigation days** prompt	press <enter> to accept the default value (0.0) and exit **Operation/Irrigation Data** window.
	At the flashing **DRILL_HO**	press <enter> to advance to **Barrier**.
K.	At the flashing **No** under **Barrier**	press <enter> which finishes the first line in the **DOABLE SCREEN.**
L.	For the second line in the **DOABLE SCREEN**	
	Under **Date Start**	type **07 01 1991** .
M.	Under **Vegetation**	press F9 to enter the **Residue and Growing Crop Information** window.
	At the **Crop** prompt	press F2 and use the arrow key if necessary to highlight *R_WWheat*. See Figure 5.1.2.7. Press <enter>.
	At the **Yield** prompt	type **2640** and press <enter>.
	At the **Flat Residue Cover** prompt	press <enter> to accept the default value (0.0).
	At the **Stem Number** prompt	type **150** and press <enter>.
	At the **Crop Ht.** prompt	press <enter> to accept the default value (2.0).
	At the **Harvest Ht.** prompt	press <enter> to accept the default value (0.8).
	At the **Crop** prompt	press F2, use the arrow key if necessary to highlight *NONE*, and press <enter> to select.
	At the **Growing Crop** prompt	(Figure 5.1.2.8) press <enter> to accept No and exit **Residue and Growing Crop Information** window.
	At the flashing **R_WWheat**	press <enter> to advance to **Operation/Event**.

Figure 5.1.2.7

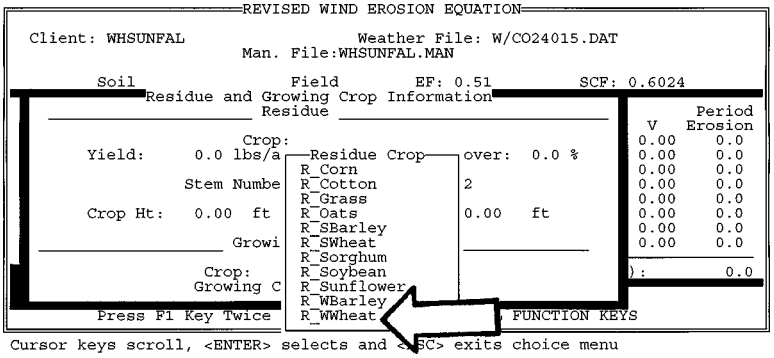
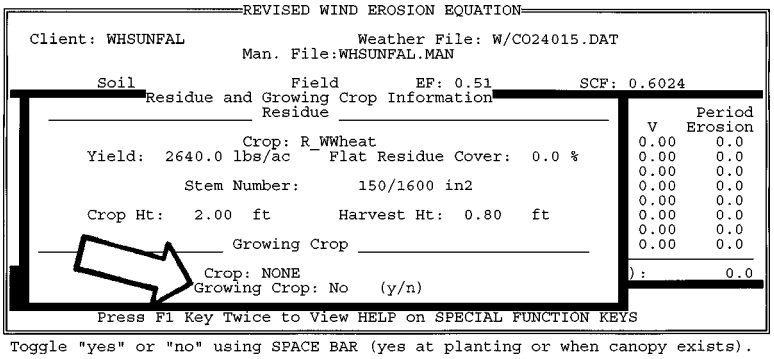
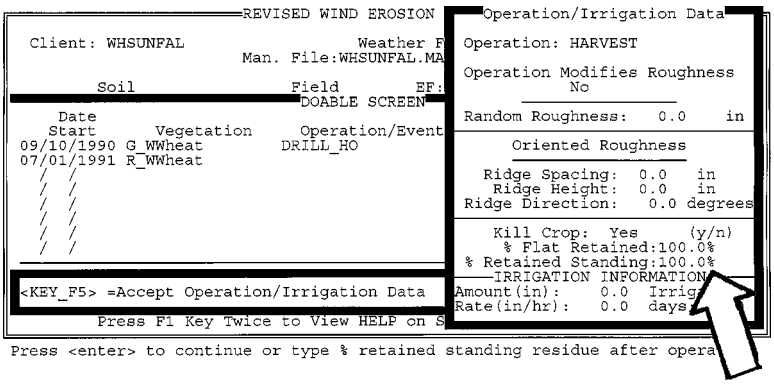


Figure 5.1.2.8



N.	Under **`Operation/Event`**	press F9 to enter the **`Operation/Irrigation Data`** window.
	At the **`Operation`** prompt	press F2, use the arrow key if necessary to highlight *Harvest*, and press <enter> to select.
	Under **`Operation Modifies Roughness`**	toggle No with space bar and press <enter>.
	At the **`Random Roughness`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Spacing`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Height`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Direction`** prompt	press <enter> to accept the default value (0.0).
	At the **`Kill Crop`** prompt	toggle Yes with space bar and press <enter>.
	At the **`% Flat Retained`** prompt	press <enter> to accept the default value (100).
	At the **`% Retained Standing`** prompt	press <enter> to accept the default value (100). (Figure 5.1.2.9)

Figure 5.1.2.9



	For irrigation information	
	At the **Amount (in)** prompt	press <enter> to accept the default value (0.0).
	At the **Rate (in/hr)** prompt	press <enter> to accept the default value (0.0).
	At the **Irrigation days** prompt	press <enter> to accept the default value (0.0).
	From the flashing **HARVEST**	press <enter> to advance to **Barrier**.
O.	At the flashing **No** under **Barrier**	press <enter> which finishes the second line in the **DOABLE SCREEN**.
P.	For the third line in the **DOABLE SCREEN**	
	Under **Date Start**	type **04 15 1992** .
Q.	Under **Vegetation**	press F9 to enter the **Residue and Growing Crop Information** window.
	At the **Crop** prompt	press F2, use the arrow key if necessary to select *R_WWheat*, and press <enter> to select.
	At the **Yield** prompt	press <enter> to accept the default value (0.0). (Only show yield when crop is harvested.)
	At the **Flat Residue Cover** prompt	press <enter> to accept the default value (0.0).
	At the **Stem Number** prompt	press <enter> to accept the default value (0.0).
	At the **Crop Ht.** Prompt	press <enter> to accept the default value (2.0).
	At the **Harvest Ht.** prompt	press <enter> to accept the default value (0.80).
	At the **Crop** prompt	press F2 and use the arrow key to select *NONE*. Press <enter>.
	At the **Growing Crop** prompt	(Figure 5.1.2.10) press <enter> to accept No and exit **Residue and Growing Crop Information** window.
	At the flashing **R_WWheat**	press <enter> to advance to **Operation/Event**.

Figure 5.1.2.10

```
REVISED WIND EROSION EQUATION
Client: WHSUNFAL                    Weather File: W/CO24015.DAT
                          Man. File:WHSUNFAL.MAN
Soil                Field        EF: 0.51          SCF: 0.6024
Residue and Growing Crop Information
                    Residue                                          Period
                                                              V    Erosion
                  Crop: R_WWheat                              0.00     0.0
Yield:     0.0 lbs/ac   Flat Residue Cover:  0.0 %            0.00     0.0
                                                              0.00     0.0
           Stem Number:        0/1600 in2                     0.00     0.0
                                                              0.00     0.0
Crop Ht:   2.00  ft       Harvest Ht:  0.80   ft              0.00     0.0
                                                              0.00     0.0
                   Growing Crop                               0.00     0.0
                  Crop: NONE                                  ):       0.0
                Growing Crop: No   (y/n)
Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Toggle "yes" or "no" using SPACE BAR (yes at planting or when canopy exists).
```

R.	Under **`Operation/Event`**	press F9 to enter the **`Operation/Irrigation Data`** window.
	At the **`Operation`** prompt	press F2, use the arrow key if necessary to highlight *Disk_OS*, and press <enter> to select.
	Under **`Operation Modifies Roughness`**	toggle Yes with space bar and press <enter>.
	At the **`Random Roughness`** prompt	press <enter> to accept the default value (1.9).
	At the **`Ridge Spacing`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Height`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Direction`** prompt	press <enter> to accept the default value (0.0).
	At the **`Kill Crop`** prompt	toggle No with space bar and press <enter>.
	At the **`% Flat Retained`** prompt	press <enter> to accept the default value (50).
	At the **`% Retained Standing`** prompt	press <enter> to accept the default value (15).
	For irrigation information	
	At the **`Amount (in)`** prompt	press <enter> to accept the default value (0.0).
	At the **`Rate (in/hr)`** prompt	press <enter> to accept the default value (0.0).
	At the **`Irrigation days`** prompt	(Figure 5.1.2.11) press <enter> to accept the default value (0.0) and exit the **`Operation/Irrigation Data`** window.
	At the flashing **`DISK_OS`**	press <enter> to advance to **`Barrier`**.
S.	At the flashing **`No`** under **`Barrier`**	press <enter> which finishes the third line in the **`DOABLE SCREEN`**.

Figure 5.1.2.11

```
REVISED WIND EROSION                          Operation/Irrigation Data
Client: WHSUNFAL                  Weather F   Operation: DISK_OS
                        Man. File:WHSUNFAL.MA
                                              Operation Modifies Roughness
      Soil                Field        EF:          Yes
                          DOABLE SCREEN
   Date                                       Random Roughness:   1.9    in
  Start      Vegetation     Operation/Event
09/10/1990 G_WWheat        DRILL_HO                Oriented Roughness
07/01/1991 R_WWheat        HARVEST
04/15/1992 R_WWheat                             Ridge Spacing:  0.0   in
  /  /                                            Ridge Height:  0.0   in
  /  /                                         Ridge Direction:   0.0 degrees
  /  /
  /  /                                          Kill Crop:  No      (y/n)
  /  /                                            % Flat Retained: 50.0%
                                              % Retained Standing: 15.0%
                                                IRRIGATION INFORMATION
<KEY_F5> =Accept Operation/Irrigation Data    Amount(in):    0.0  Irrigation
                                              Rate(in/hr):   0.0  days:  0.0
      Press F1 Key Twice to View HELP on S
Press <enter> to continue or type # of irrigation days since last operation.
```

Enter the next 6 lines using information in Table 5.1.2.1. Accept the default values in the F9 screens. Since there are no coefficients for growing sunflowers, use growing cotton for 06/01/1992. Enter the sunflower yield and stem number for 10/01/1992. On this same date remember to toggle “No” that harvest does not modify roughness and toggle “Yes” that harvest does kill the crop.

To calculate erosion press F10 and press <enter> to select highlighted *Compute Erosion*. Press the <Esc> key when prompted. Only 8 lines are shown in the **DOABLE SCREEN** at one time. Use the arrow keys to scroll up and down to view the K’, K”, V, and Period Erosion for each date. Figure 5.1.2.12 was compiled to show the 9 lines in the management file. Notice the total erosion is 1.5 t/ac or 0.5 t/ac/yr.

Figure 5.1.2.12

```
REVISED WIND EROSION EQUATION
Client: WHSUNFAL                  Weather File: W/CO24015.DAT
                        Man. File:WHSUNFAL.MAN
      Soil                Field        EF: 0.51        SCF: 0.6024
                          DOABLE SCREEN
   Date                                                                Period
  Start      Vegetation     Operation/Event  Barrier  K'   K''  V    Erosion
09/10/1990 G_WWheat        DRILL_HO            No    0.18 0.14 0.95    0.0
07/01/1991 R_WWheat        HARVEST             No    0.40 0.38 0.00    0.9
04/15/1992 R_WWheat        DISK_OS             No    0.03 0.03 0.04    0.0
05/01/1992 R_WWheat        CHI_STR             No    0.06 0.04 0.09    0.0
06/01/1992 G_Cotton        PLAN_ROW            No    0.50 0.43 0.15    0.3
10/01/1992 R_Sunflower     HARVEST             No    0.74 0.72 0.00    0.0
05/15/1993 R_Sunflower     DISK_OS             No    0.03 0.03 0.05    0.0
06/15/1993 R_Sunflower     CHI_STR             No    0.08 0.05 0.09    0.0
                                          Total Erosion (t/ac):          1.5
                                  RWEQ 97
      Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Accept or enter the operation date (MM/DD/YEAR)
```

To view the Tabular Output press F10, use the arrow key to highlight Tabular Output, and press <enter>. Only 12 periods are shown at one time in the Erosion Computation Summary. Use the arrow keys to scroll up and down to view all 81 periods. The tabular output screens for the entire three-year rotation period were combined for Figure 5.1.2.13. The greatest estimated soil loss occurs immediately after wheat planting. In this system there is no surface residue. The soil roughness was not sufficient to provide complete protection. In this example the rows are oriented N-S (0°). The sunflower planting (Period 46 - June 1, 1992) is the second period with erosion. The seedbed is prepared to have good soil-seed contact which may leave the soil in its most erodible condition. Fortunately for Akron, Colorado, this does not coincide with the highest weather factor.

Figure 5.1.2.13

Run Menu — REVISED WIND EROSION EQUATION

Erosion Computation Summary

Pd	Start Date	Days	E t/ac	CSL t/ac	Qmax lbs/ft	S ft	WF	K'	K''	V	S
1	09/10/1990	15	0.89	1.3	51.4	571	55.2	0.175	0.142	0.953	0
2	09/25/1990	15	0.00	0.0	4.2	0	43.4	0.191	0.161	0.099	0
3	10/10/1990	15	0.00	0.0	0.2	0	43.4	0.207	0.178	0.009	0
4	10/25/1990	15	0.00	0.0	0.2	0	83.4	0.221	0.195	0.003	0
5	11/09/1990	15	0.00	0.0	0.2	0	83.4	0.237	0.211	0.003	0
6	11/24/1990	15	0.00	0.0	0.1	0	63.9	0.227	0.228	0.003	0
7	12/09/1990	15	0.00	0.0	0.1	0	63.9	0.231	0.232	0.003	0
8	12/24/1990	15	0.00	0.0	0.1	0	63.9	0.236	0.237	0.003	0
9	01/08/1991	15	0.00	0.0		0	38.8	0.237	0.238	0.003	0
10	01/23/1991	15	0.00	0.0		0	38.8	0.239	0.240	0.003	0
11	02/07/1991	15	0.00	0.0	0.1	0	54.5	0.255	0.231	0.003	0
12	02/22/1991	15	0.00	0.0	0.4	0	131.2	0.257	0.258	0.003	0
13	03/09/1991	15	0.00	0.0	0.4	0	131.2	0.272	0.273	0.003	0
14	03/24/1991	15	0.00	0.0	0.4	0	131.2	0.288	0.288	0.003	0
15	04/08/1991	15	0.00	0.0	0.2	0	118.4	0.316	0.295	0.003	0
16	04/23/1991	15	0.00	0.0	0.3	0	118.4	0.332	0.312	0.003	0
17	05/08/1991	15	0.00	0.0	0.1	0	66.6	0.348	0.330	0.003	0
18	05/23/1991	15	0.00	0.0	0.1	0	66.6	0.363	0.347	0.003	0
19	06/07/1991	15	0.00	0.0	0.1	0	45.6	0.378	0.363	0.003	0
20	06/22/1991	9	0.00	0.0		0	27.3	0.387	0.373	0.003	0
21	07/01/1991	6	0.00	0.0		0	15.6	0.399	0.385	0.000	1
22	07/07/1991	15	0.00	0.0		0	39.1	0.427	0.414	0.000	1
23	07/22/1991	15	0.00	0.0		0	39.1	0.456	0.444	0.000	1
24	08/06/1991	15	0.00	0.0		0	33.3	0.508	0.496	0.000	1
25	08/21/1991	15	0.00	0.0		0	33.3	0.557	0.546	0.000	1
26	09/05/1991	15	0.00	0.0		0	55.2	0.591	0.581	0.000	1
27	09/20/1991	15	0.00	0.0	0.1	0	55.2	0.623	0.614	0.001	1
28	10/05/1991	15	0.00	0.0	0.1	0	43.4	0.636	0.627	0.002	1
29	10/20/1991	15	0.00	0.0	0.1	0	43.4	0.649	0.640	0.002	1
30	11/04/1991	15	0.00	0.0	0.7	0	83.4	0.660	0.652	0.002	1
31	11/19/1991	15	0.00	0.0	0.8	0	83.4	0.671	0.663	0.002	1
32	12/04/1991	15	0.00	0.0	0.5	0	63.9	0.670	0.670	0.002	1
33	12/19/1991	15	0.00	0.0	0.5	0	63.9	0.673	0.674	0.002	1
34	01/03/1992	15	0.00	0.0	0.3	0	38.8	0.674	0.674	0.003	1
35	01/18/1992	15	0.00	0.0	0.3	0	38.8	0.675	0.675	0.003	1
36	02/02/1992	15	0.00	0.0	0.5	0	54.5	0.681	0.673	0.003	1
37	02/17/1992	15	0.00	0.0	0.6	0	54.5	0.683	0.675	0.003	1
38	03/03/1992	15	0.00	0.0	2.2	0	131.2	0.689	0.689	0.003	1
39	03/18/1992	15	0.00	0.0	2.6	0	131.2	0.699	0.699	0.004	1
40	04/02/1992	13	0.00	0.0	1.4	0	102.6	0.712	0.705	0.004	1
41	04/15/1992	2	0.00	0.0		0	15.8	0.032	0.032	0.045	1
42	04/17/1992	14	0.00	0.0	0.7	0	110.5	0.036	0.036	0.046	1
43	05/01/1992	1	0.00	0.0		0	4.4	0.064	0.037	0.094	1
44	05/02/1992	15	0.00	0.0	2.0	0	66.6	0.081	0.060	0.099	1
45	05/17/1992	15	0.00	0.0	2.5	0	66.6	0.093	0.074	0.104	1
46	06/01/1992	15	0.33	0.3	16.7	866	45.6	0.500	0.434	0.152	1
47	06/16/1992	15	0.00	0.1	8.8	0	45.6	0.521	0.470	0.077	0
48	07/01/1992	15	0.00	0.0	0.6	0	39.1	0.554	0.518	0.009	0
49	07/16/1992	15	0.00	0.0		0	39.1	0.582	0.553	0.002	0
50	07/31/1992	15	0.00	0.0		0	33.3	0.629	0.607	0.000	0
51	08/15/1992	15	0.00	0.0		0	33.3	0.671	0.653	0.000	0
52	08/30/1992	15	0.00	0.0		0	55.2	0.699	0.684	0.000	0
53	09/14/1992	15	0.00	0.0		0	55.2	0.725	0.711	0.000	0
54	09/29/1992	2	0.00	0.0		0	7.4	0.728	0.715	0.000	0
55	10/01/1992	13	0.00	0.0		0	37.6	0.737	0.724	0.000	1
56	10/14/1992	15	0.00	0.0		0	43.4	0.747	0.735	0.000	1
57	10/29/1992	15	0.00	0.0	0.1	0	83.4	0.756	0.745	0.000	1
58	11/13/1992	15	0.00	0.0	0.1	0	83.4	0.764	0.754	0.000	1
59	11/28/1992	15	0.00	0.0		0	63.9	0.761	0.762	0.000	1
60	12/13/1992	15	0.00	0.0		0	63.9	0.764	0.764	0.000	1
61	12/28/1992	15	0.00	0.0		0	38.8	0.764	0.765	0.000	1
62	01/12/1993	15	0.00	0.0		0	38.8	0.765	0.766	0.000	1
63	01/27/1993	15	0.00	0.0		0	54.5	0.772	0.762	0.000	1
64	02/11/1993	15	0.00	0.0		0	54.5	0.773	0.763	0.000	1
65	02/26/1993	15	0.00	0.0	0.1	0	131.2	0.776	0.776	0.000	1
66	03/13/1993	15	0.00	0.0	0.1	0	131.2	0.784	0.784	0.000	1
67	03/28/1993	15	0.00	0.0	0.1	0	118.4	0.797	0.788	0.000	1
68	04/12/1993	15	0.00	0.0	0.1	0	118.4	0.805	0.796	0.000	1
69	04/27/1993	15	0.00	0.0		0	66.6	0.812	0.804	0.000	1
70	05/12/1993	3	0.00	0.0		0	13.3	0.813	0.806	0.000	1
71	05/15/1993	12	0.00	0.0	0.2	0	53.3	0.035	0.035	0.045	1
72	05/27/1993	15	0.00	0.0	0.2	0	45.6	0.039	0.039	0.045	1
73	06/11/1993	4	0.00	0.0		0	12.1	0.041	0.041	0.045	1
74	06/15/1993	11	0.00	0.0	0.8	0	33.4	0.077	0.054	0.092	1
75	06/26/1993	15	0.00	0.0	1.5	0	39.1	0.099	0.081	0.092	1
76	07/11/1993	15	0.00	0.0	1.9	0	39.1	0.120	0.104	0.092	1
77	07/26/1993	15	0.00	0.0	1.7	0	33.3	0.162	0.147	0.092	1
78	08/10/1993	15	0.00	0.0	2.3	0	33.3	0.209	0.194	0.092	1
79	08/25/1993	15	0.00	0.1	6.8	0	55.2	0.245	0.230	0.092	1
80	09/09/1993	1	0.00	0.0	0.2	0	3.7	0.248	0.233	0.092	1
81	09/10/1993	0	0.00	0.0	0.0	0	0.0	0.000	0.000	0.000	0

Total Erosion (t/ac): 1.5

KEY_ESC= Exit Period Info Display

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

5.1.3 **A management file using the DOS editor**

Figure 5.1.3.1 shows the first 2 operation dates in the management file (WHSUNFAL.MAN) which was created using RWEQ in Section 5.1.2. A # sign precedes a comment line. The program does not use a comment line; it is for information only. The first 3 lines in a management file give the creation date and time and the filename. The data for each operation are grouped under each operation date. Since the file in this figure was created by RWEQ, there are 6 decimal places for the variables. ("Flags" are either 0 or 1.) When creating a file in DOS, 6 decimal places are not necessary. It is important to begin each line with a + and to separate variables by at least one space.

Figure 5.1.3.1

```
#File Creation Date: 06/24/97
#File Creation Time: 22:30:40
#New Management File   : WHSUNFAL.MAN


09/10/1990
+	DRILL_HO
+	G_WWheat
+	NONE	0.000000	0.000000	0.000000	0.000000	0.000000
+	0.000000	0.000000	0.000000
+	40.000000	50.000000
+	0.000000	0.000000	0.000000
+	0.000000	0.000000	0.000000
+	1	0.800000	14.000000	2.000000	0.000000
+	0	1	0.463000	-1577.340000
+	0.000000	0.000000	0.000000	0.000000
+	0.000000	0.000000	0.000000
+	64.000000	26.000000	0.500000	3.000000	0.000000
+	1	160.000000	0.000000	2640.000000	0.000000	0.000000

07/01/1991
+	HARVEST
+	NONE
+	R_WWheat	2640.000000	0.000000	900.000000	2.190000	2.000000
+	150.000000	0.800000	0.200000
+	90.000000	100.000000
+	0.001300	0.013000	0.169000
+	-0.000660	1.000000	17.000000
+	0	0.000000	0.000000	0.000000	0.000000
+	1	0	0.000000	0.000000
+	0.000000	0.000000	0.000000	0.000000
+	0.000000	0.000000	0.000000
```

Instructions follow to create this shortened file by using the DOS editor. To avoid confusion this new file is called TEST_DOS.MAN. From the C:\RWEQ97> prompt type **EDIT TEST_DOS.MAN** to enter the DOS editor.

The bold face characters in the following explanation are the actual lines in the first operation in WHSUNFAL.MAN. Type these bolded values in the DOS editor. (Remember to separate variables by one or more spaces.) The data comes from the RWEQ INPUT FORM (Figure 5.1.2.1), APPENDICES B-1, B-2, and C-1.

#File Creation Date: 06/24/97 This is the date the file was created and is automatically a part of a management file created in the RWEQ program.

#File Creation Time: 22:30:40 This is the time file was created and is automatic when the file is created within RWEQ.

#New Management File: WHSUNFAL.MAN The filename should reflect the system being studied.

Enter the date of tillage, harvesting, or planting operation.
09/10/1990

Enter the tillage, harvesting, or planting operation indicated on the RWEQ INPUT FORM. (If none, type NONE.)
+ **DRILL_HO**

Enter the name of the crop planted or growing. (If none, type NONE.)
+ **G_WWheat**

Enter residue type, crop yield, percent flat residue cover if residues of a previous crop are on the soil at harvest, biomass intercept at zero yield (y_a), biomass slope (y_b) and crop height before harvest. Generic values are listed in APPENDIX B-1.

	Residue type	Yield (lbs/ac)	% Flat Residue Cover	y_a	y_b	Crop Height (ft)
+	**NONE**	**0**	**0**	**0**	**0**	**0**

Crop information is needed to estimate plant silhouette. Enter the number of stems per 40" by 40" area or an equivalent length of row or take the plant population per acre divided by 3920. Enter the after harvest height and average stem diameter in inches. Generic values are listed in APPENDIX B-1.

	Stem Number	Harvest Height	Stem Diameter
+	**0**	**0.0**	**0.0**

Enter the percent of the standing residue that remains standing after the operation (*e.g.* % Standing = 100 means that all residue remained standing). Enter the % of the flat residue that remains after the operation (*e.g.* % Flat retained = 100 means that *no* residue was buried). Generic values are listed in APPENDIX C-1.

	% Standing retained	% Flat retained
+	**40**	**50**

Enter on the next two lines the crop residue decomposition coefficients used to estimate residue decay. Generic values are listed in APPENDIX B-1.

	k_{ms}	k_{mf}	k_{sn}
+	**0**	**0**	**0**

	mcf	tof	dd_o
+	**0**	**0**	**0**

If an operation modifies soil roughness, the roughness flag entered should be one (1). The soil random roughness, ridge spacing, ridge height, and ridge direction are generic values that can be modified to fit specific conditions.

	Roughness Flag	Random Roughness (in)	Spacing (in)	Height (in)	Direction (deg)
+	**1**	**0.80**	**14**	**2**	**0**

For a harvest operation, plant growth is terminated and the residue decomposition routine is initialized. Harvesting sets the Kill Flag to 1 (all other operations set kill flag to 0). Planting sets the Gr_Plant Flag to 1 which initializes the crop canopy development program. The *pgca* and *pgcb* values are crop canopy growth parameters (APPENDIX B-2).

	Kill Flag	Gr_Plant Flag	pgca	pgcb
+	**0**	**1**	**0.4630**	**-1577.34**

When wind barriers are a part of the wind erosion control system, the height, spacing, density index, and orientation of the barrier are entered. If there are no barriers, set values to zero.

	Height (ft)	Spacing (ft)	Density Index	Orientation (deg)
+	**0**	**0.0**	**0.0**	**0.0**

When irrigation is a part of the management system, the amount, rate, and number of irrigations between operation dates must be input. If there is no irrigation, enter zeroes.

	Irrigation Rate (in/hr)	Irrigation Amount (in)	Number of Irrigation Days
+	**0.0**	**0.0**	**0**

The following two lines of soil and field information are input *for the first operation only*. There are 13 lines of data after the *first* operation date. *For subsequent operations* in the same management file there is no need to repeat the soil and field information; therefore, there are only 11 lines of data after later operation dates.

Sand, Silt, Organic Matter, and $CaCO_3$ must be entered. (RWEQ calculates percent clay.) These values are on the RWEQ INPUT FORM.

	% Sand	% Silt	% Organic Matter	% $CaCO_3$	Rock Cover
+	**64.0**	**26.0**	**0.5**	**3.0**	**0.0**

The characteristics of the field are identified as the shape, size, and orientation. Other shapes besides circular and rectangular may be added in future versions of RWEQ. In version 97, a "1" is used for a rectangular field, and a "0" for a circle. N-Length is the distance across the field from north to south borders. If a hill is present, the height and slope of the hill are included.

	Shape	Area (ac)	Orientation (deg)	N-Length (ft)	Hill Height (ft)	Hill Slope (%)
+	**1**	**160**	**0.0**	**2640**	**0.0**	**0.0**

This ends the input for the first operation date.

When all entries have been made, save the file by selecting SAVE from the FILE menu (press ALT, F, and S). Select EXIT from the FILE menu to exit the editor (press ALT, F and X). The file is saved as TEST_DOS.MAN.

5.1.4 **Deleting or inserting a line in a management file**

To insert a new data line within an existing saved management file while in the **DOABLE SCREEN**, move the cursor to the *"date start" column* of the line that should *follow* the new date. Press Shift-F5. RWEQ creates a blank line with a date which duplicates the date on the next line. Type over the date and complete the vegetation, operation, and barrier inputs.

To delete a line of data from an existing saved management file while in the **DOABLE SCREEN**, move the cursor to the *"date start" column* of the line to be deleted. Press Shift-F6. WARNING: When a line is deleted, the original management file is immediately overwritten. To protect this file -*before deleting a line*- use the F6 key to duplicate the management file under a new name. Go back to the **Man. File** prompt in the main screen and type this new name. Advance to the **DOABLE SCREEN**, make the desired deletion and calculate erosion.

5.2 WEATHER

The quality of the erosion estimates from RWEQ is directly proportional to the quality of the input data. While all input data are important, it is extremely important that good weather data are used to estimate erosion.

5.2.1 What is a weather file?

A weather file contains parameters that describe the wind speed distributions, wind directions, air temperatures, solar radiation, snow cover and rainfall data for each month. The RWEQ program identifies time periods from the management file, then computes the wind factor, rainfall, etc. for that time interval. The wind factor is adjusted for soil wetness and snow cover to produce the weather factor.

5.2.2 Sources of weather files

The weather data for RWEQ are extracted from weather data files assembled by Skidmore and Tatarko. The basic weather file consists of an identification line and 18 lines of data. Weather files may be edited in the DOS editor. The original file for Lubbock, Texas (TX23042.DAT) with an explanation for each line is in Table 5.2.2.

5.2.2.1 **Line 1:** Includes starting mark # , a unique WBAN number associated with this WERIS (Wind Energy Resource Information System) site, the country, state, and city or name of site.

5.2.2.2 **Line 2:** Latitude, longitude, and elevation (in meters) of site or field. This line also includes beginning and ending record dates (year/mo/day) and a three-letter code. For example, ARW means 24 observations each day, rooftop anemometer location, and the Weather Service as the recording agency.

A Number of observations each day

A	24	E	4
B	19-23	F	<3
C	12-18	G	>24
D	5-11	U	Unknown

R Anemometer location

R	Rooftop	E	Estimated wind, no anemometer
G	Ground-mast	O	Other
B	Beacon- tower	U	Unknown

W Recording Agency

A	Air Force	W	Weather Service
D	USDA	F	FAA
E	Expt Station	O	Other
N	Navy	U	Unknown

Fryrear, D.W., Ali Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, and T.M. Zobeck. 1998. Revised Wind Erosion Equation (RWEQ). Wind Erosion and Water Conservation Research Unit, USDA-ARS, Southern Plains Area Cropping Systems Research Laboratory. Technical Bulletin No. 1. Internet address: http://www.csrl.ars.usda.gov/wewc/rweq.htm

5.2.2.3 **Line 3:** Weibull scale parameter, *c* (m/sec). Wind speeds were recorded at different heights but were adjusted to a standard height of 10 meters in the WERIS (Wind Energy Resource Information System) files. For complete instructions see Skidmore and Tatarko (1990)(APPENDIX-Q).

5.2.2.4 **Line 4:** Weibull shape parameter, *k* (dimensionless). For complete instructions see Skidmore and Tatarko (1990)(APPENDIX-Q).

5.2.2.5 **Line 5:** Air density (kg/m^3) (Weast, 1986).

$$\rho = 348.0 \frac{(1.013 - 0.1183\,EL + 0.0048\,EL^2)}{T} \qquad \textbf{[1]}$$

where

ρ = air density, kg/m^3
EL = site elevation, kilometers
T = absolute temperature, degrees Kelvin.

5.2.2.6 **Line 6:** Prevailing erosive wind direction (degrees). Wind direction where the parallel wind forces are maximum and perpendicular wind forces are minimum. For complete instructions see Skidmore (1965).

5.2.2.7 **Line 7:** Preponderance in the prevailing wind direction. This is a ratio of the parallel/ perpendicular wind forces. A value of 1 means no prevailing direction, a value of 4 means the wind forces parallel are four times greater than the wind forces perpendicular to this direction. For complete instructions see Skidmore (1965). For each time period wind force in 4 directions is used to compute soil erosion for each direction.

5.2.2.8 **Line 8:** Positive parallel ratio is the ratio of the magnitude of wind forces in the prevailing wind direction to the forces parallel but from the opposite direction. For complete instructions see Skidmore (1965).

5.2.2.9 **Line 9:** Percent of calm time (no wind). Whenever the wind speed at a height of 10 meters is less than 0.995 m/sec, it is assumed calm or no wind. For derivation description see Skidmore and Tatarko (1990)(APPENDIX-Q).

5.2.2.10 **Line 10:** Average maximum temperature (degrees C). The maximum daily temperatures for a month are averaged. Maximum and minimum temperatures are used to compute the potential evapotranspiration (ET_p) which is used to compute soil wetness.

5.2.2.11 **Line 11:** Average minimum temperature (degrees C). The minimum daily temperatures for a month are averaged.

5.2.2.12 **Line 12:** Dew point is the temperature at which air moisture condenses on a cool body (degrees C). Obtained from CLIGEN databases (Nicks and Lane, 1989). Dew point is not used in RWEQ97 but may be used in subsequent versions.

5.2.2.13 **Line 13:** Solar radiation (Mj/m^2) is normally measured or obtained from CLIGEN databases (Nicks and Lane, 1989). Solar radiation is used to compute ET_p to quantify the effect of soil wetness on wind erosion. Values are accumulated for each time period.

5.2.2.14 **Line 14:** Precipitation (mm) is a total for each month. The number of rain-days and average maximum and minimum temperatures are used to compute decomposition days to describe plant residue decay.

5.2.2.15 **Line 15:** *DPPT* is the average number of days during the time period having measurable precipitation. It is determined from rainfall data or computed from a program developed by Hanson, Cumming, Woolhiser, and Richardson (personal communication). *DPPT* is used in RWEQ97 to compute residue decomposition and soil wetness.

5.2.2.16 **Line 16:** The probability of snow depth more than 25.4 mm is determined from maps (Dickson and Posey, 1967). Snow cover (*SC*) = 1 - probability of snow depth>25.4 mm

5.2.2.17 **Line 17:** Rainfall erosive energy (*EI*) in (Mj-mm/ha-h) is computed from recording rain gauge data or monthly distribution computed from annual *EI* value using Brown and Foster (1987) procedures. *EI* for each time period is used to determine soil roughness decay.

5.2.2.18 **Line 18:** Data line is reserved for future use.

5.2.2.19 **Line 19:** Latitude, longitude and distance from weather station to the WERIS site. Also includes state and city, and station code (WB - weather bureau, AP - airport). This information is not used in this version of RWEQ.

Table 5.2.2. Typical weather data file with key. For index to weather files see APPENDICES D1-D5.

```
1   # 23042 USA TX LUBBOCK
2   33 39 N 101 50 W 990 19500628 19641231 ARW
3   6.26  7.15  7.62  7.52  7.28  7.01  5.88  5.14  5.57  5.77  6.15  6.32
4   2.62  2.66  2.60  2.73  2.84  3.04  2.90  3.15  2.96  2.84  2.68  2.53
5   1.14  1.13  1.11  1.09  1.07  1.05  1.05  1.05  1.07  1.09  1.12  1.14
6     23   225   292   225   202   180   180   180   202    23    23   225
7    1.3   1.3   1.1   1.5   1.4   1.8   2.2   1.7   2.5   2.0   1.5   1.4
8   0.55  0.59  0.93  0.66  0.75  0.83  0.79  0.86  0.56  0.54  0.53  0.59
9    3.3   3.3   3.3   3.3   3.3   3.3   3.3   3.3   3.3   3.3   3.3   3.3
10  11.7  14.4  18.9  23.9  27.8  32.8  33.3  32.8  28.9  23.9  17.2  12.8
11  -3.9  -1.6   1.7   7.2  12.2  17.2  18.9  18.3  14.4   8.3   1.7  -2.8
12  -3.9  -3.3  -2.8   2.8   9.4  13.9  16.1  15.6  12.8   7.2  -0.6  -4.4
13   369   436   614   715   815   858   843   760   672   520   414   354
14    13    15    22    32    70    65    54    54    62    58    15    15
15     2     3     3     3     5     5     5     6     5     3     3     2
16     0     0     0     0     0     0     0     0     0     0     0     0
17     0     0    11    11   154   253   154   154   154   154    44    11
18    .0    .0    .0    .0    .0    .0    .0    .0    .0    .0    .0    .0
19   33  39   N 101  49   W    1.5  TX    LUBBOCK WB AP
```

line#	Item	Meaning
1.	#	Starting mark
	23042	Unique WBAN number associated with this WERIS (Wind Energy Resource Information System) site
	USA	Country
	TX	State
	Lubbock	Name of the site
2.	33 39 N	Latitude of the location (33° 39' N)
	101 50 W	longitude of the location (101° 50' W)
	990	Elevation (m)
	19500628	Beginning record date (YEAR/MONTH/DAY)
	19641231	Ending record date (YEAR/MONTH/DAY)
	ARW	Three letter ID:
		A -- # of observation/day
		A 24 E 4
		B 19-23 F <3
		C 12-18 G >24
		D 5-11 U unknown
		R -- Anemometer location
		R Roof-top E estimated wind, no anemometer
		G Ground mast O other
		B Beacon tower U unknown
		W -- Recording Agency
		A Air Force W weather service
		D USDA F FAA
		E Expt Station O other
		N Navy U unknown
	90	Annual rainfall erosivity (EI) in English unit (hundreds of foot-tonf-inch/acre-hour). The value is from RUSLE database.
	91	EI distribution curve number in RUSLE database.
3.	6.26 ...	Weibull scale parameter, C (m/s)
4.	2.62 ...	Weibull shape parameter, K
5.	1.14 ...	Air density (kg/m^3)
6.	23 ...	Prevailing wind erosion direction (degree)
7.	1.3 ...	Preponderance in the prevailing wind erosion direction
8.	.55 ...	Positive parallel ratio
9.	3.3 ...	Percent of calm time (no wind)
10.	11.7 ...	Average maximum temperature (°C)
11.	3.9 ...	Average minimum temperature (°C)
12.	-3.9 ...	Dew point
13.	369 ...	Solar radiation (MJ/m^2)
14.	13 ...	Precipitation (mm)
15.	2 ...	DPPT (Avg # of days during period having measurable precipitation)
16.	0 ...	Probability of snow depth over 25.4 (mm)
17.	0 ...	EI value in metric unit (MJ-mm/ha-h). The monthly distribution is calculated based on the cumulative EI distribution (using EI curve number as an index) and the annual EI value.
18.	.0...	Reserved for future use
19.	33 39 N	Latitude of CLIGEN weather station (33° 39' N)
	101 49 W	Longitude of CLIGEN weather station (101° 49' W)
	1.5	Distance (km) from the WERIS site to the weather station
	TX LUBBOCK	State and city where the weather station is located
	WB AP	Station code name (WB-weather bureau, AP-airport)

5.2.3 **Developing a new weather data file**

To assemble a weather file a reliable source of data is needed. This may sound redundant, but it cannot be overemphasized. In developing the wind data files for RWEQ, Dr. Skidmore and Dr. Tatarko took great pains to standardize the anemometer heights and identify the locations of the sensors. The WERIS (Wind Energy Resource Information System) data files are good sources, but the reporting periods may not represent long-term average conditions.

A new weather file can be developed from "scratch", but normally an existing weather file is edited to incorporate site specific or new data. An example of the need for editing a weather file is the use of edited weather files with validation sites management systems to estimate erosion with RWEQ.

Before erosion was computed, the weather data file closest to the validation site was modified to reflect the measured weather conditions at the site for the erosion measurement period. At the validation sites the wind speeds were recorded every minute. Air temperature, humidity, solar radiation, and rainfall were recorded every 10 minutes. Weather files were modified with monthly *c*, *k*, % calm, average maximum and minimum temperatures, solar radiation, precipitation, rain days and the storm erosivity (*EI*) for the time period that the erosion samplers were in the field. The prevailing wind direction, air density, preponderance, positive parallel ratios, snow cover, and dew point temperature in the weather data files were not changed.

The SAS System is used to summarize the weather data. For illustration purposes, wind speed data for May, 1990 from Big Spring, Texas is used to compute the Weibull wind speed coefficients. (See Table 5.2.3.1 for the May weather summary output by the SAS program.) All windspeed values (1440 X 31 = 44,640) from the 2-meter anemometer (*WS4*) are converted to 10-meter wind speeds (*WS10*) using the 1/7 power equation (Elliot, 1979.) The 10-meter wind speeds are used to compute the Weibull shape and scale factors and frequency of calm periods.

The wind speeds were ranked in ascending order (to the nearest 0.1m/sec). The data set begins with the 10-meter wind speed greater than but as close to 1 as possible. (See Table 5.2.3.2 for SAS output generated by PROC FREQ.) Wind speeds less than 1 m/s are considered calm. The cumulative percent (F_0) at this wind speed is 3.35 in Table 5.2.3.2. The percent of the total observations that occurred in each wind speed class was calculated. The cumulative frequency and cumulative percent were also calculated.

The cumulative percent for succeeding observations is *F(u)* (Table 5.2.3.2). The last observation in the data set gives the total number of observations in the data set in the cumulative frequency column (44,640 in Table 5.2.3.2 example).

Following the instructions in "Stochastic wind simulation for erosion modeling" (Appendix Q, equations 4-7) the data set is reduced to an *x* and a *y* variable. The *a* and *b* coefficients from a linear regression are used to compute *c* and *k*.

Table 5.2.3.1

USDA-ARS, BIG SPRING, TEXAS

SUMMARY OF BIG SPRING, TEXAS DATA LOGGER
May, 1990

WEIBULL WIND COEFFICIENTS: c=6.62 k=3.05 % calm=3.35

MON	DAY	MAX TEMP C	MIN TEMP C	WIND MAX m/sec	WIND AVG m/sec	FACTOR $(WS-5)^2(WS)$	SENSIT	AVG DIR deg	AVG RH %	TOTAL RAIN mm	EI *	SOLAR RAD cal/cm^2
5	.	42	6	11.2	4.5	401235	53777	169	42	7.4	3.36	18037
5	1	12	8	9.7	6.0	18979	1961	44	84	1.5	0.54	127
5	2	13	7	7.3	3.8	1707	2056	117	90	3.3	0.90	154
5	3	20	6	8.5	3.4	4294	1895	269	67	.	.	502
5	4	21	6	7.3	3.8	1389	1787	199	51	.	.	631
5	5	23	7	7.0	2.4	422	1715	79	44	.	.	615
5	6	26	7	8.4	2.0	102	1737	177	35	.	.	675
5	7	27	14	9.4	5.6	19761	1593	174	29	.	.	618
5	8	34	14	9.0	5.3	13279	1677	210	43	.	.	673
5	9	26	13	9.3	5.0	15150	1560	116	38	.	.	677
5	10	21	9	7.8	4.5	4276	1594	92	32	.	.	399
5	11	33	14	10.1	4.3	8637	1608	190	44	.	.	524
5	12	31	12	7.1	2.7	235	1677	240	35	.	.	702
5	13	36	16	9.9	4.8	21978	1699	147	21	.	.	654
5	14	38	21	10.4	5.2	28076	1799	187	38	.	.	646
5	15	37	23	11.2	6.3	37835	1735	193	44	.	.	577
5	16	33	19	9.7	4.4	16393	1733	227	31	.	.	711
5	17	27	14	9.1	5.8	13349	1462	87	48	.	.	429
5	18	31	20	10.7	6.9	71549	1562	179	51	.	.	574
5	19	36	21	9.8	5.2	22312	1707	233	35	.	.	694
5	20	34	18	10.6	5.1	33303	1774	256	11	.	.	701
5	21	30	13	8.2	3.9	5857	1633	93	36	.	.	681
5	22	32	15	6.1	3.2	71	1756	88	41	.	.	683
5	23	36	19	8.9	4.8	10002	1797	140	37	.	.	670
5	24	38	21	10.5	5.2	12202	1791	208	45	.	.	586
5	25	42	23	9.9	4.5	8138	1964	233	28	.	.	624
5	26	38	22	7.0	3.6	439	1976	262	28	.	.	644
5	27	33	17	7.9	4.1	5235	1899	148	27	.	.	693
5	28	28	18	7.8	4.8	3506	1622	76	62	.	.	589
5	29	33	20	10.5	4.7	11897	1422	153	60	2.5	1.92	304
5	30	35	13	7.4	2.9	354	1790	246	32	.	.	715
5	31	36	20	10.8	4.5	10509	1796	167	44	.	.	565

MONTHLY AVERAGES

Max. temp	Min. temp	Max. wind speed
30.3	15.2	8.9

Monthly averages are based on available data.

* The units of EI are megajoule-millimeter/hectare-hour.
. The first line in the table is a summary of the entire table.

Table 5.2.3.2

OUTPUT FROM PROC FREQUENCY for TX 05/1990

WS4	WS10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0.9	1.1	182	0.41	1494	3.35
1.0	1.2	221	0.50	1715	3.84
1.1	1.3	278	0.62	1993	4.46
1.2	1.4	290	0.65	2283	5.11
1.3	1.6	344	0.77	2627	5.88
1.4	1.7	373	0.84	3000	6.72
1.5	1.8	411	0.92	3411	7.64
1.6	1.9	566	1.27	3977	8.91
1.7	2.1	535	1.20	4512	10.11
1.8	2.2	575	1.29	5087	11.40
1.9	2.3	563	1.26	5650	12.66
2.0	2.5	589	1.32	6239	13.98
2.1	2.6	574	1.29	6813	15.26
2.2	2.7	556	1.25	7369	16.51
2.3	2.8	519	1.16	7888	17.67
2.4	3.0	518	1.16	8406	18.83
2.5	3.1	510	1.14	8916	19.97
2.6	3.2	523	1.17	9439	21.14
2.7	3.3	580	1.30	10019	22.44
2.8	3.5	526	1.18	10545	23.62
2.9	3.6	514	1.15	11059	24.77
3.0	3.7	541	1.21	11600	25.99
3.1	3.8	572	1.28	12172	27.27
3.2	4.0	586	1.31	12758	28.58
3.3	4.1	668	1.50	13426	30.08
3.4	4.2	658	1.47	14084	31.55
3.5	4.3	647	1.45	14731	33.00
3.6	4.5	629	1.41	15360	34.41
3.7	4.6	725	1.62	16085	36.03
3.8	4.7	691	1.55	16776	37.58
3.9	4.8	697	1.56	17473	39.14
4.0	5.0	708	1.59	18181	40.73
4.1	5.1	763	1.71	18944	42.44
4.2	5.2	683	1.53	19627	43.97
4.3	5.3	808	1.81	20435	45.78
4.4	5.5	756	1.69	21191	47.47
4.5	5.6	877	1.96	22068	49.44
4.6	5.7	859	1.92	22927	51.36
4.7	5.8	805	1.80	23732	53.16
4.8	6.0	839	1.88	24571	55.04
4.9	6.1	839	1.88	25410	56.92
5.0	6.2	812	1.82	26222	58.74
5.1	6.4	885	1.98	27107	60.72
5.2	6.5	830	1.86	27937	62.58
5.3	6.6	844	1.89	28781	64.47
5.4	6.7	877	1.96	29658	66.44
5.5	6.9	842	1.89	30500	68.32
5.6	7.0	824	1.85	31324	70.17
5.7	7.1	846	1.90	32170	72.07
5.8	7.2	782	1.75	32952	73.82
5.9	7.4	797	1.79	33749	75.60
6.0	7.5	779	1.75	34528	77.35
6.1	7.6	779	1.75	35307	79.09
6.2	7.7	731	1.64	36038	80.73
6.3	7.9	728	1.63	36766	82.36
6.4	8.0	641	1.44	37407	83.80
6.5	8.1	626	1.40	38033	85.20
6.6	8.2	585	1.31	38618	86.51
6.7	8.4	563	1.26	39181	87.77
6.8	8.5	486	1.09	39667	88.86

OUTPUT FROM PROC FREQUENCY for TX 05/1990

WS4	WS10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
6.9	8.6	460	1.03	40127	89.89
7.0	8.7	433	0.97	40560	90.86
7.1	8.9	393	0.88	40953	91.74
7.2	9.0	347	0.78	41300	92.52
7.3	9.1	346	0.78	41646	93.29
7.4	9.2	298	0.67	41944	93.96
7.5	9.4	304	0.68	42248	94.64
7.6	9.5	254	0.57	42502	95.21
7.7	9.6	240	0.54	42742	95.75
7.8	9.7	236	0.53	42978	96.28
7.9	9.9	203	0.45	43181	96.73
8.0	10.0	175	0.39	43356	97.12
8.1	10.1	158	0.35	43514	97.48
8.2	10.3	136	0.30	43650	97.78
8.3	10.4	132	0.30	43782	98.08
8.4	10.5	104	0.23	43886	98.31
8.5	10.6	98	0.22	43984	98.53
8.6	10.8	96	0.22	44080	98.75
8.7	10.9	84	0.19	44164	98.93
8.8	11.0	68	0.15	44232	99.09
8.9	11.1	57	0.13	44289	99.21
9.0	11.3	63	0.14	44352	99.35
9.1	11.4	44	0.10	44396	99.45
9.2	11.5	36	0.08	44432	99.53
9.3	11.6	42	0.09	44474	99.63
9.4	11.8	22	0.05	44496	99.68
9.5	11.9	30	0.07	44526	99.74
9.6	12.0	18	0.04	44544	99.78
9.7	12.2	18	0.04	44562	99.83
9.8	12.3	21	0.05	44583	99.87
9.9	12.4	12	0.03	44595	99.90
10.0	12.6	3	0.01	44598	99.91
10.1	12.6	10	0.02	44608	99.93
10.2	12.8	6	0.01	44614	99.94
10.3	13.0	3	0.01	44617	99.95
10.4	13.0	8	0.02	44625	99.97
10.5	13.2	3	0.01	44628	99.97
10.6	13.3	3	0.01	44631	99.98
10.7	13.4	1	0.00	44632	99.98
10.8	13.5	3	0.01	44635	99.99
10.9	13.7	3	0.01	44638	100.00
11.2	14.1	2	0.00	44640	100.00

$$F_1(u) = \left[\frac{F(u) - F_0}{1 - F_0} \right] = 1 - e^{-\left(\frac{u}{c}\right)^k} \qquad \textbf{[2]}$$

where

$F(u)$	=	cumulative distribution
$F_1(u)$	=	cumulative distribution with calm periods eliminated
F_0	=	frequency of calm periods (assumed < 1 meter/sec @ 10 meter height)
k	=	Weibull shape parameter, dimensionless
c	=	Weibull scale parameter, m/sec
u	=	wind speed at 10 meters.

Taking the logarithm twice, this equation becomes

$$ln\left[-ln\left(1 - F_1(u)\right)\right] = -k\, ln\, c + k\, ln\, u \qquad \textbf{[3]}$$

This equation may be expressed in linear fashion as

$$y = a + bx \qquad \textbf{[4]}$$

when

y	=	ln [- ln (1 - F_1 (u)]
a	=	- k ln$c$
b	=	k
x	=	ln$u$.

With this equation, the *c* and *k* coefficients can be determined using a standard least square method.

All of the changes made for May in the Big Spring, Texas weather file (Table 5.2.3.3) are bolded in Table 5.2.3.4. The same technique was used for January, February, March, and April in 1990 to complete the modified file, BSTX90.W1 (Table 5.2.3.5).

When all of the new *c*, *k*, % calm, average maximum and minimum temperatures, solar radiation, rain days and storm erosivity values were assembled, modifications to weather files were made in the DOS editor. For example, at the C:\RWEQ97> prompt, type **EDIT W\TX23005.DAT** (Big Spring, Texas WERIS file). Overwrite with updated data, but be sure to leave a space between monthly data on the same line. In the Big Spring, Texas example overwrite the May value for *c* (7.05) with the newly calculated value (6.62) (Figure 5.2.3.4).

After all changes have been made, select SAVE AS from the FILE menu. (Selecting SAVE would overwrite the original file.) Type the name of the new weather file (*e.g.* **W\BSTX90.W1**) (Figure 5.2.3.5) and press <enter>. Select EXIT from the FILE menu to exit the editor.

Table 5.2.3.3. Unmodified WERIS file for Big Spring, Texas (TX23005.DAT).

```
# 23005 USA TX BIG_SPRING
  32 14 N 101 30 W 784 19590507 19701231 AGA  95 91
   5.91  6.50  7.30  7.25  7.05  6.80  5.97  5.52  5.68  5.93  5.83  5.70
   2.13  2.15  2.35  2.47  2.65  2.68  2.82  2.61  2.47  2.26  2.15  2.12
   1.17  1.15  1.13  1.10  1.09  1.08  1.07  1.08  1.09  1.11  1.14  1.16
    247    45   247   225   180   180   180   180   180   180   180   225
    1.3   1.5   1.2   1.0   2.1   5.1   3.7   1.6   3.5   3.6   2.1   1.5
   0.70  0.56  0.71  0.79  0.86  0.93  0.96  0.85  0.75  0.80  0.64  0.60
    8.0   6.6   3.3   3.6   3.2   3.8   4.0   4.7   6.1   7.2   7.8   9.5
   13.6  16.3  20.8  25.9  29.8  33.7  34.7  34.2  30.6  25.7  19.0  15.3
   -1.3   1.1   4.8  10.3  15.2  19.5  21.6  20.9  17.3  11.4   4.5   0.4
   -3.1  -1.3  -1.0   4.0  10.5  14.9  16.0  15.2  13.7   8.5   1.9  -1.6
    378   442   612   699   810   844   845   766   668   527   411   357
     17    15    17    35    76    49    47    45    67    42    16    14
    3.5   3.2   2.7   3.8   6.2   4.6   4.8   5.0   5.5   4.5   2.9   2.7
    0.7   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.5
      0     0    16    16   226   371   226   226   226   226    64    16
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  32 13 N 101 30 W 1.9 TX BIG SPRING WB AP
```

Table 5.2.3.4. WERIS file for Big Spring, Texas with changes for May bolded.

```
# 23005 USA TX BIG_SPRING
  32 14 N 101 30 W 784 19590507 19701231 AGA  95 91
   5.91  6.50  7.30  7.25  6.62  6.80  5.97  5.52  5.68  5.93  5.83  5.70
   2.13  2.15  2.35  2.47  3.05  2.68  2.82  2.61  2.47  2.26  2.15  2.12
   1.17  1.15  1.13  1.10  1.09  1.08  1.07  1.08  1.09  1.11  1.14  1.16
    247    45   247   225   180   180   180   180   180   180   180   225
    1.3   1.5   1.2   1.0   2.1   5.1   3.7   1.6   3.5   3.6   2.1   1.5
   0.70  0.56  0.71  0.79  0.86  0.93  0.96  0.85  0.75  0.80  0.64  0.60
    8.0   6.6   3.3   3.6   3.4   3.8   4.0   4.7   6.1   7.2   7.8   9.5
   13.6  16.3  20.8  25.9  30.3  33.7  34.7  34.2  30.6  25.7  19.0  15.3
   -1.3   1.1   4.8  10.3  15.2  19.5  21.6  20.9  17.3  11.4   4.5   0.4
   -3.1  -1.3  -1.0   4.0  10.5  14.9  16.0  15.2  13.7   8.5   1.9  -1.6
    378   442   612   699   582   844   845   766   668   527   411   357
     17    15    17    35     7    49    47    45    67    42    16    14
    3.5   3.2   2.7   3.8     3   4.6   4.8   5.0   5.5   4.5   2.9   2.7
    0.7   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.5
      0     0    16    16     3   371   226   226   226   226    64    16
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  32 13 N 101 30 W 1.9 TX BIG SPRING WB AP
```

Table 5.2.3.5. Big Spring, Texas WERIS file modified for January to May 1990 with measured data (BSTX90.W1).

```
# 23005 USA TX BIG_SPRING    modified for Big Spring, TX  JAN-MAY  1990
  32 14 N 101 30 W 784 19590507 19701231 AGA  95 91
   5.68  6.07  6.21  5.90  6.62  6.80  5.97  5.52  5.68  5.93  5.83  5.70
   2.11  2.30  2.05  2.00  3.05  2.68  2.82  2.61  2.47  2.26  2.15  2.12
   1.17  1.15  1.13  1.10  1.09  1.08  1.07  1.08  1.09  1.11  1.14  1.16
    247    45   247   225   180   180   180   180   180   180   180   225
    1.3   1.5   1.2   1.0   2.1   5.1   3.7   1.6   3.5   3.6   2.1   1.5
   0.70  0.56  0.71  0.79  0.86  0.93  0.96  0.85  0.75  0.80  0.64  0.60
      5   5.2   5.6   3.4   3.4   3.8   4.0   4.7   6.1   7.2   7.8   9.5
   17.1  18.9  19.6  24.8  30.3  33.7  34.7  34.2  30.6  25.7  19.0  15.3
    0.5   2.6   6.8  10.8  15.2  19.5  21.6  20.9  17.3  11.4   4.5   0.4
   -3.1  -1.3  -1.0   4.0  10.5  14.9  16.0  15.2  13.7   8.5   1.9  -1.6
    294   349   319   474   582   844   845   766   668   527   411   357
     27    44    34    65     7    49    47    45    67    42    16    14
      3     7    10     7     3   4.6   4.8   5.0   5.5   4.5   2.9   2.7
    0.7   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.5
     72   153    86   177     3   371   226   226   226   226    64    16
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
32 13 N 101 30 W 1.9 TX BIG SPRING WB AP
```

A new weather file may be added to the choice list that is accessed in the RWEQ program. At the C:\RWEQ97> prompt, type **EDIT RWEQ.CLS**. Find "*climate"in the listing. (See Section 2.2.4.) At the end of this line press <enter>. Type the name of the new weather file (*e.g.* **BSTX90.W1**). Select SAVE from the FILE menu to save the new version of RWEQ.CLS. Select EXIT from the FILE menu to exit the editor.

5.2.4 Examples of influence of weather on erosion estimates with RWEQ

To illustrate the influence of weather, erosion is calculated using the same management file (TEST.MAN) with 9 different weather files. This management file was created in Section 5.1. It has no crop, no tillage and no barriers; the 10 acre, circular field has a sandy loam soil.

A.	At the **`Client`** prompt	type the filename **TEST** and press <enter> to bring in the TEST.MAN file prompt and the Big Spring, Texas weather file (W\TX23005.DAT).
B.	At the **`Weather File`** prompt	press <enter> to advance.
C.	At the **`Man. File`** prompt	press <enter> to advance.
D.	In the **`Soil Properties`** window	press <enter> 7 times to accept all values in the window and advance to the **`Field Geometry`** prompt.
E.	In the **`Field Geometry`** window	press <enter> 6 times to accept all values in the window.
F.	At the **`Field`** prompt	press <enter> to advance to the **`EF`** prompt.
G.	At the **`EF`** prompt	press <enter> to accept the calculated EF and advance to the **`DOABLE SCREEN`**.
H.	In the **`DOABLE SCREEN`**	press F10 to compute erosion (Figure 5.2.4.1). Select Compute Erosion in the Run Menu window and press <enter>. When computations are complete, press Esc.

Figure 5.2.4.1

```
Run Menu                 REVISED WIND EROSION EQUATION
Compute Erosion
Tabular Output                    Weather File: W\TX23005.DAT
                        Man. File:TEST.MAN

        Soil                Field        EF: 0.51        SCF: 0.6024
                            DOABLE SCREEN
    Date                                                              Period
   Start      Vegetation     Operation/Event  Barrier  K'   K''  V    Erosion
01/01/1990 NONE            NONE                  No   0.00 0.00 0.00    0.0
12/31/1990 NONE            NONE                  No   0.00 0.00 0.00    0.0
  /  /                                           No   0.00 0.00 0.00    0.0
  /  /                                           No   0.00 0.00 0.00    0.0
  /  /                                           No   0.00 0.00 0.00    0.0
  /  /                                           No   0.00 0.00 0.00    0.0
  /  /                                           No   0.00 0.00 0.00    0.0
  /  /                                           No   0.00 0.00 0.00    0.0
                                        Total Erosion (t/ac):          0.0
                          RWEQ 97

        Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Press <enter> to compute erosion or <Esc> to exit.
```

In the **DOABLE SCREEN** notice the 367.2 t/ac total erosion for the period (Figure 5.2.4.2).

Figure 5.2.4.2

REVISED WIND EROSION EQUATION

Client: TEST Weather File: W\TX23005.DAT
Man. File:TEST.MAN

Soil Field EF: 0.51 SCF: 0.6024

DOABLE SCREEN

Date Start	Vegetation	Operation/Event	Barrier	K'	K''	V	Period Erosion
01/01/1990	NONE	NONE	No	1.00	1.00	1.00	0.0
12/31/1990	NONE	NONE	No	1.00	1.00	1.00	367.2
/ /			No	0.00	0.00	0.00	0.0
/ /			No	0.00	0.00	0.00	0.0
/ /			No	0.00	0.00	0.00	0.0
/ /			No	0.00	0.00	0.00	0.0
/ /			No	0.00	0.00	0.00	0.0
/ /			No	0.00	0.00	0.00	0.0

Total Erosion (t/ac): 367.2

RWEQ 97

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Press F9 for Barrier Information window or <enter> to continue.

In the **DOABLE SCREEN** press F10 again. This time select *Tabular Output* in the **Run Menu** window and press <enter>.

The tabular output shows the weather factor (*WF*) for the 24 erosion periods (Figure 5.2.4.3). The weather factor includes the wind factor, air density, acceleration due to gravity, soil wetness, and snow cover.

Figure 5.2.4.3

Run Menu

REVISED WIND EROSION EQUATION

Erosion Computation Summary

Pd	Start Date	Days	E t/ac	CSL t/ac	Qmax lbs/ft	S ft	WF	K'	K''	V	St
1	01/01/1990	15	12.89	5.4	145.2	378	35.3	1.000	1.000	1.000	1
2	01/16/1990	15	12.89	5.4	145.2	378	35.3	1.000	1.000	1.000	1
3	01/31/1990	15	23.72	9.8	227.0	326	62.2	1.000	1.000	1.000	1
4	02/15/1990	15	23.72	9.8	227.0	326	62.2	1.000	1.000	1.000	1
5	03/02/1990	15	38.23	22.1	415.4	263	96.4	1.000	1.000	1.000	1
6	03/17/1990	15	38.23	22.1	415.4	263	96.4	1.000	1.000	1.000	1
7	04/01/1990	15	31.21	17.3	346.0	281	79.0	1.000	1.000	1.000	1
8	04/16/1990	15	31.21	17.3	346.0	281	79.0	1.000	1.000	1.000	1
9	05/01/1990	15	19.65	17.2	346.4	281	53.4	1.000	1.000	1.000	1
10	05/16/1990	15	19.65	17.2	346.4	281	53.4	1.000	1.000	1.000	1
11	05/31/1990	15	15.54	18.4	363.8	276	42.0	1.000	1.000	1.000	1
12	06/15/1990	15	15.54	18.4	363.8	276	42.0	1.000	1.000	1.000	1
13	06/30/1990	15	4.63	3.5	104.7	424	13.5	1.000	1.000	1.000	1
14	07/15/1990	15	4.63	3.5	104.7	424	13.5	1.000	1.000	1.000	1
15	07/30/1990	15	2.58	1.0	41.2	559	9.3	1.000	1.000	1.000	1
16	08/14/1990	15	2.58	1.0	41.2	559	9.3	1.000	1.000	1.000	1
17	08/29/1990	15	4.47	2.5	81.4	459	14.2	1.000	1.000	1.000	1
18	09/13/1990	15	4.47	2.5	81.4	459	14.2	1.000	1.000	1.000	1
19	09/28/1990	15	9.78	7.6	189.0	349	27.7	1.000	1.000	1.000	1
20	10/13/1990	15	9.78	7.6	189.0	349	27.7	1.000	1.000	1.000	1
21	10/28/1990	15	10.62	5.2	142.7	384	30.9	1.000	1.000	1.000	1
22	11/12/1990	15	10.62	5.2	142.7	384	30.9	1.000	1.000	1.000	1
23	11/27/1990	15	9.45	3.2	97.4	428	27.8	1.000	1.000	1.000	1
24	12/12/1990	15	9.45	3.2	97.4	428	27.8	1.000	1.000	1.000	1

Total Erosion (t/ac): 367.2

KEY_ESC= Exit Period Info Display

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Use arrows, <tab>, or <enter> keys to move through screen.

Estimated erosion with weather files from nine different regions of the country are run using this same management file (TEST.MAN). The weather factor (*WF*) and erosion (*E*) for each erosion period for these nine sites are summarized in Tables 5.2.4.1 and 5.2.4.2.

The largest 15 day WF is not in the Great Plains, but is in Kalului, Maui. The WF at Fresno, California is very small.

For these soil, field, and management conditions the weather at Akron, Colorado produced the most erosion; in fact, there is erosion in every time period for Akron, Colorado. Surprisingly, the estimated erosion at Kahului, Maui, Hawaii was next, followed by Big Spring, TX; Goodland, Kansas; Joliet, Illinois; Spokane, Washington; Orlando, Florida; Rome, New York; and Fresno, California. These erosion estimates are based on average weather conditions. Infrequent but exceptional wind events may produce considerable erosion even at Fresno, California.

Table 5.2.4.1 Comparison of weather factors (*WF*) by erosion periods for nine different weather files.

period	start date	CA	CO	FL	HI	IL	KS	NY	TX	WA
1	01/01/1990	0.0	38.8	5.1	13.3	8.5	17.9	0.0	35.3	0.0
2	01/16/1990	0.0	38.8	5.1	13.3	8.5	17.9	0.0	35.3	0.0
3	01/31/1990	0.1	54.5	11.9	9.6	29.0	27.4	0.0	62.2	8.2
4	02/15/1990	0.1	54.5	11.9	9.6	29.0	27.4	0.0	62.2	8.2
5	03/02/1990	0.8	131.2	14.3	21.8	48.3	81.6	4.2	96.4	12.7
6	03/17/1990	0.8	131.2	14.3	21.8	48.3	81.6	4.2	96.4	12.7
7	04/01/1990	1.2	118.4	8.2	41.6	47.1	82.3	14.9	79.0	15.8
8	04/16/1990	1.2	118.4	8.2	41.6	47.1	82.3	14.9	79.0	15.8
9	05/01/1990	1.4	66.6	4.2	66.6	16.1	48.6	6.6	53.4	7.7
10	05/16/1990	1.4	66.6	4.2	66.6	16.1	48.6	6.6	53.4	7.7
11	05/31/1990	1.3	45.6	3.2	100.2	11.4	45.6	2.4	42.0	6.9
12	06/15/1990	1.3	45.6	3.2	100.2	11.4	45.6	2.4	42.0	6.9
13	06/30/1990	0.2	39.1	0.6	98.2	1.9	21.2	0.9	13.5	3.1
14	07/15/1990	0.2	39.1	0.6	98.2	1.9	21.2	0.9	13.5	3.1
15	07/30/1990	0.1	33.3	0.4	81.4	0.8	19.0	0.7	9.3	2.6
16	08/14/1990	0.1	33.3	0.4	81.4	0.8	19.0	0.7	9.3	2.6
17	08/29/1990	0.0	55.2	2.3	59.0	3.7	28.6	0.9	14.2	4.3
18	09/13/1990	0.0	55.2	2.3	59.0	3.7	28.6	0.9	14.2	4.3
19	09/28/1990	0.0	43.4	4.7	38.8	7.9	23.8	2.6	27.7	5.0
20	10/13/1990	0.0	43.4	4.7	38.8	7.9	23.8	2.6	27.7	5.0
21	10/28/1990	0.0	83.4	4.0	15.4	18.7	32.2	0.0	30.9	1.6
22	11/12/1990	0.0	83.4	4.0	15.4	18.7	32.2	0.0	30.9	1.6
23	11/27/1990	0.0	63.9	5.0	10.9	3.7	22.0	0.0	27.8	0.0
24	12/12/1990	0.0	63.9	5.0	10.9	3.7	22.0	0.0	27.8	0.0
25	12/27/1990	0.0	17.0	1.3	2.9	1.0	5.9	0.0	7.4	0.0
Total WF		10.2	1563.8	129.1	1116.5	395.2	906.3	66.4	990.8	135.8

Table 5.2.4.2 Comparison of erosion (*E*) by erosion periods for nine different weather files.

period	start date	CA	CO	FL	HI	IL	KS	NY	TX	WA
1	01/01/1990	0.00	15.39	1.00	3.85	2.38	6.58	0.00	12.89	0.00
2	01/16/1990	0.00	15.39	1.00	3.85	2.38	6.58	0.00	12.89	0.00
3	01/31/1990	0.00	21.79	3.65	3.10	11.11	10.44	0.00	23.72	2.59
4	02/15/1990	0.00	21.79	3.65	3.10	11.11	10.44	0.00	23.72	2.59
5	03/02/1990	0.00	52.85	4.56	8.36	18.96	32.52	0.88	38.23	4.59
6	03/17/1990	0.00	52.85	4.56	8.36	18.96	32.52	0.88	38.23	4.59
7	04/01/1990	0.14	47.06	1.95	16.97	18.59	32.37	5.34	31.21	5.62
8	04/16/1990	0.14	47.06	1.95	16.97	18.59	32.37	5.34	31.21	5.62
9	05/01/1990	0.19	25.69	0.80	27.29	5.48	18.44	1.83	19.65	2.28
10	05/16/1990	0.19	25.69	0.80	27.29	5.48	18.44	1.83	19.65	2.28
11	05/31/1990	0.17	17.14	0.47	41.11	3.74	16.64	0.40	15.54	1.94
12	06/15/1990	0.17	17.14	0.47	41.11	3.74	16.64	0.40	15.54	1.94
13	06/30/1990	0.00	14.66	0.00	40.17	0.29	7.43	0.00	4.63	0.61
14	07/15/1990	0.00	14.66	0.00	40.17	0.29	7.43	0.00	4.63	0.61
15	07/30/1990	0.00	11.83	0.00	33.29	0.00	6.73	0.00	2.58	0.47
16	08/14/1990	0.00	11.83	0.00	33.29	0.00	6.73	0.00	2.58	0.47
17	08/29/1990	0.00	21.35	0.17	24.11	0.77	9.90	0.00	4.47	0.98
18	09/13/1990	0.00	21.35	0.17	24.11	0.77	9.90	0.00	4.47	0.98
19	09/28/1990	0.00	16.35	0.79	15.69	2.47	8.01	0.43	9.78	1.27
20	10/13/1990	0.00	16.35	0.79	15.69	2.47	8.01	0.43	9.78	1.27
21	10/28/1990	0.00	33.64	0.69	5.60	6.61	12.27	0.00	10.62	0.24
22	11/12/1990	0.00	33.64	0.69	5.60	6.61	12.27	0.00	10.62	0.24
23	11/27/1990	0.00	25.74	0.92	3.41	0.75	8.29	0.00	9.45	0.00
24	12/12/1990	0.00	25.74	0.92	3.41	0.75	8.29	0.00	9.45	0.00
25	12/27/1990	0.00	6.23	0.00	0.52	0.00	1.56	0.00	1.61	0.00
Total Erosion		1.0	614.2	30.0	446.4	142.3	341.0	17.8	367.2	41.2

The weather file used for each of the states is given below.

CA	CA93193.DAT	CO	CO24015.DAT	FL	FL12841.DAT
HI	HI22516.DAT	IL	IL14834.DAT	KS	KS23065.DAT
NY	NY14717.DAT	TX	TX23005.DAT	WA	WA24157.DAT

5.3 SOILS

The impact of soils on wind erosion is reflected in the (1) erodible fraction, (2) soil crust factor, and (3) soil wetness. (Soil roughness is examined in Section 5.5 with tillage.)

5.3.1 What is a soils file?

The soils file consists of physical (% sand, % silt, and % rock cover) and chemical property data (% organic matter and % calcium carbonate) that can be used to describe the erodibility of a soil. The RWEQ program soil files include the 12 soil texture groups in the soil texture triangle. The physical property values in these files were extracted from the midpoint of each group (APPENDIX E-3). The *OM* and $CaCO_3$ values are intended to be changed according to the region and management.

5.3.2 Sources of available data

In RWEQ, the data input from the soils file (% sand, % silt, organic matter, calcium carbonate, and rock cover) are assumed constant within an analysis period. If data are available to support that values differ, they may be updated. For example, a high residue crop rotation may modify the organic matter content over several years. The impact can be tested by updating the organic matter levels and running the erosion estimates. If soil property data are available for a specific field, these values may be used in place of the default values (APPENDIX E-3). If the SOIL INTERPRETATION RECORD is available, it may be used to determine the appropriate soil data. (See APPENDICES E-1 and E-2.) Traditional procedures should be followed in determining the soil erodibility value for the entire field when soil texture varies across the field.

To customize the soil for a specific field the simplest procedure is to overwrite the values in the **`Soil Properties`** window. To change the generic values for a region it may be more efficient to edit a particular soil file (Section 2.4.1) or create a new soil file (Section 5.3.3).

5.3.2.1 **Erodible fraction (*EF*):** Erodible fraction (*EF*) is expressed as that portion of the top 25 mm of the soil surface that can be transported by wind. This is assumed to include only particles smaller than 0.84 mm in diameter.

The weather file (TX23005.DAT) and management file (TEST.MAN) were used to estimate erosion for four different soils. The results are summarized in Table 5.3.2.1.1.

Table 5.3.2.1.1 - Estimated erosion for different soils using the client file TEST with different soils.

	sandy clay	sandy loam	loamy sand	sand
EF	0.45	0.51	0.58	0.67
SCF	.1620	.6024	.8080	.9439
Estimated erosion *t/ac*	66.5	367.2	575.5	786.0

In Table 5.3.2.1.1, there is a range in soil erosion of 66.5 to 786.0 t/ac/yr or 12-fold difference between sandy clay and sand. From the same soil textures with WEQ the soil erosion varies from 56 to 310 t/ac/yr or a 5-fold range.

To illustrate the estimated erodible fraction and soil crust factors for various conditions, a matrix of comparisons have been made and the results listed in Table 5.3.2.1.2.

Table 5.3.2.1.2 Changes in *EF* and *SCF* as influenced by sand and silt content, and for three levels of *OM* and $CaCO_3$.

Sand %	OM %	----------SILT%----------								
		10			30			50		
		----------$CaCo_3$%----------								
		1	5	10	1	5	10	1	5	10
10		SCF = 0.02			SCF = 0.04			SCF = 0.09		
	1	0.30	0.27	0.22	0.34	0.30	0.25	0.37	0.33	0.29
	2	0.28	0.24	0.19	0.31	0.27	0.23	0.35	0.31	0.26
	5	0.20	0.16	0.11	0.23	0.20	0.15	0.27	0.23	0.18
30		SCF = 0.04			SCF = 0.09			SCF = 0.27		
	1	0.37	0.33	0.28	0.40	0.36	0.32	0.44	0.40	0.35
	2	0.34	0.30	0.26	0.38	0.34	0.29	0.41	0.34	0.34
	5	0.26	0.23	0.18	0.30	0.26	0.21	0.33	0.30	0.25
50		SCF = 0.09			SCF = 0.27			Silt - 49 SCF = 0.99		
	1	0.43	0.39	0.35	0.47	0.43	0.38	0.66	0.62	0.57
	2	0.41	0.37	0.32	0.44	0.41	0.36	0.63	0.59	0.55
	5	0.33	0.29	0.24	0.37	0.33	0.28	0.56	0.52	0.47
70		SCF = 0.27			Silt - 25 SCF = 0.86					
	1	0.50	0.46	0.42	0.56	0.52	0.48			
	2	0.48	0.44	0.39	0.54	0.50	0.45			
	5	0.40	0.36	0.31	0.46	0.42	0.37			
90		Silt - 7 SCF = 0.94								
	1	0.65	0.61	0.56						
	2	0.62	0.58	0.53						
	5	0.54	0.50	0.46						

For most agricultural fields, the soil is composed of sand, silt, and clay particles. Organic matter and calcium carbonate are components important in relating soil texture to susceptibility to wind erosion (Fryrear *et al*., 1994). Using the standard compact rotary sieve (Chepil, 1962)

and a sample of the surface 20 mm of dry topsoil, the erodible fraction (*EF*) of the soil can be determined. This procedure was used on several thousand samples to develop the following equation:

$$EF = \frac{29.09 + 0.31Sa + 0.17Si + 0.33\frac{Sa}{Cl} - 2.59OM - (}{100} \qquad \textbf{[14]}$$

$$r^2 = 0.67$$

where

EF	=	erodible fraction	(0.077 to 0.822)
Sa	=	percent sand	(5.5 to 93.6)
Si	=	percent silt	(0.5 to 69.5)
Cl	=	percent clay	(1.2 to 53.0)
OM	=	percent organic matter	(0.18 to 4.79)
$CaCO_3$	=	percent calcium carbonate	(0.0 to 25.2)

The range of values in the data set are in parentheses.

With this equation the potential erodibility of a mineral soil can be estimated from the physical and chemical properties. The *EF* equation allows scientists to evaluate changes in *EF* due to cropping, tillage, or weather, and practices on small plots. If the soil surface is covered with erodible material, theoretically, erosion continues as long as the wind speed is above the threshold.

If soil sieving data are available that show an *EF* different than the generic value, it may be overwritten. For example the client file TEST calls in the weather file for Big Spring, Texas and the management file TEST.MAN. The default *EF* value is 0.51 (Figure 5.3.2.1.1) This value may be overwritten with a value based on soil sieving data (*e.g.* 0.37) and erosion calculated. The estimated erosion is 258.1 t/ac with *EF*=0.37 (Figure 5.3.2.1.2). The *EF* of 0.37 is *not* retained when a management file is saved; it must be entered every time the management file is used. Overwriting the *EF* value has no effect on the *SCF* or the decay of soil roughness.

Figure 5.3.2.1.1

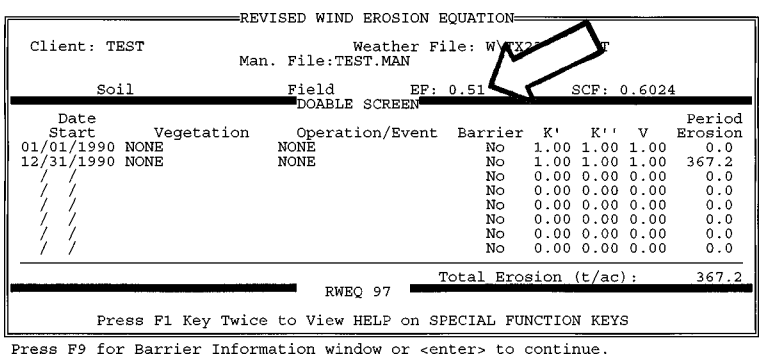


Figure 5.3.2.1.2

```
                    REVISED WIND EROSION EQUATION
 Client: TEST                    Weather File: W
                        Man. File:TEST.MAN

        Soil                Field        EF: 0.37          SCF: 0.6024
                            DOABLE SCREEN
    Date                                                                  Period
   Start      Vegetation     Operation/Event  Barrier  K'   K''  V    Erosion
01/01/1990 NONE            NONE                  No   1.00 1.00 1.00    0.0
12/31/1990 NONE            NONE                  No   1.00 1.00 1.00  258.1
  / /                                            No   0.00 0.00 0.00    0.0
  / /                                            No   0.00 0.00 0.00    0.0
  / /                                            No   0.00 0.00 0.00    0.0
  / /                                            No   0.00 0.00 0.00    0.0
  / /                                            No   0.00 0.00 0.00    0.0
  / /                                            No   0.00 0.00 0.00    0.0
                                          Total Erosion (t/ac):        258.1
                            RWEQ 97

        Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Accept or enter the operation date (MM/DD/YEAR)
```

5.3.2.2 **Soil Crust Factor (*SCF*):** The *SCF* was developed from laboratory wind tunnel tests on the abrasive resistance of soil aggregates (Hagen *et al*., 1992). The *SCF* reflects the changes in abrasive resistance of the soil surface when the surface has been modified with rainfall. Depending on soil texture, rainfall on an aggregated surface may decay fragile soil aggregates leaving a very smooth surface covered with loose erodible sand. Based on these laboratory tests, a *SCF* was developed for RWEQ. The *SCF* is set to 1 whenever tillage operations disturb the soil surface. As the rough aggregated surface is impacted by raindrops, the surface becomes aerodynamically smoother. For fine textured soils, the resulting surface may be smooth but with few loose erodible particles on the surface. Erosion may be controlled on fine textured soils and may be enhanced on coarse textured soils.

To illustrate the effect of a soil crust the client file TEST-SCF is used. This management file calls for a harrowing each month which sets the SCF to 0.6024 for a sandy loam soil each month. Calculated erosion is 41.4 t/ac. By setting the option to No for modifies roughness (Figure 5.3.2.2.1) for each operation, the soil crust remains for the entire year and the erosion increases to 54.2 t/ac. In Table 5.3.2.2.1 the effect of a soil crust on the estimated erosion for three different soils is listed.

Figure 5.3.2.2.1

```
                    REVISED WIND EROSION
 Client: TEST-SCF                Weather F
                        Man. File:TEST-SCF.MA

        Soil                Field        EF:
                            DOABLE SCREEN
    Date
   Start      Vegetation     Operation/Event
01/01/1998 NONE            HARROW_S
02/01/1998 NONE            HARROW_S
03/01/1998 NONE            HARROW_S
04/01/1998 NONE            HARROW_S
05/01/1998 NONE            HARROW_S
06/01/1998 NONE            HARROW_S
07/01/1998 NONE            HARROW_S
08/01/1998 NONE            HARROW_S

<KEY_F5> =Accept Operation/Irrigation Data

        Press F1 Key Twice to View HELP on S
Toggle "yes" or "no" using SPACE BAR key.
```

```
Operation/Irrigation Data
Operation: HARROW_S
Operation Modifies Roughness
        No
Random Roughness:   0.3    in
Oriented Roughness
Ridge Spacing: 10.0   in
 Ridge Height:  0.5   in
Ridge Direction:   0.0 degrees
Kill Crop:  No       (y/n)
 % Flat Retained: 80.0%
% Retained Standing:  0.0%
IRRIGATION INFORMATION
Amount(in):    0.0  Irrigation
Rate(in/hr):   0.0  days:  0.0
```

Table 5.3.2.2.1 Estimated erosion (t/ac) for 3 different soils with and without soil crusts.

	sandy loam	silt loam	clay loam
EF	0.51	0.41	0.36
SCF	.6024	.5127	.1159
	----------*t/ac*----------		
Crust is formed **No** - modifies roughness	54.2	32.2	3.0
Crust is disturbed **Yes** - modifies roughness	41.4	26.4	2.8

Notice that when the crust is disturbed erosion is reduced; the effect being more dramatic for the sandy loam. For a clay loam soil the *EF* is 0.36 and estimated soil erosion with a soil crust is 3.0 t/ac. Without a soil crust estimated soil erosion is 2.8 t/ac. From these examples you cannot separate the effect of a soil crust from soil roughness because they are both influenced by weather.

5.3.2.3 **Soil wetness (*SW*):** The soil wetness term was developed for RWEQ and reflects the amount and number of rainfall or irrigation events that impact soil erosion.

5.3.3 Developing and saving a soil file

To create a new file of soil properties that may be added to the choice list, use the DOS editor. At the C:\RWEQ97 > prompt type **EDIT** and the name of the new soil file (*e.g.* AMARILLO). Create a new soil file by using APPENDIX E-1 as a guide to extracting soil properties from a Soil Interpretations Record. (See example in APPENDIX E-2).

In this new file enter the following data given in bold. There are 5 lines of data in a soils data file.

% sand	**57**
% silt	**29**
% organic matter	**0.75**
% $CaCO_3$	**0**
% rock cover	**0**

SAVE the new soil file and EXIT the editor.

5.3.4 Adding a soil file to choice list

To add a new soil texture to the RWEQ choice list you *must* exit the RWEQ program. A new file of soil properties can be added to the SOIL choice list from DOS. At the C:\RWEQ97 prompt type **EDIT RWEQ.CLS**, page down to "*soil" in the file list. At the end of this line press <enter>. Type the name of the new soil properties file. Select SAVE from the FILE menu. The new version of RWEQ.CLS is saved. Select EXIT from the FILE menu and exit the editor.

5.4 **CROPS**

When crops are harvested, economic yield in the form of grain, seed, or lint are removed from the field. The stubble, stalks, or residue remaining after harvest may be standing or flat on the soil surface. Coefficients have been developed to describe residue levels and decomposition rates for flat and standing residues of specific crops (APPENDIX B-1). There are also coefficients to describe crop canopy development as a function of time (APPENDIX B-2).

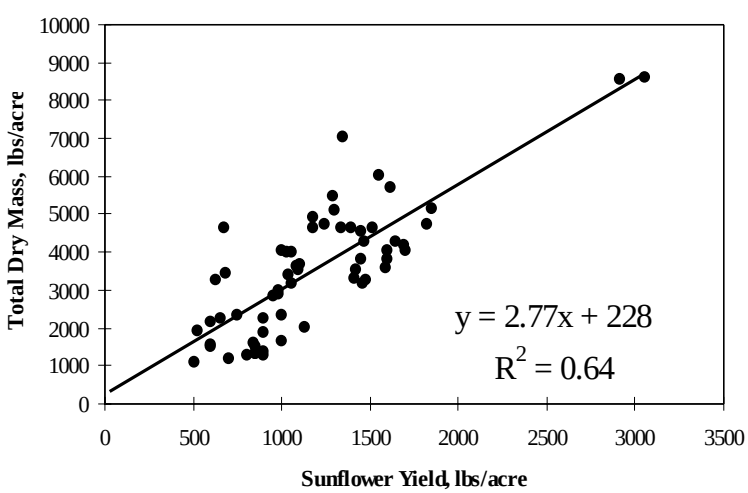
5.4.1 **Residue crop**

The present decomposition data set includes 10 crops. Additional research is underway to expand this database. The residues in a field are portioned into standing or flat with the decomposition routines.

The yield intercept (y_a) and yield slope (y_b) are very important values because the biomass value is used in computing ground cover. To illustrate one method of determining y_a and y_b, biomass and yield data for sunflowers were supplied by Dr. Lorenz Sutherland. The data were collected by Klein, Thrailkill, and Golus in 1994-1996 at North Platte, NE. Data from hail damaged sunflowers were not included. These data plus additional data from Colorado and Kansas are illustrated in Figure 5.4.1. From these 47 data points, y_a = 228 lb/acre when the yield is zero and y_b = 2.77 pounds of biomass per pound of yield with an r^2 = 0.64. These values compare to y_a = 0 and y_b = 3.60 CORE values (APPENDIX B-1). This is one example of a technique to determine y_a and y_b values for crops not listed with the CORE crops.

Another method is to estimate plant characteristics when yield is zero. Farmers know plant populations (estimates of the number of stems), plant height, and stem diameter data. Estimates for ten crops are in Table 5.4.1. These data are used to compute maximum ground cover (assuming no overlap of flat residues) and then, based on mass-to-cover conversion factor, compute biomass. This provides estimates of potential ground cover with zero yield.

Figure 5.4.1. Example of computing y_a and y_b coefficients for sunflowers.



Fryrear, D.W., Ali Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, and T.M. Zobeck. 1998. Revised Wind Erosion Equation (RWEQ). Wind Erosion and Water Conservation Research Unit, USDA-ARS, Southern Plains Area Cropping Systems Research Laboratory. Technical Bulletin No. 1. Internet address: http://www.csrl.ars.usda.gov/wewc/rweq.htm

Table 5.4.1. Computing yield intercept (y_a) from estimates of plant number, height, and diameter when yield is zero.

Crop	----Seeding Rate----		Population *	Plant Ht.	Plant Dia.	Plant Area**	Ground Cover	y_a
filename	*lb/ac*	*seeds/lb*	*plants/ac*	------*inches*-----		*ft²/ac*	*%*	*lb/ac*
Cotton	20	2200	30800	20	0.3	2500	5.7	235
W_Wheat	60	17000	714000	12	0.2	11900	27.3	483
Corn	10	1200	8400	40	0.7	1633	3.7	88
Sunflowers	6	6000	25200	40	0.5	3500	8.0	288
Soybeans	90	2500	157500	20	0.3	13125	30.1	543
Oats	60	14000	588000	15	0.2	12250	28.1	347
S_Barley	80	13000	728000	15	0.2	15167	34.8	648
W_Barley	80	13000	728000	15	0.2	15167	34.8	648
Sorghum	5	20000	70000	24	0.7	8167	18.7	518
S_Wheat	90	17000	1071000	15	0.2	22312	51.2	1087

* Based on 70% survival.

** The height of the crop is multiplied by the diameter of the stem to give a plant area (in^2). Multiplying the plant area by the number of plants per acre and dividing by 144 in^2/ft^2 gives the plant area in ft^2/acre. Dividing by 43560 ft^2/acre gives the fraction of ground covered with plant material. The entire stem is assumed to be flat on the ground and not overlapping any other stems.

5.4.1.1 **Developing and saving a residue file:** Presently RWEQ has data for ten residue crops. Research is being conducted on additional crops, but until these data are available the RWEQ user must develop a file for a new crop based on knowledge of similar crops.

A file of residue data for a crop not in the choice list must be developed in DOS. For illustration purposes, the creation of a residue crop data file for kenaf follows. Kenaf is a fiber crop in the same family as cotton. The growth rate of kenaf is equivalent to or better than corn or sorghum. Plant cover (canopy) estimates are assumed to be the same as sorghum.

Residue crop data files are designated with "R_" (*e.g.* R_kenaf). At the C:\RWEQ97> prompt type **EDIT R_KENAF**. For the kenaf residue crop data file use the following values. The data file must have one value (bolded below) on each line. The file*name* identifies the data. The file itself contains only one column of 11 numbers.

Yield intercept - *pounds/acre* (same as corn) (See APPENDIX B-1.)	**3000**
Yield slope - (same as corn)	**1.5**
Crop height - *feet* (assume dryland)	**6.0**
Stem diameter - *inches* (assume dryland)	**0.7**
After harvest height - *feet* (cut entire plant for fiber)	**0.3**
Standing mass loss coefficient - (assume same as cotton)	**0.0010**
Flat mass loss coefficient - (assume same as cotton)	**0.010**
Stem decline coefficient - (assume same as cotton)	**0.100**
Mass/cover conversion coefficient - *ha/kg* (assume same as cotton)	**-0.00025**
Takeoff factor - (assume same as corn)	**1.0**
Stem number threshold decomposition days - (assume same as cotton)	**45**

After all coefficients have been entered, SAVE the file and EXIT the editor.

Crop yield, % flat residue cover, and stem number are not part of the crop data file but are input by the operator in the RWEQ97 program as vegetation and residue information. If residue cover data are available, % cover may be entered if crop yield is left zero.

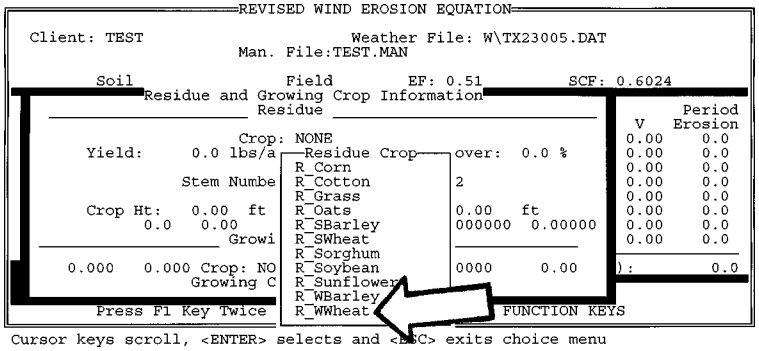
5.4.1.2 **Adding a residue crop to choice list:** To add a new residue crop filename to the RWEQ choice list you *must* exit the RWEQ program. At the C:\RWEQ97> prompt type **EDIT RWEQ.CLS,** page down to "*crop". At the end of this line press <enter>. Type the name of the new file (*e.g*. **R_KENAF**). Select SAVE from the FILE menu. The new version of RWEQ.CLS is saved. Select EXIT from the FILE menu to exit the editor.

5.4.1.3 **Example of influence of flat residue decomposition on erosion estimates:**
Residues lying on the soil surface decompose under the influence of temperature and the number of times the residues are wet. These factors are in the weather files and are incorporated into RWEQ with the decomposition routine. To illustrate the impact of weather on residue decomposition the management file TEST.MAN is modified to create a new management file called TEST_FR.MAN. (The FR denotes flat residue.) No crop is grown in TEST_FR.MAN. Flat wheat residue is "weathered" for a year.

To modify TEST.MAN enter **TEST** for the Client filename and advance to the **`DOABLE SCREEN`** using the <enter> key.

A.	Under **`Date Start`**	press <enter> to advance to **`Vegetation`**
B.	Under **`Vegetation`**	press F9 to enter the **`Residue and Growing Crop`** window.
	At the **`Crop`** prompt	press F2 and use the arrow key if necessary to highlight *R_WWheat*. (Figure 5.4.1.3.1.) Press <enter> to select.

Figure 5.4.1.3.1

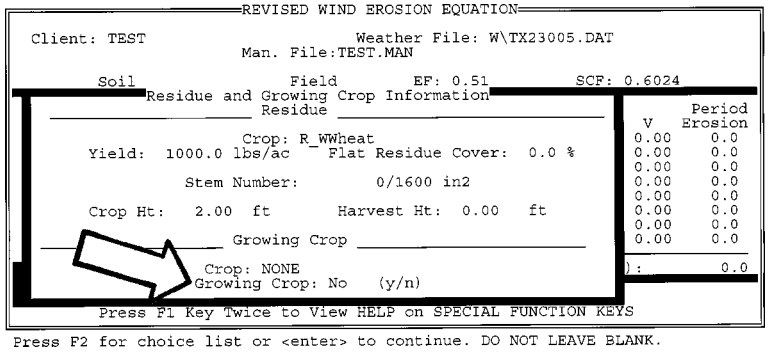


At the **`Yield`** prompt	type **1000** and press <enter>.
At the **`Flat Residue Cover`** prompt	press <enter> to accept the default value (0.0).
At the **`Stem Number`** prompt	press <enter> to accept the default value (0).
At the **`Crop Ht.`** prompt	press <enter> to accept the default value (2.00).
At the **`Harvest Ht.`** prompt	type **0** and press <enter>.

Entering a zero for the harvest height puts the residue flat on the surface, *i.e.* there is no standing residue after the crop is harvested.

At the **`Crop`** prompt	press <enter> to accept NONE.
At the **`Growing Crop`** prompt	(Figure 5.4.1.3.2) press <enter> to accept No.

Figure 5.4.1.3.2



	At the flashing **`R_WWheat`** prompt	press <enter> to advance to **`Operation/Event`**.
C.	Under **`Operation/Event`**	press F9 to enter **`Operation/Irrigation Data`** window.
	At the **`Operation`** prompt	press <enter> to accept NONE.

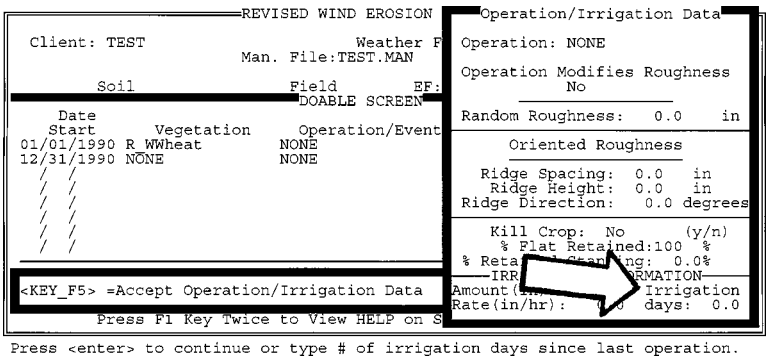
Under **`Operation Modifies Roughness`**	toggle No with the space bar and press <enter>.
At the **`Random Roughness`** prompt	press <enter> to accept the default value (0.0).
At the **`Ridge Spacing`** prompt	press <enter> to accept the default value (0.0).
At the **`Ridge Height`** prompt	press <enter> to accept the default value (0.0).
At the **`Ridge Direction`** prompt	press <enter> to accept the default value (0.0).
At the **`Kill Crop`** prompt	press <enter> to accept No.
At the **`% Flat Retained`** prompt	type **100** and press <enter> .
At the **`% Retained Standing`** prompt	press <enter> to accept the default value (0.0).

In this example the NONE for **`Operation`** and No for **`Modifies Roughness`** is correct; the **`% Flat Retained`** must be 100 to keep the program from burying a portion of the flat residue.

For irrigation information

At the **`Amount (in)`** prompt	press <enter> to accept the default value (0.0).
At the **`Rate (in/hr)`** prompt	press <enter> to accept the default value (0.0).
At the **`Irrigation days`** prompt	(Figure 5.4.1.3.3) press <enter> to accept the default value (0.0).

Figure 5.4.1.3.3

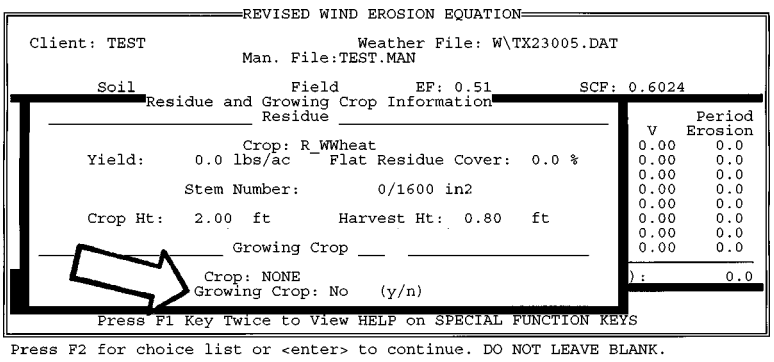


D.	At the flashing **`NONE`**	press <enter> to advance to **`Barrier`**.
E.	At the flashing **`No`** under **`Barrier`**	press <enter> which finishes the modifications of the first line in the **`DOABLE SCREEN`**.

For the second line in the **DOABLE SCREEN**

F.	Under **Date Start**	press <enter> to advance to **Vegetation.**
G.	Under **Vegetation**	press F9 to enter the **Residue and Growing Crop Information** window.
	At the **Crop** prompt	press F2, use the arrow key if necessary to highlight *R_WWheat*, and press <enter> to select.
	At the **Yield** prompt	press <enter> to accept the default value (0.0).
	At the **Flat Residue Cover** prompt	press <enter> to accept the default value (0.0).
	At the **Stem Number** prompt	press <enter> to accept the default value (0).
	At the **Crop Ht.** prompt	press <enter> to accept the default value (2.00).
	At the **Harvest Ht.** prompt	press <enter> to accept the default value (0.80).
	At the **Crop** prompt	press <enter> to accept NONE.
	At the **Growing Crop** prompt	(Figure 5.4.1.3.4) press <enter> to accept No.
	At the flashing **R_WWheat**	press <enter> to advance to **Operation/Event.**

Figure 5.4.1.3.4



H.	At the flashing **NONE**	press <enter> to advance to **Barrier.**
I.	From the flashing **No** under **Barrier**	press <enter> which finishes the modification of the second line in the **DOABLE SCREEN.**
J.	To estimate erosion	press F10 and press <enter> to select *Compute Erosion*. When prompted, press <Esc> to show estimated erosion in the **DOABLE SCREEN.** Note in Figure 5.4.1.3.5 the 2.7 /ac total erosion.

Figure 5.4.1.3.5

```
REVISED WIND EROSION EQUATION
Client: TEST                    Weather File: W\TX23005.DAT
                          Man. File:TEST.MAN

      Soil                Field        EF: 0.51        SCF: 0.6024
                          DOABLE SCREEN
   Date                                                                Period
  Start      Vegetation     Operation/Event  Barrier  K'   K''  V    Erosion
01/01/1990 R_WWheat        NONE                 No   1.00 1.00 0.03    0.0
12/31/1990 R_WWheat        NONE                 No   1.00 1.00 1.00    2.7
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
                                        Total Erosion (t/ac):          2.7
                         RWEQ 97
      Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Press F9 for Crop Information window or <enter> to continue.
```

To view the tabular output press F10, use the arrow key to highlight *Tabular Output*, and press <enter>. There are 26 15-day periods in the Tabular Output. Use the up and down arrows to scroll through the entire set of output. To move to the right use the <enter> key. See Figure 5.4.1.3.6. Press <Esc> twice to return to the **DOABLE SCREEN**.

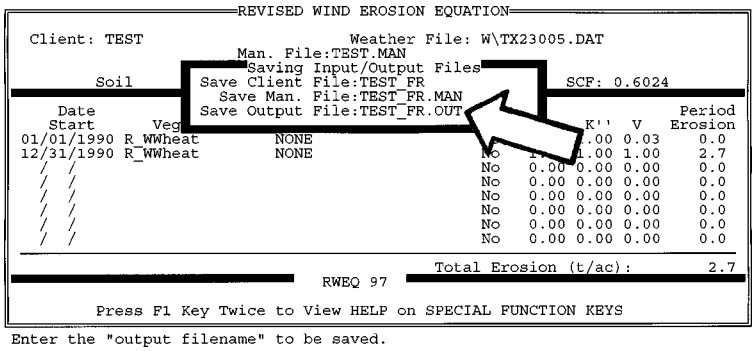
Figure 5.4.1.3.6 This figure is a combination of several screens.

```
Run Menu        REVISED WIND EROSION EQUATION
                Erosion Computation Summary
     Start          E     CSL    Qmax     S       WF      K'    K''    V     St
Pd   Date      Days t/ac   t/ac  lbs/ft   ft
 1 01/01/1990  15   0.00    0.0    1.0     0      35.3 1.000 1.000 0.034 1
 2 01/16/1990  15   0.00    0.0    1.0     0      35.3 1.000 1.000 0.034 1
 3 01/31/1990  15   0.00    0.1    2.4     0      62.2 1.000 1.000 0.034 1
 4 02/15/1990  15   0.00    0.1    2.4     0      62.2 1.000 1.000 0.034 1
 5 03/02/1990  15   0.48    0.2    5.0   921      96.4 1.000 1.000 0.034 1
 6 03/17/1990  15   0.48    0.2    5.0   921      96.4 1.000 1.000 0.034 1
 7 04/01/1990  15   0.35    0.1    3.8   985      79.0 1.000 1.000 0.034 1
 8 04/16/1990  15   0.35    0.1    3.8   985      79.0 1.000 1.000 0.034 1
 9 05/01/1990  15   0.25    0.1    4.3   986      53.4 1.000 1.000 0.034 1
10 05/16/1990  15   0.25    0.1    4.3   986      53.4 1.000 1.000 0.034 1
11 05/31/1990  15   0.19    0.2    4.6   968      42.0 1.000 1.000 0.034 1
12 06/15/1990  15   0.19    0.2    4.6   968      42.0 1.000 1.000 0.034 1
13 06/30/1990  15   0.00    0.0    0.8     0      13.5 1.000 1.000 0.036 1
14 07/15/1990  15   0.00    0.0    0.8     0      13.5 1.000 1.000 0.037 1
15 07/30/1990  15   0.00    0.0    0.3     0       9.3 1.000 1.000 0.039 1
16 08/14/1990  15   0.00    0.0    0.3     0       9.3 1.000 1.000 0.041 1
17 08/29/1990  15   0.00    0.0    0.8     0      14.2 1.000 1.000 0.044 1
18 09/13/1990  15   0.00    0.0    0.8     0      14.2 1.000 1.000 0.046 1
19 09/28/1990  15   0.00    0.1    2.9     0      27.7 1.000 1.000 0.048 1
20 10/13/1990  15   0.17    0.1    3.1  1067      27.7 1.000 1.000 0.049 1
21 10/28/1990  15   0.00    0.1    2.1     0      30.9 1.000 1.000 0.050 1
22 11/12/1990  15   0.00    0.1    2.1     0      30.9 1.000 1.000 0.050 1
23 11/27/1990  15   0.00           1.3     0      27.8 1.000 1.000 0.051 1
24 12/12/1990  15   0.00           1.3     0      27.8 1.000 1.000 0.051 1
25 12/27/1990   4   0.00    0.0    0.2     0       7.4 1.000 1.000 0.051 1
26 12/31/1990   0   0.00    0.0    0.0     0       0.0 0.000 0.000 0.000 0
                                        Total Erosion (t/ac):          2.7
KEY_ESC= Exit Period Info Display
      Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Use arrows, <tab>, or <enter> keys to move through screen.
```

The windy months of March and April result in some erosion.

K.	To save the management file	press F6.
	At the **`Save Client File`** prompt	type **TEST_FR** and press <enter>.
	At the **`Save Man. File`** prompt	type **TEST_FR.MAN** and press <enter>. Press <Esc> when prompted.
	At the **`Save Output File`** prompt	type **TEST_FR.OUT** (Figure 5.4.1.3.7) and press <enter>. Press <Esc> when prompted. The output file is the tabular output viewed in Figure 5.4.1.3.6 .

Figure 5.4.1.3.7



To show the importance of residue, go back to the first line in the **`DOABLE SCREEN`.**

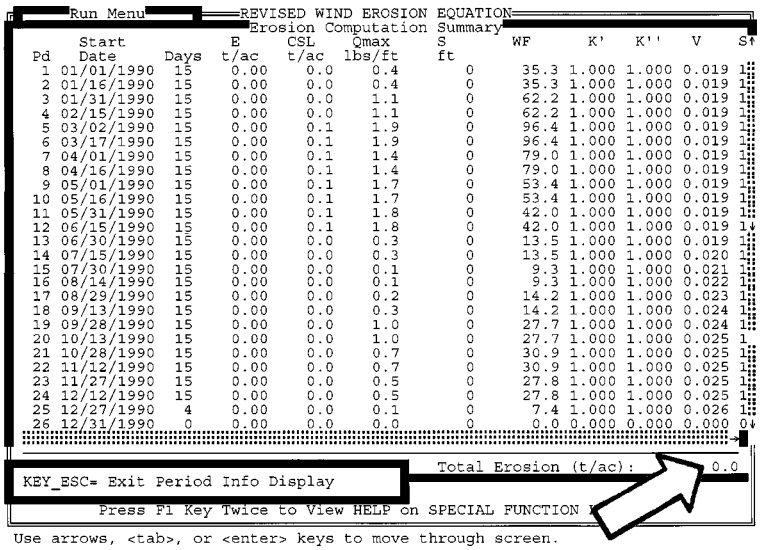
L.	Under **`Date Start`**	press <enter> to advance to **`Vegetation`**.
M.	Under **`Vegetation`**	press F9 to enter the **`Residue and Growing Crop Information`** window.
	At the **`Crop`** prompt	press <enter> to accept the *R_WWheat*.

When <enter> is pressed and *R_WWheat* is selected, yield, flat residue cover, and stem number remain as they were when the F9 screen was entered. Default values are called in for crop height and harvest height.

At the **`Yield`** prompt	type **2000** to increase the wheat yields from 1000 and press <enter>.

	At the **`Flat Residue Cover`** prompt	press <enter> to accept the default value (0.0).
	At the **`Stem Number`** prompt	press <enter> to accept the default value (0).
	At the **`Crop Ht.`** prompt	press <enter> to accept the default value (2.00).
	At the **`Harvest Ht.`** prompt	type **0** and press <enter>. Since the default value was recalled it is necessary to re-enter the zero.
	At the **`Crop`** prompt	press <enter> to accept NONE.
	At the **`Growing Crop`** prompt	press <enter> to accept No.
N.	To estimate erosion	press F10 and press <enter> to select *Compute Erosion*. When prompted, press <Esc> to show estimated erosion in the **`DOABLE SCREEN`**. Compare the estimated erosion (0.0 t/ac) and tabular output in Figure 5.4.1.3.8 with the estimated erosion (2.7 t/ac) and tabular output in Figure 5.4.1.3.6.

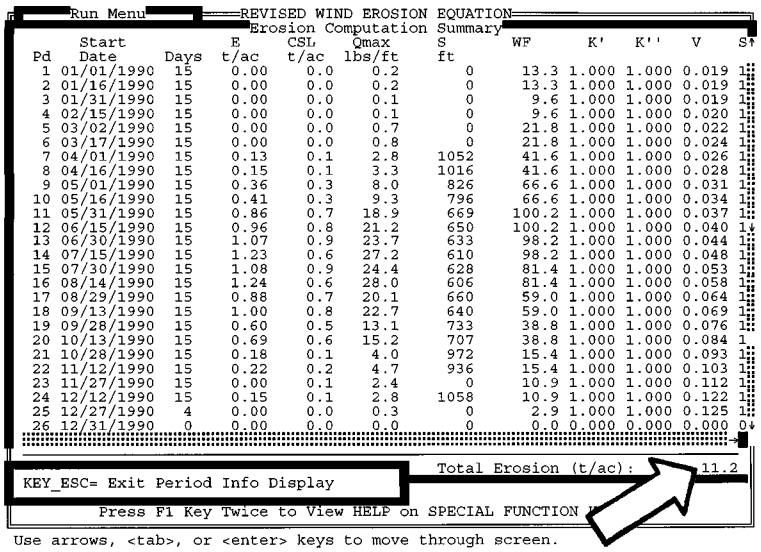
Figure 5.4.1.3.8 Several screens have been combined for this figure.



Pd	Start Date	Days	E t/ac	CSL t/ac	Qmax lbs/ft	S ft	WF	K'	K''	V	S
1	01/01/1990	15	0.00	0.0	0.4	0	35.3	1.000	1.000	0.019	1
2	01/16/1990	15	0.00	0.0	0.4	0	35.3	1.000	1.000	0.019	1
3	01/31/1990	15	0.00	0.0	1.1	0	62.2	1.000	1.000	0.019	1
4	02/15/1990	15	0.00	0.0	1.1	0	62.2	1.000	1.000	0.019	1
5	03/02/1990	15	0.00	0.1	1.9	0	96.4	1.000	1.000	0.019	1
6	03/17/1990	15	0.00	0.1	1.9	0	96.4	1.000	1.000	0.019	1
7	04/01/1990	15	0.00	0.1	1.4	0	79.0	1.000	1.000	0.019	1
8	04/16/1990	15	0.00	0.1	1.4	0	79.0	1.000	1.000	0.019	1
9	05/01/1990	15	0.00	0.1	1.7	0	53.4	1.000	1.000	0.019	1
10	05/16/1990	15	0.00	0.1	1.7	0	53.4	1.000	1.000	0.019	1
11	05/31/1990	15	0.00	0.1	1.8	0	42.0	1.000	1.000	0.019	1
12	06/15/1990	15	0.00	0.1	1.8	0	42.0	1.000	1.000	0.019	1
13	06/30/1990	15	0.00	0.0	0.3	0	13.5	1.000	1.000	0.019	1
14	07/15/1990	15	0.00	0.0	0.3	0	13.5	1.000	1.000	0.020	1
15	07/30/1990	15	0.00	0.0	0.1	0	9.3	1.000	1.000	0.021	1
16	08/14/1990	15	0.00	0.0	0.1	0	9.3	1.000	1.000	0.022	1
17	08/29/1990	15	0.00	0.0	0.2	0	14.2	1.000	1.000	0.023	1
18	09/13/1990	15	0.00	0.0	0.3	0	14.2	1.000	1.000	0.024	1
19	09/28/1990	15	0.00	0.0	1.0	0	27.7	1.000	1.000	0.024	1
20	10/13/1990	15	0.00	0.0	1.0	0	27.7	1.000	1.000	0.025	1
21	10/28/1990	15	0.00	0.0	0.7	0	30.9	1.000	1.000	0.025	1
22	11/12/1990	15	0.00	0.0	0.7	0	30.9	1.000	1.000	0.025	1
23	11/27/1990	15	0.00	0.0	0.5	0	27.8	1.000	1.000	0.025	1
24	12/12/1990	15	0.00	0.0	0.5	0	27.8	1.000	1.000	0.025	1
25	12/27/1990	4	0.00	0.0	0.1	0	7.4	1.000	1.000	0.026	1
26	12/31/1990	0	0.00	0.0	0.0	0	0.0	0.000	0.000	0.000	0

Another way to see the influence of residue decomposition is to calculate erosion using the weather file from Kahului, HI (HI22516.DAT) and TEST_FR.MAN. Compare the erosion estimate (0.0 t/ac) using 2000 #/ac wheat yield and Texas weather with the erosion estimate (11.2 t/ac in Figure 5.4.1.3.9) using the same wheat yield but Hawaii weather.

Figure 5.4.1.3.9



Run Menu — REVISED WIND EROSION EQUATION
Erosion Computation Summary

Pd	Start Date	Days	E t/ac	CSL t/ac	Qmax lbs/ft	S ft	WF	K'	K''	V	S
1	01/01/1990	15	0.00	0.0	0.2	0	13.3	1.000	1.000	0.019	1
2	01/16/1990	15	0.00	0.0	0.2	0	13.3	1.000	1.000	0.019	1
3	01/31/1990	15	0.00	0.0	0.1	0	9.6	1.000	1.000	0.019	1
4	02/15/1990	15	0.00	0.0	0.1	0	9.6	1.000	1.000	0.020	1
5	03/02/1990	15	0.00	0.0	0.7	0	21.8	1.000	1.000	0.022	1
6	03/17/1990	15	0.00	0.0	0.8	0	21.8	1.000	1.000	0.024	1
7	04/01/1990	15	0.13	0.1	2.8	1052	41.6	1.000	1.000	0.026	1
8	04/16/1990	15	0.15	0.1	3.3	1016	41.6	1.000	1.000	0.028	1
9	05/01/1990	15	0.36	0.3	8.0	826	66.6	1.000	1.000	0.031	1
10	05/16/1990	15	0.41	0.3	9.3	796	66.6	1.000	1.000	0.034	1
11	05/31/1990	15	0.86	0.7	18.9	669	100.2	1.000	1.000	0.037	1
12	06/15/1990	15	0.96	0.8	21.2	650	100.2	1.000	1.000	0.040	1
13	06/30/1990	15	1.07	0.9	23.7	633	98.2	1.000	1.000	0.044	1
14	07/15/1990	15	1.23	0.6	27.2	610	98.2	1.000	1.000	0.048	1
15	07/30/1990	15	1.08	0.9	24.4	628	81.4	1.000	1.000	0.053	1
16	08/14/1990	15	1.24	0.6	28.0	606	81.4	1.000	1.000	0.058	1
17	08/29/1990	15	0.88	0.7	20.1	660	59.0	1.000	1.000	0.064	1
18	09/13/1990	15	1.00	0.8	22.7	640	59.0	1.000	1.000	0.069	1
19	09/28/1990	15	0.60	0.5	13.1	733	38.8	1.000	1.000	0.076	1
20	10/13/1990	15	0.69	0.6	15.2	707	38.8	1.000	1.000	0.084	1
21	10/28/1990	15	0.18	0.1	4.0	972	15.4	1.000	1.000	0.093	1
22	11/12/1990	15	0.22	0.2	4.7	936	15.4	1.000	1.000	0.103	1
23	11/27/1990	15	0.00	0.1	2.4	0	10.9	1.000	1.000	0.112	1
24	12/12/1990	15	0.15	0.1	2.8	1058	10.9	1.000	1.000	0.122	1
25	12/27/1990	4	0.00	0.0	0.3	0	2.9	1.000	1.000	0.125	1
26	12/31/1990	0	0.00	0.0	0.0	0	0.0	0.000	0.000	0.000	0

Total Erosion (t/ac): 11.2

KEY_ESC= Exit Period Info Display

Press F1 Key Twice to View HELP on SPECIAL FUNCTION

Use arrows, <tab>, or <enter> keys to move through screen.

For a summary of the influence of weather and residue amounts on residue decomposition see the differences in erosion in Table 5.4.1.3. All other parameters (*i.e.* soil, field, management) were the same.

Table 5.4.1.3 Erosion estimates based on residue from two different wheat yields in the TEST_FR.MAN file.

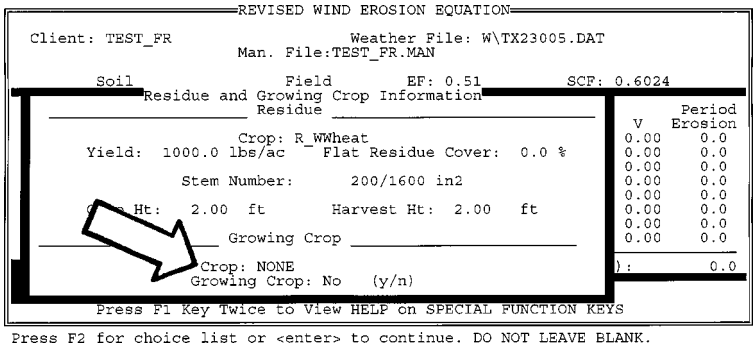
Weather filename	1000 lbs/ac	2000 lbs/ac
	----------*t/ac*----------	
TX23005.DAT	2.7	0.0
HI22516.DAT	31.8	11.2

5.4.1.4 **Example of influence of standing residue decomposition for on erosion estimates:** The following example illustrates the decay of standing residues for the same yield. TEST_FR.MAN is modified to show standing instead of flat residue.

To modify TEST_FR.MAN advance to the **`DOABLE SCREEN`** using the <enter> key.

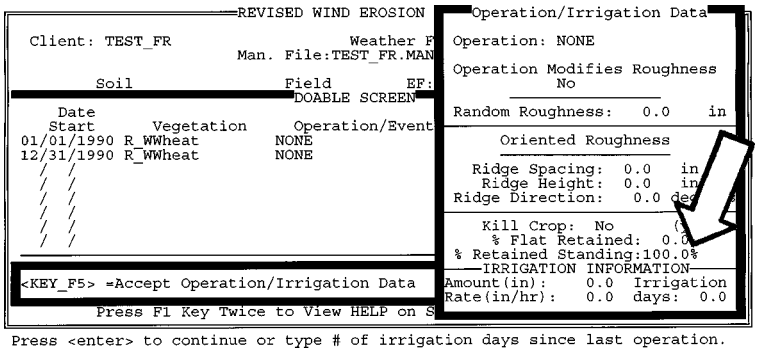
A.	Under **`Date Start`**	press <enter> to advance to **`Vegetation.`**
B.	Under **`Vegetation`**	press F9 to enter the **`Residue and Growing Crops Information`** window.
	At the **`Crop`** prompt	press F2, use the arrow key if necessary to select *R_WWheat*, and press <enter> to select.
	At the **`Yield`** prompt	press <enter> to accept 1000.
	At the **`Flat Residue Cover`** prompt	press <enter> to accept the default value (0.0).
	At the **`Stem Number`** prompt	type **200** and press <enter>.
	At the **`Crop Ht.`** prompt	press <enter> to accept the default value (2.00).
	At the **`Harvest Ht.`** prompt	type **2** and press <enter>.
	At the **`Crop`** prompt	press <enter> to accept NONE.
	At the **`Growing Crop`** prompt	(Figure 5.4.1.4.1) press <enter> to accept No.
	At the flashing **`R_WWheat`**	press <enter> to advance to **`Operation/Event.`**

Figure 5.4.1.4.1



C.	Under **`Operation/Event`**	press F9 to enter **`Operation/Irrigation data`** window.
	At the **`Operation`** prompt	press <enter> to accept NONE.
	Under **`Operation Modifies Roughness`**	toggle No with the space bar and press <enter>.
	At the **`Random Roughness`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Spacing`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Height`** prompt	press <enter> to accept the default value (0.0).
	At the **`Ridge Direction`** prompt	press <enter> to accept the default value (0.0).
	At the **`Kill Crop`** prompt	press <enter> to accept the default value (No).
	At the **`% Flat Retained`** prompt	press <enter> to accept the default value (0.0).
	At the **`% Retained Standing`** prompt	type **100** and press <enter> (Figure 5.4.1.4.2).
	For irrigation information	
	At the **`Amount (in)`** prompt	press <enter> to accept the default value (0.0).
	At the **`Rate (in/hr)`** prompt	press <enter> to accept the default value (0.0).
	At the **`Irrigation days`** prompt	press <enter> to accept the default value (0.0).

Figure 5.4.1.4.2



D.	From the flashing **NONE**	press <enter> to advance to **Barrier.**
E.	From the flashing **No** under **Barrier**	press <enter> which finishes the modification of the first line in the **DOABLE SCREEN.**

For the second line in the **DOABLE SCREEN**

E.	Under **Date Start**	press <enter> twice to advance to **Operation/Event.**
F.	Under **Operation/Event**	press F9 to enter **Operation/irrigation data** window.
	At the **Operation** prompt	press <enter> to accept NONE.
	Under **Operation Modifies Roughness**	toggle No with the space bar and press <enter>.
	At the **Random Roughness** prompt	press <enter> to accept the default value (0.0).
	At the **Ridge Spacing** prompt	press <enter> to accept the default value (0.0).
	At the **Ridge Height** prompt	press <enter> to accept the default value (0.0).
	At the **Ridge Direction** prompt	press <enter> to accept the default value (0.0).
	At the **Kill Crop** prompt	press <enter> to accept the default value (No).
	At the **% Flat Retained** prompt	press <enter> to accept the default value (0.0).
	At the **% Retained Standing** prompt	type **100** and press <enter>.
	For irrigation information	
	At the **Amount (in)** prompt	press <enter> to accept the default value (0.0).

	At the **`Rate (in/hr)`** prompt	press <enter> to accept the default value (0.0).
	At the **`Irrigation days`** prompt	press <enter> to accept the default value (0.0).
G.	From the flashing **`NONE`**	press <enter> to advance to **`Barrier.`**
H.	From the flashing **`No`** under **`Barrier`**	press <enter> which finishes the modification of the second line in the **`DOABLE SCREEN`**.
I.	To estimate erosion	press F10 and press <enter> to select *Compute Erosion.* When prompted, press <Esc> to show estimated erosion in the **`DOABLE SCREEN`**. Note in Figure 5.4.1.4.3 the 0.0 t/ac erosion.

Figure 5.4.1.4.3

```
REVISED WIND EROSION EQUATION
Client: TEST_FR                    Weather File: W\TX23005.DAT
                          Man. File:TEST_FR.MAN
      Soil                Field        EF: 0.51        SCF: 0.6024
                          DOABLE SCREEN
   Date                                                          Period
  Start      Vegetation     Operation/Event  Barrier  K'   K''  V    Erosion
01/01/1990 R_WWheat        NONE                 No   1.00 1.00 0.00    0.0
12/31/1990 R_WWheat        NONE                 No   1.00 1.00 0.10    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
  /  /                                          No   0.00 0.00 0.00    0.0
                                       Total Erosion (t/ac):          0.0
                         RWEQ 97
      Press F1 Key Twice to View HELP on SPECIAL FUNCTION
Press F9 for Operation/Irrigation Data window or <enter> to continue.
```

To view the tabular output	press F10, use the arrow key to select *Tabular Output*, and press <enter>. There are 26 15-day periods in the Tabular Output. Use the up and down arrow keys to scroll through the entire set of output. To move to the right use the <enter> key. See Figure 5.4.1.4.4. Press <Esc> twice to return to the **`DOABLE SCREEN`**.

Figure 5.4.1.4.4. This figure is a combination of several screens.

Run Menu — REVISED WIND EROSION EQUATION
Erosion Computation Summary

Pd	Start Date	Days	E t/ac	CSL t/ac	Qmax lbs/ft	S ft	WF	K'	K''	V	St
1	01/01/1990	15	0.00	0.0		0	35.3	1.000	1.000	0.000	1
2	01/16/1990	15	0.00	0.0		0	35.3	1.000	1.000	0.000	1
3	01/31/1990	15	0.00	0.0		0	62.2	1.000	1.000	0.000	1
4	02/15/1990	15	0.00	0.0		0	62.2	1.000	1.000	0.000	1
5	03/02/1990	15	0.00	0.0		0	96.4	1.000	1.000	0.000	1
6	03/17/1990	15	0.00	0.0		0	96.4	1.000	1.000	0.000	1
7	04/01/1990	15	0.00	0.0		0	79.0	1.000	1.000	0.000	1
8	04/16/1990	15	0.00	0.0		0	79.0	1.000	1.000	0.000	1
9	05/01/1990	15	0.00	0.0		0	53.4	1.000	1.000	0.000	1
10	05/16/1990	15	0.00	0.0		0	53.4	1.000	1.000	0.000	1
11	05/31/1990	15	0.00	0.0		0	42.0	1.000	1.000	0.000	1
12	06/15/1990	15	0.00	0.0		0	42.0	1.000	1.000	0.000	1
13	06/30/1990	15	0.00	0.0		0	13.5	1.000	1.000	0.000	1
14	07/15/1990	15	0.00	0.0		0	13.5	1.000	1.000	0.000	1
15	07/30/1990	15	0.00	0.0	0.0	0	9.3	1.000	1.000	0.002	1
16	08/14/1990	15	0.00	0.0	0.0	0	9.3	1.000	1.000	0.004	1
17	08/29/1990	15	0.00	0.0	0.0	0	14.2	1.000	1.000	0.008	1
18	09/13/1990	15	0.00	0.0	0.1	0	14.2	1.000	1.000	0.013	1
19	09/28/1990	15	0.00	0.0	0.4	0	27.7	1.000	1.000	0.015	1
20	10/13/1990	15	0.00	0.0	0.5	0	27.7	1.000	1.000	0.017	1
21	10/28/1990	15	0.00	0.0	0.4	0	30.9	1.000	1.000	0.018	1
22	11/12/1990	15	0.00	0.0	0.4	0	30.9	1.000	1.000	0.018	1
23	11/27/1990	15	0.00	0.0	0.3	0	27.8	1.000	1.000	0.019	1
24	12/12/1990	15	0.00	0.0	0.3	0	27.8	1.000	1.000	0.019	1
25	12/27/1990	4	0.00	0.0	0.1	0	7.4	1.000	1.000	0.019	1
26	12/31/1990	0	0.00	0.0	0.0	0	0.0	0.000	0.000	0.000	0

Total Erosion (t/ac): 0.0

KEY_ESC= Exit Period Info Display

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Use arrows, <tab>, or <enter> keys to move through screen.

J. To save the management file — press F6.

At the **`Save Client File`** prompt — type **TEST_SR** and press <enter>. This client filename (TEST_SR) is automatically added to the choice list when it is saved.

At the **`Save Man. File`** prompt — type **TEST_SR.MAN** and press <enter>.

At the **`Save Output File`** prompt — type **TEST_SR.OUT** (Figure 5.4.1.4.5) and press <enter>. Press <Esc> when prompted. The output file is the tabular output in Figure 5.4.1.4.4.

Figure 5.4.1.4.5

```
REVISED WIND EROSION EQUATION

Client: TEST_FR                    Weather File: W\TX23005.DAT
                                 Man. File:TEST_FR.MAN
                                 Saving Input/Output Files
        Soil                     Save Client File:TEST_SR          SCF: 0.6024
                                   Save Man. File:TEST_SR.MAN
                                 Save Output File:TEST_SR.OUT
    Date                                                                  Period
   Start       Veg                                    '    K''   V       Erosion
01/01/1990 R_WWheat        NONE                      00 1.00 0.00          0.0
12/31/1990 R_WWheat        NONE                      No   1.00 0.10          0.0
  / /                                                 No   0.00 0.00          0.0
  / /                                                 No   0.00 0.00          0.0
  / /                                                 No   0.00 0.00          0.0
  / /                                                 No   0.00 0.00          0.0
  / /                                                 No   0.00 0.00          0.0
  / /                                                 No   0.00 0.00          0.0

                                          Total Erosion (t/ac):            0.0
                                 RWEQ 97

        Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Enter the "output filename" to be saved.
```

The modifications tell the program that there is no flat residue after the crop is harvested. The residues are all standing after harvest, *i.e.* the % retained standing is 100 in the Operation/ Irrigation Data window.

RWEQ first decays the standing stubble until the standing stubble begins to fall. As it falls it becomes flat cover and the SLR_f values increase. The estimated erosion with Kahului, Hawaii weather (HI22516.DAT) and TEST_SR.MAN is given in Figure 5.4.1.4.6.

Figure 5.4.1.4.6.

```
Run Menu        REVISED WIND EROSION EQUATION
                Erosion Computation Summary
     Start          E    CSL   Qmax     S       WF      K'   K''    V    SLRc  SLRf  SLRs   WD
Pd   Date     Days  t/ac  t/ac  lbs/ft   ft
 1 01/01/1990  15   0.00   0.0              0     13.3 1.000 1.000 0.000 1.000 1.000         45
 2 01/16/1990  15   0.00   0.0              0     13.3 1.000 1.000 0.000 1.000 1.000         45
 3 01/31/1990  15   0.00   0.0              0      9.6 1.000 1.000 0.000 1.000 1.000         67
 4 02/15/1990  15   0.00   0.0              0      9.6 1.000 1.000 0.001 1.000 0.057 0.024   67
 5 03/02/1990  15   0.00   0.0   0.4        0     21.8 1.000 1.000 0.015 1.000 0.040 0.379   67
 6 03/17/1990  15   0.00   0.0   1.1        0     21.8 1.000 1.000 0.029 1.000 0.038 0.776   67
 7 04/01/1990  15   0.21   0.2   4.7      935     41.6 1.000 1.000 0.035 1.000 0.038 0.936   67
 8 04/16/1990  15   0.23   0.2   5.1      918     41.6 1.000 1.000 0.037 1.000 0.038 0.983   67
 9 05/01/1990  15   0.48   0.4  10.7      770     66.6 1.000 1.000 0.037 1.000 0.038 0.995   67
10 05/16/1990  15   0.48   0.4  10.8      769     66.6 1.000 1.000 0.038 1.000 0.038 0.998   67
11 05/31/1990  15   0.85   0.7  18.8      671    100.2 1.000 1.000 0.037 1.000 0.037 0.989   67
12 06/15/1990  15   0.85   0.7  18.8      671    100.2 1.000 1.000 0.037 1.000 0.037 1.000   67

                                          Total Erosion (t/ac):                          7.2
KEY_ESC= Exit Period Info Display
        Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Use arrows, <tab>, or <enter> keys to move through screen.
```

The climatic effects on standing residue decomposition are evident in comparing the tabular output for Spokane, Washington; Kahului, Maui, Hawaii; and Big Spring, Texas. The effect of rainfall and temperatures on decomposition of standing residues and on the time required for the standing residues to fall onto the soil surface are illustrated in the outputs from Big Spring, Texas (hot, dry climate), Spokane, Washington (cooler, drier climate), and Kahului, Maui, Hawaii (wet, tropical climate). As shown in Table 5.4.1.4, the Big Spring standing residues start falling on June 15, at Spokane, on July 15, and at Kahului on February 15. At Big Spring and Spokane

there were still stalks standing on December 30. At Kahului all of the standing stalks were flat on the ground by June 15. The decay of flat residues in the wet, tropical climate is vary rapid compared to dry, hot climates. The impact of termites is not included in these estimates of residue decays.

Table 5.4.1.4. Decay of standing wheat residue at Spokane, Washington; Big Spring, Texas; and Kahului, Hawaii.

		WA24157.DAT		TX23005.DAT		HI22516.DAT	
period	start date	SLR_f	SLR_s	SLR_f	SLR_s	SLR_f	SLR_s
1	01/01/1990	1.00	0.00	1.00	0.00	1.00	0.00
2	01/16/1990	1.00	0.00	1.00	0.00	1.00	0.00
3	01/31/1990	1.00	0.00	1.00	0.00	1.00	0.00
4	02/15/1990	1.00	0.00	1.00	0.00	0.06	0.02
5	03/02/1990	1.00	0.00	1.00	0.00	0.04	0.38
6	03/17/1990	1.00	0.00	1.00	0.00	0.04	0.78
7	04/01/1990	1.00	0.00	1.00	0.00	0.04	0.94
8	04/16/1990	1.00	0.00	1.00	0.00	0.04	0.98
9	05/01/1990	1.00	0.00	1.00	0.00	0.04	0.99
10	05/16/1990	1.00	0.00	1.00	0.00	0.04	1.00
11	05/31/1990	1.00	0.00	1.00	0.00	0.04	1.00
12	06/15/1990	1.00	0.00	1.00	0.00	0.04	1.00
13	06/30/1990	1.00	0.00	0.14	0.00	0.04	1.00
14	07/15/1990	1.00	0.00	0.07	0.01	0.04	1.00
15	07/30/1990	0.23	0.00	0.05	0.04	0.04	1.00
16	08/14/1990	0.11	0.00	0.04	0.10	0.04	1.00
17	08/29/1990	0.07	0.01	0.04	0.21	0.04	1.00
18	09/13/1990	0.06	0.02	0.04	0.33	0.04	1.00
19	09/28/1990	0.05	0.03	0.04	0.40	0.04	1.00
20	10/13/1990	0.05	0.04	0.04	0.47	0.04	1.00
21	10/28/1990	0.05	0.05	0.04	0.49	0.04	1.00
22	11/12/1990	0.05	0.05	0.04	0.52	0.04	1.00
23	11/27/1990	0.04	0.06	0.04	0.53	0.04	1.00
24	12/12/1990	0.04	0.06	0.04	0.54	0.04	1.00
25	12/27/1990	0.04	0.06	0.03	0.55	0.03	1.00

5.4.2 **Growing crop**

Canopy data are available for the 6 crops in the RUSLE data files. These crop growth coefficients describe the relationship between canopy cover and plant age for 60 to 75 days after planting. The current crop growth parameters (APPENDIX B-2) are mathematical expressions of the canopy development data in RUSLE. Research is continuing to expand this core database. A best guess of equivalent values will have to be used for new crops. Growing crops also provide canopy cover after seeding. Crop canopy in RUSLE was converted to a Soil Loss Ratio for crop canopy (SLR_c).

The crop growth model is not tied to the weather file; therefore RWEQ will grow any crop any where in the world. As data are available the plan is to tie the crop growth function to the weather file in subsequent versions of RWEQ. If similar data on canopy development as a function of days after planting are available, the equivalent coefficients can be developed using statistical relationships in Table Curve, Stat-Pac, or other analysis packages. If the same general equation form is used the coefficients can be compared. These coefficients in APPENDIX B-2 are for the first 75 days (60 for winter small grains) after planting, not the entire growth period.

5.4.2.1 **Developing a growing crop input file:** To create a growing crop input file for kenaf, at the C:\RWEQ97> prompt type **EDIT G_KENAF**. Since the canopy development of kenaf is similar to sorghum, use the plant growth coefficients given for sorghum in APPENDIX B-2.

Plant growth coefficient “a”, pgca	**0.408**
Plant growth coefficient “b”, pgcb	**-2273.16**

There are only two numbers in a growing crop input file. Choose SAVE from the FILE menu. Select EXIT from the FILE menu to exit the editor.

5.4.2.2 **Adding a growing crop input file to the choice list:** To add a new growing crop filename to the RWEQ choice list you *must* exit the RWEQ program. Add a new growing crop input file to the choice list from DOS. At the C:\RWEQ97> prompt type **EDIT RWEQ.CLS**, page down to “*gcrop”. At the end of this line press <enter>. Type the name of the new growing crop file (*e.g.* **G_KENAF**). Select SAVE from the FILE. The new version of RWEQ.CLS is saved. Select EXIT from the FILE menu to exit the editor.

5.5 TILLAGE

A management file contains separate input lines for planting, cultivating, and other tillage operations. The development of a management input file begins with the RWEQ INPUT FORM (APPENDIX A-2). Multiple tillage operations are listed on this form (*e.g.* Table 5.1.2.2). It is only necessary to enter the date, residue and growing crops, and tillage implement if the default (generic) values for roughness, ridges, and residues are acceptable.

Tilling a soil is a common method of controlling weeds, erosion, and preparing a seedbed. In the process of preparing a seedbed the surface crust is disturbed and large stable soil aggregates (clods) are broken into smaller aggregates. When these aggregates are smaller than 0.84 mm in diameter, they are susceptible to erosion by wind.

Tillage information is incorporated into RWEQ through the **`DOABLE SCREEN`** in the **`Operation/Irrigation Data`** window. These inputs are stored in the management file.

5.5.1 What is a tillage file?

RWEQ uses external files to input default (generic) values to describe a tillage implement. APPENDIX C-1 is a listing of the implements, filenames and the data associated with the implement. These data include random roughness, ridge spacing, ridge height, % of the standing residue not flattened by the tillage operation, and % of the flat residue not buried by the tillage operation. A tillage file contains these five numbers.

5.5.2 What is the source of available tillage information?

Since soil aggregation is not usually described, photos of different roughness conditions and the corresponding random roughness values are in Figure 5.5.2. Farmers are a major source for input data; they are knowledgeable of the ridge height and spacing generated by their implements on their soil. The farmer can also estimate the % of the flat residue that is still on the soil surface and the % of the residue that continues to stand after the tillage operation. With this information a tillage file may be customized for unique situations or for a specific region.

5.5.3 Using tillage information in the DOABLE SCREEN

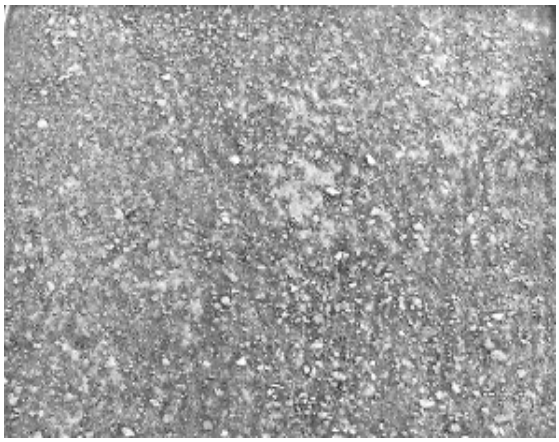
Any tillage information may be input through the **`DOABLE SCREEN.`** Under the **`Operation/Event`** column press F9 to enter the **`Operation/Irrigation Data`** window. After the operation is selected the question is asked “Operation Modifies Roughness”. If “No” is toggled, values cannot be overwritten. If “Yes” is toggled, the random roughness and the ridge spacing, height and orientation may be modified.

5.5.4 Using a tillage input file

If an implement is used frequently, a tillage file for that implement may be developed, saved and added to the choice list.

5.5.4.1 **Developing a tillage input file** For illustration purposes, the development of a tillage input file for a rotary hoe is shown. This implement is used on moist soils to roughen the soil surface or to aid in seedling emergence after a rain.

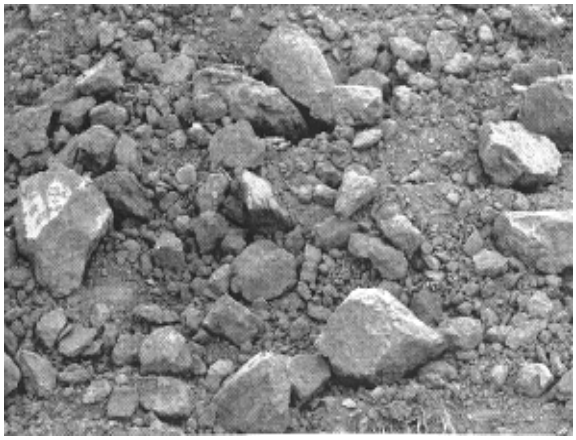
Figure 5.5.2



RR = 0.23

RR = 0.53

RR = 0.95



RR = 1.14

RR = 2.52

The random roughness for a rotary hoe varies for different regions of the country but generally is similar to a spike harrow (RR=0.4).

This implement has minimal effect on ridge roughness. If the previous implement was a deep furrow drill with the rows 14" apart and ridges 3" high, the rotary hoe may leave ridges 14" apart and 2.5" high. The ridge height and spacing of the previous implement must be considered to properly input the rotary hoe.

The rotary hoe is normally not used when residues are standing. Again, the spike harrow values come close to describing the effect of a rotary hoe on residues.

5.5.4.2 **Creating and saving a tillage file** From DOS at the C:\RWEQ97> prompt type **EDIT ROTARY_H**. (There is an 8 character limit on the file name.) The file consists of one column of the 5 values (bolded) as shown below.

Random roughness, *inches* (assume spike harrow)	**0.4**
Ridge spacing, *inches* (previous implement- deep furrow drill)	**14**
Ridge height, *inches*	**2.5**
% Flat retained (assume spike harrow)	**80**
% Standing (assume spike harrow)	**0**

After five data values are entered, select SAVE from the FILE menu and EXIT the editor.

5.5.4.3 **Adding a tillage file to the choice list** To add a new tillage filename to the RWEQ choice list you *must* exit the RWEQ program. A new tillage file can be added to the choice list from DOS. At the C:\RWEQ97> prompt, type **EDIT RWEQ.CLS**. Find "*Operation" in the listing. At the end of this line press <enter>. Type the new tillage filename (*e.g.* **ROTARY_H**). Select SAVE from the FILE menu. The new version of RWEQ.CLS is saved. Select EXIT from the FILE menu to exit the editor.

5.5.5 **Example of influence of tillage and soil roughness on erosion estimates**
Tillage implements modify soil roughness. A tillage operation may result in *random* roughness over the entire soil surface. *Oriented* roughness is expressed as the ridge height and spacing produced by the implement.

5.5.5.1 **Random roughness** To illustrate the impact of random roughness on erosion, the client file BIGTEX is used to estimate erosion for six random roughness values.

Table 5.5.5.1. Estimated erosion using BIGTEX.MAN and W\TX23005.DAT on a 320-acre field with different levels of random roughness. Ridge height and ridge spacing are set to zero for each operation to eliminate oriented roughness effects.

Random roughness, *in*	0	.25	.40	.75	1.05	1.60
Erosion estimate, *t/ac*	53.5	24.2	17.6	9.3	5.6	1.9

As the random roughness increases, estimated erosion decreases. While a little random roughness has a major impact on erosion, the small aggregates associated with a random roughness of 0.25 are readily decayed by rainfall.

5.5.5.2 **Oriented roughness** To illustrate the effect of oriented roughness BIGTEX is used. The ridge spacing remains 20 inches while the ridge height is varied from 2 to10 inches. Ridge height/spacing ratios usually do not vary less than 1 to 4 but for this example they vary from 1 to 2.

Table 5.5.5.2. Estimated erosion using BIGTEX.MAN and W/TX23005.DAT on a 320 acre field with different ridge heights. Random roughness is set to zero and ridge spacing is 20 inches.

Ridge height, *in*	0	2	4	6	8	10
Erosion estimate, *t/ac*	53.5	42.6	30.5	23.8	19.5	17.2

There is an 20% reduction in soil erosion when going from a flat surface (ridge height = 0) to a surface with 2 inch ridges. The reduction is 43% when going from the flat surface to 4 inch ridges. The 6 and 8 inch ridges further reduce erosion. The benefit of soil ridging is more pronounced if there is a dominant wind direction in the weather file because the magnitude of the impact of soil ridges is partially controlled by the variations in dominant wind direction.

5.5.5.3 **Ridge direction** To illustrate the effect of ridge direction BIGTEX.MAN and W\TX23005.DAT are used. For this weather file the preponderence values for January through April are 1.0 to 1.5. These values indicate the lack of a dominant wind direction. Any system that is directionally sensitive such as tillage or windbarriers is not as effective as nondirectional systems.

Table 5.5.5.3. Estimated erosion with BIGTEX.MAN and W\TX23005.DAT on a 320 acre field with two ridge orientations.

Ridge orientation, *deg.*	0	90
Erosion estimates, *t/ac*	8.0	7.1

5.5.6 **Decay of soil roughness**

To illustrate the decay of soil roughness by weather, the TEST-LIS.MAN is used with four weather files on a 160-acre circular field. This management file begins with a lister operation. The K’ and K” values from the tabular output are combined in Table 5.5.5. The increase in the K’ and K” values over the 25 erosion periods indicate the impact of rainfall on roughness decay.

Table 5.5.6.

		HI22516.DAT		IL14834.DAT		WA24157.DAT		TX23005.DAT	
		K′	K″	K′	K″	K′	K″	K′	K″
1	01/01/1990	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.04
2	01/16/1990	0.05	0.05	0.02	0.02	0.02	0.02	0.01	0.04
3	01/31/1990	0.05	0.12	0.03	0.08	0.02	0.02	0.02	0.02
4	02/15/1990	0.07	0.15	0.04	0.09	0.03	0.03	0.02	0.02
5	03/02/1990	0.10	0.18	0.10	0.05	0.04	0.04	0.02	0.07
6	03/17/1990	0.13	0.21	0.12	0.07	0.04	0.04	0.03	0.07
7	04/01/1990	0.16	0.24	0.14	0.09	0.05	0.05	0.05	0.05
8	04/16/1990	0.19	0.27	0.17	0.12	0.06	0.06	0.05	0.06
9	05/01/1990	0.20	0.28	0.21	0.16	0.07	0.07	0.17	0.07
10	05/16/1990	0.21	0.30	0.26	0.21	0.08	0.08	0.21	0.12
11	05/31/1990	0.22	0.30	0.33	0.29	0.09	0.09	0.27	0.17
12	06/15/1990	0.23	0.31	0.41	0.36	0.10	0.10	0.34	0.24
13	06/30/1990	0.27	0.28	0.49	0.50	0.11	0.11	0.38	0.28
14	07/15/1990	0.29	0.29	0.60	0.60	0.11	0.12	0.43	0.33
15	07/30/1990	0.30	0.30	0.67	0.67	0.12	0.12	0.47	0.37
16	08/14/1990	0.32	0.32	0.73	0.73	0.13	0.13	0.51	0.42
17	08/29/1990	0.32	0.33	0.79	0.76	0.13	0.14	0.55	0.47
18	09/13/1990	0.33	0.33	0.83	0.80	0.14	0.14	0.59	0.51
19	09/28/1990	0.32	0.39	0.84	0.82	0.15	0.15	0.63	0.55
20	10/13/1990	0.33	0.40	0.85	0.83	0.15	0.15	0.66	0.59
21	10/28/1990	0.36	0.43	0.86	0.84	0.16	0.16	0.67	0.60
22	11/12/1990	0.40	0.46	0.87	0.85	0.17	0.17	0.68	0.61
23	11/27/1990	0.45	0.46	0.87	0.87	0.18	0.18	0.64	0.64
24	12/12/1990	0.49	0.49	0.87	0.87	0.19	0.19	0.64	0.65
25	12/27/1990	0.49	0.50	0.87	0.87	0.19	0.19	0.64	0.65
Annual rainfall,mm		1781		871		407		440	
Rain days		165.5		103.4		111.8		49.4	
EI		N/A		25.48		150		1613	
Total erosion,t/ac		49.7		16.7		0.2		33.6	

The impact of soil roughness on soil erosion is influenced by the climatic conditions. While Hawaii has over 4 times the rainfall of Big Spring, Texas and over 3 times the number of rain days, the impact on soil deterioration is not as evident because the rainfall erosive energy (*EI*) is not available in the weather file. Consequently, the decay of soil roughness is not represented by this weather file.

Joliet, Illinois has twice the rain of Big Spring, Texas and essentially all the benefits of soil roughening were gone by September.

Spokane, Washington has slightly less rain, more than twice the number of raindays and a tenth of the rainfall erosive energy of Big Spring, Texas, and soil roughness was still a major factor in reducing soil erosion in December. Part of the difference in erosion is undoubtly due to less wind movement.

5.6 BARRIERS

Shelter belts, shrubs, grasses, and annual crops have been used as vegetative barriers to reduce wind speed. To describe the impact of the barrier on wind erosion, the barrier was assumed to protect the downwind surface for a distance equal to 10 times the effective height of the barrier. This rule is valid for one wind speed, one barrier density, and one surface condition.

A barrier is most effective when it is perpendicular to the erosive wind. For most regions of the country, wind directions are not constant. In RWEQ, erosion is computed along the path of the dominate wind direction. Erosion is also computed for the two directions 90 degrees (perpendicular) to the dominant wind direction, and for the direction that is 180 degrees (opposite) to the dominant wind direction. These erosion computations are added to determine total erosion for every time period.

In RWEQ97, a new barrier routine has been developed that permits the input of wind speed, barrier height, spacing, and optical density (OD) to compute the protected zone downwind. This routine uses a measured or estimated optical density of the barrier along with the effective height.

To demonstrate the influence of barriers on wind erosion the basic management input file (TESTH.MAN) is used with the weather file for Big Spring, Texas (TX23005.DAT) or a modified weather file (MODPPPR.DAT). (Table 5.6.1.) This modified weather file is the Big Spring, Texas weather file which was modified by setting the wind directions to 0°, the preponderance values to 10, and the positive parallel ratios to one for each month. The soil properties in TESTH.MAN are for a sandy loam (64% sand, 26% silt, 0.5% organic matter, and 3% calcium carbonate, no rocks). The field geometry is a square (660 feet x 660 feet), 10-acre field with no hill. The barrier inputs are added to the **`DOABLE SCREEN`** by pressing F9 under **`Barrier`**. The barrier data is input in the **`Field Barrier Information`** screen (Figure 5.6.1).

Table 5.6.1

RWEQ INPUT FORM

CLIENT: TESTH WEATHER FILE: WTX23005.DAT MANAGEMENT FILE: TESTH.MAN

Soil Properties:
soil texture SANDY LOAM OR sand 64 %, silt 26 %, organic matter 0.5 %, calcium carbonate 3 %, rock cover – %

Field Geometry: shape circular or rectangular; area 10, acres; orientation 0, ° from north; length_N 660, feet; slope gradient –; slope length –, feet

Longitude_____ Latitude_____ Elevation_____ Annual Rainfall_____

DATE	VEGETATION					OPERATION / EVENT									--IRRIGATION--			BARRIERS			
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge Spac.	Ridge Ht.	Ridge Orient.	Kill Crop	% Flat	% Stand.	Amt.	Rate	# Days	Ht.	DI	Spac.	Orient.
1/1/98	NONE	–		–	NONE	NONE	N	–	–	–	–	N	–	–	–	–	–	2	50	50	0
12/31/98	NONE	–		–	NONE	NONE	N	–	–	–	–	N	–	–	–	–	–	2	50	50	0

Fryrear, D.W., Ali Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, and T.M. Zobeck. 1998. Revised Wind Erosion Equation (RWEQ). Wind Erosion and Water Conservation Research Unit, USDA-ARS, Southern Plains Area Cropping Systems Research Laboratory. Technical Bulletin No. 1. Internet address: http://www.csrl.ars.usda.gov/wewc/rweq/readme.htm

Figure 5.6.1.

```
REVISED WIND EROSION EQUATION
Client: TESTH                    Weather File: W\TX23005.DAT
                          Man. File:TESTH.MAN
      Soil                Field        EF: 0.51        SCF: 0.6024
                          DOABLE SCREEN
   Date                                                          Period
  Start      Vegetation     Operation/Event  Barrier  K'   K''  V   Erosion
01/01/1990 NONE            NONE              No    0.00 0.00 0.00    0.0
12/31/1990 NONE            NONE
 /  /                                   Field Barrier Information
 /  /                                     Optical
 /  /                                Height  Density    Spacing    Orient.
 /  /                                 2.0     50.0       50.0       0.0
 /  /
 /  /                                      No    0.00 0.00 0.00     0.0
                                        Erosion (t/ac):              0.0
<KEY_F5> =Accept Barrier Information
      Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Press <enter> to continue or type orientation from North (0-360).
```

For this example the client file TESTH is called into the program. To show the effect of height, spacing, and optical density the TX23005.DAT weather file is used. The modified weather file (W\MODPPPR.DAT) is used to show the effect of barrier orientation.

Table 5.6.2. Erosion estimates with TESTH.MAN and TX23005.DAT on square, 10-acre, sandy loam field. With *no* barriers the erosion estimate is 367.3 t/ac.

When optical density = 50%, spacing = 50 feet, and barrier orientation 0°,

Barrier height, *ft*	2	5	10
Erosion estimate, *t/ac*	211.8	140.1	78.5

When height = 5 feet, spacing = 50 feet, and barrier orientation = 0°,

Optical density, *%*	10	50	100
Erosion estimate, *t/ac*	182.0	140.1	129.6

When height = 5 feet, optical density = 50%, and barrier orientation = 0°,

Barrier spacing, *ft*	10	50	100	200
Erosion estimate, *t/ac*	86.2	140.1	197.7	263.9

If the optical density is 50 % and the barrier spacing is 50 feet, increasing the barrier height from 2 to 10 feet decreases erosion from 211.8 to 78.5 t/ac.

If the barrier height is 5 feet and spacing is 50 feet, increasing optical density from 10 to 100% (100% is a solid barrier) decreases erosion from 182.0 to 129.6 t/ac.

If the barrier height is 5 feet and the optical density is 50 %, increasing barrier spacing from10 feet to 200 feet increases erosion from 86.2 to 263.9 t/ac.

Table 5.6.3. Erosion estimates with TESTH.MAN and W\MODPPPR.DAT on square, 10-acre, sandy loam field. With *no* barriers the erosion estimate is 373.9 t/ac.

When height = 5 feet, optical density = 50 %, and spacing = 50 feet,

Barrier orientation, °	0	30	45	60	90
Erosion, *t/ac*	372.1	113.2	24.6	13.2	2.7

If the barrier height is 5 feet, the optical density is 50 %, and the spacing is 50 feet, changing the barrier orientation from 0 to 90° decreases erosion from 372.1 to 2.7 t/ac.

The effectiveness of barriers is largely dependent on the preponderance values in the weather file. The more dominant the wind direction, the greater the benefit from orienting the barrier perpendicular to the wind, reducing barrier spacing, increasing barrier height, or increasing barrier density.

5.7 HILLS

Most agricultural fields are not perfectly flat. Within the field boundaries there may be knolls or hills. The question is basically "When and how do I input the knoll or hill effect on soil erosion?" Future models may be based on GIS data systems that will include soil properties, topographic effects, and variations in the surface residues or yields within the field. At this time a hill in RWEQ begins at the upwind boundary of the field. If there is a flat field upwind of the hill, the hill must be treated as a separate field.

The effect of a hill is to accelerate the wind speed on the upwind side and decelerate the wind speed on the downwind side. The measurement of wind speeds over hills has been described by Queney (1948). The assumption in RWEQ is that the variation in wind speeds reflects the potential for soil erosion. Erosion data are being collected in the Pacific Northwest and may provide additional insight into the true effect of hills on erosion.

5.7.1 Hill data in RWEQ

In RWEQ the hill options are input through the **`Field Geometry`** window. The slope length is input in feet; the slope gradient, in %. To be considered a knoll or hill there must be a 3% or greater change in the slope from the hill to the hill slope along the prevailing wind erosion direction. Slope length is the length of the windward face of the hill along the prevailing wind erosion direction.

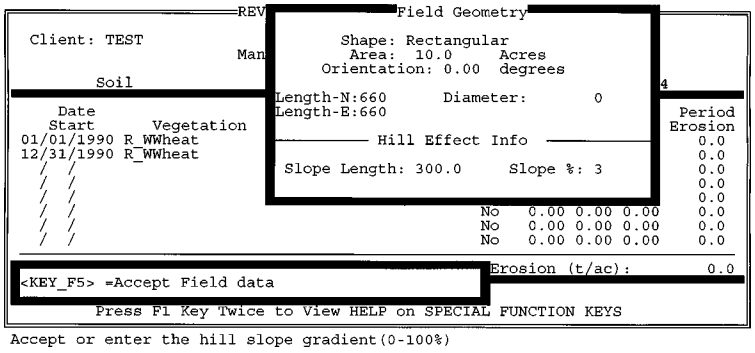
5.7.2 Source of available hill data

The source of slope length and gradient data are topographic maps or field surveys.

5.7.3 Developing hill data

In RWEQ the information on a hill can be assembled on the RWEQ INPUT FORM. This provides very limited input for fields with multiple hills or complex shapes. The current method is to enter the **`Field Geometry`** window and input the hill information. For example, the **`Field Geometry`** window for a 10-acre rectangular field with a slope length of 300 feet and a slope gradient of 3% is shown in Figure 5.7.3.1.

Figure 5.7.3.1



Fryrear, D.W., Ali Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, and T.M. Zobeck. 1998. Revised Wind Erosion Equation (RWEQ). Wind Erosion and Water Conservation Research Unit, USDA-ARS, Southern Plains Area Cropping Systems Research Laboratory. Technical Bulletin No. 1. Internet address: http://www.csrl.ars.usda.gov/wewc/rweq/readme.htm

5.7.4 **Saving hill data**

In RWEQ the hill information is considered a part of the management file and is automatically saved in the management file.

5.7.5 **Examples of hill effects**

To demonstrate the effect of hills the management file TESTH.MAN is used with the modified Big Spring, Texas weather data file (MODPPPR.DAT). This management file has a sandy loam soil and a square, 10-acre field. This weather file has the wind directions set to 0°, the preponderance set to 10, and the positive parallel ratios set to 1 for each month. There are no barriers.

In the **`Field Geometry`** screen the slope length is set to 300 feet. The slope gradient is varied from 3% to 30% (Table 5.7.5.1).

Table 5.7.5.1. Estimated erosion using TESTH.MAN and MODPPPR.DAT. The soil is a sandy loam and the 10-acre field is square.

Slope gradient, *%*	0	3	5	10	15	30
Erosion estimate, *t/ac*	373.9	354.2	345.0	338.4	357.0	572.3

These values illustrate that hills can have a dramatic effect on soil erosion. The hill effect is amplified even more if soil erodibility is increased or residue levels decreased.

Erosion estimates are shown for two slope gradients as the slope length varies from 100 to 300 feet. For comparison, the erosion estimate for this system with no hill is 373.9 t/ac.

Table 5.7.5.2. Estimated erosion using TESTH.MAN and MODPPPR.DAT. The soil is a sandy loam and the 10-acre field is square.

Slope length, *feet*	100	200	300
Erosion estimate, *t/ac* with 5% slope	370.6	357.9	345.0
Erosion estimate, *t/ac* with 10% slope	369.9	353.5	338.4

5.8 IRRIGATION

In RWEQ irrigation impacts soil roughness decay and surface residue decomposition the same as an equivalent rain. *EI* is computed from irrigation amount and application rate. An irrigation initiates the soil crust factor development. RWEQ begins calculating the effect of an irrigation at the beginning of the erosion period in which the irrigation is described.

5.8.1 What is irrigation data

RWEQ uses the amount of irrigation water, the application rate, and the number of days that irrigation water was applied. Anytime irrigation information is supplied in the **`Operation/ Irrigation Data`** window, the effects of that irrigation are calculated at the beginning of that erosion period. The soil wetness term is used to adjust the wind factor, and the number of irrigation days is used to decompose residues and decay soil roughness.

5.8.2 Source of irrigation data

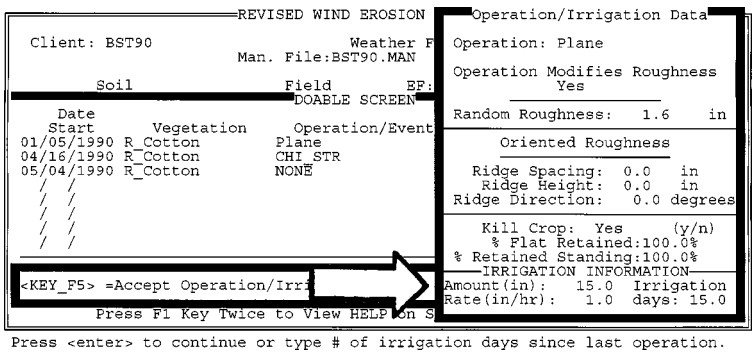
The farmer is the source of irrigation data.

5.8.3 Developing an irrigation file

Based on historical records or personal knowledge, an irrigation plan is developed.

To show the effect of irrigation on erosion estimates the management file BST90.MAN is used with the weather file W\BST90.DAT from Big Spring, Texas (CLIENT filename = BST90). This management file is modified to be an extreme example with random roughness = 1.6, ridge spacing = 0, ridge height = 0, and ridge orientation = 0. Three irrigation scenarios are used. In the first example 15 inches of irrigation water are applied at the rate of 1 inch/hour over 15 days. The second case calls for 15 inches of irrigation water to be applied at the rate of 1 inch/hour in one day. The third case calls for 1 inch of irrigation water to be applied at the rate of 1 inch/hour over a period of 15 days. An example of where to make these changes is in Figure 5.8.3.

Figure 5.8.3



Fryrear, D.W., Ali Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, and T.M. Zobeck. 1998. Revised Wind Erosion Equation (RWEQ). Wind Erosion and Water Conservation Research Unit, USDA-ARS, Southern Plains Area Cropping Systems Research Laboratory. Technical Bulletin No. 1. Internet address: http://www.csrl.ars.usda.gov/wewc/rweq.htm

Table 5.8.3.1 compares erosion estimates for the three examples with no irrigation water.

Table 5.8.3.1. Erosion estimates using BST90.MAN and BST90.W1 with different irrigation scenarios. The irrigation rate was the same for all (1 inch/hour).

Irrigation amount, *inches*/ irrigation days, *number*	None	15/15	15/1	1/15
Erosion estimate, *t/ac*	5.7	0	40.1	4.1

Part of the benefits of wet soil from the irrigations are offset by a decay of soil roughness. Soil roughness on 02/04/1990 went from 0.088 with rainfall only to 0.57 with 15 inches of irrigation (Table 5.8.3.2).

Table 5.8.3.2. Random roughness (K') for each erosion period in the tabular output for a dryland system compared to three irrigation senarios. All examples started with random roughness = 1.6, ridge spacing = 0, ridge height = 0, ridge orientation = 0 for the 01/05/1990 line of data.

		Irrigation amount, *inches*/ irrigation days, *number*			
period	start date	None	15/15	15/01	01/15
1	01/05/1990	0.055	0.169	0.169	0.060
2	01/20/1990	0.064	0.356	0.356	0.077
3	02/04/1990	0.088	0.570	0.570	0.111
4	02/19/1990	0.117	0.737	0.737	0.152
5	03/06/1990	0.135	0.840	0.840	0.182
6	03/21/1990	0.154	0.905	0.905	0.215
7	04/05/1990	0.184	0.939	0.939	0.257
8	04/16/1990	0.126	0.126	0.126	0.126
9	04/20/1990	0.172	0.172	0.172	0.172

In Table 5.8.3.1 the effect of 15 inches of irrigation varies depending on whether the water is applied in one day (15/1) or 15 days (15/15). The difference in erosion is due to the reduction in WF, not changes in soil roughness (Table 5.8.3.2).

5.9 FIELD

The size and shape of a field are normally fixed by landscape conditions.

To evaluate the effect of field size and shape on erosion several examples are run with the same management file (TEST-FT.MAN) that is made up of 12 **HARROW_S** operations on the first of each month. (Figure 5.9.1 has been compiled to show what the **DOABLE SCREEN** should look like.) There is no residue or growing crop for any of the dates entered. The harrow is used each month with **Random Roughness** = 0.1 and no ridges (Figure 5.9.2) .

Figure 5.9.1

```
REVISED WIND EROSION EQUATION

Client: TEST-FT                    Weather File: W\MODPPPR.DAT
                        Man. File:TEST-FT.MAN

        Soil                Field        EF: 0.58          SCF: 0.8080
                            DOABLE SCREEN
    Date
   Start      Vegetation     Operation/Event  Barrier  K'   K''  V    Period
                                                                     Erosion
01/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
02/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
03/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
04/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
05/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
06/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
07/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
08/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
09/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
10/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
11/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0
12/01/1998 NONE            HARROW_S              No   0.00 0.00 0.00    0.0

                                          Total Erosion (t/ac):        0.0
                          RWEQ 97

        Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS
Press F9 for Operation/Irrigation Data window or <enter> to continue.
```

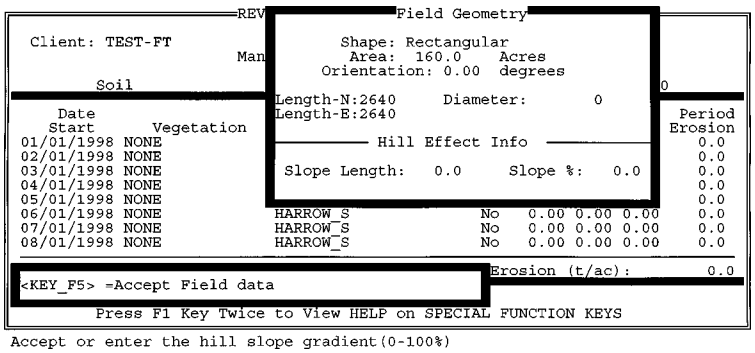
Figure 5.9.2

```
REVISED WIND EROSION                 Operation/Irrigation Data

Client: TEST-FT                    Weather F  Operation: HARROW_S
                        Man. File:TEST-FT.MAN

        Soil                Field        EF:   Operation Modifies Roughness
                            DOABLE SCREEN              Yes
    Date                                        Random Roughness:   0.1    in
   Start      Vegetation     Operation/Event
01/01/1998 NONE            HARROW_S                 Oriented Roughness
02/01/1998 NONE            HARROW_S
03/01/1998 NONE            HARROW_S              Ridge Spacing:  0.0   in
04/01/1998 NONE            HARROW_S                Ridge Height:  0.0   in
05/01/1998 NONE            HARROW_S            Ridge Direction:   0.0 degrees
06/01/1998 NONE            HARROW_S
07/01/1998 NONE            HARROW_S              Kill Crop:  No      (y/n)
08/01/1998 NONE            HARROW_S                % Flat Retained: 80.0%
                                               % Retained Standing:  0.0%
                                                 IRRIGATION INFORMATION
<KEY_F5> =Accept Operation/Irrigation Data   Amount(in):    0.0  Irrigation
                                             Rate(in/hr):   0.0  days:  0.0
        Press F1 Key Twice to View HELP on S
Press F2 for choice list or <enter> to continue. DO NOT LEAVE BLANK.
```


Fryrear, D.W., Ali Saleh, J.D. Bilbro, H.M. Schomberg, J.E. Stout, and T.M. Zobeck. 1998. Revised Wind Erosion Equation (RWEQ). Wind Erosion and Water Conservation Research Unit, USDA-ARS, Southern Plains Area Cropping Systems Research Laboratory. Technical Bulletin No. 1. Internet address: http://www.csrl.ars.usda.gov/wewc/rweq.htm

The soil properties are not changed. These examples are all run with a rectangular field. The area of the field, the orientation of the field and the length of the side running closer to north (Length-N) are varied. The changes are made in the **`Field Geometry`** window (Figure 5.9.3) and then erosion is calculated.

Figure 5.9.3



Erosion is estimated with two different weather files for each example. One weather file is from Dodge City, Kansas (Table 5.9.1) . The other weather file is the Big Spring, Texas file modified to show a prevailing wind erosion direction of 0° , a preponderance of 10, and a positive parallel ratio of 1 (Table 5.9.2).

Table 5.9.1 Dodge City, Kansas weather file - KS13985.DAT

```
# 13985 USA KS DODGE_CITY
  37 46 N 99 58 W 796 19610421 19781231 AGW  115 88
   6.85  7.07  7.90  7.94  7.43  7.20  6.70  6.42  6.77  6.88  6.82  6.94
   2.65  2.55  2.56  2.60  2.73  2.66  2.85  2.86  2.66  2.69  2.65  2.72
   1.19  1.18  1.15  1.12  1.11  1.09  1.08  1.08  1.10  1.13  1.16  1.18
      0     0     0   180   180   180   180   180   180   180     0     0
    6.6   3.4   2.7   3.1   3.6   5.8   4.1   4.7   5.7   5.5   3.4   3.8
   0.81  0.89  0.69  0.58  0.73  0.89  0.95  0.86  0.64  0.55  0.65  0.75
    1.3   1.0    .8    .7    .9   1.3    .8   1.0   1.1    .9   1.2   1.0
    6.8  10.6  15.2  21.7  26.5  32.1  35.0  34.3  29.3  23.4  14.3   8.7
   -6.9  -4.1  -0.1   6.3  11.7  17.0  19.7  18.6  14.0   7.7   0.2  -4.8
   -6.6  -4.0  -2.4   3.8  10.9  15.4  17.3  16.1  11.8   6.2  -0.5  -4.6
    323   373   539   647   733   801   825   734   610   472   352   298
     14    23    37    41    91    98    77    74    64    47    27    18
    3.1   3.5   4.7   4.8   7.7   7.0   6.3   5.7   5.0   3.5   3.4   2.9
   10.7  30.4   6.3   0.0   0.0   0.0   0.0   0.0   0.0   0.0   5.8  13.8
      0     0    19    39   195   469   469   332   254    97    58    19
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  37 16 N 99 19 W 79.8 KS COLDWATER A
```

Table 5.9.2 Modified Big Spring, Texas weather file - MODPPPR.DAT

```
#  BIG_SPRING, TEXAS    DIRECTION=0  PREPOND=10   POSIT/PARALL/RATIO=1
  32 14 N 101 30 W 784 19590507 19701231 AGA  95 91
   5.91  6.50  7.30  7.25  7.05  6.80  5.97  5.52  5.68  5.93  5.83  5.70
   2.13  2.15  2.35  2.47  2.65  2.68  2.82  2.61  2.47  2.26  2.15  2.12
   1.17  1.15  1.13  1.10  1.09  1.08  1.07  1.08  1.09  1.11  1.14  1.16
      0     0     0     0     0     0     0     0     0     0     0     0
     10    10    10    10    10    10    10    10    10    10    10    10
      1     1     1     1     1     1     1     1     1     1     1     1
    8.0   6.6   3.3   3.6   3.2   3.8   4.0   4.7   6.1   7.2   7.8   9.5
   13.6  16.3  20.8  25.9  29.8  33.7  34.7  34.2  30.6  25.7  19.0  15.3
   -1.3   1.1   4.8  10.3  15.2  19.5  21.6  20.9  17.3  11.4   4.5   0.4
   -3.1  -1.3  -1.0   4.0  10.5  14.9  16.0  15.2  13.7   8.5   1.9  -1.6
    378   442   612   699   810   844   845   766   668   527   411   357
     17    15    17    35    76    49    47    45    67    42    16    14
    3.5   3.2   2.7   3.8   6.2   4.6   4.8   5.0   5.5   4.5   2.9   2.7
    0.7   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   2.5
      0     0    16    16   226   371   226   226   226   226    64    16
    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  32 13 N 101 30 W 1.9 TX BIG SPRING WB AP
```

As field length increases, the quantity of material being transported from the soil surface to a height of 2 meters (78.4") rapidly increases until the wind has attained 63.2% of its maximum transport capacity. The field length where the wind contains 63.2% of its capacity is called critical field length and is designated *s*. At *s* the average upwind soil loss is maximum. As field length decreases below *s* or is greater than *s*, average soil loss decreases.

Table 5.9.3 Comparison of field length and field size.

Field orientation *degrees*	Length-N *feet*	Field size *acres*	Erosoin estimate using KS13985.DAT *t/ac*	MODPPPR.DAT *t/ac*
0	2640	160	147	108
0	2640	20	311	162
0	400	20	670	593
0	330	20	709	651
0	165	10	654	615
0	100	6	563	478
1	100	6	525	431
10	100	6	675	512
22	100	6	745	558
45	100	6	725	600
89	100	6	283	187
90	100	6	242	146

In these examples as the field width decreases from 2640 to 330 feet, the soil loss increases dramatically. As field length decreases from 330 to 100 feet, soil loss decreases. From the data in Table 5.9.3 the field width with maximum annual soil erosion is about 330 feet.

From the Tabular Output (Table 5.9.4) using the w\MODPPPR.DAT weather file and the 160 acre field with Length-N = 2640, the *s* value varies from 197 to 786 feet.

For modifying field length to be effective in reducing soil erosion, the field length parallel to the dominant wind directrion must be less than the critical field length (*s*). This explains why some strip cropping systems have an accumulation of eroded soil at the upwind edge of each strip.

Figure 5.9.4 Tabular output from TEST-FT.MAN and MODPPPR.DAT with field orientation = 0°, length-N = 2640 feet, and field size = 160 acres.

Run Menu — REVISED WIND EROSION EQUATION

Erosion Computation Summary

Pd	Start Date	Days	E t/ac	CSL t/ac	Qmax lbs/ft	S ft	WF	K'	K''	V	SL
1	01/01/1998	15	3.46	18.8	369.7	275	35.3	0.675	0.675	1.000	1.
2	01/16/1998	15	3.47	18.9	370.8	274	35.3	0.677	0.677	1.000	1.
3	01/31/1998	1	0.23	0.5	24.7	749	2.4	0.678	0.678	1.000	1.
4	02/01/1998	14	8.41	63.7	899.0	197	58.0	1.000	1.000	1.000	1.
5	02/15/1998	14	8.41	63.7	899.0	197	58.0	1.000	1.000	1.000	1.
6	03/01/1998	1	0.63	1.8	67.0	517	6.4	0.673	0.673	1.000	1.
7	03/02/1998	15	9.48	75.0	1012.8	189	96.4	0.678	0.678	1.000	1.
8	03/17/1998	15	9.54	75.7	1020.0	188	96.4	0.683	0.683	1.000	1.
9	04/01/1998	15	7.79	57.3	832.5	203	79.0	0.680	0.680	1.000	1.
10	04/16/1998	15	7.87	58.1	840.9	202	79.0	0.687	0.687	1.000	1.
11	05/01/1998	15	5.56	36.1	594.3	230	53.4	0.719	0.719	1.000	1.
12	05/16/1998	15	5.87	38.9	627.5	226	53.4	0.759	0.759	1.000	1.
13	05/31/1998	1	0.39	1.0	42.0	615	3.6	0.761	0.761	1.000	1.
14	06/01/1998	14	4.15	24.2	443.8	257	39.2	0.731	0.731	1.000	1.
15	06/15/1998	15	4.77	29.3	509.6	244	42.0	0.783	0.783	1.000	1.
16	06/30/1998	1	0.32	0.7	34.1	665	2.8	0.787	0.787	1.000	1.
17	07/01/1998	14	1.83	7.9	195.8	348	12.6	1.000	1.000	1.000	1.
18	07/15/1998	15	1.96	8.7	209.8	339	13.5	1.000	1.000	1.000	1.
19	07/30/1998	2	0.26	0.5	28.0	715	1.8	1.000	1.000	1.000	1.
20	08/01/1998	13	0.83	2.7	88.5	467	8.1	0.708	0.708	1.000	1.
21	08/14/1998	15	1.01	3.5	107.4	434	9.3	0.745	0.745	1.000	1.
22	08/29/1998	3	0.18	0.4	21.7	786	1.9	0.752	0.752	1.000	1.
23	09/01/1998	12	1.17	4.3	124.8	411	11.4	0.709	0.709	1.000	1.
24	09/13/1998	15	1.54	6.2	164.9	370	14.2	0.749	0.749	1.000	1.
25	09/28/1998	3	0.31	0.7	33.3	670	2.8	0.757	0.757	1.000	1.
26	10/01/1998	12	1.47	5.8	156.7	378	22.2	0.456	0.456	1.000	1.
27	10/13/1998	15	2.06	9.2	219.7	333	27.7	0.512	0.512	1.000	1.
28	10/28/1998	4	0.56	1.6	60.2	538	7.4	0.526	0.526	1.000	1.
29	11/01/1998	11	2.24	10.4	239.8	322	22.7	0.682	0.682	1.000	1.
30	11/12/1998	15	3.12	16.3	333.0	285	30.9	0.695	0.695	1.000	1.
31	11/27/1998	4	0.83	2.7	89.2	465	8.2	0.698	0.698	1.000	1
32	12/01/1998	11	2.00	8.9	213.3	337	20.4	0.676	0.676	1.000	1.
33	12/12/1998	15	2.74	13.7	292.7	299	27.8	0.681	0.681	1.000	1.
34	12/27/1998	5	0.91	3.0	97.8	450	9.3	0.682	0.682	1.000	1.
35	01/01/1999	0	0.00	0.0	0.0	0	0.0	0.000	0.000	0.000	0.

Total Erosion (t/ac): 107.7

KEY_ESC= Exit Period Info Display

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Use arrows, <tab>, or <enter> keys to move through screen.

6. FLOW DIAGRAMS

The RWEQ program is written in "C " language. The WEQ coding was sent by NRCS to Manhattan and then to Dr. Saleh in Big Spring. Dr. Saleh modified the coding to include new science (technology), upgraded the interface (Vermont Views 4.05), included extended memory, deleted nonessential portions, and incorporated new factors (*e.g.* input screen, output, graphics, etc.).

Coding has been reviewed by Chuck Meyer, USDA and Bob Pickle, Vermont Views software consultant. Suggestions from these reviewers have been incorporated in RWEQ Version 97. To facilitate maintenance of the code, comments and documentation are being added.

Two sets of flow diagrams are presented. Traditional computer flow diagrams by Dr. Saleh are in Section 6.1. If these illustrate and answer all of your questions on RWEQ programs, do not read Section 6.2.

Generalized flow diagrams are given in Section 6.2. They are intended to illustrate the sequences in which the input data are used to compute changes in surface conditions and soil erosion.

6.1 DR. SALEH'S TRADITIONAL COMPUTER FLOW DIAGRAMS

6.1.1 Start

6.1.2 Roughness

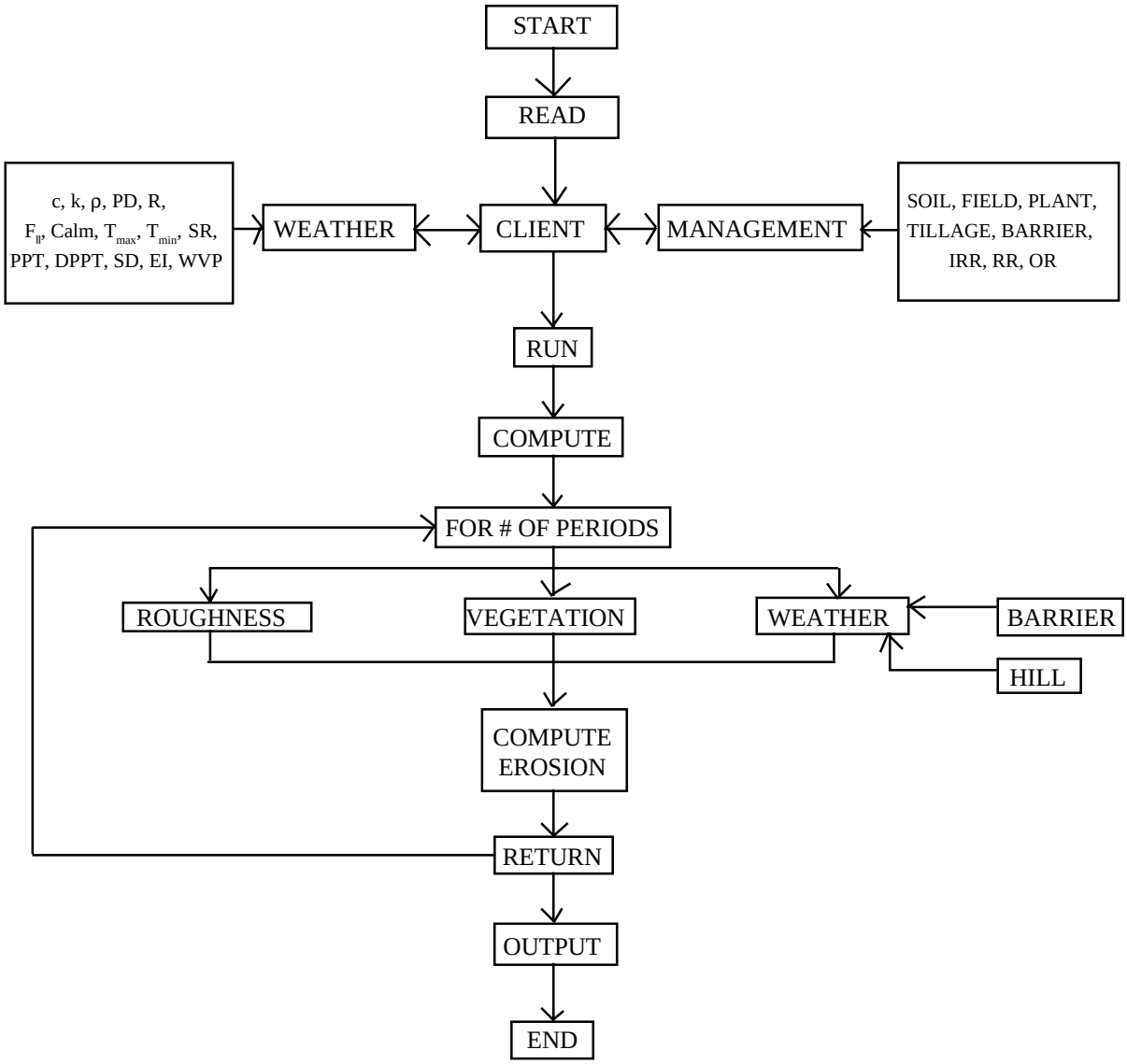
6.1.3 Vegetation

6.1.4 Weather

6.1.5 Erosion

Flow Diagram 6.1.1

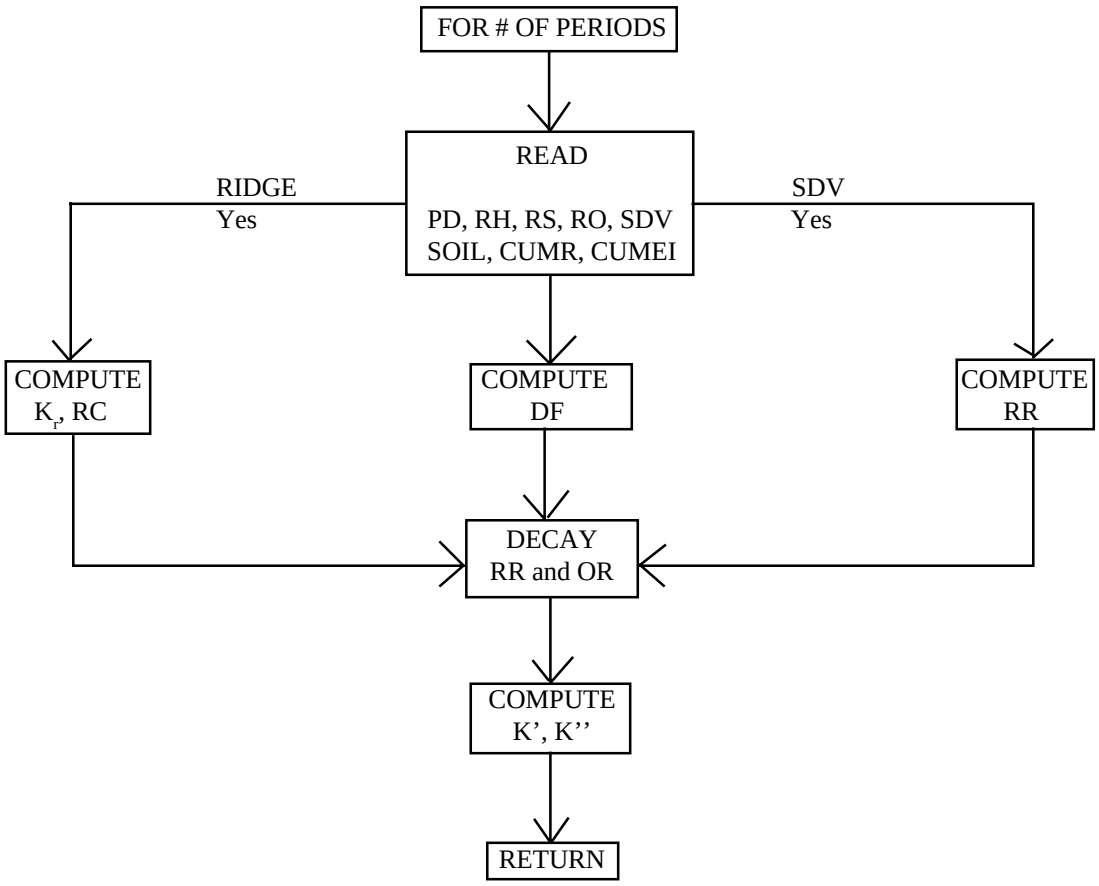
START



c	= Weibull scale parameter	SD	= probability of snow cover
k	= Weibull shape parameter	EI	= storm erosivity index
ρ	= air density	WVP	= wind velocity probability value
PD	= prevailing wind direction	SOIL	= % sand, % silt, % clay, % OM, % $CaCO_3$
R	= preponderance	FIELD	= size, shape, orientation, and length
F_{ll}	= positive parallel ratio	PLANT	= residue and growing crop properties
CALM	= no wind	TILLAGE	= tillage operations
T_{max}	= average maximum temperature	BARRIER	= height, spacing, porosity, and orientation
T_{min}	= average minimum temperature	IRR	= amount, rate, and number of irrigations
SR	= solar radiation	RR	= random roughness (standard dev. of aggregates)
PPT	= precipitation	OR	= oriented roughness (ridge height, ridge spacing, direction)
DPPT	= number of rain days	HILL	= height and slope gradient

Flow Diagram 6.1.2

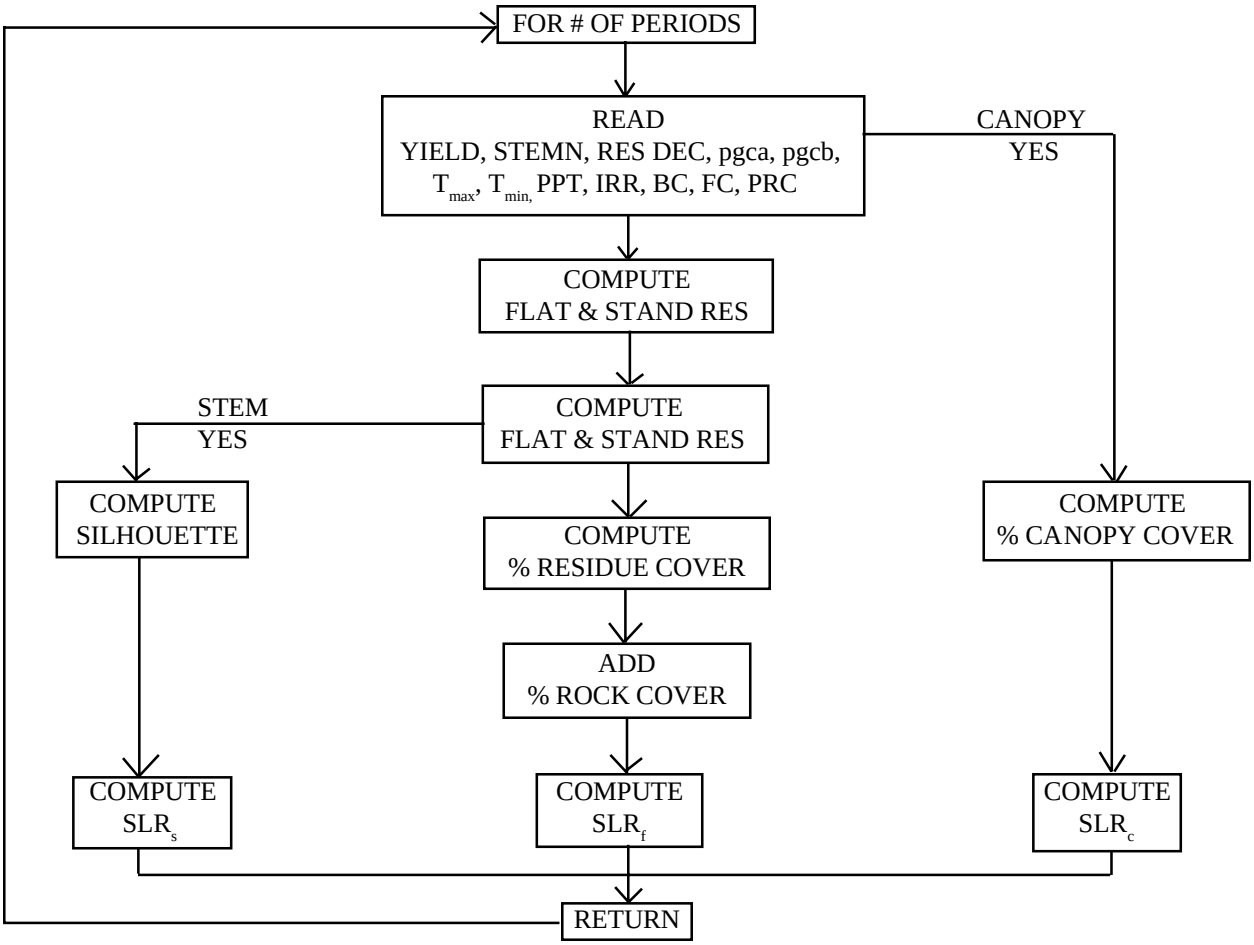
ROUGHNESS



PD	= wind direction	K_r	= ridge roughness coefficient
RH	= ridge height	RC	= rotational coefficient
RS	= ridge spacing	DF	= decay factor
RO	= ridge orientation	RR	= random roughness
SDV	= standard deviation of random roughness	OR	= oriented roughness
SOIL	= % sand, % silt, % clay, % OM, % $CaCO_3$	K'	= soil roughness coefficient perpendicular to wind
CUMR	= cumulated rainfall and irrigation	K"	= soil roughness coefficient parallel to wind
CUMEI	= cumulated storm erosivity index		

Flow Diagram 6.1.3

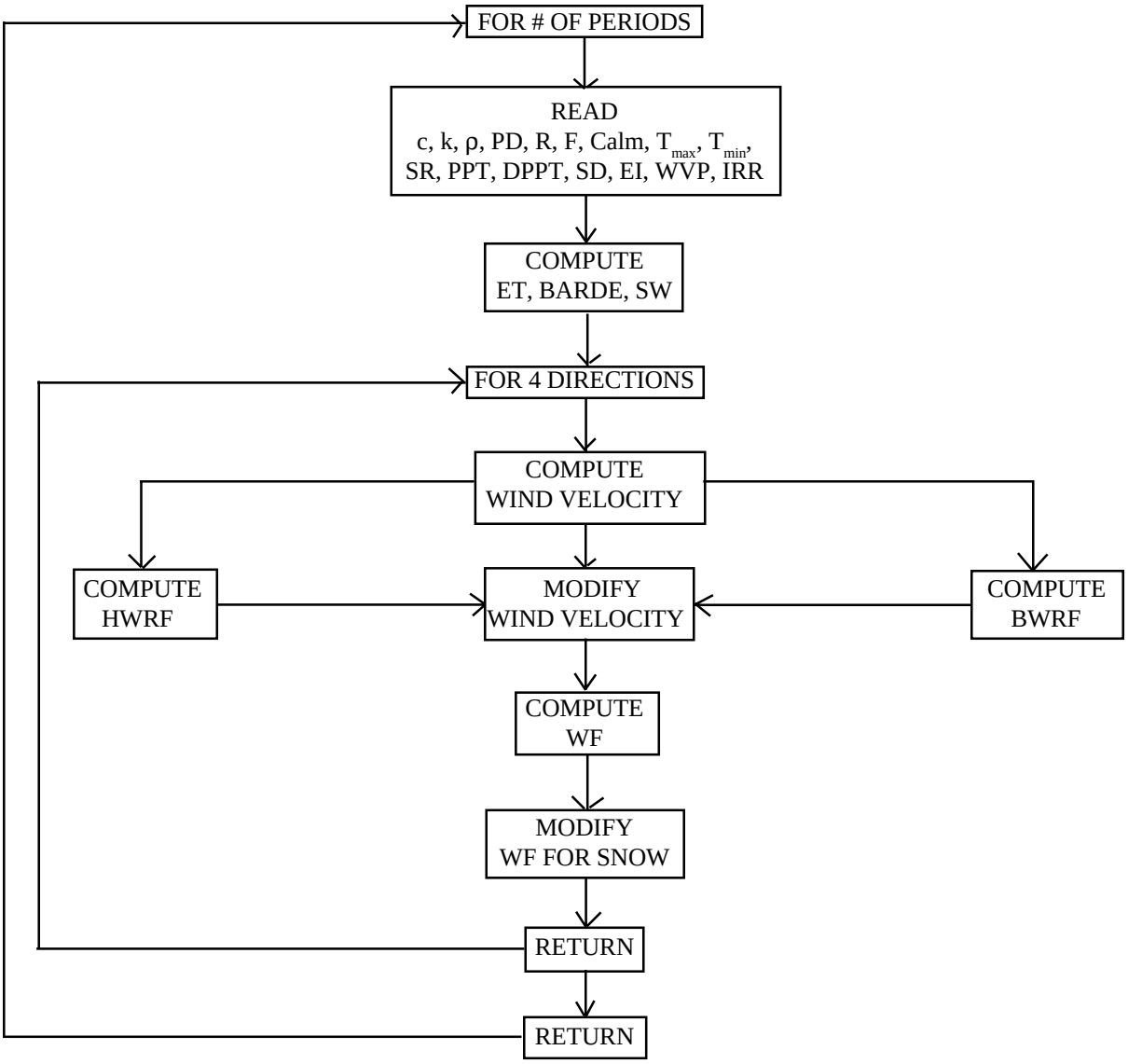
VEGETATION



YIELD	=	crop yield
STEMN	=	stem number
RES DEC	=	residue decay
pgca	=	plant growth coefficient, intercept
pgcb	=	plant growth coefficient, slope
T_{max}	=	average maximum temperature
T_{min}	=	average minimum temperature
PPT	=	precipitation
IRR	=	amount, rate, and number of irrigations
BC	=	burial coefficients
FC	=	flattening coefficients
PRC	=	% rock and gravel cover
SLR_s	=	soil loss ratio for silhouette
SLR_f	=	soil loss ratio for flat cover
SLR_c	=	soil loss ratio for crop canopy

Flow Diagram 6.1.4

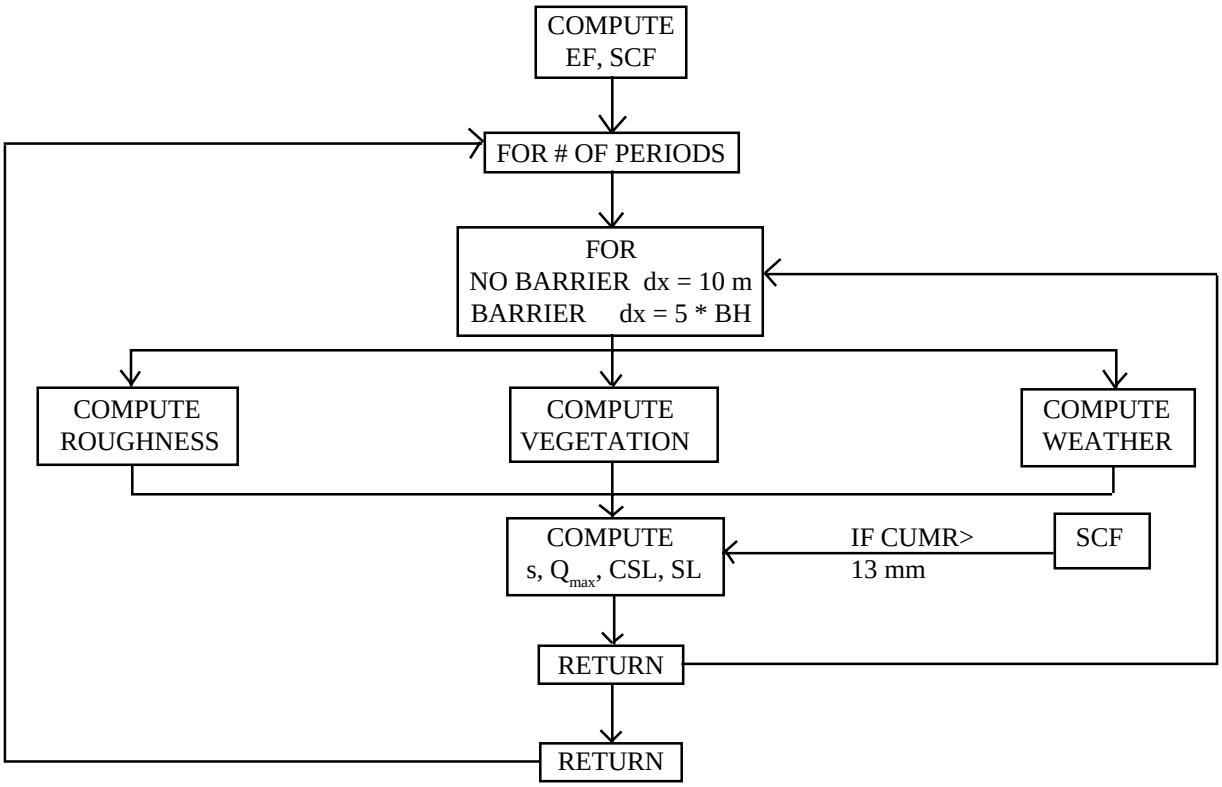
WEATHER



c	=	Weibull scale parameter
k	=	Weibull shape parameter
ρ	=	air density
PD	=	prevailing wind direction
R	=	preponderance
F	=	positive parallel ratio
CALM	=	no wind
T_{max}	=	average maximum temperature
T_{min}	=	average minimum temperature
SR	=	solar radiation
PPT	=	precipitation
DPPT	=	number of rain days
SD	=	probability of snow cover
EI	=	storm erosivity index
WVP	=	wind velocity probability value
IRR	=	amount, rate, and number of irrigations
ET	=	evapotranspiration
BARDE	=	barrier direction effect
SW	=	soil wetness factor
HWRF	=	hill wind reduction factor
BWRF	=	barrier wind reduction factor
WF	=	weather factor

Flow Diagram 6.1.5

EROSION



EF	=	erodible fraction
SCF	=	soil crust factor
dx	=	field length simulation spacing
s	=	critical field length
Q_{max}	=	maximum transport capacity
CSL	=	calculated soil loss
SL	=	soil loss
CUMR	=	cumulated rainfall and irrigation
BH	=	barrier height

6.2 GENERAL FLOW DIAGRAMS

The Flow Diagrams 1-9 correspond to the following section numbers.

6.2.1 Overview

A CLIENT file is made up of a WEATHER file and a MANAGEMENT file. When a CLIENT filename is specified in RWEQ, the associated WEATHER and MANAGEMENT files are automatically called into the start program. (Flow Diagram 6.2.1)

6.2.2 Start

The WEATHER and MANAGEMENT files supply data for both RUN and EROSION. (Flow Diagram 6.2.2)

6.2.3 Weather

The operator selects a weather file. The 16 components of the weather file are identified in Section 5.2 and are listed in Flow Diagram 6.2.3.

The computer selects 500 uniformly distributed probability values between 0 and 1 for each time period. These values are used with *c*, *k*, and calm coefficients to compute wind speeds at 10 meters. These velocities are converted to an equivalent 2-meter wind speed. The 2-meter velocities are adjusted for threshold velocity, multiplied by air density, divided by acceleration due to gravity, number of observations, and multiplied by soil wetness and snow cover to compute the weather factor. The rainfall-temperature-solar radiation data are used to calculate soil wetness.

Weather factors are computed for the prevailing wind direction, perpendicular to the prevailing, and opposite but parallel to the prevailing direction. For each time period, *WF* 's are computed for four directions. Only the prevailing wind direction *WF* data are printed in the output file.

The estimated erosion is the soil loss from the downwind edge of the field. Erosion is computed for four wind directions. For each time period there are four erosion estimates, four critical soil loss values, and four critical field lengths. Erosion output is the total soil loss from the four directions.

Temperature and rainfall/irrigation data are used in RUN to decay plant residues. Rainfall/ irrigation amounts, rain/irrigation days, and *EI* values are used in RUN to adjust soil roughness.

6.2.4 Management

The MANAGEMENT input file contains information on CROP, TILLAGE, SOIL, irrigation, period, field, hills, and barrier that is unique to a single field or farmer. A management file contains input for RUN and EROSION. (Flow Diagram 6.2.4)

6.2.5 Soil

The SOIL file contains input data on percent sand, silt, organic matter, calcium carbonate, and rock cover. These data are used to compute the erodible fraction (*EF*). The *EF* is considered a property of the soil and is not adjusted within RWEQ. (Flow Diagram 6.2.5)

6.2.6 **Crop**

The CROP file contains input on residue decomposition and crop canopy coefficients. The operator must input crop yield and an estimate of the number of standing stems in a unit area. The operator may also input percent ground cover on any operation date. (Flow Diagram 6.2.6)

6.2.7 **Tillage**

The TILLAGE file contains input for ridge height/spacing, random roughness, ridge orientation, and residue burial and flattening coefficients. The operator may overwrite any of these values in the **DOABLE SCREEN** to customize the implement effects for a specific region or farmer. (Flow Diagram 6.2.7)

6.2.8 **Run**

Within RUN soil roughness/residue level data are generated for each time period. This is the only loop in RWEQ where values are updated as the erosion season progresses. (Flow Diagram 6.2.9)

In RWEQ RUN assembles input from SOIL, TILLAGE, and CROP. Initial values of soil roughness and residue levels are modified with input from MANAGEMENT and WEATHER. The modified values for surface roughness and residue levels at the end of a time period are initial conditions for the next period.

SOIL, TILLAGE, and WEATHER data are used to compute soil roughness decay. The rock cover from SOIL is added to the flat cover value in CROP to provide a single SLR_f coefficient. Rock cover is not changed with tillage or weather.

SCF is automatically set to a value of 1 by any tillage operation that disturbs the soil surface. When 13 mm of precipitation is received after a tillage operation, the SCF is used in EROSION.

Changes in standing residue mass are computed using weather file and crop decomposition. The plant growth coefficients are used to compute canopy cover based on days after planting.

Flat and standing residue mass decay rates are a function of crop, number of rainfall/irrigation events, and temperatures within the time period. The mass values at the end of each time period are adjusted with burial and flattening coefficients from TILLAGE. The remaining mass is converted to Soil Loss Ratio coefficients for flat cover (SLR_f), for standing silhouette (SLR_s), and if there is growing vegetation, for crop cover (SLR_c).

From the ridge height/spacing input data a ridge roughness coefficient (K_r) is determined. When K_r is combined with random roughness, soil roughness perpendicular (K') to the wind is computed. Random roughness is decayed with rainfall/irrigation amounts (*CUMR*) and *EI* values (*CUMEI*) for each period.

6.2.9 **Erosion**

Estimates of erosion are based on the *WF* adjusted for barriers, hills, ridge orientation, and surface conditions for a 1 to 15-day period. No adjustments in *EF*, *K*', *K*", or residue levels are made within a single time period or during an erosion event.

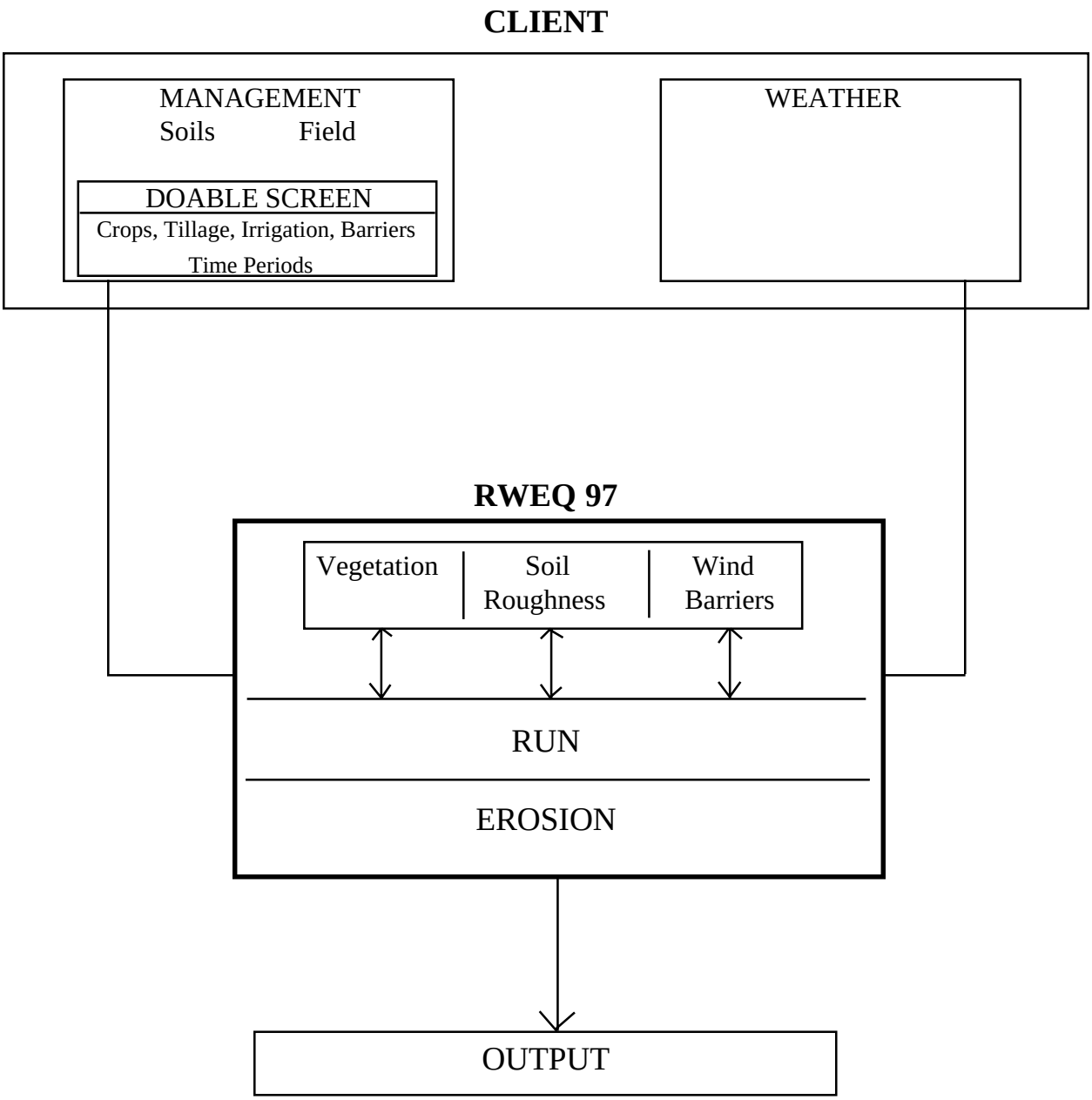
RWEQ computes the average field length for 200 equal width strips. The average of the 200 field lengths is used to compute the mass loss. Total mass is divided by the field area to compute average soil loss (*SL*). EROSION computes the field length (*s*) where the wind has attained 63.2% of the maximum transport capacity. EROSION also computes the maximum transport capacity of that wind over that field surface. Output from EROSION does not loop to any other routine within RWEQ.

6.2.9.1 **Barriers:** Annual or perennial barriers reduce the leeward wind speed. The protected zone of a barrier is influenced by wind speed and barrier properties.

Distance increments for are 10 meters for a no-barrier field and 5 barrier heights (BH) for a field with windbarriers.

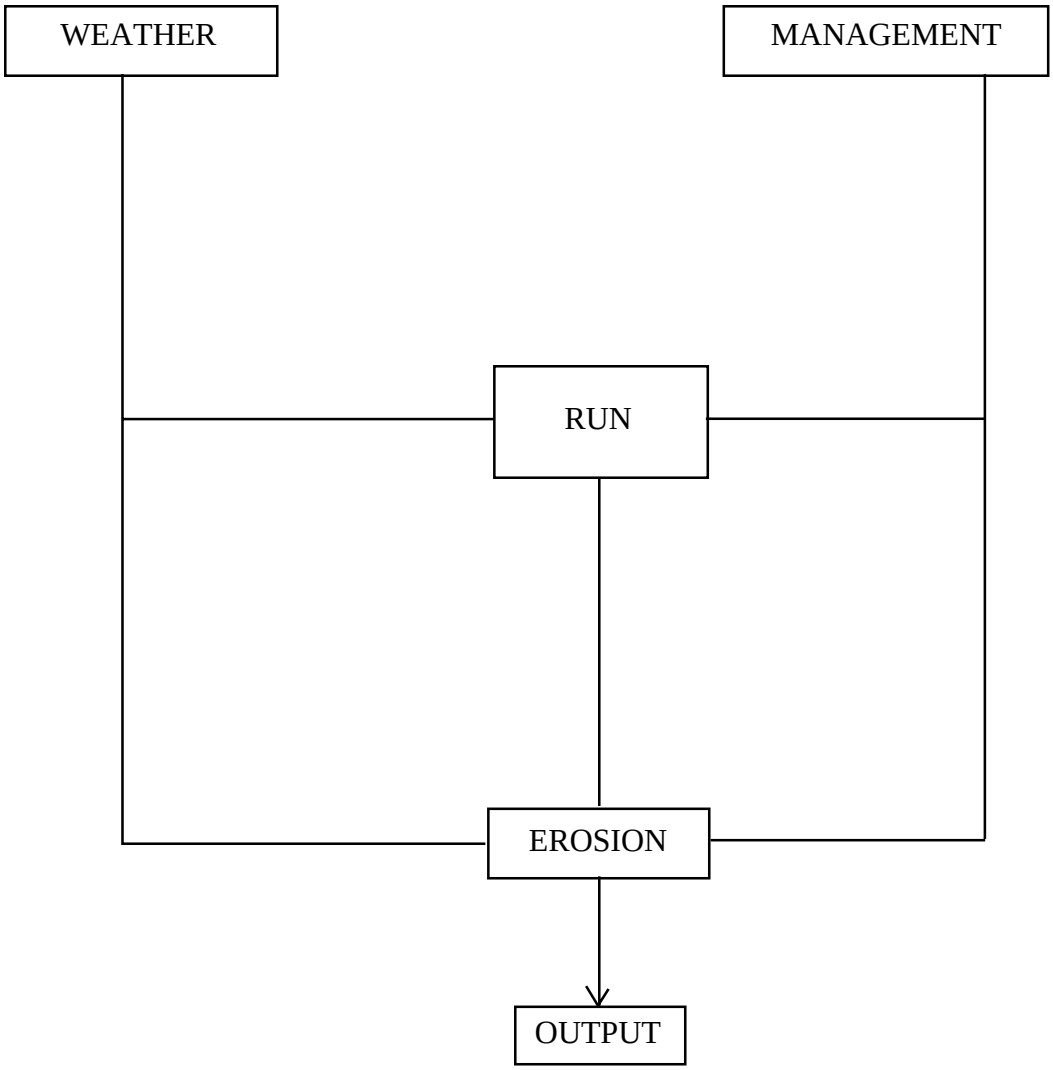
6.2.9.2 **Hills:** Hills or knolls increase the velocity of the wind on the upwind slope and decrease the velocity on the downwind slope. A hill may be treated as a separate field to modify soil erodibility or residue levels.

Flow Diagram 6.2.1



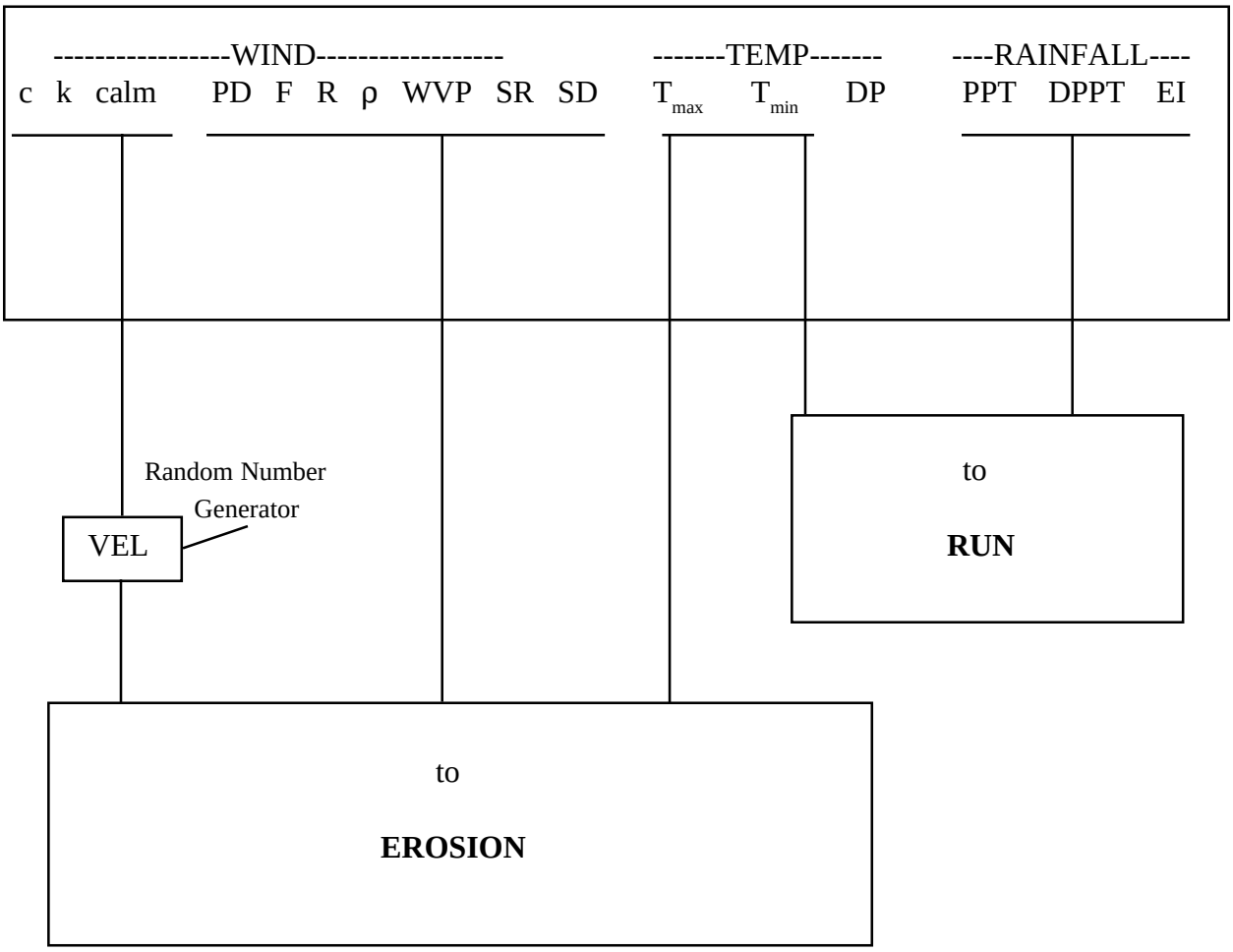
Flow Diagram 6.2.2

START



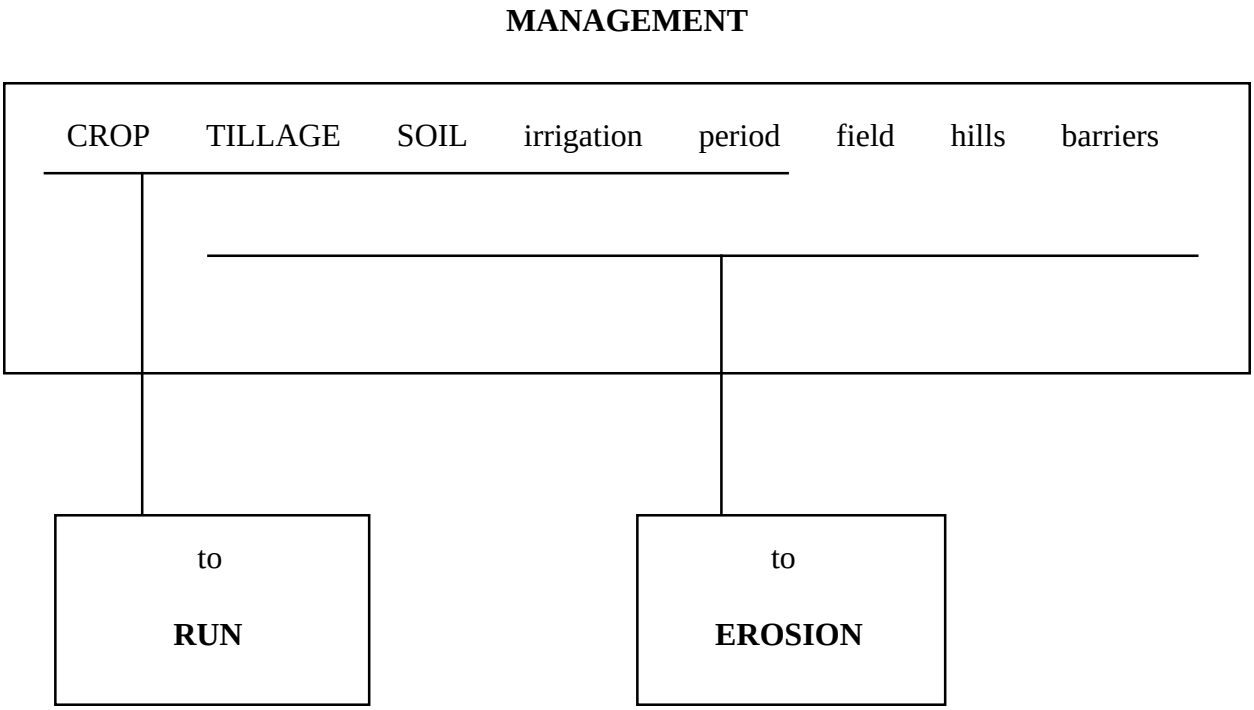
Flow Diagram 6.2.3

WEATHER



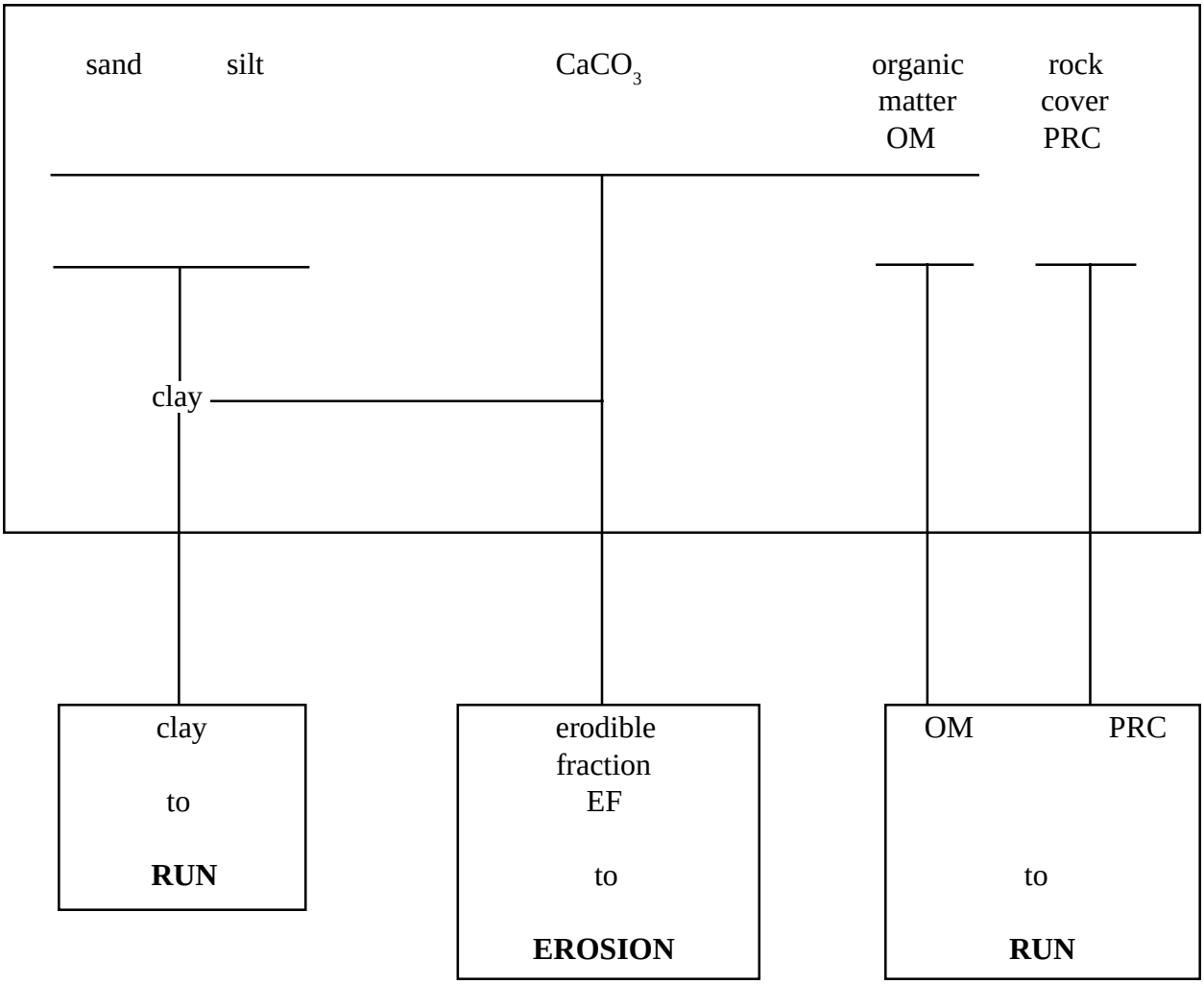
c	=	Weibull scale parameter	SD	=	probability of snow depth greater than 25.4 mm
k	=	Weibull shape parameter	T_{max}	=	average maximum air temperature
calm	=	percent of calm time	T_{min}	=	average minimum air temperature
PD	=	prevailing wind erosion direction	DP	=	dew point temperature
F	=	positive parallel ratio in opposite directions	PPT	=	precipitation
R	=	preponderance in PD	DPPT	=	number of rain days
ρ	=	air density	EI	=	erosiveness index from RUSLE databases
WVP	=	wind velocity probability value	VEL	=	wind velocity
SR	=	solar radiation			

Flow Diagram 6.2.4



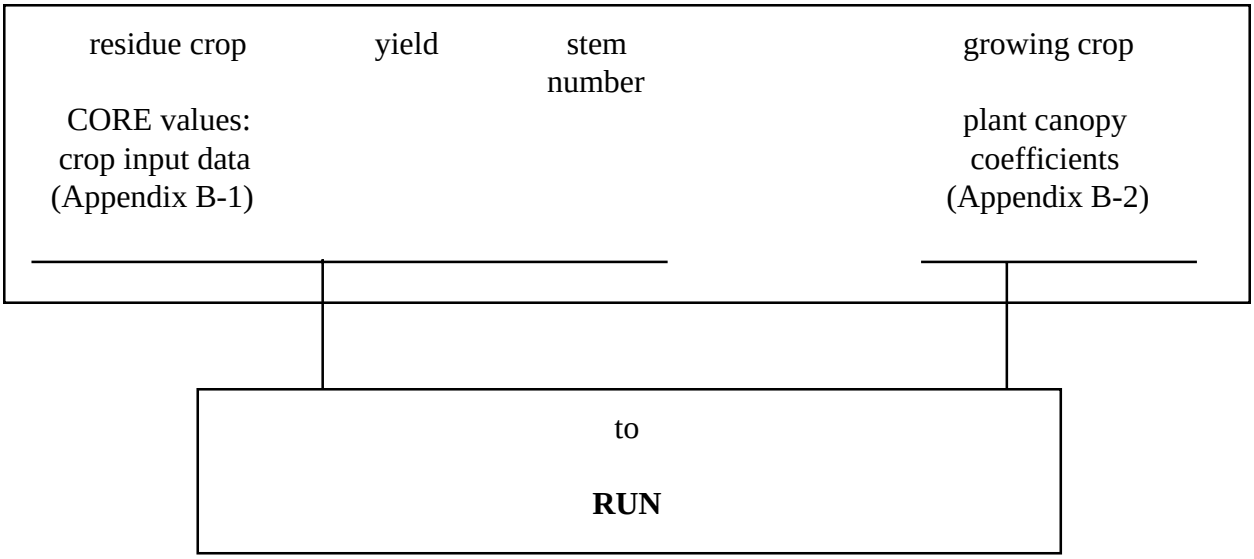
Flow Diagram 6.2.5

SOIL



Flow Diagram 6.2.6

CROP



Appendix B-1: CORE Values: Crop Input Data Set

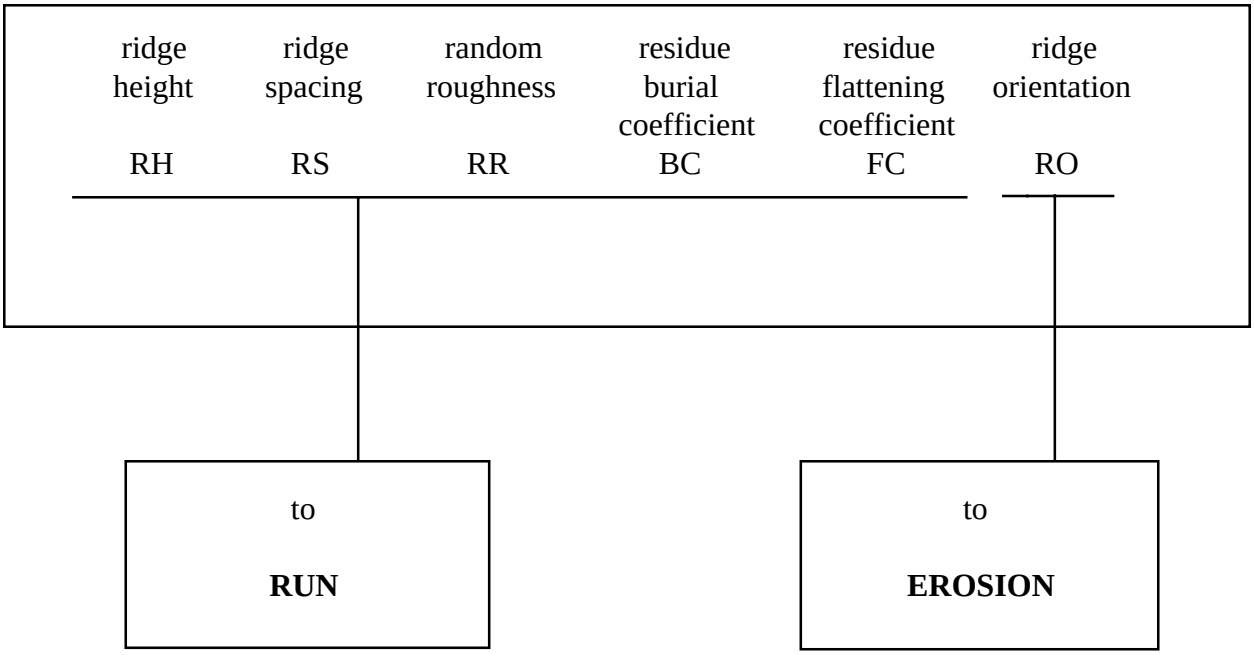
y_a = yield intercept
y_b = yield slope
CH = crop height
SDIAM = stem diameter
HH = after harvest height
k_{ms} = standing mass loss coefficient
k_{mf} = flat mass loss coefficient
k_{sn} = stem decline coefficient
mcf = mass/cover conversion coefficient
tof = takeoff factor
dd_o = stem number threshold decomposition days

Appendix B-2: Plant Canopy Coefficients for Growing Crops

pgca = plant growth coefficient
pgcb = plant growth coefficient

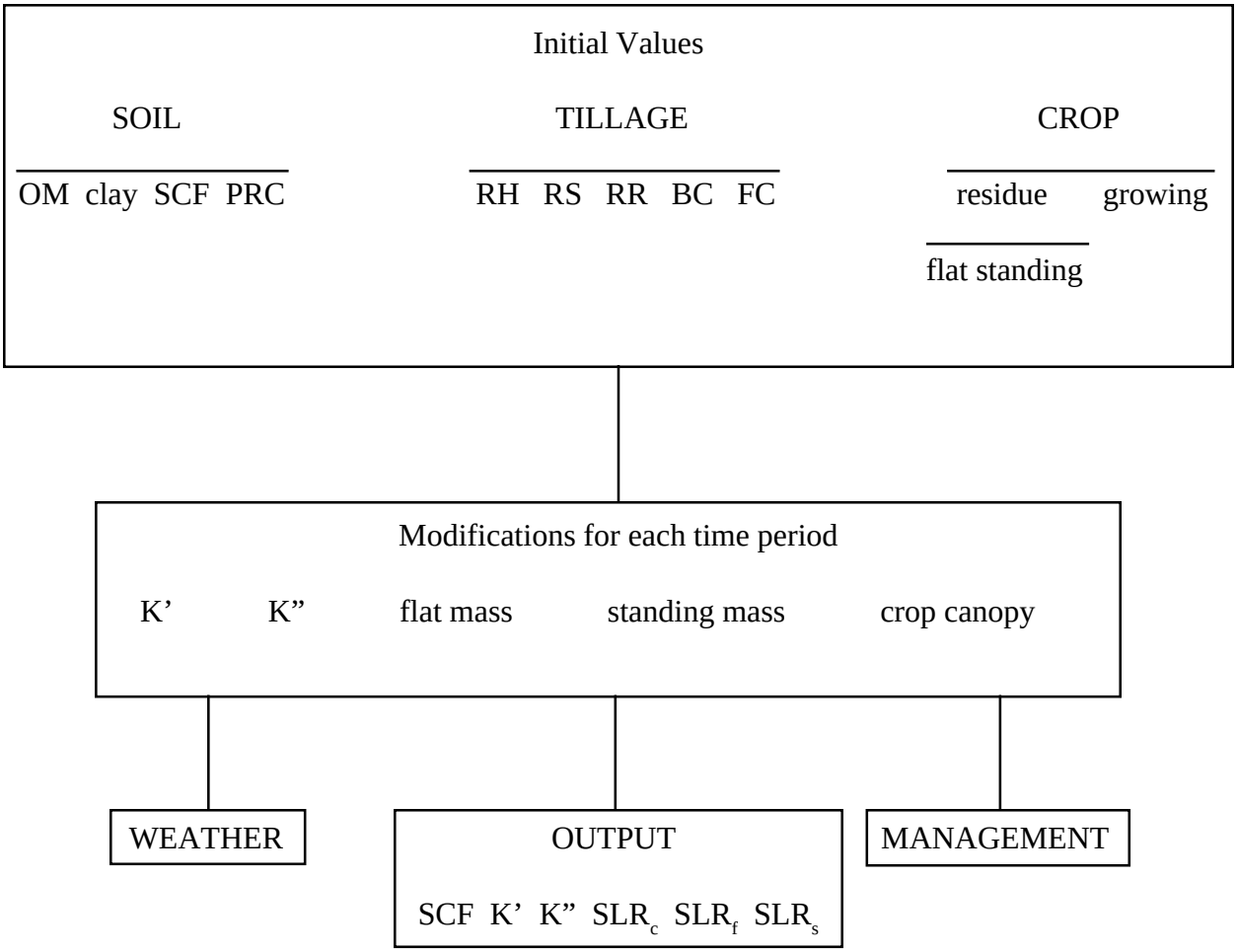
Flow Diagram 6.2.7

TILLAGE



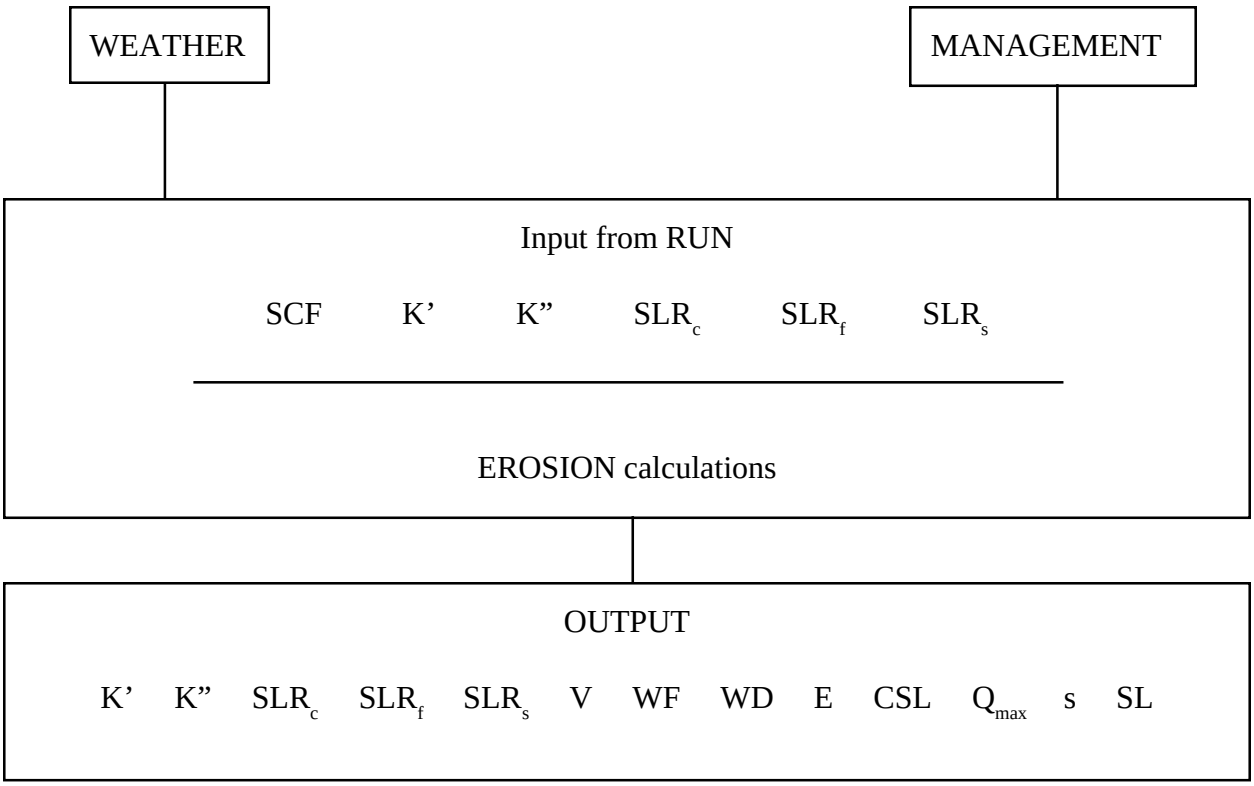
Flow Diagram 6.2.8

RUN



Flow Diagram 6.2.9

EROSION



K' = soil roughness perpendicular to prevailing wind
K" = soil roughness parallel to prevailing wind
SLR_f = flat residue cover plus rock cover coefficient
SLR_s = silhouette coefficient
SLR_c = growing crop canopy coefficient
V = vegetation (SLR_f x SLR_s x SLR_c)
WF = weather factor
WD = prevailing wind direction
E = erosion
CSL = critical soil loss
Q_{max} = maximum transport capacity
s = critical field length
SL = average field soil loss

7. RESEARCH NEEDS

Whenever a model is developed, there are areas not included because of lack of data. This was true with the Wind Erosion Equation, and is true with the Revised Wind Erosion Equation. The following areas need further study to provide additional insight into wind erosion mechanics and improve wind erosion estimates.

7.1 FREEZE and THAW

A routine is needed to describe the changes in soil surface conditions as a result of freeze/thaw or overwinter effects. The soil surface resulting from freeze/thaw may be highly resistant or susceptible to wind erosion.

Some data have been collected but the highly divergent results make it difficult to model the process. The soil-erosion-weathering relationships are very complex since the freeze/thaw effect is dependent upon the moisture status of the soil when it is frozen in the fall.

7.2 PM-10 or SUSPENSION

Erosion of soils by wind may produce tremendous clouds of visible dust, but the concentrations of very fine particles (*i.e.* less than 10 microns) within the dust cloud have not been defined for most agricultural situations. Traditional PM-10 instruments have been placed in agricultural fields, but the measurements of PM-10 have been questioned because the instruments collect significant numbers of large particles.

7.3 CROP GROWTH TIED TO WEATHER

The present crop growth coefficients are a mathematical expression of the cover crop data. Crop canopy development should be tied to weather files to avoid the appearance of good canopy cover in areas where rainfall may not be sufficient for the crop to survive.

The Pendleton wheat growth model is being evaluated to see if it can be adapted for RWEQ.

7.4 WINDBARRIER GROWTH AND DECOMPOSITION

In the RWEQ model, the effect of windbarriers is immediate. The barrier is fully developed whenever the operator inputs the barrier characteristics. A routine is needed to grow and then decay annual crop barriers. Barrier crop growth coefficients would grow a barrier like a normal crop. This routine would output plant height and silhouette to be used after frost (or maturity) to begin the decomposition routine.

7.5 ORGANIC SOILS

Field erosion data are being collected in Florida. These data are essential to properly express the factors commonly used in RWEQ, but for organic soils. Factors include soil erodibility, transport capacity, and surface roughness.

7.6 RANGELANDS

To use RWEQ for rangeland erosion requires the operator to make major assumptions for soil and plant conditions. Data are being collected from rangelands in the El Paso, Texas area to test a modified version of RWEQ for rangelands (RWEQR). The basic physics is the same but expressions for non-uniform plant populations, uneven surface roughness, and variable soil erodibility must be incorporated.

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