The Wind Erosion Prediction System

WEPS 1.0
User Manual

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Preface and Acknowledgments

Preface

Wind erosion is a serious problem on agricultural lands throughout the United States as well as the world. The ability to accurately predict soil loss by wind is essential for, among other things, conservation planning, natural resource inventories, and reducing air pollution from wind blown sources. The Wind Erosion Equation (WEQ) is currently widely used for assessing average annual soil loss by wind from agricultural fields. The primary user of WEQ is the United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). When WEQ was developed more than 35 years ago, it was necessary to make it a simple mathematical expression, readily solvable with the computational tools available. Since its inception, there have been a number of efforts to improve the accuracy, ease of application, and range of WEQ. Despite these efforts, the structure of WEQ precludes adaptation to many problems.

The USDA appointed a team of scientists to take a leading role in combining the latest wind erosion science and technology with databases and computers, to develop what should be a significant advancement in wind erosion prediction technology. The Wind Erosion Prediction System (WEPS) incorporates this new technology and is designed to be a replacement for WEQ.

Unlike WEQ, WEPS is a process-based, continuous, daily time-step model that simulates weather, field conditions, management, and erosion. WEPS 1.0 consists of the WEPS science model with a user-friendly interface that has the capability of simulating spatial and temporal variability of field conditions and soil loss/deposition within a field. WEPS 1.0 can also simulate simple field shapes and barriers on the field boundaries. The saltation/creep, suspension, and PM10 components of eroding material also can be reported separately by direction in WEPS 1.0. WEPS 1.0 is designed to be used under a wide range of conditions in the United States and is adaptable to other parts of the world. For further information regarding WEPS contact:

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Finally, acknowledgment is made of the many other individuals who have made this release of WEPS possible by reviewing this document and those who contributed through fundamental research on which many of the underlying concepts of WEPS are based.

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INTRODUCTION

Introduction

How to Use This Document

The Wind Erosion Prediction System or 'WEPS' is a process-based, daily time-step, wind erosion simulation model. It represents the latest in wind erosion prediction technology and is designed to provide wind erosion soil loss estimates from cultivated, agricultural fields. WEPS 1.0 consists of the computer implementation of the WEPS science model with a graphical user interface designed to provide easy to use methods of entering inputs to the model and obtaining output reports. WEPS was developed by the Wind Erosion Research Unit (WERU) of the United States Department of Agriculture, Agricultural Research Service.

The WEPS 1.0 User Manual is designed to provide information to different levels of users. Those users who are completely new to WEPS should start by reading all of this chapter to get an introduction to WEPS. It is recommended that, as a minimum preparation to use WEPS, the user should read the "Overview of the Wind Erosion Prediction System."

The minimum computer requirements and the steps to install WEPS onto your computer are described in this chapter. Once WEPS has been installed on your computer, you should learn how to make a simple simulation run using the "Quick Start for WEPS 1.0." More experienced users should become familiar with the "Interface Reference - How to Operate WEPS", which goes into detail of how to use all of the capabilities of WEPS 1.0. These details are also available in the 'Online Help,' accessible through the toolbars on the WEPS 1.0 interface screen.

"Using WEPS in Conservation Planning" contains sections on 'Interpreting Outputs', 'Special Field Configurations', and 'Using Barriers for Erosion Control in WEPS.' This section also has 'Exercises,' which guide the user through scenarios that describe how to use WEPS to design conservation systems.

The "Science Overview" contains information for more advanced users. For users interested in more details on the interface and science behind WEPS, 'Interface Implementation and Science Model' is recommended. An even more detailed description of the science of the WEPS model is available in the "WEPS Technical Description," which can be obtained from WERU.

The Science Overview also contains information for more advanced users, such as the WEPS 'Databases' and a listing of 'Submodel Report Flags and Command Line Options.' Databases are described for the Weather, Soil, Crop, Management, and Operations sections of WEPS. Submodel Report Flags and Command Line Options are set under the

'Configurations' tabs available through the Main Screen of the interface. Certain permissions may be required to alter some of these flags and options. There is an section on "Using WEPS with Measured Data" that will be useful to researchers and other users, such as those outside the United States who do not have their soils data in the SSURGO database format.

Finally this manual contains a series of "HowTo" Guides which provide the user with in depth detail of simulating barriers and strip cropping. There are also "HowTo" Guides that guide the user in developing additional crop and management operation database records.

Throughout this manual, the term "user" refers to the person(s) using WEPS 1.0 to set up and make a simulation run. "Operator" refers to the producer or land manager whose actual field is being simulated with WEPS. This manual contains many graphics that are examples of what can be seen on the computer screen using WEPS. In addition, WEPS will continually be improved and the screens may change. Therefore, the user may or may not see the exact same screens as those illustrated in this manual.

WEPS is a model developed primarily for use by the USDA, Natural Resources Conservation Service (NRCS). As such, many of the capabilities of WEPS reflect the needs of NRCS for use in cultivated agricultural systems. But, WEPS has capabilities to be used in other situations where wind affected soil movement is a problem. Contact WERU if you wish to use WEPS to predict erosion for situations other than traditional cultivated agricultural systems.

Minimum Computer Requirements

The minimum recommended requirements to install and operate WEPS 1.0 effectively are: A personal computer (PC) with Windows 95/98 (48 Mb RAM), Windows NT (64 Mb RAM), Windows 2000 (192 Mb RAM), or Windows XP (256 Mb RAM); 300 MHz Pentium; 150 Mb free disk space on the hard drive; internet web access to download and install or a CD-ROM drive for installation; and a VGA color monitor with a minimum screen resolution of 800 x 600 pixels. Requires Java 1.60 or later (may be provided with some releases). Contact WERU if you need assistance.

Installation

For Windows operating systems, insert the WEPS 1.0 CD into the CD-ROM drive (see web access and installation instructions in the next paragraph). Click [Start], [Run], and enter {d:/WEPS_1.0_install.exe} where "d" represents the drive letter for your CD-ROM drive. Alternatively one can click on *WEPS_1.0_install.exe* within the CD-ROM drive accessible using the 'explore' option though the 'My Computer' desktop icon. Follow the instructions on the screen. NOTE: See the "readme" file for up-to-date installation instructions for this CD-ROM. Also note that on Windows NT, 2000, and XP machines, the user must either be logged in as "administrator" or have sufficient privileges to successfully install WEPS 1.0. The WEPS install program will inform the user attempting installation if they do not have sufficient privileges to perform the installation.

WEPS1.0 is also available for download on the WERU web site at: http://www.weru.ksu.edu/weps . Click the link for "Downloads" and fill out the WEPS Download Registration form. If you fill out the registration form, WERU provides email notices of updates to the model. The download file consists of an executable file that will install WEPS onto your Windows computer. Contact WERU if you need assistance at:

Phone: 785-537-5559
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An Overview of the Wind Erosion Prediction System

Introduction

Soil erosion by wind is a serious problem in the United States and the world. Wind erosion is a threat to agriculture and the earth's natural resources. It renders soil less productive by removing the most fertile part of the soil, namely, the clays and organic matter. This removal of clays and organic matter also damages soil structure. In addition to the soil, wind erosion can damage plants, primarily by the abrasive action of saltating particles on seedlings and fruits. Eroded soil can also be deposited into waterways where it impacts water quality and emitted into the air where it degrades the air resources. By affecting these resources, wind erosion can also become a health hazard to humans and other animals. The ability to accurately simulate soil loss by wind is essential for, among other things, environmental and conservation planning, natural resource inventories, and reducing air and water pollution from wind blown sources.

The Wind Erosion Equation (WEQ) was published in 1965 by Woodruff and Siddoway (1965). For years, WEQ has represented the most comprehensive and widely used model in the world for estimating soil loss by wind from agricultural fields. The functional form of WEQ is:

$$E = f(I, C, K, L, V)$$

where, E is the average soil loss (tons/acre/year), I is the soil erodibility, K is the soil ridge roughness, C is the climatic factor, L is the field length along the prevailing wind erosion direction, and V is the vegetative factor. WEQ is largely empirical in nature and was derived from nearly 20 years of field and laboratory studies by scientists at the USDA-Agricultural Research Service (ARS), Wind Erosion Research Unit (Chepil, 1958, 1959, 1960; Chepil and Woodruff, 1959). Many improvements were made to WEQ over the next 30 years. Because of the limitations of adapting WEQ to many problems and environments, as well as advancements in wind erosion science and computer technology, the USDA Natural Resources Conservation Service requested that ARS develop a replacement for WEQ (Hagen,1991).

Development of WEPS

Research in the 1980's (Cole et. al., 1983; Cole, 1984; and Lyles, et. al., 1985) provided the initial attempt to outline a processed based approach to simulating wind erosion that would replace WEQ. Following this initial work, the modular structure used in the current WEPS model was developed (Hagen, 1991) and the experimental research needed to support that structure was outlined. Numerous field and laboratory studies were conducted to develop relationships for surface conditions and erosion. Experimental data were collected for weather (Skidmore and Tatarko, 1990), hydrology (Durar and Skidmore, 1995), crop growth (Retta and Armbrust, 1995), residue decomposition (Steiner et. al., 1995), soil (Hagen, et. al., 1995; Potter, 1990, Zobeck and Popham, 1990, 1992), management (Wagner and Ding, 1995), and erosion (Hagen, 1995). Experiments were also conducted to validate that the erosion routines were producing accurate and precise erosion estimates (Fryrear, et. al, 1991).

A multi-disciplinary team was assembled to develop WEPS that included climate modelers, agronomists, agricultural engineers, soil scientists, and crop modelers. The WEPS development project had a multi-agency commitment consisting of the Agricultural Research Service, Natural Resources Conservation Service, and the Forest Service from the U.S. Department of Agriculture, along with the Environmental Protection Agency, the Army Corps of Engineers, and the Bureau of Land Management. In 2005, WEPS was released to the NRCS for testing and further development for field office conservation planning. In 2008, WEPS was released to NRCS for field office implementation.

WEPS User Requirements

Early in the WEPS development process, input was requested from potential users on the needed capabilities of a new wind erosion simulation model. These user requirements were summarized by Hagen (1991). Based on these requirements, WEPS was designed to:

1. Provide more accurate and detailed estimates of soil loss by wind from agricultural fields. Results for WEQ were an annual average soil loss based essentially on average weather and field conditions. Since erosion is often the result of extreme weather events (e.g., high wind or dry soil conditions), an approach that accounts for such extreme conditions was needed to simulate the extreme soil loss for these situations. In addition, WEPS is capable of outputting erosion loss and surface conditions on a relatively fine temporal scale (e.g., hourly). However, for practical purposes, the default time step for WEPS output is two weeks. Such detail allows the user to observe the periods when the excessive erosion occurs and the wind or surface conditions which caused the soil loss (e.g., low vegetative cover). These conditions can then be addressed by altering management or other control measures.

2. Develop more cost-effective erosion control methods. Because of the detail in the soil loss and field conditions provided by WEPS, it is a valuable tool for testing various management scenarios or control methods through simulation. Each scenario can be evaluated before a change in farming practices in made in the field. Surface conditions and management can be observed during periods of excessive loss and adjusted to minimize erosion.

3. Simulate the amount of soil loss by direction. With increasing concern of the offsite impacts of wind erosion on soil, water, and air quality, the capability of WEPS to provide the direction of soil loss is useful. For example, creep and saltation loss to a roadside ditch or waterway will impact water quality, so attention can be focused in these scenarios to controlling loss in that direction. Similarly, suspension loss in the direction of highly populated areas can be simulated with WEPS and control strategies simulated.

4. Separate soil loss into creep/saltation, suspension, and PM10 components. Each of these components have specific characteristics and effects. Creep/saltation are typically deposited locally where they can affect soil and water quality, bury crops, roads, and irrigation ditches, or be deposited as dunes in fences or windbreaks. Suspension, by definition, can be lifted into the air and carried great distances. As such, it can be a detriment to air quality, become a health hazard, and reduce visibility along transportation systems. PM10 has been determined by the U.S. Environmental Protection Agency to be a hazard to air quality and a respiratory hazard in particular (U.S. EPA, 1996). Estimating soil loss of each of these components can aid in environmental assessments.

Taking all user requirements into consideration, WEPS is designed to be and aid in: 1) soil conservation planning, 2) environmental assessment and planning; and 3) determining off-site impacts of wind erosion.

WEPS Modeling Approach

WEPS is a process-based, daily time-step model that simulates weather, field conditions, and erosion. As such, it simulates not only the basic wind erosion processes, but also the field processes that modify a soil's susceptibility to wind erosion. The initial model release is WEPS 1.0 and is designed to provide the user with a simple tool for inputting initial field conditions, calculating soil loss, and displaying either simple or detailed outputs for conservation planning and designing erosion control systems.

WEPS 1.0 Geometries
To simplify inputs, WEPS 1.0 is designed with specific geometric constraints when specifying the simulation region or field (Figure 1.2). The simulation region is limited to a rectangular area. However other field shapes such as circles or half circles can also be simulated by defining a rectangle of the same length, width, or area of the desired field shape. The simulation area may be rotated to orient the field correctly on the landscape to account for the effects of varying tillage, planting, and wind directions.

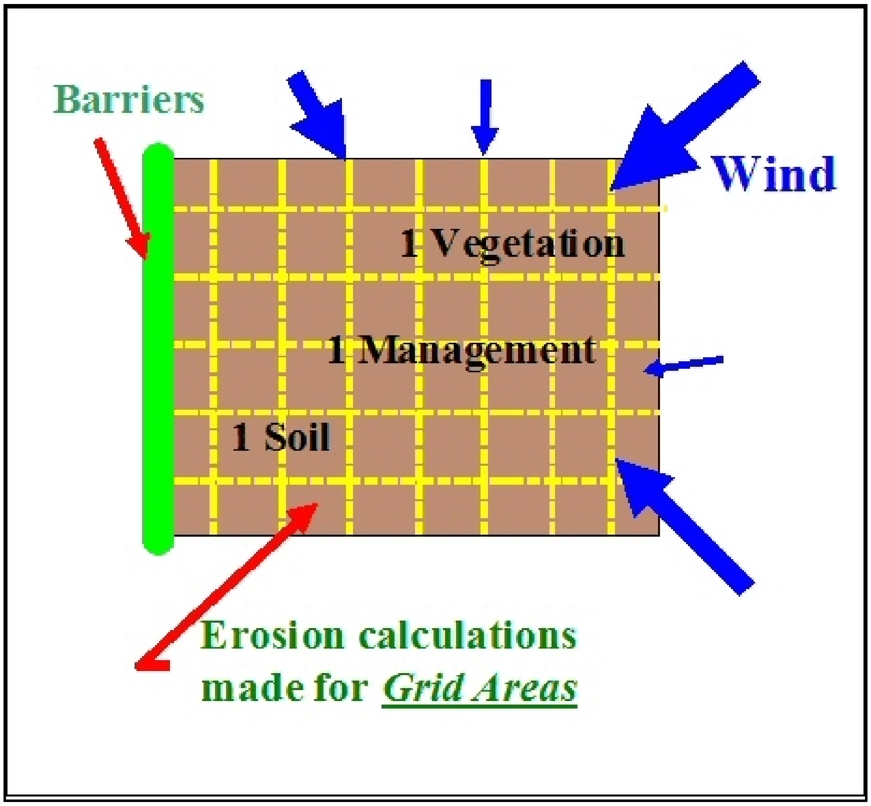

Figure 1.1. WEPS simulation geometries.

A uniform simulation region surface is assumed in that only one soil type (uniform soil properties), crop type (biomass properties), and management are uniformly distributed over the field. In reality, fields are often not uniform so the user may select the dominant-critical (i.e., most erodible) soil or crop condition for a simulation. Barriers may be placed on any or all field boundaries. When barriers are present, the wind speed is reduced in the sheltered area on both the upwind and downwind sides of the barriers. However WEPS may simulate deposition in front of downwind barriers. The erosion submodel determines the threshold friction velocity at which erosion can begin for each surface condition. When wind speeds exceed the threshold, the submodel calculates the loss/deposition over a series of individual grid cells representing the field. The soil loss and deposition is divided into components of saltation/creep and suspension, because each has unique transport modes, as well as off-site impacts. The field surface is periodically updated during erosion events to simulate the surface changes caused by erosion. Surface updating during an erosion event includes changes to aggregate size distribution of the surface as fine particles are removed, smoothing of ridge roughness as ridges are eroded and furrows filled with eroded materials.

WEPS 1.0 Model Implementation
The structure of WEPS 1.0 is modular and consists of the science model, coded in FORTRAN 95 coupled with a graphical user interface, which is coded in JAVA. The model also includes five databases, two weather simulation models, and six submodels (Figure 1.2).

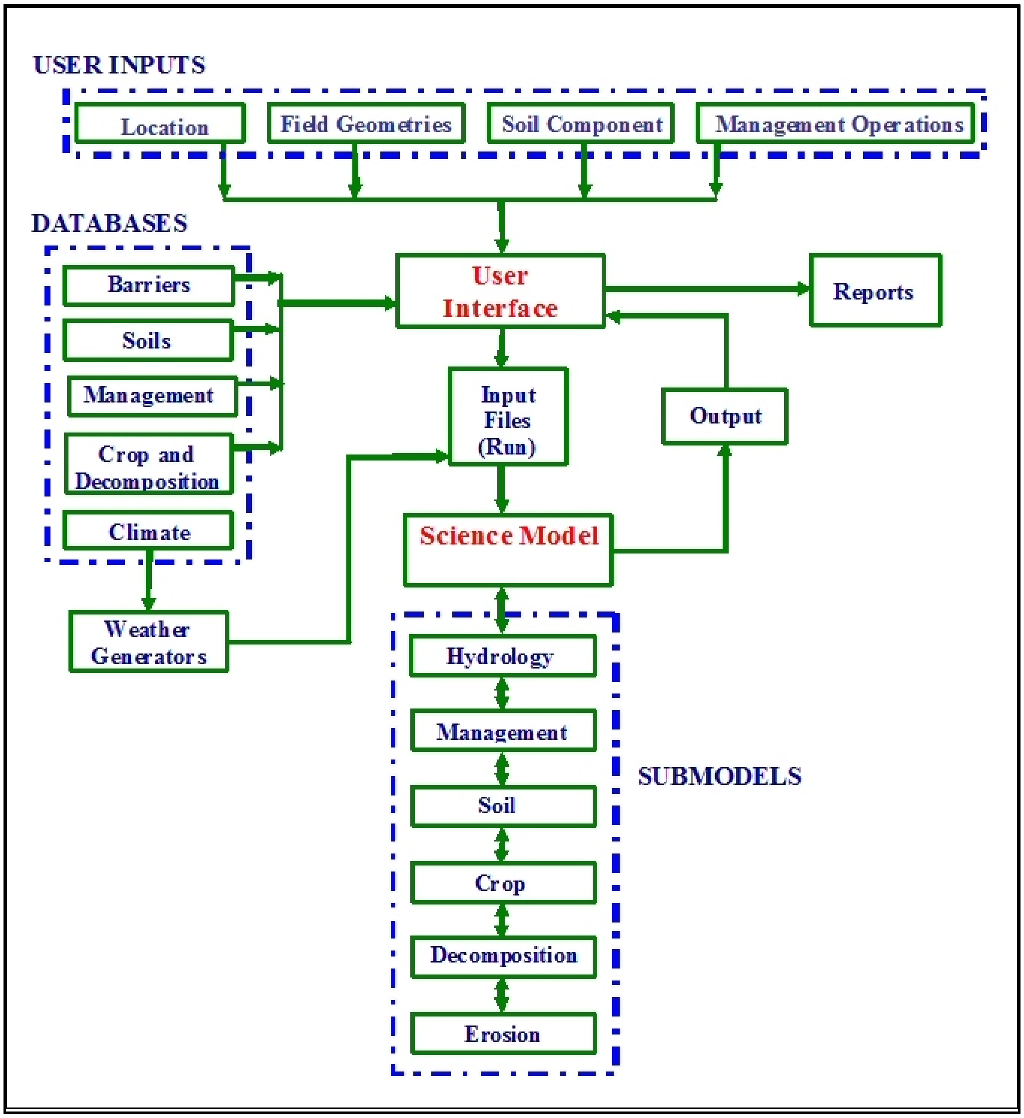

Figure 1.2. Structure of the WEPS model.

The user interface provides a means for the user to enter initial conditions such as the field dimensions, orientation, barriers, location, management operations, and soil component desired for the simulation region. Field dimensions are entered as a length and width and orientation as an angle deviation from north. The user selects the barrier type from a list accessed through the interface. For location, the user can either select the state and county or enter a latitude and longitude for simulation. The interface then selects the weather stations for which historical weather parameters are used to simulate weather parameters. The soil component is selected from a list of soils supplied by the NRCS Soil Survey Geographic (SSURGO) database for the Soil Survey Area of the simulation region. Management operation and dates are compiled in the Management Crop Rotation Editor for WEPS (MCREW), a spreadsheet type table editor.

Given the user supplied inputs, the interface accesses five databases for climate, soils, management, barriers, and crop growth and residue decomposition for the simulation. These databases provide needed parameters for location and conditions simulated as specified by the user. The interface writes the information needed for a WEPS simulation, obtained from the user and the databases, to input files. The interface also calls the weather submodel which generates weather files containing daily precipitation, maximum and minimum temperatures, solar radiation, and dew-point temperature as well as a daily wind direction and subdaily (e.g., hourly) wind speeds. These input files for a given simulation are collectively known in WEPS as a "Run". To reduce computation time, a daily time step is used in WEPS, except for selected subroutines in the Hydrology and Erosion submodels, which may use hourly or sub-hourly time steps (e.g., 15 minutes). The science model reads the input run files and calls the Hydrology, Soil, Crop, and Decomposition submodels daily which account for changes in the soil surface erodibility as influenced by Management and Weather. If surface conditions for a given day are such that erosion can occur for the maximum wind speed for that day, Erosion submodel routines are called to calculate soil loss and deposition. Soil erosion by wind is initiated when the wind speed exceeds the saltation threshold speed for a given soil and biomass condition. After initiation, the duration and severity of an erosion event depend on the wind speeds and the evolution of the surface conditions.

WEPS Model Use

WEPS is a comprehensive wind erosion model with many options for inputs and outputs. For basic simulations however, WEPS 1.0 is simple to operate. Only four types of information are entered on the main screen: 1) describe of the simulation region geometry by defining the field dimensions and field orientation; 2) select the field location for which to generate simulated weather; 3) select the soil; and 4) select a management scenario. For U.S. simulations, the last three may be selected from lists provided with the WEPS model. New input files will usually be created using previous input files as templates modified within the user-interface. By varying inputs, particularly the field management, the user can compare various alternatives to control soil loss by wind. Interpreting the outputs of WEPS is an integral part of using WEPS as a tool to develop conservation plans for controlling wind erosion. WEPS provides options for viewing very detailed outputs by periods (default is two weeks) including soil loss as saltation/creep, suspension, and PM10. Period output is also available for weather parameters such as wind energy, as well as surface conditions such as soil erodibility and biomass amounts. Such information is useful in determining which period is resulting in severe erosion and the conditions that are contributing to the loss. WEPS outputs also include amount of loss for each direction which aid the user in the placement of barriers, strip cropping, or other directional erosion control methods. More detailed features of WEPS and information on use of WEPS outside the U.S. are included in the WEPS User Manual, available from WERU. WEPS also has a Multiple Run Management View option to allow easy comparisons of alternative outputs.

Conclusion

The Wind Erosion Prediction System is a process-based, daily time-step model that simulates weather, field conditions, and erosion. WEPS development was in response to customer requests for improved wind erosion technology. It is intended to replace the predominately empirical Wind Erosion Equation as a prediction tool for those who plan soil conservation systems, conduct environmental planning, or assess offsite impacts caused by wind erosion. The WEPS model is continually being improved with periodic updates. Plans are in place to develop the following enhancements to WEPS for future upgrades: i) provide plant damage estimates, ii) integration with the Water Erosion Prediction Project (WEPP) model, iii) add capabilities for other, non-cropped lands, iv) predict visibility effects of dust storms, v) dust prediction via weather forecasting, vi) prediction of PM2.5 and PM-coarse (PM10 minus PM2.5), and vii) include capabilities for complex fields in terms of relief, multiple soils, crops, and management on one simulated field.

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Quick Start for WEPS 1.0

WEPS is a comprehensive wind erosion model with many options for inputs and outputs. For basic simulations however, WEPS is simple to operate. The following quick start guide will describe how to make a simple simulation run. To learn the more detailed features of WEPS, see the WEPS User Manual.

To start WEPS, double left click on the Weps1.0 icon on the computer screen 'desktop' . Note: the NRCS standard is to start WEPS from the 'Start Menu' (e.g., "Start > Programs > USDA Applications > WEPS 1.0 > WEPS 1.0"). The WEPS 1.0 main screen will then appear.

<u>A Simple Simulation</u>
For a simple simulation, only four types of information are entered on the main screen.

1. Describe the simulation field geometry by selecting the field dimensions and field orientation in the panel labeled "Simulation Region Information".
    a. Type in the specific X-Length and Y-Length field dimensions.
    b. Enter the specific field orientation ($\pm 45^{o}$ max) relative to true north, in the "Orientation" box.

2. Select a field location (for weather files).
    a. In the panel labeled "Location Information", use the mouse to select a State and County from the drop down menus . The closest weather stations to the center of the selected county will be loaded.

3. Select a soil.
    a. In the bottom panel of the window, to the right of the button labeled 'Soil', use the mouse to select a soil from the drop down "Template" menu .

4. Select a management scenario.
    a. In the bottom panel of the window labeled 'MCREW', use the mouse to select a crop rotation from the drop down "Template" menu .

Once these items are complete, click the 'Run' button on the tool bar at the top of the screen. You will be asked to enter a name for the simulation run and click 'OK'. Once a run name is entered, you will then see indicators that WEPS 1.0 is running. When the simulation run is finished, the "WEPS Run Summary" screen will appear.

WEPS Run Summary

The Run Summary displays user information, input parameter files, and basic soil loss information by rotation year and the average annual for the total simulation. Soil loss output in the Run Summary includes: ***Gross Loss***, the average erosion within the field; ***Total***, the average total net loss from the field; ***Creep/Salt***, the average creep plus saltation net loss from the field; ***Suspension***, the average suspension net loss from the field; and ***PM10***, the average net loss of particulate matter less than 10 microns in size from the field.

Exiting WEPS 1.0

To exit WEPS 1.0, click "Project" on the menu bar at the top of the main screen, then click "Exit". You will be asked if you want to save your project. You will also be asked to confirm if you really want to exit WEPS 1.0.

Additional Information

WEPS has the capability for many simulation input options, including adding barriers and specifying numerous management options. WEPS also can optionally produce very detailed output to provide the user with a better understanding of what field conditions and management situations cause soil loss by wind. Consult the WEPS 1.0 User Manual for complete details. For further information regarding WEPS, contact:

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Manhattan, Kansas 66502
U.S.A.

Phone: 785-537-5559
E-mail: weps@weru.ksu.edu
Web: http://www.weru.ksu.edu/weps

INTERFACE REFERENCE

WEPS Interface Main Screen

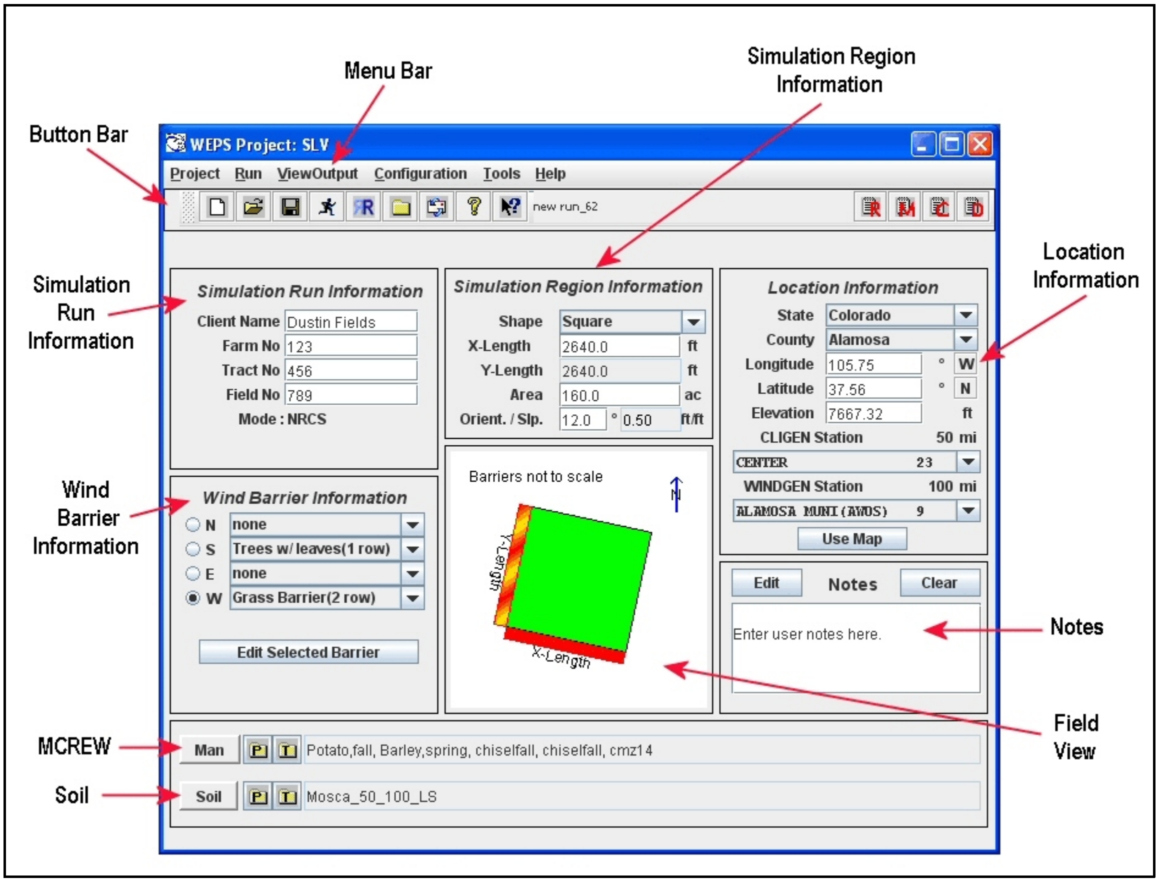


Figure 2.1. Main screen of the Wind Erosion Prediction System.

The WEPS main screen (Fig. 2.1) should appear at the model startup. Each part of the main screen is labeled in the Figure with regard to its function. A brief description of each part is given below. More detailed descriptions of their functions and use follow later in this chapter.

- The **Button Bar** and **Menu Bar** are collectively referred to as Toolbars. The Menu Bar provides the user with access to many of the operational functions of WEPS. The Button Bar provides a shortcut way of executing some of the Menu Bar functions.

- The **Simulation Run Information** panel is used to enter customer information for a simulation run, as well as information regarding the run length. The customer information is for information only and is not critical to the operation of WEPS.

- The **Simulation Region Information** panel provides the physical dimensions (i.e., length and width or radius) and the orientation of the simulation field.

- The **Location Information** panel is used to specify the location of the simulation field. This information is used to assist in determining the climate and wind stations selected for the simulation.

- The properties and placement of barriers on the field borders is entered in the **Wind Barrier Information** panel.

- The **Field View** panel displays the physical dimensions and orientations of the field and barriers. This panel is for information only and is not editable.

- User **Notes** can be entered in the lower right of the screen. These notes are retained as part of the project and can be printed from the Output Summary form.

- Access to **MCREW** (Management/Crop Rotation Editor for WEPS) allows for the selection, creation, and editing of management scenarios.

- The **Soil** panel is used to select and view the soil information for the simulation. Only one soil is allowed for the WEPS simulation region.

Toolbars

Menu Bar

The menu bar is the top line of the WEPS main screen. A description of each item on the menu bar is given below.

Project
The '**Project**' menu is a drop down list of various computer operations pertaining to WEPS projects. The Project menu contains the following options:

- **New** - allows user to create a new project from scratch (Ctrl-N).
- **Open...** - allows user to open an existing project (Ctrl-O).
- **Save** - saves the currently displayed project to its current file name (Ctrl-S).
- **Save As...** - saves the currently displayed project under a different file name (Ctrl-A).
- **Set Run Location** - allows the user to change the default Run Directory (Ctrl-U).
- **Delete Project** - opens a file chooser to delete a WEPS project (Ctrl-P).
- **Delete Run** - opens a file chooser to delete a WEPS run (Ctrl-D).
- **Delete Management Rotation File** - opens a file chooser to delete a WEPS management file (Ctrl-M).
- **Delete IFC Soil File** - opens a file chooser to delete a WEPS soil file (Ctrl-L).
- **Exit** - exit the WEPS program (Ctrl-X).

Run
This allows the user to run WEPS using the current inputs specified on the WES main screen or to restore inputs from previous WEPS Runs. The '**Run**' menu on the WEPS Main Screen displays the following options:

- '**Make a WEPS Run**' - begin a WEPS simulation using the current selected inputs (Ctrl-R).

- '**Make a Yield Calibration WEPS Run**' - begins a WEPS simulation running WEPS in "yield calibration mode". See section titled "Making a WEPS Run" for more information on calibration runs (Ctrl-C).

- '**Restore a WEPS Run**' - opens a list of previous WEPS runs to select and load the inputs used in a previous WEPS run (Ctrl-E).

ViewOutput
This menu allows the user to view output for the most recent (i.e., most current) WEPS run and previous WEPS runs.

- '**Most Recent Run**' - clicking on this menu item opens a list of output options.
  - '**Run Summary'** - displays a brief output summary for the most recent WEPS run (Ctrl+Shift-S).
  - '**Crop Summary**' - displays a summary of yield parameters for the most recent WEPS run (Ctrl+Shift-C).
  - '**Management Summary**' - displays a summary of management operations for the most recent WEPS run (Ctrl+Shift-M).
  - '**Detailed Reports**' - displays a detailed output for the most recent WEPS run (Ctrl+Shift-R).
  - '**Debugging Reports**' - displays a screen to view additional output files from the most recent WEPS run (Ctrl+Shift-O).

- '**Previous Run**' - clicking on this menu item opens the following list of output options.
  - '**Run Summary**' - opens a brief output summary of a previous WEPS run (Ctrl+Alt-S).
  - '**Crop Summary**' - opens a summary of yield parameters for a previous WEPS run (Ctrl+Alt-C).
  - '**Management Summary**' - opens a summary of management operations for a previous WEPS run (Ctrl+Alt-M).
  - '**Detailed Reports**' - opens the detailed output for a previous WEPS run (Ctrl+Alt-R).
  - '**Debugging Reports**' - displays a screen to view additional output files from a previous WEPS run (Ctrl+Alt-O).

- '**Multiple Run Manager**' - opens a window displaying output information from multiple runs for 'side-by-side' comparisons of the runs. The "Run" menu at the top of the screen contains items that allow the user to add a directory of runs, or a single run. The user can also restore a selected run in WEPS so that its results can be viewed in more detail or modified for another run. The "Help" menu item allows the user to display version information about the Multiple Run Manager.

Configuration

The '**Configuration**' menu currently has only one item, '**Edit Configuration**', which brings up a tabbed window with various configuration options for WEPS (Ctrl+Alt+E).

- '**Executables**' - opens a tab that allows the user to select executable files and command-line arguments (see Appendix of the WEPS User Manual for the command-line argument definitions):
  - WindGen exe - enter the path and file name for the default Windgen executable or click the folder icon to display a file chooser.
  - WindGen cmd - enter the default Windgen command-line arguments (see Appendix for argument list).
  - WindGen db - enter the location for the Windgen database location or click the folder icon to display a file chooser.
  - WindGen idx - enter the location of the index file (used to generate list of Windgen stations) or click the folder icon to display a file chooser.

  - CliGen exe - enter the path and file name for the default Cligen executable or click the folder icon to display a file chooser.
  - CliGen cmd - enter the default Cligen command-line arguments (see Appendix for argument list).
  - CliGen db - enter the location for the Cligen database location or click the folder icon to display a file chooser.
  - CliGen idx - enter the location of the index file (used to generate list of Cligen stations) or click the folder icon to display a file chooser.

  - WEPS exe - enter the path and file name for the default WEPS executable or click the folder icon to display a file chooser.
  - WEPS cmd - enter the default WEPS command-line arguments (see Appendix for argument list).
  - WEPS Cal. cmd - enter the command-line arguments to be used for a yield calibration run (see Appendix for argument list).

- ‘**Directories**’ - opens a tab that allows the user to select the directories used for templates, skeleton files, databases, and projects by entering the path or clicking the folder icon to display a file chooser:
    - Man Template Open- enter the default directory for opening the management templates or click the folder icon to display a file chooser.
    - Man Template Save- enter the default directory for saving the management templates or click the folder icon to display a file chooser.
    - Man Skeleton - enter the default directory for the management skeleton files or click the folder icon to display a file chooser.
    - Man Op DB - enter the default directory for the management operation database files.
    - Crop DB - enter the default directory for the crop database files or click the folder icon to display a file chooser.
    - MCREW Dir - enter the default directory for MCREW configuration files or click the folder icon to display a file chooser.
    - Soil DB - enter either the default directory for “ifc” soil database files or the name of a SSURGO Microsoft Access database file, including the path or click the folder icon to display a file chooser. If an “ifc” directory is entered, the ‘Soil DB spec’ field below should be left blank.
    - Open MDB files with JDBC.- click the check box to open the SSURGO soil data in a Microsoft Access database (MDB) file with JDBC.
    - Projects Dir - enter the default directory for WEPS projects or click the folder icon to display a file chooser.
    - MCREW config - enter the default directory for MCREW configuration file or click the folder icon to display a file chooser.
    - MCREW Data Config. - enter the default file for MCREW configuration parameters or click the folder icon to display a file chooser.
    - SKEL Translations- enter the translation file for converting NRCS RUSLE2 "skeleton" files to WEPS files or click the folder icon to display a file chooser.
    - Report Image Filen...- enter the file name of the image to be displayed on the report files such as a agency logo or click the folder icon to display a file chooser.

- ‘**Output**’ - opens a tab that allows the user to set the following output options:
    - Reporting period for detailed submodel reports.
    - Flags for submodel reports, which give model developers and advanced users more detailed output than is available through the interface. See the Appendix for flag numbers to set for submodel reports.

- ‘**Email**’ - opens email configuration settings:

  Settings
  - Send From: enter the email address of the sender.
  - Send to:
    - Comments: enter the email address of the recipient for comments.
    - Bug Reports: enter the email address for recipient for WEPS bug reports.

  Outgoing settings
  - Click the button to select to either “Use SMTP server” or “Use default mail client.” For “Use SMTP server” - enter your mailhost SMTP server address. Clicking “Use default mail client” causes your default system mail client to be used for outgoing email from your WEPS application. This setting does not work for all clients.

- ‘**Run**’ - opens a tab with run options:
  - WEPS Run Length Mode - click a button to select a type of run length as either the NRCS method (which specifies a fixed number of cycles and is required for all “official” NRCS WEPS runs), use simulation run start and end dates on the main screen, or specify the use of rotation cycles on the main screen. If the NRCS method is selected, the run length can be entered as the number of rotation cycles.
  - Alternative weather files - click the check box next to the name of a weather file type to use alternative weather files (e.g., measured wind data). The user will then be able to enter the file name and path in the **‘Location Information’** panel on the main WEPS screen.
  - File(s) to delete after running a simulation - Enter the name(s) of files that should be deleted after a simulation run. This is intended to reduce the number of files in the run directory. A list of multiple files should be delimited by commas or blank spaces.

- ‘**Miscellaneous**’ - opens a tab that allows the user to set the following:
  - Measurement Units- display either Metric or English units on WEPS screens.
  - Time steps per day for wind speed distribution- enter the number of time steps used for the daily distribution of simulated wind speed.
  - Display latitude and longitude fields- check box to display the latitude and longitude fields in the ‘**Location Information’** panel on the Main screen. Un-check the box to hide these fields.
  - Display state and county fields- check box to display the state and county fields in the ‘**Location Information’** panel on the Main screen. Un-check the box to hide these fields.

- Display elevation- check box to display the elevation field in the '**Location Information'** panel on the Main screen. Un-check the box to hide this field.
- Display use map button- check box to display the '**Use Map**' button in the '**Location Information**' panel on the Main screen. Un-check the box to hide this button.
- Region slope is read only- check box to only display the simulation region slope and not allow it to be edited.
- Enable full MCREW editing functionality in WEPS- check box to enable the full MCREW editing functionality in WEPS. Allows additional editing functionality of MCREW. This should be disabled for normal WEPS operation because of undesirable effects for WEPS operation. Un-check the box to disable this functionality. When this functionality is disabled, the MCREW File **'Open'** and **'Open Copy of Template'** menu items are disabled.
- Allow estimations in the Soil UI- check box to enable the estimation of soil parameters in the user interface (UI) when they are missing from the soil database.
- Do not display system locale warning at startup- check box to turn off the display of a warning when WEPS is installed in a non-US locale. To avoid problems, WEPS is always installed using the "US locale", regardless of the local PC settings. The following is an example of the warning message displayed if the box is not checked and WEPS is installed in a non-US locale.

  > "WEPS has detected that this machine is using the German (Germany) locale. WEPS uses the English (United States) locale. You do not need to change your machine's locale, but be aware that numbers will be formatted in the English (United States) style."

  For more info about what a "locale" is, see:
  www.microsoft.com/globaldev/DrIntl/faqs/Locales.mspx
- Do not estimate missing soil values from SSURGO database- check box to disable the estimation of soil parameters in the user interface when they are missing from the soil database.
  - Organic matter fraction minimum- enter the minium fraction of organic matter in the soil surface
- Do not prompt to review warnings when restoring a run.- check box to turn off warnings displayed from a previous run when it is restored.
- Search Radius- enter the search radius for the climate station choice lists (kilometers or miles, depending upon the "Measurement Units" setting). The user usually will want the nearest station to their simulation site. The user may want to select a different station more typical of the climate for the field being simulated if the nearest station doesn't meet their criteria. An example of not selecting the closest station might occur in mountainous areas where the nearest station does not always typify the climate for the simulated field.

- Tooltip Delay: - sets the delay time for the initial appearance of the tooltip and for the dismissal of the tooltip box from the screen. The units are in milli-seconds. To disable tooltip display, set the "Initial" value to 1000 (1 second) and the "Dismiss" value to zero.

‣ '**Formats**' - opens a tab that allows the user to set the following format option:
  - Operation Date - click the down arrow ▾ to the right of the box displays a list of available formats for the operation date. The format is displayed on this tab, next to "Operation Date" when a format is selected.

At the bottom of the Configuration panel are three buttons:

‣ OK - saves the changes for the current running instance of the user interface only and closes the window.

‣ Save - saves any changes made in the configuration window permanently to the WEPS configuration file.

‣ Help - opens general help for the configuration window.

Tools

This menu contain various tools available for use with WEPS, including:

‣ '**Send Email**' - send email comments to WERU, providing the computer is connected to the Internet and the email configuration options are properly configured. The user can also attach current WEPS project and run files to the messages (Ctrl+Alt-S).

‣ '**Display Wind Station**' - displays wind information for the selected WINDGEN station including wind parameters by month. Clicking the down arrow to the right of the station name ▾ displays a list of available wind stations from which to choose. The assumed wind speed threshold (see discussion below) for the calculations (m/s), the station elevation (m), and the average wind energy for the year (kJ/m^2/day) are also displayed. The following parameters are displayed for each month (Ctrl+Alt-W).
  - Winds > Threshold - the percentage of the time the wind is above the given threshold. This parameter will give the user an indication of the percentage of time winds are near or above erosive speeds and should only be used for general purposes. The actual threshold of wind erosion used in WEPS varies with the surface conditions.
  - Energy - the erosive wind energy greater than the given threshold (kJ/m^2/day).

- Monthly Percent - percentage of the annual erosive wind energy.
- Preponderance - the prevalence of the prevailing wind erosion direction for the month (maximum ratio of parallel to perpendicular erosion forces). A preponderance value of 1.0 indicates no prevailing wind erosion direction. A value of 2.0 indicates a prevailing wind erosion direction, with wind erosion forces twice as great parallel as perpendicular to prevailing wind erosion direction.
- Prevailing Wind Erosion Direction - displays the prevailing wind erosion direction for the month.

► ‘**WEPS Diff**’ - opens a window that allows a comparison of differences in two files.

Help

This menu contains help options for WEPS, including:

► ‘**Help Topics**’ - displays a window containing the WEPS online help system (Ctrl+Alt+T).

► ‘**About WEPS**’ - displays the Build Date, Release Number, and Java Runtime Version used for WEPS (Ctrl+Alt+A).

Button Bar

At the top of the main WEPS window (below the menu bar) is a series of buttons with icons, designed to help the user in the operation of WEPS.

Project Operations

 This button allows user to create a new WEPS project from scratch. This has the same function as selecting ‘**New**’ under ‘**Project**’ on the menu bar.

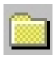
 This button opens an existing WEPS project. This has the same function as selecting ‘**Open**’ under ‘**Project**’ on the menu bar.

 This button saves the currently displayed WEPS project to its current file name. This has the same function as selecting ‘**Save**’ under ‘**Project**’ on the menu bar.

Run and Help

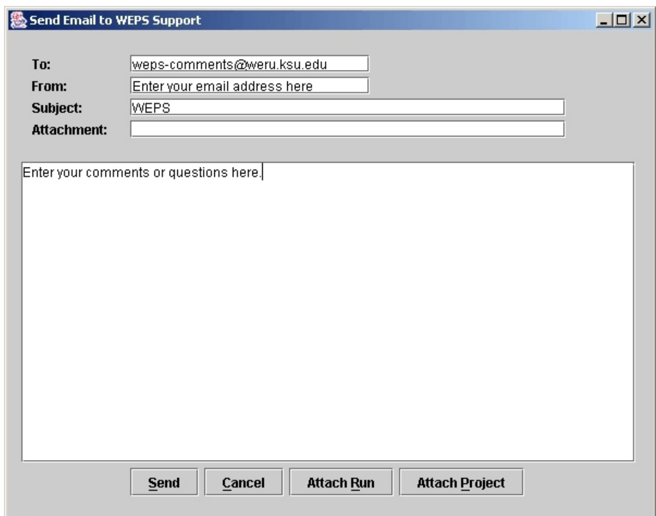
This ‘**Run**’ button begins a WEPS simulation run.

This ‘**Reload**’ button allows the user to “restore the inputs from a previous WEPS run” into the main WEPS interface window.



This ‘**Set Run Location**’ button allows the user to change the default Run Directory.

This ‘**Email**’ button allows the user to email comments to WERU, along with the contents of a WEPS project or WEPS run, if desired. Clicking the ‘**Email**’ button brings up a separate window (see left).



The user should enter their email address, if it has not been previously set in the configuration panel, and a short message. Click the appropriate box at the bottom of the window to select and attach a WEPS project and/or WEPS run to your email. See the ‘Interface Reference: Making a WEPS Run’ section in the User Manual for a description of WEPS projects and WEPS run files.

If you are connected to the Internet and the email options are properly set in the configuration screen, clicking ‘**Send**’ will email the message to WERU, along with any attached files, so that your inquiry can be answered.

This ‘**Question**’ button opens the general help system for WEPS.

This ‘**Context Help**’ button provides help for a particular item on the WEPS screen. Clicking the ‘**Context Help**’ button on the tool bar and then clicking on the item on the screen for which help is desired brings up a help screen for that specific item.

Following the icon buttons, the current run name is displayed. If the run name is tool long to fit on the button bar, it will be truncated at the end of the name.

These buttons display the Run, Crop, Management Summary Screens and the Detailed Report respectively.

Describing the Field and Barriers

One of the first tasks in beginning a new simulation is to describe the simulated field and any barriers that are present. This section describes the WEPS procedures for specifying the field geometries and barrier properties.

Field View

The Field View panel (Fig. 2.2) is located in the center of the WEPS1.0 main screen. It is designed to give the user a view of the field size, shape, and orientation (green). The placement of any barriers present is also displayed in red. A yellow bar on the side of the field in the Field View panel indicates which side of the field has been selected for barrier placement using the radio button in the Wind Barrier Information panel. This is useful for selecting field barrier placement when the field is oriented at angles close to 45 degrees. A red barrier shaded with yellow, as shown for the south barrier in Figure 2.2, indicates a selected barrier that has already been placed on the field border. Note that if the ratio of length to width of the field or barriers is too great to display to scale, this will be indicated within the panel, and an approximation of the field or barrier shape will be displayed. This panel is for viewing only and is not editable.

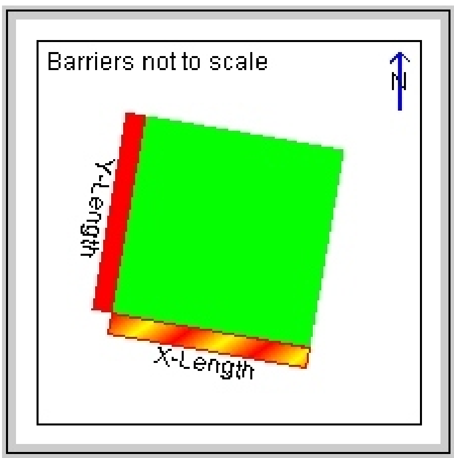


Figure 2.2. Field View panel for a rectangular field.

When a full, half, or quarter circle field is simulated (Fig. 2.3), it is approximated within WEPS as a square or rectangular field with an area equal to that specified in the Simulation Region Information panel. The Field View panel displays an approximate inscribed a circle (or half or quarter) within the simulated rectangular field When a non-rectangular field is selected, the field described in the Simulation Region Information panel has an area equal to that of the simulated rectangular field.

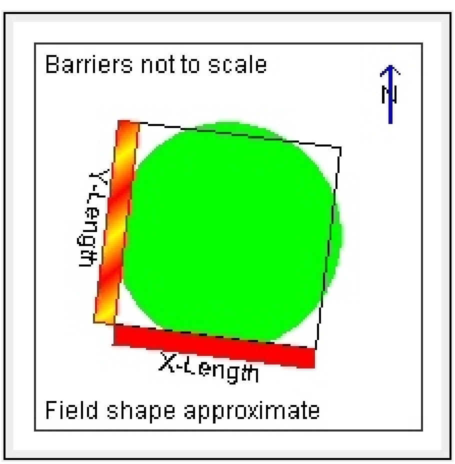


Figure 2.3. Field View panel for a circular field.

Simulation Run Information

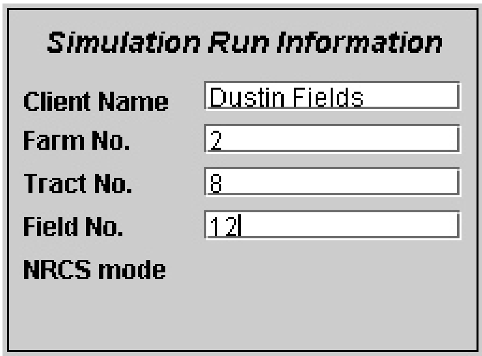


Figure 2.4. Simulation Run Information panel.

Customer information for a simulation run is entered by using the upper left panel of the WEPS1.0 main screen (Fig. 2.4), which is labeled ‘Simulation Run Information’.

The Client Name and as the Farm, Tract, and Field Number for the simulation run can be entered by typing the information in the appropriate boxes in the panel. These four items (Client Name and Farm, Tract, and Field No.) are for informational purposes only and do not affect the results of a WEPS simulation.

The run-length mode can potentially affect results. Note that there are three options for run-length mode. An ‘NRCS mode’ specification indicates that the number of cycles is fixed. This option is locked for official NRCS field use. Other users can specify a simulation run start date and end date or enter the number of management rotation cycles in the ‘Simulation Run Information’ panel of the main screen. The length of run is controlled through the ‘Run’ tab on the ‘Configuration’ panel (see the discussion on ‘Configuration’ for more details).

Wind Barrier Information

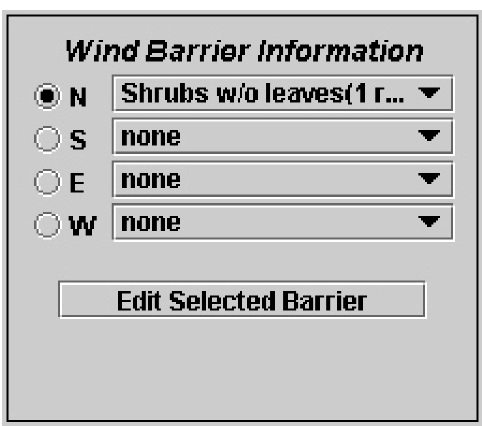


Figure 2.5. Wind Barrier Information panel.

The Wind Barrier Information panel (Fig. 2.5) is used to add barriers to the field borders. Note that WEPS1.0 only allows barriers on the borders of the field, not within the field. The barrier location is labeled for the side of the field on which the barrier is to be placed, such as ‘N’ for north, ‘S’ for south, ‘E’ for east, and ‘W’ for west. If the field is rotated, the location is labeled for the direction closest to one of the four cardinal directions. The barrier type can be selected from the drop-down list in the panel by clicking the down arrow to the right of the barrier type to bring up the list of available barriers and clicking on the appropriate barrier. Once a barrier type is selected, the barrier properties may be viewed and edited by clicking the ‘Edit Selected Barrier’ button at the bottom of the panel. This displays a separate panel where one may enter the barrier width, height, and porosity in the appropriate spaces. Note that the area of the barrier is displayed but cannot be edited. If barrier properties are modified, it will be noted in the type list with a '<mod>' designation before the type name. To remove a barrier from the field, click the radio button to select it (notice the barrier will be 'highlighted' when selected), then select the barrier type 'None' to remove it. To 'deselect' all barrier locations, click each enabled radio button to the off position. See the "WEPS How To Guide" for Barriers for further explanations on how to use barriers within WEPS and how to modify the barrier database. The Wind Barrier Information panel is not the best way to simulate the effects of strip cropping, but it may be useful in strip cropping designs that include barriers along the strips. See the "WEPS How To Guide" for Strip Cropping for a detailed description of simulating strip cropping with WEPS.

Simulation Region Information

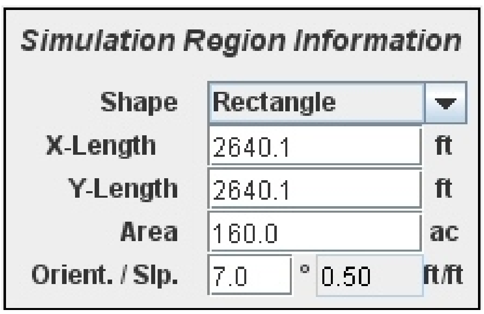


Figure 2.6. Simulation Region Information panel with rectangular field selected.

The Simulation Region Information panel is shown in Figure 2.6. To describe the simulation region, the field dimensions are entered. For example, the X-Length and Y-Length are entered for a rectangle. Note that the area of the region will be displayed. To orient the field, simply type in the angle in degrees of deviation from north for the north/south field border and click 'Enter'. Note that the field will only rotate in a range of ±45 degrees. By rotating and adjusting the field length and width, the user should be able to obtain the desired field size and orientation for a field.

Other field shapes can be specified by clicking the down arrow to the right of the 'Shape' box to display a list of valid field shapes. Figure 2.7 illustrates the panel entry for a circular field. To describe a circular field, either the radius or the area of the field is specified. For simulation purposes within WEPS, fields that are circles or partial circles (i.e., half or quarter circle) are approximated as a square or rectangular filed with an area equal to that specified in the Simulation Region Information panel. Field shapes that can be selected include Rectangle, Square, Circle, Half Circle VE (vertical east), Half Circle VW (vertical west), Half Circle HS (horizontal south), Half Circle HN (horizontal north), Quarter Circle NE (northeast), Quarter Circle SE (southeast), Quarter Circle SW (southwest), and quarter Circle NW

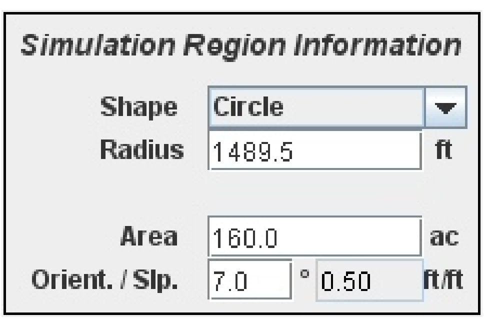


Figure 2.7. Simulation Region Information panel with circular field selected.

(northeast). For a square, enter either the X-Length or the area. If area is entered, the field side length will be calculated and displayed. For rectangular fields enter either the X-Length and Y-Length or the area and one length. For circles or partial circles, enter the radius or the area. If area is entered, the radius is calculated and displayed.

Special shapes or configurations such as circles and strip cropping are further discussed under the “Special Field Configurations” section of the chapter titled “Using WEPS for Conservation Planning” in the WEPS User Manual. Strip cropping is further discussed in detail in the “WEPS How To Guide” for Strip Cropping. The orientation of tillage direction is specified within the Management Crop Rotation Editor for WEPS (MCREW).

The Simulation Region must be considered carefully. The boundaries of this region are assumed to be non-erodible. This is assumed so that unknown quantities of material will not be entering from a neighboring area. Typically, stable boundaries do not allow creep and saltation sized material to pass through and include barriers or a surface at lease 15 feet wide that has vegetation sufficient to stop erosion. However there are situations where one may want to simulate a field with erodible boundaries such as an area within an erodible field. In these situations the user should consult their agency’s policy for simulating such areas.

Choosing a Location

Choosing a location within WEPS defines the physical location of the field to be simulated. This location information is used within WEPS to select the weather stations (CLIGEN and WINDGEN) to be used for the simulation.

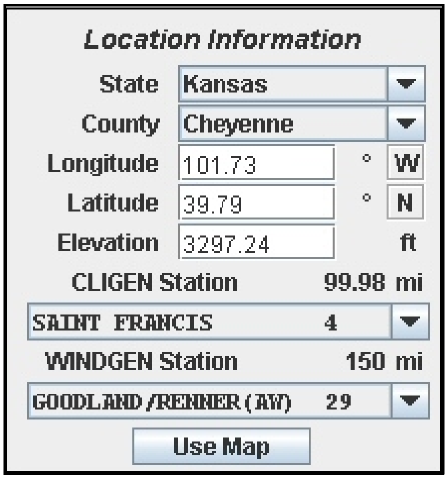


Figure 2.8. 'Location Information' panel.

Location information is entered through the rightmost panel of the main interface screen, labeled 'Location Information' (Fig. 2.8). Select the state and county of interest from the drop-down list by clicking the down arrow to the right of the state and county. The centroid latitude and longitude coordinates of the county will automatically be displayed. The CLIGEN and WINDGEN stations nearest to the center of the selected county will then be selected by the interface and displayed. As an alternative, the longitude and latitude of the location can also be entered, which will automatically display the state and county in which the coordinates reside and select the nearest CLIGEN and WINDGEN stations to that latitude and longitude. Clicking the buttons to the right of the Longitude and Latitude fields will toggle between the Western W and Eastern E hemispheres for Longitude and the Northern N and Southern S hemispheres for Latitude. Note that the default hemispheres are the Northern and Western hemispheres for the United States. If the Southern hemisphere is desired, the user should select CLIGEN stations and management files appropriate operation dates for this hemisphere. Once the stations are displayed, the user can click on the down arrow next to the stations to bring up a list of nearby stations from which to choose an alternative station if desired. The search radius for the list of stations (maximum distance to all stations on the list) are listed to the right of 'CLIGEN Station' and 'WINDGEN Station.' The State and County, as well as the Longitude and Latitude, fields are optional and can be added to or removed from the interface through the 'Miscellaneous' tab of the 'Configuration' panel (see the discussion on 'Configuration' for more details).

An alternative method to choosing a location in the United States is by using the Map Viewer. Clicking on the 'Use Map' button (displayed via the configuration panel) displays the Map Viewer with a map of the United States including state and county boundaries (Fig 2.9). The map can be centered and 'zoomed' in or out by selecting the appropriate button at the bottom of the screen and clicking within the map area. Clicking the check boxes at the left side of the Map Viewer window will display the location of Climate stations or Wind stations. Double clicking a location on the map will select the nearest CLIGEN and WINDGEN station and close the map viewer. The map viewer is a convenient way to view all of the climate stations within a state or region. The map viewer button is optional and can be added to or removed from the interface through the 'Miscellaneous' tab of the 'Configuration' panel (see the discussion on 'Configuration' for more details).

The western region of the United States has areas where the mountainous terrain results in stations that vary significantly over short distances in climate and wind energy. NRCS has developed Cligen and Windgen maps to assist users in selecting the appropriate weather station. These maps are available on the web as part of the Field Office Technical Guide for each state.

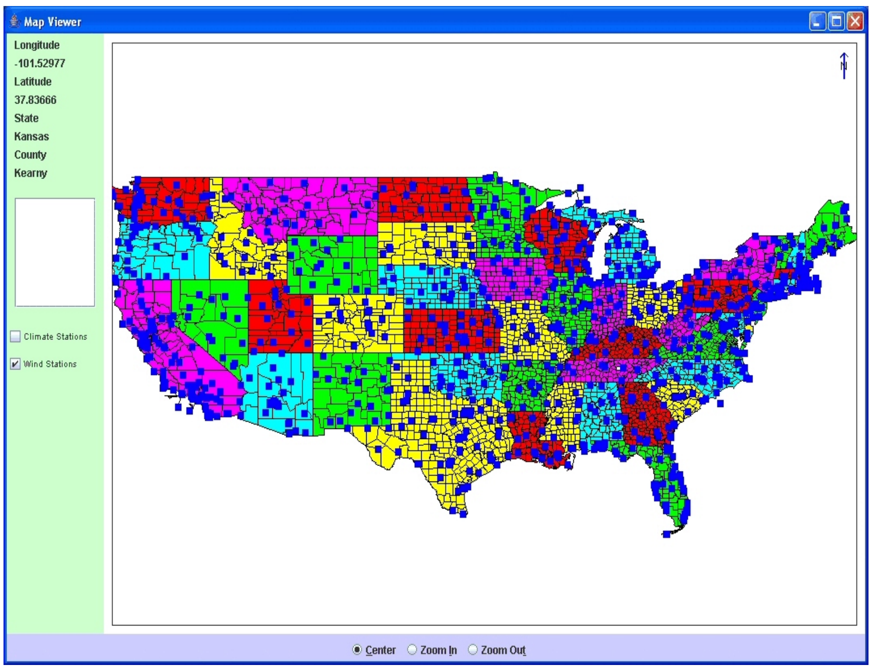


Figure 2.9. WEPS Map Viewer with wind stations displayed.

Notes

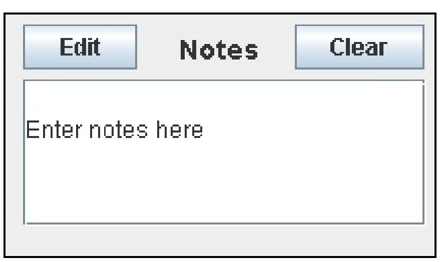


Figure 2.10. 'Notes' panel.

The user may type in notes for the run using the 'Notes' panel (Fig. 2.10). Clicking the 'Edit' button opens a window where notes may be entered and edited. Clicking the 'Clear' button clears the notes. These notes will be displayed and can also be edited within the Project Summary output report after a WEPS run has been completed. These notes are kept with the WEPS run as a record of any sort the user desires.

Choosing and Editing a Management Rotation

Management rotation scenarios for a simulation run can be selected or a rotation editor can be opened by using the '**Man**' button on the left side of the bottom panel of the WEPS main screen (Fig 2.11).

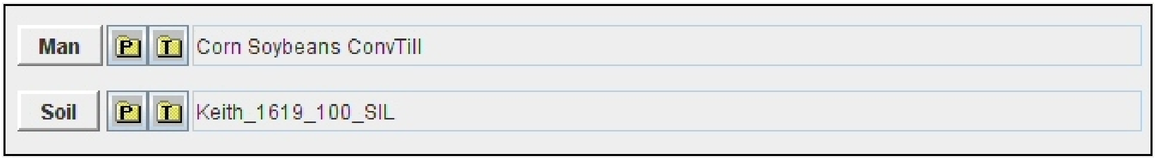


Figure 2.11. Bottom panel of the WEPS main screen with the MCREW box at the top.

A management rotation for a WEPS simulation run can be selected from pre-generated management files. Click the template folder in the management box, which is located in the bottom panel of the main screen (Fig. 2.11), and then select the management rotation desired from the template directory. Once selected, the name of the management file will appear in the panel. The user may also select management files stored in the current WEPS project directory by clicking on the project folder. Management rotation files in a WEPS project are usually derivatives of those selected from the "Template" directory, with local "project-specific" modifications. To open the Management/Crop Rotation Editor for WEPS (MCREW), double click on the '**Man**' button Man, on the left side of the management box. This will open the MCREW window (Fig. 2.12), which allows the user to view, edit, and save management rotation information.

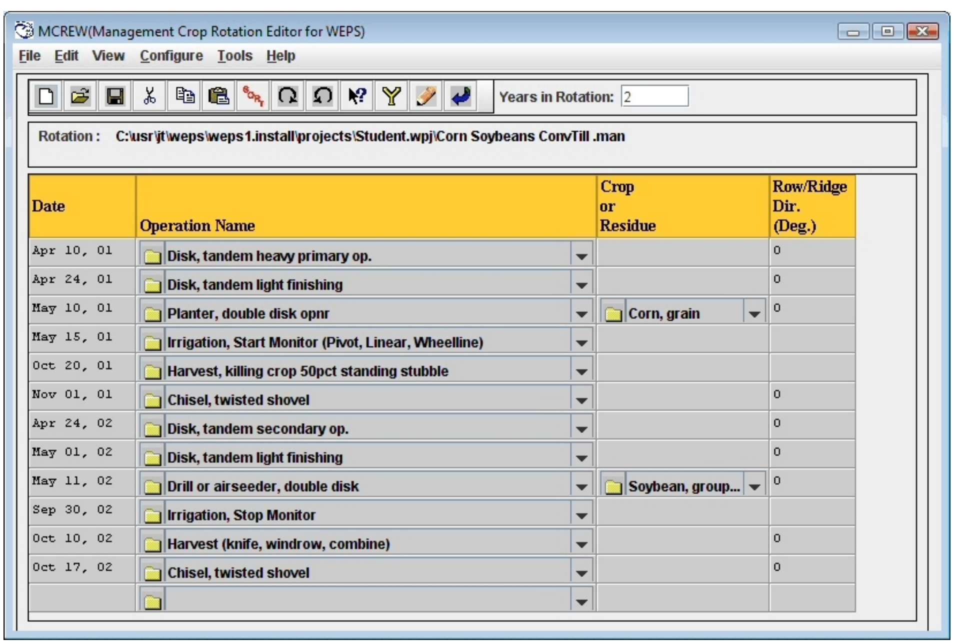


Figure 2.12. Management/Crop Rotation Editor for WEPS (MCREW) window.

MCREW's principle purpose is to create/modify/construct management rotation files required for making WEPS simulation runs. Although it is an integral component of the WEPS 1.0 interface, it can be used as a stand-alone program to edit management rotation files independent of the WEPS interface and was designed to be configurable for uses outside of WEPS. Much of MCREW's functionality, behavior, and visual appearance is controlled via ASCII XML-based configuration files. Changing the appropriate configuration files allows one to specify the structure and definition of the management/crop rotation file format and control the user's ability to view and edit specific operation, and/or crop properties, etc.

MCREW is fundamentally a date-ordered list of management operations. This release of MCREW provides the user with a tabular, row-oriented view of the operations and their associated dates. In WEPS, a management operation is defined as any human-initiated process, such as a tillage event, seeding, irrigation application, etc. If the operation triggers the WEPS model to start simulating the growth of a crop (or any other plant vegetation supported with a crop database record containing the necessary vegetation growth parameters), e.g., a planting/seeding/transplanting operation, then the name of that crop is listed in the same row in the column next to the name of the operation.

Using MCREW

MCREW is designed to allow easy creation and editing of management rotation files for WEPS. The MCREW screen consists of 5 major components:

1. Menu bar

The menu bar consists of assorted menu options that provide access to MCREW’s functions. Functions of the menu bar are discussed later in this document.

2. Button bar

The Button toolbar consists primarily of buttons that provide quick access to some of MCREW’s most common functions. Functions of the buttons are discussed later in this document.

3. Years in Rotation

On the right of the button bar, the user may view and edit the number of years in a rotation cycle.

4. Rotation

This window displays the name and full path of the management rotation file that is loaded. If the management rotation name is too large, a scroll bar is automatically provided so the user can view the entire rotation name.

5. Table View

Date (MMM dd, yy)	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)
May 01, 01	Wide-sweep plow (60 inch blade spacing)		0
Jul 01, 01	Wide-sweep plow (60 inch blade spacing)		0
Sep 01, 01	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0
Sep 02, 01	Drill - double disk openers (8 inch row spacing)	wheat, winter, hard	0
Jul 01, 02	Harvest Small Grain (cutter bar)		
Sep 01, 02	Chisel plow (3 inch wide twisted pts)		0

The Table View displays the sequence of operations, with their associated dates and any crops planted, in a tabular format. Spreadsheet-style editing functions are available to manipulate the order, selection, and removal of operations and/or crops, etc. More details of the editing functions of the Table View are given later in this section.

Opening and Saving MCREW files

In WEPS 1.0, there are two primary locations in which management rotation files exist:

1. In the "Management Templates" directory.
   This is the location in which complete or partial (single or multi-crop year) management rotation files are kept. Files in this directory always show up on the management rotation selection choice lists. Management rotation files to

be used in WEPS projects are typically selected from previously built management rotation files or they can be constructed from several partial management rotation files located in this directory.

2. Within a "WEPS Projects" directory.
Any edited or viewed management rotation file used in a WEPS project run is always located in that WEPS project's directory. There can be more than one management rotation file in a WEPS project. The current management rotation file to be used when making a WEPS run is the one specified in the "weps.run" file (e.g., the one listed in the "management" input field on the WEPS main screen. Management rotation files in a WEPS project usually are simply copies of those selected from the "Template" directory, with local "project- or run-specific" modifications.

Menu Bar Functions

File

Once the MCREW window is open, rotation files can be created from scratch and saved in the desired location, and/or other rotation files may be opened for editing. The **"File"** menu allows access to the file management functions for MCREW. It contains all of the options listed here, with the common functions (**"New"**, **"Open"**, and **"Save"**) also being available on the toolbar:

- **New** Ctrl-N
  Opens an empty, unnamed rotation file.

- **Open**... Ctrl-O
  Displays an "**Open File**" dialog box from which the user can select the desired rotation file from those in the current project. This is not accessible if the "Enable full MCREW editing functionality in WEPS" option is not enabled in the "Miscellaneous" tab of the WEPS interface Configuration panel.

- **Open Copy of Template** Ctrl-T
  Displays an "**Open File**" dialog box from which the user can select the desired rotation file from the "Management Templates" directory. A copy of the selected file is then added to the current WEPS project and made available for editing in MCREW. To edit a management file, the "Enable full MCREW editing functionality in WEPS" option must be enabled in the "Miscellaneous" tab of the WEPS interface Configuration panel.

- **Save** Ctrl-S
  Saves the current project's rotation file being edited (in the current WEPS project directory). The "saved" filename will become the selected management file in the main WEPS interface screen upon exit of MCREW.

- **Save As...** Ctrl-A
  Displays a "**Save File**..." dialog box from which the user can specify the desired filename with which to save the rotation file for the current project (the default location is in the current WEPS project directory). The "saved" filename will become the selected management file in the main WEPS interface screen upon exit of MCREW.

- **Save As Template** Ctrl-L
  Displays a "**Save File**" dialog box from which the user can specify the desired filename with which to save a copy of the currently edited rotation file into the "Management Templates" directory. The original file is still the current file being edited within MCREW.

- **Print** Ctrl-P
  Displays a print dialog box through which the MCREW table view can be printed.

- **Exit** Ctrl-E
  Exits MCREW. If MCREW finds that the rotation file has been modified and not saved, it will display a popup message and ask if the user wants to save it before leaving.

Edit

A WEPS 1.0 management rotation file is a date-ordered list of tillage/management operations. MCREW provides basic editing functionality to insert, delete, modify, and change dates for those operations. In WEPS, each operation is defined by a list of physical processes, such as residue burial, soil inversion, flattening standing residue, creation of ridges, planting a crop, etc., which are described to the model via one or more parameter values.

In its most basic form then, a WEPS management rotation file can be viewed within MCREW via the table view.

The primary editing functions available are accessible via the 'Edit' menu option. The table view editing functions are:

- **Cut Row(s)** Ctrl-X
  Removes the currently selected operation row(s) from the rotation and stores in a temporary buffer for possible pasting back into the rotation later.

- **Copy Row(s)** Ctrl-C
  Copies the selected operation row(s) from the rotation and stores in a temporary buffer for possible future pasting back into the rotation.

- **Paste Row(s)** Ctrl-V
  Pastes the previously cut or copied operation row(s) above the selected operation.

- **Delete Row(s)** Ctrl-D
  Deletes the selected operation row(s).

The "**Cut**", "**Copy**", and "**Paste**" buttons on the toolbar can also be used for these operations.

- **Undo Delete** Ctrl-Z
  Restore a deleted item. Note, this item is not active for the current version.

- **Sort by Date** Ctrl-R
  Sorts the operations in ascending order by date. See "Management File Date Adjustment Functions" section later in this chapter for alternate methods of manipulating dates.

- **Insert Row** Ctrl-I
  Inserts a blank row above the selected row.

- **Insert Operation**
  Inserts an row, then opens a window that allows the selection of an operation.

- **Cycle Forward** Ctrl-F
  Causes the last year in the rotation to become the first year in the rotation, while the other rotation years are incremented by one year. See "Management File Date Adjustment Functions" section later in this chapter for alternate methods of manipulating dates.

- **Cycle Backward** Ctrl-B
  Causes the first year in the rotation to become the last year in the rotation, while the other rotation years are decremented by one year. See "Management File Date Adjustment Functions" section later in this chapter for alternate methods of manipulating dates.

- **Notes** Ctrl-M
  Displays the Management Field Notes, where the user may enter notes regarding the management file. These notes are saved with the management file and can be viewed by clicking the Notes Button or the **'Edit'** menu item **'Notes'**.

View

The View menu allows the user to select from a list of columns to display in the MCREW window. Select each item to display by clicking on that item and note the item will be displayed and that item will be checked in the View menu. To remove items from display columns similarly click the item on the View menu and those columns will be removed from the MCREW window and the item will be unchecked in the menu. The menu items list may change and not appear as seen in the figure to the left.

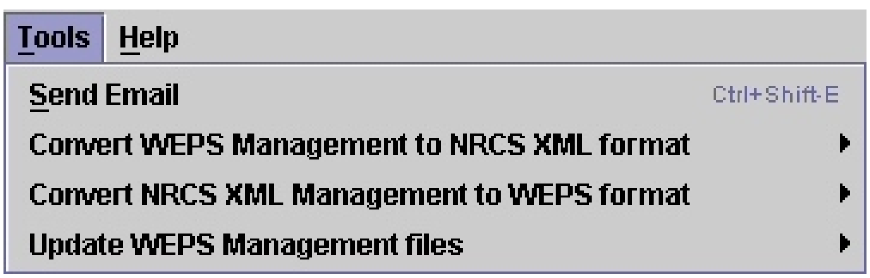
Configure

The Calibration Toggle function is the only option listed that is currently implemented in this menu. The other options are disabled. See "Make a Yield Calibration WEPS Run" in the chapter titled "Making a WEPS Run" for further explanations on the use of the Calibration Toggle function.

- **Configuration**
  Intended to display a "configuration" window. This is not functioning in the current version.

- **Column Options**
  Intended to display a window that allows the addition or removal of parameter columns from the MCREW screen. This is not functioning in the current version.

Tools



The 'Tools' menu item provides access to tools and utilities related to the use of MCREW.

- **Send Email** Ctrl + Shift-E
  Provides a method to communicate with WEPS developers via email.

- **Convert WEPS Management to NRCS XML Format** (this item has two options)
  ‣ **select individual files**
  Converts a single WEPS management file to the NRCS standardized summary management XML file format.

  ‣ **select directory (recursively)**
  Converts multiple WEPS management files recursively in a single directory to the NRCS standardized summary management XML file format.

- **Convert NRCS XML Management to WEPS Format** (this item has two options)
  - **select individual files**
    Converts single NRCS standardized summary management XML format files to the WEPS management file format.

  - **select directory (recursively)**
    Converts multiple NRCS standardized summary management XML format files recursively to the WEPS management file format.

- **Update WEPS Management Files** (this item has two options)
  - **select individual files**
    Updates individual WEPS management files with the most current crop and operation database parameters.
  - **select directory (recursively)**
    Updates WEPS management files recursively with the most current crop and operation database parameters.

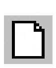
Help

The 'Help' menu item displays help options about MCREW and includes:

- **Help Topics** Ctrl-H
  Opens a window containing the MCREW online help system.

- **About MCREW**
  Displays the current version, build date, and other information about the current version of MCREW.

Button Bar Functions


Opens a blank MCREW screen. This has the same function as selecting '**New**' under '**File**' on the menu bar.


0pens an existing MCREW file. This has the same function as selecting '**Open**' under '**File**' on the menu bar.

Saves the rotation file being edited to the current project. This has the same function as selecting '**Save**' under '**File**' on the menu bar.

Cuts a row or rows of the management file and places into the clipboard. This has the same function as selecting '**Cut Row(s)**' under '**Edit**' on the menu bar.

Copies a row or rows of the management file and places into the clipboard. This has the same function as selecting '**Copy Row(s)**' under '**Edit**' on the menu bar.

Pastes a row or rows of the management file from the clipboard. This has the same function as selecting '**Paste Row(s)**' under '**Edit**' on the menu bar.

Sorts the rows of the management operations into date order. This has the same function as selecting '**Sort by Date**' under '**Edit**' on the menu bar.

Cycles the rotation year for the management operations forward. This has the same function as selecting '**Cycle Forward**' under '**Edit**' on the menu bar.

Cycles the rotation year for the management operations backward. This has the same function as selecting '**Cycle Backward**' under '**Edit**' on the menu bar.

Enables context-sensitive help. Click on this button, then click on any item on the screen for help on that item.

Toggles the display of extra columns for yield calibration. When this option is on (columns displayed), a red border surrounds the button.

Opens the Management File Notes display, where the user may enter notes regarding the management file. These notes are saved with the management file and can be viewed by clicking the Notes Button or the **'Edit'** menu item **'Notes'**.

Saves the displayed data to the current file name and closes MCREW.

Editing by Using the Table View

Row and Cell Selection Functions

The mouse is currently the primary method used to "select" either a row and/or an individual table cell. If a particular table cell cannot be directly edited within the cell, this is indicated by a gray background, (e.g., Date, Operation Name, or Crop) and the row is selected (indicated by the blue background in all cells within the row). The following figure shows an example of a row selection after a left mouse click within the "Drill" operation row.

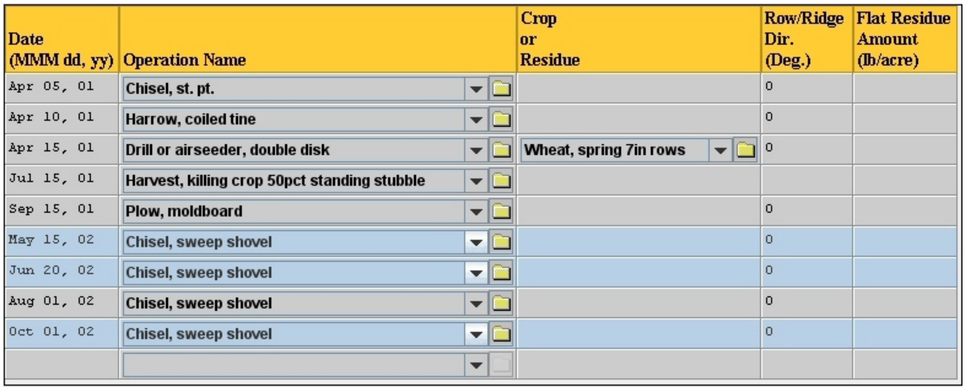
Date (MMM dd, yy)	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)
May 01, 01	Wide-sweep plow (60 inch blade spacing)		0
Jul 01, 01	Wide-sweep plow (60 inch blade spacing)		0
Sep 01, 01	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0
Sep 02, 01	Drill - double disk openers (8 inch row spacing)	wheat, winter, hard	0
Jul 01, 02	Harvest Small Grain (cutter bar)		
Sep 01, 02	Chisel plow (3 inch wide twisted pts)		0

One can select multiple rows at one time by depressing and holding down the left mouse button on the first row to be selected and dragging the mouse cursor over the additional contiguous rows to also be selected. Release the left mouse button on the last row to be selected. All selected rows will be highlighted with a blue background (see following figure for example of multiple row selection).

Date (MMM dd, yy)	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)
May 01, 01	Wide-sweep plow (60 inch blade spacing)		0
Jul 01, 01	Wide-sweep plow (60 inch blade spacing)		0
Sep 01, 01	Disk harrow, tandem, inline (18 inch dia blades, 9 inch		0
Sep 02, 01	Drill - double disk openers (8 inch row spacing)	wheat, winter, hard	0
Jul 01, 02	Harvest Small Grain (cutter bar)		
Sep 01, 02	Chisel plow (3 inch wide twisted pts)		0

The user can append contiguous rows adjacent to a previously selected, row or multi-row selection, by holding down the "shift" key and clicking the left mouse button on the last desired contiguous row to append to the selection. This is similar to how Microsoft Windows append selection works with the "shift" key depressed.

Similarly, one can append non-contiguous rows by holding down the "ctrl" key and making an additional multi-row (or single row) selection similar to the original row or multi-row selection (see following figure for example of non-contiguous row selection). As many non-contiguous rows can be selected, as desired, via this method. Again this is similar to how Microsoft Windows non-contiguous selection method works with the "ctrl" key depressed.



Date (MMM dd, yy)	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)	Flat Residue Amount (lb/acre)
Apr 05, 01	Chisel, st. pt.		0	
Apr 10, 01	Harrow, coiled tine		0	
Apr 15, 01	Drill or airseeder, double disk	Wheat, spring 7in rows	0	
Jul 15, 01	Harvest, killing crop 50pct standing stubble			
Sep 15, 01	Plow, moldboard		0	
May 15, 02	Chisel, sweep shovel		0	
Jun 20, 02	Chisel, sweep shovel		0	
Aug 01, 02	Chisel, sweep shovel		0	
Oct 01, 02	Chisel, sweep shovel		0	

Any row or multi-row selection can be de-selected and replaced by simply clicking the left mouse button anywhere within the MCREW table display (with no keyboard keys pressed).

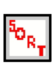
Row Editing Functions

Using the **"Edit"** menu, the user can cut, copy, paste, and delete rows. One can also insert a new blank row ("**Insert Row**") immediately above the currently selected row. In addition, the user can press the right mouse menu button to display a popup menu that contains row editing functions. The **"Set Date"** and "**Adjust Date**" options will be described under "Management File Date Adjustment Functions".

The contents of another (previously created) management file can also be inserted via the "**Insert Management File**" option immediately above the currently selected row. The "File Chooser" dialog will pop up, allowing the user to select the desired management file from which to include all the operations and their associated dates into the current management file being edited.

Management File Date Adjustment Functions

There are several date adjustment functions available in MCREW, in the "**Edit**" menu and the icon toolbar. These operations are:



Sort by Date


Cycle Forward

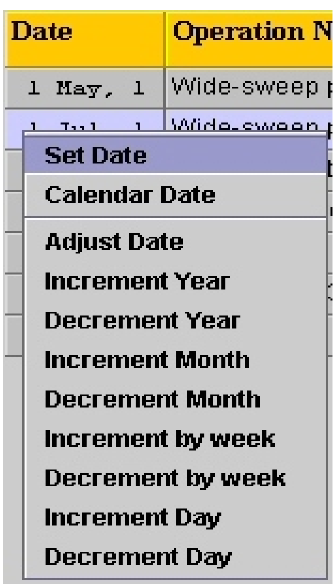

Cycle Backward

The "**Sort by Date**" function sorts the management operations by ascending date order. Thus, the user can adjust/set the dates of management operations without having to worry about whether they are in the correct sequential order at that time. When the user wants to see the list of operations in the correct date-ordered format, they can simply select the **"Sort by Date**" function from the toolbar icon or the "**Edit**" menu.

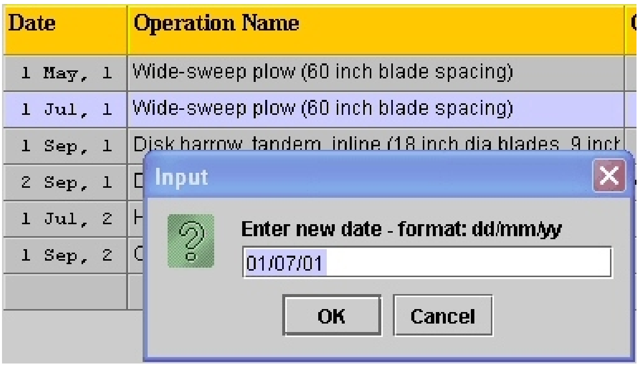
MCREW will not allow the user to save a WEPS management file without the operations being listed in date order. The user is given the options to automatically sort them, if they are not sorted during a management file save operation, or to go back to the editor and allow the user to correct the problem(s) manually.

The "**Cycle Forward**" and "**Cycle Backward**" functions will rotate the "rotation year" of the management operation dates forward or backward in increments of one year. For example, a three-year management file rotation 'cycled forward' would change the operation dates in the first year to the 2nd year, those in the 2nd year to the 3rd year and those in the 3rd year to the 1st year. Thus, the crops grown and harvested in the first year would now occur in the second year, etc. Likewise, a rotation 'cycled backward' would shift the rotation the opposite direction, making the 2nd year operations occur in the first year, etc.

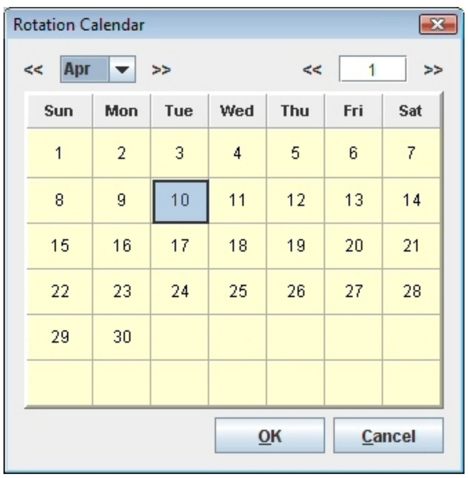
Date Column Editing Functions



Limited date editing functions are available by right clicking on a cell in any column. Clicking the right mouse button while the cursor is on a date column cell causes a date editing popup menu to appear that has additional date editing functions (see figure to the left). These functions allow the user to adjust dates for one row or all operation rows selected (highlighted in blue) simultaneously (single-row date editing operations are made inaccessible and are greyed out if multiple rows are selected). The top two items (above the line) are specific to single rows, and if multiple rows are selected, these items will be blanked.



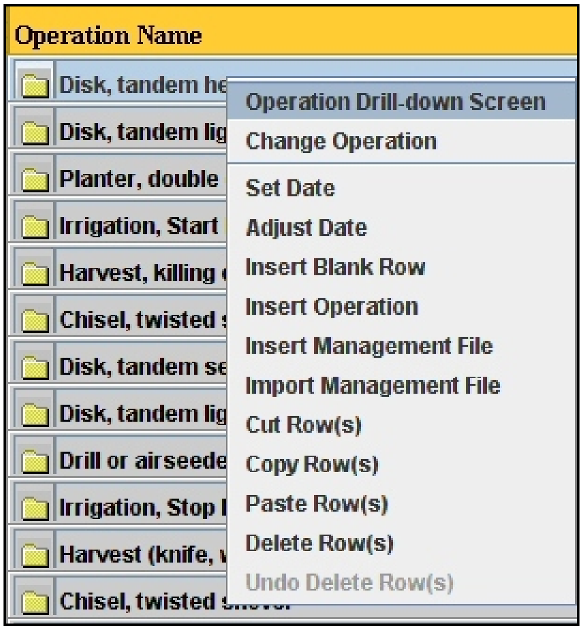
Selecting the **"Set Date"** option will display a dialog box that allows the user to type in a specific date (day/month/rotation year) for the selected operation row (highlighted in blue). The figure to the left shows an example of "**Set Date**" popup window.



The "**Calendar Date**" option displays a popup calendar to aid in adjusting dates. Double left mouse clicking in a date cell, displays the popup calendar as well. This calendar window allows the user to select the desired date. The calendar allows the user to increment (>>) or decrement (<<) the month and year values if desired. Then the day of the operation within that month/year can be selected. The user can either double right mouse click on the day value or click on the "OK" button to accept the specified date (see the figure to the left). The "Calendar Date" function is only applicable when a single operation row is selected.

The "**Adjust Date**" function is available from this menu, but year, month, week, and day increment and decrement functions are also available. They apply to all dates in the rows that are selected. The user can adjust the operation dates on the selected rows. Selecting the "**Adjust Date**" option will display a dialog box allowing the user to adjust the operation dates in the selected rows by a specified ± number of days, months, or years (see figure to the left). Additional menu options are also available to increment (increase) or decrement (decrease) the dates of selected rows by a day, week, month, or year.

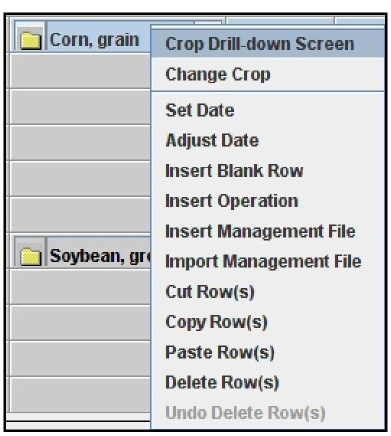
Operation Column Editing Functions



Editing functions for the Operation column are displayed by right clicking within the column (see figure to the left). Clicking on one of the functions available will apply to the function to the highlighted row(s). The top item above the line ('Operation Drill-down Screen') is specific to single rows however, and if multiple rows are selected, these items will be disabled. The operation drill-down screen function is described next.

A new operation can be added to a blank line or a different operation can be selected to replace an existing operation bu clicking the down arrow to the right in the 'Operation Name' column and selecting the desired operation. A new operation can also be added by double clicking the left mouse button with the mouse cursor in an operation cell. This action will display the "File Chooser" dialog. It allows the user to select a management operation record from within the dialog window. The user can also access this "File Chooser" dialog from the "**Change Operation**" menu option via the right mouse menu (described earlier under "Row Editing Functions"). Other operation column functions allow the user the option of setting or adjusting the date of the operation or inserting a blank row to be filled by the user. The user can also insert an entire management file, which is useful in building multiple crop/year rotations. Finally, there are functions that allow the user to cut, copy, paste, and delete a row or multiple rows.

Crop or Residue Column Editing Functions



Editing functions for the 'Crop or Residue' column are displayed by right clicking within the column (see figure to the left). Clicking on one of the functions available will apply to the function to the highlighted row(s). The top two items (above the line) are specific to single rows however, and if multiple rows are selected, these items will be blanked. The Crop Drill-down Screen function is described in the next section.

A Crop can be specified for planting (and subsequent harvest) only for operations that contain the "planting/seeding" process. Those that have this process defined will either display the name of the crop to be planted in the "crop" column or display the string "no crop", signifying that no crop is to be planted or it hasn't yet been selected by the user. A crop can be added or an existing crop can be replaced by clicking on the down arow to the right in the ‘Crop or Residue’ column and selecting the desired crop from the list. A new crop may also be selected by double clicking the left mouse button with the cursor in a crop cell. This action will pop up the "File Chooser" dialog. It allows the user to select a crop record from within the dialog window. The user can also access this "File Chooser" dialog from the "**Change Crop**" menu option via the right mouse menu (described earlier under “Row Editing Functions”). Other crop column functions allow the user the options of setting or adjusting the date of the operation or inserting a blank row to be filled by the user. The user can also insert an entire management file, which is useful in building multiple crop/year rotations. Finally, there are functions that allow the user to cut, copy, paste, and delete a row or multiple rows.

Operation and Crop Dialog Drill-Down Screens

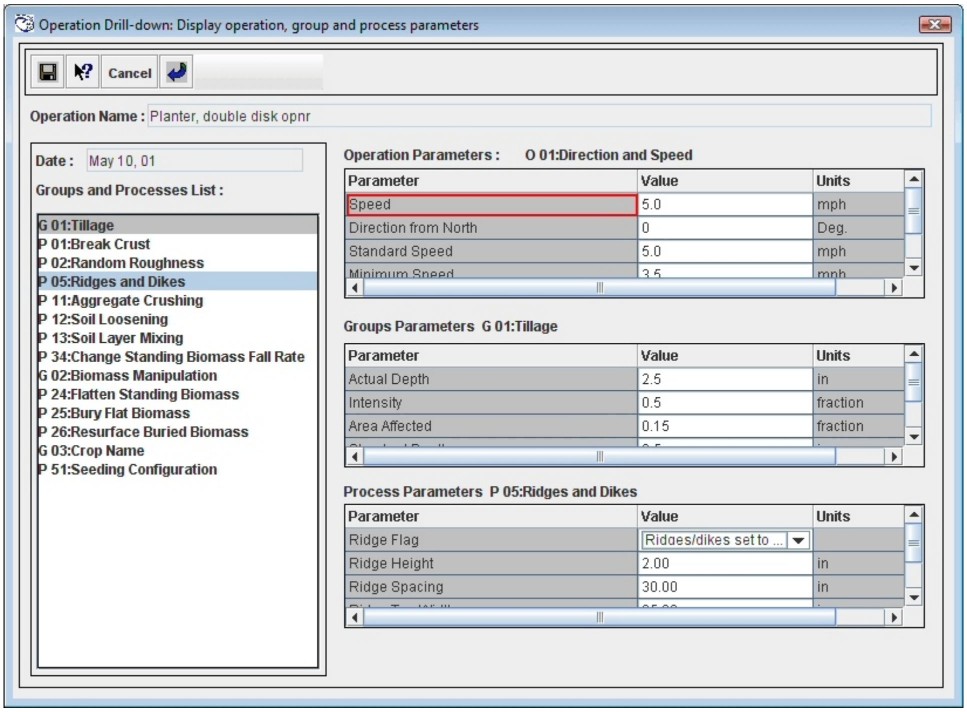


Figure 2.14. Example Operation Dialog drill-down screen.

Both the MCREW Operation and Crop columns have a "drill-down" function available that allows the user to display a popup screen that makes many of the specific operation or crop parameter values viewable or editable. The operation parameters specify how WEPS operations simulate soil and biomass properties that influence wind erosion. Similarly, the crop parameters specify how WEPS simulates crop planting, growth, and harvest, as well as residue decomposition. The specific content of these screens depends upon both the type of crop or operation and specific XML-format configuration files. The configuration files describe which parameters are viewable or hidden to the user and, if viewable, whether or not they are editable by the user. In addition, for each parameter that is displayed, the prompt information for the parameter is described in these XML-format files. Examples of Operation and Crop Dialog drill-down screens are shown in Figures 2.14 and 2.16.

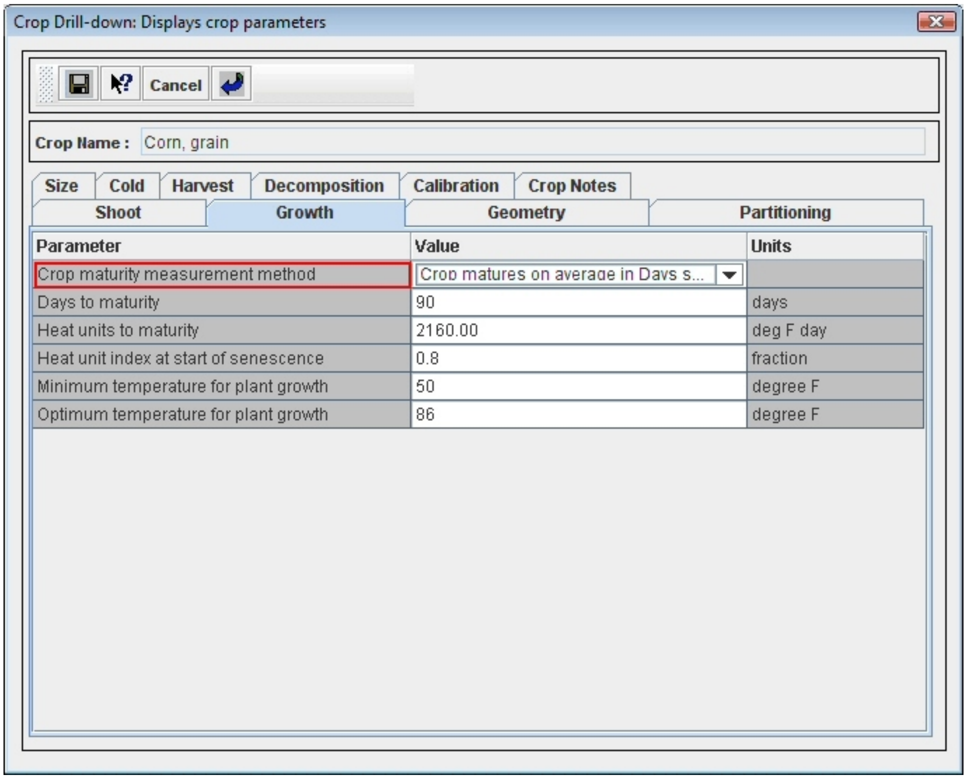


Figure 2.15. Example Crop Dialog drill-down screen.

The drill-down functions are cell specific and are available only when a single operation row is selected. The Operation drill-down screen is accessible if the selected cell is in the operation column (identified by the red rectangular box around it) and a Crop drill-down screen is accessible if the selected cell is in the crop column. To access the Operation or Crop drill-down screen, click the folder icon to the tight of the Operation or Crop name. An alternative method is to left click in the cell and selecting "Operation Drill-down Screen."

Definitions and ranges for specific crop parameters are available in the WEPS How To Guide, **"Crop Database Record Development"**. Definitions and ranges for specific operation parameters are also available in the WEPS How To Guide, **"Management Operation Database Record Development"**. These guides also provide guidelines for determining parameters for crops not listed in the crop or operation databases.

Choosing a Soil

A soil for a simulation run is selected by using the 'Soil' box on the right side of the bottom panel of the WEPS1.0 main screen (Fig. 2.16).

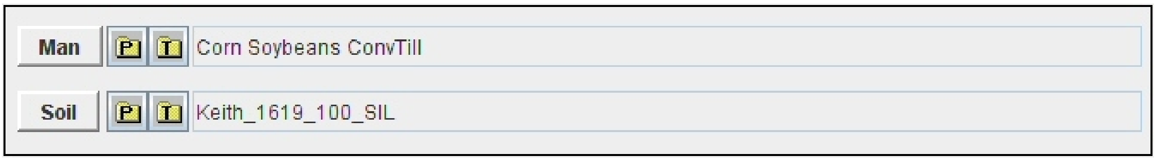


Figure 2.16. Bottom panel of the WEPS main screen with the Soil box on the bottom.

A soil for a WEPS simulation run is typically selected from a list of soils contained in the NRCS Soil Survey Geographic (SSURGO) database file. This is done by clicking the '**Template**' folder to the left of the soil name.

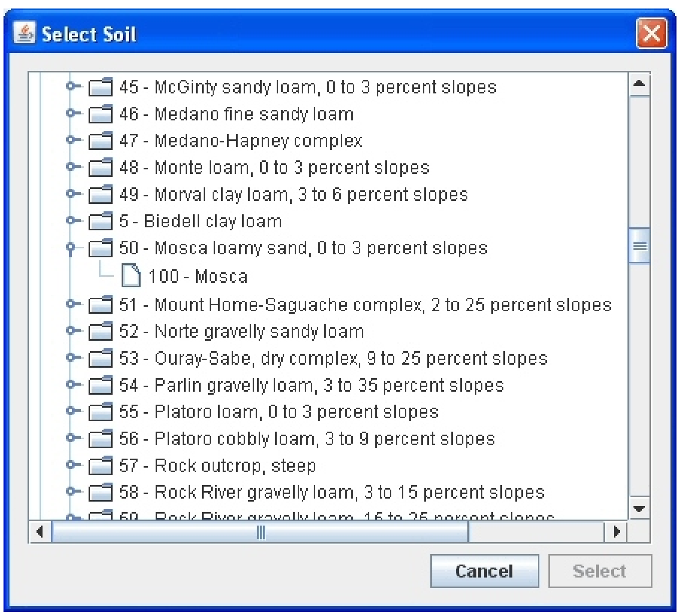


Figure 2.17. The 'Select SSURGO Soil' window.

Clicking on the '**Template**' folder opens a window titled '**Select SSURGO Soil**' (Fig. 2.17). Navigate through the database tree to find the soil survey area (or county) desired. Navigation is performed by clicking on the 'key' symbol to open the display to the next level of the tree. To close a level of the tree, click the 'key' symbol to close. The soil files are listed according to the soil map unit symbol, map unit name, surface texture, and local phase. Selecting a soil then displays its components and the percentage that each component contributes to the map unit. Click a soil component to highlight it and click the '**Select**' button at the bottom of the screen (or double click the component with the left mouse button). This action converts the soil from the SSURGO database to a WEPS soil file format (with an 'ifc' extension) and returns the user to the main screen. The loaded soil file name will appear in the soil box window. Clicking the '**Cancel**' button in the '**Select SSURGO Soil**' window aborts the selection of a new soil.

Soils that have been previously loaded to projects or modified and saved to another name can be opened by clicking on the '**Project**' folder. This will open a window in which the user can select the desired soil or type in the soil file name.

Users have the option to view the parameters for the soil file displayed in the soil box by clicking on the button labeled '**Soil**', on the left side of the soil box. This will open the WEPS Soil User Interface screen (Fig. 2.19).

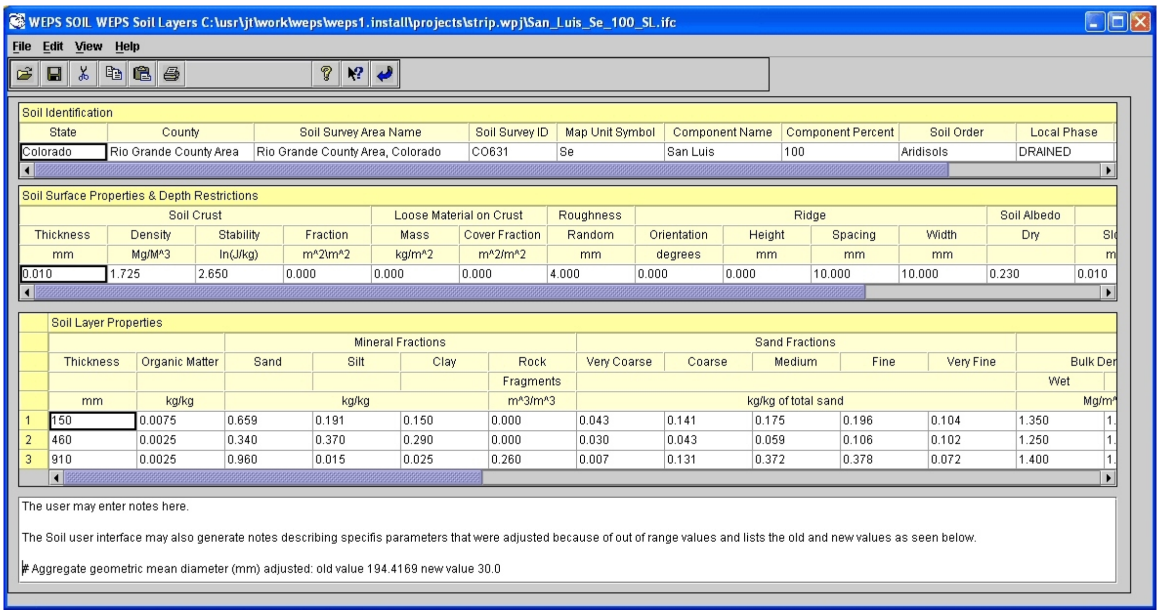


Figure 2.18. WEPS Soil User Interface screen.

Many soil properties that affect soil wind erodibility vary with time as a result of weather and management. The parameters displayed in the Soil User Interface only represent the initial soil conditions and properties that exist prior to the first day of simulation. Beginning with the first day of simulation, the soil parameters change in response to weather and management conditions.

Soil properties greatly affect the erodibility of a field surface directly through their effects on such things as roughness and aggregate size distribution. The soil properties also affect erodibility indirectly through their effects on soil hydrology and plant growth. The Soil User Interface allows the user to view, edit (disabled for NRCS), and save the initial soil information under a new file name for the project. Users typically are discouraged from editing parameters derived from a SSURGO database file unless the user has specific knowledge of the parameter and more suitable values. A more detailed description of the soil parameters required by WEPS, as well as directions for obtaining a SSURGO database

file for WEPS use, are found in Appendix 2 of the WEPS User Manual.
Users whose soils are not contained in a SSURGO database can create their own soil file by opening a new file and entering the appropriate parameters. It is recommended that in this case, the user enter the minimum set of parameters and let the Soil User Interface generate all parameter fields. The generation function is described under the Menu Bar function "View", later in this chapter. Again, if the user has specific knowledge of the parameter and more suitable values, they may edit that value. As an alternative, the user may wish to find an existing soil file within a SSURGO database with properties similar to the soil they want to simulate with WEPS and edit any parameters that may differ.

The various functions of the WEPS Soil User Interface are described next. More detailed definitions of soil parameters and a description of how to download a SSURGO database and import it into WEPS are available in Appendix 2 of the WEPS User Manual.

Menu Bar Functions

The menu bar provides the following options:

File
This displays a drop-down list of various file options.

- **New** Ctrl-N
  Opens an empty, unnamed soil screen.

- **Open**... Ctrl-O
  Displays an "**Open a Soil File**" dialog box from which the user can select a soil (ifc) file from those in the current project.

- **Open Local BD** Ctrl-L
  Opens the "Select SSURGO Soil" window (Fig. 2.17) to select a soil from a local database residing on your computer.

- **Open Remote DB** Ctrl-R
  Intended to access a remote database on the internet. This function is not currently working.

- **Save** Ctrl- S
  Saves the current file.

- **Save As**... Ctrl-A
  Saves the current soil file to a new name.

- **Print** Ctrl-P
  Opens a print dialog window to allow printing the soil file.

- **Exit** Alt-F4
  Exits the soil interface.

Edit

This menu displays a drop-down list of various layer editing functions.

- **Cut Layer** Ctrl-X
  Cuts a soil layer or layers and places it into the clipboard. The layer(s) (contiguous only) must be first selected by dragging the mouse while holding the left mouse button.

- **Copy Layer** Ctrl-C
  Copies a soil layer or layers and places it into the clipboard. The layer(s) (contiguous only) must be first selected by dragging the mouse while holding the left mouse button.

- **Paste Before Layer** Ctrl-B
  Pastes a soil layer or layers from the clipboard before the highlighted row.

- **Paste After Layer** Ctrl-V
  Pastes a soil layer f or layers from the clipboard after the highlighted row.

The edit functions for layers are also available by highlighting a row or set of contiguous rows then right clicking within the selected row(s) to display the edit functions.

View

This displays options for changing the parameters displayed in the Soil User Interface. Two exclusive options are available, of which only one can be chosen. Click '**All fields**' to display on the Soil User Interface screen all the fields required by WEPS. Or, click '**Minimum fields'** to display only the minimum input parameters required by the Soil User Interface. The minimum parameters displayed when the '**Minimum fields**' box is checked are used by the soil interface as inputs to estimate or generate the parameters required by WEPS. These generated parameters are displayed when the '**All fields**' box is checked. Any parameters that were adjusted because of out-of-range values, as well as the old and new values, are displayed in the Notes table at the bottom of the Soil User Interface screen.

Help
This menu displays a drop down list of help options.

- **Help Topics** Ctrl-H
  Opens a window containing the Soil User Interface online help system.

- **About Soil**
  Displays the current version of the Soil User Interface.

Button Bar Functions

The button bar provides a shortcut to some of the menu items.


Opens an existing soil file. This has the same function as selecting ‘**Open**’ under ‘**File**’ on the menu bar.


Saves the soil file being edited to the current project. This has the same function as selecting ‘**Save**’ under ‘**File**’ on the menu bar.


Cuts the row or rows of the soil file and places into the clipboard. This has the same function as selecting ‘**Cut Layer**’ under ‘**Edit**’ on the menu bar.


Copies a row or rows of the soil file and places into the clipboard. This has the same function as selecting ‘**Copy Layer**’ under ‘**Edit**’ on the menu bar.


Pastes a row or rows of the soil file from the clipboard to a row above the currently selected row. This has the same function as selecting ‘**Paste Before Layer**’ under ‘**Edit**’ on the menu bar.


Prints the soil properties currently displayed.


Opens the general help system for the Soil User Interface.


Enables context-sensitive help. Click on this button, then on any item of the screen, for help on that item.


Saves the currently displayed data and closes the Soil Users Interface.

The Soil User Interface displays data in four tables. The Soil Identification table provides information regarding the soil identification, location, and classification. The Soil Identification parameters are not critical to the operation of WEPS and are used for identification purposes only. The Soil Surface Properties & Depth Restrictions table provides information pertaining to the configuration of the soil surface in terms of crusts, roughness, albedo, slope, and rock cover. It also contains the depth to root and water restrictive layers. The Soil Layer Properties table contains soil properties by layer or horizon. At the bottom of the screen is the Soil Notes table. The user may enter any notes pertaining to the soil file. These notes are appended to the bottom of the Soil file. The Soil Notes may also contain notes generated by the interface. These generated notes specify parameters that were adjusted because of out-of-range values, and lists the old and new values. The notes are not critical to the operation of WEPS and are used for information purposes only.

Downloading Soil Data

This section describes how to download soil data from the NRCS Soil Data Mart and how to extract it for use within WEPS. A Microsoft Access database is available for importing the data in the export file. You must have Microsoft Access 97 or later installed on your PC.

Soil data for NRCS and most other users in the US, is currently available for download from the NRCS Soil Data Mart at: http://soildatamart.nrcs.usda.gov/ . Soil survey data that is exported from the Soil Data Mart is in what is referred to as “SSURGO” (Soil Survey Geographic) format. To obtain soil data for a Soil Survey Area of interest, go to the Soil Data Mart and click ‘Select State’ at the top of the Soil Data Mart screen. Select the desired state then click ‘Select Survey Area’ or ‘Select County’. Select the soil survey area, then click ‘Download Data’. On the download screen select ‘Tabular Data Only’, select the version of Microsoft Access on your computer, and enter your e-mail address, then click ‘Submit Request’. You will see a message stating “Your request has been logged. At a later time you will receive an e-mail with a link to download the export file. The format of an export file name is: soil_ssasymbol.zip, where ssasymbol is the soil survey symbol of the corresponding soil survey area.

After the export file has been copied to your PC, it must be unzipped by using either WinZip or a similar program. For additional information, please see the file named README.txt in the root directory that is created by unzipping the export file. For additional soil survey areas, each zip file should be copied and unzipped into individual directories. When an export file is unzipped, the following directory hierarchy is produced in the directory to which the export file was unzipped:

\spatial
\tabular

The top-level directory contains the following files:

soil_metadata_ssasymbol.txt - a Federal Geographic Data Committee (FGDC) metadata file in plain ASCII format.

soil_metadata_ssasymbol.xml - the same FGDC metadata file in XML format.

readme.txt - a text file containing additional information.

The root directory will also contain a zipped, empty MS Access SSURGO template database, if one was requested as part of the download. The non-extension part of the zipped template database file name varies, but if one was included, it will be the only file in the top-level directory with an extension of "zip". This file should be unzipped as well. For example, "soildb_US_2002.zip" unzips to "soildb_US_2002.mdb".

The directory "tabular" contains any tabular data that was requested. The directory "spatial" contains any spatial data that was requested. Note that spatial data is not required nor recommended (due to large file sizes) for WEPS. It is possible to request tabular data from the Soil Data Mart without including the corresponding spatial data, and vice versa.

Tabular data is provided as a set of ASCII delimited files. Each file corresponds to a table in the SSURGO 2.1 data model. The tabular data isn't particularly useful until it has been imported into the MS Access SSURGO template database. Current Soil Data Mart downloads include a template database. The database is the "soildb_US_xxxx.zip" or the "soildb_US_xxxx.mdb" (unziped) file where "xxxx" varies depending on the version of database downloaded. If a template database was not included in the export file, you can download one from the following URL:

http://soildatamart.nrcs.usda.gov/templates.aspx

To import tabular data, load the template file into MS Access. A 'SSURGO Import' screen will display, asking for the full path to the tabular data directory (Fig. 2.19). Type (or cut and paste) the full path of the tabular directory and click 'OK'. A list of database tables will appear and a folder will be created in the top level directory. The folder will have the base name (non-extension part) of the template name. At the same time, an MS Access database file (*.mdb), which contains the data required for WEPS, will be created in the template folder.

To import more than one soil survey area into a single MS Access database, run the Import macro specifying the full path to the directory the SSURGO data was unzipped into. Repeat the Import macro for each area desired. When done, save the template database with the imported data to a new name (*.mdb).

The WEPS1.0 soil input file Version 1.0 extracts data from the following SSURGO data files located in the \tabular directory:

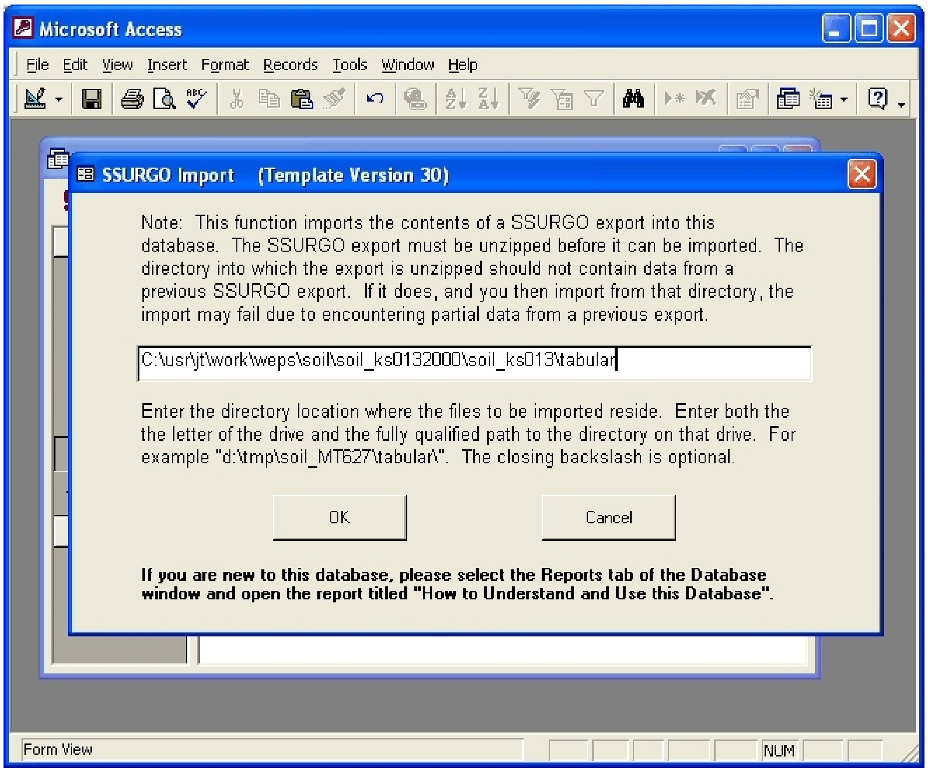


Figure 2.19. WEPS Soil User Interface screen.

chfrags.txt
chorizon.txt
chtexgrp.txt
comp.txt
crstrcts.txt
legend.txt
mapunit.txt
muaggatt.txt
version.txt

If multiple soil survey areas are imported into a single MS Access database, the database may become very large. To reduce the size of the Access database file, one may run the Export macro and delete the SSURGO data (*.txt) files created in the tabular directory that are not listed above before importing into a template Access database.

Using SSURGO Data With WEPS

Within WEPS, open the "**Configuration**" window, then click the "**Directories**" tab. Fill out the full path and SSURGO soil database file name (*.mdb) for "**Soil DB**" and close the configuration window (click "Save" if you want to use that path in subsequent WEPS runs). Selecting the Soil Template folder at the bottom of the main WEPS screen will display the list of soil survey areas to choose from. Select the desired soil survey area and select the soil map unit and component for the simulation run. If the SSURGO database is not populated with data required by WEPS, you will get an error message when selecting that soil. More detailed information on selecting soils, see the "**Interface Reference: Choosing a Soil**" section of the WEPS User Manual.

Missing Data

In one mode of operation the Soil Interface estimates limited values if they are not populated in the SSURGO database. NRCS users must click the check box for "Do not estimate missing values from SSURGO database" under the "Miscellaneous" tab of the "Configuration" window so that these values are not estimated. If a soil database record generates an error listing missing data upon loading, contact your local NRCS office for assistance.

Making a WEPS Run

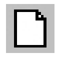
WEPS Projects

A "WEPS project" is a directory that can be thought of as a working area where WEPS simulation runs are created and stored along with their outputs. A project stores all the parameters for the current simulation run being prepared within the WEPS interface, as well as any past WEPS simulation runs. For example, a particular project may represent a directory for an individual farm under which all the simulation runs for each field and management alternatives on that farm are stored. When a project is saved, all of the information contained on the current interface screen is stored in the project directory. Multiple WEPS projects can be created and given various names by the user. These directories can also be managed (i.e., renamed, deleted, or moved) with a file manager such as Windows Explorer (not provided with WEPS). One can also remove unnecessary WEPS project and WEPS run directories from within the WEPS interface via the pertinent options under the "Project" or "Run" menus. Note that known characters that are invalid in WEPS file names include: \ / < > | ? * & " ~ ` '

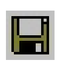
All WEPS simulation run results are stored in subdirectories within a WEPS project directory. A WEPS run subdirectory is created every time a simulation run is made. A WEPS run subdirectory stores a copy of all input files used to make the simulation run, together with the output files generated from those inputs. Thus, one is able to reproduce the identical WEPS run at a later date (and presumably get the same outputs when using the same version of WEPS 1.0 and the weather generators/databases) because the original input files are still available. Typically, 're-running' a previous run is not necessary since the outputs are stored in the run directory and can be reviewed via the ViewOutput menu. However, if additional outputs not generated with the original run are desired, it will be necessary to load the previous run and run using the desired output options. The run directories make it relatively easy to archive or remove WEPS runs as alternative erosion planning scenarios are tested for a field or farm. If, for example, a change is made to create a different management alternative, all the information pertaining to this new scenario will be saved to a new subdirectory under a new WEPS run name, when the simulation is made.

Working with Projects

Clicking the '**Project**' menu item displays a list of various options pertaining to WEPS projects. These options are discussed below.

The 'New' menu item (same as  on the button bar) allows the user to create a new project from scratch. Clicking on this menu item causes WEPS to check for any unsaved changes to the parameters displayed on the screen. If there are unsaved changes, the user is asked if they want to '**Save current project?**'. If the user clicks '**Yes**', the current parameters are saved to the old (current) project. A file chooser then appears that allows the user to specify a name for the new WEPS project. The current WEPS interface screen is then cleared, and the newly created project becomes the current project. If the user clicks '**No**', a file chooser opens immediately, allowing the user to name the new project to be created, and resets the parameters to the system defaults without saving any changes to the previous (current) project. In either case, the user can then proceed to build the new project by entering information on the interface screens. If the user clicks '**Cancel**', the process of creating a new project is aborted and the screen returns to the previous project.

The '**Open...**' menu item (same as  on the button bar) opens an existing project. Clicking on this menu item causes WEPS to check for any unsaved changes to the displayed parameters. If there are unsaved changes, the user is asked if they want to '**Save current project?**'. If the user clicks '**Yes**', the current parameters are saved to the old (current) project. A file chooser then appears that allows the user to specify the name of an existing project to open. The newly opened project becomes the current project. If the user clicks '**No**', the old project is closed without saving any changes and a file chooser opens that allows the user to select an existing project to be re-opened. In either case, the user can then proceed to view the project information or modify the project by entering information on the interface screens. If the user clicks '**Cancel**', the process of selecting a previous project is aborted and the screen returns to the old project. When leaving the project or WEPS, the user is asked if they want to save the current project.

The '**Save**' menu item (same as  on the button bar) saves the current WEPS project to the current project name.

'**Save As...**' allows the user to save a copy of the currently displayed WEPS project to a new name. The name must be new and cannot overwrite the name of an existing project. The user must enter a unique name. The copy then becomes the current project.

The **'Delete Project'** and the **'Delete Run'** menu item opens a file chooser to delete a WEPS project and run.

The **'Delete Management Rotation File'** menu item opens a file chooser to delete a WEPS management file. The **'Delete IFC Soil File'** item opens a file chooser to delete a WEPs soil file. **'Exit',** exits the WEPS program.

The default project folder (i.e., directory) for these various project options, under which new projects will be created and existing projects will be opened, can be specified under the ‘**Directories**’ tab of the ‘**Configuration**’ window. Enter the default directory on the line labeled ‘**Projects Dir**’. By default, the last project that was open when WEPS was exited is the current project when WEPS is restarted.

Making a WEPS Run

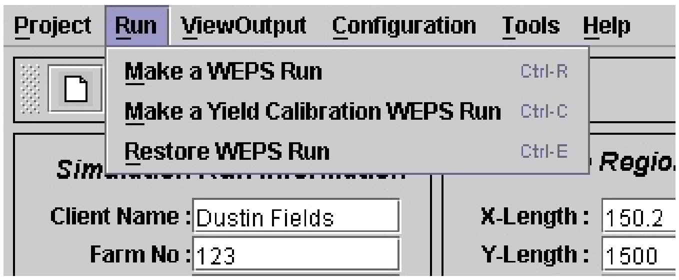


Figure 2.20. The run menu of the main screen.

Once the desired information is entered through the interface screens, a simulation run can be started. Clicking on the ‘**Run**’ menu, then selecting ‘**Make a WEPS Run**’ (Fig. 2.20), begins a WEPS simulation run. One can also click the run button on the button bar to begin a WEPS simulation run.

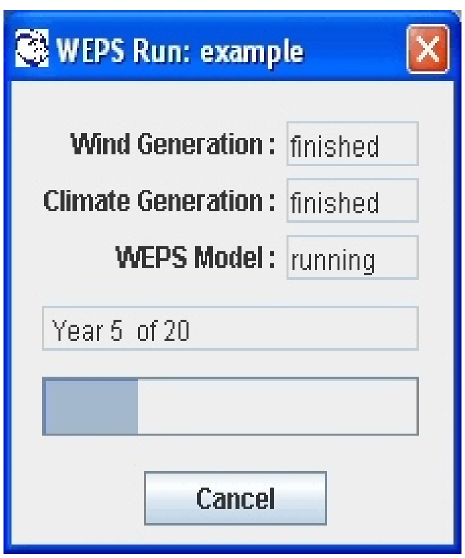


Figure 2.21. WEPS run status window.

A box will appear, asking the user to “**Enter a run name**”. Note that some special characters are not allowed in file names. Known characters that are not allowed include ? ‘ ` & ~ / \ < > | : * ”. When a run name has been entered, the simulation begins and a window appears that shows the status and progress of the run (Fig. 2.21). At the conclusion of the run, a window may appear, if warranted, displaying any warnings that have been generated. These warnings are for informational purposes and may or may not be of interest to the user. Upon completion of a run, a WEPS Run Summary report will appear for the user to review and print if desired. The Run Summary is saved in the run directory, along with more detailed output reports for later retrieval. The summary and detailed reports for a run can be viewed or created any time by the user. See the section of the WEPS User Manual titled ‘**WEPS Output**’ for more detailed descriptions of the WEPS output types and how to select them for viewing or printing.

If a crop does not reach maturity, a warning will appear, indicating that the crop only reached the specified percent of the expected maturity for a given year. This warning can result from one of two causes. First, the crop variety chosen has a growing season too short for the climate being simulated. For example, a 120-day corn variety may be specified for a location that usually grows 110-day corn. In this case, a variety that matures over a longer period for that location should be chosen. If a variety of suitable length is not available in the crop drill-down list, a new variety can be created by following the method outlined in the WEPS How To Guide: Crop Database Record Development. Another cause of this warning may be that the growing season as specified by plant and harvest dates are too close together, not allowing the crop enough days to reach maturity. In this case, be sure the planting and harvest dates are correct, and adjust accordingly. If a crop is harvested before full maturity (e.g., for alfalfa or silage), a warning message will also appear.

Make a Yield Calibration WEPS Run

Differences in crop management by producers or local climate and soil variances may result in crop yields, generated by WEPS, that do not reflect the actual yields observed by a producer. WEPS provides a method to "calibrate" yields and associated crop residue biomass from WEPS so that they more accurately reflect those of individual producers or a county as a whole. The following steps describe how to make a yield calibration run.

a) Within MCREW, press the '**Yield Calibrate**' button to display additional columns related to the crop-yield calibration function in WEPS. When the columns are displayed, the '**Yield Calibrate**' button is outlined in red .

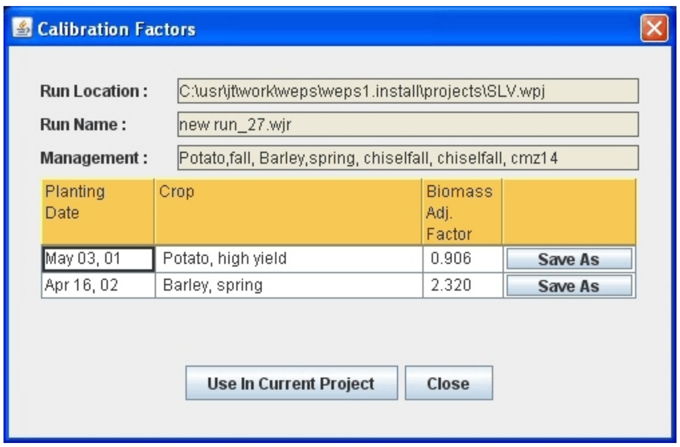
b) Within MCREW, select the crop (or crops) that you want to calibrate by checking the box in the '**Calib. Yield?**' column for the respective row the crop planting operation is in.

c) Fill in the desired '**Target Yield**' for the selected crop(s). The yield units are displayed but not editable. The units may be changed in the Crop Drill-down window under the "Harvest" tab and the "Harvest yield conversion factor" must be adjusted to reflect the new units. Note that changing the water content requires changing the columns labeled "Yield Coef." and "Residue Intercept"because all three parameters are interrelated . See the Crop How To Guide for more information on these parameters.

d) Save the rotation management file in MCREW. This currently can be done by: I) pressing the '**Save**' icon , ii) via the '**File > Save**' menu option, iii) using the '**Ctrl-S**' keyboard shortcut, or iv) by clicking the Save and Close button , which saves the displayed data to the current file name and closes MCREW.

e) Exit MCREW. This can be done either by: I) clicking on the "Close Window" button in the top right corner of the MCREW window frame or ii) via the '**File > Exit**' menu option. Note that if one forgets to save the management file before attempting to exit MCREW, the user will be notified and given the opportunity to do so before exiting MCREW.

f) Click the '**Make a Yield Calibration WEPS Run**' via the '**Run**' menu bar option on the main screen (Fig. 2.20) or the 'Calibrate Run' button on the main screen tool bar. The shortcut '**Ctrl-C**' will also work if the main WEPS screen has focus.



g) After the Calibration Run has completed, a popup dialog window will appear that displays the '**Calibration Factors**' for each crop selected for calibration (see figure to the left). One may then save each crop record as a new crop by clicking the "Save As" button **Save As** for each crop. The user may also use the Biomass Adjustment factor in the current project by clicking the "Use in Current Project" button at the bottom of the window. The biomass adjustment factor determined for each crop is also written into the 'notes' file for the calibration run.

Restore a WEPS Run

A previously created WEPS run can be restored by clicking on the '**Run**' menu and selecting '**Restore a WEPS Run**' (Fig. 2.20). This will open a file chooser that allows the user to select a previously created WEPS run. One can also click the restore button to restore a run. 'Restoring a WEPS Run' actually loads the inputs of the previous WEPS run into the WEPS interface. These inputs can be modified and a new simulation run again with a new WEPS run name. The new run will be saved into a new subdirectory; previous WEPS runs cannot be overwritten. Runs can be removed via the 'Project>Delete Run' menu option. It is recommended that the user remove unwanted runs regularly to prevent these runs from filling hard-disk space.

Viewing Previous Outputs

Output from either the current run or previous runs can be viewed by using the '**ViewOutput**' menu. This menu allows the user to view output for the most recent (current) or previous runs. Clicking on the '**Current Run**' menu item displays a list of output reports for the current (last completed WEPS simulation) run. Clicking on the '**Previous Run**' menu item displays a list of output reports for previous runs. For previous runs, a file chooser opens to allow the user to pick the desired run for which to view the output. The **"Multiple Run Manager"** allows the user to open a list of previous WEPS runs. See the section of the WEPS User Manual titled '**WEPS Output**' for more detailed description of WEPS outputs.

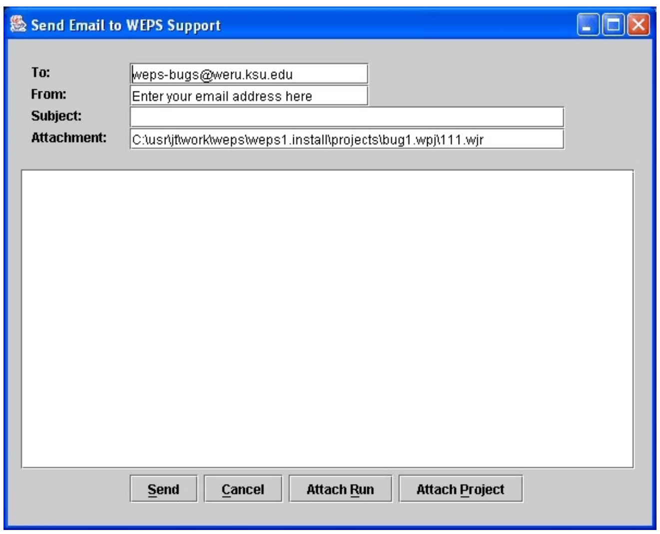


Figure 2.22. E-mail error report window.

Errors

If an error occurs during a WEPS simulation run, an error message will appear. Once the error message is closed, an e-mail window opens that allows the user to report the error to USDA-ARS Wind Erosion Research Unit (Fig. 2.23). The user should enter an e-mail address and a short message. Click the appropriate box at the bottom of the window to attach either the current project (with all associated run directories) or the current run files to your e-mail. One typically would only attach the run, unless there is a specific reason to attach the project and all its associated run directories. Because of the number of potential files within a project, attaching a project could create a large size attachment. Note that, by default, the project is attached to the e-mail message. If you are connected to the Internet, clicking '**Send**' will e-mail the message to WERU, along with any attached files, so that your inquiry can be answered. Also note that the user cannot send e-mail from WEPS unless they have correctly configured the WEPS e-mail client within the '**Configuration**' window.

WEPS Output

WEPS provides numerous outputs to aid the user in conservation planning. These outputs are accessed through the '**ViewOutput**' menu on the main screen. Clicking on this menu displays two choices, '**Current Run**' and '**Previous Run**'. Clicking on '**Current Run**' displays a list of output options for the most recent WEPS run. The 'Previous Run' choice allows the user to view results of previous WEPS runs. A description of the choices under these two submenus follows.

Run Summary

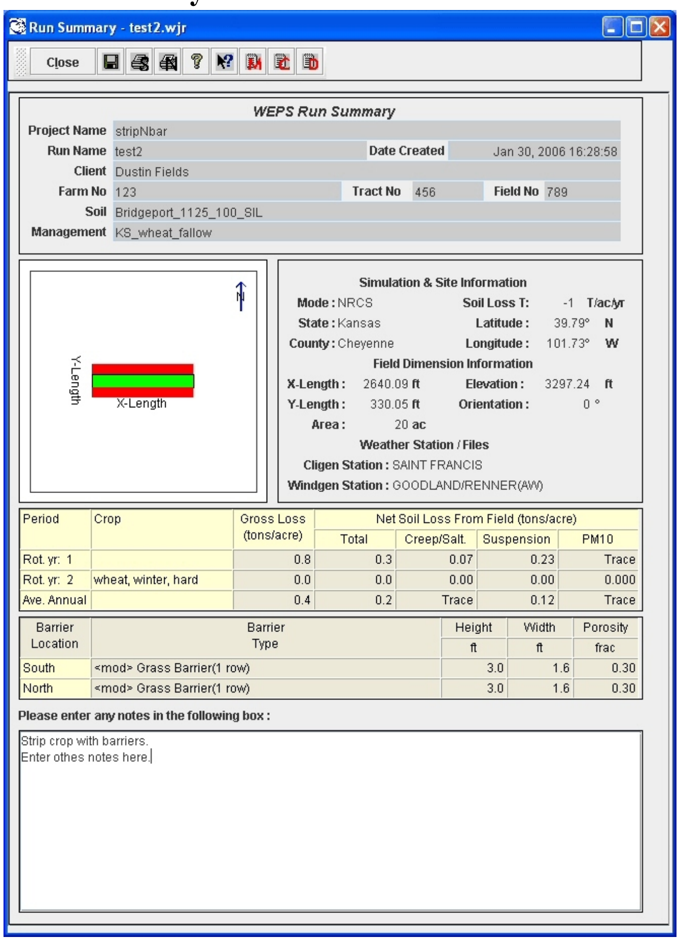


Figure 2.23. The WEPS Run Summary screen.

The Run Summary report screen (Fig. 2.23) will automatically display at the conclusion of a simulation run. If the Run Summary screen has been closed, the user can display the Run Summary screen for the most recent WEPS run or previous runs by clicking the '**ViewOutput**' menu on the WEPS main screen menu bar.

The Run Summary contains names of the input files, as well as other input parameters, basic soil loss information by rotation year, and the average annual for the total simulation.

Soil loss output in the Run Summary includes: **Gross Loss,** which is the average erosion within the field (i.e., removal of soil with no deposition taken into account); **Net Total**, the average total net loss from the field (net losses are gross losses minus deposition within the field); Net Creep/Salt, the average creep plus saltation net loss from the field; **Net Suspension**, the average suspension net loss from the field; and **Net PM10**, the average PM10 (particulate matter less than 10 microns) net loss from the field. Deposition occurs when the wind speed drops as it travels across the field or the surface conditions become less erodible in a downwind part of the field (i.e., transport capacity of the wind exceeds transport capacity for the surface conditions). In WEPS 1.0, deposition only occurs with a drop in wind speed across the field due to a barrier present on the downwind side of the field or surface conditions changing across the field because of the erosion process. In many simulations, however, it is not uncommon to have equal gross and net total loss.

If an erosion event occurred, but values generated by the model are too small to be displayed on the output table (i.e., <0.001 kg/m^2), then the amount is listed as "trace". If amounts are too large to be accurately displayed, then the amount is listed simply as greater than a specified amount (i.e., > 300 kg/m^2). In these cases, erosion amounts are so large that they are generally unacceptable. If any barriers were present on the field borders, a summary of their properties is also listed. Finally, any notes entered on the main screen for the run are reproduced, and they can be edited or added to, if desired, and saved via the appropriate button at the top of the form.

A button bar is included at the top of the Run Summary screen that allows the user to close the window Close, save the notes to the summary, print the summary, print the notes, open general help for WEPS, use the context help, and display the Management Summary screen, the Crop Summary screen, and Detailed Reports screen.

Crop Summary

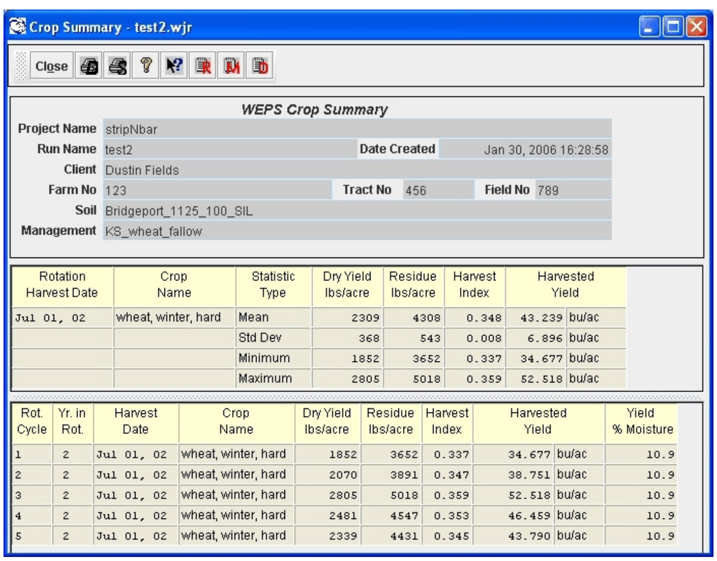


Figure 2.24. The WEPS Crop Summary screen.

The Crop Summary report screen (Fig. 2.25) contains simulation run information, including the names of the input files. It also contains a Detailed Report table and a Summary Report table for each crop grown during the simulation run.

The Crop Summary table displays crop yield data for each crop year in the simulation. A table below the Crop Summary table provides statistical summary parameters for each rotation year. For example, it displays the mean yield for all the simulation years that an individual crop was grown.

A button bar is included at the top of the screen that allows the user to close the window Close, print the crop detail table, print the crop summary table, open general help for WEPS, use the context help, and display the Run Summary screen, the Management Summary screen, and Detailed Reports screen.

Management Summary

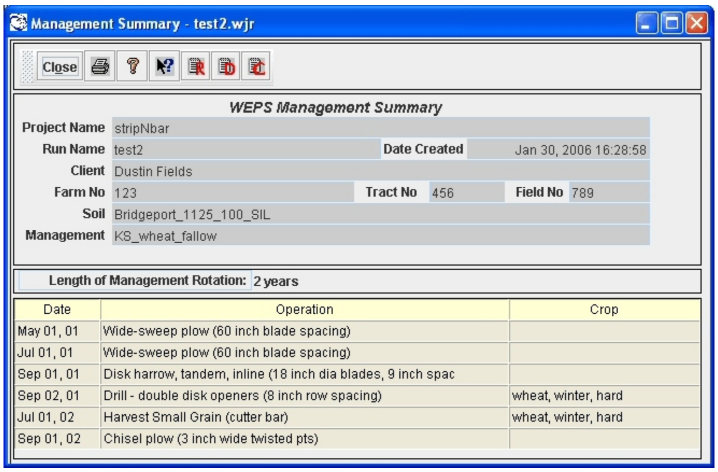


Figure 2.25. The WEPS Management Summary screen.

The Management Summary report screen (Fig. 2.25) contains general run information as well as a summary of the management information for the run. The Management Summary table at the bottom of the screen displays the management operation date, operation, and crop for the run.

A button bar is included at the top of the Management Summary screen that allows the user to close the window Close, print the Management Summary, open general help for WEPS, use the context help, and display the Run Summary screen, the Detailed Report screen, and Crop Summary screen.

Detail Reports

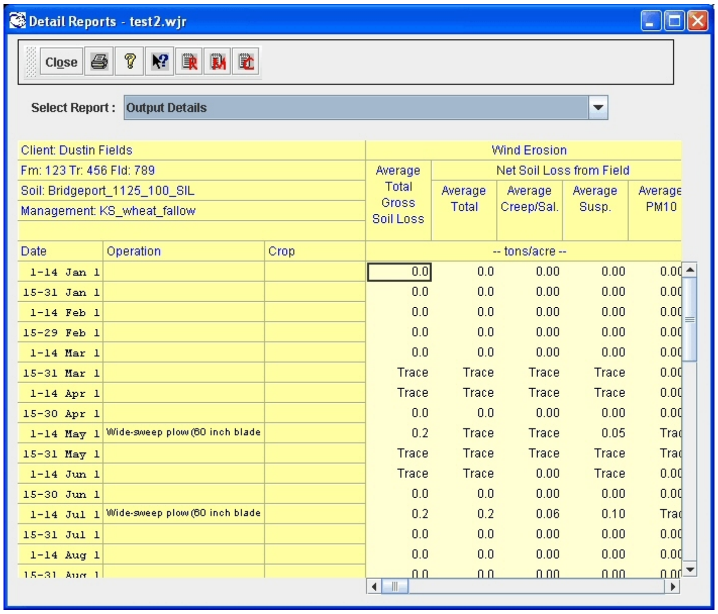


Figure 2.26. The WEPS Detailed Reports screen showing the drop down report list.

The Detail Reports screen (Fig. 2.27) provides a choice list where the user can select various types of output.

A button bar is included at the top of the Detail Reports screen that allows the user to close the window [Close], print any detail report, open general help for WEPS, use the context help, and display the Management Summary screen, the Run Summary screen, and Crop Summary screen. Below the button bar is a drop-down report list labeled '**Select Report**'. Clicking the down arrow to the right of '**Select Report**' displays the list of outputs available. Click the desired list and it will be displayed in the window below. The following is a description of each report screen.

Output Details

The Output Details report contains all of the erosion, weather, and surface information available by period, by rotation year, and for the entire simulation run.

The columns of the Output Details report have the following information.

Date - The start and end dates (day/month/rotation year) of the reporting period.

Operation - The management operation that occurred on the specified date (if multiple operations have been specified on the same date, only the last one listed on that date will be displayed).

Crop -The crop planted on the specified date.

Wind Erosion

Average Number Erosion Events - This column displays the average number of erosion events per period (fraction).

Total Number Erosion Events - The total number of erosion events during that period for the simulation.

Gross Loss per Erosion Event - The gross erosion within the field for each event, averaged across the field, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Net Loss per Erosion Event - The net erosion within the field for each event, averaged across the field, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre). Some deposition within a field can occur, especially when barriers are present downwind. Net soil loss is the amount of gross loss minus deposition.

Average Total Gross Soil Loss - The average erosion (soil loss) within the field, averaged across the field, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre). This value is the total amount of soil being removed from the surface of the field. It does not take into consideration the amount of that entrained soil that may be re-deposited downwind within the field due to wind barriers, etc. The "gross" soil loss values are most important when evaluating the "onsite" effects of wind erosion.

Net Soil Loss from Field

The 'Net Soil Loss from Field' columns display the "actual" soil loss from the field (net losses are gross losses minus deposition within the field). Specific areas within the field may experience: 1) a net soil loss, 2) a net soil gain (deposition), 3) no soil movement, or 4) soil movement, but the soil loss is equal to the deposition within the specified area. Under some scenarios, a portion of soil entrained upwind can get deposited within the field borders, due to a reduction in wind speed (and thus it's soil-carrying capacity) caused by downwind barriers, changes in surface roughness across the field, etc. Therefore, the "net" soil loss reported will be less than the "gross" soil loss in these situations. The "net" soil loss values are most important when evaluating "offsite" effects of wind erosion.

Average Total - The average total net soil loss from the field (kg/m^2 or tons/acre). This value represents the average amount of soil actually leaving the field boundaries. If there are any downwind barriers, this value will be somewhat less than the 'Average Total Gross Soil Loss' value due to deposition occurring within the field.

Average Creep & Saltation - The quantity of creep plus saltation-size material leaving the field for the period, averaged across the field grid areas, as well as averaged over the number of simulation years in each year of the crop rotation (kg/m^2 or tons/acre).

Average Suspension - The quantity of suspension-size material leaving the field for the period, averaged across the field grid areas, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Average PM10 - The quantity of PM10 (particulate matter less than 10 microns) material leaving the field for the period, averaged across the field grid areas, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Mass of Soil Passing Indicated Field Boundary

These columns display the average soil loss across the indicated field boundary, per unit length of field border, for the specified size range of eroding material.

Creep+Saltation - Average mass of creep plus saltation-size material passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated  .

Suspension - Average mass of suspension-size material passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated  .

PM10 - Average mass of PM10 size material passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated .

Within-Field Wind Erosion Activity

The information in this section is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any, should be applied and where. This information is also useful in understanding how much of the field is actively eroding, and thus may be causing plant or soil damage, or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Saltating Emission Region

Soil Loss	- The amount of soil loss from that area of the field that had significant saltation emission (kg/m^2 or tons/acre).
Field Area	- Both the area (acres or hectares) and fraction of the field area that had saltation emission.

Deposition Region

Soil Deposition	- The amount of soil deposited in that area of the field where deposition is the primary activity (kg/m^2 or tons/acre).
Field Area	- Both the area (acres or hectares) and fraction of the field area that had deposition.

High Flux Region

Field Area	- Both the area (acres or hectares) and fraction of the field area that was near transport capacity.

Sheltered Region

Field Area	- Both the area (acres or hectares) and fraction of the field area that had no saltation or suspension material being emitted. Sheltered areas are typically those immediately downwind of barriers.

Weather Info

Average Total Period Precip	- The total precipitation for the period averaged over the simulation years in each year of the crop rotation (mm or inches).
Average Wind Energy >8 m/s	- The average daily wind energy for the period for winds greater than 8 m/s (18 mi/h), averaged over the simulation years in each year of the crop rotation (KJ/m^2/day).
Snow Depth > 20 mm	- The total average fraction of time that snow cover on the field which is greater than 20 mm (0.787 in) in depth (mm or inches).

Average Biomass Surface Conditions on Date

Crop Vegetation (Live)

Canopy Cover	- The fraction of live crop biomass cover (vertical view) at the period end, averaged over the simulation years for the period listed (fraction).
Effective Standing Silhouette	- The standing silhouette area index of live plants, expressed on a fraction basis. If the plants are planted in the furrow, as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. These are values at the period end, averaged over the simulation years in each rotation year.
Leaf and Stem Mass	- The total live crop biomass, above ground, at the period end, averaged over the simulation years for the period listed (kg/m^2 or lbs/acre).
Root Mass	- The total live crop biomass, below ground, at the period end, averaged over the simulation years for the period listed (kg/m^2 or lbs/acre).
Crop Height	- The height of the crop above the soil surface (mm or inches).

Crop Residue (Dead)

Surface Cover	- The amount of flat residue cover (dead) on the soil surface, expressed as a fraction. These are values at the period end, averaged over the simulation years in each rotation year (fraction).
Effective Standing Silhouette	- The standing silhouette area index of plant residues, expressed on a fraction basis. These are values at the period end, averaged over the simulation years in each rotation year.
Flat Mass	- The amount of flat residue mass on the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Standing Mass - The amount of standing residue mass on the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Buried Mass - The amount of buried residue mass including roots, below the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Buried Root Mass - The amount of root mass, below the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Weighted Residue Height - The height of residue weighted by residue pool (residue is various stages of decomposition) (mm or inches).

Number of Residue Stems - The number of standing residue stems per hectare or acre.

Live and Dead Biomass

Surface Cover - The amount of flat surface cover from live vegetation and dead plant residue (flat cover) biomass on the soil surface, expressed on a fraction basis. These are values at the period end, averaged over the simulation years in each rotation year (fraction).

Effective Standing Silhouette - The standing silhouette area index of live vegetation plus dead plant residue. If the plants are planted in the furrow, as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. These are values at the period end, averaged over the simulation years in each rotation year (fraction).

Flat Mass - The amount of flat live vegetation (air dried) and dead plant residue biomass on the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Effective Standing Mass - The amount of standing live vegetation and plant residue biomass. If the plants are planted in the furrow, as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

All Buried Mass - The amount of vegetative material, both live and dead below the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Average Soil Surface Conditions on Date

Oriented Roughness

Ridge Orientation - The orientation of soil ridges, with zero degrees (0°) representing north/south ridges.

Ridge Height - The height of ridges. This is the value, at the period end, averaged over the simulation years in each rotation year (mm or inches).

Ridge Spacing - The spacing between ridges. This is the value at the period end, averaged over the simulation years in each rotation year (mm or inches).

Random Roughness - The standard deviation of the soil surface random roughness. This is the value at the period end, averaged over the simulation years in each rotation year (mm or inches).

Aggregation

Aggregates < 0.84 mm - The fraction of aggregates less than 0.84 mm (0.033 inches). Aggregates < 0.84 mm are generally considered to be erodible. This is the value at the period end, averaged over the simulation years in each rotation year.

Dry Aggregate Stability - The dry aggregate stability is the log of crushing energy of dry soil aggregates (ln(J/kg)), which is related to abrasion resistance. This is the value at the period end, averaged over the simulation years in each rotation year.

Crust Cover - The fraction of the soil surface that is crusted. This is the value at the period end, averaged over the simulation years in each rotation year.

The **rows** in the Output Details table differ, depending on the number of cropping years in the rotation and the number of management operations in each year of the rotation.

Each year of the rotation has output displayed for the two week periods, as well as for each management operation date. This output allows the user to view the erosion and other output for each year of the rotation. At the end of each year in the rotation is a row that contains the average annual value for that rotation year.

The last row in the output form contains the average annual values for the complete crop rotation.

The remaining menu list items on the Detail Reports screen are generally a subset of the Output Details menu option just described.

Erosion
The Erosion report displays soil loss parameters for each rotation year and the average annual for all rotation years.

Field Loss (summary)
The Field Loss summary report displays average soil loss by rotation year and for the entire simulation run. The values displayed include: Average Total Gross Soil Loss, the average erosion within the field; Net Average Total, the average total net loss from the field; Net Average Creep/Salt, the average creep plus saltation net loss from the field; Net Average Suspension, the average suspension net loss from the field; and Net Average PM10, the average PM10 net loss from the field.

Field Loss (details)
The Field Loss detailed report displays average soil loss by period, by rotation year, and for the entire simulation run. The values displayed include: Average Total Gross Soil Loss, the average erosion within the field; Net Average Total, average total net loss from the field; Net Average Creep/Salt, the average creep plus saltation net loss from the field; Net Average Suspension, the average suspension net loss from the field; and Net Average PM10, the average PM10 net loss from the field.

Boundary Loss (summary)
The Boundary Loss summary report displays the average mass passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated  . These parameters are reported for each rotation year and for the simulation run. The columns labeled 'Creep + Saltation' contain the mass per unit boundary length of creep plus saltation-size material that passed the field boundary for each direction. The Suspension columns contain the mass per unit boundary length of suspension-size material that passed the field boundary for each direction. The PM10 columns contain the mass per unit boundary length of PM10-size

material that passed the field boundary for each direction.

Boundary Loss (details)
The Boundary Loss detailed report displays the average (by period, rotation year, and simulation run) mass passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated . These parameters are reported by period, for each rotation year, and for the simulation run. The columns labeled 'Creep + Saltation' contain the mass per unit boundary length of creep plus saltation-size material that passed the field boundary for each direction. The Suspension columns contain the mass per unit boundary length of suspension-size material that passed the field boundary for each direction. The PM10 columns contain the mass per unit boundary length of PM10-size material that passed the field boundary for each direction.

Within-field Erosion (summary)
The Within-field Erosion summary report displays information for various types of erosion activity by rotation year and for the simulation run. These activities include amounts, as well as area and fraction of the field that had significant saltation emission and deposition. In addition, high flux and sheltered areas and fraction of the field are given. The high flux region is that area that is near transport capacity. A sheltered area is one that had no saltation or suspension material being emitted. Sheltered areas are typically those immediately downwind of barriers. This information is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any, should be applied and where. This information is also useful in understanding how much of the field is actively causing plant or soil damage or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Within-Field Erosion (details)
The Within-Field Erosion detailed report displays information for various types of erosion activity by period, by rotation year, and for the simulation run. These activities include amounts, as well as areas and fraction of the field that had significant saltation emission and deposition. In addition, high flux and sheltered area and fraction of the field are given. The high flux region is that area that is near transport capacity. A sheltered area is one that had no saltation or suspension material being emitted. Sheltered areas are typically those immediately downwind of barriers. This information is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any, should be applied and where. This information is also useful in understanding how much of the field is actively causing plant or soil damage, or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Erosion (summary)

The erosion summary report displays all of the information available on erosion contained in the Field Loss (summary), Boundary Loss (summary), and Within-field Loss (summary) reports.

Erosion (details)

The erosion detailed report displays all of the information available on erosion contained in the Field Loss (details), Boundary Loss (details), and Within-field Loss (details) reports.

Erosion (monthly details)

The erosion monthly detailed report displays all of the information available on erosion contained in the Erosion (summary) report, but includes monthly average values (averaged across rotation years).

Erosion (yearly details)

The erosion yearly detailed report displays all of the information available on erosion contained in the Erosion (summary) report, but includes individual simulation-year values.

Weather (summary)

The weather summary report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field is greater than 20 mm. These parameters are reported for each rotation year and for the simulation run.

Weather (details)

The weather detailed report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field is greater than 20 mm. These parameters are reported by period, for each rotation year, and for the simulation run.

Weather (monthly details)

The weather monthly detailed report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field is greater than 20 mm. These parameters are reported for each rotation year, by month and for the simulation run.

Weather (yearly details)

The weather yearly detailed report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field is greater than 20 mm. These parameters are reported for each rotation year, each individual simulation year and for the simulation run.

Crop Vegetation (details)

The crop vegetation detailed report displays average live above-ground biomass conditions that existed on the end date for the period reported. The conditions displayed include canopy cover, effective standing silhouette, and above ground mass. Canopy cover is the fraction of live crop biomass cover from a vertical view. Effective standing silhouette is the standing silhouette area index of live plants. These values are standing silhouette area per area of soil surface, expressed as a fraction. If the plants are planted in the furrow, as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. Above-ground mass is the total above-ground biomass.

Crop Residue (details)

The crop residue detailed report displays average dead above-ground biomass conditions that existed on the end date for the period reported. The conditions displayed include flat cover, effective standing silhouette, flat mass, and standing mass. Flat cover is the fraction of dead crop biomass cover from a vertical view. Effective standing silhouette is the standing silhouette area index of dead plants. These values are standing silhouette area per area of soil surface, expressed as a fraction. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. Flat mass is the above-ground biomass that is lying flat on the soil surface. Standing mass is the above-ground biomass that is in a standing or upright position on the soil surface.

Crop Biomass (details)

The crop biomass detailed report displays the average live plus dead above-ground biomass conditions that existed on the end date for the period reported. The conditions displayed include flat cover, effective standing silhouette, flat mass, and standing mass. Flat cover is the fraction of live plus dead crop biomass cover from a vertical view. Effective standing silhouette is the standing silhouette area index of live plus dead plants. These values are standing silhouette area per area of soil surface, expressed as a fraction. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. Flat mass is the above-ground biomass that is lying flat on the soil surface. Standing mass is the above-ground biomass that is in a standing or upright position on the soil surface.

Crop Veg, Res & Biomass (details)

The crop vegetation, residue and biomass detailed report displays the all information on vegetative material contained in the Crop reports as described above.

Soil Surface (details)

The soil surface detailed report displays average soil conditions at the surface that existed on the end date for the period reported. The conditions displayed includes ridge orientation, ridge height, ridge spacing, random roughness, aggregates greater than 0.84 mm, aggregate stability, and crust cover. Ridge orientation is the orientation of the ridges, with zero degrees

(0°) representing north/south ridges. Random roughness is the standard deviation of the soil surface roughness height. Aggregates greater than 0.84 mm are expressed as a fraction and are those aggregates generally considered to be non-erodible. Aggregate stability is the log of crushing energy of dry soil aggregates (ln(J/kg)).

Surface Conditions (details)
The surface conditions detailed report displays all of the information available on the field surface contained in the Crop, Residue, Biomass, and Soil Surface reports.

Erosion and Crop (details)
These reports contain a combination of the erosion and crop reports as described above.

Debugging Reports

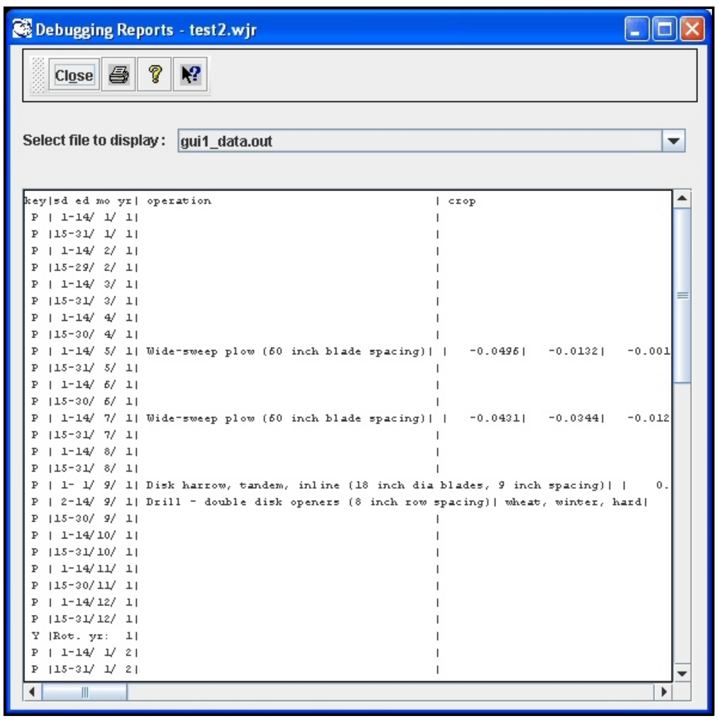


Figure 2.27. The WEPS Debugging Reports screen showing the drop down report list.

The Debugging Reports screen (Fig. 2.27) provides a means of directly accessing all output files generated by the WEPS science model, including those that are used by the WEPS user interface to generate reports. A list of selectable output files are available on a drop-down list. Clicking the down arrow to the right of '**Select file to display**' displays the list of output available. Click the desired list and it will be displayed in the window below. These files are generally for advanced users and model developers. For more information on accessing and interpreting the WEPS science model output files, contact WEPS support.

A button bar is included at the top of the Debugging Reports screen that allows the user to close the window Close, print the opened file, open general help for WEPS, and use the context help.

USING WEPS IN CONSERVATION PLANNING

Interpreting Outputs

Interpreting outputs of WEPS is an important part of controlling wind erosion through conservation planning. By observing how the soil loss is affected by weather and field conditions, the management operations can be adjusted to reduce soil loss. In developing new conservation plans, the user should build or modify several different scenarios and compare outputs to determine the best management to control wind erosion. Existing or current field conditions should be evaluated to determine if an erosion problem exists. If run times are an issue, a shorter run length may be chosen to assess possible problems. WEPS needs at least fifteen rotation cycles to obtain stable results. This will allow more runs to assess relative soil loss values for comparisons. Once one or two scenarios are selected, fifteen rotation cycles are recommended for more accurate erosion loss estimates. The number of erosion cycles can be set by selecting “Configuration” then “WEPS Developers Options” menus on the main screen.

The Detail Reports screen (Figure 3.1) is a date ordered list of numerous parameters generated by the WEPS model. The Detail Reports can be accessed by clicking the Detail Report button on the Main or Run Summary screens as well as through the View Output menu. At the top of the Detail Reports window is a button bar that allows the user to close the window Close, print the data, or view the Run Summary, Management Summary, or Crop Summary.

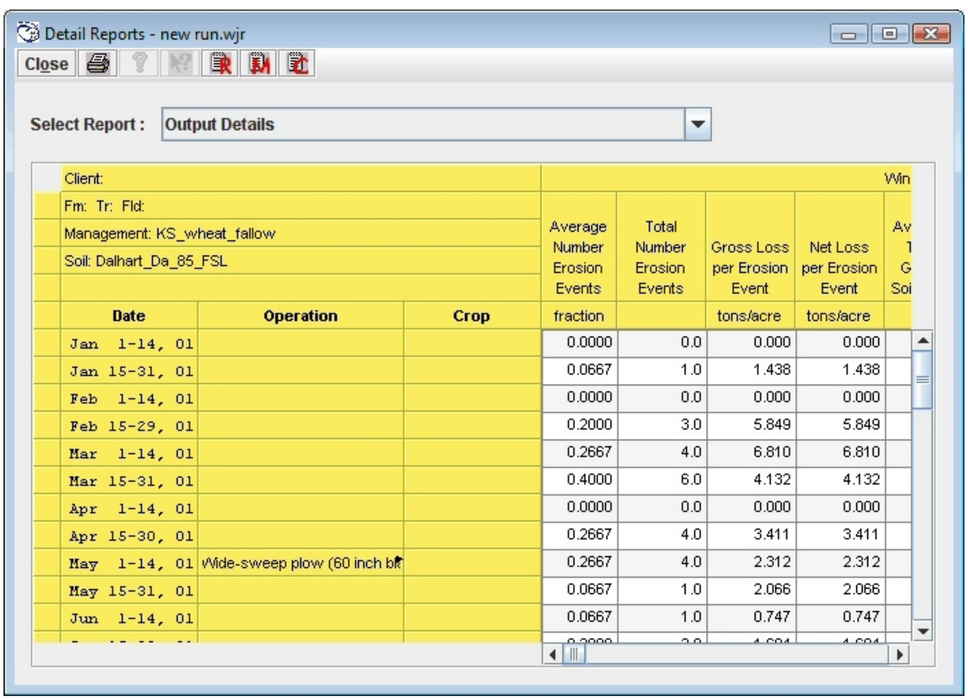


Figure 3.1. Detail Reports window.

Since the detailed reports contains large amounts of information a method is provided to select smaller portions of information to view. Below the menu bar is a drop down list labeled Select Report. Clicking the down arrow to the right displays a list of reports that are subsets of all data available. These allow the user to pick a smaller, easier to view report. The Output Details is the most comprehensive report and is displayed by default. Note that the Detail Reports window may be expanded to display more dates and parameters than the default window.

The following section outlines the content of the Output Details portion of the Detail Reports screen and describes how they can be used to interpret results and design management systems to control erosion by wind. The WEPS User Guide section titled "Interface Reference: Output" contains the definition of each row and column in the detailed reports.

Date
This column contains the start and end date of the period for which the row information is reported (start day-end day month rotation year). Items in each row represent values from the end of the previous period to the current date. The date column, along with soil loss, will indicate which periods have the greatest wind erosion and are thus in need of changes of management to control wind erosion.

The number of **rows** in the Output Details screen differ, depending on the number of cropping years in the rotation and the number of management operations in each year of the rotation. Each year of the rotation has regular output displayed for either fifteen day periods (1st of month to 14th and 15th to the end of the month) or from the date of an operation to the end of the regular period. Occasional reporting from the date of a management operation are reported since operations can change field conditions. This output allows the user to view the erosion and other output for each year of the rotation. At the end of each year in the rotation is a row that contains the average annual value for that rotation year. The last row in the output form contains the average annual values for the complete crop rotation.

Operation
This column contains the management operation that occurred on the specified date. It is the management operation or the date of operation that most users will modify to affect field conditions and thus wind erosion.

Crop
This column lists the name of the crop planted on the date shown. Crop is another choice the land manager may change to control wind erosion. Crops that produce substantial residue (e.g., corn or small grain) will tend to lower the erosion rate if the residue is managed properly.

Wind Erosion

The Wind Erosion columns provide a summary of all the wind erosion soil loss for the simulation run. The numbers in these columns are those that the user will try to affect by adjusting management dates and operations. If an erosion event occurred, but values generated by the model are too small to be displayed on the output table (i.e., < 0.001 kg/m^2 or 0.00455 tons/acre), then the amount is listed as "trace". If amounts are too large to be accurately displayed then, the amount is listed simply as greater than a specified amount (i.e., > 300 kg/m^2 or 1338 tons/acre). In these cases, erosion amounts are so large that they are generally unacceptable.

<u>Number and Loss per Erosion Event</u>

These columns give the user an indication of the frequency and severity of erosion events. Some periods will have numerous events while others may have one. One event may have severe erosion while many others may have only slight erosion totaling less erosion than another single event.

<u>Average Total Gross Soil Loss</u>

This column contain the gross erosion within the field, averaged across the field, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

<u>Net Soil Loss from Field</u>

These columns contain net soil loss from the field averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre). Some deposition within a field can occur, especially when barriers are present downwind. Net soil loss is the amount of gross loss minus deposition. **Average Total** is the average total net loss from the field, **Average Creep and Saltation** is the average creep plus saltation net loss from the field, **Average Suspension** is the average suspension net loss from the field, and **Average PM10** is the average PM10 (particulate matter less than 10 microns) net loss from the field.

Mass Passing Indicated Field Boundary

These columns  contain the mass per unit length of various-sized material that passed the field boundary for each direction (kg/m or tons/1000 ft). This information is useful in determining how much material is leaving the field in each direction. For the **Creep+Saltation** size, the material will most likely be deposited on the field boundary, such as a stream, fence, ditch, or road. If deposited in a ditch, subsequent rainfall may wash the material into waterways, where it can affect water quality. If deposited on a roadway, the roadway will likely need to be cleared. For **Suspension** and **PM10** sizes, the material may travel great distances, affecting air quality. The material passing each boundary may indicate that barriers may be needed on the opposite or upwind side of the field to control wind erosion. The direction of soil loss may also indicate a needed change in the direction of tillage.

Within Field Wind Erosion Activity

The information in these columns is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any, should be applied and where. This information is also useful in understanding to what extent the field is actively eroding and thus causing plant or soil damage, or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss. Acres indicate the size of the eroding area and the fraction the proportion of the field eroding.

Weather Information

The Weather columns provide a summary of some of the weather information for the simulation run and help the user understand which periods are erosive and why.

Average Total Precip.

This column contains the total precipitation for the period, averaged over the simulation years in each year of the crop rotation (mm or inches). This section is useful in determining how precipitation amounts may be affecting biomass production and roughness decay.

Average Wind Energy > 8m/s (18 miles/hour)

This column contains the average daily wind energy for the period for winds greater than 8 m/s (~18 mph), averaged over the simulation years in each year of the crop rotation (KJ/day). This will indicate which periods have the most erosive winds.

Snow Depth > 20 mm (0.787 in)

Fractions of the field covered with snow greater than 20 mm deep are considered non-erodible.

Average Biomass Surface Conditions on Date

The Average Surface Biomass Conditions on Date columns provide a summary of average surface conditions, including crop biomass and soil roughness, for the simulation run.

Crop Vegetation (Live)

These columns provide information on the structural configuration of live growing biomass. By observing the canopy cover, the standing silhouette area index, and the above-ground mass, the user can determine which periods are not providing sufficient cover to control wind erosion.

Crop Residue (Dead)

These columns provide information on the structural configuration of dead biomass or residue. By observing the flat cover, the standing silhouette area index, the flat mass, and the standing mass, the user can determine which periods are not providing sufficient residue cover to control wind erosion.

Live and Dead Biomass

These columns provide information on the structural configuration of both the live growing biomass and the dead biomass or residue. By observing the flat cover, the standing silhouette area index, the flat mass, and the standing mass, the user can determine which periods are not providing sufficient cover to control wind erosion.

Average Soil Surface Conditions on Date

Roughness

For cropping systems that do not produce sufficient residue for erosion control (e.g., cotton and most vegetable crops), roughness management is often used to reduce wind friction velocity at the soil surface. This reduces the amount of soil detachment and transport and increases deposition and thus reduces soil loss.

Oriented Roughness

Oriented roughness is also know as ridge roughness. These columns refer to regularly spaced roughness elements caused by tillage implements such as ridges, furrows and dikes. Ridge orientation, width, and height may be adjusted for periods of high soil loss to determine its effect on wind erosion. The user can also follow the roughness decay over time as result of rainfall or wind erosion.

Random Roughness

This column contains soil surface random roughness, defined as the standard deviation of the elevation from a plane across a tilled area. Random roughness does not take into account oriented roughness. Random roughness is the value at the period end, averaged over the simulation years in each rotation year (inches or mm). Random roughness is primarily the result of aggregate size distribution, but is also affected by various types of tillage tools. Random roughness values for typical field operations are listed in Table 3.1. Photographs (Figs. 3.2 - 3.10) can be used as a guide to determine relative random roughness values. These photos were taken at an oblique angle to provide an image similar to that seen by an observer standing a few feet from the plot.

Aggregation

Soil aggregate size and aggregate dry stability affect erosion by wind. Soil aggregates less than 0.84 mm (0.03 inches) in diameter are generally considered to be erodible and so the higher the fraction of aggregates < 0.84mm, the more erodible the surface. Dry stability is related to abrasion resistance where harder, more stable aggregates result in a lower erodibility of the soil. The larger the dry stability value ($\ln(J/m^2)$), the more resistant the aggregates to abrasion and erosion by wind.

Crust Cover

A soil crust will resist abrasion and erosion more than a loose, finely divided soil surface. In general, the more of the surface is covered by a crust, the less erosion occurs. Crusts are transient and generally represent a degraded soil quality, and therefore, crusts should not be relied upon to control erosion by wind. But a greater crust cover may explain a lesser erosion amount that would normally be expected.

Table 3.1 Random roughness values for typical management operations, based on a silt loam soil (from USDA Agriculture Handbook 537 and National Agronomy Manual 703, Tab 5-5).

Field Operation	Random Roughness (inches)	Field Operation	Random Roughness (inches)
Chisel, sweeps	1.2	Fertilizer applicator, anhydrous knife	0.6
Chisel, straight point	1.5	Harrow, spike	0.4
Chisel, twisted shovels	1.9	Harrow, tine	0.4
Cultivator, field	0.7	Lister	0.8
Cultivator, row	0.7	Manure injector	1.5
Cultivator, ridge till	0.7	Moldboard plow	1.9
Disk, 1-way	1.2	Mulch threader	0.4
Disk, heavy plowing	1.9	Planter, no-till	0.4
Disk, Tandem	0.8	Planter, row	0.4
Drill, double disk	0.4	Rodweeder	0.4
Drill, deep furrow	0.5	Rotary hoe	0.4
Drill, no-till	0.4	Vee ripper	1.2
Drill, no-till into sod	0.3		

Figure 3.2. Random roughness of 0.25 inches (6 mm).

Figure 3.3. Random roughness of 0.40 inches (10 mm).

Figure 3.4. Random roughness of 0.65 inches (17 mm).

Figure 3.5. Random roughness of 0.75 inches (19 mm).

Figure 3.6. Random roughness of 0.85 inches (22 mm).

Figure 3.7. Random roughness of 1.05 inches (27 mm).

Figure 3.8. Random roughness of 1.60 inches (41 mm).

Figure 3.9. Random roughness of 1.70 inches (43 mm).

Figure 3.10. Random roughness of 2.15 inches (55 mm).

Special Field Configurations

Although WEPS 1.0 is designed to simulate rectangular field shapes, special field configurations such as circles or strip cropping can be simulated. By manipulating the field shape to represent a field with the same area and rotating the field along, with any barriers, many field shapes can be approximated.

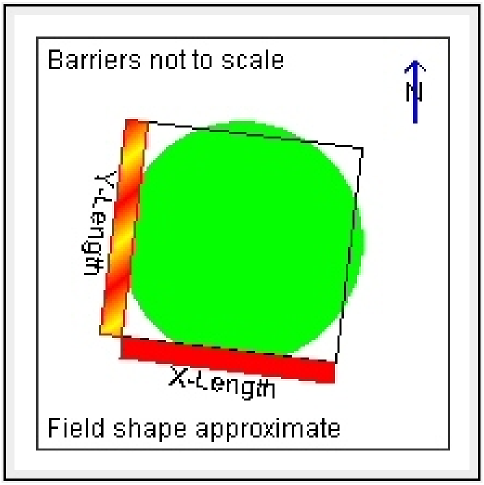


Figure 3.11. Example of the Field View panel for a circular field.

Circular Fields. A circular field can be simulated by selecting a field shape 'Circle' in the Simulation Region Information panel. Note that the circle is approximated within WEPS as a square field with an area equal to that specified in the Simulation Region Information panel. The Field View panel displays an approximate inscribed circle within the simulated rectangular field (Fig. 3.11). When a circular field is selected, the field described in the Simulation Region Information panel has an area equal to that of the simulated rectangular field. For such fields, barriers should be added and the field rotated to best simulate the actual field configuration.

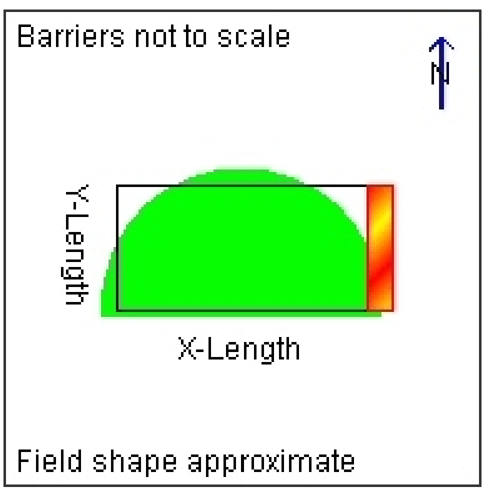


Figure 3.12. Example of the Field View panel for a half circle field.

Irregular Field Shapes. Half circles can also be simulated by selecting 'Half Circle' in Simulation Region Information panel. A half circle is approximated within WEPS as a rectangular field with an area equal to that specified in the Simulation Region Information panel. The Field View panel displays an approximate inscribed half circle within the simulated rectangular field (Fig. 3.13). To simulate an irregular field shape such as a field along a stream, select the shape in Simulation Region Information panel that most represents the shape of the actual field with the same area.

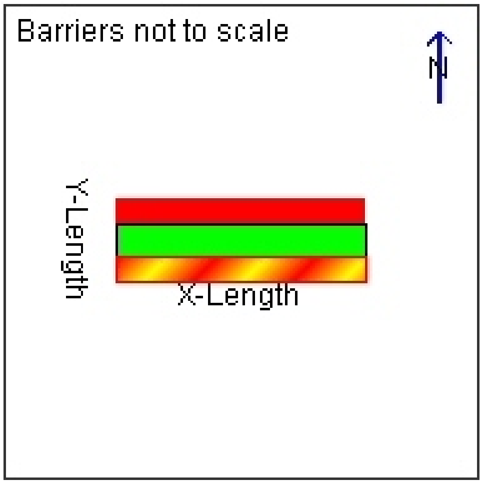


Figure 3.13. Example field layout for simulating strip cropping or grass barriers.

Strip Cropping. Fields managed for wind erosion control by strip cropping in WEPS 1.0 are simulated as linear strips, with each strip of unique management as an individual rectangular field and the erosion losses for each unique strip multiplied by the number of those strips. A tract of land where strips are installed ideally will have strips with long side perpendicular to prevailing winds. They will also be of equal width across the field, thus allowing for the shortest width of the field along the most erosive winds. The field will be resized down to the strip width that a producer agrees with, or to other widths for demonstration purposes. We can change the field size by just typing in the field dimensions. See the Interface Reference section "How To Guide: Barriers" for more details on adding and modifying field barriers. Figure 3.13 illustrates a field layout for simulating strip cropping or grass barriers.

Tillage Direction. WEPS 1.0 only allows tillage in one direction, typically parallel to the field border (e.g., Northwest/Southeast for a field oriented in that direction). Observing the effects that tillage direction may have for a particular simulation may illustrate the need to alter tillage directions in the actual field to control wind erosion. Multiple tillage directions for an individual field, such as the operator tilling parallel to each border of the field in a spiraling pattern, or a circular tillage pattern on circular fields, cannot be directly simulated with WEPS 1.0. However, wind erosion on fields with tillage parallel to each border can be estimated by averaging outputs from two runs. Each run should be made with tillage direction perpendicular to each other and the results averaged.

Using Barriers for Erosion Control in WEPS

Using WEPS, we can quickly determine the field edge where the greatest amount of eroded soil is leaving the field. In most cases, a field windbreak would be most effective on the upwind side of this field.

Wind barriers in WEPS include any structure designed to reduce the wind speed on the downwind side of the barrier. Barriers trap moving soil and reduce abrasion of the downwind immobile clods, crusts, and residues along the prevailing wind erosion direction. Barriers include, but are not limited to, linear plantings of single or multiple rows of trees, shrubs, or grasses established for wind erosion control, crop protection, and snow management. Snow fences, board walls, bamboo and willow fences, earthen banks, hand-inserted straw rows, and rock walls have also been used as barriers for wind erosion control in limited situations. Barriers also reduce evapotranspiration, shelter livestock, and provide wildlife habitat. One advantage of barriers over most other types of wind erosion control is they are relatively permanent. During drought years, barriers (excepting annual types) may be the only effective and persistent control measure on crop land. Annual barriers such as small grain or corn are used primarily to provide temporary protection during the most critical wind erosion period and can be removed and replaced every year. Barriers can also be used in sand dune areas to aid the initial stabilization of the areas while grass and trees are being established.

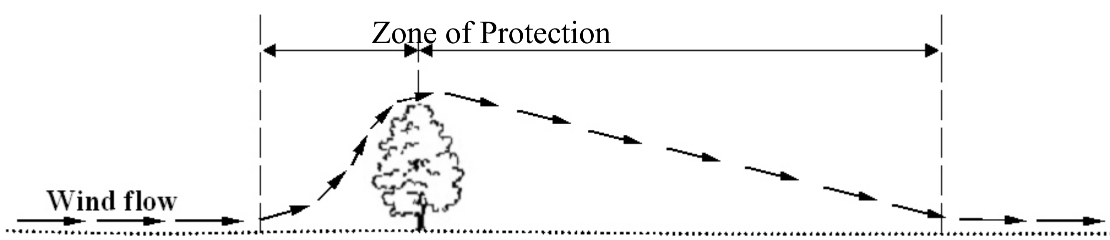


Figure 3.14. Diagram showing wind flow pattern over a barrier.

Barriers primarily alter the effect of the wind force on the soil surface by reducing wind speed on the downwind side of the barrier but also reduce wind speed to a lesser extent upwind of the barrier (Fig. 3.14). Research has shown that barriers significantly reduce wind speed downwind, sheltering a portion of the field from erosion and, in effect, reducing the field length along the erosive wind direction. The protected zone of any barrier diminishes as porosity increases however, and is reduced significantly when barrier porosity exceeds 60 percent. Protection is also reduced as wind velocity increases, but the protected area diminishes as the wind direction deviates from the perpendicular to the barrier. Various types of barriers are used for wind erosion control in WEPS 1.0. The WEPS interface provides a method of selecting from a list of barriers to place on the field and editing the barrier properties. The user can also modify properties in the barrier database that appear in the drop-down list. Each of these properties are described here.

The length of a barrier is defined by field length along the border on which the barrier is placed.

Width The width of a barrier is defined as the distance from one side of the barrier to the other, in the units of measure displayed on the screen (feet or meters) (Fig. 3.15). For a single-row wind barrier, the width is equal to the diameter of the tree, shrub, or grass; for artificial barriers, it is the thickness of the material (e.g. slat fence). This is illustrated as "a" in Fig. 3.15. For multiple-row barriers, the width is the distance from one side of the barrier to the other as illustrated by "b" in Fig. 3.15.

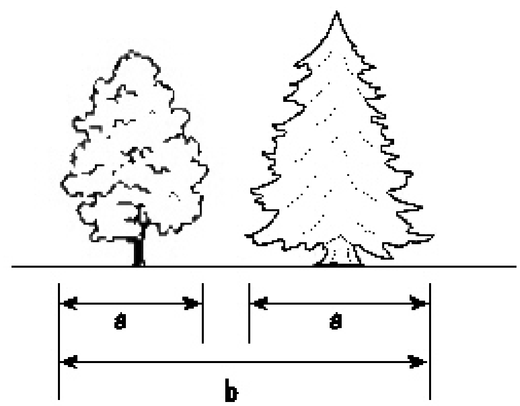


Figure 3.15. Barrier width for single (a) and multiple (b) row barriers.

Height The height of a barrier is the average height of individual elements (e.g., trees) in the barrier ("a" in Fig. 3.16 for single-row barriers). The units of measure for barrier height are displayed on the input screen in feet or meters. For multiple-row barriers, use the height of the tallest barrier row ("b" in Fig. 3.16).

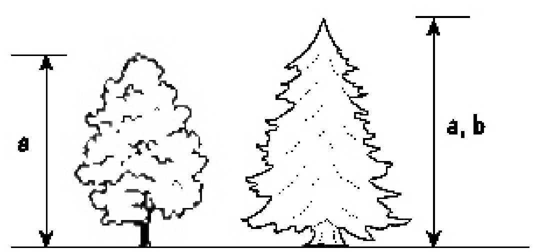


Figure 3.16. Barrier height for single (a) and multiple (b) row barriers.

Area The area of the barrier is calculated from the barrier width and length (i.e., barrier width x field length). This is not an editable item, but is calculated within WEPS 1.0.

Porosity Barrier porosity is defined as the total optical porosity of all rows in the barrier. It is the open space (i.e., absence of leaves and stems) as viewed looking perpendicular to the barrier, expressed as a percentage of the total area (ie., (1.0 - silhouette area) x 100). WEPS 1.0 does not "grow" living

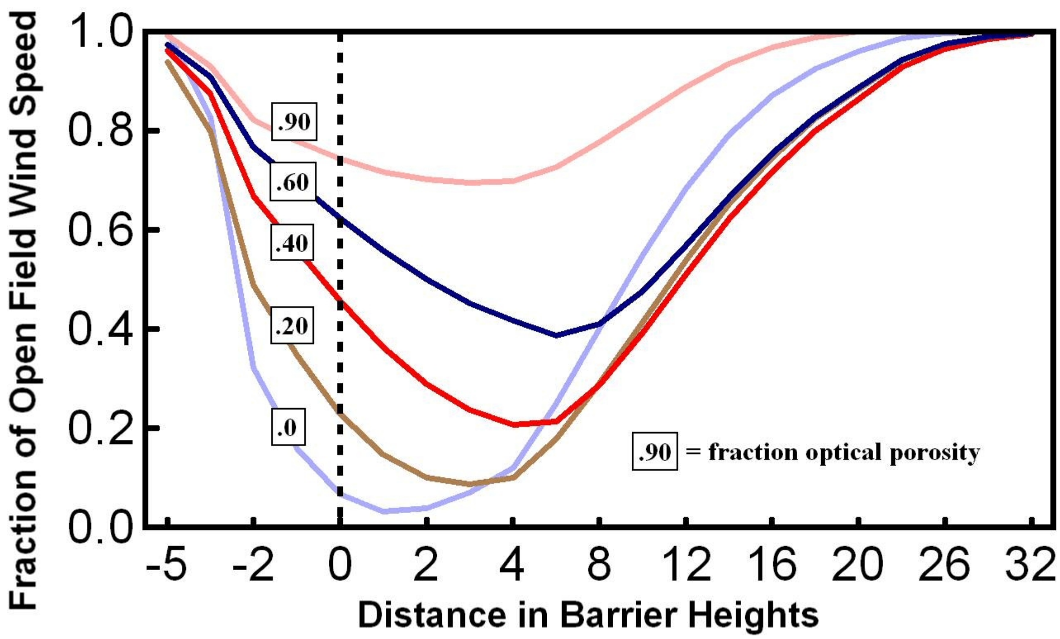


Figure 3.17. Effect of the fraction of optical porosity on near-surface wind speed along the wind direction relative to barrier.

barriers. Barriers in WEPS do not increase or decrease porosity with leaf growth and leaf drop (senescence) throughout the year, nor do they increase in size from one year to the next. As such, the porosity of barriers in WEPS does not change with the seasons nor from year to year. Therefore the user should input the porosity of the barrier that is present when the erosion hazard is the greatest. Figure 3.17 illustrates the effect of porosity on the near-surface wind speed relative to an open field without a barrier (see also Fig. 3.14). The "Distance in Barrier Heights" refers to the distance from the barrier at 0, measured in multiples of the barrier height.

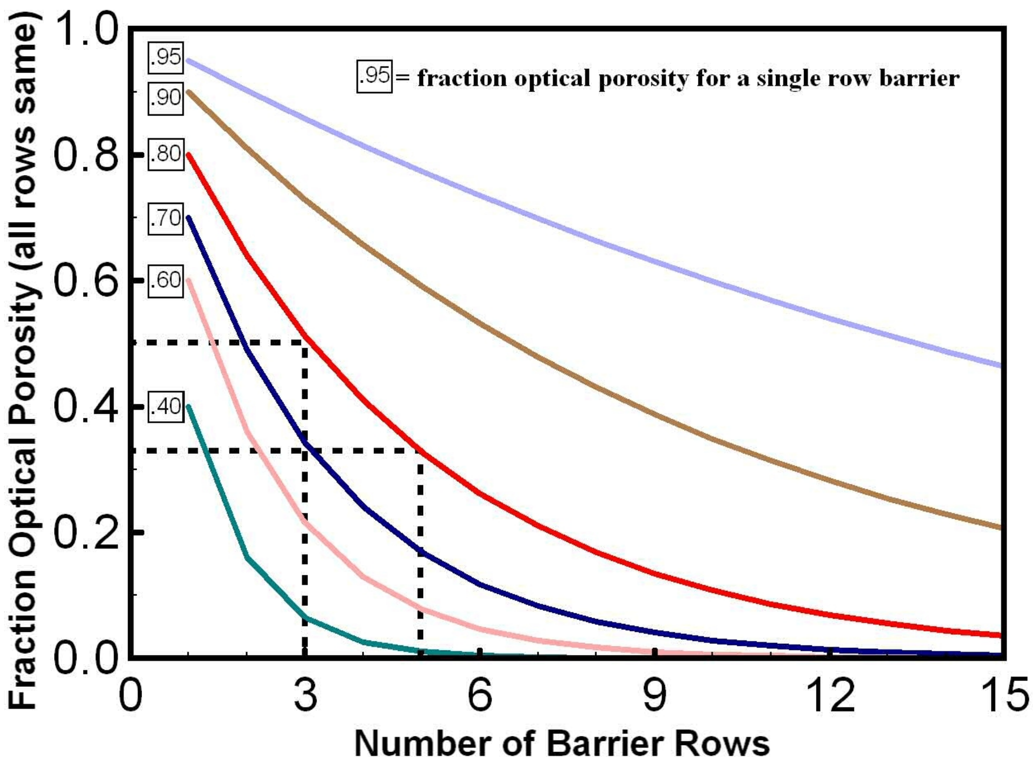


Figure 3.18. Effect of number of barrier rows on optical porosity where all barrier rows are the same.

At times, it is most efficient to estimate optical porosity for a single row, particularly for crop barriers. Then, for multiple-row barriers, the optical porosity decreases for the entire barrier as illustrated in Figure 3.18. For example, a single row of corn has an optical porosity of 0.80. Three rows of corn have an optical porosity of 0.50, and five rows of corn have an optical porosity of 0.33.

Exercises Introduction: Evaluating Wind Erosion Problems with WEPS

These exercises are designed to provide the user with step-by-step examples of some common tasks performed with the WEPS model. These exercises cover many topics including basic model operation, file management, and building and editing field management rotations within the Management/Crop Rotation Editor of WEPS (MCREW). The focus of the exercises should be on learning to use WEPS for conservation planning. Although the exercise scenarios use locations in various parts of the United States, the skills learned in each exercise are intended to build the users proficiency with WEPS that are applicable in many locations. Therefore new users are encourages to complete all the exercises regardless of location of the scenario. Since WEPS is constantly being improved and parameters modified, the results you get may not exactly match those reported in the exercises. This is not unexpected.

Note: As the WEPS model finishes a given run, it may sometimes display a warning that one or more of the crops simulated did not reach maturity. This is not uncommon, especially for crops that are harvested before reaching maturity such as forage crops. If such a message is obtained, click “OK” to complete the run. If most of the years crops reach about 95% maturity the run is OK to use. However, if many of the years crops are lower than 95%, check to make sure planting and harvesting dates for the crop are as expected for the location being simulated. If it still does not reach 95%, contact the Natural Resources Conservation Service (NRCS) Database Manager or NRCS Wind Erosion Specialist. The user should resolve such maturity issues for crops that are harvested after reaching maturity.

<u>Definitions and Considerations</u>

Projects and Runs: A "WEPS Project" is a directory that can be thought of as a working area where WEPS simulation runs are created and stored. A project stores all the parameters and files for the current simulation run being prepared within the WEPS interface, as well as any past WEPS simulation runs. For example, a particular project may represent a directory for an individual farm under which all the simulation runs for each field and management alternatives on that farm are stored. When a project is saved, all of the information contained on the current interface screen is stored in the project directory. Multiple WEPS projects can be created and given various names by the user. One can also remove unnecessary WEPS project and run directories from within the WEPS interface via the pertinent options under the “Project” menu. A Project directory can be accessed through the Project menu and Project management or soil files accessed through their respective Project folder icon .

A “WEPS Run” refers to a single simulation of a field with all associated input and output files. Each run is stored in a separate folder or subdirectory which by default is located under the current WEPS project directory. A WEPS run subdirectory is created every time a simulation run is made. A WEPS run subdirectory stores a copy of all input files used to make the simulation run, together with the output files generated from those inputs. Thus, one is able to recall the identical WEPS run at a later date (and presumably get the same outputs when using the same version of WEPS 1.0 and the weather generators/databases) because the original input files are still available. Typically, ‘re-running’ a previous run is not necessary since the outputs are stored in the run directory and can be reviewed via the ViewOutput menu. However, if additional outputs not generated with the original run are desired, it will be necessary to load the previous run and re-run it using the desired output options. The run directories make it relatively easy to archive or remove WEPS runs as alternative erosion planning scenarios are tested for a field or farm. If, for example, a change is made to create a different management alternative, all the information pertaining to this new scenario will be saved to a new subdirectory under a new WEPS run name, when the simulation is made.

File and project naming in WEPS should be considered carefully. Management or project names should be long enough to uniquely describe them but not so long so that the name is difficult to view in file chooser windows. Some special characters are not allowed in file or directory names used in WEPS. Known characters that are not allowed or recommended include: @ ? ‘ ` & ~ / \ < > | : * ”

Templates: A “Template” is a pre-built management rotation file or soil file. Management templates are accessed through the Management Template folder icon and are intended to be used as a template from which to create other management files and saved to a different name and location. Soil templates are NRCS Soil Survey Geographic (SSURGO) database files and individual soils are accessed through the Soil Template folder icon . It is recommended that the user not edit or otherwise change template file or names.

Simulation Region Orientations and Angles: Field orientation and direction of tillage within the simulation region in WEPS are independent and measured relative to true North (0 degrees). Angles are important in WEPS because wind directions are simulated to mimic the historic wind direction distribution for the selected location. As such wind direction varies from day to day and therefore erosion losses will also vary relative to field angle or ridge orientation. The field orientation in WEPS should be rotated to represent the actual orientation on the landscape. Note that the field will only rotate in a range of ±45 degrees. By rotating and adjusting the field length and width, the user should be able to obtain the desired field size and orientation for a field. Tillage direction should also be entered relative to true North. For example, if a rectangular field has its long side oriented 20.0 degrees from true North and tillage is performed parallel to that long side of the field, the tillage direction should also be entered as 20.0 degrees within the Management Editor.

Plant Damage: Although soil loss is the primary concern in wind erosion, damage to plants should also be considered. Crops can be damaged by blowing soil particles, exposure of plant roots, burial of plants by drifting soil, or desiccation and twisting of plants by the wind. In several exercises, we will examine and take into account the crop tolerance to blowing soil. The NRCS has published a table listing the tolerance of various crops to blowing soil (USDA-NRCS,2000; National Agronomy Manual; Table 502-4, pg 502-19). This table should be referred to as needed during the exercises (Table 3.2). Crops can tolerate greater amounts of blowing soil than shown, but yield and quality may be affected adversely.

Table 3. 2 Crop tolerances used by Natural Resource Conservation Service (NRCS) to design wind erosion control methods (USDA-NRCS, 2000).

Tolerant # "T"	Moderate Tolerance 2 ton/ac	Low Tolerance 1 ton/ac	Very Low Tolerance 0 to 0.5 ton/ac
Barley	Alfalfa (mature)	Broccoli	Alfalfa (seedlings)
Buckwheat	Corn	Cabbage	Asparagus
Flax	Onions (> 30 days)	Cotton	Cantaloupe
Grain Sorghum	Orchard Crops	Cucumbers	Carrots
Millet	Soybeans	Garlic	Celery
Oats	Sunflowers	Green/Snap Beans	Eggplant
Rye	Sweet Corn	Lima Beans	Flowers
Wheat		Peanuts	Kiwi Fruit
		Peas	Lettuce
		Potatoes	Muskmelons
		Sweet Potatoes	Onion (seedlings)
		Tobacco	Peppers
			Spinach
			Squash
			Strawberries
			Sugar Beets
			Table Beets
			Tomatoes
			Watermelons

Crop tolerance is defined as the maximum wind erosion that a growing crop can tolerate, from crop emergence to field stabilization, without an economic loss to stand, yield, or quality.

Reference:

USDA-NRCS. 2000. *National Agronomy Manual, Part 502-Wind Erosion, 190-V NAM. 3rd Edition*. Washington, D. C.

Exercise 1 - Wisconsin: A Basic Simulation

Skill Building: This example introduces basic skills needed to perform a simple wind erosion simulation. It uses the rotations saved in the NRCS CMZ (Crop Management Zone) Management Files.

Scenario: The farm is located near **Stevens Point, Wisconsin**, in **Portage County.** The **CLIGEN** station is **Stevens Point** and the **WINDGEN** station is **Wausau/Alexander.** The Soil Map Unit used in the evaluation is **Mecan_MfB_100_LS.** The original two-year cropping system is **Peas, green, drilled** and **Bean, green snap mech harv.** The field size is about 126 acres. The WEPS evaluation of the cropping system will be run for **15 rotation cycles** (NRCS mode). The fields are fully irrigated with a circle system.

Getting Started: First, load the project called **Student** into the main interface. In the WEPS interface: Click "Project" then "Open". Click the project directory named *Student.wpj* and click "Open" (Figure 3.19) . You may be asked to save the current project, if so click "Yes". Now you should have the Student project loaded into the interface.

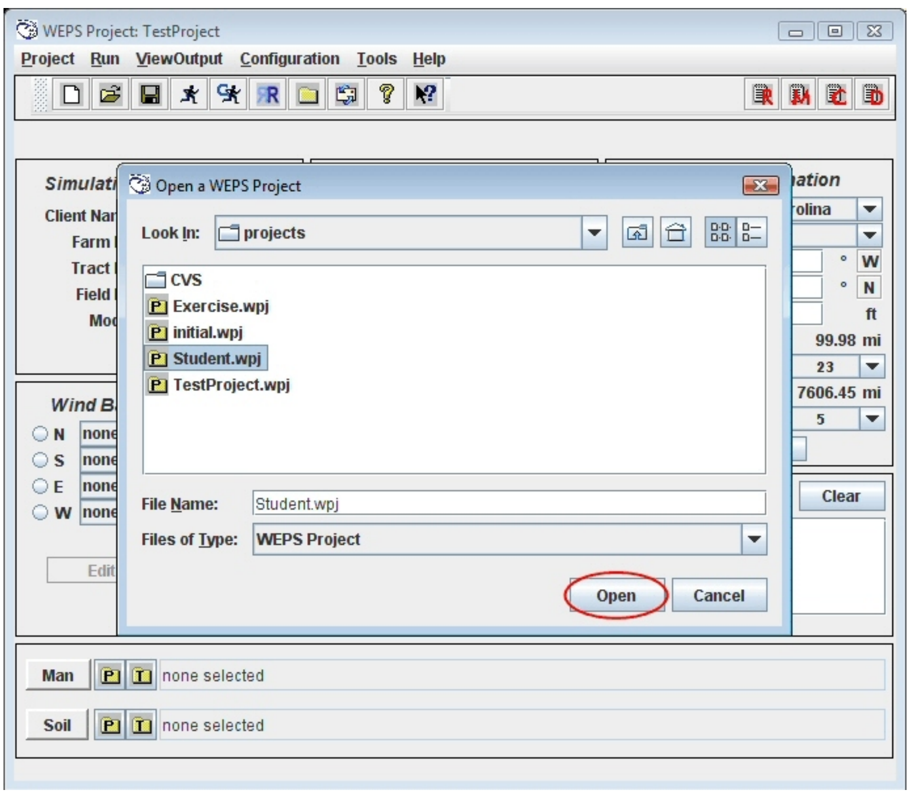


Figure 3.19. Opening a new project (student.wpj).

Fill in the following interface sections:

Step 1: Under the Simulation Run Information panel, for Client Name enter ***Exercise 1.***

Step 2: Under the Simulation Region Information panel, for Shape select ***Circle*** by clicking the down arrow next to "Shape"; and for Area enter ***126*** ac.

Step 3: Under the Location Information panel, for State, select ***Wisconsin***; for County, select ***Portage***. You should see the following weather stations listed; CLIGEN Station: ***STEVENS POINT***; WINDGEN Station: **MOSINEE/CENTRAL WI**. Since the scenario calls for a WINDGEN station of Wausa/Alexander click the down arrow next to Mosinee/Central WI to display the list of nearby stations. Select ***WAUSAU/ALEXANDER***.

Step 4: Click the "Project" button next to the "Man" button near the bottom of the WEPS screen. For these exercises, beginning management files have been placed in the Student project directory. From the list, select: ***Peas, green, drilled, st pt, disk, fcult,-Bean, green snap, st pt, disk, fcult, CMZ4.man***. Note: the management files are displayed with a management symbol in front of them. The crop management file name will be displayed near the bottom of the WEPS interface.

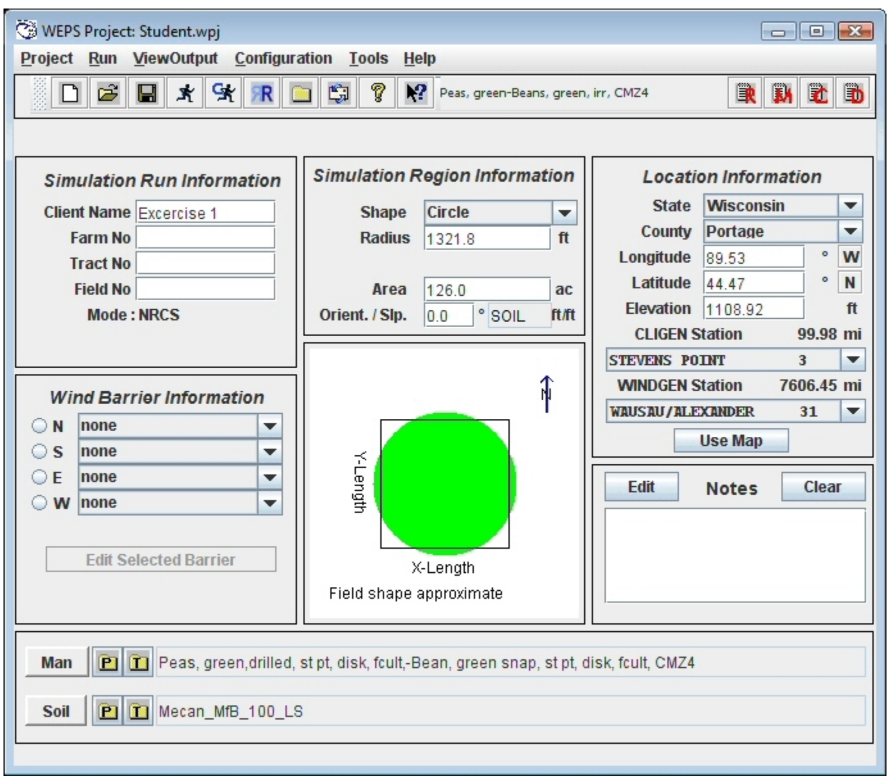


Figure 3.20. WEPS interface with required information for the initial scenario of Exercise 1.

Step 5: Click the "Project" button next to the "Soil" button near the bottom of the WEPS screen. Select the *Mecan_MfB_100_LS* soil. Note: the soil files are displayed with a soil symbol in front of them. When selected, the soil name will be displayed near the bottom of the WEPS interface. Also note: Most of the time you will use the Template button to select a soil from the SSURGO survey database.

Simulation Run:
All required information has now been entered (Figure 3.20). To begin the simulation run, click the "Run" button . WEPS will ask you to enter a name for the run, type in ***Peas, green-Beans, green, irr, CMZ4*** and Click "OK" (Figure 3.21).

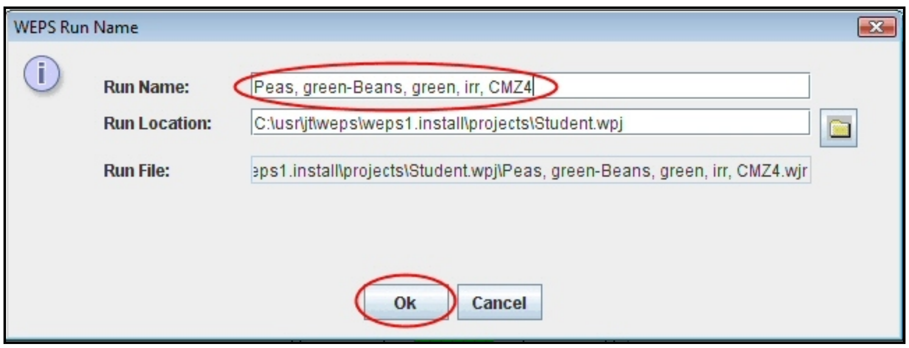


Figure 3.21. After clicking the Run button, enter a name for the run and click "OK".

During a simulation run, a window will appear that shows the simulation progress. Upon completion the WEPS Run Summary report window will appear (Figure 3.22). The simulation reports an Average Annual soil loss of 1.0 tons/ac/year. Since crop residue (correlated with crop yields) can affect erosion , the user should check to see if yields are as expected. Expected yields for this area are 3400 lbs/ac for peas and 8100 lbs/ac for the beans. However for this example, WEPS calculated 18612 lbs/acre for peas and 7880 lbs/acre for the beans (see Figure 3.22). Since these yields are more that 5% different for both crops, the run needs to be calibrated.

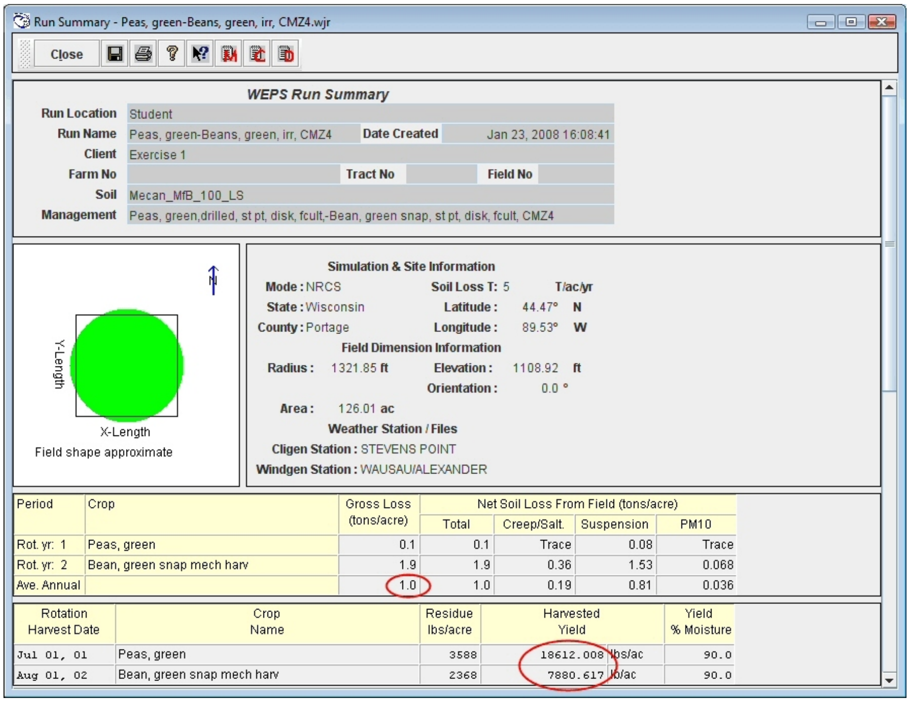


Figure 3.22. WEPS Summary report showing Average Annual soil loss and Harvested Yield for each crop.

Calibration:
WEPS can recalculate the crop growth based on the actual yield history of the field we are evaluating. This is called "Calibration" of the crop and adjusts the Harvested Yield simulated to within 5% of the expected or historic yield entered . To calibrate the example run, close the Run Summary and you should now have the main interface showing.

Step 1: On the main screen, click the "Man" button [Man] to open the Management Crop Rotation Editor for WEPS (MCREW). MCREW displays a date ordered list of all management operations and crops for the rotation (Figure 3.23). A more detailed explanation of MCREW use will be covered in later exercises. For now, click the Yield Calibrate button on the tool bar. This displays seven additional columns; the first three pertain to the target yield and calibration. The target yields can be edited on this screen. Remember, the target yield is 3400 lbs/ac for peas and 8100 lbs/ac for beans. Enter these yields on the MCREW screen. By clicking the Yield Calibrate button we have set WEPS to run in Calibration mode and the yields we want are the default values. Click the Return button to close MCREW and return to the main WEPS screen.

Step 2: On the main interface screen, click "Run" then "Make a Yield Calibration WEPS Run", or you can click the Yield Calibration Run button on the main toolbar.

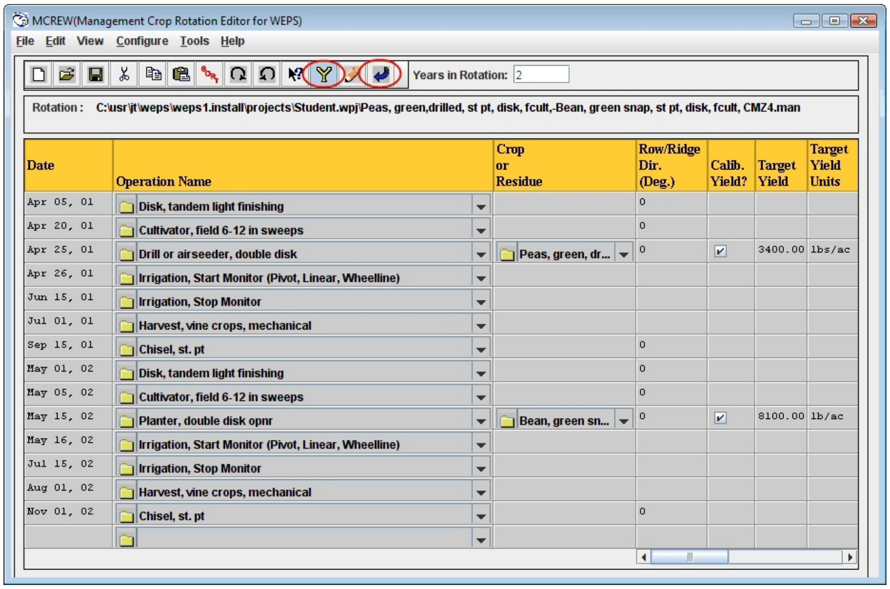


Figure 3.23. The Management Crop Rotation Editor for WEPS showing the Yield Calibrate and Return buttons.

You will be asked to enter a Run Name. The default Run Name is the last run name plus an incremented number appended to the name (in this example "_1" is appended). This time you should back space to remove the "_1" and add the word "*cal*" to the end of the name and click "OK" (Figure 3.24).

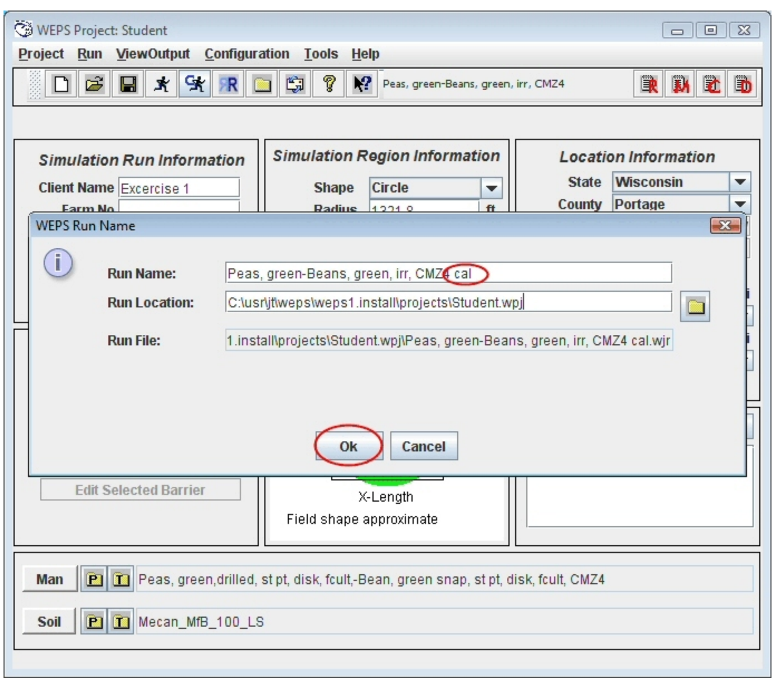


Figure 3.24. After clicking the Calibration Run button, add "cal" to the run name and click "OK".

WEPS now displays a table showing two Calibration factors, one for peas and one for beans (Figure 3.25). For WEPS to produce the expected pea residue for this farm, yields need to be reduced from 18612 lbs/ac to 3400 lbs/ac. Therefore we would expect the factor to be less than 1.0 and the Biomass Adjustment Factor is 0.281. Likewise the beans need slightly more yield, hence the 1.0 value, increasing the yield by 15%. You can do three things with this screen. One, you can use both these factors for all peas and bean run in this Project by clicking “Use in Current Project”. Or two, clicking “Project” then “Save as...” allows you the save a localized version of the crop file to the local subdirectory in the crop database for use with another local field. Or three, click “Close” to use the factors only in the current run. For this exercise we will click “Use In Current Project”. WEPS will then display a message that “The current project is now using the calibrated management file.”

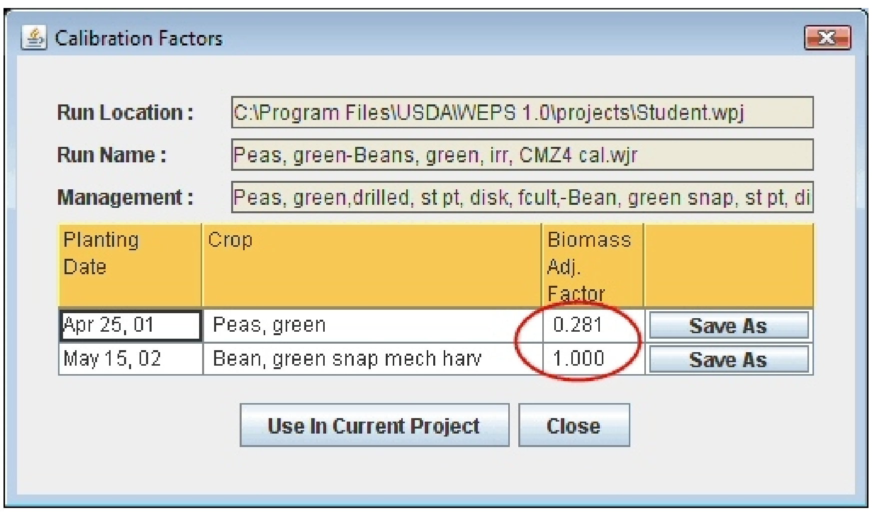


Figure 3.25. The Calibration Factors window showing the Biomass Adjustment Factor for each crop.

Upon completion, the WEPS Run Summary report window will appear (Figure 3.26). The simulation reports an Average Annual Gross Soil Loss of 3.6 tons/acre. This is below the T-value (Soil Loss Tolerance) of 5 T/ac/yr. Note that the Biomass Adjustment Factors appear in the “Notes” box near the bottom of the Run Summary report.

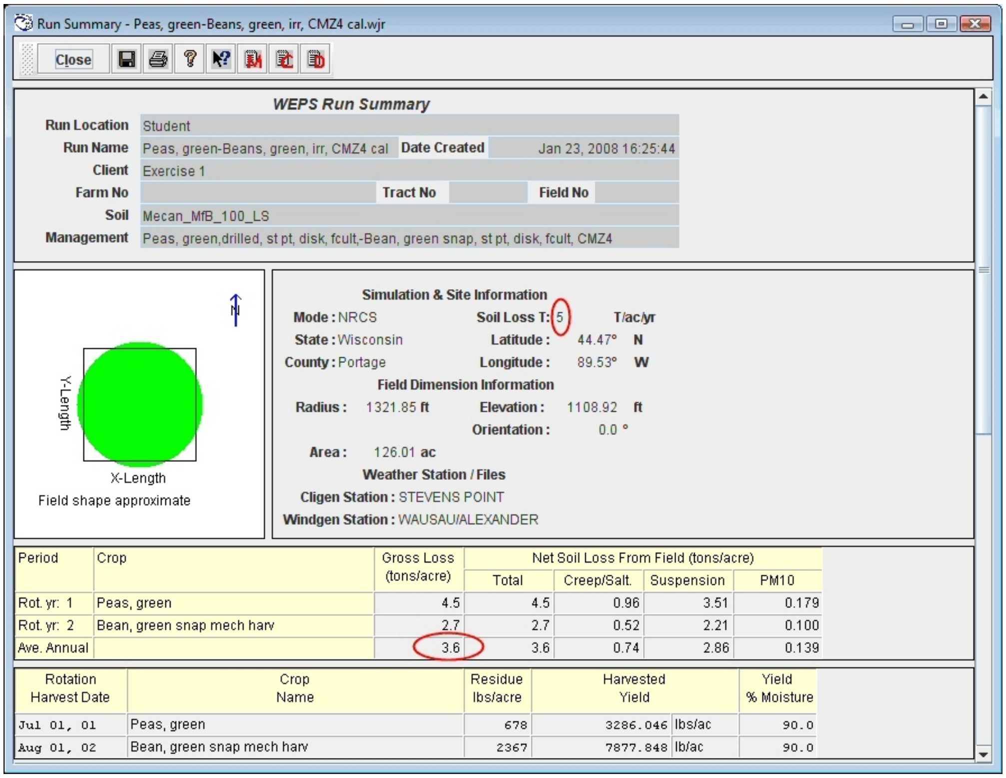
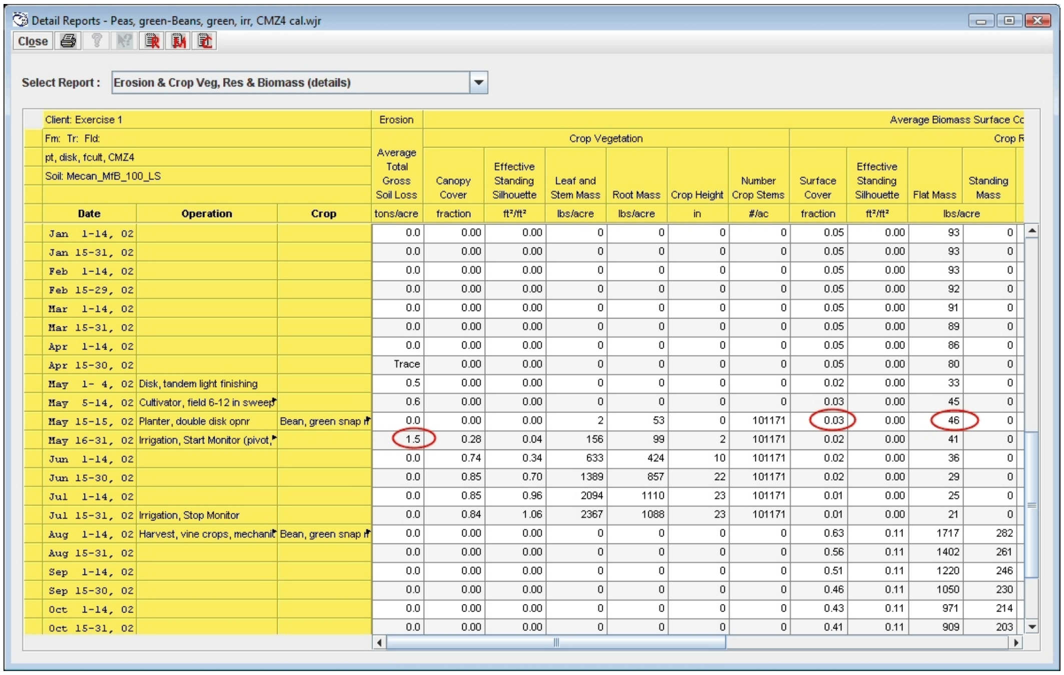


Figure 3.26. The Run Summary report showing the T-value (Soil Loss Tolerance) and the average annual soil loss obtained with the calibrated crops.

Is the percent ground cover and mass of flat residue after seeding adequate to protect both crops?

Hint: Click the Detailed Report button at the top of the Summary Report. Near the top of the Detailed Report is a window that allows the user to "Select Report". This should should display "Erosion & Crop Veg, Res & Biomass (details)" as default. If not select it from the drop down list by clicking the drop down arrow . The Detailed Report includes a date ordered list of output parameters by periods (every 15 days or the period between management operations). This detailed report allows the user to view the amount of cover and flat residue after seeding each crop (Figure 3.27).



Date	Operation	Crop	Average Total Gross Soil Loss (tons/acre)	Canopy Cover (fraction)	Effective Standing Silhouette (ft²/ft²)	Leaf and Stem Mass (lbs/acre)	Root Mass (lbs/acre)	Crop Height (in)	Number Crop Stems (#/ac)	Surface Cover (fraction)	Effective Standing Silhouette (ft²/ft²)	Flat Mass (lbs/acre)	Standing Mass (lbs/acre)
Jan 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.05	0.00	93	0
Jan 15-31, 02			0.0	0.00	0.00	0	0	0	0	0.05	0.00	93	0
Feb 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.05	0.00	93	0
Feb 15-29, 02			0.0	0.00	0.00	0	0	0	0	0.05	0.00	92	0
Mar 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.05	0.00	91	0
Mar 15-31, 02			0.0	0.00	0.00	0	0	0	0	0.05	0.00	89	0
Apr 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.05	0.00	86	0
Apr 15-30, 02			Trace	0.00	0.00	0	0	0	0	0.05	0.00	80	0
May 1- 4, 02	Disk, tandem light finishing		0.5	0.00	0.00	0	0	0	0	0.02	0.00	33	0
May 5-14, 02	Cultivator, field 6-12 in sweep		0.6	0.00	0.00	0	0	0	0	0.03	0.00	45	0
May 15-15, 02	Planter, double disk opnr	Bean, green snap	0.0	0.00	0.00	2	53	0	101171	0.03	0.00	46	0
May 16-31, 02	Irrigation, Start Monitor (pivot,		1.5	0.28	0.04	156	99	2	101171	0.02	0.00	41	0
Jun 1-14, 02			0.0	0.74	0.34	633	424	10	101171	0.02	0.00	36	0
Jun 15-30, 02			0.0	0.85	0.70	1389	857	22	101171	0.02	0.00	29	0
Jul 1-14, 02			0.0	0.85	0.96	2094	1110	23	101171	0.01	0.00	25	0
Jul 15-31, 02	Irrigation, Stop Monitor		0.0	0.84	1.06	2367	1088	23	101171	0.01	0.00	21	0
Aug 1-14, 02	Harvest, vine crops, mechani	Bean, green snap	0.0	0.00	0.00	0	0	0	0	0.63	0.11	1717	282
Aug 15-31, 02			0.0	0.00	0.00	0	0	0	0	0.56	0.11	1402	261
Sep 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.51	0.11	1220	246
Sep 15-30, 02			0.0	0.00	0.00	0	0	0	0	0.46	0.11	1050	230
Oct 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.43	0.11	971	214
Oct 15-31, 02			0.0	0.00	0.00	0	0	0	0	0.41	0.11	909	203

Figure 3.27. The Detailed Report showing average soil loss and residue amounts just after planting Beans.

By examining the Detailed Report table you will note that Bean residue after planting Peas (Date: Apr 25-25, 01) was 6% (0.06 fraction) surface cover and 105 lbs/ac flat mass. These amounts provide enough protection that WEPS estimates an average total gross soil loss after planting to be 0.0 tons/acre. Therefore the probability of damage to Peas by blowing soil is very low.

However, the Pea residue after planting Beans (Date: May 16-31, 02) was 3% surface cover and 46 lbs/ac flat mass (Figure 3.27). For these residue amounts, WEPS estimates an average total gross soil loss after planting of 1.5 tons/acre. Although the soil loss is less than the T-value, there is a problem with 1.5 ton/ac soil loss the first 15 day period after planting beans. The NRCS National Agronomy Manual has a Crop Tolerance to Blowing Soil table that lists Green/snap beans in the "no more than 1 ton/ac" low tolerance column (See the table in the Exercises Introduction) . This means that there still could be an issue with the system from the plant protection perspective.

Exercise 2 - Texas: Add a Crop to a Rotation

Skill Building: This exercise will begin with a pre-built management file, make the run, then add another crop to the rotation in the management editor and then make the second run. We will also consider a strip tillage system to meet “T” and reduced tillage to address the erosion problem.

Scenario: The farm is located in **Lubbock County, Texas**. The **CLIGEN** station is **Lubbock WB AP** and the **WINDGEN** Station is **Lubbock APT**. The soil in the field is **Amarillo Loamy Fine Sand**, in the Student Project it is: **Amarillo_4_100_LFS**. The crop rotation is continuous **Cotton, stripper**. We think it is possible to add Milo or **Sorghum, grain** to the rotation. There is also some new technology from Texas A&M, using in-row subsoil planters for strip tillage that we would like to model for an alternative. The field is a **half section** of land (320 acres) and is oriented east and west. Normal yield for the Cotton is ¾ bale or 375 lbs lint/ac. Sorghum will yield on average 25 bu/ac. The Cotton management file we will use is: *Cotton,Stripper;CT,FC,CMZ19.man.* The mulch-till file we will add is: *Sorghum,Grain;MT,CMZ19.man.*

Getting Started

Step 1: Start up the WEPS interface and add the information listed above, except for the management. Be sure to show the field as a rectangle (simulation area as 5280 by 2640 feet) with the short side (Y-length = 2640 ft) on the east and west. See Figure 3. 28.

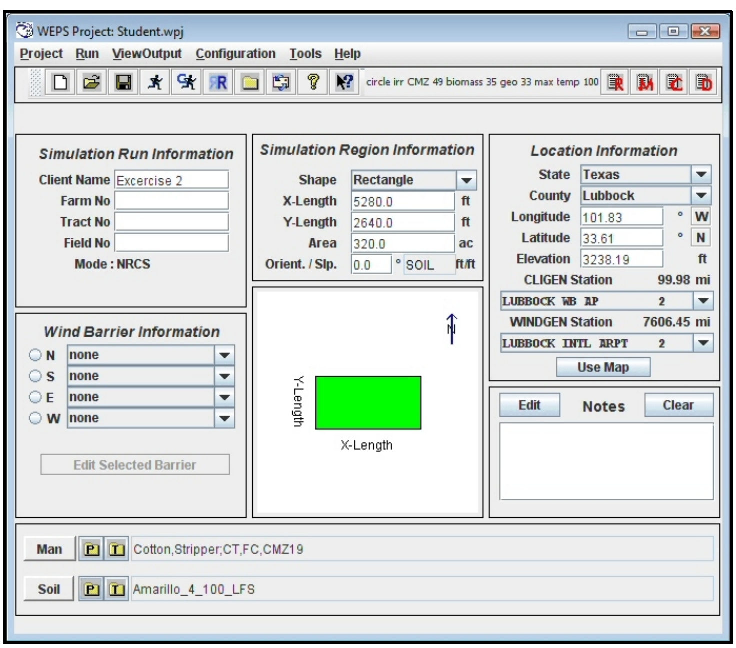


Figure 3.28. Beginning screen for Exercise 2.

Step 2: Click the Project Folder button to display the managements in the project folder. Load the pre-built file called *Cotton,Stripper;CT,FC,CMZ19.man* by clicking selecting the File, then clicking "Select". Make the standard run as shown in Exercise 1 by clicking the Run button. Type in the Run name of *Cotton, CT,FC,CMZ19 TX.* Upon completion, the Run Summary will appear (Figure 3. 29).

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Cotton, stripper	30.8	30.8	7.71	23.07	0.595
Ave. Annual		30.8	30.8	7.71	23.07	0.595

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Oct 20, 01	Cotton, stripper	1851	630.655	lb/ac lint	7.5

Figure 3.29. Portion of Run Summary showing soil loss and yield.

The continuous Cotton run gave a 30.7 ton/ac/yr soil loss. How much cotton lint is listed? **Answer:** 631 lbs/ac/yr. The inventory states that we should have 375 lbs/ac lint. This is almost twice too much. Go back and calibrate the yield as you were shown in Exercise 1.

Step 3: Check the Yield in the MCREW (Management Editor) by clicking the 'Man' button in the lower left corner of the main interface. Second, click the Yield Calibrate button to change the editor view adding the yield columns. You may have to drag the window open a bit to see the yield column. Be sure to change the 500 lbs/ac default to 375 lbs/ac (Figure 3.30).

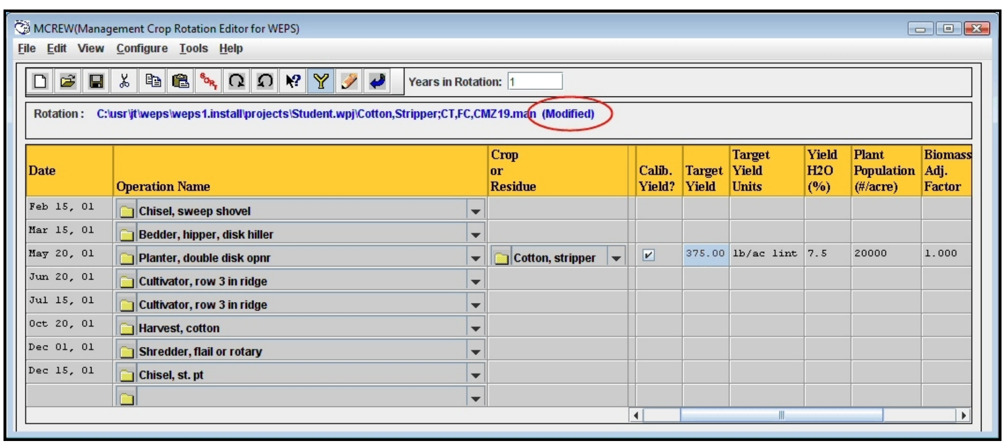


Figure 3.30. MCREW window with modified target yield.

Notice that the Rotation name box is now blue with the word "(Modified)" appended to the end of the name. This means that you have changed the data in the original file and not saved it yet. When you click the 'Close' button , WEPS will save the file (same name) and move you back to the main interface. If you want to save it with a new name you must click "File", then "Save as..." and give it a new name. In this case we want to save it to a new name, called *Cotton,Stripper;CT,FC,CMZ19 adj yield*. The Rotation name returns to black text with the new name. Now return to the main interface by clicking the 'Close' button .

Step 4 - Make the run by clicking the Calibrate Run button , and append the word "Cal" to the end of the name: *Cotton, CT,FC,CMZ19 TX Cal*.

Notice we now have a new Biomass Adj. Factor of 0.766 (Figure 3.31). Click "Use in Current Project" then "OK". You should now have about 34.4 ton/ac/yr as your calibrated soil loss. Check to see if the yield is around the 375 lbs/ac needed.

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Cotton, stripper	34.4	34.4	8.45	25.95	0.668
Ave. Annual		34.4	34.4	8.45	25.95	0.668

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Oct 20, 01	Cotton, stripper	1152	371.461	lb/ac lint	7.5

Date	Operation	Crop
Feb 15, 01	Chisel, sweep shovel	
Mar 15, 01	Bedder, hipper, disk hiller	
May 20, 01	Planter, double disk opnr	Cotton, stripper
Jun 20, 01	Cultivator, row 3 in ridge	
Jul 15, 01	Cultivator, row 3 in ridge	
Oct 20, 01	Harvest, cotton	Cotton, stripper
Dec 01, 01	Shredder, flail or rotary	
Dec 15, 01	Chisel, st. pt	

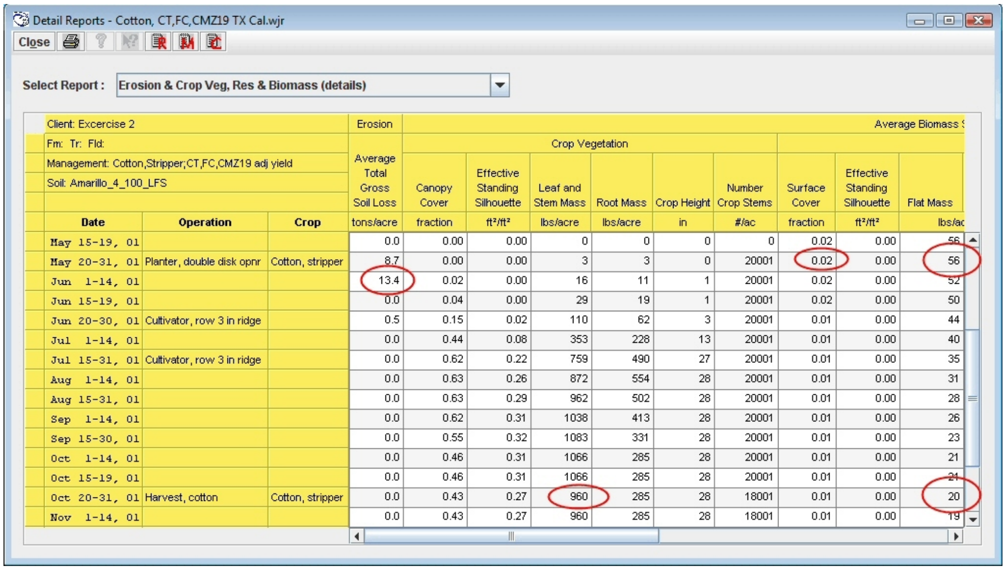
Please enter any notes in the following box :

20/ 5/ 1 Cotton, stripper 0.766

Figure 3.31. Portion of Run Summary showing Loss, Yield, and Biomass Adjustment Factor.

What do you do when the soil loss is too high? Let's consider some options to lower the soil loss.

What is the total residue (flat mass) at planting time? Hint: Open the Detailed Report and check the total flat mass of residue at that time.
Answer: About 56 lbs/ac and 2% surface cover (Figure 3.32) are present at planting.



Detail Reports - Cotton, CT,FC,CMZ19 TX Cal.wjr

Close

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Client: Excercise 2
Fm: Tr: Fld:
Management: Cotton,Stripper;CT,FC,CMZ19 adj yield
Soil: Amarillo_4_100_LFS

			Erosion	Crop Vegetation						Average Biomass		
			Average Total Gross Soil Loss	Canopy Cover	Effective Standing Silhouette	Leaf and Stem Mass	Root Mass	Crop Height	Number Crop Stems	Surface Cover	Effective Standing Silhouette	Flat Mass
Date	Operation	Crop	tons/acre	fraction	ft²/ft²	lbs/acre	lbs/acre	in	#/ac	fraction	ft²/ft²	lbs/ac
May 15-19, 01			0.0	0.00	0.00	0	0	0	0	0.02	0.00	56
May 20-31, 01	Planter, double disk opnr	Cotton, stripper	8.7	0.00	0.00	3	3	0	20001	0.02	0.00	56
Jun 1-14, 01			13.4	0.02	0.00	16	11	1	20001	0.02	0.00	52
Jun 15-19, 01			0.0	0.04	0.00	29	19	1	20001	0.02	0.00	50
Jun 20-30, 01	Cultivator, row 3 in ridge		0.5	0.15	0.02	110	62	3	20001	0.01	0.00	44
Jul 1-14, 01			0.0	0.44	0.08	353	228	13	20001	0.01	0.00	40
Jul 15-31, 01	Cultivator, row 3 in ridge		0.0	0.62	0.22	759	490	27	20001	0.01	0.00	35
Aug 1-14, 01			0.0	0.63	0.26	872	554	28	20001	0.01	0.00	31
Aug 15-31, 01			0.0	0.63	0.29	962	502	28	20001	0.01	0.00	28
Sep 1-14, 01			0.0	0.62	0.31	1038	413	28	20001	0.01	0.00	26
Sep 15-30, 01			0.0	0.55	0.32	1083	331	28	20001	0.01	0.00	23
Oct 1-14, 01			0.0	0.46	0.31	1066	285	28	20001	0.01	0.00	21
Oct 15-19, 01			0.0	0.46	0.31	1066	285	28	20001	0.01	0.00	21
Oct 20-31, 01	Harvest, cotton	Cotton, stripper	0.0	0.43	0.27	960	285	28	18001	0.01	0.00	20
Nov 1-14, 01			0.0	0.43	0.27	960	285	28	18001	0.01	0.00	19

Figure 3.32. Detailed Report showing loss and residue at planting and vegetative material at harvest.

What management period has the highest erosion loss?
Answer: After planting the cotton (Jun 1-14, 01), 13.4 tons/ac (Figure 3.32).

How much total residue do we have to work with the first period after harvest?
Answer: The residue after harvest is 980 lbs/ac (20 lbs/ac flat mass + 960 lbs/ac effective standing mass) (Figure 3.32). We need more residue to effectively control the erosion. Cotton does not produce enough residue by itself. We will try adding sorghum to the rotation to see what effect this will have on the residue and erosion rate.

Add a Crop to a Rotation:

Close any of the report windows you have open until you only have the main interface window open. Click on the 'Man' button to open the MCREW management editor.

Step 1: Right click the last row in the second column (Operation Name) of the cotton file. Select 'Import Management File', then repeatedly click the up-directory button  on the top toolbar until the 'projects' directory appears. Click 'projects' then 'Student.wpj' and select ***Sorghum,Grain;MT,CMZ19.man***. Click Select.

Notice that the sorghum crop comes into the rotation in the second year and the dates are correct because both single management files have all their tillage in one year, (not 0 and 1 as with a RUSLE file) with fall tillage. The dates look right and seem reasonable. Be sure to click the  and enter 25 bu/ac yield as expected for the new sorghum crop. Check that you still have 375 lbs/ac yield for the cotton also and that both “Calib. Yield?” boxes are checked.

Step 2: Notice the rotation name in the Rotation box is blue. We need to save the file with a new name.

Click ‘File’ then ‘Save as...’. Notice MCREW has detected we only have “1” in the year box (Figure 3.33). We must either change the value in the box to something different than 2 or accept 2. Click ‘OK’ to accept the change to a 2 year rotation.

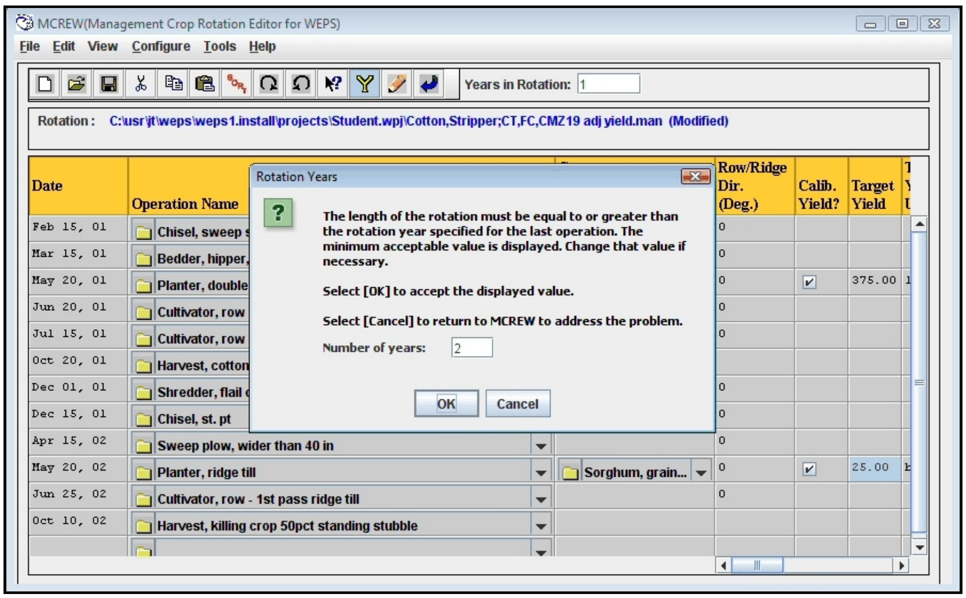


Figure 3.33. MCREW will ask for number of rotation years if a crop was added with dates that increase the number of years.

You are then asked for a new name for the two year rotation. Enter *Cotton,Stripper;CT,FC-Sorghum, MT CMZ19*, and click ‘Save’. Note that it saved the new two year rotation to the Student Project directory.

Step 3: Make the new run. This time let’s see if WEPS will give us an appropriate yield for the sorghum in this rotation. Return to the main interface by clicking the Close button . Click the Run button and call the run *Cotton,stripper, CT,FC-Sorghum, MT CMZ19 TX.*

What is the soil loss?

Answer: You should see approximately 24 ton/ac/yr on the Run Summary (Figure 3.34) although your version of WEPS may display a different value. Average annuls soil loss is still too high!

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre) Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Cotton, stripper	31.5	31.5	7.79	23.68	0.606
Rot. yr: 2	Sorghum, grain	16.4	16.4	3.77	12.64	0.331
Ave. Annual		23.9	23.9	5.78	18.16	0.468

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Oct 20, 01	Cotton, stripper	1272	415.845	lb/ac lint	7.5
Oct 10, 02	Sorghum, grain	1057	14.166	bu/ac	14.0

Figure 3.34. Portion of Run Summary showing soil loss and yield for each crop.

What is the sorghum yield?
Answer: You should see approximately 14 bu/ac on the Run Summary (Figure 3.34).

Do we need to calibrate the sorghum?
Answer: Yes, 14 bu/ac/yr is not close enough to the 25 bu/ac/yr we were wanting.

Close the run summary and make another calibrated run by clicking the Calibrate Run button . Name this run *Cotton, CT,FC-Sorghum, MT CMZ19 TX cal.*

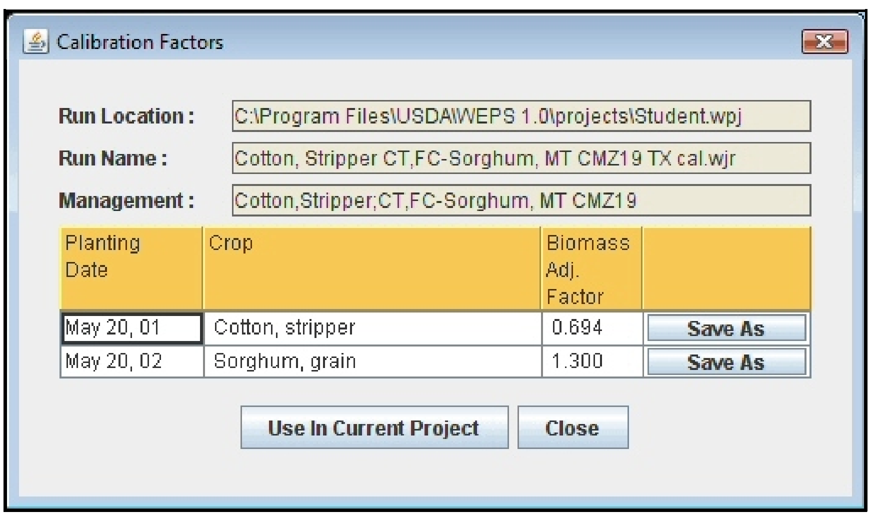
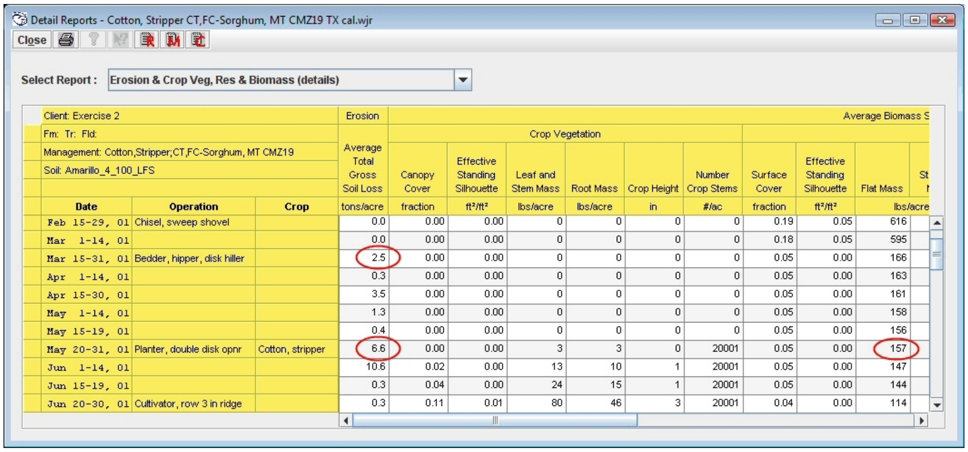


Figure 3.35. Calibration window showing Biomass Adjustment Factors for each crop.

Notice we have a slightly different Biomass Adj. Factor for Cotton as well as a 1.300 for the Sorghum crop (Figure 3.35). Click, 'Use In Current Project' then 'OK'.

How much flat mass do we have now after planting Cotton on the detailed report?
Answer: Remember to click the Detailed Report. We have about 157 lbs/ac flat mass and the erosion rate is 6.6 tons/ac at cotton planting (Figure 3.36).



Date	Operation	Crop	Average Total Gross Soil Loss (tons/acre)	Canopy Cover (fraction)	Effective Standing Silhouette (ft²/ft²)	Leaf and Stem Mass (lbs/acre)	Root Mass (lbs/acre)	Crop Height (in)	Number Crop Stems (#/ac)	Surface Cover (fraction)	Effective Standing Silhouette (ft²/ft²)	Flat Mass (lbs/acre)
Feb 15-29, 01	Chisel, sweep shovel		0.0	0.00	0.00	0	0	0	0	0.19	0.05	616
Mar 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.18	0.05	595
Mar 15-31, 01	Bedder, hipper, disk hiller		2.5	0.00	0.00	0	0	0	0	0.05	0.00	166
Apr 1-14, 01			0.3	0.00	0.00	0	0	0	0	0.05	0.00	163
Apr 15-30, 01			3.5	0.00	0.00	0	0	0	0	0.05	0.00	161
May 1-14, 01			1.3	0.00	0.00	0	0	0	0	0.05	0.00	158
May 15-19, 01			0.4	0.00	0.00	0	0	0	0	0.05	0.00	156
May 20-31, 01	Planter, double disk opnr	Cotton, stripper	6.6	0.00	0.00	3	3	0	20001	0.05	0.00	157
Jun 1-14, 01			10.6	0.02	0.00	13	10	1	20001	0.05	0.00	147
Jun 15-19, 01			0.3	0.04	0.00	24	15	1	20001	0.05	0.00	144
Jun 20-30, 01	Cultivator, row 3 in ridge		0.3	0.11	0.01	80	46	3	20001	0.04	0.00	114

Figure 3.36. Detailed Report showing soil loss and flat mass.

What is the date of the first erosion period after harvest of the sorghum?
Answer: After the Bedder, hipper, disk hiller, 'Mar 15-31, 01' at 2.5 tons/ac/yr (Figure 3.36).

The Average annual wind erosion of 24 tons/ac is still to high. Let's look a reduce tillage.

Reduce Tillage:

Let's try one last set of adjustments to our set of runs. We know cotton is glyphosate ready for weed control, and strip-till works for cotton. We also know that standing residue is twice as good at controlling erosion than flat. We will start with the last run and reduce some of the tillage. Close any of the report windows you have open, until you only have the main interface window open.

Step 1: Click the 'Man' button on the main interface. Check to see that you have the *Cotton,Stripper;CT,FC-Sorghum, MT CMZ19.man* file loaded. We are going to remove the 'Feb 15, 01' *Chisel, sweep shovel, the Bedder, hipper, disk hiller*, 'Jun 20, 01' and 'Jul 12, 01' two *Cultivator, row 3 in ridge*, and the 'Dec 1, 01' *Shredder, flail or rotary* operations. Right click on the operation name and select the next to the last selection on the menu "Delete row(s)". Do this for all the operation mentioned above.

Step 2: Now, change the standard planter for the sorghum from *Planter, ridge till* to *Planter, in-row subsoiler*. Do this by right clicking on *Planter, ridge till* and select 'Change

Operation'. Double click 'NRCS' then select the *Planter, in-row subsoiler* operation from the list then click 'Select' (Figure 3.37).

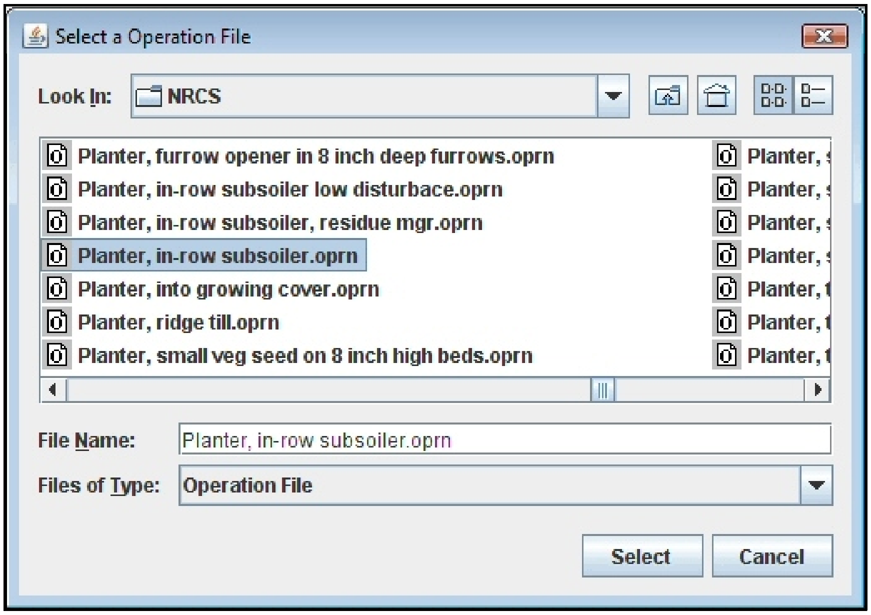


Figure 3.37. Selecting the Operation file *Planter, in-row subsoiler*.

Step 3: Add a spray operation on 'Jun 20, 01' for the glyphosate to control weeds in the cotton. Right click the "*Harvest, cotton*" operation and select "*Insert Operation*". Find and select "*Sprayer, post emergence, in crop*" so that it is now in the Operation Name cell. This operation adds 50 lbs/ac standing mass to the residue pool so you will need to click in the cell and enter 50 in the Flat Residue Amount column.

Lastly change the date of the sprayer operation from the 'May 20, 01' default to 'Jun 20, 01' by right clicking the date on the sprayer row. Select "*Increment Month*" and the date should now be 'Jun 20, 01' (Figure 3.38).

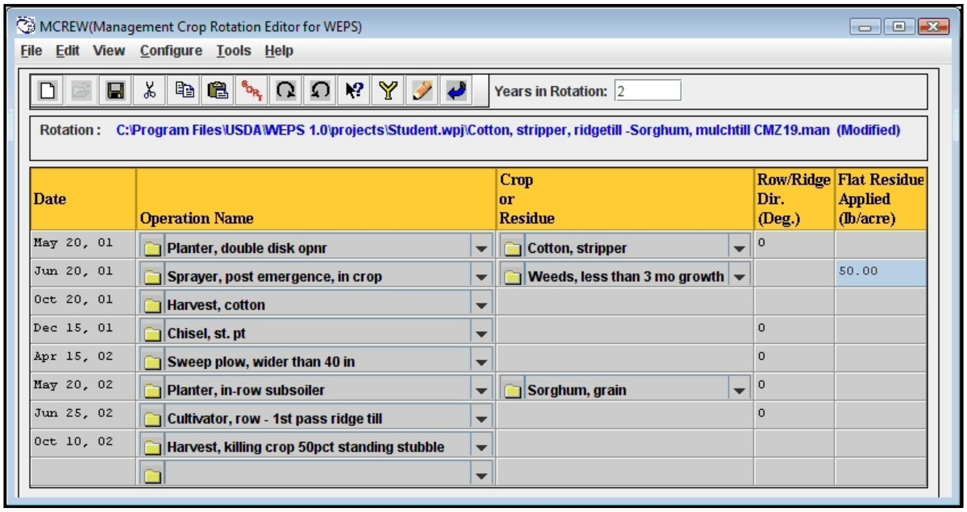


Figure 3.38. MCREW window show the added *Sprayer, post emergence, in crop* operation.

Save the new file as *Cotton, stripper, ridgetill-Sorghum, mulchtill CMZ19,* and close MCREW to return to the interface.

Note: In the future you may decide that a new management file is worthy of addition to what is known as the Local Management subdirectory. To do this, follow these steps: 1) Start with the edited and tested management file loaded in MCREW. It must have any Biomass Adjustment Factors to make the run for that locality where it will be used. 2) The location to save a Template Management Local file is *C:\Program Files\USDA\WEPS\WEPS 1.0 (beta 20b)\db\man\NRCS\local*. 3) Save the file by clicking 'File', 'Save as Template', and navigate to the above directory. Use the name you have given it or one consistent with any naming conventions you have chosen to use. 4) Then click 'Save'.

Note: NRCS field offices will have a file structure on the *F:\WEPS* drive to store the Local Records. This will allow the local work group to have access to any locally made records.

Step 4: Make the run and call it *Cotton, stripper, striptill-Sorghum, mulchtill CMZ19 TX.* It is not necessary to calibrate the sorghum since it produced a 29 bu/ac yield in the last run, which is close enough to the desired 25 bu/acre yield.

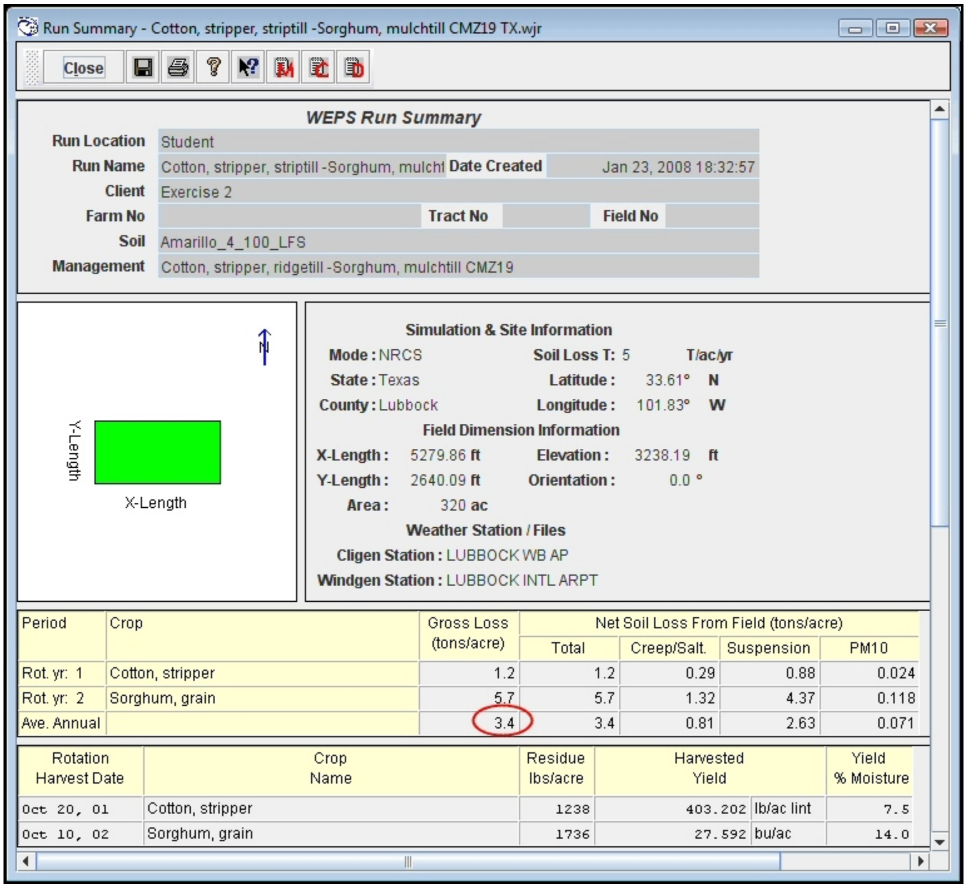


Figure 3.39. Run summary showing annual soil loss of less than 5.0 tons/acre.

This run shows that it is possible to meet the soil loss tolerance of 5 tons/acre/year using a cotton-sorghum rotation (Figure 3.39). Leaving the cotton stalks standing is very effective at controlling wind erosion. Looking at the Detailed Report shows there is over 650 lbs/ac flat mass and 20% flat cover of sorghum residue after planting cotton, and over 630 lbs/ac flat mass, 19% surface cover of cotton residue after planting sorghum.

Exercise 3 - South Dakota: Templates and Add Irrigation

Skill Building: This exercise will call up a template management run with fallow, make a run, calibrate the run, replace the fallow with sorghum, make two more runs (one calibration), and then add irrigation.

Scenario: The field is located in **Haakon County, South Dakota**. The **CLIGEN** station is Milesville. The **WINDGEN** station is **Pierre Municipal**. The critical dominate Soil Map Unit is **CRAFT_Cv_85_VFSL**. The existing cropping system is **Winter Wheat-Fallow.** Consider adding sorghum dry land or corn if irrigated. The field size is a **160 ac square**. The field orientation is 45 degrees from North. Management includes **fall chisel at a 45 degree angle** to the field borders after the winter wheat harvest, producing about 40 bu/ac/yr. The dryland yield for sudangrass will be 1.5 ton/ac/yr. The crop management file we will start with is *Wheat, winter; fallow; Conv, CMZ5.man***.**

Getting Started

Step 1: Make sure you are in the Student project. Enter all the needed data mentioned above into the interface. Be sure to change the field Orientation to 45.0 degrees in the Simulation Region Information panel. You will see the field orientation rotate in the Field View panel. Open a template file by clicking the Management Template Folder icon and clicking ‘Example Mgt. Files’ then select *WWheat-fallow, Conv, CMZ5.man*. An alternative way to open the template file is to open the MCREW Management editor by clicking the ‘Man’ button. Click ‘File’, then ‘Open Copy of Template’ and load *WWheat-fallow, Conv, CMZ5.man* into the editor. Be sure to highlight all the operations, right click in the Row/Ridge Dir. (Deg.) column, and select **Set to 45 deg**. See Figure 3.40.

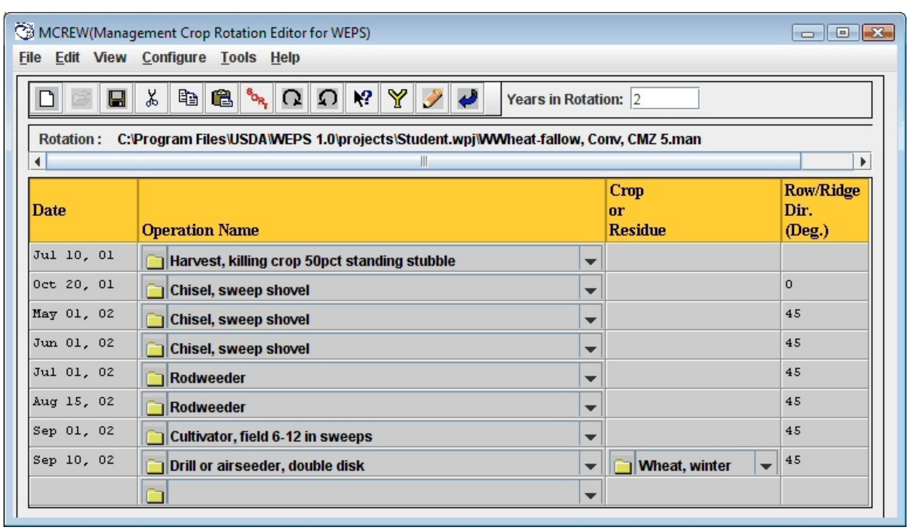


Figure 3.40. Template management showing Row/Ridge direction.

Note: All degree settings, including field orientation and tillage direction, are measured from 0 degrees (i.e., North). The fall chisel (Oct 20, 01) direction should be **0** or North because the field angle is 45 degrees. If you do not make these changes the answer will be different.

Select the soil **Craft Cv 85 VFSL**. Click Yield Calibrate button  to turn on the yield function and click the Return button  to return to the main interface.

Step 2: Make a Yield Calibration WEPS Run and name the run *WWheat-Follow, Conv, CMZ5 cal*. The soil loss is **8.0 ton/ac** and the Biomass Adjustment Factor is **0.930**. Use this Biomass Adjustment Factor in the project.

Add Sudangrass

Now replace the fallow with a short sudangrass forage crop. Note that forage crops are not calibrated. WEPS will grow the crop without calibration. This may change in future versions, but for now (Version 1) do not calibrate forage crops.

Step 1: Open up the management editor again. Make a new management file called *Wheat, winter-Sudangrass, forage, Conv, CMZ5.man*, by clicking 'File', 'Save as...' and type the new name and click 'Save'.

Edit the file to add in the sudangrass. Planting time for sudangrass is April 15, so we need to add a chisel and a field cultivator to the file before we plant the sudangrass. Schedule these operations with two days between each operations. We will start in the spring time of the second year. Change the date of the spring chisel from 'May 01, 02' to 'Apr 11, 02' (right click the date cell on the May 1 Chisel line and select 'Calendar Date' to change the date).

Now change the operation to a *Chisel, sweep shovel* by right clicking on the operation name and clicking "Change Operation". Right click the date on the next line (June 1), and change the date to 'Apr 13, 02'. Then change the operation to *Cultivator, field 6-12 in sweeps*.

On the next line, change the date to 'Apr 15,02' and the operation to *Drill or airseeder, double disk*. We will have to add the sudangrass hay crop. In this case, the name for the crops is *Sorghum, forage*. Sudangrass is a type of sorghum.

Next, change the 'Aug 15,02' line to a hay harvest line with a 'Sep 01, 02' harvest date. Change the operation to *Harvest, hay, no regrowth*.

Now we want to add a ***Chisel, sweep shovel*** before the Cultivator, field 6-12 in sweeps. Right click the *Chisel, sweep shovel* operation on the second row and copy rows(s). Right click the 'Sep 01, 02' *Cultivator, field 6-12 in sweep*s and paste row(s). Now change the date of the chisel to 'Sep 03, 02' and the cultivator to 'Sep 05, 02'. Be sure to change the year on the Chisel from year 1 to year 2.

The last thing to do is to change all the direction of tillage operations to 45 degrees except for the 'Oct 20, 01' chisel, should stay at 0 degrees. The updated management file should look as in Figure 3.41. Finally 'Save' the management.

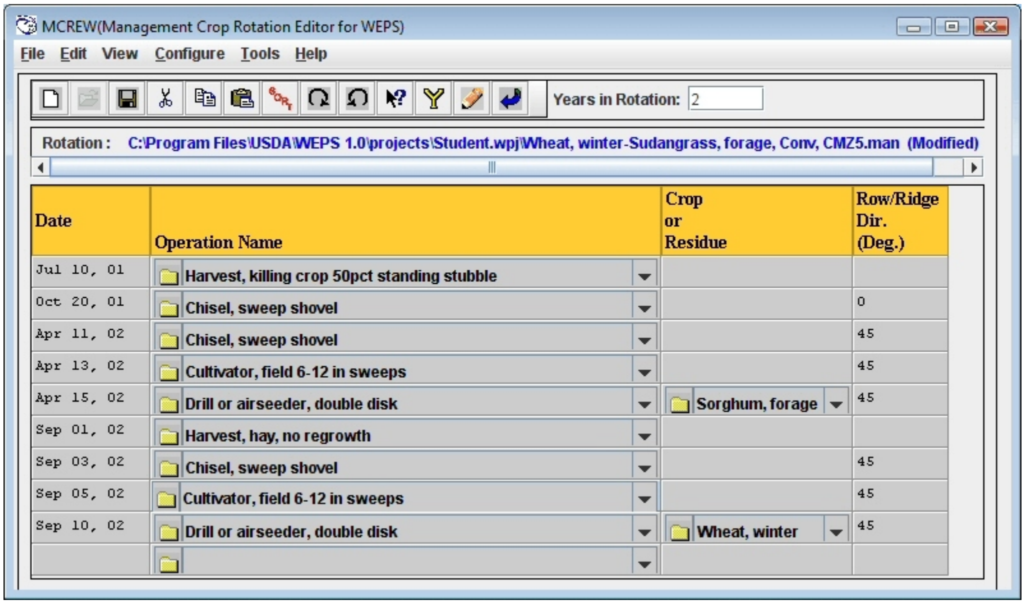
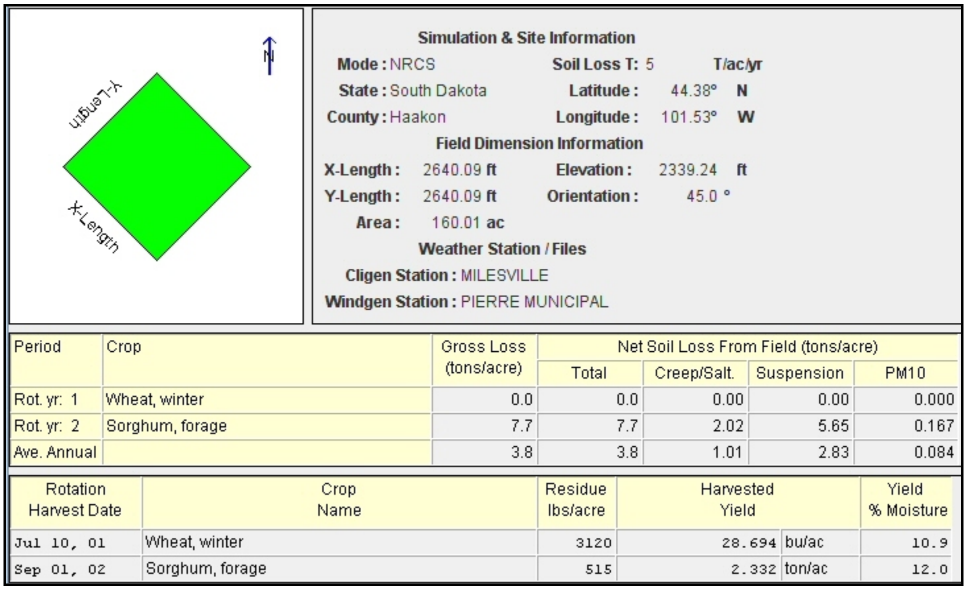


Figure 3.41. Management window with sudangrass added.

Step 2: Make the run and call it *Winter Wheat-Sudangrass, forage, conv, CMZ5*. Be sure that the winter wheat has the 0.93 value in the Bio Adj. Factor column in the MCREW management editor screen. The soil loss is now **3.9 ton/ac** (Figure 3.42). This is a good reduction of the erosion rate.

Note: If a disk had been used to prepare the seed bed for the hay, the soil loss would be 4 ton/acre more. The **2.3 ton/ac** yield of sudangrass hay seems reasonable.



Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Wheat, winter	0.0	0.0	0.00	0.00	0.000
Rot. yr: 2	Sorghum, forage	7.7	7.7	2.02	5.65	0.167
Ave. Annual		3.8	3.8	1.01	2.83	0.084

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Jul 10, 01	Wheat, winter	3120	28.694	bu/ac	10.9
Sep 01, 02	Sorghum, forage	515	2.332	ton/ac	12.0

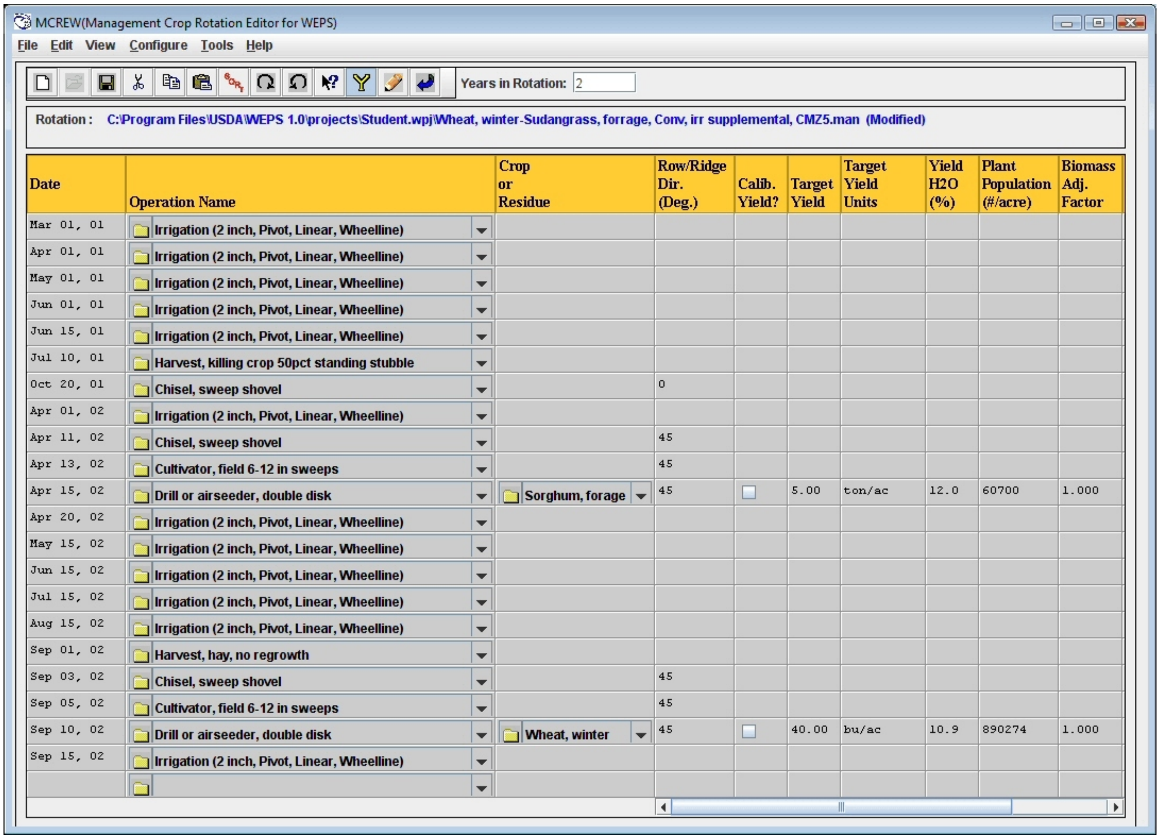
Figure 3.42. Portion of Run Summary showing soil loss and yields.

Add Supplemental Irrigation

The producer can apply about 12 inches of water per year to the crops and would like to see the effect of this in the yield. This is a relatively easy question to answer.

Step 1: Open up the last management we ran: *Wheat, winter-Sudangrass, forage, Conv*, *CMZ5.man*. Save a new version of this rotation by clicking 'File', 'Save as...' and adding irrigation to the name: *Wheat, winter-Sudangrass, forage, Conv, irr supplemental, CMZ5.man*.

The producer wants to add supplemental irrigation to see the effect on yields. Right click the third line in the Operation Name column and insert an operation. Select, *Irrigation (2 inch, Pivot, Linear, Wheelline)*, and change the date to 'Apr 01' and year to '01'. Now use the copy-paste function by right clicking on the irrigation operation just created and click 'Copy Row(s)'. Now right click in the same row and click 'Paste Row(s)'. Repeat this to give six irrigation operations and change the dates to 'Apr 01', 'Apr 20', 'May 15', 'Jun 15', 'Jul 15', and 'Aug 15' with year of '01'. The wheat also needs the two inch irrigations on 'Sep 15', 'Mar 01', 'Apr 01', 'May 01', 'Jun 01', and Jun 15' of year '02'. You can copy the six lines of irrigation for the sudangrass by left clicking and dragging the mouse over the six sudangrass irrigations to highlight them, copy, and paste at the end of the file. Then change the dates for wheat. The last thing to do is to sort the file by clicking the sort button, on the top of the tool bar, then save the file. The completed management window should look like Figure 3.43.

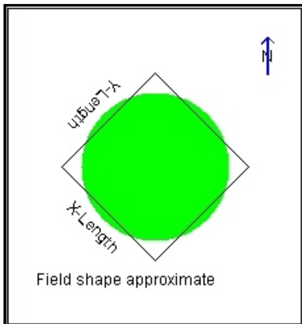


Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)	Calib. Yield?	Target Yield	Target Yield Units	Yield H2O (%)	Plant Population (#/acre)	Biomass Adj. Factor
Mar 01, 01	Irrigation (2 inch, Pivot, Linear, Wheelline)								
Apr 01, 01	Irrigation (2 inch, Pivot, Linear, Wheelline)								
May 01, 01	Irrigation (2 inch, Pivot, Linear, Wheelline)								
Jun 01, 01	Irrigation (2 inch, Pivot, Linear, Wheelline)								
Jun 15, 01	Irrigation (2 inch, Pivot, Linear, Wheelline)								
Jul 10, 01	Harvest, killing crop 50pct standing stubble								
Oct 20, 01	Chisel, sweep shovel		0						
Apr 01, 02	Irrigation (2 inch, Pivot, Linear, Wheelline)								
Apr 11, 02	Chisel, sweep shovel		45						
Apr 13, 02	Cultivator, field 6-12 in sweeps		45						
Apr 15, 02	Drill or airseeder, double disk	Sorghum, forage	45	☐	5.00	ton/ac	12.0	60700	1.000
Apr 20, 02	Irrigation (2 inch, Pivot, Linear, Wheelline)								
May 15, 02	Irrigation (2 inch, Pivot, Linear, Wheelline)								
Jun 15, 02	Irrigation (2 inch, Pivot, Linear, Wheelline)								
Jul 15, 02	Irrigation (2 inch, Pivot, Linear, Wheelline)								
Aug 15, 02	Irrigation (2 inch, Pivot, Linear, Wheelline)								
Sep 01, 02	Harvest, hay, no regrowth								
Sep 03, 02	Chisel, sweep shovel		45						
Sep 05, 02	Cultivator, field 6-12 in sweeps		45						
Sep 10, 02	Drill or airseeder, double disk	Wheat, winter	45	☐	40.00	bu/ac	10.9	890274	1.000
Sep 15, 02	Irrigation (2 inch, Pivot, Linear, Wheelline)								

Figure 3.43. Management window with irrigation added.

Note: This example shows how to use supplemental irrigation. If you want to use full irrigation to meet crop consumptive use, put a *Start Monitor (Pivot, Linear, Wheelline)* operation just after planting and an *Irritation, Stop Monitor* operation 15 days before harvest. This will auto-irrigate the crop during the growing season similar to the way Exercise 1 was run.

Step 2: Return to the main interface and make the run without calibration (Biomass Adjustment Factor set to 1.0 for wheat) to see how much additional yield the producer may get with the supplemental irrigation. This time, show the Simulation Region as a circle by changing the "Shape" to **circle**, and typing **120 ac** in the area box. Call the run: *Wheat, winter-Sudangrass, forage, Conv, irr supplemental, CMZ5*.



Simulation & Site Information

Mode : NRCS **Soil Loss T:** 5 **T/ac/yr**

State : South Dakota **Latitude :** 44.38° **N**

County : Haakon **Longitude :** 101.53° **W**

Field Dimension Information

Radius : 1290.03 **ft** **Elevation :** 2339.24 **ft**

Orientation : 45.0 **°**

Area : 120.01 **ac**

Weather Station / Files

Cligen Station : MILESVILLE

Windgen Station : PIERRE MUNICIPAL

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Wheat, winter	0.0	0.0	0.00	0.00	0.000
Rot. yr: 2	Sorghum, forage	1.3	1.3	0.41	0.89	0.027
Ave. Annual		0.7	0.7	0.21	0.45	0.013

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Jul 10, 01	Wheat, winter	5400	55.637	bu/ac	10.9
Sep 01, 02	Sorghum, forage	570	2.581	ton/ac	12.0

Figure 3.44. Portion of Run Summary showing soil loss and yields after irrigation.

Note that the wheat yield increased to 55.6 bu/ac and the sudangrass hay only increased 249 lbs/ac (Figure 3.45). This may not be a good investment of the 12 inches of water per year. The soil loss dropped to 0.7 ton/ac/yr.

Exercise 4 - Minnesota: Simulate a Cover Crop and Windbreak

Skill Building: This exercise will start with a template management and add a spring barley cover crop to protect the sugar beet the first 40 days of growth. WEPS (version 1) can only grow one crop at a time for this exercise so you need to know how to build a work around for these special management rotations. We will also explore the effects of a windbreak.

Scenario: The farm is located in **Clay County, Minnesota**. The **CLIGEN** station is **FARGO AIRPORT** and the **WINDGEN** station is **FARGO/HECTOR FIELD**. The critical dominant soil in the field is **426 Foldahl loamy fine sand** (13.4% of the field and the most erodible by wind) (Figure 3.46). The field is 80 acres (1320 ft north and south and 2640 ft east and west). There is a single row of elm trees on the north side of the field and the leaves are on the trees during the period of erosive winds in the spring. The trees are 25 feet tall and about 20 feet in width. The porosity of the windbreak is about 50% during the critical wind period.

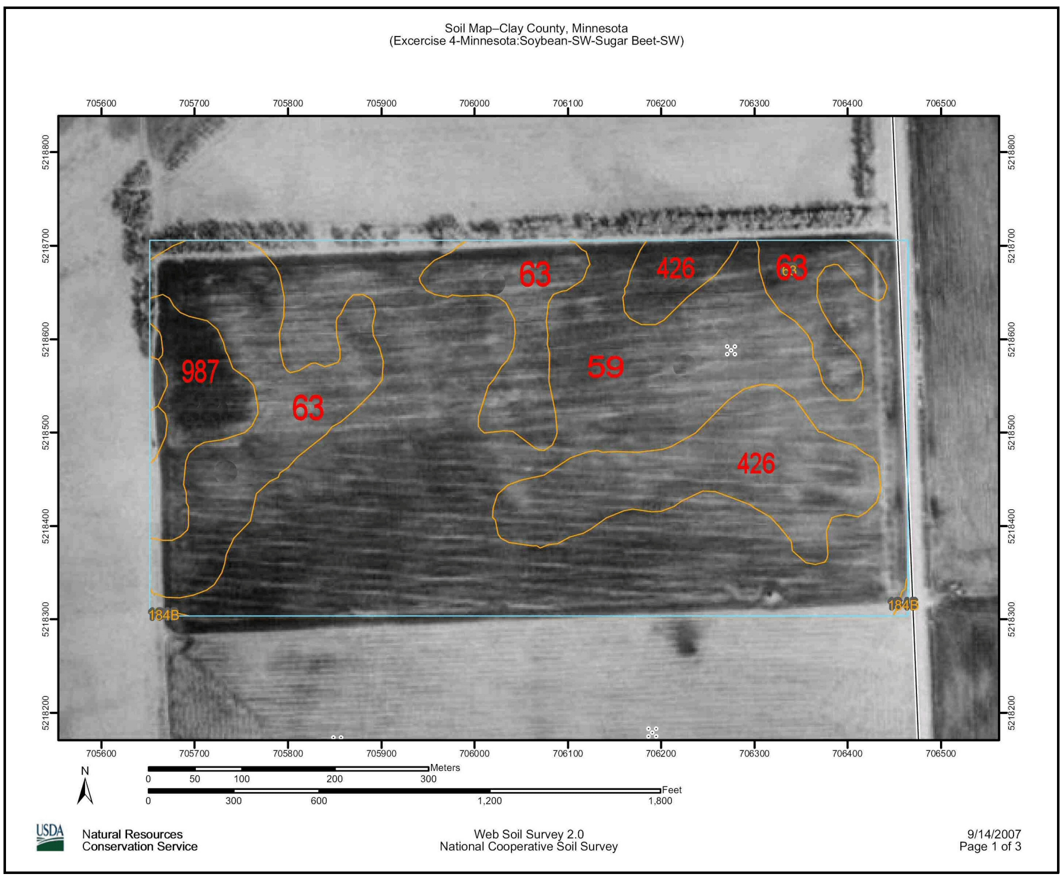
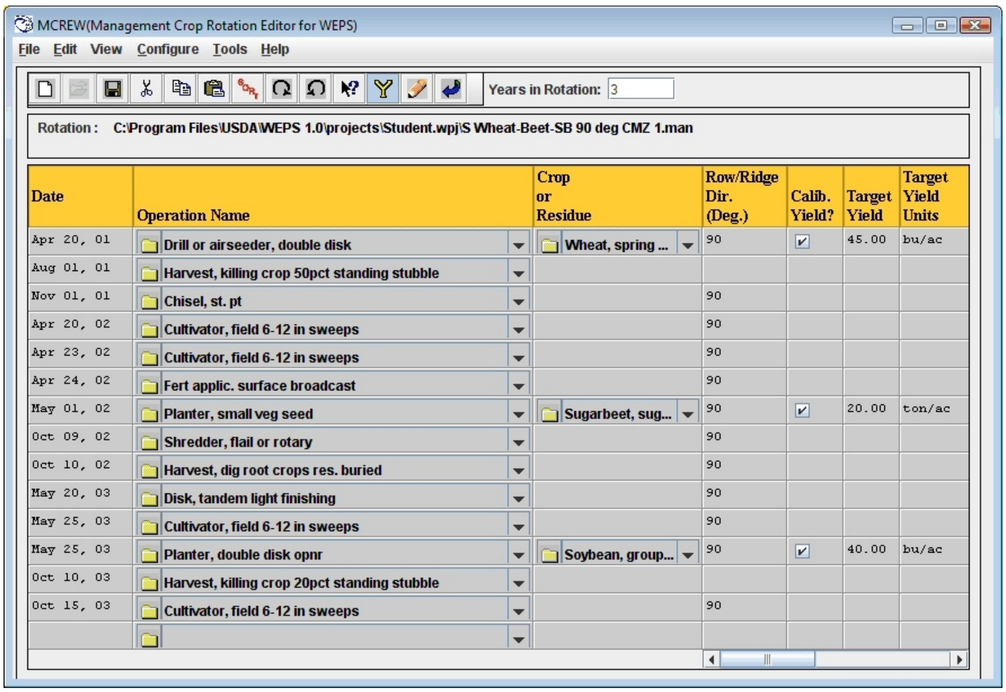


Figure 3.45. Soil map showing the critical dominant soil 426 - Foldahl loamy find sand. Also notice the windbreak on the North filed border.

The crop rotation is **Spring Wheat-Sugarbeets-Soybean**. There is a problem with the sugarbeets just after planting. One out of three years that sugarbeets are planted, they have to be replanted because of abrasion of the young beet plants by blowing soil. We will call the rotation: *S Wheat-Beet-SB CMZ 1.man*. Crop yields are: Spring Wheat, 45 bu/ac; Sugarbeets, 20 tons/ac; and Soybean, 40 bu/ac.

Getting Started

Step 1: Make sure you have the Student project loaded. Enter all the above information but **without** the wind break on the main WEPS interface. Click the Project Folder button next to the 'Man' button and load the *S Wheat-Beet-SB CMZ 1.man* file. Open MCREW and click the Yield Calibrate button and make sure that the yields match the inventory values above. Also change all tillage directions to 90 degrees (parallel to the long dimension). See Figure 3.46 .



Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)	Calib. Yield?	Target Yield	Target Yield Units
Apr 20, 01	Drill or airseeder, double disk	Wheat, spring ...	90	✓	45.00	bu/ac
Aug 01, 01	Harvest, killing crop 50pct standing stubble					
Nov 01, 01	Chisel, st. pt		90			
Apr 20, 02	Cultivator, field 6-12 in sweeps		90			
Apr 23, 02	Cultivator, field 6-12 in sweeps		90			
Apr 24, 02	Fert applic. surface broadcast		90			
May 01, 02	Planter, small veg seed	Sugarbeet, sug...	90	✓	20.00	ton/ac
Oct 09, 02	Shredder, flail or rotary		90			
Oct 10, 02	Harvest, dig root crops res. buried		90			
May 20, 03	Disk, tandem light finishing		90			
May 25, 03	Cultivator, field 6-12 in sweeps		90			
May 25, 03	Planter, double disk opnr	Soybean, group...	90	✓	40.00	bu/ac
Oct 10, 03	Harvest, killing crop 20pct standing stubble					
Oct 15, 03	Cultivator, field 6-12 in sweeps		90			

Figure 3.46. Initial MCREW window for Exercise 4.

Step 2: Make a Calibration Run and call it: *S Wheat-Beet-SB CMZ 1 cal*. Use the Biomass Adjustment Factors in the Project. Notice all of them are more than 0.05 above 1.0 (Figure 3. 47).

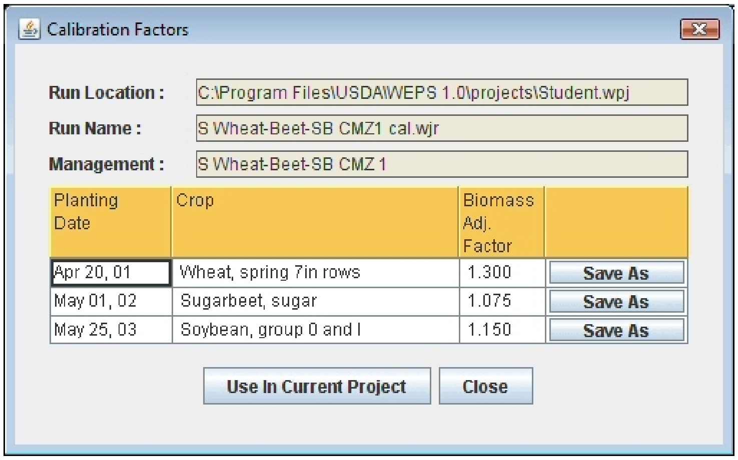


Figure 3.47. Calibration Factors for initial run.

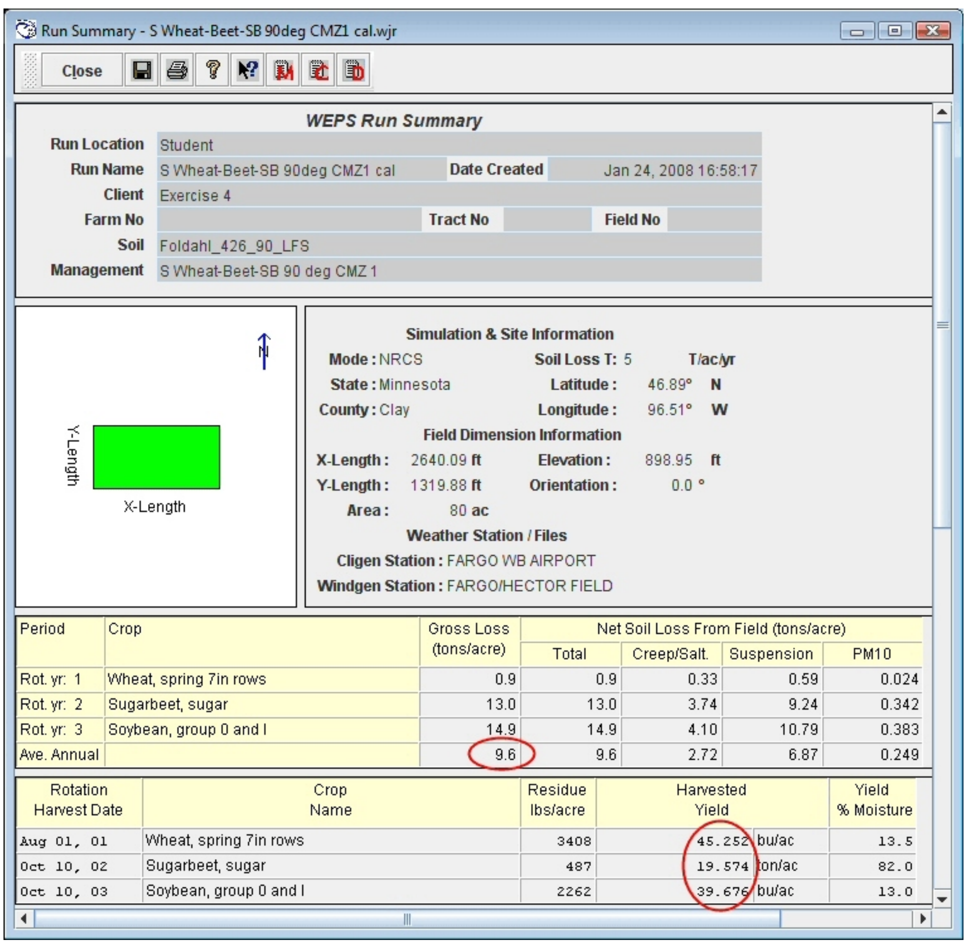
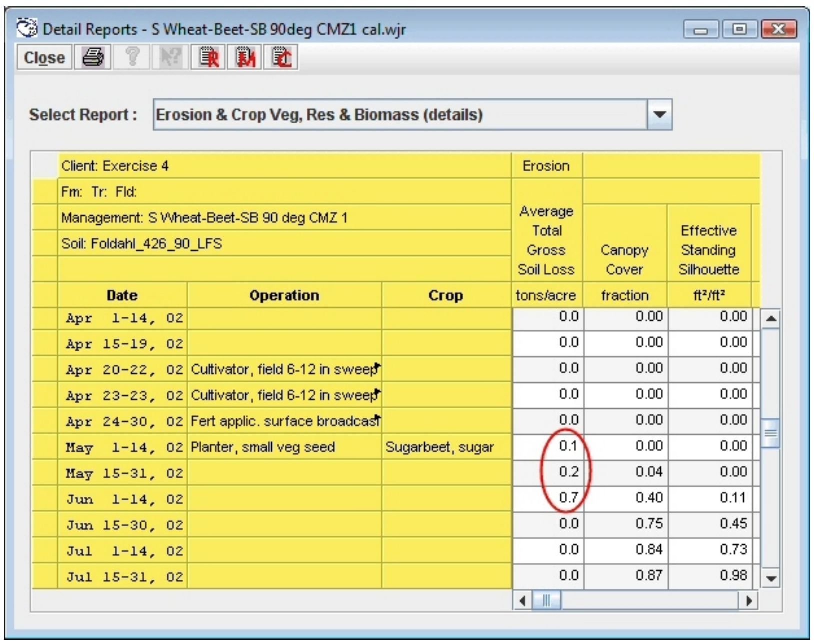


Figure 3.48. Run Summary showing soil loss and yields.

Notice that the soil loss is 9.6 ton/ac, and that the yields are close to the ones mentioned in the inventory (Figure 3.48). The producer has had trouble with the sugarbeet being damaged by blowing soil just after planting. Look on the detailed report and find the soil loss for the period just after the beets are planted.

What is the sum of soil lost just after planting the beets?
Answer: The first three periods sum to 1.0 ton/ac (Figure 3.49).
The NRCS National Agronomy Manual, Crop Tolerance to Blowing Table lists crop sensitivity to wind erosion after planting. Sugarbeets have a 0.0 - 0.5 ton/ac tolerance (See Table 3.? in the Exercises Introduction) .



Date	Operation	Crop	Average Total Gross Soil Loss tons/acre	Canopy Cover fraction	Effective Standing Silhouette ft²/ft²
Apr 1-14, 02			0.0	0.00	0.00
Apr 15-19, 02			0.0	0.00	0.00
Apr 20-22, 02	Cultivator, field 6-12 in sweep		0.0	0.00	0.00
Apr 23-23, 02	Cultivator, field 6-12 in sweep		0.0	0.00	0.00
Apr 24-30, 02	Fert applic. surface broadcast		0.0	0.00	0.00
May 1-14, 02	Planter, small veg seed	Sugarbeet, sugar	0.1	0.00	0.00
May 15-31, 02			0.2	0.04	0.00
Jun 1-14, 02			0.7	0.40	0.11
Jun 15-30, 02			0.0	0.75	0.45
Jul 1-14, 02			0.0	0.84	0.73
Jul 15-31, 02			0.0	0.87	0.98

Figure 3.49. Detailed report showing erosion soil loss after planting sugarbeets.

Is this run OK?
Answer: No, it is too high because of the sensitivity of sugarbeets to abrasion.

Run the Model with a Windbreak

See if the windbreak will help the abrasion problem on sugarbeets just after planting.

Step 1:
There is a one row windbreak on the north side of the field. In the 'Wind Barrier Interface' panel on the left side of the main interface, click the radio button next to the 'N' to place a barrier on the north side (N) of the field (see Figure 3.50). Notice that a yellow bar appears on the north side of the simulation area.

The trees for this windbreak are given as 25 ft tall, 20 ft wide, and have porosity fraction in April of 0.50 (50%). Click on the down arrow next to the barrier in the 'Wind Barrier Information' panel. Select the record labeled '**Tree, leaf on (1 row)**'. Notice that the barrier bar turns red indicating that the barrier type has been selected (Figure 3.50). Then click the 'Edit Selected Barrier' button Edit Selected Barrier . Enter the information from the onsite inventory and click 'Save'. Notice the barrier type has '<mod>' added in front of the name indicating the barrier properties have been modified by the user.

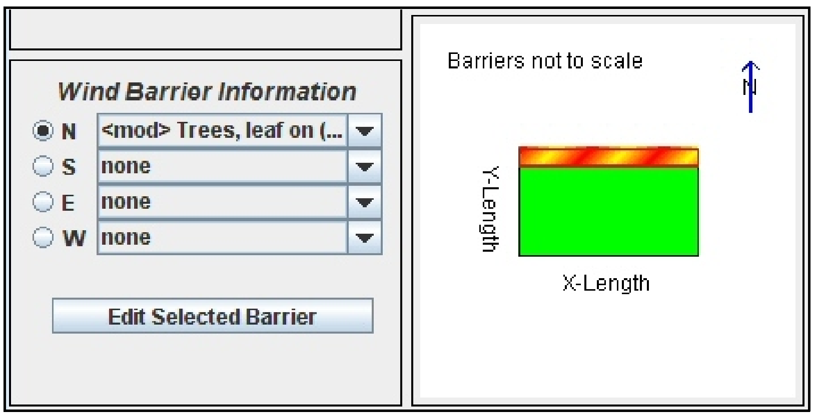


Figure 3.50. Selecting a wind barrier.

Step 2: Make the run by clicking the 'Run' button on the main tool bar and call the run *S Wheat-Beet-SB, windbreak CMZ 1*.

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Wheat, spring 7in rows	0.5	0.5	0.20	0.27	0.012
Rot. yr: 2	Sugarbeet, sugar	4.3	4.2	1.65	2.53	0.095
Rot. yr: 3	Soybean, group 0 and I	7.8	7.7	3.17	4.49	0.163
Ave. Annual		4.2	4.1	1.68	2.43	0.090

Figure 3.51. Portion of Run Summary showing reduction in average annual soil loss.

Note: On the run summary, the windbreak reduced soil loss 5.4 ton/acre (9.6 - 4.2 tons/acre) (Figures 3.51 and 3.48). If we multiply the 5.4 ton/acre by 80 acres in the field we see that the barrier saved about 432 tons of soil per year on a field basis. Also notice that the net soil loss (4.1 ton/ac) is lower than the gross loss (4.2 ton/ac). This is because soil was deposited in front of the windbreak before leaving the field during storms with a southerly wind.

Apr 23-23, 02	Cultivator, field 6-12 in sweep		0.0	0.00
Apr 24-30, 02	Fert applic. surface broadcast		Trace	0.00
May 1-14, 02	Planter, small veg seed	Sugarbeet, sugar	Trace	0.00
May 15-31, 02			0.2	0.04
Jun 1-14, 02			0.5	0.40
Jun 15-30, 02			0.0	0.75
Jul 1-14, 02			0.0	0.84
Jul 15-31, 02			0.0	0.87

Figure 3.52. Portion of Detailed Report showing soil loss after planting sugarbeets.

What was the savings for the sugarbeets after planting on the detailed report?
Answer: Soil loss went down from 1.0 ton/ac to 0.7 ton/acre (Figure 3.52). This is helpful, but let's see what a spring barley cover crop can do. An example of a barley cover crop after spraying and planting to winter wheat is shown in Figure 3.53

Figure 3.53. Example of a barley cover crop after spraying and planting to fall planted winter wheat.

Add the Spring Barley Cover crop

The producer told us that the sugarbeets blow out 1 out of 3 years. We need to consider an alternative that can keep them from being killed by blowing soil. Adding a cover crop (spring barley) that grows simultaneous with a crop (sugarbeets) requires special crop files and special operations. These will require the NRCS user to contact the National Wind Erosion Specialist to develop these files.

WEPS can only grow one crop at a time. In this case we will model the barley growth for the first 40 days, and then switch to the sugarbeets that are growing under the cover of the spring barley.

Step 1: On the main interface window, click the 'Man' button to open the Management Editor, and make sure you have the original management file loaded: *S Wheat-Beet-SB CMZ 1.man*. Click 'File', 'Save as...' and rename the file *S Wheat-Beet, cover crop-SB, CMZ1.man*.

On the 'May 1, 02' line right click the Operation Name column and add two operations. The first operation will be the 'Seeder-Broadcast' and the second will be the 'Harrow, spike tooth, cover seed' operation. The seeder operation requires a crop name in the next column. Select *Barley, spring covercrop*. This file is a standard barley file that will grow about 300 lbs/ac biomass during the 40 days it will be in the field. Both the seeder and harrow need the same date 'Apr 30, 02'.

Now, right click the operation cell on 'May 01, 02' and change the *Planter, small veg seed* to *Planter, into growing cover.* This is a special planter that shows tilled ground on the day the planter was used, but does not call in a growing crop of sugarbeets yet. You have planted them in the field on that day but for now we want to continue to grow only the spring barley cover crop until the sugarbeets produce a dominant amount of vegetation.

On the next line (Oct 09, 02) in the operation cell, right click and add an operation, *Sprayer, kill cover in growing crop*. Make the date 'Jun 10, 02', 40 days after planting the cover crop. In the next column over, click the pull down arrow and find and select, *Sugarbeet, growing after cover crop kill*. This is a modified Sugarbeet file that will show some biomass growth in the roots and leaves on the date the beets were planted.

Note: This type of logic will be necessary when a growing cover crop is planted and then killed after both crops grow for a time. We can use the same logic if a cover such as rye is seeded and started to grow in a growing crop.

Click the Yield Calibrate button and make sure the barley cover crop line is unchecked because this is a forage crop and we want WEPS to control the yield growth. The Biomass

Adjustment Factors must be the same as the first run. They are Wheat, 1.3; Sugarbeets, 1.075; and Soybeans, 1.150 (Figure 3.54). We will not calibrate the cover crop since it will be killed before planting the sugarbeets.

Now click the 'Return' button to return the main interface.

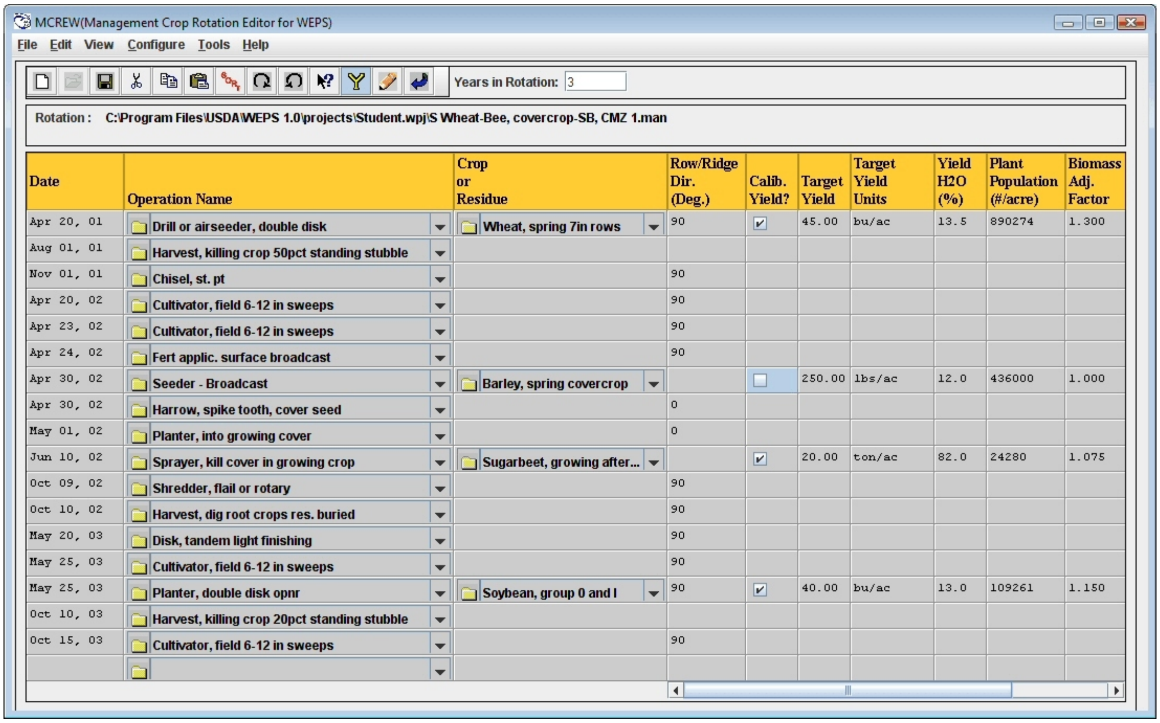


Figure 3.54. MCREW window with cover crop added.

Now click the 'Return' button to return the main interface.

Step 2: Make sure you uncheck the radio button for the windbreak by selecting barrier type 'none' by using the drill down arrow. Click 'Calibrate Run' button to make a Calibration WEPS Run, call it *S Wheat-Beets, cover crop-SB CMZ 1 cal*.

Note: The biomass adjustment factor for the beets changed from 1.075 to 1.236. This means that WEPS needed to make additional adjustment to produce the 20 ton/ac yield. We know that this is possible in the field, however there may be times we do not know what effect growing the barley may have on the crop. If moisture is short, there may be a yield reduction. Click "Use in the Current Project" to save the new factors.

Without the windbreak on this sandy site, the cover crop (40 days) does little to reduce the overall erosion (Figure 3.55). We started with 9.6 tons/ac and only reduced it to 7.0

tons/acre. This is still too high and we would suggest additional runs with less tillage to find a system where the rate is closer to the desired 5 ton/acre rate.

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Wheat, spring 7in rows	0.8	0.8	0.30	0.54	0.022
Rot. yr: 2	Sugarbeet, growing after covercrop kill	9.8	9.8	2.93	6.82	0.250
Rot. yr: 3	Soybean, group 0 and I	10.6	10.6	2.97	7.58	0.270
Ave. Annual		7.0	7.0	2.07	4.98	0.181

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Aug 01, 01	Wheat, spring 7in rows	3410	45.288	bu/ac	13.5
Oct 10, 02	Sugarbeet, growing after covercrop kill	486	20.961	ton/ac	82.0
Oct 10, 03	Soybean, group 0 and I	2248	39.417	bu/ac	13.0

Figure 3.55. Portion of Run Summary showing soil loss with cover crop.

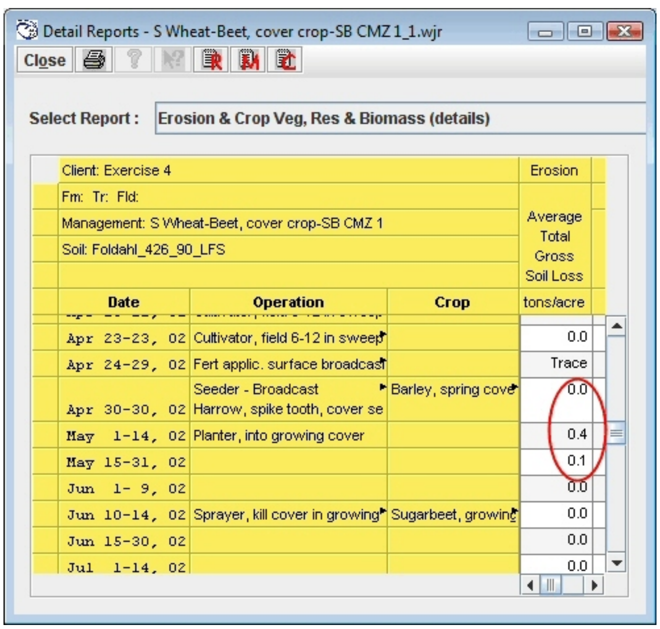


Figure 3.56. Portion of Detailed Report showing loss after planting sugarbeets.

Note: The spring barley cover has reduced the wind erosion from 1.0 to 0.5 for the sugarbeet crop (Figure 3.56). This can save about $170/ac in re-seeding cost and loss of yield potential.

Now add back the windbreak and see the effects a windbreak and cover crop.

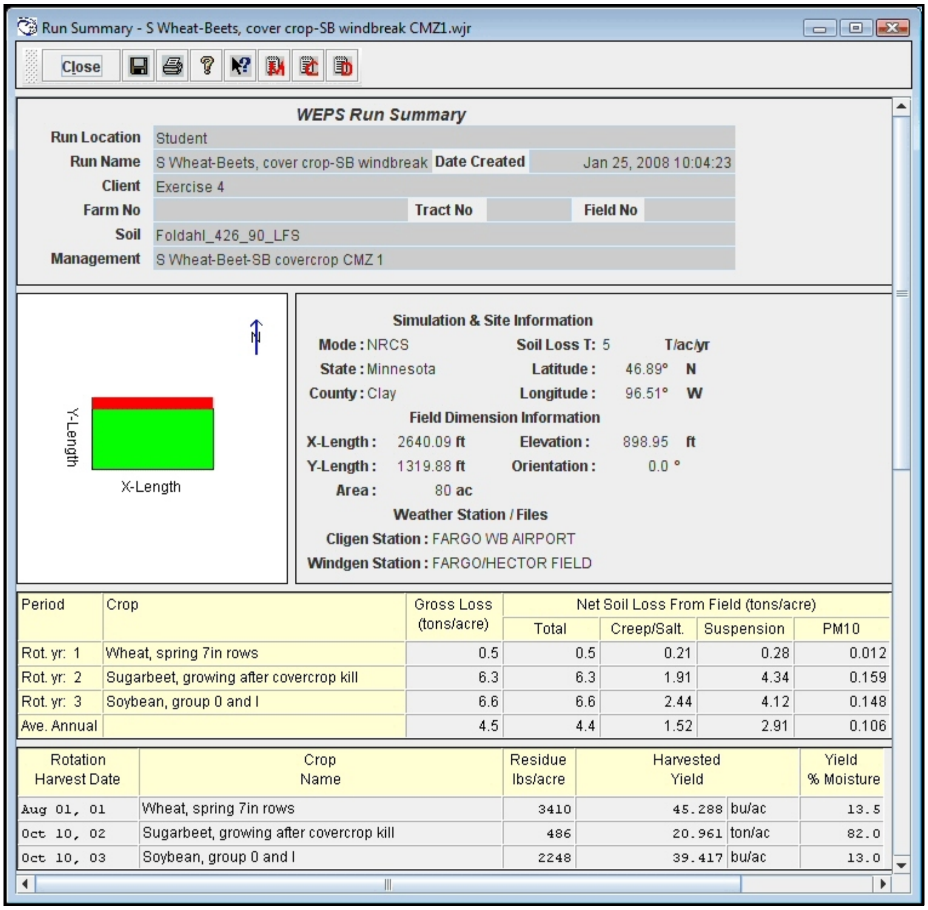


Figure 3.57. Run Summary screen showing loss with cover crop and windbreak.

With the windbreaks and the cover crop on these sandy soils, WEPS indicates there continues to be a problem (Figure 3.57). However, net soil loss of 4.4 tons/acre/year is below the T value of 5.0 tons/acre/year. To further reduce soil loss and provide protection for emerging crops an alternative could be a rye or winter wheat cover crop after harvest of the sugarbeets.

Exercise 5 - Washington: Alfalfa Hay, Editing, and More Irrigation

Skill Building: In this exercise we will learn to simulate a forage crop cut for hay. We will add a year of alfalfa to the three year rotation. This will show the power of the editor. There are many ways to edit data using the copy-paste and increment and decrement groups of operations to move seeding dates. You will be able to understand the basic format to build other forage crop files based on this example. Irrigation can be added in preset amounts, added in a custom amounts, or applied as needed as the plant uses it. In this example we will model full irrigation and apply water as the crop uses it. Many circles on a quarter section of land (160 acres) have 120 acres "under the iron". For this example there is an end gun that turns on and off as needed when the circle turns. The producer can irrigate 10 more acres for a total of 130 acres.

Scenario: The producer is near **Moses Lake, Washington** in **Grant County**. The soil is a **Quincy Fine Sand** (***Quincy_97_100_FS.ifc***). The field has full pivot or **circle irrigation**. Potatoes are a high dollar cash rental crop and must be rotated with other crops for disease and nematode control. The rotation is **Alfalfa 3 yrs-Potato-Winter Wheat**. If the alfalfa stand is good and the price for hay is strong they will leave the hay for 4 years. The irrigated circle is **130 acres**. The annual yield for the **alfalfa crop is about 6-7 ton/ac** cut 4 times with a 5th cut in some years. Alfalfa is cut on 30 day cycles. The **potato yield is 30 ton/ac** or (600 cwt/ac). The **winter wheat yield is 100 bu/ac**. The erosive wind comes in the spring from the west and tillage/planting direction is north and south.

WEPS can simulate crops that are cut multiple times in a growing season. However, forages can not calibrate biomass in the same way as grain crops. We will not calibrate the forage crop with WEPS. Calibration is very important for almost all other crops. Saving a calibrated crop to the local crop folder for use in future run can save run time on any subsequent runs. Each forage cutting yield that under-perform usually does not affect the erosion rate since there is more than adequate cover to shut down the erosion during a subsequent growing of a forage crop. So, if the hay yield is low, do not reject the run unless there is substantial erosion occurring in that 2 week management period.

Getting Started

Step 1: Make sure you are in the Student project. Set the "Shape" to Circle and the "Area" to 130 ac. Notice that the radius is 1343 feet, slightly bigger than the 1320 ft border to border of a 160 acre quarter section. In the location box set the state to **Washington** and the county to **Grant**. The field is near Moses Lake so we want to change the WINDGEN Station to **Moses Lake/Grant Co**. Leave the CLIGEN station set to **Ephrata CAA AP**.

Load a pre-made file by clicking the Man Project Folder button . Find the run called ***Alfalfa, fall seed, 3yr-Potato-WWheat, circle irr CMZ49.man***, and load it into the management editor. Load the soil called ***Quincy_97_100_FS.ifc*** from the Soil Project Folder button .

Step 2: Make the run by clicking the management button on the main interface. Click the Yield Calibrate button button and check the yields for all the crops and make sure that all match the inventory (**100 bu/ac, WWheat, 600 cwt/ac Potato, and 6.5 ton/ac Alfalfa**). Also make sure you do not put a check mark in the "Calib. Yield?" column for the Alfalfa crop (Figure 3.58). The other crops will be calibrated if checked and the Alfalfa left unchecked will not be calibrated. Click the Return button to save and return.

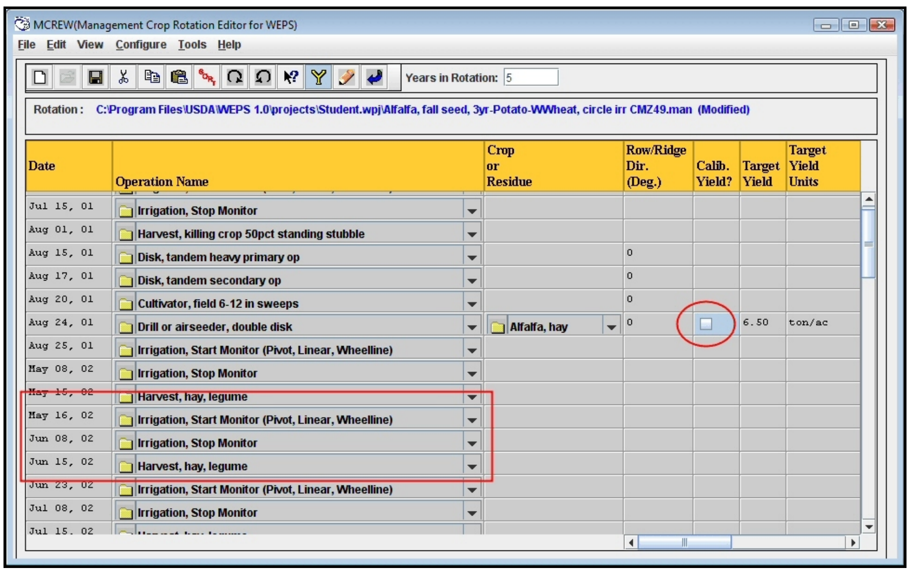


Figure 3.58. Initial MCREW window for Exercise 5.

Notice the way the alfalfa crop irrigation and harvests are modeled. Each hay harvest has an *Irrigation, Start Monitor (Pivot, Linear, Wheelline); Irrigation, Stop Monitor;* and *Harvest, hay, legume* operation associated with the harvest. The irrigation is stopped 7 days before harvest to allow the soil surface to dry out enough to help cure the hay.

Now, click 'Run' then 'Make a Calibration WEPS Run'. Name the run *Alfalfa 3yr-Potato-WWheat, circle irr CMZ 49*. This file is a long 5yr rotation. It will take the computer several minutes to calibrate the 75 year run. If you were going to use these crops in future runs that were similar to this run, you should use the 'Save as...' button to store the 1.225 Biomass Adjustment Factor for wheat to a local record in the crops file. For now let's click 'Use in Current Project'. Look at the yields in the Run Summary (Figure 3.59).

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Aug 01, 01	Wheat, winter, CMZ 50 hi ppt 7-10in spac	7923	104.049	bu/ac	13.5
May 15, 02	Alfalfa, hay	725	2.366	ton/ac	15.0
Jun 15, 02	Alfalfa, hay	444	1.270	ton/ac	15.0
Jul 15, 02	Alfalfa, hay	344	0.981	ton/ac	15.0
Aug 15, 02	Alfalfa, hay	471	1.563	ton/ac	15.0
Sep 15, 02	Alfalfa, hay	393	1.261	ton/ac	15.0
May 15, 03	Alfalfa, hay	903	2.831	ton/ac	15.0
Jun 15, 03	Alfalfa, hay	536	1.549	ton/ac	15.0
Jul 15, 03	Alfalfa, hay	402	1.195	ton/ac	15.0
Aug 15, 03	Alfalfa, hay	501	1.669	ton/ac	15.0
Sep 15, 03	Alfalfa, hay	403	1.308	ton/ac	15.0
May 15, 04	Alfalfa, hay	911	2.906	ton/ac	15.0
Jun 15, 04	Alfalfa, hay	526	1.475	ton/ac	15.0
Jul 15, 04	Alfalfa, hay	438	1.323	ton/ac	15.0
Aug 15, 04	Alfalfa, hay	514	1.735	ton/ac	15.0
Sep 15, 04	Alfalfa, hay	394	1.240	ton/ac	15.0
Sep 30, 05	Potato, late, harvest	802	597.190	cwt/ac	79.0

Figure 3.59. Portion of the Run summary showing Alfalfa yields.

WEPS can not calibrate each cutting of hay in a year but the average yield for all years can be adjusted by using the Biomass Adjustment Factor. In this example, adding up the yield in each of the three years gives 7.4 ton/ac in year 01, 8.6 ton/ac in year 02, and 8.7 ton/ac in year 03, for an annual average of 8.2 ton/ac yield of hay per year. Remember the reported yield was 6.5 ton/ac. WEPS can adjust the yield by dividing the expected yield by the observed (6.5 /8.2 = 0.793). Thus the new Biomass Adjustment Factor of 0.793 should provide an average yield close to the 6.5 ton/ac needed.

Make a second run using the new Biomass Adjustment Factor, but do not calibrate the run since we did that the on the first run and told it to use the factors in this project. Name the run the same with *Adj* added to indicate the yields were adjusted. By using the 0.793 factor for alfalfa we have an average alfalfa yield of 6.16 ton/ac, that is close enough to 6.5 (Figure 3.60).

The potatoes made 595 cwt/ac (about 30 ton/ac). The winter wheat made 104 bu/ac. This management file has been calibrated for this location and there is a Biomass Adjustment Factor for the potatoes, wheat, and alfalfa.

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Aug 01, 01	Wheat, winter, CMZ 50 hi ppt 7-10in spac	7894	103.615	bu/ac	13.5
May 15, 02	Alfalfa, hay	460	1.431	ton/ac	15.0
Jun 15, 02	Alfalfa, hay	336	0.959	ton/ac	15.0
Jul 15, 02	Alfalfa, hay	273	0.756	ton/ac	15.0
Aug 15, 02	Alfalfa, hay	361	1.172	ton/ac	15.0
Sep 15, 02	Alfalfa, hay	306	0.965	ton/ac	15.0
May 15, 03	Alfalfa, hay	702	2.169	ton/ac	15.0
Jun 15, 03	Alfalfa, hay	417	1.171	ton/ac	15.0
Jul 15, 03	Alfalfa, hay	321	0.937	ton/ac	15.0
Aug 15, 03	Alfalfa, hay	393	1.294	ton/ac	15.0
Sep 15, 03	Alfalfa, hay	309	0.984	ton/ac	15.0
May 15, 04	Alfalfa, hay	715	2.229	ton/ac	15.0
Jun 15, 04	Alfalfa, hay	424	1.179	ton/ac	15.0
Jul 15, 04	Alfalfa, hay	327	0.955	ton/ac	15.0
Aug 15, 04	Alfalfa, hay	397	1.320	ton/ac	15.0
Sep 15, 04	Alfalfa, hay	306	0.948	ton/ac	15.0
Sep 30, 05	Potato, late, harvest	799	595.037	cwt/ac	79.0

Figure 3.60. Portion of Run Summary showing alfalfa yields after inclusion of the Biomass Adjustment Factor.

Potatoes have a high soil loss in Rotation year 5 of 30.3 ton/ac. **Why is that?**
Answer: Potatoes do not produce much residue and the harvest process leaves very little residue on the surface. The winter wheat grown behind the potatoes is seeded very late in the year and does not produce growth as is needed to control erosion. The average soil loss is 6.3 ton/ac.

Client: Exercise 5 Fm: Tr: Fld: Management: Alfalfa, fall seed, 3yr-Potato-WWheat, circle irr CMZ49 Soil: Quincy_97_100_FS			Erosion	Average Biomass Surface Conditions on Date												
				Crop Vegetation							Crop Residue					
			Average Total Gross Soil Loss	Canopy Cover	Effective Standing Silhouette	Leaf and Stem Mass	Root Mass	Crop Height	Number Crop Stems	Surface Cover	Effective Standing Silhouette	Flat Mass	Standing Mass	Buried Mass	Buried Root Mass
Date	Operation	Crop	tons/acre	fraction	ft²/ft²	lbs/acre	lbs/acre	in	#/ac	fraction	ft²/ft²	lbs/acre		lbs/acre	lbs/acre
Sep 30-30, 05	Harvest, dig root crops res. burie	Potato, late, harvest	0.3	0.00	0.00	0	0	0	0	0.04	0.00	75	0	779	3439
Oct 1- 1, 05	Disk, offset, heavy Cultipacker, roller Drill or airseeder, double disk	Wheat, winter, CMZ 5(	0.1	0.00	0.00	1	54	0	890308	0.10	0.00	183	0	774	3304
Oct 2-14, 05	Irrigation (2 inch, Pivot, Linear, Wh		4.7	0.03	0.00	28	31	1	890308	0.09	0.00	168	0	679	3049
Oct 15-31, 05			11.2	0.08	0.00	77	69	1	890308	0.09	0.00	157	0	617	2857
Nov 1-14, 05			4.6	0.13	0.00	130	108	1	890308	0.09	0.00	153	0	592	2777

Figure 3.61. Portion of Detail Report showing high soil loss and low biomass after Potato year 5.

Let's get back to the high loss on the Potato year.
What is the highest period of loss in the Potato year? Answer: 'Oct 15-31, 05'.

What is the soil loss? Answer: 11.2 ton/ac (Figure 3.61).

Why is it high? Answer: After potatoes, there is only a small amount of residue as flat mass (157 lbs/ac) and the growing winter wheat is small (77 lbs/ac Leaf and Stem Mass).

Why did the residue go up as the field was tilled and planted to wheat (75 lbs/ac to 183 lbs/ac)? Answer: 108 lbs/ac of the 4218 lbs/ac buried residue (779 lbs/ac buried potato residue + 3439 lbs/ac buried root mass) was resurfaced when planting the winter wheat.

Add in another year of alfalfa

The producer reports that sometimes he adds another year of alfalfa to the rotation if the hay market is promising and the stand of alfalfa is OK. In this part of the exercise we will use some of the editing power of MCREW.

Step 1: Close any of the report screens you have open. From the main interface open the management editor. Scroll down the operation list until you get to the 'Mar 15, 04', *Irrigation, Start Monitor (Pivot, Linear, Wheelline)*. From there drag the mouse to highlight down to (not including) the Disk on 'Apr 10, 05'. The section should be blue now. Right click in the Operation column and select "Copy Row(s)". Now right click the Disk on 'Apr 10, 05' and paste the rows, by selecting "Paste Row(s)". You have now made a complete set of operations for year 4 of alfalfa. Note that the dates still have year 4 instead of year 5. Now with the group of cells still highlighted, right click the date column and select "Increment Year". Finally, highlight the Disk on 'Apr 10, 05' though the end of the file. Right click the date column and increment the year. The year should now be 06 for the potato crop year. We have added a year to the rotation so we must change the "Years in Rotation" box at the top of the editor screen from 5 to 6 (Figure 3.62).

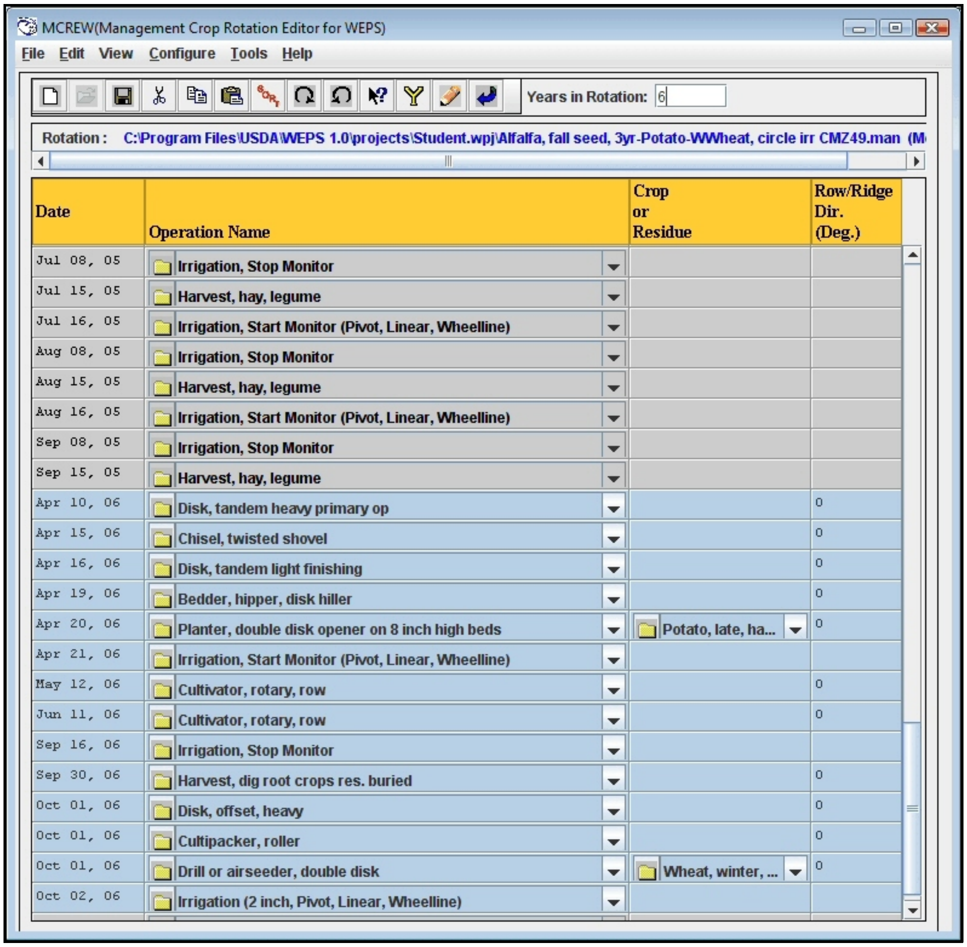
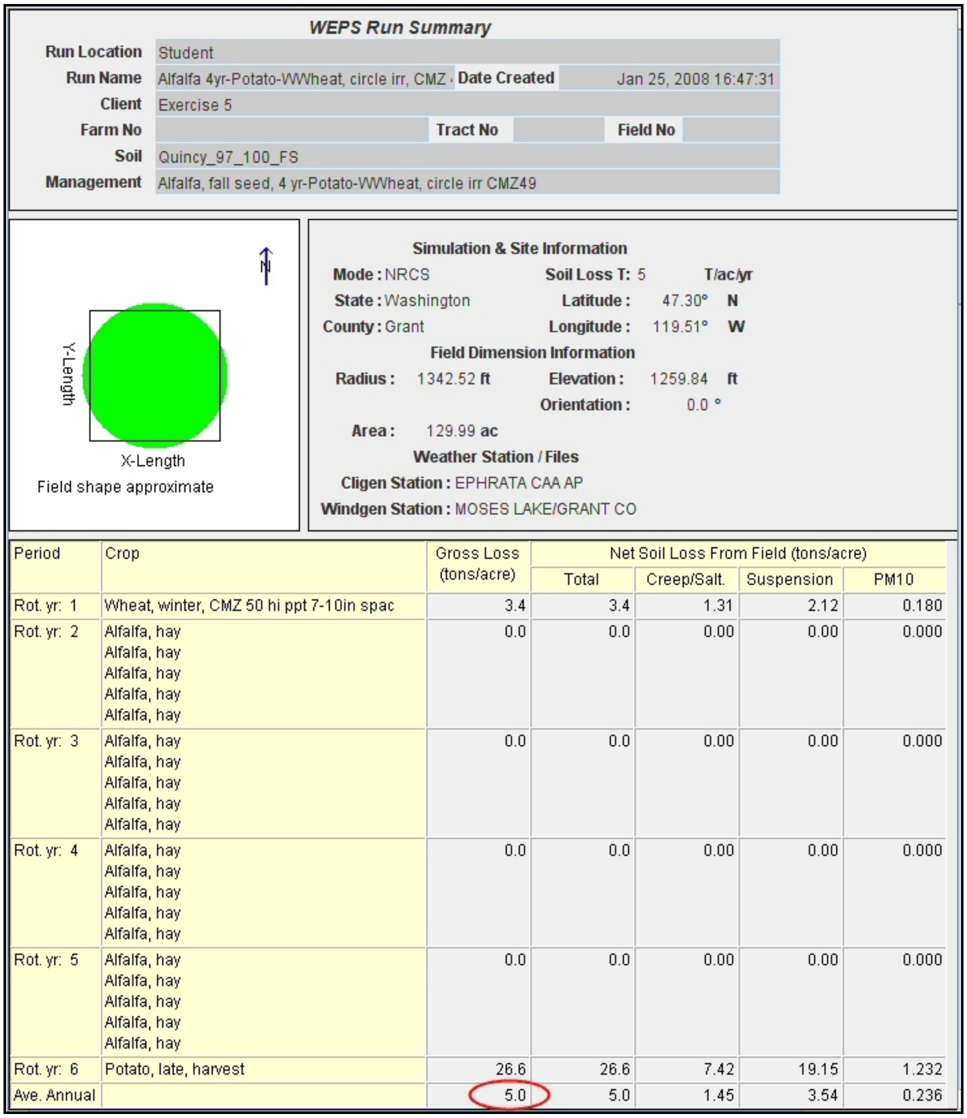


Figure 3.62. MCREW window after adding another year of alfalfa.

Once you are sure all the dates are sequential and are correct click 'File', Save as...', and name the file *Alfalfa, fall seed, 4yr-Potato-WWheat, circle irr CMZ49*.

Step 2: We can now make the run without calibration since we have saved the previous run and added back to the management file the Biomass Adjustment Factors for alfalfa (0.793), potatoes (1.225), and the winter wheat (1.225). Name this run ***Alfalfa 4yr-Potato-WWheat, circle irr CMZ 49***.

The results are shown in Figure 3.63. The erosion rate is now 5.0 tons/ac/yr, just at the Tolerable rate of 5 ton/acre/yr.



WEPS Run Summary

Run Location Student
Run Name Alfalfa 4yr-Potato-WWheat, circle irr, CMZ · **Date Created** Jan 25, 2008 16:47:31
Client Exercise 5
Farm No **Tract No** **Field No**
Soil Quincy_97_100_FS
Management Alfalfa, fall seed, 4 yr-Potato-WWheat, circle irr CMZ49

Simulation & Site Information
Mode : NRCS **Soil Loss T:** 5 **T/ac/yr**
State : Washington **Latitude :** 47.30° **N**
County : Grant **Longitude :** 119.51° **W**
Field Dimension Information
Radius : 1342.52 **ft** **Elevation :** 1259.84 **ft**
Orientation : 0.0 °
Area : 129.99 **ac**
Weather Station / Files
Cligen Station : EPHRATA CAA AP
Windgen Station : MOSES LAKE/GRANT CO

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Wheat, winter, CMZ 50 hi ppt 7-10in spac	3.4	3.4	1.31	2.12	0.180
Rot. yr: 2	Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay	0.0	0.0	0.00	0.00	0.000
Rot. yr: 3	Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay	0.0	0.0	0.00	0.00	0.000
Rot. yr: 4	Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay	0.0	0.0	0.00	0.00	0.000
Rot. yr: 5	Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay	0.0	0.0	0.00	0.00	0.000
Rot. yr: 6	Potato, late, harvest	26.6	26.6	7.42	19.15	1.232
Ave. Annual		5.0	5.0	1.45	3.54	0.236

Figure 3.63. Portion of Run Summary showing annual average soil loss.

Exercise 6 - New York: Tomato, Rye Cover Crop, and Plastic Mulch

Skill Building: In this exercise we will start with a template rotation. We will then add rye for winter cover and then plastic mulch to the basic run. This will give you a sense of value for these conservation practices. The picture below (Figure 3.64) is an example of plastic mulch with a rye cover crop (inter-furrow) and onions. Many times there will not be a cover between the rows. The current version of WEPS can not directly model temporary barriers (between the rows) or two crops growing at the same time like the one shown below in Figure 3.64, but can simulate these situations none-the-less.

Figure 3.64. Photograph of onions with plastic mulch and rye grown in the inter-row area.

We will model systems with cover crops planted either in the fall or spring and plastic mulch added to the field near or at planting time for the crop (in this case tomatoes). The mulch is accounted for in WEPS as special residue. Therefore we can grow any other crop with plastic mulch in place. We can count the green cover crop as residue when we plant the tomatoes if we place a 'kill crop' operation before planting the tomatoes. This means that even though the rye is still growing, WEPS will not show rye growth. WEPS will however show the amount of rye biomass as dead residue when the tomatoes are planted thus providing the intended protection.

Scenario: The field we are working on is in **Suffolk Co., New York**. The soil is **Riverhead Sandy Loam** (**Riverhead_RdA_80_LS.ifc**). The CLIGEN station is **Riverhead Research** and **Westhampton Beach** is the correct WINGEN station. The simulation region is **600 ft for the X-Length** and **1000 feet for the Y-Length** to give a field size of 13.8 acres. The field is oriented **-15.0 degrees** from true North (i.e., 345 degrees). The filed will produce tomatoes. The yield is: **300 cwt/ac** for the tomatoes. The field is tilled parallel to the long side of the field. The producer indicates that in some years there is wind and soil abrasion damage to the young tomato transplants if he does not place plastic mulch on the beds.

Step 1: Be sure you are in the Student project. From the main interface enter the information listed in the inventory. Click the Soil Project Folder button and select the soil ***(Riverhead_RdA_80_LS.ifc)***. Click the Management Project Folder button to select the ***Tomato, conv, no plastic Z65.man*** file. This is the management without the rye cover crop or the plastic mulch applied.

This management file has been calibrated to give near correct yields of the crops. You can check by clicking the Yield Calibrate button in the management window and scroll left to the Biomass Adjustment Factor column. If the number in the column is other than 1.0, this indicates that the crop and the management file has already been calibrated. In case it is missing, it should be changed for tomato to 0.64.

Step 2: Check the management window to see if the tillage is parallel to the orientation of the field.

What is the current row/ridge direction value of all the tillage? Answer: 0 degrees from true North.

What is the value we are looking for? Answer: -15 degrees.

Why? Answer: Because the field is oriented -15 degrees from true North (i.e., 345^{o}).

Highlight all the rows in the management file by clicking the header of the 'Row/Ridge Dir. (Deg.)' column. Then right click the column and click 'Decrement 15 deg'. This will set all the tillage to be the same as the field orientation mentioned in inventory (i.e., -15). Leave the editor and save the changes to the current file (see Figure 3.65).

Step 3: Make the run and save it as ***Tomato, conv, no plastic, Z65***.

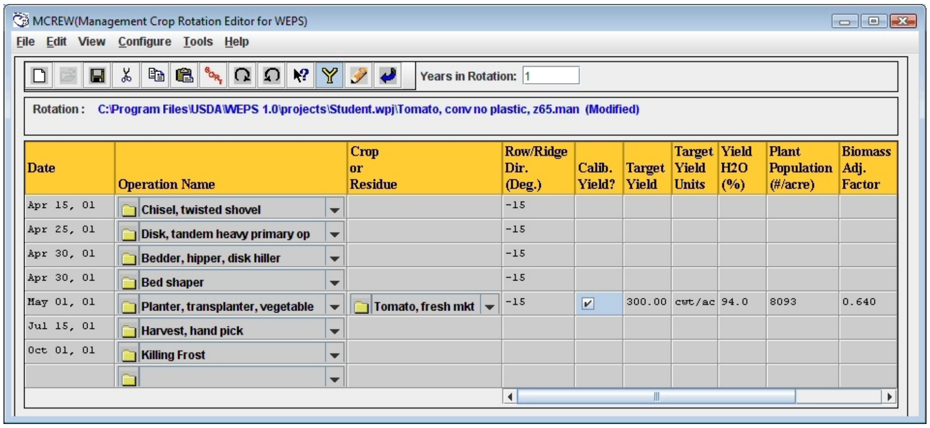


Figure 3.65. Management for the initial run.

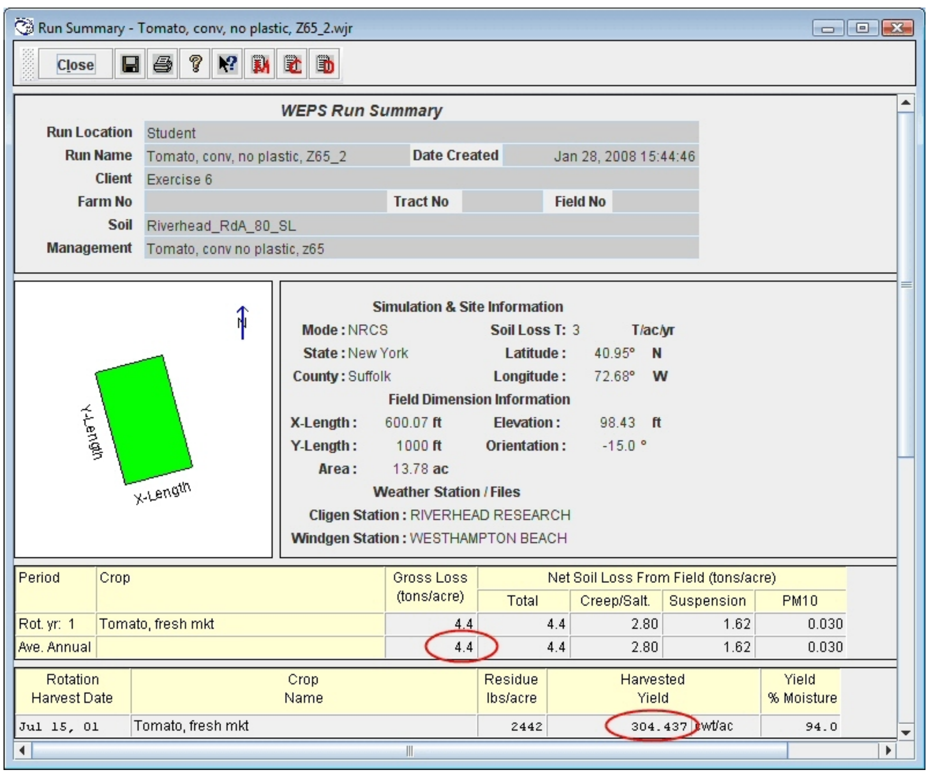


Figure 3.66. Run Summary showing soil loss and yields near the expected values.

Is the yield close? Answer: Yes, at 304 cwt/ac, see Figure 3.66.

What is the erosion rate? Answer: 4.4 ton/ac. This is above the tolerance for tomatoes (see Table 3.? in the Exercises Introduction) so we sill see the effect of a rye cover crop.

Add in the Rye Cover Crop after Tomato

Step 1: Right click the killing frost operation row and change the operation to Drill or airseeder, double disk. Select Rye, winter cover for the crop to be planted. Change the date to Aug. 1, 01 for this planting. Now insert a light disk 5 days after harvest (Disk, tandem light finishing, Jul 20, 01). Save the file with a new name. Save the file with a new name by clicking ‘File’, ‘Save as...’, and enter **Tomato, cover-Soybean-Corn, cover, Conv CMZ67.man**. Click the blue Return button .

Step 2: Make the run and call it, **Tomato, cover, conv Z65**.

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Tomato, fresh mkt	1.2	1.2	0.78	0.45	Trace
Ave. Annual		1.2	1.2	0.78	0.45	Trace

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Jul 15, 01	Tomato, fresh mkt	2546	317.961	cwt/ac	94.0

Figure 3.67. Portion of the Run Summary showing soil loss after adding the rye cover crop.

What is the soil loss now? Answer: It is 1.2 ton/ac (Figure 3.67).

What period of the year has the erosion problem? Answer, May 1-14, 01 (Figure 3.68).

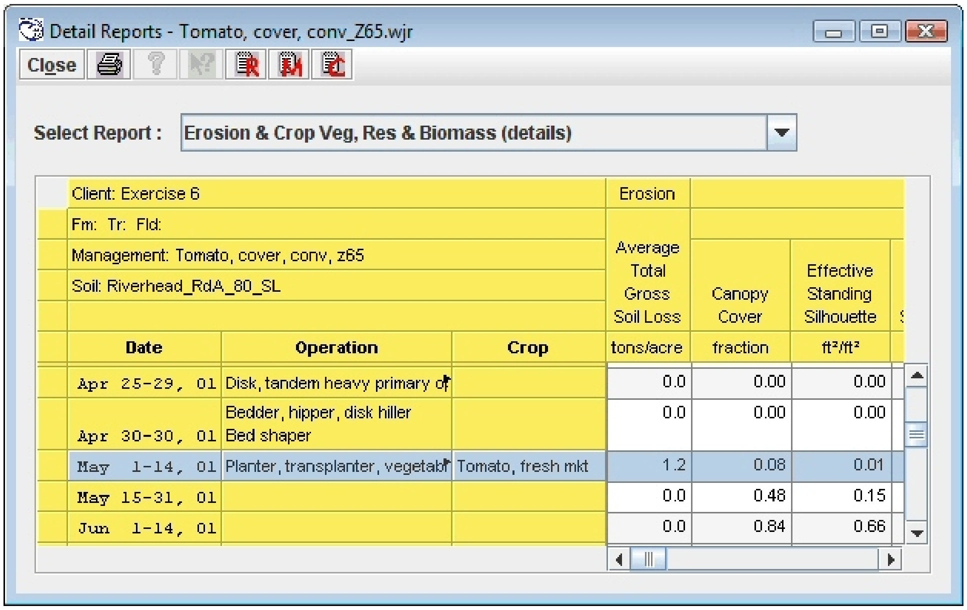


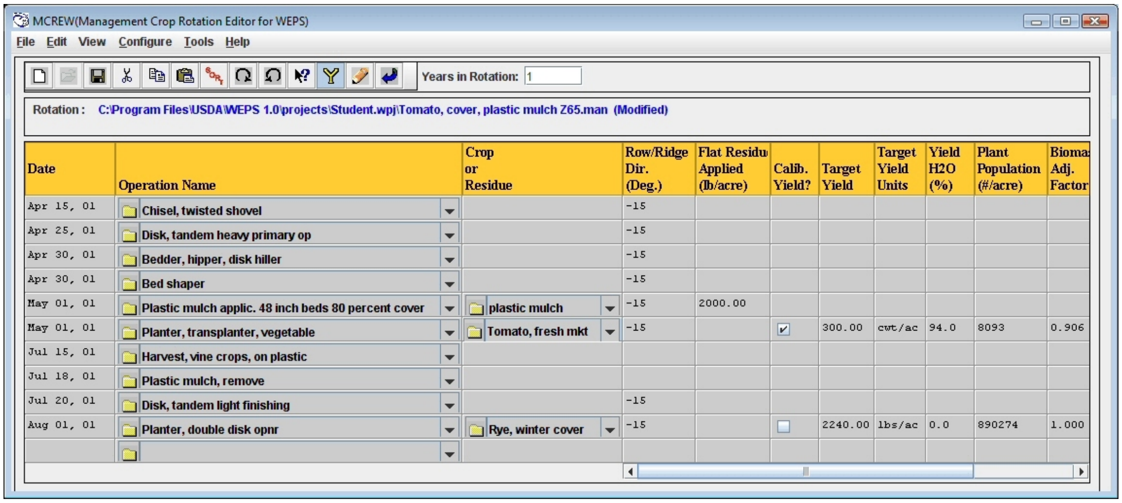
Figure 3.68. Portion of the Detail Report showing soil loss after planting tomatoes.

Add Plastic Mulch

Is there an apparent need for plastic mulch indicated by the Run Summary?

Answer: Yes. The NRCS National Agronomy Manual, Crop Tolerance to Blowing Soil table lists tomatoes in the 'Very Low Tolerance' category (See Table 3.? in the Exercises Introduction) . Also, the producer stated that there is a problem some years with blowing soil damage to the young tomato plants. The 1.3 ton/ac value is an average over many years of the simulation. Some years may have higher and some may have lower erosion, with the higher erosion years causing more damage to the tomatoes. As resource planners we must also listen to the producer to determine whether a practice is needed or not.

Step 1: Close any reports you have open and click the 'Man' button to open MCREW. You should see the **Tomato, cover, conv Z65.man** management file. First save the file as **Tomato, cover, plastic mulch Z65**. Right click in the operation column on the 'May 01, 01', **Planter, transplanter, vegetable operation**. Select 'Insert operation'. Select **Plastic mulch applic. 48 inch beds 80 percent cover;** make the date 'May 01, 01'. The mulch application requires a Crop or Residue - select 'Plastic mulch'. Be sure to set the angle of tillage to -15 degrees. Now move to and right click 'Jul 20, 01' **Disk, tandem light finishing.** In the operation column, right click and 'Insert an operation' **Plastic mulch, remove,** and make the date 'Jul 18, 01'. Last, change the harvest operation for the tomatoes to **Harvest, vine crops, on plastic**. The completed management file should appear as in Figure 3.69.



Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)	Flat Residu Applied (lb/acre)	Calib. Yield?	Target Yield	Target Yield Units	Yield H2O (%)	Plant Population (#/acre)	Bioma Adj. Factor
Apr 15, 01	Chisel, twisted shovel		-15							
Apr 25, 01	Disk, tandem heavy primary op		-15							
Apr 30, 01	Bedder, hipper, disk hiller		-15							
Apr 30, 01	Bed shaper		-15							
May 01, 01	Plastic mulch applic. 48 inch beds 80 percent cover	plastic mulch	-15	2000.00						
May 01, 01	Planter, transplanter, vegetable	Tomato, fresh mkt	-15		✔	300.00	cwt/ac	94.0	8093	0.906
Jul 15, 01	Harvest, vine crops, on plastic									
Jul 18, 01	Plastic mulch, remove									
Jul 20, 01	Disk, tandem light finishing		-15							
Aug 01, 01	Planter, double disk opnr	Rye, winter cover	-15		☐	2240.00	lbs/ac	0.0	890274	1.000

Figure 3.69. Management with rye cover and plastic mulch added.

Note: Before you leave the editor that a default Flat Residue Amount of 2000 lbs/ac has been applied to the land the day that the plastic is applied. In version 1.0 we are applying plastic as a high biomass amount of residue for WEPS to simulate no erosion while the plastic is in place. If the inter-furrow area does not have a cover there could be additional erosion occurring that is not a counted for.

Step 2: Click the blue Return button to return to the main interface. Make the run and call it **Tomato, plastic mulch, cover Z65.**

The Run Summary shows a significant decrease in soil loss (Figure 3.70). With the plastic mulch in place only a trace of wind erosion shows up on the run summary report. Notice though by using the plastic and the cover crop our yield has grown to 324 cwt/ac, this is 20 cwt/ac more than the first calibrated run. If you recalibrated the run it would not raise the erosion above a trace. The obvious benefit of the mulch is that the tomatoes are not damaged using the plastic, the yield is higher, and the crop does not have to be replanted.

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Tomato, fresh mkt	Trace	Trace	0.05	Trace	Trace
Ave. Annual		Trace	Trace	0.05	Trace	Trace

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Jul 15, 01	Tomato, fresh mkt	2597	324.702	cwt/ac	94.0

Figure 3.70. Portion of the Run Summary after adding rye cover crop and plastic mulch.

Exercise 7 - New Mexico: Irrigated Corn Silage, Add Manure and a Winter Forage Crop

Skill Building: In this exercise we will start with a blank management and add the operations from scratch. Corn silage is a low residue crop from the wind erosion standpoint because most of the biomass is harvested. We will add manure from a dairy and add winter wheat, cut for silage in the spring.

Inventory: The location of the dairy is in **Curry Co., New Mexico**, just south of Clovis. The correct CLIGEN station is **CLOVIS 13N**, and the correct WINDGEN station is **CANNON AFB/CLOVIS**. This field is an irrigated **half circle** on the west half of a quarter section of land. It is **62.7 acres** (see soils maps in Figures 3.77, 3.78, 3.79). The soil is an Amarillo loamy fine sand: **Amarillo_AnB_85_LFS**. The producer has a Compressive Nutrient Management Plan that requires him to **apply 15 ton/ac of very dry manure, 25% moisture by weight** (15 tons/ac x 2000 lbs/ton = 30,000 lbs/ac wet wt. or 30,000 lbs/ac x 0.75 = 22,500 lbs/ac on a dry weight basis). The option of fall application exists since there is no surface or ground water near the dairy and little rainfall runoff over the winter. Spring application fits the work schedule. A Low Elevation Spray Application (LESA) nozzle package on the pivot can meet the Consumptive Use of both crops, corn and winter forage.

The field wet weight yield for the **corn silage is 23 ton/ac** at 65% moisture. The wet weight for the **winter wheat silage is 7 ton/ac** at about 70% moisture.

Table 3.3 System operations for corn silage alone.

Date	Operation	Crop	Flat Residue Amt Added (lbs/ac)
May 1	Manure spreader, solid and semi-solid manure, semi-solid		22,500
May 15	Disk, offset, heavy		
May 18	Cultivator, field 6-12 in sweeps		
May 20	Planter, double disk opener	Corn, silage	
May 21	Irrigation, Start Monitor (Pivot, Linear, Wheelline)		
Sep 1	Irrigation, Stop Monitor		
Sep 20	Harvest, silage		
Sep 25	Disk, tandem heavy primary operation		

The amount of residue added (22,500 lbs/ac) contains some fairly fine, quickly decomposable organic material. This organic material will have a long-term impact on soil quality.

Table 3.4 Additional operations for the winter wheat silage.

Date	Operation	Crop	Flat Residue Amt Added (lbs/ac)
Mar 1	Irrigation, Start Monitor (Pivot, Linear, Wheelline)		
Apr 12	Irrigation, Stop Monitor		
Apr 12	Harvest, silage		
Oct 3	Drill or airseeder, double disk	Wheat, winter silage	

Let's get started by making a run where no manure is applied.
Step 1: Enter all the information listed above on the main interface. In the Simulation Region Information box under the Shape pull down, select the 'Half Circle VW' to indicate the vertical west half of a circle. Enter the 62.7 acres from the digitized soils map (Figures 3.77, 3.78, 3.79). In the soil section, click the 'Project Folder' button and select the **Amarillo_AnB_85_LFS.ifc** soil.

Step 2: Open up the management editor and enter all the operations listed above (Table 3.3) one at a time (Figure 3.71). This will give you a feel for why it is a good idea to create a template for most of the management systems that are commonly used in your area. Click 'File', 'Save as...', and call it, **Corn, silage, conv, no manure, pivot CMZ19.man**. Click the Return button to leave the editor.

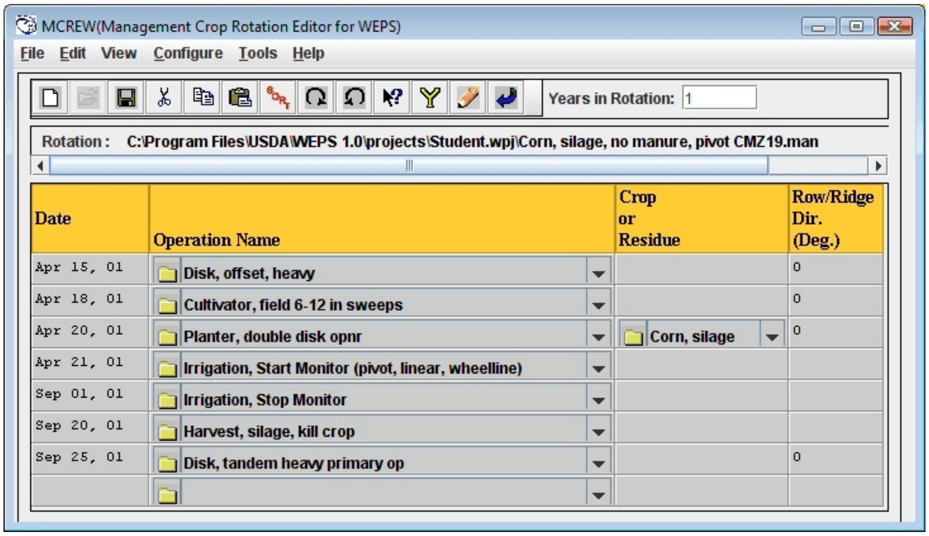


Figure 3.71. The Management rotation for 'Corn, silage, conv, no manure, pivot, CMZ10'.

Step 3: Click the Run button and call the run **Corn, silage, conv, no manure, pivot CMZ19.**

Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre) Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Corn, silage	>100	>100	43.16	61.62	1.944
Ave. Annual		>100	>100	43.16	61.62	1.944

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Sep 20, 01	Corn, silage	287	20.175	ton/ac	65.0

Figure 3.72. Portion of the Run Summary for 'Corn, silage, conv, no manure, no fall till, pivot, CMZ10'.

What is the yield of silage? Answer: 20.2 ton/ac (Figure 3.72). This is close enough to the 23 ton/ac mentioned in the inventory.

How much soil loss was calculated? Answer: >100 ton/ac (Figure 3.72).

Add Manure in the Spring

Step 1: Open the management editor and right click the operation cell on the first line, click 'Insert Operation' and select **Manure spreader, solid and semi-solid**. Set the date to 'Apr 1, 01'. Now in the Crop or Residue column, select **manure, semi-solid**. Move to the Total Manure Applied column, and type in the 22,500 lbs/ac manure applied in the spring (Figure 3.73). Now, click 'File', 'Save As...', and save the file as **Corn, silage, conv, spring**

manure, pivot CMZ19.man. Finally, click the 'Return' button to return the main interface.

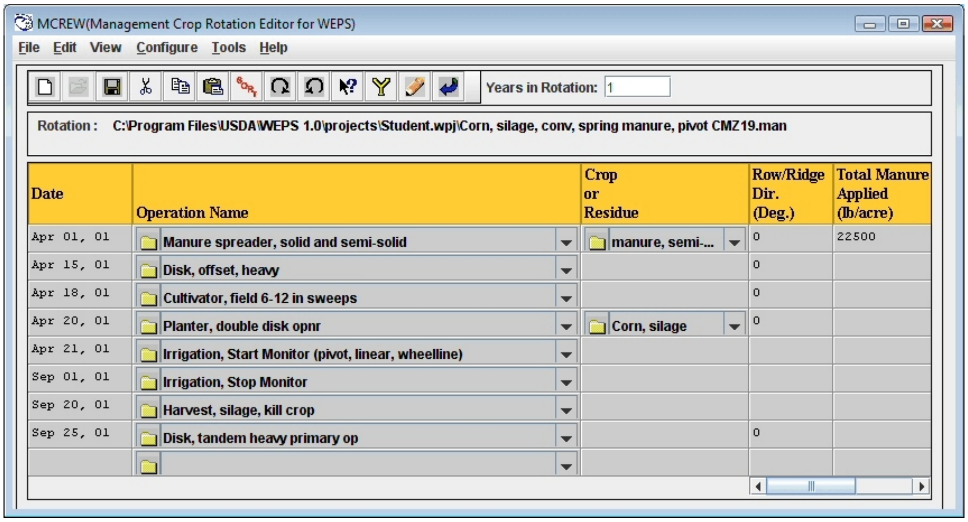
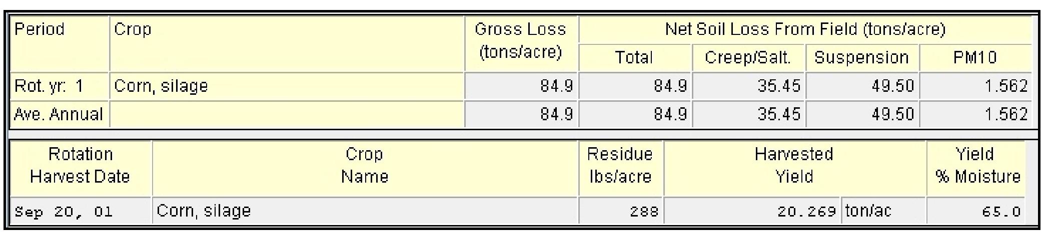


Figure 3.73. The Management rotation for 'Corn, silage, conv, spring manure, pivot, CMZ10'.

Step 2: Click the Run button on the main toolbar to make the run. Call it: **Corn, silage, conv, spring manure, pivot CMZ19**.

What is the soil loss with the manure applied in the spring and tilled in? Answer: 85 ton/ac (Figure 3.74).

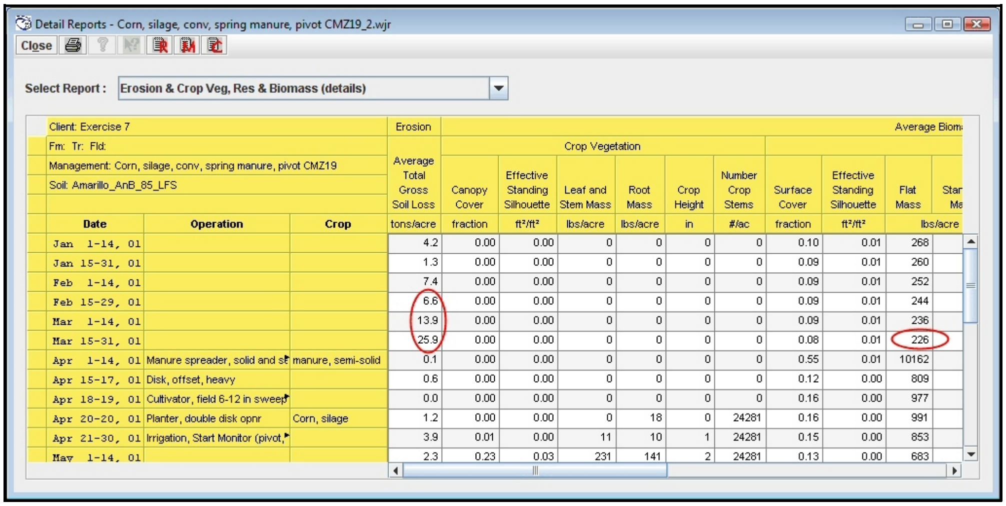


Period	Crop	Gross Loss (tons/acre)	Net Soil Loss From Field (tons/acre)			
			Total	Creep/Salt.	Suspension	PM10
Rot. yr: 1	Corn, silage	84.9	84.9	35.45	49.50	1.562
Ave. Annual		84.9	84.9	35.45	49.50	1.562

Rotation Harvest Date	Crop Name	Residue lbs/acre	Harvested Yield		Yield % Moisture
Sep 20, 01	Corn, silage	288	20.269	ton/ac	65.0

Figure 3.74. Portion of the Run Summary for 'Corn, silage, conv, spring manure, pivot, CMZ10'.

When and where are the high erosion trouble spots? Answer: March is the big month with 40 ton/ac occurring in March, just before the manure is applied. March also has a large value for the Wind Energy at 6,069 KJ/m^2/day and the lowest Flat Mass at 226 lbs/ac (Figure 3.75).


Detail Reports - Corn, silage, conv, spring manure, pivot CMZ19_2.wjr

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Client: Exercise 7
Fm: Tr: Fld:
Management: Corn, silage, conv, spring manure, pivot CMZ19
Soil: Amarillo_AnB_85_LFS

Date	Operation	Crop	Erosion: Average Total Gross Soil Loss	Crop Vegetation: Canopy Cover	Crop Vegetation: Effective Standing Silhouette	Crop Vegetation: Leaf and Stem Mass	Crop Vegetation: Root Mass	Crop Vegetation: Crop Height	Crop Vegetation: Number Crop Stems	Average Biom: Surface Cover	Average Biom: Effective Standing Silhouette	Average Biom: Flat Mass	Average Biom: Star Ma
			tons/acre	fraction	ft²/ft²	lbs/acre	lbs/acre	in	#/ac	fraction	ft²/ft²	lbs/acre	
Jan 1-14, 01			4.2	0.00	0.00	0	0	0	0	0.10	0.01	268	
Jan 15-31, 01			1.3	0.00	0.00	0	0	0	0	0.09	0.01	260	
Feb 1-14, 01			7.4	0.00	0.00	0	0	0	0	0.09	0.01	252	
Feb 15-29, 01			6.6	0.00	0.00	0	0	0	0	0.09	0.01	244	
Mar 1-14, 01			13.9	0.00	0.00	0	0	0	0	0.09	0.01	236	
Mar 15-31, 01			25.9	0.00	0.00	0	0	0	0	0.08	0.01	226	
Apr 1-14, 01	Manure spreader, solid and se	manure, semi-solid	0.1	0.00	0.00	0	0	0	0	0.55	0.01	10162	
Apr 15-17, 01	Disk, offset, heavy		0.6	0.00	0.00	0	0	0	0	0.12	0.00	809	
Apr 18-19, 01	Cultivator, field 6-12 in sweep		0.0	0.00	0.00	0	0	0	0	0.16	0.00	977	
Apr 20-20, 01	Planter, double disk opnr	Corn, silage	1.2	0.00	0.00	0	18	0	24281	0.16	0.00	991	
Apr 21-30, 01	Irrigation, Start Monitor (pivot,		3.9	0.01	0.00	11	10	1	24281	0.15	0.00	853	
May 1-14, 01			2.3	0.23	0.03	231	141	2	24281	0.13	0.00	683	

Figure 3.75. The Detailed report for 'Corn, silage, conv, spring manure, pivot, CMZ10' showing soil loss and flat mass.

Add the Winter Wheat Forage Crop

Step 1: Close all reports and reopen the management editor. Add to the existing system, the additional operations for the winter wheat silage listed in Table 3.4. Hint: These can be added to the end of the run and sorted or inserted. When you have them entered and sorted, then click 'File', 'Save as...', and enter the management name as: **Corn, silage-WWheat, silage, conv, spring manure, pivot CMZ19.man**. Close the editor and return to the main interface.

Step 2: Make the run and call it, **Corn, silage-WWheat, silage, conv, spring manure, pivot CMZ19**.

How does the soil loss look now? Answer: 5.7 ton/ac. By harvesting less silage for each crop, the soil loss may be reduced below "T".

The yield has dropped off for the corn, silage to 18.6 ton/ac. This may be a little low, but remember forage crops, including winter wheat cut for silage, can not be calibrated. If you have trouble with this, contact your NRCS State Wind Erosion Specialist or the ARS Wind Erosion Research Unit in Manhattan, Kansas.

At the end of the run, some warnings are generated (Figure 3.76). These warnings tell you that the winter wheat did not reach maturity. This is because, as silage, we harvested it before it finished it's growth cycle.

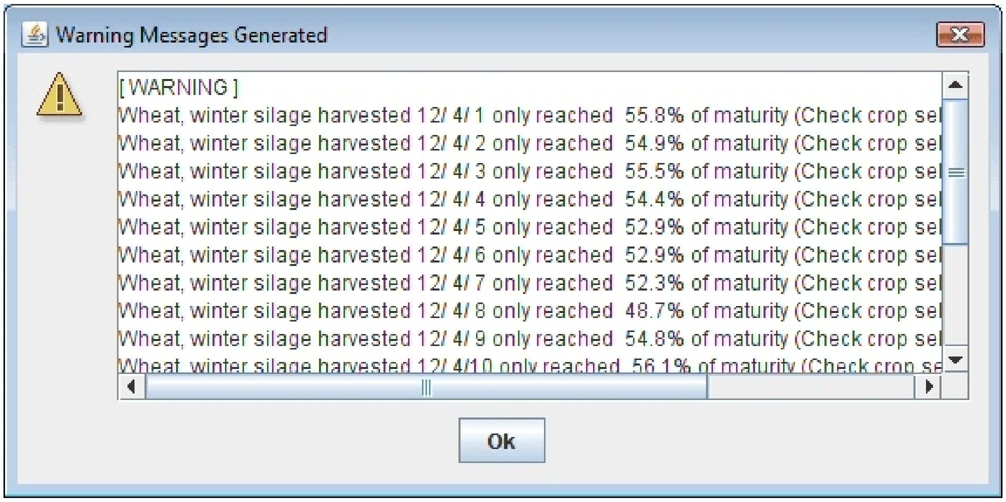


Figure 3.76. Warnings generated after addition of winter wheat silage to the rotations.

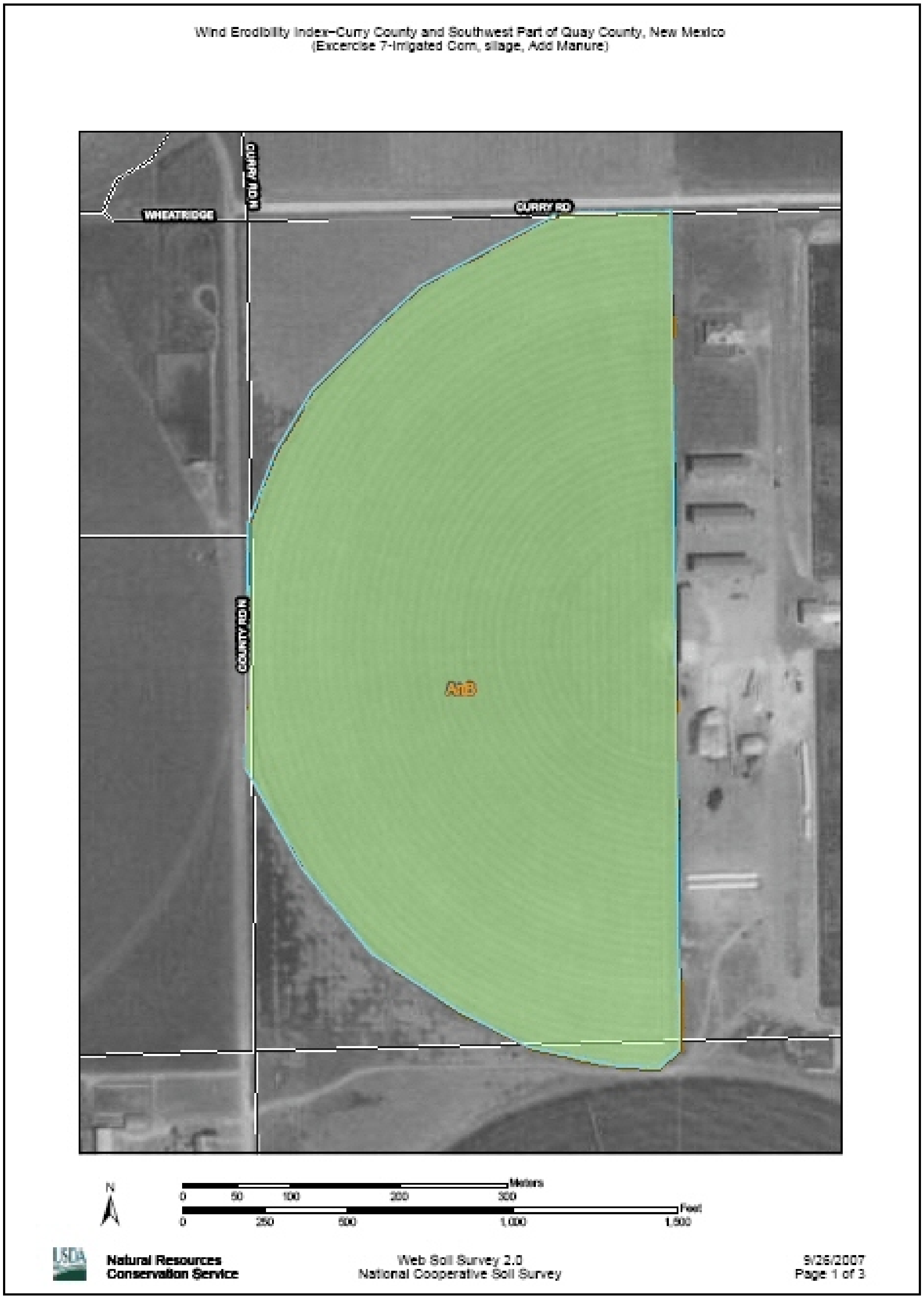
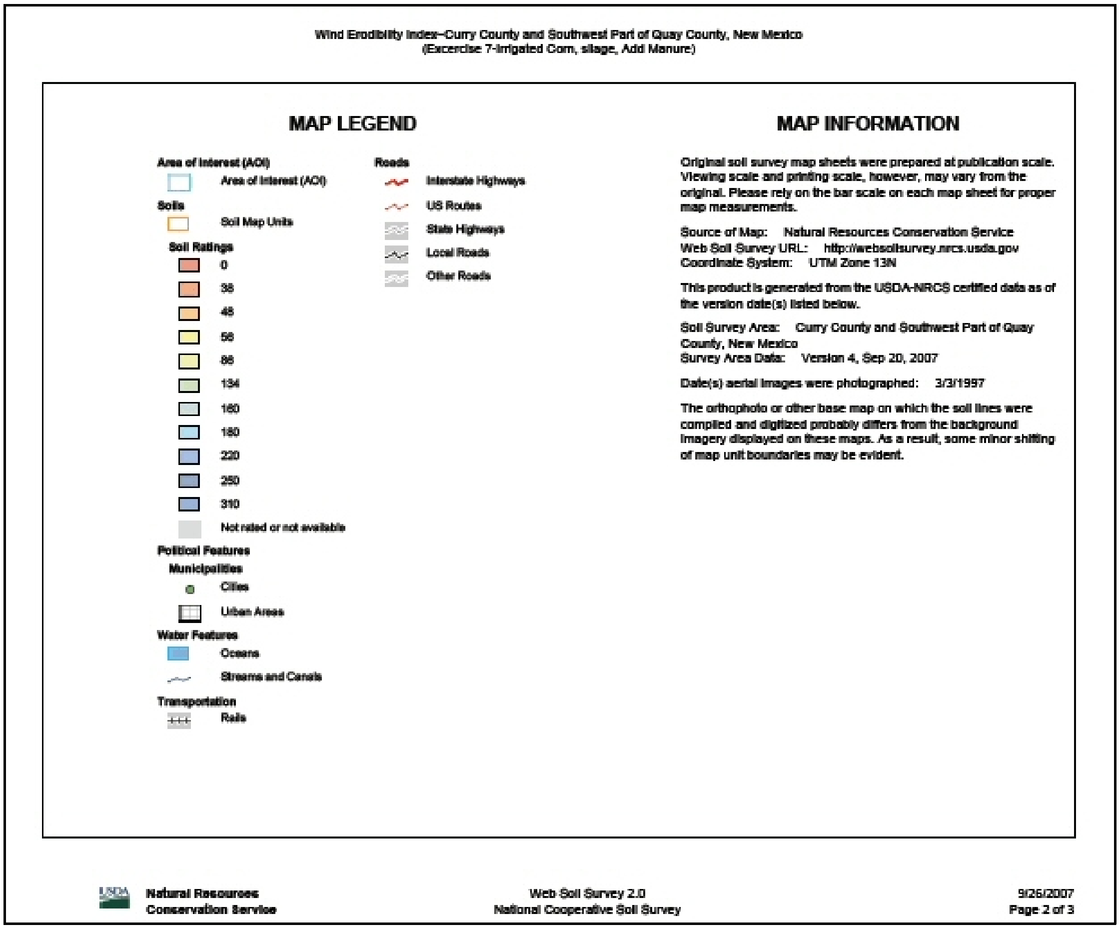


Figure 3.77. Map of the field for Exercise 7.



Wind Erodibility Index–Curry County and Southwest Part of Quay County, New Mexico
(Excercise 7-Irrigated Corn, silage, Add Manure)

MAP LEGEND

Area of Interest (AOI)
Area of Interest (AOI)
Soils
Soil Map Units
Soil Ratings
0
38
48
56
86
134
160
180
220
250
310
Not rated or not available
Political Features
Municipalities
Cities
Urban Areas
Water Features
Oceans
Streams and Canals
Transportation
Rails
Roads
Interstate Highways
US Routes
State Highways
Local Roads
Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Curry County and Southwest Part of Quay County, New Mexico
Survey Area Data: Version 4, Sep 20, 2007

Date(s) aerial images were photographed: 3/3/1997

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Natural Resources Conservation Service
Web Soil Survey 2.0
National Cooperative Soil Survey
9/26/2007
Page 2 of 3

Figure 3.78. Map Legend and Map Information for the field in Exercise 7.

Wind Erodibility Index–Curry County and Southwest Part of Quay County, New Mexico

Excercise 7-Irrigated Corn, silage, Add Manure

Wind Erodibility Index

Wind Erodibility Index— Summary by Map Unit — Curry County and Southwest Part of Quay County, New Mexico				
Map unit symbol	Map unit name	Rating (tons per acre per year)	Acres in AOI	Percent of AOI
AnB	Amarillo loamy fine sand, 1 to 3 percent slopes	134	62.7	100.0%
Totals for Area of Interest (AOI)			62.7	100.0%

Description

The wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Rating Options

Units of Measure: tons per acre per year

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

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Figure 3.79. The Wind Erodibility Index table for Exercise 7.

Exercise 8 - Critical Dominate Soil

Skill Building: WEPS version 1.0 is able to estimate only one soil map unit in a field at a time. It is recommended that the user select the most erodible soil of a "manageable size". This is called the "Critical Dominate Soil".

The most erodible soil can be considered to be the one with the highest percentage of sand. Calcareous soils will be more erodible than non-calcareous (<15% calcium carbonate) at the same texture class. For example, a fine sandy loam will be more susceptible to erosion than a loam. Bottom-line: Take a look at the soils first when running WEPS.

Example: Consider the soil map of a field in Grant Co., Washington. There are three map units in the half circle (Figure 3.80). A good rule of thumb would be to use the most erodible soil greater than 10% of the field or greater than 10 acres in size (i.e., a manageable size).

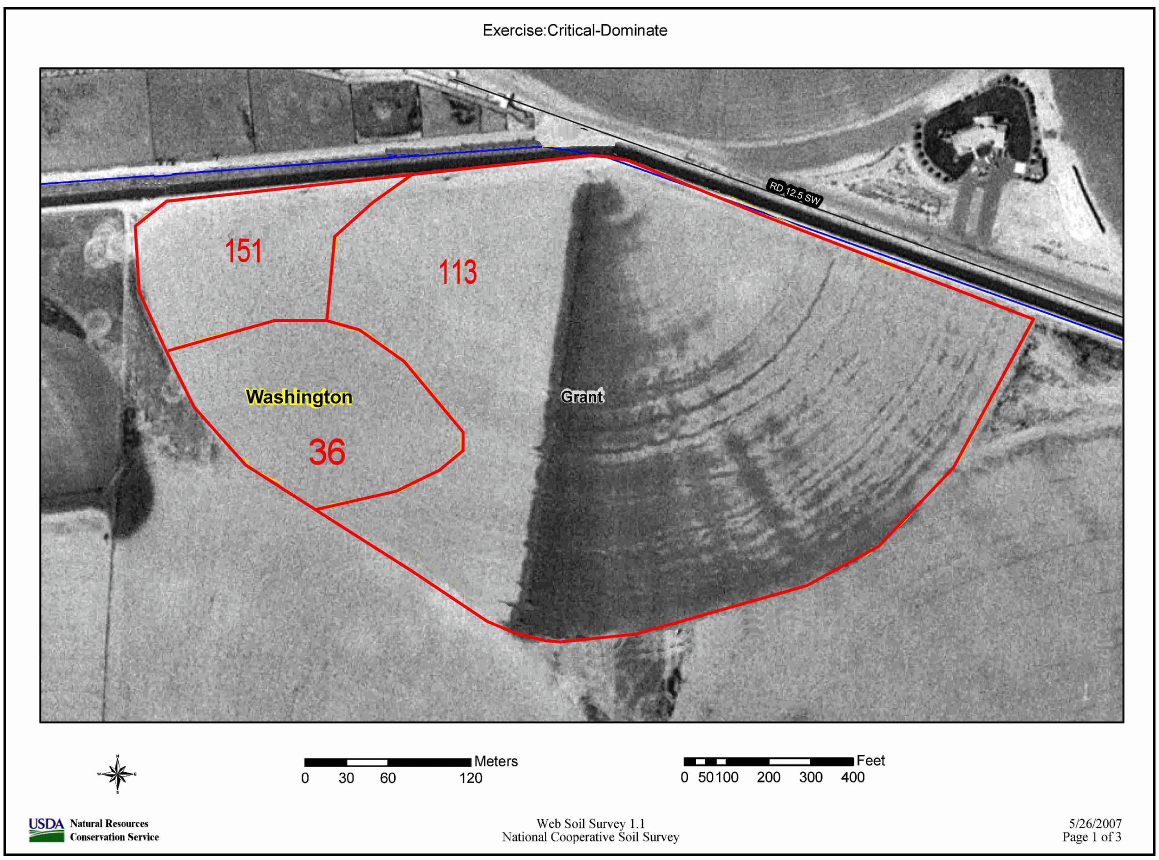

Figure 3.80. Map of the field for Exercise 8.

Soil Survey of Grant County, Washington — Exercise:Critical-Dominate

Map Unit Legend Summary

Grant County, Washington

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
36	Ekrub fine sand, 0 to 25 percent slopes	4.5	11.5
113	Royal loamy fine sand, 0 to 10 percent slopes	30.4	77.2
151	Taunton loamy fine sand, 0 to 10 percent slopes	4.4	11.3

Figure 3.81. Map Unit Legend Summary for the field in Exercise 8.

The total of the field is 39.3 acres.

Question: What soil should be used to estimate the soil loss?

Answer: From Figure 3.81 we see that the Royal loamy fine sand (map unit 113) and Taunton loamy fine sand (map unit 151), comprise the majority field with 88.5% of the area. The Ekrub fine sand (map unit 36) makes up 11.5% of the area. However the Ekrub fine sand should be used because it is the most erodible and greater than 10% of the field and it is upwind of the damaging westerly spring winds.

Exercise 9 - Selecting the correct simulation region, X-length and Y-length

Skill Building: The X-length is the **longest** (one direction) distance from a stable boundary to the opposite site of the field. The Y-length is the **longest** (90 degrees to the X-length) distance from a stable boundary to the opposite side of the field. These are the **unsheltered distances** WEPS will use to calculate the erosion rate. A **stable boundary** is one that stops surface creep and saltation phases of wind erosion. A grass strip at least 13 ft wide and 1.5 foot high would be an example of a stable boundary. Vegetation width, height, and porosity are to be considered in declaring a stable boundary.

This exercise will assist the user to set the correct distance for the X-length and the Y-length in the Simulation Region of the main WEPS interface window.

Scenario: See Figure 3.82. A 40 acre field (tan) is to be evaluated for wind erosion. The remaining land (green) is not controlled by the 40 ac owner and the management on the remaining land cannot be controlled by the owner of the 40 acre tract. The remaining land may however contribute to the wind erosion process on the 40 acre field. The green land (one section in size, 640 ac) has a road on all sides with a 50 ft band of green vegetation (grass 1.5 ft tall perimeter buffer). The non-erodible buffer is represented in dark brown. Both the 40 acres and the remaining 600 acres are farmed in a winter wheat-summer fallow, conventional tillage rotation.

Question - What is the correct X-length and Y-length to evaluate or enter in the Simulation Region Information panel on the WEPS interface?

A. Y=1320 ft by X=2640 ft,
B. Y=3960 ft by X=5280 ft,
C. Y=1320 ft by X=1320 ft, or
D. Y=5280 ft by X=5280 ft

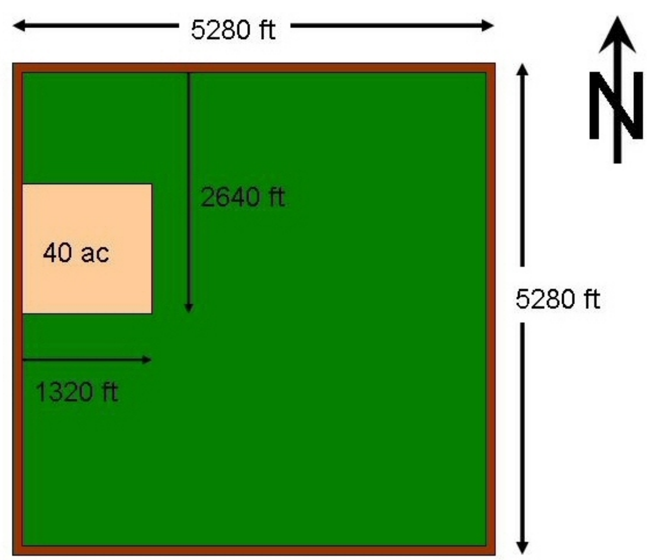

Figure 3.82. Field diagram for Exercise 9.

Answer: B. Because the management outside the field is not controlled by the same owner for conservation planning purposes, the unsheltered distance should be the **longest distance** from a stable boundary through the length of the field to the down-wind edge of the field. On the X axis the longest distance (X-Length) would start at the East boundary and extend West all the way though the 40 acre field (5280 ft.). On the Y axis the longest distance (Y-Length) would start at the South boundary and extend North all the way though the 40 acre field (3960 ft.). Therefore the dimensions (X-Length, L-Length, and acres) entered on the WEPS interface will be larger than the actual field for this scenario.

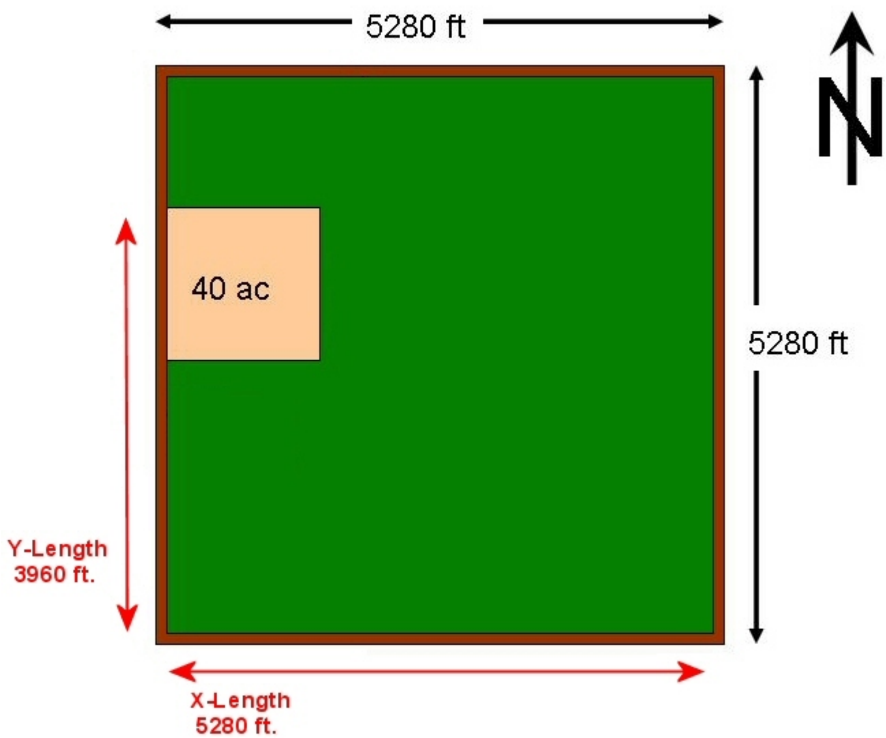

Figure 3.83. Field diagram showing correct field lengths for Exercise 9.

SCIENCE OVERVIEW

WIND EROSION PREDICTION SYSTEM

Interface Implementation and Science Model

Interface

This section describes the WEPS 1.0 User Interface program implementation and how it interacts with the WEPS science model. The WEPS 'science' model refers to the computer code and executable program that performs the actual calculations of field conditions and erosion processes for a simulation run. A simple flow diagram of the WEPS science model and User Interface is shown in Figure 4.1. A detailed description of how to operate the WEPS 1.0 User Interface is described elsewhere in the WEPS User's Guide in a chapter titled 'Interface Reference'.

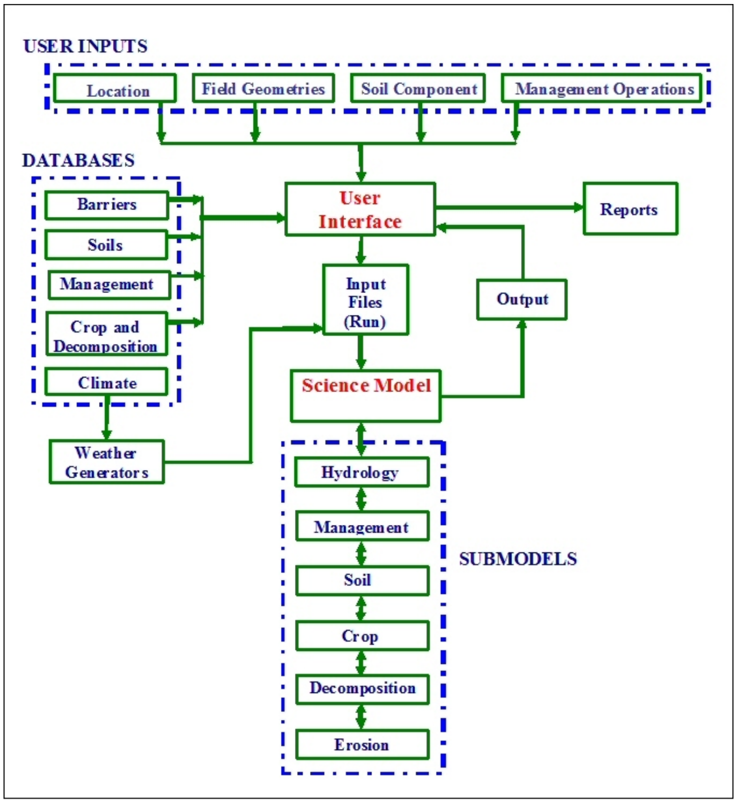

Figure 4.1. A flow diagram of the WEPS science model and User Interface.

A simplified description of the science model is provided later in this chapter. The inputs to the science model reside in a series of ASCII input files. These input files are: a Windgen file (*.win), a Cligen file (*.cli), an initial field conditions file (*.ifc), a management file (*.man), and a run file (weps.run). The science model can be executed from the command line or through the interface. When WEPS is executed, the science model reads the input files, calls each submodel performing daily time-step simulations, and writes output files. The output is written to one or more ASCII files. Building input files by hand, executing the model on the command line, and interpreting the output files can be time consuming and confusing; the WEPS 1.0 User Interface simplifies this process.

The WEPS 1.0 User Interface is written in Java. The interface can be thought of as a 'shell' or 'wrapper' around the science model, which does not affect the execution of the science model. Through the interface program, the user can easily enter the information necessary to create and edit the input files. A description of how to enter this information is given elsewhere in the WEPS User's Guide in a chapter titled 'Interface Reference'. Once the field, location, soil, and management are described, pressing the 'Run' button performs a series of commands to execute the science model. The interface first calls the CLIGEN and WINDGEN weather generators, which create the WINDGEN and CLIGEN files for the simulation. Then the WEPS science model is called and executed as described earlier. When the science model is finished, the interface reads and displays the output.

Main Program

The MAIN program is the portion of the science model that controls the initialization and execution of a WEPS simulation run. It calls subroutines that read input data and generates the summary and other reports. In addition, MAIN calls submodels on a daily basis, which update the field conditions. If the maximum wind speed for the day exceeds a set velocity great enough to cause soil movement (i.e., 8 m/s or 18 mi/hr), MAIN then calls the EROSION submodel to simulate erosion processes. The current version of WEPS reads in the climate data produced by the WEATHER submodel; performs daily simulation of the hydrologic and soil conditions, crop growth, and residue decomposition; and accounts for management effects. Finally, the model determines soil erosion by wind for the desired simulation period.

Program Description

The current version of MAIN requires the following files for a WEPS simulation run: a) a simulation run file that describes the field shape and barriers, simulation period, location of other input files, and types of output ; b) an initial field conditions file that describes soil conditions at the start of a simulation; d) a tillage/management file that describes the management system; and e) two climate files, one each in the CLIGEN and WINDGEN formats, that provide climate data on a daily basis.

The MAIN program begins by initializing local variables and then calls the subroutine INPUT, which reads the simulation run file and the initial field conditions file. The simulation then is executed as a daily loop that controls the counters for the current day. The model can perform any length of simulation on a daily time step, but WEPS performs a simulation for one rotation cycle to initialize surface conditions before simulations of wind erosion are performed. For each simulation day, the daily weather is read from the CLIGEN and WINDGEN data files. As some of the submodels are executed, summary information may be compiled for output. All submodels except EROSION are called within the subregion loop. Once field conditions are updated, if maximum wind speed for the day exceeds a set minimum (i.e., 8 m/s), the EROSION submodel then is called to determine threshold conditions and compute soil erosion. Finally, the MAIN program calls routines to account for field conditions and soil loss for periods throughout the rotation.

The “WEPS Technical Description” provides a more detailed description of the science behind WEPS and is available from WERU. The current WEPS science model is coded in FORTRAN conforming to the ANSI FORTRAN 77 and Fortran 95 standards. The inputs to the science model reside in a series of ASCII input files. These input files are: a WINDGEN file (*.win), a CLIGEN file (*.cli), an initial field conditions file (*.ifc), a management file (*.man), and a run file (weps.run). The science model can be executed from the command line or the interface. When WEPS is executed, the science model reads the input files, accesses necessary databases, calls each submodel daily and performs the simulation, and writes output files. The output is written to one or more ASCII files.

Weather Submodel and Databases

WEPS requires wind speed and direction to simulate the process of soil erosion by wind. These and other weather variables (precipitation, air temperature, and solar radiation) are also needed to drive temporal changes in hydrology, soil erodibility, crop growth, and residue decomposition in WEPS.

Often it is not practical to use measured historical wind data with WEPS, because many wind records have missing data. Also, one may want to simulate wind erosion for a longer period than the length of the measured data record (e.g., for 40 years, is the length of a typical WEPS simulation run). In addition, the measured data require much more computer disk space than do wind summary statistics combined with a stochastic wind generator. Therefore, a stochastic wind generator is often more appropriate for use with WEPS than is using the measured data directly.

WINDGEN was developed specifically for use with WEPS. It stochastically generates daily wind direction and hourly wind speed (van Donk et al., 2004). An earlier version of WINDGEN was described by Skidmore and Tatarko (1990). CLIGEN is the weather generator developed for the Water Erosion Prediction Project (WEPP) family of erosion models (Nicks et al., 1987). It is used by WEPS to stochastically generate daily precipitation, maximum and minimum temperature, dew point temperature, and solar radiation. Those interested in CLIGEN and how it simulates these variables should consult the WEPP documentation (Nicks et al., 1995) and the CLIGEN web site (USDA, 2004). Both CLIGEN and WINDGEN are executed under the WEPS user interface.

Statistical distributions of weather variables are needed by stochastic weather generators to be able to generate data. There are two steps in the stochastic generation of wind data. First, statistics need to be calculated from a historical record of measured data, describing the distributions of wind direction and speed. Second, the wind data are stochastically generated from these statistics.

Calculation of statistics to be used for stochastic wind generation
A quality-controlled hourly wind data set (TD-6421, version 1.1), including 1304 stations in the 48 contiguous states of the USA, was obtained from the National Climatic Data Center (NCDC). Stations with less than 5 years of data were excluded, leaving 971 stations for use with a stochastic generator. Wind direction frequencies were calculated for each of 16 directions for each month. Wind speeds less than or equal to 0.5 m/s were treated as ‘calm’. For the wind speeds that were not calm, the fraction less than or equal to certain wind speeds was calculated for each month-direction combination (12*16 = 192 combinations per station). The wind speeds used were 0.5, 1.5, 2.5, ..., 20.5, 25.5, ..., and 45.5 m/s. Rather than using the Weibull model, we chose to use the measured wind speed distributions themselves,

without fitting to any model, but instead using linear interpolation between the measured distribution points. The reasons for this choice are described by van Donk et al. (2004).

Stochastic wind generation
First, one of the 16 cardinal wind directions or calm is selected by using a random number generator with the distribution for the current month. The selected direction is applied for an entire day. Next, 24 hourly wind speeds are generated for this day. If calm was selected in the previous step, 24 wind speeds of 0 m/s are generated. Otherwise, if one of 16 directions was selected, 24 wind speeds are generated from the cumulative wind speed distribution. The distribution for the current month and wind direction is selected, and a wind speed is generated from the linearly interpolated distribution, by using a random number generator.

For more detail on the science behind this submodel, please see the WEPS technical documentation.

References

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Nicks, A.D., J.R. Williams, C.W. Richardson, and L.J. Lane. 1987. Generating climatic data for a water erosion prediction model. Paper No. 87-2541, International Winter Meeting ASAE, December 15-18, Chicago, IL.

Skidmore, E.L., and J. Tatarko. 1990. Stochastic wind simulation for erosion modeling. Transactions of the ASAE. 33(6): 1893-1899.

USDA. 2004. Cligen Weather Generator, expanded and improved by USDA Agricultural Research Service and U. S. Forest Service. http://horizon.nserl.purdue.edu/Cligen

Van Donk, S.J., L.E. Wagner, E.L. Skidmore, and J. Tatarko. 2004. Stochastic wind generation, comparing the Weibull model with a more direct approach. Submitted to Transactions of the ASAE.

Hydrology Submodel

The HYDROLOGY submodel of the Wind Erosion Prediction System (WEPS) uses inputs generated by other WEPS submodels, such as WEATHER, CROP, SOIL, MANAGEMENT, and DECOMPOSITION, to predict the water content in the various layers of the soil profile, and at the soil-atmosphere interface, throughout the simulation period. Accurate simulation by the other WEPS submodels requires prediction of the daily changes in soil water profiles. Estimating soil wetness at the soil-atmosphere interface is emphasized however, because it significantly influences the susceptibility of the soil to wind erosion.

The HYDROLOGY submodel of WEPS maintains a continuous, daily, soil water balance by using the equation:

$$SWC = SWCI + (PRCP + DIRG) + SNOW - RUNOFF - ETA - DPRC \qquad \textbf{(4.2)}$$

where SWC is the amount of water on the soil profile in any given day, SWCI is the initial amount of water in the soil profile, PRCP is the amount of daily precipitation, DIRG is the amount of daily irrigation, SNOW is the daily snow melt minus daily snow accumulation, RUNOFF is the amount of daily surface runoff, ETA is the amount of daily actual evapotranspiration, and DPRC is the amount of daily deep percolation.

The amount of daily precipitation (PRCP) is partitioned between rainfall and snowfall on the basis of the average daily air temperature. If the average daily temperature is 0°C or below, the precipitation takes the form of snowfall; otherwise, it takes the form of rainfall.

The snow term (SNOW) can be either positive, equaling the daily snow melt, or negative, equaling the daily snow accumulation. The melted snow is treated as rainfall and added to the precipitation term in Equation 4.1 when accounting for daily runoff and infiltration. On the other hand, the accumulated snow is subtracted from the daily precipitation during the estimation of the daily soil water balance with Equation 4.1.

Simulation of soil-water dynamics on a daily basis by the HYDROLOGY submodel involves three major sequences. First, the submodel partitions the total amount of water available from precipitation, irrigation, and/or snow melt into surface runoff and infiltration. The submodel stores the daily amount of water available for infiltration into the soil profile. Second, the submodel determines the influence of ambient climatic conditions by calculating the potential evapotranspiration. Third, the submodel redistributes soil water in the soil profile on an hourly basis, which provides hourly estimations of water content in the soil profile. The submodel estimates the actual rate of evapotranspiration by adjusting the potential rate on the basis of soil water availability. Deep percolation from the soil profile is estimated to be equal to the conductivity of the lowermost simulation layer, assuming a unit hydraulic gradient.

The HYDROLOGY submodel estimates surface runoff and infiltration for each simulation day that has precipitation and/or irrigation. The submodel estimates the daily amount of water available for infiltration into the soil by subtracting the amount of daily surface runoff from the amount of daily precipitation, snow melt, and/or irrigation. The infiltration water is stored in the uppermost simulation layer, until its water content reaches field capacity. Any excess water then is added to the succeeding lower layer, where it is stored with the same maximum storage restriction. This is repeated until complete water storage is obtained. Any excess water that flows out from the lowest simulation layer becomes a part of deep percolation.

Potential evapotranspiration is calculated by using a revised version of Penman's combination method (Van Bavel, 1966). The total daily rate of potential evapotranspiration then is partitioned on the basis of the plant leaf area index into potential soil evaporation and potential plant transpiration. The potential rate of soil evaporation is adjusted to account for the effect of plant residues in the simulation region. Furthermore, the daily potential rates of soil evaporation and plant transpiration are adjusted to actual rates on the basis of water availability in the soil profile.

The HYDROLOGY submodel uses a simplified, forward finite-difference technique to redistribute soil water with the one-dimensional Darcy equation for water flow. The time step of the soil water redistribution is 1 hour, which allows for an hourly estimation of soil wetness as needed for WEPS. Knowledge of the relationship between unsaturated hydraulic conductivity and soil water content is required for solving the governing transport equations of water movement through the soil. The submodel uses Campbell's (1974) method to calculate the unsaturated hydraulic conductivity of the soil from the more readily available soil water characteristic curve and saturated hydraulic conductivity data. Because water release curve data of the soil are not always available, the submodel provides alternative options to estimate the hydraulic parameters of the water release curve that are needed as inputs to run the soil water redistribution segment of the submodel.

The HYDROLOGY submodel predicts, on an hourly basis, soil wetness at the soil-atmosphere interface by using a combination of two techniques. The submodel extrapolates water content to the soil surface from the three uppermost simulation layers. A numerical solution known as Cramer's rule (Miller, 1982) is used to obtain an estimate of the extrapolated water content at the soil surface by solving the three simultaneous equations that describe the relationship between water content and soil depth for the three uppermost simulation layers. The submodel also interpolates the functional relationship between surface-soil wetness and the hourly evaporation ratio.

References

Campbell, G. S. 1974. A simple method for determining unsaturated conductivity from moisture retention data. Soil Sci. 117(6):311-314.

Miller, A. R. 1982. FORTRAN programs for scientists and engineers. SYBEX Inc., Berkeley, CA.

Van Bavel, C. H. M. 1966. Potential evaporation: the combination concept and its experimental verification. Water Resources Res. 2(3):455-467.

Management Submodel

Introduction
WEPS is expected to reflect effects of various management practices upon wind erosion. The diversity of current practices applied to crop land by land managers makes this a daunting task, but WEPS must adequately simulate typical cultural practices to accurately assess their effects upon wind erosion control. The MANAGEMENT submodel is assigned the task of handling the cultural practices that affect the soil/surface "state" within WEPS.

Purpose
All cultural practices are by definition "human initiated". These human-controlled processes affecting the soil and field surface "state" are initiated by typical management practices such as tillage operations, planting, harvesting, irrigation, etc. Therefore, the purpose of the MANAGEMENT submodel is to model what are considered the *major* human-controllable actions that can affect the "system state" within WEPS, in particular the system state variables defining the temporal soil and surface conditions.

Objectives
The MANAGEMENT submodel objectives are:

1. To model the primary human-initiated processes that can affect a site's susceptibility to wind erosion.

2. To provide the framework necessary to process a list of specified human-initiated actions (i.e., the cultural practices applied to a field such as a tillage/crop rotation sequence).

Keeping with the WEPS philosophy, The MANAGEMENT submodel simulates processes via a physical basis if possible, incorporates the conservation of mass and energy concepts, and uses a minimum number of parameters with readily available and/or attainable values.

Assumptions and Limitations
Several assumptions and limitations have been imposed on the MANAGEMENT submodel. The reasons range from simply limiting the scope of the submodel, to inadequate knowledge of specific processes that may have a significant impact on the soil and/or surface. Here is the list of current assumptions and limitations, provided in no particular order, that impact the MANAGEMENT submodel:

1. Total soil water content within the current tillage zone is assumed to be unaffected by a tillage operation. The HYDROLOGY submodel is expected to handle changes in surface water content and, therefore, appropriately represent the usual rapid drying of the surface layer after tillage.

2. Tillage depth is assumed not to influence how a tillage operation affects the soil and surface, except for determining which soil layers are directly affected by a tillage operation.

3. Effects of tillage operations on soil layers below the tillage depth are not considered, (i.e., subsoil compaction below the tillage zone due to tillage).

4. Effects of a management operation are assumed homogeneous within a subregion. Effects due to tractor tires will not be considered (except where they may knock down a significant proportion of standing residue). Certain zone-related tillage operations, such as row cultivator, will be treated in a manner such that the result will be "averaged" or "equivalent" values that represent the homogeneous region.

5. Ridge and dike geometric specifications (oriented roughness) will be provided by the user. If the tillage depth specified is not sufficient to create or destroy them (for a particular tillage operation that does so), the MANAGEMENT submodel will modify the tillage depth accordingly to obtain the desired ridge and/or dike specifications. Tillage operations that do not modify the current ridge and/or dike specifications will not do so (i.e., ridge tillage equipment).

6. Soil tillage depths will be adjusted to the nearest soil layer boundary. This will ensure that the most recent tillage operation modifications on the soil "state" are adequately represented.

7. Aggregate stability and aggregate density are assumed to be unaffected by tillage operations. This decision is based on limited field data analysis. Future research may provide statistically significant affects that could then be modeled. These properties may still change among soil layers within the tillage zone due to aggregate mixing among layers caused by tillage operations.

Submodel Description

The approach taken within the MANAGEMENT submodel to deal with the variety of land management actions was to:

1. Identify the primary physical processes involved.

2. Represent individual management operations as a sequence of those primary physical processes.

3. Develop a MANAGEMENT file format allowing the input of user-specified sequences of management operations, (i.e., a management practices/crop rotation file).

All operations modeled within the MANAGEMENT submodel fall within the defined management categories as listed in Table 4.1.

Table 4.1. Management operation classes.

Operation Class	Description
Primary tillage	Tillage performed to primarily reduce surface residue, increase short-term infiltration rates, loosen subsoil hardpans, and control weed growth. After-harvest tillage operations usually fall in this category.
Secondary tillage	Tillage typically performed in preparation for seeding or planting operations. These operations usually are intended to smooth the soil surface, reduce the average aggregate size, and control weed growth, if present.
Cultivation	Tillage specifically designed to eliminate weed growth after crop germination.
Planting/Seeding	Operations required to plant or seed a crop into a field.
Harvesting	Operation to remove biomass from a field. Biomass removed may be grain, root material, or the entire above-ground biomass.
Irrigation	The artificial application or addition of water to the soil.
Burning	The removal of surface biomass with fire.

When a management or tillage operation is performed, it is simulated through a group of individual physical processes that represent the total effects of that operation. The basic individual physical processes to be modeled within the MANAGEMENT submodel of WEPS have been grouped according to the target of their actions and outlined in Table 4.2.

Table 4.2. MANAGEMENT submodel processes.

Action	Process	Description
Soil Mass Manipulation	Crush	The application of forces to the soil to modify the soil aggregate structure by breaking down soil aggregates.
	Loosen/ Compact	The process of decreasing soil bulk density and increasing porosity (incorporation of air), or the inverse process of increasing soil bulk density by removing air from the soil.
	Mix	The process of uniting or blending of soil layer properties, including biomass.
	Invert	The reversing of the vertical order of occurrence of soil layers within the current specified tillage zone.
Surface Manipulation	Ridge/Dike	The process of creating or destroying ridges and/or dikes (oriented surface roughness).
	Roughen	The process of modifying the random surface roughness.
	Crust	The process of modifying the soil surface crust characteristics.
Biomass Manipulation	Bury/Lift	The process of moving above-ground biomass into the soil, or the inverse process of bringing buried biomass to the surface.
	Cut	The process of cutting standing biomass to a prescribed height.
	Drop	The process of moving a portion of the standing biomass to the soil surface.
	Kill	The death of live biomass.
	Remove	The removal of biomass from the system (harvest, grazing, and burning).
Soil Amendments	Plant	Addition of seeds/plants to the soil.
	Irrigate	Addition of water to the soil.

The underlying philosophy behind the MANAGEMENT submodel was to attempt to develop representations based on physical law, if possible, for each of the chosen physical processes. These processes are assumed to be independent with respect to each other and are to be simulated sequentially, even though many of them occur simultaneously in the real world. The order they are initiated in the submodel is dependent upon the specific operation.

The list of management operations performed for a given management plan (crop rotation or cyclical management practices) is specified in a MANAGEMENT input file. The MANAGEMENT submodel checks on a daily basis for any operations to be performed on that day. If operations are needed, the MANAGEMENT submodel will execute the specified routines required to simulate the effects of those operations as instructed in the MANAGEMENT input file. When the last operation is performed for that particular crop rotation cycle, the same sequence will be repeated for the next year(s) of simulation.

A single MANAGEMENT input file may include multiple management operation lists, one for each subregion being simulated.

Crop Submodel

Introduction

The primary purpose of the WEPS plant growth submodel (CROP) is to obtain realistic estimates of plant growth so that the influence of vegetative cover on soil loss by wind erosion can be properly evaluated. The CROP submodel (Retta and Armbrust, 1995) was adapted from the Erosion Productivity Impact Calculator (EPIC) crop-growth model (Williams et.al., 1990). Additional capabilities and modifications have been developed and incorporated into the CROP submodel to meet the need for predicting effects of a growing crop on wind erosion.

Young seedlings provide some protection from wind erosion, but not all plant parts are equally effective. Stems of young plants, on a per-unit area basis, are roughly 10 times more effective than leaves in depleting wind energy. Other differences between leaves and stems are that: a) leaves are more sensitive to sandblast damage than are stems; and b) leaf and stem residues decompose at different rates. To properly account for these differences, the CROP submodel gives daily estimates of leaf and stem growth in mass and area. At harvest, the ‘grain’ is removed and the ‘straw’ may consist of leaves, stems, and ‘chaff’. In most cases, the leaf and ‘chaff’ residue is short-lived, and only the stem residue may provide protection on a longer-term basis. The CROP submodel gives estimates of the amount of leaf, stem, ‘grain’, and ‘chaff’ mass produced on a daily basis.

An important consideration is the effect of plant density on the amount of cover provided by growing seedlings during the early vegetative growth period. Many management practices leave the soil vulnerable to the forces of wind erosion from before seeding until the growing plants develop sufficient cover. During the period from emergence to the development of adequate cover, the amount of cover is directly proportional to the number of seedlings per unit area. The greater the number of plants per unit area, the greater the cover provided by the growing vegetation. To account for the differences in cover due to initial plant density, the leaf and stem area indexes at emergence (which are used by the EROSION submodel in computations of soil loss) are calculated by multiplying the initial areas per plant by the number of seedlings per unit area. Thus, the greater the number of seedlings per unit area at emergence, the greater the protection provided by the young seedlings from wind erosion.

The CROP submodel uses data inputs of plant, weather, hydrology, and management to estimate leaf mass, stem mass, reproductive mass, yield mass, ‘chaff’ mass, and root mass of ‘live’ plants (crops) on a daily basis. Other plant characteristics estimated daily are root mass by soil layer, rooting depth, plant height, and canopy cover.

Phenological development

Phenological development of the crop is based on growing-degree-day (GDD) accumulation. The crop growth parameters, for each crop, consist of: a) the potential GDD from planting to physiological maturity; and b) the relative GDD from planting to emergence, to the start of the reproductive phase, and to the start of leaf senescence. CROP uses the same procedures as EPIC for simulating annual or perennial plants and winter or summer crops. Annual plants 'grow' from planting to the date when the accumulated GDD equal the potential GDD for the crop. For annual winter crops, such as wheat, GDD accumulation (therefore growth) does not occur during the period of dormancy. Perennial crops maintain their root systems throughout the year, although the plant may become dormant after a frost. After the end of dormancy, plants start growing when the average daily air temperature exceeds the base temperature of the plant.

Emergence

Emergence occurs when the GDD accumulation from date of planting equals 6% of the seasonal GDD. The CROP submodel does not account for effects of soil temperature, soil water, soil crusting, soil strength, seeding depth, or soil removal or deposition caused by wind erosion, any of which can influence germination, seedling emergence, survival, and growth.

Biomass Production

Biomass production is determined on the basis of : a) the amount of shortwave radiation received, which is used to estimate the amount of photosynthetically active radiation (PAR) intercepted by the canopy; and b) the biomass efficiency factor assigned to the crop.

Growth Constraints

Potential growth and yield seldom are achieved, because of stress caused by sub-optimal conditions. The CROP submodel adjusts daily biomass and area growth for water and temperature stresses. Water and temperature stress factors range from 0, where no growth will occur, to 1, no limitation in normal growth. For any simulation day, the minimum value of the water or temperature stress factor determines the adjustment to daily produced biomass.

References

Retta, A. and D.V. Armbrust. 1995. WEPS technical documentation: Crop submodel. Proceedings of the WEPP/WEPS Symposium. Soil and Water Conservation Society, Ankeny, IA.

Williams, J.R., C.A. Jones, and P.T. Dyke. 1990. The EPIC Model. An Erosion/Productivity Impact Calculator: 1. Model Documentation. eds. A.N. Sharply and J.R. Williams. USDA Tech. Bulletin No. 1768.1 235pp.

Residue Decomposition Submodel

This submodel simulates the decrease in crop residue biomass due to microbial activity. The decomposition process is modeled as a first-order reaction with temperature and moisture as driving variables. Decomposition is a function of decomposition days. Under optimum temperature and moisture conditions, one decomposition day per day is accumulated. Only a fraction of a decomposition day is accumulated if conditions are less than optimum. Biomass remaining after harvest is partitioned between standing, flat, buried, and root pools. Below-ground biomass decomposition is calculated for each soil layer.

Residue from different crops may decompose at different rates. Because residue decomposition can require a long period of time, crop residue biomass from sequential harvests is accounted for in three separate pools. Biomass from the most recently harvested crop will be in pool one, biomass from the penultimate crop in pool two, and there is a third pool for biomass from the oldest crop(s). After harvest, any residue biomass remaining from a previous crop is moved into the older age pools, and residue from the just harvested crop is moved into the first residue-decomposition pool.

Standing residue losses not only result from microbial activity, but also from physical forces. Physical transfer of crop residue from the standing biomass pool will reduce both the stem population and standing biomass. A daily estimate of the standing stem population is required to evaluate the vertical stem area that the wind encounters. This area is quantified by the stem area index, which is calculated from standing stem number, stem height, and stem diameter. It affects aerodynamic resistance and, ultimately, wind erosion. Stems start to fall over after a threshold of cumulative decomposition days since harvest has been reached. Stem area index decreases proportionally with decreasing standing stem number.

Both standing and flat crop residue provide cover to the soil surface, protecting it against wind erosion. Soil cover from standing residue is typically small. It is calculated from stem number and stem diameter. Soil cover from flat residue is calculated from flat residue mass. Tillage may alter the amount of residue in the different pools.

For more detail on the science behind this submodel, please see the WEPS technical documentation.

Soil Submodel

Introduction

All the soil properties that control soil wind erodibility vary with time. Hence, the objective of the soil submodel is to simulate these temporal soil properties on a daily basis in response to various driving processes. On days when wind erosion or management activities occur, the EROSION and MANAGEMENT submodels may also update some of the same temporal variables. The driving processes that change soil temporal properties are mostly weather related; hence, the sequence of occurrence of individual driving processes is highly variable. Thus, the submodel must be able to update the soil variables, given an arbitrary driving process and the soil conditions for the prior day. This section provides a brief overview of the major processes that are simulated, and the temporal variables that are updated by the SOIL submodel. For an in-depth discussion of the equations used in the SOIL submodel, see the SOIL Submodel Technical Document (Hagen et al., 1995).

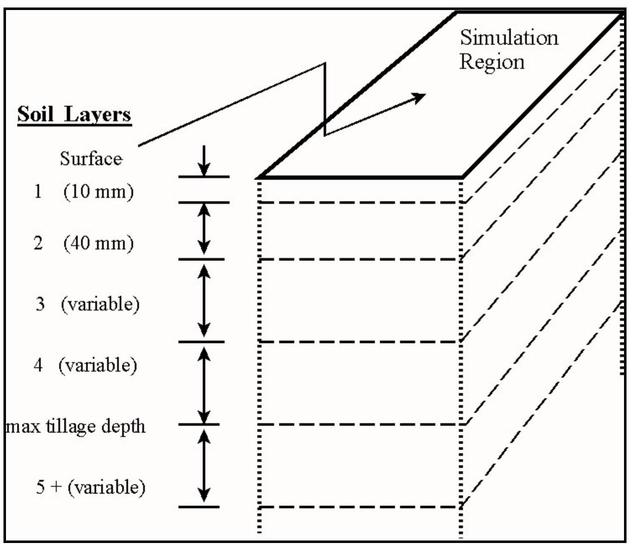

Figure 4.2. Diagram representing the spatial domain of the SOIL submodel.

Spatial Regime

In the SOIL submodel, the spatial regime is considered to be uniform in the horizontal direction over the simulation region, but non-uniform in the vertical direction (Fig. 4.2). Hence, the vertical direction is divided into layers in each soil profile. Some of the layer boundaries are selected to coincide with the layers determined by the NRCS Soil Survey of each soil. Layers one and two are initially set at 10 and 40 mm (0.39 and 1.57 inches), respectively, to allow simulation of sharp gradients in temporal soil properties near the surface.

Soil Layering Scheme

The HYDROLOGY and CROP submodels of WEPS depend upon the soil being stratified by layers. Hydrology moves water up and down within the soil in response to the relative wetness of adjacent layers. The CROP submodel estimates of plant growth are based upon several factors, one of the most important being availability of water within the root zone. It is important that WEPS keep track of how much water is available at various soil depths. Hence, WEPS views the soil as a series of layers, each layer possibly having distinct physical characteristics.

WEPS divides the soil into layers on the basis of the National Soil Information System (NASIS) input data. The layering scheme respects the underlying NASIS data. That is, no NASIS layers are combined when creating WEPS layers. Much of the complexity of the layering process is due to the creation of the very thin top layers. The design criteria are:

8. Preserve NASIS layering, (i.e., a WEPS layer cannot cross a NASIS layer boundary).

9. Define the first three layers to be 10, 40 and 50 mm, if possible.

10. Preserve the relative sizes, 1:4:5:5, of the top layers if the absolute size cannot be attained.

11. Divide the remaining layers into relatively uniform thicknesses, somewhat thinner at the top and thicker as depth increases.

Processes Simulated and Variables Updated

The processes simulated and the variables updated are summarized in Table 4.3. The effect of the processes on roughness is always to reduce the roughness. In contrast, many of the other variables either increase or decrease in value depending upon the prior-day value, soil intrinsic properties, and the driving process. To simulate the dry stability and aggregate size distribution for a wide range of soils, these variables were first normalized by using the means and standard deviations of the variables for each soil series to give a range from 0 to 1 for each variable. The driving processes were then applied to the normalized ranges to determine the change in the normalized variable. Finally, the updated normalized values were converted to the real values of these variables.

Table 4.3. SOIL submodel variable and process matrix.

	Surface Processes			Layer Processes		
Soil Temporal Variables	Rain	Sprinkler Irrigation	Snow Melt	Wet/dry	Freeze/thaw	Freeze/dry
Roughness:						
Ridge Height	X	X	X			
Dike Height	X	X	X			
Random	X	X	X			
Crust:						
Depth	X	X	X			
Cover fraction	X	X	X			
Density	X	X	X			
Stability	X	X	X	X	X	X
Loose mass	X	X	X			
Loose cover	X	X	X			
Aggregates:						
Size distribution	X	X	X	X	X	X
Dry stability	X	X	X	X	X	X
Density	X	X	X	X	X	X
Layers:						
Bulk density	X	X	X			

In summary, the Soil submodel outputs updated values on a daily basis for each of the variables listed in Table 4.3 in response to the occurrence of the various driving processes.

References

Hagen, L.J., T.M. Zobeck, E.L. Skidmore, and I. Elminyawi. 1995. WEPS technical documentation: soil submodel. Proceedings of the WEPP/WEPS Symposium, Soil and Water Conservation Society, Ankeny, IA.

Erosion Submodel

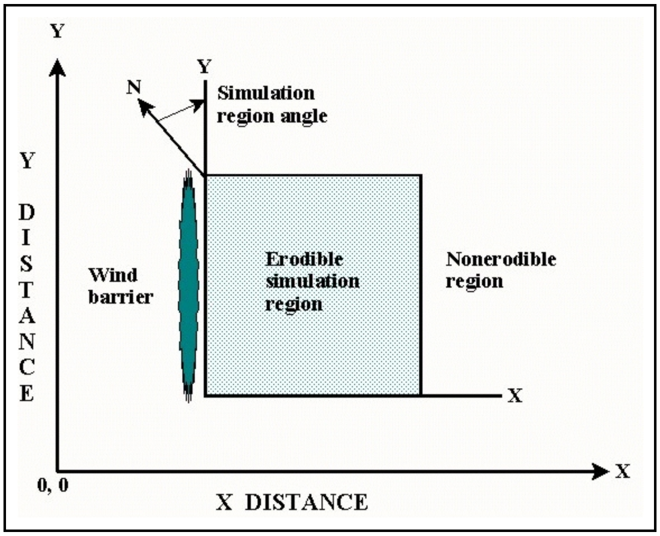

Figure 4.3. Schematic of simulation region geometry. Field orientation, end points of barriers, and opposite corners of the rectangular simulation region are input to the EROSION submodel.

Introduction

The objective of the EROSION submodel is to simulate the components of soil loss/deposition over a rectangular field in response to wind speed, wind direction, field orientation, and surface conditions, on a sub-hourly basis (Fig. 4.3). In WEPS 1.0, barriers may be placed on any or all field boundaries. When barriers are present, the wind speed is reduced in the sheltered area on both the upwind and downwind sides of the barriers. The submodel determines the threshold friction velocity at which erosion can begin for each surface condition. When wind speeds exceed the threshold, the submodel calculates the loss/deposition over a series of individual grid cells representing the field. The soil/loss deposition is divided into components of saltation/creep and suspension, because each has different transport modes, as well as off-site impacts. Finally, the field surface is periodically updated to simulate the changes caused by erosion. This paper provides users with a brief overview of the submodel. For an in-depth description of the equations used in this submodel, see the WEPS Erosion Submodel Technical Description (Hagen, 1995).

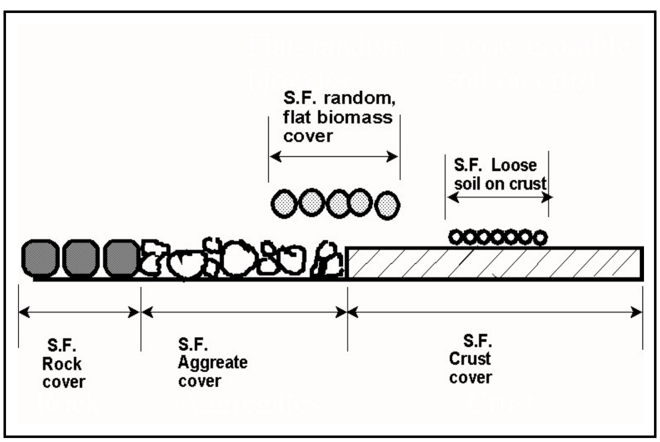

Figure 4.4. Diagram illustrating components of flat surface cover inputs to the EROSION submodel.

Parameters Describing Soil Surface Conditions

Surface roughness is represented by both random roughness and oriented roughness. The parameters used are standard deviation of the surface heights for random roughness and the height, width of ridge tops, and spacing of ridges for oriented roughness.

Surface cover is represented on three levels (Fig. 4.4). In the first level, surface rock, aggregates and crust compose 100 percent of the cover. In the second level, the parameter is the fraction of the crusted surface covered with loose, erodible soil. When there is no crust, this parameter is always zero. In the third level, the parameter is the fraction of total surface covered by flat, random biomass.

The aggregate density and size distribution are soil parameters that indicate soil mobility. The dry mechanical stability of the clods/crust are input parameters that indicate their resistance to abrasion from impacts by eroding soil. Surface soil wetness is also input and used to increase the threshold friction velocity at which erosion begins.

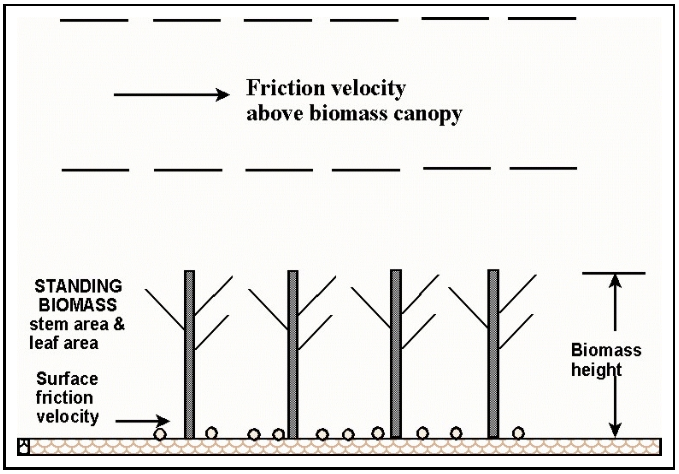

Figure 4.5. Diagram illustrating friction velocity above standing biomass that is reduced by drag of stems and leaves to the surface friction velocity below the standing biomass.

Uniformly distributed standing biomass is 5 to 10 times more effective in controlling wind erosion than is flat biomass, and thus, standing biomass is treated separately. The wind friction velocity above standing biomass is depleted by the leaves and stems to obtain the friction velocity at the surface that is used to drive erosion (Fig. 4.5). Leaves are represented by a leaf area index and stems are represented by a stem silhouette area index.

Erosion Processes Simulated

Soil transport during wind erosion occurs in three modes: creep-size aggregates, 0.84 to 2.0 mm (0.033 - 0.079 in.) in diameter, roll along the surface; saltation-size aggregates, 0.10 to 0.84 mm (0.004 - 0.033 in.) in diameter, hop over the surface; and suspension-size aggregates, less than 0.01 mm (0.004 in.) in diameter, move above the surface in the turbulent flow. Variations in friction velocity, aggregate density, and sediment load obviously may change the mass of aggregates moving in a given mode. Saltation and creep are simulated together because they have a limited transport capacity that depends mainly upon friction velocity and surface roughness. The suspension component is simulated with no upper limit on its transport capacity at the field scale. A portion of the suspension component also is simulated as PM-10 (i.e., particulate matter less than 10 micrometers (0.0004 in.) in diameter), which is regulated as a health hazard.

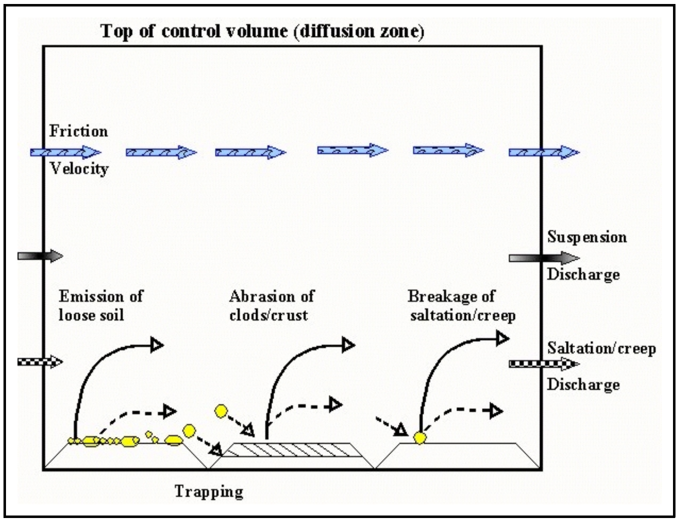

Figure 4.6. Diagram illustrating processes simulated by the EROSION submodel on a bare soil surface in an individual grid cell.

Multiple physical erosion processes are simulated in the erosion submodel, and these are illustrated for a single grid cell in Fig. 4.6. The two sources of eroding soil are emission of loose soil and entrainment of soil abraded from clods and crust. These sources are apportioned between saltation/creep and suspension components on the basis of the source process and soil characteristics. Three processes deplete the amount of moving saltation/creep. These include trapping in surface depressions, interception by plant stems/leaves, and breakage of saltation/creep size particles and aggregates into suspension-size.

Simulation of surface rearrangement is accomplished by allowing emissions to deplete the loose soil and armor the surface in the upwind field area. In contrast, processes such as abrasion of the protruding aggregates and trapping in depressions dominate in downwind areas and lead to smoothing the surface and a build-up of loose saltation/creep. A build-up of saltation/creep often occurs, because the transport capacity may be satisfied, but abrasion of clods/crust continues to create additional saltation/creep-size soil.

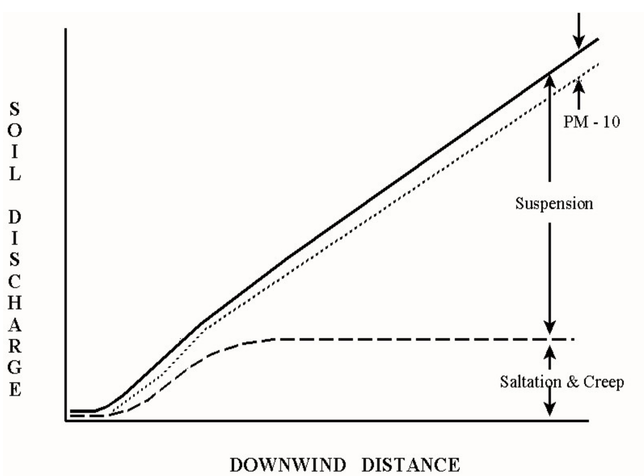

Figure 4.7. Diagram illustrating downwind transport capacity for saltation & creep, but a continuing increase in transported mass of suspension-size soil downwind.

Typical behavior of the downwind soil discharge simulated along a line transect for the saltation/creep and suspension components is illustrated in Fig. 4.7. The suspension component keeps increasing with downwind distance, even though saltation/creep reaches transport capacity. This is because the sources for suspension-size soil are usually active over the entire field. These sources include emissions from impacts on loose soil, abrasion from clods/crust, and breakage from impacting saltation/creep-size aggregates. Moreover, the suspension component has a transport capacity many times larger than that of saltation/creep, so on large fields it is the ‘freightliner’ for moving soil whereas saltation/creep is merely the ‘pickup truck’.

Outputs

The EROSION submodel calculates total, suspension, and PM-10 soil loss/deposition at each grid cell in the field. The grid cell data are summarized in other parts of WEPS and reported to users as averages over the field for selected periods. The submodel also calculates the components of soil discharge crossing each field boundary. These are reported to users, according to the size ranges of aggregates as saltation/creep, suspension, and PM-10. These latter outputs are useful for evaluating off-site impacts in any given direction from the eroding field.

References

Hagen, L.J. 1995. Wind Erosion Prediction System (WEPS) Technical Description: Erosion submodel. Proceedings of the WEPP/WEPS Symposium. Soil and Water Conservation Society, Ankeny, IA.

Flags and Command Line Options

Submodel Report Flags

To generate various kinds of reports, a flag must be set. To set the option through the interface, use the output tab of the Configuration screen. A flag number is entered in the box in the appropriate submodel. A flag of zero, '0', will result in no output being generated to the listed file. It should be noted that generating these files may create large file sizes and significantly slow the execution of the WEPS model.

Submodel & flag no.	file name(s)	description
Hydrology		
0		no output generated
1	hydro.out	daily output
2	water.out	hourly output for each day
3	hydro.out & water.out	generates both files
4	temp.out	daily soil temperature output by layer
5	temp.out & hydro.out	generates both files
6	temp.out & water.out	generates both files
7	temp.out & water.out & hydro.out	generates all three files
Soil		
0		no output generated
1	soil.out	daily submodel output
Management		
0		no output generated
1	manage.out	daily submodel output
Crop		
0		no output generated
1	crop.out	daily submodel output
Decomposition		
0		no output generated
1	dabove.out	daily above-ground submodel output
2	dbelow.out	daily below-ground submodel output
3	dabove.out & dbelow.out	generates both files

Erosion

0		no output generated
1	erosion.out	currently generates an empty file
	eegt.out	currently generates an empty file
	eros.tmp	currently generates an empty file
	subday.out	daily wind direction and subdaily (i.e., hourly) wind speeds
3	emit.out	Subdaily (e.g. hourly) suspension

A flag of one, '1', for any submodel generates the file 'plot.out', which contains a variety of output variables on a daily basis. This file is suitable for input into spreadsheets or plotting packages for plotting of daily data. See the header of the file or contact the WEPS developers for more information on the variables output to 'plot.out'.

Command Line Options

Windgen 4

Usage: wind_gen4 -D -V -v -h -l -f dbfile -o outfile -s # -x # -r # -b # -y #-u # -d # -?

-D	debug flag
-V	display version and exit
-v	set the verbose option
-h	do not display output title heading
-l	display long (additional) output
-f dbfile	specify wind database file (wind_gen.wdb)
-o outfile	specify output file (stdout)
-s #	specify station WBAN no.
-x #	specify station database index no.
-r #	specify random number seed (default = 54321)
-b #	specify beginning simulation (calendar) year (default = 1)
-y #	specify number of years to simulate (default = 1)
-u #	specify storm duration length in hours (default = 6)
-d #	specify number of days to build storms from (default = 5)
-?	Display the available command line options

The wind station WBAN code number is required. Note that only the "-f" option (with the location of the appropriate wind_gen database file to access) is required for WEPS 1.0. All other options are either automatically added internally by WEPS 1.0 or are optional. Those that WEPS 1.0 automatically sets are:

-s #
-y #
-o outfile

Those that can be added to the command line and should work within WEPS 1.0 are:

-D
-v
-x #
-r #
-b #
-u #
-d #

Those that can't be specified when wind_gen4 is run within WEPS 1.0 are:

-V
-l
-h
-?

Cligen Version 5.2254

CLIGEN V-5.2254 - Climate Generator w/ QC-SNDG
Usage: cligen -S -s -I -o -b -y -f -F -H -r -t -I# -v -V -? -O

-S<state number>
-s<station ID number>
-i<input file name>
-o<output file name>
-b<beginning year>
-y<duration in years>
-f old WEPS record format
-F overwrite output file if it exists
-H omit header output
-r<random seed>
-t<Sim Type (WEPP: 4=SglStm, 5=Contin)>
-I0 no interpolation (default)
-I1 linear interpolation
-I2 Fourier interpolation
-I3 interpolation to preserve avgs
-v
-V verbose
-h, -?, -\\?, /h help
-O <option 6 – observed data filename>

Make sure there are no spaces between each flag and its parameter. If command line options are omitted, CLIGEN will interactively request the required information.

Note that the "-I" option (with the location of the appropriate cligen database file to access), the "-b" option (specifying the start year; usually 1), the "-t" option with value "5", and the "-F" option are all required for WEPS 1.0. All other options are either automatically added internally by WEPS 1.0, are optional, or not applicable when used with WEPS 1.0.

Those that WEPS 1.0 automatically sets are:

-S#
-s#
-y#
-ooutfile

Those that can be added to the command line and should work within WEPS 1.0 are:

-r#
-I0
-I1
-I2
-I3
-V

Those that can't be specified when cligen5110 is run within WEPS 1.0 are:

-v
-h
-?
-t# (with options values other than 5)

WEPS 1.0

Usage: weps -? -C# -E# -I# -L# -l# -O# -p# -P./ -R# -S# -s# -w# -Y -X#

where # represents the options listed:

Valid command line options:

-? Display the help screen
-h Display the help screen

-C WEPS crop calibration mode
 0 = Do not run crop calibration (default)
 1 = Run crop calibration

-E Simulate \"erosion\" in WEPS run
 0 = Do not run the erosion submodel
 1 = Run the erosion submodel (default)

-I Specify if initialization is done and if so, the # loops
- 0 = No initialization
- 1 = Runs one management cycle (default)
- 2 = Runs x management cycles

-L Specify soil layer thickness to scale layer splitting (mm)
- Specify -L2 for layer splitting to use 2 mm (no decimals) (default)

-l Specify rate of soil layer thickness increase with depth for
- layer splitting in percent increase of layer thickness
- Specify -l50 to 50 percent for each layer (no decimals). l25 is default.

-O Generate stand alone erosion input file on simulation day
- Specify -O2932 to output file on simulation day 2932

-o Generate stand alone erosion input file on DD/MM/YY
- Specify -o020901 to output file on day 2 month 9 year 1
- Day and month must be 2 digits, Year can be 1 to 4 digits. Default is no file generated.

-p Select soil puddling with saturation all above freezing
- 0 = disable (default)
- 1 = enable

-P Specify path to WEPS project run directory
- Must be specified if other command line switches are used.
- Must be the last option specified. Default is ./
- Specifying only the path without the \"-P\" option only works if no other command line switches are specified (e.g., \"weps path_to_weps.run_file\")

-R WEPS debug messages dumped to screen
- 0 = no debug messages sent to screen (default)
- 1 = 1st-level debug messages sent to screen
- 2 = 1st- and 2nd-level debug messages sent to screen
- 3 = 1st-, 2nd-, and-3rd level debug messages sent to screen

-S Vary type of value input for 1/3 bar, 15 bar water
- 0 = 1/3bar(vol) 15bar(vol)
- 1 = 1/3bar(vol) 15bar(grav)
- 2 = 1/3bar(grav) 15bar(grav)
- 3 = use texture-based calculation
- 4 = use Rawls texture for full properties (default)
  - Override 1/3bar, 15bar, bulk density w/ texture estimate

-s Specify soil ifc file input format type
- 0 = new format (additional parameters) (default)
- 1 = old format (slope set in weps.run)

-w Specify method of weighting for layer conductivity and flow
- 0 = arithmetic mean method (default)
- 1 = layer thickness proportional method
- 2 = internodal method, Darcian mean

-Y Optional functional yield/residue ratio
    0 = Use full staged biomass partitioning
    1 = Use functional yield/residue ratio (default)

-X Specify maximum wind speed cap (m/s)
    Specify -X25.0 to limit input wind speeds to a maximum of 25.0 m/s.
    If -X0, no cap is set (default).

Default options are set to:
-C0 -E1 -I1 -L2 -l25 -Oo(no file) -p0 -P./ -R0 -S4 -s0 -w0 -Y1 -X0

Note that only the "-P" option is required for WEPS 1.0. (It must be the last option specified if more than one option is listed because WEPS 1.0 appends the current WEPS Project Run directory path before executing the WEPS science model.

The options that the WEPS 1.0 interface set automatically are:
-Ppath
    WEPS 1.0 assumes that the user has specified "-P" (as the last option) within the WEPS 1.0 configuration panel without the "path". WEPS 1.0 appends the path of the current WEPS Project Run directory before executing the WEPS science model.

Those that can be added to the command line and should work within WEPS 1.0 are:
-I#
-S#
-s#
-R#
-O
-o
-E#
-C#
-Y#

Those that can't be specified when run within the WEPS 1.0 interface are:
-h
-?

Using WEPS with Measured Data

Introduction

The Wind Erosion Prediction System (WEPS) is designed to simulate soil loss by wind from cultivated fields by simulating weather and field conditions (Wagner, 1997). In some situations however, WEPS may be run using measured or simulated data from other models. This is typically done to validate various components or submodels of WEPS, particularly the erosion portion of the model. For example, a user may have measured soil loss data and limited weather and soil data. This user can input the measured weather and soil data to compare the model soil loss with the measured loss. This section will explore the use of WEPS with measured or other simulated data.

WEPS is a process-based, continuous, daily time-step model that simulates weather, field conditions, and erosion by wind. It has the capability of simulating spatial and temporal variability of a field's soil, crop, and residue conditions and soil loss/deposition within a field. The saltation/creep, suspension, and PM10 components of eroding material are also reported separately by direction. The WEPS model is modular, with submodels that simulate weather, soil conditions, crop growth, residue decomposition, management operations, and soil loss by wind. It is designed to be used by the USDA-NRCS, under a wide range of conditions throughout the United States. With proper inputs however, WEPS is easily adapted to other parts of the world.

In typical applications, input files are created within the user interface, which supplies these files to the science portion of the model to calculate field conditions and erosion. WEPS requires the following input files for a simulation run: a 'Run file', WINDGEN file', 'CLIGEN file', 'Soil file', and a 'Management file'. These files can be modified with measured or other data and run with WEPS under certain constraints. All input files except the Management file, may be easily altered using a standard text editor or the WEPS user interface to reflect measured data. All input files must be formatted to meet the requirements for WEPS. These input files and considerations for their creation with measured data are described in this Appendix.

It is important to note that the purpose of the WEPS model is to simulate changes in field conditions as a result of management and weather to estimate wind erosion. To simulate these changes in field conditions, WEPS is intended for simulations of multiple-day periods of time. If one desires to simulate only a single storm, field conditions are essentially static and the full WEPS model is not necessary. To simulate single erosion events of one day or less, the standalone erosion submodel is recommended. The use of the standalone submodel is also described in this Appendix.

WEPS can be run from either the interface or the command line. Users typically will run the model through the interface, in which modified input files can be selected. See the individual input file descriptions for information on how to select modified files within the interface. Some input files are best modified within the interface (e.g., soil and management files), whereas others require some sort of separate editing or creation with a separate program (e.g., weather files). Files that are modified by the user but input via the interface must be placed in the appropriate project directory (i.e., folder). Those wishing to run WEPS via the command line are advised to see the section titled "Flags and Command Line Options" in the WEPS User Manual.

Output files obtained from WEPS are described elsewhere in the WEPS User Manual. For additional assistance using measured data with WEPS, please contact WERU (office@weru.ksu.edu) or go to (http://www.weru.ksu.edu/weps).

Run File

The default file name of the WEPS run file is 'weps.run'. This file contains general information for a simulation run, including the dates of the simulation, the field and barrier dimensions, the field location, and the path and names of the other input files. The 'run file' parameters can be modified to match the parameters for the field simulated. The list of the other input files should specify the path and name of measured data to be used. This file contains comments (indicated by a '#' in column one) which describes each line of input data to aid in checking and modifying input data.

An example Run File is shown in Figure 4.8. Note that lines beginning with '#' character are comment lines. Lines beginning with '# RFD' are comments used by the interface. Some of the parameters are critical to the science model (SC), some are critical to the operation of the interface (IC), and some are critical to both (SC+IC); others are not critical to either (NC). An example of non-critical parameters would be the User Name, which does not affect the operation of WEPS and is used for informational purposes only. In all cases however, some sort of 'placeholder' is required, even for non-critical parameters. In other words, blank lines are not allowed and each expected line must be present and filled with some characters.

The interface is a simple way to input data into the Run file and is recommended. The information herein is presented for the benefit of those users who wish to modify the input file themselves.

Run File Parameters:

--USER INFORMATION
UserName - This character variable holds the user name. (NC)

FieldNo - This character variable is a part of a field tract that is separated by permanent boundaries. (NC) Note that FieldNo, TractNo, FarmNo, RunMode, RunCycle, and RotCycle are all entered on one line, with each parameter separated by the pipe "|" symbol.

TractNo - This character variable is often used by FSA and NRCS to identify a field. (NC)

FarmNo - This character variable is a farm identification number. (NC)

RunMode - This character variable specifies the type of run length as either the NRCS method (specifies a fixed number of cycles), use simulation run start and end dates on the main screen, or specify the use of management rotation cycles on the main screen. (IC)

RunCycle - This variable specifies the number of management rotation cycles to simulate in a WEPS run. (IC)

RotCycle - This character variable specifies the number of years in the rotation cycle. (IC)

SiteCounty and SiteState - This character variable specifies the county and state to be simulated. (NC)

--SITE INFORMATION
LatitudeSign - This parameter is used to specify the specify the hemisphere of the latitude. Enter a plus sign (+) for the Northern hemisphere and a minus sign (-) for the Southern hemisphere. (IC)

Latitude -The latitude of the location modeled in degrees and fraction of degrees. The CLIGEN and WINDGEN stations nearest to the center of the location county will then be determined by the interface and listed. Latitude is also used by the science model to determine day length and time of sunrise. (SC+IC)

LongitudeSign - This parameter is used to specify the specify the hemisphere of the longitude. Enter a plus sign (+) for the Eastern hemisphere and a minus sign (-) for the Western hemisphere. (IC)

Longitude -The longitude of the location modeled in degrees and fraction of degrees. The CLIGEN and WINDGEN stations nearest to the center of the location county will be determined by the interface. Longitude is used by the science model to determine day length and time of sunrise. (SC+IC)

Elevation (meters) - The average elevation for the location to be modeled in the units of measure displayed on the screen (feet or meters). The science model requires elevation in meters, and converts feet to meters. (SC+IC)

CliGenStationID - The name of the CLIGEN station used to generate many of the weather parameters for WEPS. (IC)

WindGenStationID - The name of WINDGEN station used to generate the wind parameters for WEPS. (IC)

--*SIMULATION PERIOD*
StartDate (day, month, year) - The "Start Date" is the date from which you want the simulation to begin. The format is the numerical value for day, month (e.g., 03 for March), and year (two or four characters), each value separated by a blank space. (SC+IC)

> A typical run begins on January 1 and ends on December 31 with multiple years of simulation. For those using WEPS with historical data however, other start and ending days and months may be entered. The correctness of output has not been tested in these situations.

EndDate (day, month, year) - The "End Date" is the date on which you want the simulation to end. The format is the numerical value for day, month (e.g., 03 for March), and year (two or four characters), each separated by a blank space. (SC+IC)

> A typical run begins on January 1 and ends on December 31 with multiple years of simulation. For those using WEPS with historical data however, other start and ending days and months may be entered. The correctness of output has not been tested in these situations.

TimeSteps (per day) - The number of time steps per day used for the daily distribution of simulated wind speed for erosion calculations. If none is entered through the interface Configuration Screen, the number of time steps is assumed to be 24. (SC)

--*RUN FILE NAMES (INPUT)*
climate file - This character variable holds the path and CLIGEN input file name. (SC+IC)

wind file - This character variable holds the path and WINDGEN input file name. (SC+IC)

soil file - This character variable holds the path and soil input file name. (SC+IC) management file - This character variable holds the path and management input file name. (SC+IC)

--WEPS OUTPUT OPTIONS
OutputFile - This character variable holds the path and general output file name. (SC+IC)

ReportForm - This variable was intended to hold six (6) flags for selecting various general report forms, but is not used in the current version of WEPS. (NC)

OutputPeriod - This variable was intended to hold a flag for selecting the period of output, but is not used in the current version of WEPS. (NC)

SubmodelOutput - This variable holds numerical flags to print detailed reports for various submodels. Submodel detail report flags are described elsewhere in the WEPS User Manual. (SC+IC)

DebugOutput - This variable holds numerical flags to print debug reports for various submodels. Submodel debug report flags are described elsewhere in the WEPS User Manual. (SC+IC)

--SIMULATION REGION INFORMATION
RegionAngle (degrees from North) - This is the angle of the field with respect to North. (SC enter angle 0-360 decrees, clockwise from North) or (IC enter angle up to +/- 45 degrees)

SimCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the simulation region. This is typically the lower left corner for the North-South oriented rectangular simulation region. (SC+IC)

SimCoords2 (meters) - These two variables hold the X and Y coordinates of the opposite corner of the simulation region (furthest from the origin). This is typically the upper right corner for the North-South oriented rectangular simulation regions. (SC+IC)

ScaleFactors - These two variables were intended to hold scale factors for displaying the simulation region in the interface, but are not used in the current version of WEPS. (NC)

AcctRegNo - This variable holds the number of accounting regions in the simulation region. If more than one accounting region is present (i.e., AcctRegNo > 1), then the accounting region coordinates are repeated in succession to account for each accounting region. (SC+IC)

AcctCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the accounting region. This is typically the lower left corner for the North-South oriented rectangular accounting region. (SC+IC)

AcctCoords2 (meters)- These two variables hold the X and Y coordinates of the opposite corner of the accounting region (furthest from the origin). This is typically the upper right corner for the North-South oriented rectangular accounting regions. (SC+IC)

SubRegNo - This variable holds the number of subregions in the simulation region. If more than one accounting region is present (i.e., SubRegNo > 1), then the subregion coordinates are repeated in succession to account for each subregion. (SC+IC)

SubCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the current subregion. This is typically the lower left corner for the North-South oriented rectangular subregion. (SC+IC)

SubCoords2 (meters) - These two variables hold the X and Y coordinates of the opposite corner of the subregion (furthest from the origin). This is typically the upper right corner for the North-South oriented rectangular subregions. (SC+IC)

AverageSlope (%) - The average slope of the subregion. This information is now obtained from the soil input file. (NC)

-- *BARRIERS*
NumberBar - This variable holds the number of barriers in the simulation region. If more than one barrier is present (i.e., NumberBar > 1), then the barrier information (i.e., barrier coordinates and parameters) are repeated in succession to account for each barrier. (SC+IC)

BarrierCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the barrier. This is typically the lower left corner of the barrier. (SC+IC)

BarrierCoords2 (meters) -These two variables hold the X and Y coordinates of the opposite corner of the barrier (furthest from the origin). This is typically the upper right corner of the barrier. (SC+IC)

BarrierType - This character variable specifies the name of the type of barrier. (NC)

BarrierHeight (meters) - This parameter is the barrier average height. (SC+IC)

BarrierWidth (meters) - This parameter is the barrier average width (not length). (SC+IC)

BarrierPorosity (%) - The barrier porosity is expressed as an optical porosity. It is the open space as viewed looking perpendicular through the barrier expressed as a percentage of the total area (i.e., ((1.0 - silhouette area) x 100).

Figure 4.8. Example Run file.

```
#------------ WEPS SIMULATION RUN FILE ------------
# Note: Lines beginning with '#' are comment lines.
#       Lines beginning with '#   RFD' are comments used by the interface.
#
# --USER INFORMATION
#   RFD-UserName
Dustin Fields
#   RFD-FieldNo RFD-TractNo RFD-FarmNo RFD-RunMode RFD-RunCycle RFD-RotCycle
789 | 456 | 123 | cycle | 2 | 2
#   RFD-SiteCounty and SiteState
Finney, Kansas
#
# --SITE INFORMATION
#   RFD-LatitudeSign RFD-Latitude
+38.00
#   RFD-LongitudeSign RFD-Longitude
-100.66
#   RFD-Elevation (meters)
801
#   RFD-CliGenStationID
CIMARRON
#   RFD-WindGenStationID
GARDEN CITY MUNI
#
# --SIMULATION PERIOD
#   RFD-StartDate (day_month_year)
01 01 01
#   RFD-EndDate (day_month_year)
31 12 4
#   RFD-TimeSteps (per_day)
24
#
# --RUN FILE NAMES (INPUT)
#   RFD-climate file
cli_gen.cli
#   RFD-wind file
win_gen.win
#   RFD-sub-daily file
none
#   RFD-SoilFile
Otero_101OF_100_FSL.ifc
#   RFD-ManageFile
KS_wheat_fallow.man
#
# --WEPS OUTPUT OPTIONS
#   RFD-OutputFile
output.tmp
#   RFD-ReportForm
0 0 0 0 0 0
#   RFD-OutputPeriod
2
#   RFD-SubmodelOutput
0 0 0 0 0 0
#   RFD-DebugOutput
0 0 0 0 0
```

```
#
# --SIMULATION REGION INFORMATION
#   RFD-RegionAngle (deg_clockwise_north)
21
#   RFD-SimCoords1 (meters)
0.0  0.0
#   RFD-SimCoords2 (meters)
1500.2  1500
#   RFD-ScaleFactors (place holder - needed for older versions of WEPS)
5.5 5.5
#
#   RFD-AcctRegNo
1
#   RFD-AcctCoords1 (meters)
    0.0  0.0
#   RFD-AcctCoords2 (meters)
1500.2  1500
#
#   RFD-SubregionNo
1
#   RFD-SubCoords1 (meters)
0.0  0.0
#   RFD-SubCoords2 (meters)
1500.2  1500
#   RFD-AverageSlope (%)
0.50
#  --BARRIERS
#   RFD-NumberBar
2
#   RFD-BarrierCoord1 (meters)
-1 0
#   RFD-BarrierCoords2 (meters)
0 1500
#   RFD-BarrierType
Snow fence
#   RFD-BarrierHeight (meters)
1.2
#   RFD-BarrierWidth (meters)
1
#   RFD-BarrierPorosity (%)
0.6
#   RFD-BarrierCoord (meters)
0 -2
1500.2 0
#   RFD-BarrierType
Sorghum(2 row)
#   RFD-BarrierHeight (meters)
2
#   RFD-BarrierWidth (meters)
2
#   RFD-BarrierPorosity (%)
0.5
#
#---------- END OF SIMULATION RUN FILE ------------
```

Weather Files

WEPS runs are made for multiple years in full-year increments beginning on January 1. If only a partial year of weather data is available (typical), the user has two options. One option is to substitute measured data within the simulated weather file for the desired location, and observe the output for the period with measured data. For this option, the user should note that the field conditions cannot be input into the simulation at the point the measured data begins (although future versions of WEPS with this capability are planned). The field conditions will be the result of the simulation up to that point and may not exactly match actual field conditions for the measured data site. The second option is to use the stand-alone Erosion model (described later) for single-day simulations. Two weather files are required by the full WEPS model, a WINDGEN file and a CLIGEN file.

If alternative weather files are to be used in the full WEPS model, they are input through the interface. Alternative weather files are designated by first checking the appropriate wind or climate box in the "Run" tab of the "Configuration" window, then entering the file name and path or choosing the file by clicking the folder icon on the "Location Information" panel of the main screen.

<u>WINDGEN File</u>

The WINDGEN file extension is "win" (e.g., wind_gen.win). This file contains both the wind speed (m s^{-1}) on a subdaily time step and one wind direction (degrees clockwise from North) for each day of the simulation. If more than one wind direction is measured for the day (typical), an average wind direction should be calculated. A wind direction can be calculated by using average weighted by wind speed. This weighting is recommended to provide more weight to stronger, erosive winds. Average wind direction for a day is calculated as:

$$Ue = \sum_{i=1}^{k} (Si * \sin Ti) \qquad [4.1]$$

$$Un = \sum_{i=1}^{k} (Si * \cos Ti) \qquad [4.2]$$

$$Tu = \arctan \frac{Ue}{Un} \qquad [4.3]$$

where

k = number of directions per day,
Si = wind speed (any units),
Ti = wind directions (0 - 360 degrees),
Tu = average wind direction (0 - 360 degrees). If $Tu < 0$, then $Tu = Tu + 360$.

The subdaily wind speeds, are by default, the average hourly speeds (i.e., 24, 1-hour averages of point measurements), but can be of other time steps of equal length (e.g., 96, 15-minute averages of point measurements) if specified in the weps.run file. If data are available, it is recommended that time steps less than or equal to1 hour be used, because the smaller the time step (more periods) are more accurate representation of the true winds. Also, the height of the wind measurement in WEPS is assumed to be 10 meters. If wind speeds were taken at a height other than 10 meters, speeds should be adjusted to what they would be at a 10-meter height. WEPS ignores the WINDGEN file header information which is in the first seven rows. Figure 4.9 shows an example WINDGEN file.

WINDGEN File Parameters:

Lines 1 - 7:	Comment lines (ignored). These do not need to be filled out, but WEPS does need to have these seven lines present with a '#' at the beginning of the line.
Line 8 +:	wind data, one day at a time as described next.
Items 1, 2, 3:	**day mo year** - the day, month, and year of simulation (integer).
Item 4:	**dir** - wind direction for the day. WEPS assumes that the direction is constant for the day (real- degrees clockwise with North = 0.0, East = 90.0, South = 180.0, etc.).
Items 5 - end:	**hr1 hr2 hr3 . . .** - average 1-hour wind speeds, distributed throughout the entire day. These represent, by default, twenty-four 1-hour average wind speeds (real-meters/second). If other time steps are used, they should be of equal length and the number of these periods should be specified in the weps.run file.

Figure 4.9. Example WINDGEN file.

```
#    WIND_GEN3  $Revision: 1.12 $ Hourly values per day output
# station: 13985 DODGE_CITY, KS  USA
# lat:  37deg  46min N  lon:  99deg  58min W
# period: 19610421-19781231  el: 796m
# day mo year dir   hr1   hr2   hr3   hr4   hr5   hr6   hr7   hr8   hr9  .  .  .
#              deg   m/s   m/s   m/s   m/s   m/s   m/s   m/s   m/s   m/s  .  .  .
# -----------------------------------------------------------------------------------
  1  1    1   0.0   3.7   4.7   6.1   6.4   6.9   7.7   8.3   9.3  14.4  .  .  .
  2  1    1 180.0   3.5   4.7   5.5   5.8   6.4   6.9   7.5   7.9   8.5  .  .  .
  3  1    1   0.0   3.7   4.7   6.1   6.4   6.8   7.7   8.1   9.3  12.1  .  .  .
  4  1    1 157.5   2.9   3.5   4.1   4.3   4.6   5.0   5.4   5.6   7.4  .  .  .
  5  1    1 135.0   2.3   2.9   3.5   3.8   4.5   4.8   5.4   6.0   8.2  .  .  .
  6  1    1  22.5   3.5   4.6   5.2   5.8   6.6   7.2   7.9   8.8  11.0  .  .  .
  7  1    1 180.0   3.8   4.9   5.6   5.8   6.5   7.1   7.7   8.0   9.4  .  .  .
  8  1    1 202.5   4.0   4.8   5.2   5.7   5.9   6.2   6.7   7.2   8.1  .  .  .
  9  1    1  22.5   3.5   4.6   5.1   5.8   6.4   7.1   7.7   8.8  10.3  .  .  .
 10  1    1 135.0   2.1   2.8   3.4   3.8   4.4   4.7   5.3   5.8   6.7  .  .  .
 11  1    1 202.5   4.2   5.0   5.3   5.7   5.9   6.4   6.9   7.4   9.5  .  .  .
 12  1    1 337.5   3.1   3.6   4.4   4.9   5.5   6.5   7.1   8.0   9.0  .  .  .
 13  1    1 270.0   3.0   3.3   3.8   4.2   4.6   4.8   5.0   5.5   6.3  .  . .
 14  1    1   0.0   3.6   4.4   5.7   6.3   6.6   7.2   7.9   9.0  10.1  .  .  .
 15  1    1   0.0   3.7   4.5   6.1   6.3   6.7   7.7   8.0   9.1  11.3  .  .  .
 16  1    1 157.5   2.5   3.4   3.9   4.3   4.5   4.9   5.2   5.6   6.1  .  .  .
 17  1    1 292.5   3.4   4.0   4.3   4.6   5.2   5.4   5.8   6.2   7.2  .  .  .
 18  1    1  22.5   3.3   4.5   5.0   5.6   6.2   7.0   7.7   8.5   9.0  .  .  .
 19  1    1 157.5   3.0   3.6   4.1   4.4   4.7   5.1   5.4   5.7   8.2  .  .  .
 20  1    1 180.0   3.8   4.8   5.6   5.8   6.4   7.0   7.7   8.0   8.9  .  .  .
 21  1    1   0.0   3.7   4.4   6.0   6.3   6.7   7.5   8.0   9.1  10.5  .  .  .
 22  1    1  22.5   3.5   4.7   5.2   5.8   6.6   7.3   8.0   8.9  11.7  .  .  .
 23  1    1 270.0   3.1   3.4   3.9   4.2   4.6   4.8   5.0   5.5   6.5  .  .  .
 24  1    1 135.0   2.0   2.8   3.4   3.7   4.2   4.7   5.3   5.8   6.5  .  .  .
 25  1    1 157.5   2.7   3.5   4.0   4.3   4.5   5.0   5.2   5.6   6.9  .  .  .
 26  1    1  22.5   3.4   4.6   5.1   5.7   6.2   7.1   7.7   8.6   9.7  .  .  .
 27  1    1 180.0   3.8   4.9   5.6   6.0   6.6   7.1   7.7   8.0  10.0  .  .  .
 28  1    1 315.0   2.8   3.5   4.1   4.5   4.9   5.5   6.1   6.4   7.1  .  .  .
 29  1    1 202.5   4.0   4.9   5.2   5.7   5.9   6.2   6.7   7.2   8.4  .  .  .
 30  1    1 247.5   2.6   3.1   3.6   4.2   4.5   4.9   5.2   5.6   6.7  .  .  .
 31  1    1   0.0   3.7   4.4   5.9   6.5   7.4   8.2   9.2  10.1  12.2  .  .  .
  .  .    .     .     .     .     .     .     .     .     .     .     .  .  .  .
  .  .    .     .     .     .     .     .     .     .     .     .     .  .  .  .
  .  .    .     .     .     .     .     .     .     .     .     .     .  .  .  .
```

CLIGEN File

The default CLIGEN file extension is “cli” (e.g., cligen.cli). The CLIGEN weather generator was developed for use with the Water Erosion Prediction Project (WEPP) (Flanagan, et.al., 2001) and is used by WEPS to simulate other weather parameters. The input file created by CLIGEN includes precipitation amount (mm), duration (hr), time to peak (fraction of duration), and peak intensity (mm hr^{-1}), as well as maximum and minimum air temperature (°C), solar radiation (ly d^{-1}), and dew point temperature (°C). This file also contains historical monthly averages for maximum and minimum temperature (°C), which are required by WEPS.

Although WEPS ignores non-needed data in the CLIGEN file, WEPS reads the entire file, so each line and column in WEPS must be populated, even though some elements may be ‘dummy’ variables not used by WEPS. For example, line 2 contains information not used by WEPS, but it must be present with any characters present. The CLIGEN file is read in free format. Figure 4.10 shows an example CLIGEN file.

CLIGEN File Parameters:

Line 1: CLIGEN version number. Must be “5.110" for the file format described in this document.

Lines 2-6: Information in these lines are not required by WEPS, but must be present as placeholders.

Line 7: Observed monthly average maximum temperatures (ºC).

Line 8 Comment line.

Line 9: Observed monthly average minimum temperatures (ºC).

Lines 10-15: Comment lines.

Line 16 +: daily weather data.

Columns 1, 2, 3: **day mon year** - the day, month, and year of simulation (integer).

Column 4: **prcp** - total precipitation for the day, including snow, hail, and rain (real- millimeters).

Column 5: **dur** - duration of the rainfall event (real- hours).

Column 6: **tp** - fraction of time to peak (real- time to peak in hours/duration in hours).

Column 7: **ip** - WEPP data, ignored in WEPS, but must have some numbers present (e.g., 0.0)(real).

Columns 8, 9: **tmax tmin** - the maximum and minimum daily air temperature (real - C).

Column 10: **rad** - daily solar radiation (real - ly/day).

Columns 11-12: WEPP wind data, ignored in WEPS, but numbers must be present (e.g., 0.0) (real).

Column 13: **dew** - dew point temperature (real - C).

Figure 4.10. Example CLIGEN File.

```
5.110
  1   0   0
  Station:  CIMARRON KS                                 CLIGEN VERSION 5.110 -r:    0 -I: 0
Latitude Longitude Elevation(m) Obs. Years  Beginning year  Years simulated Command Line:
   37.80  -100.35      801         54           1             6        -S14 -s1522 -idb\cligen_fs.db -b1
Observed monthly ave max temperature ©)
  6.9  10.1  14.5  20.8  25.3  31.1  34.2  33.2  28.8  22.8  13.8   8.3
Observed monthly ave min temperature ©)
 -8.1  -5.8  -2.1   4.1   9.8  15.3  18.0  17.0  12.2   5.3  -2.4  -6.7
Observed monthly ave solar radiation (Langleys/day)
253.0 317.0 420.0 525.0 564.0 643.0 635.0 578.0 491.0 374.0 307.0 234.0
Observed monthly ave precipitation (mm)
 14.3  17.0  33.6  48.3  90.9  89.8  87.2  68.4  45.1  37.0  21.5  13.4
da mo year  prcp  dur   tp     ip  tmax  tmin  rad  w-vl w-dir  tdew
            (mm)  (h)               ©)   ©) (l/d) (m/s)(Deg)   ©)
 1  1    1   0.0  0.00 0.00   0.00   3.9  -2.6 250.  5.5   75.  -0.4
 2  1    1   0.0  0.00 0.00   0.00  -2.5  -5.5 143.  6.0  297.  -6.8
 3  1    1   0.0  0.00 0.00   0.00   0.3  -4.0 219.  8.2  238. -16.9
 4  1    1   0.0  0.00 0.00   0.00  17.8 -10.2 253.  4.0  227. -16.5
 5  1    1   0.0  0.00 0.00   0.00   6.3 -12.3 254.  5.9  314.  -4.9
 6  1    1   0.0  0.00 0.00   0.00  15.3  -3.6 148.  8.3  238.  -4.0
 7  1    1   0.0  0.00 0.00   0.00   0.5 -10.2 257.  7.0   23.  -9.4
 8  1    1   0.4  1.66 0.01   1.01  13.9 -14.2 258.  7.9  355.  -8.5
 9  1    1   0.0  0.00 0.00   0.00   7.1  -5.6 230.  2.6  328.  -6.5
10  1    1   0.0  0.00 0.00   0.00  10.1  -6.2 283.  8.6   49.  -4.8
11  1    1   0.0  0.00 0.00   0.00  10.0  -9.0 263.  0.0    7. -20.9
12  1    1   0.0  0.00 0.00   0.00   2.8 -12.2 231.  6.9  222.  -4.8
13  1    1   0.0  0.00 0.00   0.00  -0.3 -14.1 267.  1.2  317.  -7.3
14  1    1   0.0  0.00 0.00   0.00  -4.0  -6.7 173.  3.4  313. -12.1
15  1    1   0.0  0.00 0.00   0.00  -1.7 -14.8 270.  2.7  132. -18.0
16  1    1   2.3  1.29 0.04   1.01   0.6  -4.9 262.  9.9   15. -13.7
17  1    1   0.0  0.00 0.00   0.00   6.0  -5.0 241.  7.0  338. -12.3
18  1    1   0.0  0.00 0.00   0.00   7.8  -9.1 203.  4.2  262. -13.5
19  1    1   0.0  0.00 0.00   0.00  12.3 -10.5 181.  3.7  275.  -8.1
20  1    1   0.0  0.00 0.00   0.00  -8.9 -10.5 266.  6.0    6. -17.9
21  1    1   0.0  0.00 0.00   0.00  14.7  -9.8 283.  5.7  264.  -3.7
22  1    1   0.0  0.00 0.00   0.00   3.9  -8.0 132.  3.5  233.  -8.2
23  1    1   0.0  0.00 0.00   0.00  11.2 -10.0 196.  4.9  150.  -6.5
24  1    1   0.0  0.00 0.00   0.00   2.3 -15.9 230.  4.6  136. -19.5
25  1    1   0.0  0.00 0.00   0.00  12.6 -13.7 172.  6.2  312.  -0.7
26  1    1   0.0  0.00 0.00   0.00  14.4  -6.0 272.  7.5  156.   4.0
27  1    1   0.0  0.00 0.00   0.00   2.6   0.9 213.  5.7  176.  -5.1
28  1    1   4.2  1.19 0.00   1.01  15.2 -15.3 173.  7.7  170. -14.8
29  1    1  10.6  1.73 0.05   1.01  24.8  -3.5 302.  4.8  206.  -7.3
30  1    1   3.5  1.92 0.29   4.81   8.3  -5.9 280.  2.7  277. -14.0
31  1    1   0.0  0.00 0.00   0.00  20.9   2.3 228.  2.9  240.   1.3
 1  2    1   0.0  0.00 0.00   0.00   7.5  -4.9 241.  7.3  316.  -5.8
 2  2    1   0.0  0.00 0.00   0.00   7.6  -4.6 316.  2.2  169. -10.1
 3  2    1   0.0  0.00 0.00   0.00   3.6 -12.8 326.  4.3  322.  -4.7
 .  .    .   .    .    .      .      .     .    .    .     .     .
```

Soil File
The default soil file name has an "ifc" extension (e.g., amarillo.ifc). This file contains the initial soil conditions at the start of a simulation run. The soil and management submodels then simulate the changes in these conditions as affected by weather, management, and erosion for each simulation day. Even intrinsic parameters such as particle size distribution will change with tillage as layers are mixed. If simulated soil parameters differ significantly from measured values, it is recommended that the user use the stand-alone Erosion model (described in this chapter) to simulate single storms using measured values. The soil input file includes the taxonomic order, number, and thickness (mm) of soil layers; detailed particle size distribution (fraction); wet and dry bulk density (Mg m^{-3}); aggregate stability (ln(J m^{-2})), density (Mg m^{-3}), and size distribution (fraction); soil crust properties (varies); random and oriented (ridge) roughness (mm); soil water characterization parameters (varies); dry albedo (fraction); organic matter (fraction); pH; calcium carbonate (fraction); and cation exchange capacity (meq $100g^{-1}$). This file also contains comments (indicated by a '#' in column one) that describe each line of input data to aid in checking and modifying input data. A description of the items required by WEPS follows, which can be viewed and edited within soil panel of the WEPS interface. The absolute range is that allowable by WEPS; the typical range lists the range of values to be expected with typical soils. An example Soil file is shown in Figure 4.11.

The WEPS soil interface is a simple way to edit input data in the Soil file and is recommended. It is also recommended that the user select an existing soil file from the database with similar properties to the desired soil and modify its properties. Soil database files that were derived from the NRCS SSURGO database are accessed through the "Template" button at the bottom of the WEPS main screen. Once a soil is selected, the soil interface is accessed by clicking the "Soil" button at the bottom of the main screen. The information presented here is for the benefit of those users who wish to modify the input file themselves.

Soil File Parameters:

Version
Version: - A version number to allow the user to choose between an older ifc file format and the newer format, which is Version 1.0 (described here). Contact WERU if you have ifc files in an older format that you want to use with WEPS.

Soil Identification
Soil ID - Soil identifying information consisting of the following (separated by a dash). Note that these items are not critical to the operation of WEPS, and are used for identification purposes only.

Soil Survey Area ID - The soil survey area identification for the soil (character). The soil survey area identification is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Map Unit Symbol - The symbol used to uniquely identify the soil map unit in the soil survey (character). The map unit symbol is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Component Name - The name of the soil (character). The soil component name is not critical to the operation of WEPS, and is used for identification purposes only.

Estimated by: “Unknown”

Component Percent - The percentage of the soil component of the map unit (integer). The soil component percentage is not critical to the operation of WEPS, and is used for identification purposes only.
Absolute range = >0 to 100 Typical range = >0 to 100
Estimated by: “Unknown”

Surface Texture Class - The class of the surface layer based on USDA system for particle size (character). The texture class is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

State - The state in which the soil occurs (character). The state is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

County - The county in which the soil occurs (character). The county is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Soil Survey Area Name - The soil survey area name in which the soil occurs (character). The soil survey area name is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Local Phase - Phase criterion used at the local level to help identify soil components (character). The local phase is not critical to the operation of WEPS, and is used for identification purposes only.

Estimated by: "Unknown"

Soil Order - The taxonomic soil order is the name for the highest level in soil taxonomy (character). The taxonomic soil order is not critical to the operation of WEPS, and is used for identification purposes only.

Estimated by: "Unknown"

Soil Loss Tolerance (T factor) - The maximum amount of erosion at which the quality of a soil as a medium for plant growth can be maintained. (Tons/acre/year) The soil loss tolerance is not critical to the operation of WEPS, and is used for identification purposes only.

Absolute range = 1 - 5 Typical range = 1 - 5
Estimated by: "Unknown"

Dry Soil Albedo - The estimated ratio of the incident short-wave (solar) radiation that is reflected by the air dry, less than 2 mm fraction of the soil surface (unitless).

Absolute range = 0.00 to 1.00 Typical range = 0.05 to 0.25
Estimated by: method of method of Post et.al. (2000) or Baumer (1990).

Slope Gradient - The difference in elevation between two points on the overall field surface, expressed as a fraction of the distance between those points. (real fraction)

Absolute range = 0.0 - 0.999 Typical range = 0.0 - 0.3
Estimated by: slope = 0.01

Soil Surface Properties & Depth Restrictions

Surface Fragment Cover - The fraction of the surface area covered by rock greater than 2.0 mm (m^3/m^3).

Absolute range = 0.0 to 1.0 Typical range = 0.0 - 0.5
Estimated by: Surface layer fragment volume

Depth to Bedrock - The observed depth to the top of the bedrock layer, if present (mm).

Absolute range = 0.0 to 99990.0 Typical range = ?
Estimated by: depth to bedrock = 99990.0

Depth to Root Restricting Layer - The depth to the upper boundary of a restrictive layer, if present (mm).

Absolute range = 0.0 to 99990.0 Typical range = ?
Estimated by: depth to bedrock = 99990.0

Soil Layer Properties

Number of Soil Layers - The number of soil horizons of layers for which properties are reported.

Layer Thickness - The thickness of each soil layer (mm). WEPS requires a specific layer structure, which is determined by the soil interface.

Estimated by: user defined (required)

Sand - Mineral particles 0.05 to 2.0 mm in equivalent diameter as a weight fraction of the less than 2.0 mm fraction (kg/kg).

Absolute range = (>0.0) to 1.0 Typical range = [1.0 - (silt + clay)]

Estimated by: sand = 1.0 - (silt + clay)

Silt - Mineral particles 0.002 to 0.05 mm in equivalent diameter as a weight fraction of the less than 2.0 mm fraction (kg/kg).

Absolute range = (>0.0) to 1.0 Typical range = [1.0 - (sand + clay)]

Estimated by: silt = 1.0 - (sand + clay)

Clay - Mineral particles less than 0.002 mm in equivalent diameter as a weight fraction of the less than 2.0 mm fraction (kg/kg).

Absolute range = (>0.0) to 1.0 Typical range = [1.0 - (sand + silt)]

Estimated by: clay = 1.0 - (silt + sand)

Rock Fragments - The volume fraction of the layer occupied by the 2.0 mm or larger (20 mm or larger for wood fragments) on a whole soil basis (m^3/m^3).

Absolute range = 0.0 to 1.0 Typical range = 0.0 - 0.5

Estimated by: rock fragments = 0.0

Sand Fractions

Sand Fractions: Coarse - Mineral particles 0.5 to 1.0 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0

Estimated by: CS = 0.0

Sand Fractions: Very Coarse - Mineral particles 1.0 to 2.0 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0

Estimated by: VCS = 0.0

Sand Fractions: Medium - Mineral particles 0.2 to 0.5 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0

Estimated by: MS = 0.0

Sand Fractions: Fine - Mineral particles 0.1 to 0.2 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).
Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0
Estimated by: FS = 0.0

Sand Fractions: Very Fine - Mineral particles 0.05 to 0.1 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).
Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0
Estimated by: user defined (required)

Bulk Density

Bulk Density 1/3 Bar - The oven dry weight of the less than 2 mm soil material per unit volume of soil at a tension of 1/3 bar (Mg/m^3).
Absolute range = (>0.0) to 10.0 Typical range = 0.8 to 1.6
Estimated by: user defined (required)

Other Layer Properties

Organic Matter - The amount by weight of decomposed plant and animal residue expressed as a weight fraction of the less than 2 mm soil material (kg/kg).
Absolute range = 0.0 to 1.0 Typical range = 0.0005 to 0.05
Estimated by: user defined (required)

pH - The negative logarithm to the base 10, of the hydrogen ion activity in the soil according to the 1:1 soil:water ratio method (unitless). A numerical expression of the relative acidity or alkalinity of a soil sample.
Absolute range = 1.0 to 14.0 Typical range = 4.0 to 9.0
Estimated by: pH = 7.0

CaCO3 - The quantity of carbonate (CO3) in the soil expressed as CaCO3 and as a weight percentage of the less than 2 mm size fraction (kg/kg).
Absolute range = 0.0 to 1.0 Typical range = 0.0 to 0.3
Estimated by: user defined (required)

CEC - The cation exchange capacity (meq/100g).
Absolute range = 0.0 to 400.0 Typical range = 0 to 400.0
Estimated by: user defined (required)

Linear Extensibility Percent - The linear expression of the volume difference of natural soil fabric at 1/3 or 1/10 bar water content and oven dryness. The volume change is reported as a percentage change for the whole soil (%).
Absolute range = 0.0 to 30.0 Typical range = ?
Estimated by: Soil Survey Staff (1996).

Aggregates

Aggregate Geometric Mean Diameter - Soil aggregate geometric mean diameter of the modified log-normal distribution (mm).

Absolute range = 0.03 to 30.0 Typical range = 0.1 to 15.0

Estimated by: aggr. gmd = exp(l.343 - 2.235 * sand - 1.226 * silt - 0.0238*sand/clay + 33.6 * om + 6.85 * $CaCO_3$) * (1.0 + 0.006 * layer depth)

Aggregate Geometric Standard Deviation - Soil aggregate geometric standard deviation of the modified log-normal distribution (dimensionless).

Absolute range = 1.0 to 20.0 Typical range = 4.0 to 15.0

Estimated by:

aggr. gsd = 1.0 / (0.0203 + 0.00193(aggr. gmd) + 0.074 / $(\text{aggr.gmd})^{0.5}$)

Maximum Aggregate Size - Upper limit of the modified log-normal aggregate size distribution (mm).

Absolute range = 1.0 to 1000.0 Typical range = 2.0 to 100.0

Estimated by: aggr.max. size = $(\text{aggr. gsd})^{p}$ * (aggr. gmd) + 0.84

where p = 1.52 * $(\text{aggr. gsd})^{-0.449}$

Minimum Aggregate Size - Lower limit of the modified log-normal aggregate size distribution (mm).

Absolute range = 0.001 to 5.0 Typical range = 0.006 to 0.020

Estimated by: aggr min. size = 0.01

Aggregate Density - The aggregate density for (Mg/m^3).

Absolute range = 0.6 to 2.5 Typical range = 0.8 to 2.0

Estimated by: Rawls (1983)

aggr density = 2.0 for layer depth > 300 mm

aggr density = 2.01 *(0.72 + 0.00092 * layer depth) for layer depth < 300 mm

Aggregate Stability - Mean of natural log of aggregate crushing energies (ln(J/kg)).

Absolute range = 0.1 to 7.0 Typical range = 0.5 to 5.0

Estimated by: aggr. stability = 0.83 + 15.7 * clay - 23.8 * clay^{2}

Soil Crust

Soil Crust Thickness - Average thickness of the consolidated zone in the surface layer (mm).

Absolute range = 0.0 to 23.0 Typical range = 0.0 to 10.0

Estimated by: crust thickness = 0.01

Soil Crust Density - The density of the soil crust (Mg/m^3).

Absolute range = 0.6 to 2.0 Typical range = 0.8 to 1.6

Estimated by: aggregate density

Soil Crust Stability - Mean of natural log of crust crushing energies (ln(J/kg)).
Absolute range = 0.1 to 7.0 Typical range = 0.3 to 5.0
Estimated by: aggregate stability

Crust Surface Fraction - Fraction of surface covered with consolidated soil, as opposed to aggregated soil (m^2/m^2).
Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0
Estimated by: 0.0

Mass of Loose Material on Crust - Mass of the loose, saltation-size soil on the surface soil crusted area (kg/m^2).
Absolute range = 0.0 to 3.0 Typical range = 0.0 to 1.0
Estimated by: 0.0

Fraction of Loose Material on Crust - Fraction of total soil surface area covered with loose material on the crust (m^2/m^2).
Absolute range = 0.0 to soil crust fraction Typical range = 0.0 to 0.5
Estimated by: 0.0

Roughness

Random Roughness - The standard deviation of elevation from a plane of a random soil surface, including any flat biomass adjusted as suggested by Allmaras et al. (1966) (mm).
Absolute range = 1.0 to 70.0 Typical range = 2.0 to 10.0
Estimated by: 4.0

Ridge Orientation - Direction of the tillage ridge, clockwise from true north (degrees).
Absolute range = 0.0 to 179.99 Typical range = 0.0 to 179.99
Estimated by: 0.0

Ridge Height - The height of soil ridges from bottom of furrow to top of ridge (mm).
Absolute range = 0.0 to 500. Typical range = 0.0 to 300.0
Estimated by: 0.0

Spacing Between Ridge Tops - Spacing between ridge tops (mm).
Absolute range = 10.0 to 2000.0 Typical range = 60.0 to 1000.0
Estimated by: 10.0

Ridge Width - Width of the top of the ridge (i.e. bed width) (mm)
Absolute range = 10.0 to 4000.0 Typical range = 100.0 to 2000.0
Estimated by: 10.0

Hydrologic properties

Initial Bulk Density (1/3 Bar) - The oven dry weight of the less than 2 mm soil material per unit volume of soil at a tension of 1/3 bar (Mg/m^3).

Absolute range = (>0.0) to 10.0 Typical range = 0.8 to 1.6

Estimated by: user defined (required)

Initial Water Content - Soil water content at the beginning of the simulation (cm^3/cm^3).

Absolute range = 0.0 to ?? Typical range = varies with soil texture

Estimated by: ½ (field capacity + wilting point)

Saturation Water Content - Soil water content when soil pores are completely filled (i.e. zero soil matric potential) (cm^3/cm^3).

Absolute range = 0.0 to ?? Typical range = varies with soil texture

Estimated by: Saxton, et al. (1986)

Note: Saturated water content > Field capacity water content > Wilting point water content

Field Capacity Water Content - The amount of soil water retained at 1/3 bar (33 kPa), expressed as a fraction of the less than 2 mm, oven-dry soil by volume (cm^3/cm^3).

Absolute range = 0.0 to ?? Typical range = varies with soil texture

Estimated by: Saxton, et al. (1986)

Note: Saturated water content > Field capacity water content > Wilting point water content

Wilting Point Water Content - The amount of soil water retained at 15 bars (1500 kPa), expressed as a percentage of the less than 2 mm, oven-dry soil by volume (cm^3/cm^3).

Absolute range = 0.0 to ?? Typical range = varies with soil texture

Estimated by: Saxton, et al. (1986)

Note: Saturated water content > Field capacity water content > Wilting point water content

Soil CB Value - The power of Campbell's model of the soil water characteristics curve (unitless).

Absolute range = 0.917 to 27.027 Typical range = varies with soil texture

Estimated by: Saxton, et al. (1986)

Air Entry Potential - The air entry potential is defined as the potential at which the largest water-filled pores start to drain and hence gas flow can be observed (Joules/kg).

Absolute range = -17.91 to 0.0 Typical range = varies with soil texture

Estimated by: Saxton, et al. (1986)

Saturated Hydraulic Conductivity - The amount of water that would move vertically through a unit area of saturated soil in a unit time under unit hydraulic gradient (m/s).

Absolute range = 0.0 to 1E-3 Typical range = 0.0 to 1E-3

Estimated by: Saxton, et al. (1986)

Notes - The user may enter any notes pertaining to the soil file. These notes are appended to the bottom of the soil file. The soil notes may also contain notes generated by the interface. These generated notes specify parameters that were adjusted because of out-of-range values, and lists the old and new values. The notes are not critical to the operation of WEPS, and are used for information purposes only.

Figure 4.11. Example Soil file.

```
Version: 1.0
#
# Soil ID
CO631-Se-San Luis-100-SL-Colorado-Rio Grande County Area-Rio Grande County Area,
Colorado
#
# Local Phase
DRAINED
# Soil Order
Aridisols
# Soil Loss Tolerance (tons/acre/year)
3
# Dry soil albedo (fraction)
0.230
# Slope gradient (fraction)
0.010
# Surface fragment cover or surface layer fragments (area fraction)
0.000
#
# Depth to bedrock (mm)
99990
# Depth to root restricting layer (mm)
99990
#
# Number of layers
3
# Layer thickness (mm)
150     460     910
#
# Sand fraction
0.659     0.340     0.960
# Silt fraction
0.191     0.370     0.015
# Clay fraction
0.150     0.290     0.025
# Rock fragments
0.000     0.000     0.260
# Sand fraction very coarse
0.043     0.030     0.007
# Sand fraction coarse
0.141     0.043     0.131
# Sand fraction medium
0.175     0.059     0.372
# Sand fraction fine
0.196     0.106     0.378
# Sand fraction very fine
0.104     0.102     0.072
#
# Bulk Density (1/3 bar)(Mg/m^3)
1.350     1.250     1.400
# Organic matter (kg/kg)
0.0075     0.0025     0.0025
# Soil PH (0-14)
8.50     9.80     7.90
# Calcium carbonate equivalent (CaCO3)
0.08     0.15     0.06
# Cation exchange capacity (CEC) (meq/100g)
10.00     15.00     2.50
# Linear extensibility
0.015     0.045     0.015
```

```
#
# Aggregate geometric mean diameter (mm)
2.647     15.675     2.929
# Aggregate geometric standard deviation
13.086     13.393     13.463
# Maximum aggregate size (mm)
33.055     49.322     33.579
# Minimum aggregate size (mm)
0.010     0.010     0.010
# Aggregate density (Mg/m^3)
1.725     2.000     2.000
# Aggregate stability (ln(J/m^2))
2.650     3.381     1.208
#
# Crust thickness (mm)
0.010
# Crust density (Mg/m^3)
1.725
# Crust stability (ln(J/m^2))
2.65
# Crust surface fraction (m^2/m^2)
0.00
# Mass of loose material on crust (kg/m^2)
0.00
# Fraction of loose material on crust (m^2/m^2)
0.00
#
# Random roughness (mm)
4.00
# Ridge orientation (deg)
0.00
# Ridge height (mm)
0.00
# Spacing between ridge tops (mm)
10.00
# Ridge width (mm)
10.00
#
# Initial Bulk Density (1/3 bar)(Mg/m^3)
1.350     1.250     1.400
# Initial soil water content (m^3/m^3)
0.140     0.222     0.037
# Saturation soil water content (m^3/m^3)
0.434     0.494     0.313
# Field capacity water content (m^3/m^3)
0.188     0.296     0.060
# Wilting point water content (m^3/m^3)
0.091     0.148     0.014
#
# Soil CB value (exponent to Campbell's SWRC)
5.909     6.175     3.957
# Air entry potential (J/kg)
-0.429     -1.633     -0.423
# Saturated hydraulic conductivity (m/s)
2.821E-5     2.819E-6     9.174E-5
#
# Notes:
#  The user may enter notes here.
```

Management File

The default file name is **'*.man'**. This file contains parameters for the manipulation of soil and biomass properties as a result of various management operations performed on the field on a given date. These operations include planting, harvesting, cultivation, defoliation, fertilization, and irrigation. The management file should only be altered by using the Management Crop Rotation Editor for WEPS (MCREW), to guarantee that parameters are correct. MCREW is accessed through the WEPS user interface.

Stand-alone Erosion Submodel

The Erosion submodel (tsterode) can also be operated as a stand-alone model to simulate erosion for a single storm (i.e., daily). Input parameters that must be provided for the day include the field and barrier dimensions, as well as biomass, soil, hydrology, and weather parameters. Wind speed can be entered either as Weibull distribution parameters or listed as average wind speeds for each time period throughout the day. Valid command line options for the stand-alone erosion submodel are:

Command Line Options

Usage: tsterode -i"input_filename" -x# -y# -t# -u -E -Plot -? -h

Valid command line options:

-? or -h Display the available command line options.

-x# Number of grid points in x direction (min. = 3; max. = 500). The submodel calculates the loss/deposition over a series of individual, equal-sized grid cells representing the entire simulation region. The more grid points, the smaller the area in each grid cell. The recommended total number of grid cells is 30 for a field without a barrier and 60 for a field with a barrier. Increasing the number of grid cells increases the accuracy of the soil loss/deposition estimates, as well as increases the run time. If not specified, the number of grid points is calculated within the model.

-y# Number of grid points in y direction (min. = 3; max. = 500). The submodel calculates the loss/deposition over a series of individual, equal-sized grid cells representing the entire simulation region. The more grid points, the smaller the area in each grid cell. The recommended total number of grid cells is 30 for a field without a barrier and 60 for a field with a barrier. Increasing the number of grid cells increases the accuracy of the soil loss/deposition estimates, as well as increases the run time. If not specified, the number of grid points is calculated within the model.

-t# Interval for surface updating in seconds (min. = 60 seconds; max. = 86400 seconds). This is used to specify a fixed surface updating interval and is primarily for testing and evaluation purposes. Because the erosion code contains an update loop dependent upon the number of time intervals/day and an inner loop that allows more frequent surface updating to occur, the imp interval must be evenly divisible into both the number of time intervals/day and 24 (hours in a day). If these conditions are not met, the program aborts with an error message.

-u Disable erosion surface updating.

-i"input_filename" Specify input filename. The input filename must be specified and listed before the -Einp, -Erod, -Egrd, and -Emit options. Quotes are required if spaces are within the file name.

-Einp Writes (echos) the input file to “input_filename.einp”. This is useful for debugging purposes. The “input_filename” is the same name as the input filename with a “.eimp” extension, and will be created in the same directory specified for the input filename.

-Erod Output erosion summary (kg/m^2) (positive values are soil loss). The one line output in the file contains the following:

Total loss, saltation plus creep, suspension, PM10, and the input filename

The “-Erod’ option requires that the input file (-i"input_filename") be specified as a command line argument before the “-Erod” option, e.g.:

tsterode -iinput_filename.ext -Erod

The “input_filename” in the erosion summary is the same name as the input filename with a “.erod” extension, and will be created in the same directory specified for the input filename.

-Egrd Output grid summary results (kg/m^2) (positive values are soil loss). The "-Egrd' option requires that the input file (-i"input_filename") be specified as a command line argument before the "-Egrd" option, e.g.:

tsterode -iinput_filename.ext -Egrd

The "input_filename" in the grid summary is the same name as the input filename with a ".egrd" extension, and will be created in the same directory specified for the input filename.

-Emit Output hourly erosion results (kg/m^2) (positive values are soil loss). The "-Emit' option requires that the input file (-i"input_filename") be specified as a command line argument before the "-Emit" option, e.g.:

tsterode -iinput_filename.ext -Emit

The "input_filename" in the hourly erosion results is the same name as the input filename with a ".emit" extension, and will be created in the same directory specified for the input filename.

-Eplt Enable printing of a file that can be used to plot various data. The data is appended to the file for each run.

-Esgrd Output all grid cell values for selected grid cell variables (e.g., RR, ridge ht, friction velocity, etc.) as well as the standard erosion results for each subdaily period. Each "period" is identified by the "yy mm dd hr variable_name_title" prior to the grid cell values. The "-Esgrd' option requires that the input file (-i"input_filename") be specified as a command line argument before the "-Esgrd" option, e.g.:

tsterode -iinput_filename.ext -Esgrd

The "input_filename" in the grid summary is the same name as the input filename with a ".sgrd" extension, and will be created in the same directory specified for the input filename.

Default options are set to:
-t900

Note that these command line options cannot be specified when the erosion submodel is run through the WEPS interface.

The input file contains comments (indicated by a '#' in column one) that describe each line of input data to aid in checking and modifying input data, which follows the comments. Specific definitions of these parameters are documented within the comment lines within the input file (Fig. 4.12).

Figure 4.12. Example stand-alone erosion input file.

```
#**************************************************************
#    erod_template.in   Template INPUT DATA FILE
#                       Updated January 2006 - LEW
#**************************************************************
#
#     +++ PURPOSE +++
#
#     Input file for standalone erosion submodel program (tsterode)
#
#     All lines beginning with a "#" character are assumed to
#     be comment lines and are skipped.
#
#     +++ DEFINITIONS +++
#
#     All comments prior to each line of data input
#     in this template input file have the following format:
#
#     Variable_Name, Var_type, Text Definition
#
#     where Var_type is: I = integer L = logical R = real
#
#
# +++ DEBUG STUFF +++
#
#     debugflg - debug flag for providing different levels of debug info
#                currently useful to debug/check input file data format
#
#                value of 0 will print no debug information
#                value of 1 will print out and number all input file lines
#                value of 2 will print out and number all data input lines
#                value of 3 will do both 1 and 2
 0
#
#
# +++ INIT STUFF +++
#
#     am0eif, L, EROSION "initialization" flag
#                Must be set to .TRUE. for standalone erosion runs
 .TRUE.
#
#     am0efl, I, EROSION "print" flag
#               NOTE:  Not sure if all of these have yet been replaced by
#                      "tsterode" cmdline options.  Regardless, this flag
#                      should be considered deprecated in this file. - LEW
#               Range: 0 to 6
#               0 = print input, no output
#               1 = print input, standard output
#               2 = print input, 1 line output
#               3 = used in WEPS to print input, then create file "emit.out"
#                       containing hourly suspended emission rates
#            4 = used in standalone to print input, then create file "emit.out"
#                       containing hourly suspended emission rates
#               5 = not used at present
#               6 = print input, detail output each step using calls
#                       to sb1out and sb2out
 1
#
# +++ SIMULATION REGION +++
#
#     amxsim(x,y), R, Simulation Region diagonal coordinates (meters)
#                     Input (x,y) coordinates in this form: x1,y1 x2,y2
#                      Typical Range: 10.0 to 1600.0
#
#                     NOTE:  Accounting region and Subregion coordinates
#                            must also be set to the same values
```

```
#
  0.0, 0.0 1000.0, 200.0
#
#
#     amasim, R, Simulation Region orientation angle (degrees from North)
 0.0
#
#
# +++ ACCOUNTING REGIONS +++
#
#     nacctr, I, Number of accounting regions (must always be 1 for now)
 1
#
#     amxar(x,y,a), R, Accounting Region diagonal coordinates (meters)
#                      Input (x,y) coordinates in this form: x1,y1 x2,y2
#                      for each Accounting Region specified (nacctr)
#
#                      NOTE:  Accounting Region coordinate values must
#                             match Simulation Region coordinates above
#
 0.0, 0.0 1000.0, 200.0
#
#
# +++ BARRIERS +++
#
#     nbr, I, Number of barriers (0-5)
 2
#     NOTE: Remaining BARRIER inputs are repeated for each barrier specified
#           If no barriers specified (nbr=0), then no BARRIER inputs will
#           be listed here.
#
#     amxbr(x,y,b), R, Barrier linear coordinates (meters)
#                      Input (x,y) coordinates in this form: x1,y1 x2,y2
#                      for each barrier specified (nbr)
 0.0, 0.0 0.0, 200.0
#
#       amzbr(b),  R, Barrier height (meters)
#       ampbr(b),  R, Barrier porosity (m^2/m^2)
#       amxbrw(b), R, Barrier width (meters)
#
 0.2 0.5 15.0
#
#       Repeat previous two input lines for each additional barrier
#
#       Barrier #2 coordinates (x1,y1) (x2,y2)
 0.0, 0.0 1000.0, 0.0
#       Barrier #2 height, porosity and width
 0.2 0.5 15.0
#
#
# +++ SUBREGION REGIONS +++
#
#     nsubr, I, Number of subregions (1-5)
#               NOTE:  Currently not fully tested for multiple subregions
#                      Only use value of 1
#
 1
#
#     NOTE: Remaining SUBREGION inputs (BIOMASS, SOIL, and HYDROLOGY,
#     ie. variables defined by subregion) are repeated for "nsubr"
#     subregions specified
#
#     amxsr(x,y,s), R, Subregion diagonal coordinates (m)
#                      Input (x,y) coordinates in this form: x1,y1 x2,y2
#                      for each subregion specified (subr)
#
#                      NOTE:  Since only one subregion is currently supported,
```

```
#                              subregion coordinate values must match
#                              Simulation Region coordinates above
#
 0.0, 0.0 1000.0, 200.0
#
#
#     +++ BIOMASS +++
#
#
#       adzht_ave(s), R, Height of standing residue (meters)
#                        WEPS generated input files will provide
#                        "SAI weighted" average residue height
#                        across all residue pools.
#            Typical Range: 0.0 to 3.0
 0.21
#
#       aczht(s), R, Average height of growing crop (meters)
 0.0
#
#       acrsai(s), R, Growing crop stem area index (m^2/m^2)
#               Typical Range: 0.0 to 3.0
#       acrlai(s), R, Growing crop leaf area index (m^2/m^2)
#               Typical Range: 0.0 to 8.0
 0.0 0.0
#
#       adrsaitot(s), R, Residue stem area index (m^2/m^2)
#       adrlaitot(s), R, Residue leaf area index (m^2/m^2)
#                        WEPS generated input files will provide
#                        total "SAI" and "LAI" values
#                        across all residue pools.
 0.02 0.00
#
#      acxrow(s), R, Growing crop row spacing (meters)
#                    Use value of 0.0 if not planted in rows,
#                    e.g. broadcast seeded
#      ac0rg(s) , I, Specify seed location (0=furrow,1=ridge)
#                    Value doesn't matter if no ridges exist
 0.3, 0
#
#       abffcv(s), R, Flat biomass cover (m^2/m^2)
 0.0
#
#
#     +++ SOIL +++
#
#     nslay(s), I, (s1layr.inc) Number of soil layers (1-100)
#                  NOTE:  Only surface soil layer necessary
 1
#
#     NOTE: Remaining SOIL inputs are repeated on each input line
#           for each layer specified
#
#     aszlyt(l,s), R, Thickness (mm)
 1000.0
#
#     asdblk(l,s), R, Bulk density of soil layer (Mg/m^3)
#                  Typical Range: >0.0 to 10.0
 1.8
#     asfsan(l,s), R, Fraction of sand content in soil layer (Mg/Mg)
#                  Range: 0.0 to 1.0 (sand + silt + clay = 1.0)
 0.90
#     asfvfs(l,s), R  Fraction of very fine sand in soil layer (Mg/Mg)
#                  Range: 0.0 to 1.0 (fraction of total soil < 2.0 mm)
 0.21
#     asfsil(l,s), R, Fraction of silt content in soil layer (Mg/Mg)
#                  Range: 0.0 to 1.0 (sand + silt + clay = 1.0)
 0.08
```

```
#     asfcla(l,s), R, Fraction of clay content in soil layer (Mg/Mg)
#                  Range: 0.0 to 1.0 (sand + silt + clay = 1.0)
 0.02
#
#     asvroc(l,s), R, Rock volume in soil layer (m^3/m^3)
#                  Range: 0.0 to 1.0
 0.30
#
#     asdagd(l,s), R, Average aggregate density of soil layer (Mg/m^3)
#                  Typical Range: 0.5 to 2.5
 1.8
#     aseags(l,s), R, Average dry aggregate stability of soil layer [ln(J/kg)]
#                  Typical Range: 0.1 to 7.0
 2.50
#
#       ---- Size distribution of soil aggregates ----
#         GMD - Geometric Mean Diameter of aggregates
#         GSD - Geometric Mean Standard Deviation of aggregates
#
#     aslagm(l,s), R, GMD of aggregate sizes in soil layer (mm)
#                  Typical Range: 0.03 to 30.0
 0.47
#     aslagn(l,s), R, Minimum aggregate size in soil layer (mm)
#                  Typical Range: 0.001 to 5.0
 0.043
#     aslagx(l,s), R, Maximum aggregate size in soil layer (mm)
#                  Typical Range: 1.0 to 1000.0
 89.8
#     as0ags(l,s), R, GSD of aggregate sizes in soil layer (mm/mm)
#                  Typical Range: 1.0 to 40.0
 12.0
#
#     +++ SOIL SURFACE +++
#
#     asfcr(s),  R, Surface crust fraction (m^2/m^2)
#             Range: 0.0 to 1.0
#     aszcr(s),  R, Surface crust thickness (mm)
#             Typical Range: 0.0 to 23.0
#    asflos(s), R, Fraction of crusted surface with loose material on top of crust
#             (m^2/m^2)
#             Range: 0.0 to 1.0
#     asmlos(s), R, Mass of loose material on top of crust (kg/m^2)
#             Typical Range: 0.0 to 3.0
#     asdcr(s),  R, Density of soil crust (Mg/m^3)
#             Typical Range: 0.6 to 2.0
#     asecr(s),  R, Dry crust stability [ln(J/kg)]
#             Typical Range: 0.0 to 7.0
 0.6 7.0 0.2 0.4 0.1 1.0
#
#     aslrr(s),  R, Allmaras random roughness (mm)
#             Typical Range: 1.0 to 60.0
 5.0
#     aszrgh(s), R, Ridge height (mm)
#             Typical Range: 0.0 to 500.0
#     asxrgs(s), R, Ridge spacing (mm)
#             Typical Range: 0.0 to 2000.0
#     asxrgw(s), R, Ridge width (mm)
#             Typical Range: 0.0 to 4000.0
#     asxrgo(s), R, Ridge orientation (degrees)
#             Range: 0.0 to 179.99
#                   NOTE: If no ridges, then specify 0.0 for height, width and
spacing
 0.0 0.0 0.0 0
#     asxdks(s), R, Dike spacing (mm)
#             Typical Range: 0.0 to 1000.0
#                   NOTE: If no dikes, then specify 0.0
 0.0
```

```
#
#     +++ HYDROLOGY +++
#
#     ahzsnd(s), R, Snow depth (mm)
#             Typical Range: 0.0 to 1000.0
 0.0
#
#     ahrwcw(l,s), R, Wilting point water content of soil layer (Mg/Mg)
#             Typical Range: 0.0 to 0.25
 0.077
#
#     ahrwca(l,s), R, Current water content of soil layer (Mg/Mg)
#             Typical Range: 0.0 to 0.50
 0.0
#
#
#     ahrwc0(h,s), R, Surface layer water content (Mg/Mg)
#             Typical Range: 0.0 to 0.50
#                  NOTE: The near surface water content is specified on an
#                        hourly basis.  We read in the hrly water content
#                        on two lines, with 12 values in each line.
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
#
#
# NOTE: This is the end of the SUBREGION variables
#
#     +++ WEATHER +++
#
#     awdair, R, Air density (kg/m^3)
#             Typical Range: 0.7 to 1.5
 1.2
#
#     awadir, R, Wind direction (degrees) measured clockwise from North
#             Typical Range: 0.0 to 359.9
 270.0
#
#     ntstep, I, Number of intervals/day to run EROSION
#             Range: 24 to 96
#
#                NOTE:  ntstep = 24 means hourly updates
#                       ntstep = 48 means 30 minute updating
#                       ntstep = 96 means 15 minute updating
 24
#
#     anemht, R  anemometer height (m)
#             Typical Range: 0.5 to 30.0
#     awzzo,  R  aerodynamic roughness at anemometer site (mm)
#             Typical Range: 0.5 to 2000.0
#     wzoflg, I (global variable) zo location flag
#               (flag =0 - at weather station location - zo is a constant)
#              (flag = 1 - on field location - zo varies based on field surface)
   10.0,  10.00  0
#
#     wflg, I, Wind/Weibull flag
#              (0 - read in Weibull parameters, 1 - read in wind speeds)
 1
#
# NOTE: This is only present when (wflg=0)
#     wfcalm, R, Fraction of time winds are calm (hr/hr)
#             Range: 0.0 to 1.0
#     wuc, R, Weibull "c" factor (m/s)
#             Typical Range: >0.0 to 30.0
#     w0k, R, Weibull "k" factor
#             Typical Range: 1.0 to 3.0
#   0.217  7.125  2.971   <--- Example data line for wind expressed as Weibull
parameters
```

```
#
# NOTE: The remaining data is only present when (wflg=1)
#     awu(i), R, Wind speed for (ntstep) intervals (m/s)
#              Typical Range: 0.0 to 30.0
#
#                 NOTE: We can read multiple lines with 6 values per line
#                       Wind data should be AVERAGES for the period.
#                       Hourly averages will often under estimate wind erosion.
#                            30 minute averages or shorter time interval is more
suitable.
8.181  4.068  4.068  4.426  5.052  5.052
4.739  4.292  4.515  3.353  3.621  2.280
5.275  6.750  7.242  7.868  9.835  13.814
17.211       12.651       11.712       12.964       10.014       8.583
#
#
# ******************************************************
#    NOTE:  Not necessary to modify any information below this line
#           unless one is interested in generating a "plot.out" file.
# ******************************************************
#
#    + + + DATA TO PLOT + + +
#
#      "xplot" flag for writing variables to file 'tsterode.eplt'.
#       -1 = write nothing
#        0 = write erosion variables;
#      Actual variables listed below are only written if flagged with a 1
#
#      NOTE:  This flag is deprecated.  Tsterode cmdline options determine
#             if this file is create and/or data appended to it.
  0
#
#      Next are 2 lines per variable:
#       1st line: flag (0=don't write, 1=do write) and variable description
#       2nd line: this info is used as a header in 'plot.out'
#           place header within first 12 positions of the line
#
# xin(i), R, (field length)
   1
  Length(m)
# abzht, R, (biomass ht.(m))
   1
 bio_ht(m)
# abrsai, R (stem area index)
  1
 stem_area
#   abrlai(s), R, Biomass leaf area index (m^2/m^2)
  1
 lai_area
# abffcv, R, (biomass flat fraction cover)
  0
 flat_cov
#     asfvfs(1,s), R, (soil fraction very fine sand in layer 1)
  0
  vfsand
#     asfsan(1,s), R, (soil fraction sand in layer 1)
  1
   sand
#     asfsil(1,s), R (soil fraction silt in layer 1)
  0
  silt
#     asfcla(1,s), R (soil fraction clay in layer 1)
  0
  clay
#     asvoc(1,s), R (soil volume roc in layer 1)(m^3/m^3)
  0
  rock_vol
```

```
#     aseags(1,s), R (soil aggregate stability) (ln J/m^3)
  0
  ag_stab
#     aslagm(1,s), R (soil aggregate geom. mean dia.) (mm)
  0
  ag_gmd
#     aslagn(1,s), R (soil aggregate min. dia.) (mm)
  0
  ag_min
#     aslagx(1,s), R (soil aggregate max. dia.) (mm)
  0
  ag_max
#     as0ags(1,s), R (soil aggregate geo. std. dev.)
  0
  ag_std
#     asfcr(s), R, (s1surf.inc) Surface crust fraction (m^2/m^2)
  0
  crust_cv
#     aszcr(s), R, (s1surf.inc) Surface crust thickness (mm)
  0
 crust_z(mm)
#     asflos(s), R, (s1surf.inc) Fraction of loose material on surface (m^2/m^2)
  0
  los_cv
#     asmlos(s), R, (s1surf.inc) Mass of loose material on crust (kg/m^2)
  0
  los(kg/m^2)
#     asdcr(s), R, (s1surf.inc) Soil crust density (Mg/m^3)
  0
  cr_den(Mg/m^3)
#     asecr(s), R, (s1surf.inc) Soil crust stability ln(J/kg)
  0
  cr_se
#     aslrr(s), R, (s1sgeo.inc) Allmaras random roughness (mm)
  0
  rr(mm)
#     aszrgh(s), R, (s1sgeo.inc) Ridge height (mm)
  0
  z_rgh(mm)
#     asxrgs(s), R, (s1sgeo.inc) Ridge spacing (mm)
  0
  x_rgs(mm)
#     asxrgw(s), R, (s1sgeo.inc) Ridge width (mm)
  0
  x_rgw(mm)
#     asxrgo(s), R, (s1sgeo.inc) Ridge orientation (deg)
  0
  a_rgo(deg)
#
```

Figure 4.13 is an example of a stand-alone erosion submodel output file. It contains a listing of the inputs to the submodel, followed by the generated results labeled 'OUTPUT FROM ERODOUT.FOR'. This section lists the amount of total, suspension, and PM10 leaving each boundary and field grid cell. At the bottom of the file is the field average of each of these grid cells.

Figure 4.13. Example stand-alone erosion output file.

```
REPORT OF INPUTS (read by erodin.for)

+++ Control Flags, etc. +++

ntstep  am0eif  nsubr  nacctr  nbr am0efl
 48      T      1      1      0      1

+++ SIMULATION REGION +++

orientation and dimensions of sim region
amasim(deg)  amxsim - (x1,y1) (x2,y2)
    0.00    0.00    0.00  276.00  276.00

+++ ACCOUNTING REGIONS +++

nacctr - number of accounting regions
1
accounting region dimensions (x1,y1) (x2,y2)
    0.00    0.00  276.00  276.00

+++ BARRIERS +++

 no barriers

+++ SUBREGIONS +++

nsubr - number of subregions
1
subregion dimensions (x1,y1) (x2,y2)
    0.00    0.00  276.00  276.00

*********************** Subregion  1  ***********************

+++ BIOMASS +++

Biomass ht, SAI,    LAI,  flat cover
   0.000   0.000   0.000   0.000

+++ SOIL +++

nslay - number of soil layers
3

layer depth b.density vfsand   sand   silt   clay    rock vol
  1  230.00    1.05    0.14    0.22    0.71    0.08    0.00
  2  680.00    1.05    0.14    0.22    0.71    0.08    0.00
  3  610.00    1.05    0.14    0.22    0.71    0.08    0.00

layer    AgD     AgS  GMD    GMDmn     GMDmx    GSD
  1    1.87    1.00    1.64    0.01   36.73   15.13
  2    2.00    1.87    7.68    0.01   41.79   16.17
  3    2.00    1.87   30.00    0.01   70.96    9.98

Cr frac mass LOS frac.LOS, density stability
    0.00    0.00    0.00    1.87    1.87

    RR,    Rg ht,  width, spacing, orient., dike spacing
    1.50    0.00    0.00    0.00    0.00    0.00

+++ HYDROLOGY +++

Snow depth (mm)
0.00000000E+00

layer  wilting and actual water contents
  1    0.05    0.02
  2    0.05    0.02
  3    0.05    0.02
Hourly water contents - ahrwc0
    0.02    0.02    0.02    0.02    0.02    0.02
    0.02    0.02    0.02    0.02    0.02    0.02
    0.02    0.02    0.02    0.02    0.02    0.02
    0.02    0.02    0.02    0.02    0.02    0.02
```

```
+++ WEATHER +++

 anemht    awwzo   wzoflg
2.00000000 25.0000000 1
 wind dir (deg) and max wind speed (m/s)
  250.00   11.86

Wind speeds (m/s) -  48  intervals
    0.00    0.00    0.00    0.00    0.00    1.19
    2.76    3.47    4.00    4.44    4.84    5.20
    5.54    5.87    6.20    6.53    6.86    7.20
    7.56    7.95    8.39    8.91    9.57   10.64
   11.86   10.02    9.21    8.64    8.16    7.75
    7.38    7.03    6.69    6.36    6.04    5.71
    5.37    5.02    4.64    4.23    3.75    3.15
    2.24    0.00    0.00    0.00    0.00    0.00

END OF INPUTS

OUTPUT FROM ERODOUT.FOR

Total grid size: ( 31 , 31 )   Inner grid size: ( 29 , 29 )

  Passing Border Grid Cells - Total    egt (kg/m)
  top(i=1,imax-1,j=jmax) bottom(i=1,imax-1,j=0) right(i=imax,j=1,jmax-1) left(i=0, j=1,jmax-1)
      0.72      1.98      3.58      5.51      7.90     10.63     13.56     16.56     19.55     22.35
   24.57     26.02     26.87     27.36     27.64     27.79     27.88     27.92     27.95     27.96
 27.97     27.98     27.98     27.98     27.98     27.98     27.98     27.98     27.98
      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
    0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
     13.93     37.80     59.60     70.80     74.85     76.21     76.66     76.81     76.86     76.87
   76.88     76.88     76.88     76.88     76.88     76.88     76.88     76.88     76.88     76.88
 76.88     76.88     76.88     76.88     76.88     76.88     76.88     76.88     76.88
      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
    0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00

  Passing Border Grid Cells - Suspension     egtss (kg/m)
  top (i=1,imax-1, j=jmax) bottom (i=1,imax-1, j=0) right (i=imax, j=1,jmax-1) left (i=0,
j=1,jmax-1)
      0.21      0.72      1.65      3.09      5.03      7.52     10.57     14.18     18.34     23.03
   28.15     33.59     39.21     44.95     50.76     56.59     62.45     68.32     74.20     80.08
 85.96     91.85     97.73    103.61    109.50    115.38    121.26    127.15    133.03
      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
    0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
     10.00     33.70     67.44    105.62    144.28    181.22    215.22    245.57    271.88    294.03
  312.14    326.54    337.67    346.04    352.18    356.56    359.62    361.70    363.09    364.00
364.58    364.95    365.17    365.31    365.39    365.44    365.46    365.48    365.49
      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
    0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
  0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00

  Passing Border Grid Cells - PM10    egt10 (kg/m)
  top (i=1,imax-1, j=jmax) bottom (i=1,imax-1, j=0) right (i=imax, j=1,jmax-1) left (i=0,
j=1,jmax-1)
    0.0046    0.0193    0.0473    0.0912    0.1488    0.2196    0.3027    0.3977    0.5039    0.6207
  0.7463    0.8784    1.0145    1.1531    1.2931    1.4338    1.5750    1.7164    1.8579    1.9995
2.1412    2.2828    2.4245    2.5662    2.7079    2.8496    2.9913    3.1329    3.2746
    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
  0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
    0.3050    0.9706    1.8304    2.7605    3.6919    4.5786    5.3937    6.1209    6.7510    7.2814
  7.7153    8.0603    8.3271    8.5281    8.6755    8.7810    8.8547    8.9051    8.9387    8.9607
8.9748    8.9836    8.9891    8.9924    8.9944    8.9956    8.9963    8.9966    8.9969
    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
  0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

  Leaving Field Grid Cells - Total    egt (kg/m^2)
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
   -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
 -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
   -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
 -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
```

```
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.73     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.87     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.72     -1.91     -2.06     -2.16
  -2.12     -1.99     -1.88     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.72     -1.91     -2.06     -2.16
  -2.13     -1.99     -1.88     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.72     -1.90     -2.05     -2.16
  -2.13     -2.00     -1.89     -1.81     -1.76     -1.74     -1.72     -1.71     -1.71     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.71     -1.89     -2.04     -2.15
  -2.14     -2.02     -1.90     -1.82     -1.77     -1.74     -1.72     -1.71     -1.71     -1.70
-1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.97     -1.24     -1.49     -1.70     -1.88     -2.03     -2.14
  -2.15     -2.04     -1.93     -1.84     -1.79     -1.75     -1.73     -1.72     -1.71     -1.71
-1.71     -1.71     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
    -0.27     -0.51     -0.73     -0.96     -1.23     -1.48     -1.68     -1.86     -2.00     -2.12
  -2.16     -2.09     -1.97     -1.88     -1.82     -1.78     -1.75     -1.74     -1.73     -1.72
-1.72     -1.72     -1.71     -1.71     -1.71     -1.71     -1.71     -1.71     -1.71
    -0.27     -0.51     -0.73     -0.95     -1.21     -1.45     -1.65     -1.81     -1.96     -2.08
  -2.16     -2.14     -2.05     -1.96     -1.89     -1.84     -1.80     -1.78     -1.77     -1.76
-1.75     -1.75     -1.74     -1.74     -1.74     -1.74     -1.74     -1.74     -1.74
    -0.26     -0.50     -0.72     -0.93     -1.18     -1.40     -1.59     -1.75     -1.89     -2.01
  -2.10     -2.16     -2.15     -2.09     -2.02     -1.97     -1.92     -1.89     -1.87     -1.85
-1.84     -1.83     -1.82     -1.82     -1.82     -1.81     -1.81     -1.81     -1.81
    -0.26     -0.49     -0.70     -0.88     -1.12     -1.32     -1.50     -1.65     -1.78     -1.89
  -1.98     -2.07     -2.13     -2.16     -2.17     -2.15     -2.13     -2.10     -2.08     -2.06
-2.04     -2.03     -2.02     -2.01     -2.01     -2.00     -2.00     -1.99     -1.99
    -0.26     -0.47     -0.67     -0.81     -1.01     -1.19     -1.35     -1.49     -1.61     -1.71
  -1.79     -1.87     -1.94     -1.99     -2.04     -2.08     -2.11     -2.13     -2.15     -2.16
-2.17     -2.18     -2.18     -2.18     -2.18     -2.18     -2.18     -2.18     -2.18
```

```
     -0.24     -0.41     -0.59     -0.72     -0.81     -0.96     -1.08     -1.20     -1.30     -1.38
   -1.45     -1.52     -1.57     -1.62     -1.66     -1.69     -1.72     -1.74     -1.76     -1.78
 -1.80     -1.81     -1.82     -1.82     -1.83     -1.83     -1.84     -1.84     -1.84
     -0.20     -0.30     -0.40     -0.50     -0.59     -0.65     -0.70     -0.74     -0.76     -0.79
   -0.82     -0.84     -0.86     -0.87     -0.88     -0.89     -0.90     -0.90     -0.91     -0.91
 -0.91     -0.91     -0.92     -0.92     -0.92     -0.92     -0.92     -0.92     -0.92

  Leaving Field Grid Cells - Suspension     egtss (kg/m^2)
     -0.06     -0.15     -0.27     -0.41     -0.56     -0.72     -0.88     -1.04     -1.20     -1.35
   -1.48     -1.57     -1.62     -1.66     -1.68     -1.69     -1.69     -1.69     -1.70     -1.70
 -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.06     -0.15     -0.27     -0.41     -0.56     -0.72     -0.88     -1.04     -1.20     -1.35
   -1.48     -1.57     -1.62     -1.66     -1.68     -1.69     -1.69     -1.69     -1.70     -1.70
 -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.06     -0.15     -0.27     -0.41     -0.56     -0.72     -0.88     -1.04     -1.20     -1.35
   -1.48     -1.57     -1.62     -1.66     -1.68     -1.69     -1.69     -1.69     -1.70     -1.70
 -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
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  Leaving Field Grid Cells - PM10    egt10 (kg/m^2)
   -0.0013   -0.0043   -0.0081   -0.0127   -0.0166   -0.0204   -0.0240   -0.0274   -0.0307   -0.0337
 -0.0363   -0.0381   -0.0393   -0.0400   -0.0404   -0.0406   -0.0408   -0.0408   -0.0409   -0.0409
-0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409
   -0.0013   -0.0043   -0.0081   -0.0127   -0.0166   -0.0204   -0.0240   -0.0274   -0.0307   -0.0337
 -0.0363   -0.0381   -0.0393   -0.0400   -0.0404   -0.0406   -0.0408   -0.0408   -0.0409   -0.0409
-0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409
   -0.0013   -0.0043   -0.0081   -0.0127   -0.0166   -0.0204   -0.0240   -0.0274   -0.0307   -0.0337
 -0.0363   -0.0381   -0.0393   -0.0400   -0.0404   -0.0406   -0.0408   -0.0408   -0.0409   -0.0409
-0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409
     .         .         .         .         .         .         .         .         .         .
   .         .         .         .         .         .         .         .         .         .
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**Averages - Field
     Total    salt/creep      susp       PM10
     egt                      egtss      egt10
   -----------------kg/m^2--------------------
     -1.58       -0.34       -1.24     -0.0308

**Averages - Crossing Boundaries
Location      Total      Suspension      PM10
--------------------kg/---------------------
top           21.59        55.45         1.39
bottom         0.00         0.00         0.00
right         72.45       287.44         7.12
left           0.00         0.00         0.00

   Comparision of interior & boundary loss
      interior       boundary    int/bnd ratio
   -120593.77      120593.91           -1.00

repeat of total, salt/creep, susp, PM10:      1.58      0.34      1.24    0.0308
```

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"HOW TO" GUIDES

WEPS How To Guide

Barriers

Wind barriers in WEPS include any structure designed to reduce the wind speed on the downwind side of the barrier. They also trap moving soil. Barriers include, but are not limited to, linear plantings of single or multiple rows of trees, shrubs, or grasses established for wind erosion control, crop protection, and snow management. Snow fences, board walls, bamboo and willow fences, earthen banks, hand-inserted straw rows, and rock walls have also been used as barriers for wind erosion control in limited situations. Barriers also reduce evapotranspiration, shelter livestock, and provide wildlife habitat. One advantage of barriers over most other types of wind erosion control is that they are relatively permanent. During drought years, barriers may be the only effective and persistent control measure on crop land. Barriers primarily alter the effect of the wind force on the soil surface by reducing wind speed on the downwind side of the barrier, but they also reduce wind speed to a lesser extent upwind of the barrier (Fig. 5.1).

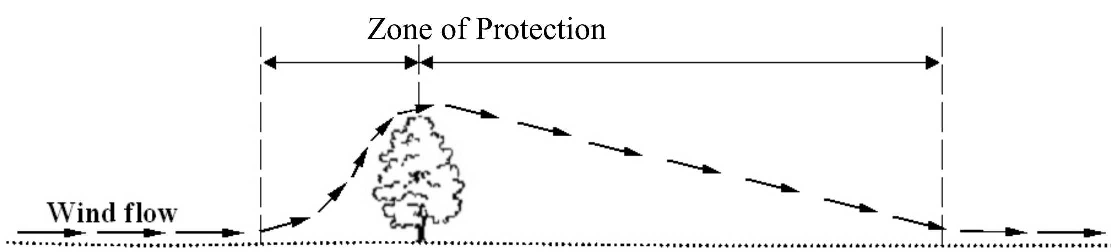


Figure 5.1. Diagram showing wind flow pattern over a barrier.

Research has shown that barriers significantly reduce wind speed downwind, sheltering a portion of the field from erosion and in effect, reducing the field length along the erosive wind direction. The protected zone of any barrier diminishes as porosity increases, and is reduced significantly when barrier porosity exceed 60 percent. Protection is also reduced as wind velocity increases, but the protected area diminishes as the wind direction deviates from the perpendicular to the barrier. Various types of barriers are used for wind erosion control in WEPS 1.0. The WEPS interface provides a method of selecting from a list of barriers to place on the field and editing the barrier properties. The user can also modify properties in the barrier database that appear in the drop-down list. Each of these properties are described in this section.

Adding and Removing Barriers Using the Interface

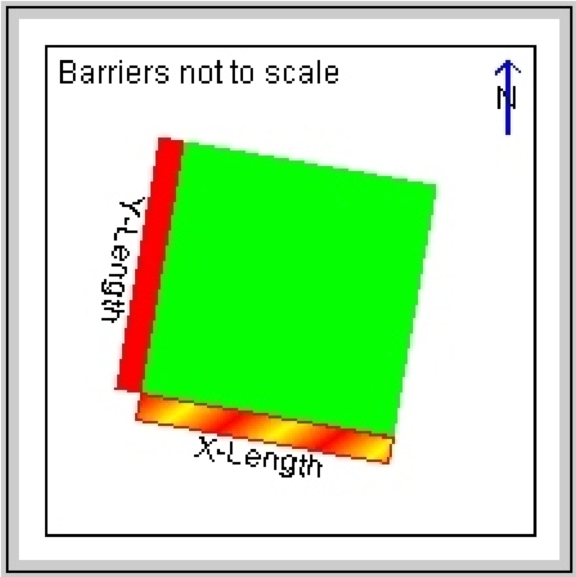


Figure 5.2. Field View Panel.

The Field View panel (Fig. 5.2), located in the center of the WEPS1.0 main screen, is designed to give the user a view of the field size, shape, and orientation (green). The placement of any barriers present is displayed in red. Note that if the ratio of actual length to width of the field or barriers is too great to display to scale, this will be indicated within the panel, and an approximation of the field or barrier shape will be displayed. This panel is for viewing only and is not editable.

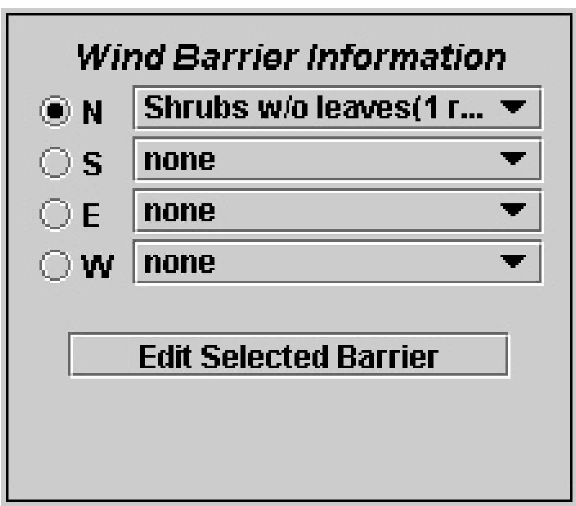


Figure 5.3. Wind Barrier Information panel.

The Wind Barrier Information panel (Fig. 5.3) is used to add barriers to the field. Note that WEPS1.0 only allows barriers on the borders of the field. The barrier location for each field border is labeled 'N' for north, 'S' for south, 'E' for east, and 'W' for west. The barrier type can be selected from the drop-down list in the panel by clicking the down arrow to the right of the barrier type to bring up the list of available barriers, and then clicking on the appropriate barrier. Once a barrier type is selected, the barrier properties may be viewed and edited by clicking the 'Edit Selected Barrier' button at the bottom of the panel. A separate panel opens, in which the user may change the default barrier width, height, and porosity values in the appropriate fields. The modified barrier parameters are stored with the project. If a barrier other than 'None' is selected, the 'Edit Selected Barrier' button will open the properties panel when the radio button is clicked on for that barrier. To remove a barrier from the field, click the radio button to select it (notice the barrier in the View Panel will be 'highlighted' when selected), then select the barrier type 'None' to remove it.

Edit Selected Barrier

To view and edit the properties of a barrier, click the radio button for the corresponding barrier , then click the ‘Edit Selected Barrier’ button. A window will open displaying the properties described next. If properties are modified by the user through the interface, the barrier type will display ‘<mod>’ in front of the barrier type name.

The length of a barrier is defined by the field length along the border on which the barrier is placed.

Width The width of a barrier is defined as the distance from one side of the barrier to the other, in the units of measure displayed on the screen (feet or meters) (Fig. 5.4). For a single-row wind barrier, the width is equal to the diameter of the tree, shrub, or grass, or for artificial barriers, the thickness of the material (e.g., slat fence). This is illustrated as “a” in Fig. 5.4. For multiple-row barriers, the width is the distance from one side of the barrier to the other as illustrated by “b” in Fig. 5.4.

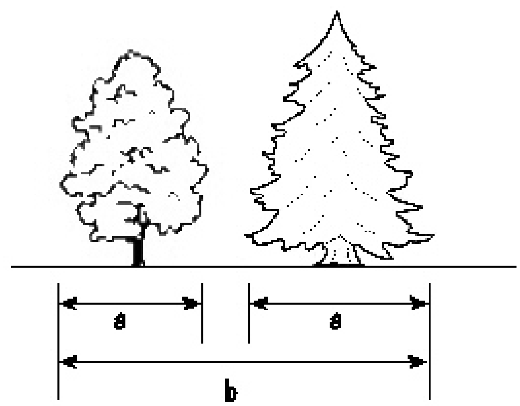


Figure 5.4. Barrier width for single-row (a) and multiple-row (b) barriers.

Height The height of a barrier is the average height of individual elements (e.g., trees) in the barrier (“a” in Fig. 5.5 for single-row barriers). The units of measure for barrier height are displayed on the input screen in feet or meters. For multiple-row barriers, use the height of the tallest barrier row (‘b” in Fig. 5.5).

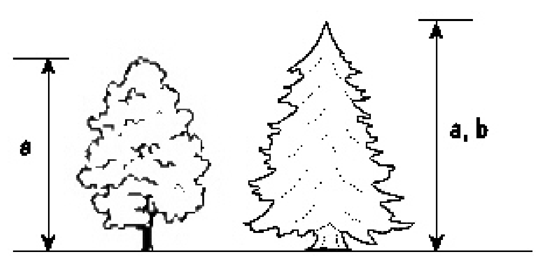


Figure 5.5. Barrier height for single-row (a) and multiple-row (b) barriers.

Area The area of the barrier is calculated from the barrier width and length (i.e., barrier width x field length). This is not an editable item, but is calculated within WEPS 1.0.

Porosity Barrier porosity is defined as the total optical porosity of all rows in the barrier. It is the open space (i.e., absence of leaves and stems) as viewed looking perpendicular to the barrier, expressed as a percentage of the total area (ie., (1.0 - silhouette area) x 100). WEPS 1.0 does not "grow" living barriers. They do not increase or decrease porosity with leaf growth and leaf drop (senescence), nor do they increase in size from one year to the next. As such, the porosity of barriers in WEPS does not change with the seasons nor from year to year. Therefore, the user should input the porosity of the barrier that is present when the erosion hazard is the greatest. Figure 5.6 illustrates the effect of porosity on the near-surface wind speed, relative to an open field without a barrier (see also Figure 5.1).

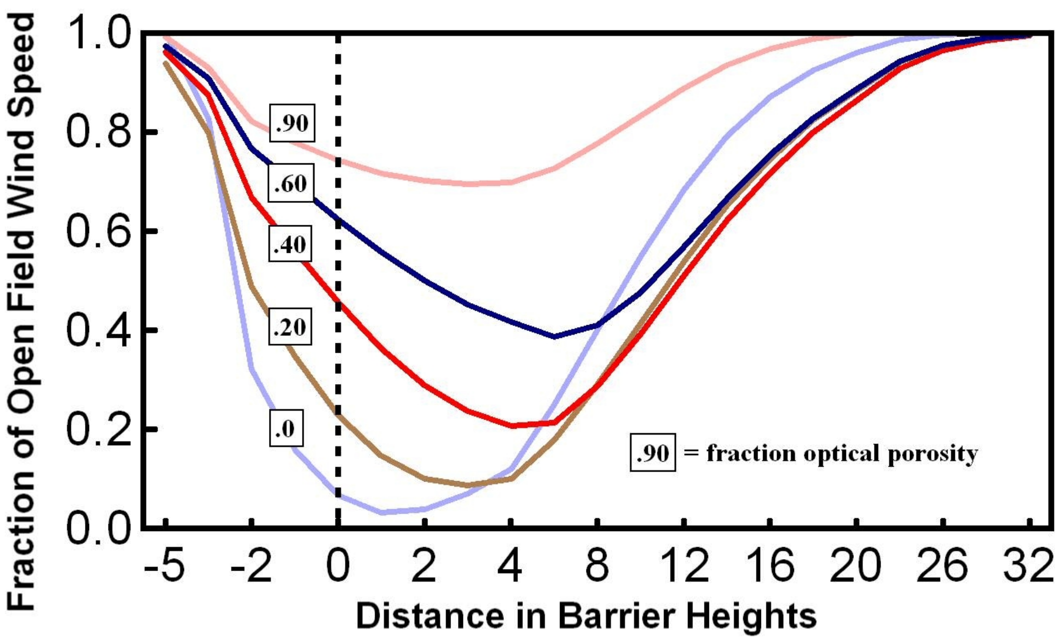


Figure 5.6. Effect of the fraction of optical porosity on near-surface wind speed along the wind direction relative to barrier. The "Distance in Barrier Heights" refers to the distance from the barrier at 0, measured in multiples of the barrier height.

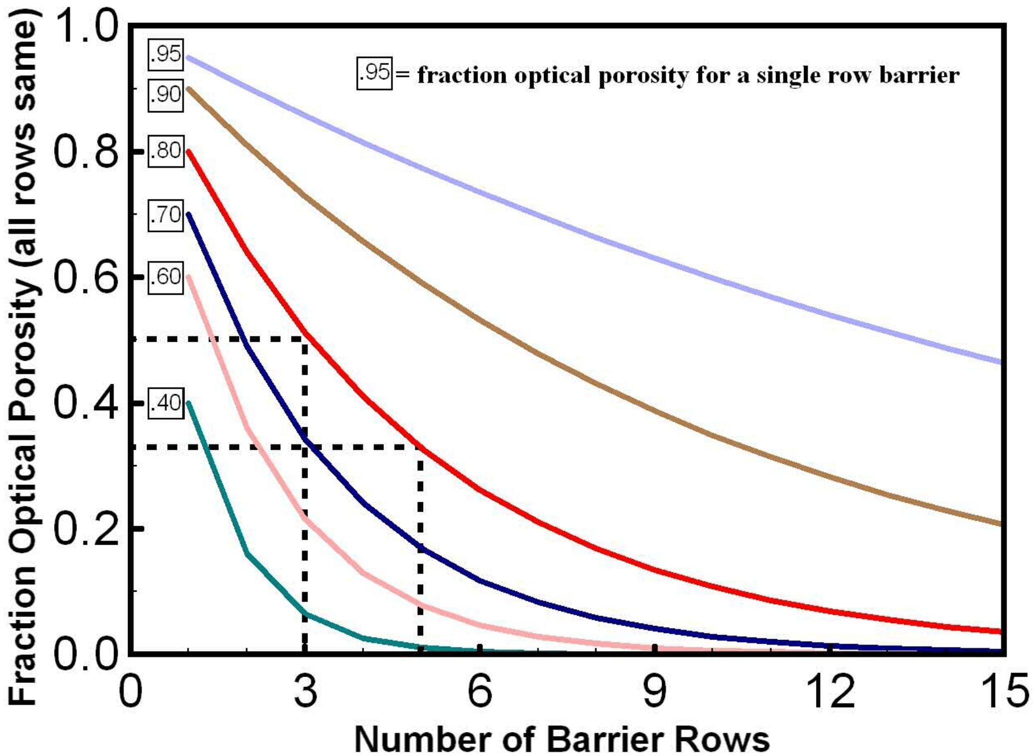


Figure 5.7. Effect of number of barrier rows on optical porosity when all barrier rows are the same.

At times, it is most efficient to estimate optical porosity for a single row, particularly for crop barriers. Then for multiple row barriers, the optical porosity decreases for the entire barrier as illustrated in Figure 5.7. For example, a single row of corn has an optical porosity of 0.80. Three rows of corn have an optical porosity of 0.50, and five rows of corn have an optical porosity of 0.33.

Barrier Property Database

Default barrier properties specified in the barrier property database cannot be permanently changed through the WEPS interface. But they can be modified and stored with the current project. Barrier properties may, however, be modified in the barrier database file. Figure 5.8 shows the barrier database file, 'barrier.dat', which is located in the "WEPS1.0 Install" directory. This ASCII file may be edited (for NRCS only by designated qualified agronomists) by using a standard text editor to add new barriers or modify parameters of existing barriers. The file separates barriers into various categories (i.e., TREES, SHRUBS, HERBACEOUS, etc.). The user interface does not read nor display these barrier categories, and they only serve as a visual aid within the database. Actual database values are in rows which begin with a blank in column one, and each database parameter is separated by the pipe symbol, '|'. The parameters are listed as follows: barrier name | height (meters) | number of rows (not used) | porosity (fraction) | width (meters). Barrier height, width, and porosity were defined previously in this document. The barrier name is a character descriptor of the barrier and is the name displayed in the choice lists. The 'number of barrier rows' parameter is not currently used by WEPS nor is it displayed in the interface. Once the barrier database file has been updated, restart WEPS and the new barrier and/or modified parameter values should appear in the barrier drop-down list on the WEPS user interface.

Figure 5.8. Barrier database file "barrier.dat".

```
TREES
 Trees w/o leaves(1 row)|8|1|0.8|3
 Trees w/o leaves(2 row)|8|2|0.7|7
 Trees w/o leaves(4 row)|8|4|0.6|15
 Trees w/ leaves(1 row)|8|1|0.6|3
 Trees w/ leaves(2 row)|8|2|0.5|7
 Trees w/ leaves(4 row)|8|4|0.4|15
SHRUBS
 Shrubs w/o leaves(1 row)|2|1|0.7|2
 Shrubs w/o leaves(2 row)|2|2|0.5|5
 Shrubs w/ leaves(1 row)|2|1|0.5|2
 Shrubs w/ leaves(2 row)|2|2|0.3|5
HERBACEOUS
 Grass Barrier(1 row)|0.8|1|0.7|0.5
 Grass Barrier(2 row)|0.8|2|0.5|1.0
CROP
 Kenaf(1 row)|2.5|1|0.7|1
 Kenaf(2 row)|2.5|2|0.5|2
 Sorghum(1 row)|2|1|0.7|1
 Sorghum(2 row)|2|2|0.5|2
 Flax(1 row)|0.5|1|0.7|0.5
 Flax(2 row)|0.5|2|0.5|1
 Corn(2 row)|1.5|2|0.7|2
 Corn(3 row)|1.5|2|0.6|3
 Corn(4 row)|1.5|2|0.5|4
 Wheat/Rye(1 row)|0.8|1|0.7|0.5
 Wheat/Rye(2 row)|0.8|2|0.6|0.6
 Wheat/Rye(3 row)|0.8|3|0.6|0.8
 Wheat/Rye(4 row)|0.8|4|0.5|1.0
 Wheat/Rye(1 row)|0.8|4|0.5|1.0
ARTIFICIAL
 Snow fence|1.2|1|0.6|1
 Solid fence|2|1|0.05|1
```

Supplemental Barrier Information for Users Manual

The following are some of the assumptions used in building the default property values for the barriers. For the Tree and Shrub barriers, the heights used are based on the 20-year heights which is the standard height used for designing windbreaks. Since the model does not grow the barriers, it needs to be recognized that erosion rates will gradually decrease during the growth of the barrier. Because of this, alternative treatment options will need to be used during this growth period such as annual barriers, herbaceous barriers and/or changes in crop residue management.

The Herbaceous barriers were divided between perennial and annual. The perennial barriers include species such as switchgrass, tall wheatgrass, elephant grass, etc. The annual barriers were divided into three height categories: short, medium and tall. The short annual barriers could include small grains e.g, wheat, barley, or rye. These small grains provide protection to wind sensitive crops in the early growth stages and are usually sprayed with herbicide. The medium annual barriers also include the small grains as well as flax that are allowed to grow nearly to maturity before being sprayed. The tall annual barriers may include corn, sunflowers, or sorghum reaching heights of 4 to 5 feet. The default porosities assigned to these annual barriers are based on the assumption that the planting rate/acre is the same whether it is one row or two rows or three rows. The porosity of a single row could be altered by increasing the number of plants per acre.

The orchard default values include two age categories: one year old and mature height. They are also divided into three size classes: dwarf, semi-dwarf, and standard. The height of some fruit trees can be controlled by the type of root stock such as an apple tree that is dwarf may have a 7 to 8 foot mature size while a standard tree may reach 16 to 18 feet. It was assumed that the dwarf size trees were spaced about 12 feet apart, the semi-dwarf about 20 feet and the standard up to 30 feet for the larger nut trees such as walnut and pecan.

The “Forest Edge” example is trying to account for large patches of forest on the field edge. These forest patches are assumed to be “wide” i.e. several hundred feet wide. These patches do not function the same as a windbreak in modifying wind flow. The tendency is for the wind reduction profile adjacent to these wide patches to be reduced in length acting more similarly to the wind profile of a more porous barrier where the wind will return to open field velocity more quickly than a narrower windbreak.

Two artificial fences were also included. One assumes a four foot height with a 50 percent porosity similar to a slatted snow fence. The other is a solid board fence with a similar height but very low porosity.

WEPS How To Guide

Strip Cropping (Field Design)

Introduction

Dividing large fields into smaller fields is a design practice that often aids in controlling both wind and water erosion. The main effect achieved by reducing field size for wind erosion control is to reduce the amount of damaging abrader composed of saltating aggregates that impact immobile clod or crust surfaces, as well as to reduce the breakage of the mobile saltation and creep aggregates. Reducing abrader permits the surface to become armored with immobile material as the loose soil is removed or moved into a sheltered area on rough surfaces. But merely reducing field size with strips provides only a small amount of wind erosion reduction on fields that lack significant amounts of clods, crust, growing biomass, or residues. Reducing abrader is also important for seedling protection. The Wind Erosion Prediction System (WEPS) provides a means of evaluating the effectiveness of strip cropping in reducing wind erosion. The objectives of this guide are to provide an overview of the effects of field size on wind erosion as simulated in the WEPS model and to suggest some possible field designs to enhance wind erosion control. Examples using WEPS to evaluate strip-cropping scenarios are also provided.

One method to accomplish a reduction in field size is to divide large fields into alternating strips. This practice is referred to as strip cropping, and an example is illustrated in Figure 5.8. In low rainfall areas, one-half the strips may be fallowed on alternate years. In other areas, one-half the strips may be producing low-residue crops. Comparison of Figure 1a and Figure1b illustrates important differences between the large fallow field and the same field when farmed in strips. On the large field, both moving soil and snow are removed. In contrast, when strip-cropped, part of the moving soil and snow are typically trapped in the next strip, and this results in a gain in both moisture and soil on portions of the stripped field. The saltation/creep crossing eroding strip boundaries may be used in WEPS to estimate the soil gain on adjacent non-eroding strips.

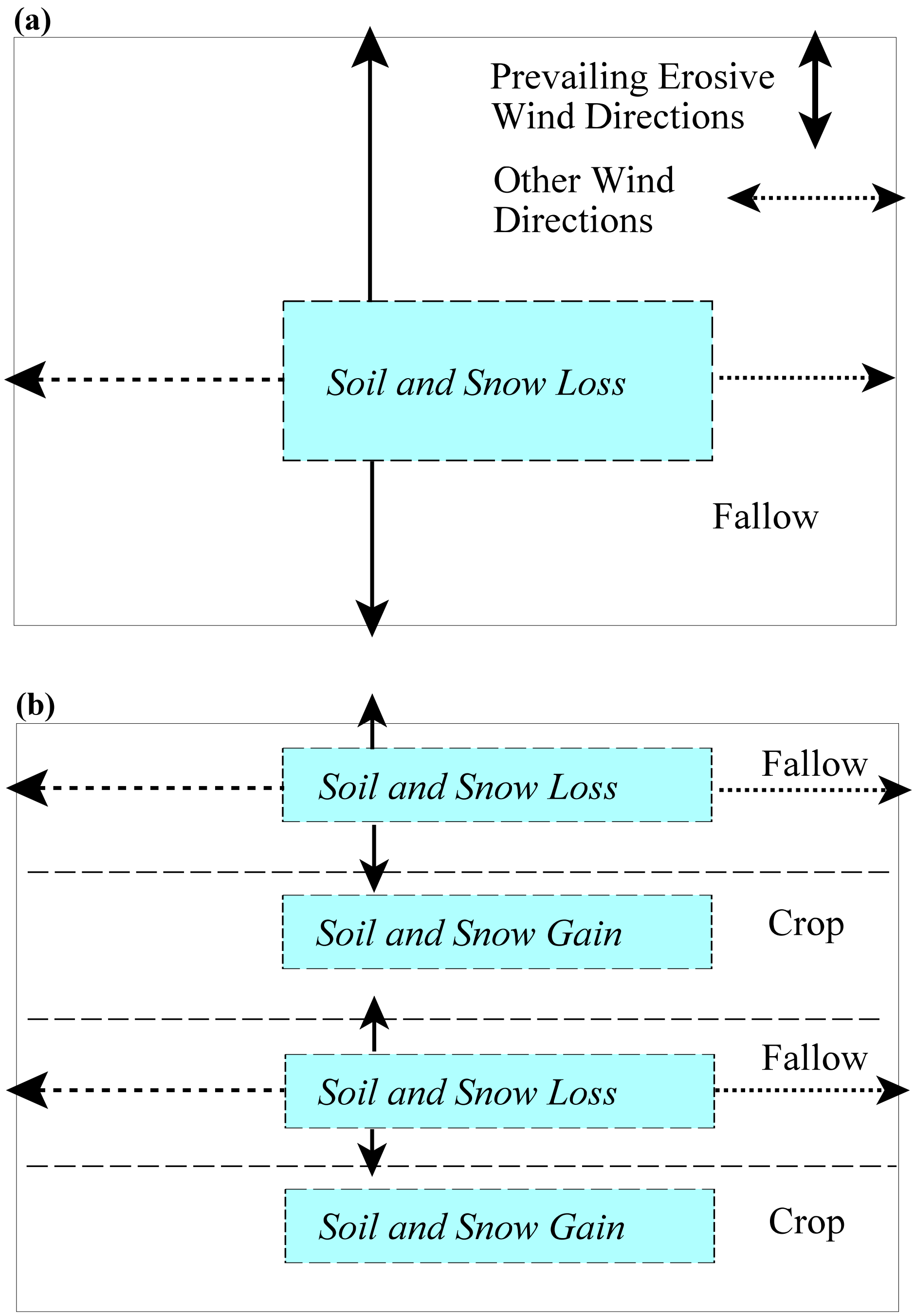


Figure 5.8. Comparison of (a) large fallow field and (b) the same field strip cropped with alternating crop and fallow strips.

Effects of Field Scale on Wind Erosion

The erosion processes in WEPS are simulated for an initially uniform field, and these include: emission (entrainment) of loose soil, abrasion of immobile clods/crusts, breakage of saltation/creep-size aggregates to suspension size, and trapping of saltation/creep-size aggregates in sheltered depressions between clods, ridges, and plants or residues (Fig. 5.9). If standing biomass is present, a reduction of wind drag at the soil surface, and biomass interception of mobile aggregates, are also simulated. Using these processes, the model simulates a horizontal discharge (i.e., amount removed up to a downwind distance) of mobile saltation/creep (Fig. 5.10) and suspension-size aggregates (Fig. 5.11). On long erodible fields, the saltation/creep discharge may reach transport capacity. Transport capacity is defined as the maximum horizontal discharge of saltation/creep possible for a given wind speed and surface condition. At transport capacity, the deposition of saltation/creep from the air stream per unit area equals the amount entrained into the air stream. There generally is still a net removal of saltation/creep aggregates from the surface to replace those lost by breakage to suspension size. In this case, saltation-creep can only approach transport capacity. In contrast, the suspended discharge is not limited by transport capacity, because these particles continually diffuse into the atmosphere. As a consequence, the mass of suspended material increases over the entire length of eroding fields, with the rate of increase controlled by the erosion processes.

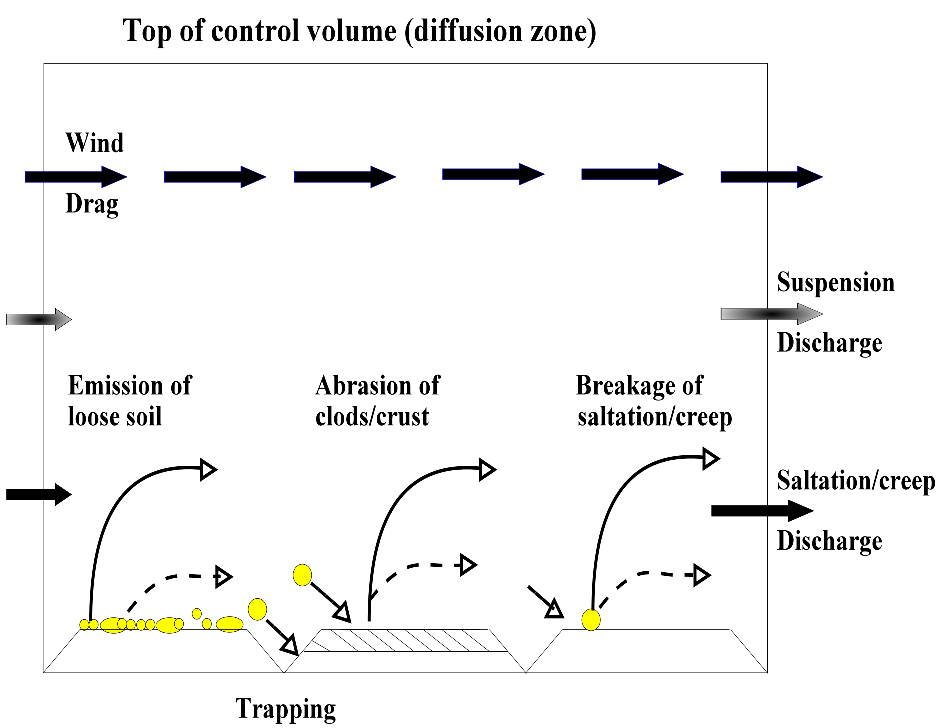


Figure 5.9. Wind erosion processes on a bare field simulated in WEPS.

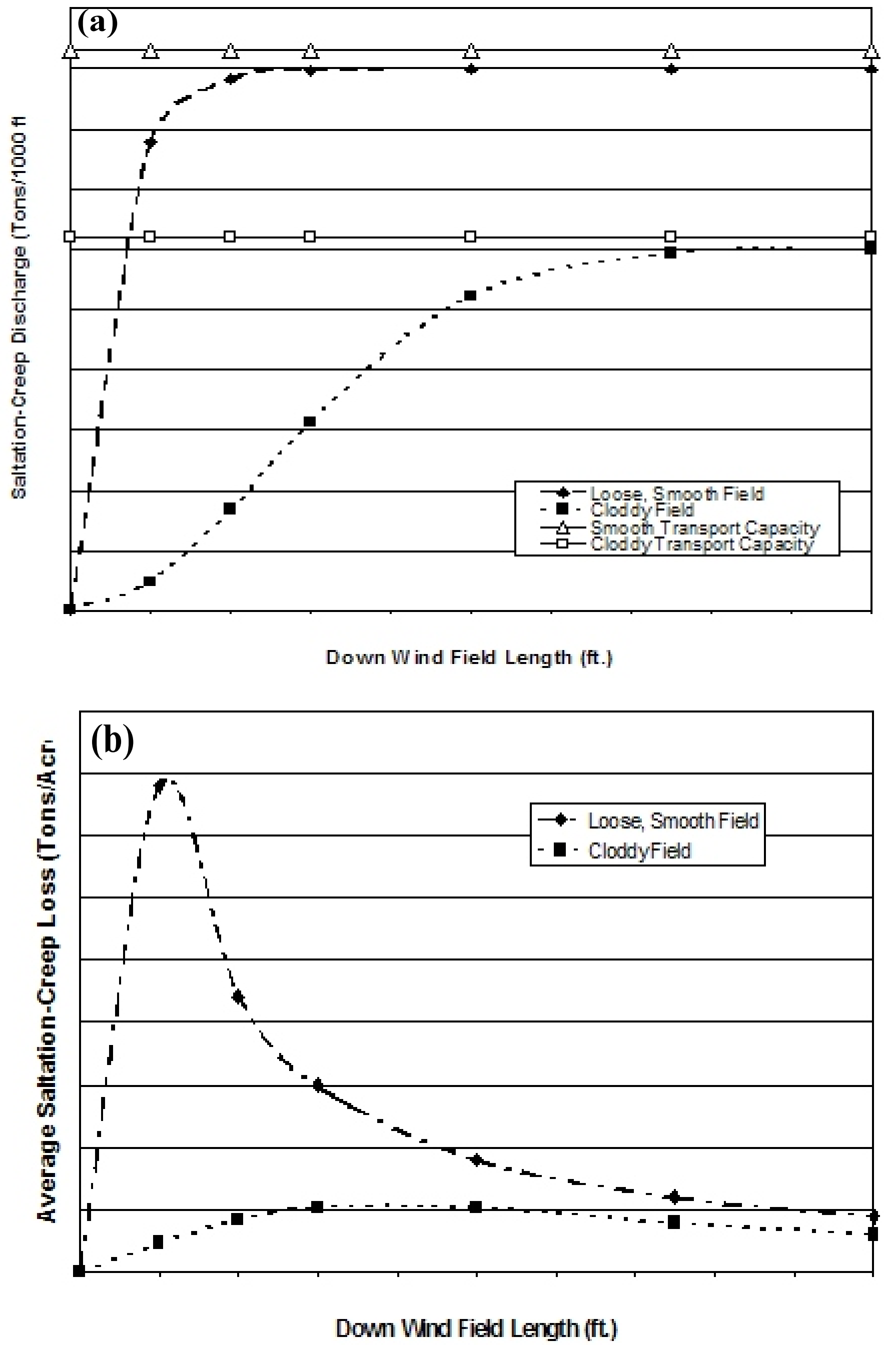
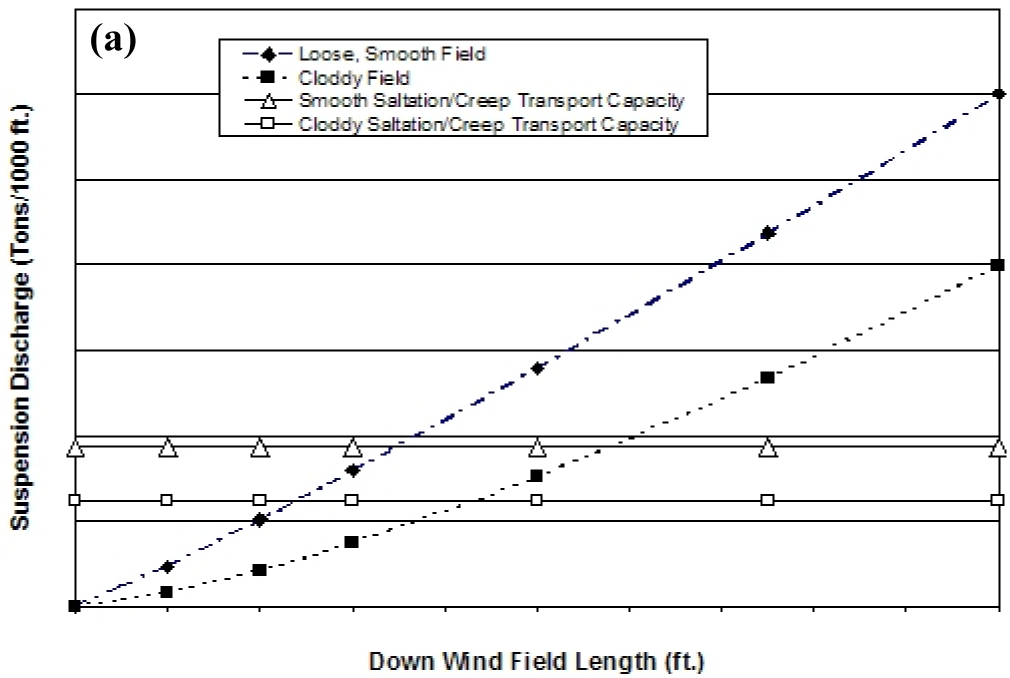


Figure 5.10. Comparison of (a) downwind discharge per 100 ft. of border width and (b) average soil loss for saltation-creep.



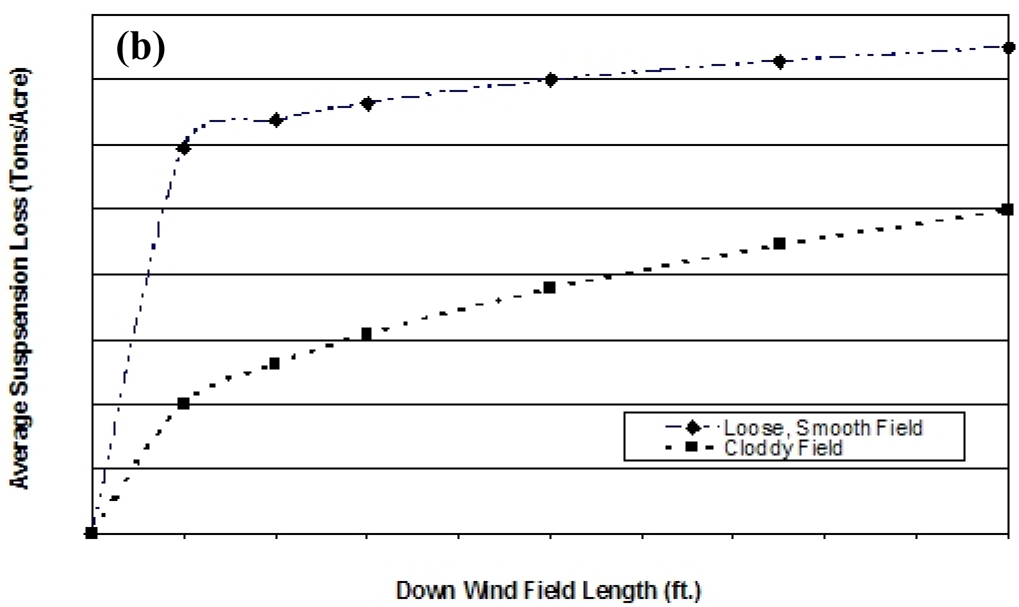


Figure 5.11. Downwind (a) discharge per 100 ft. of border width and (b) average soil loss of suspended soil.

Conservation planners often design control systems based on average soil loss (i.e., amount removed per area). Total horizontal discharge at any downwind distance divided by the upwind field length represents the average soil loss over the upwind area. Using this calculation, one can illustrate the effects of different field lengths on soil loss. Depending upon field surface conditions, the erosion processes cause differing patterns of horizontal soil discharge and, consequently, differing soil loss for the saltation/creep-size (Fig. 5.10) and the suspension-size soil (Fig. 5.11). After saltation/creep reaches transport capacity, dividing the nearly-constant transport capacity by field length to give average soil loss shows that there is a steady decrease in loss per unit area with increasing field length (i.e., area increases, whereas transport remains essentially the same). In contrast, there is generally a large net loss of suspension-size soil over the entire field length. Total soil loss for any field length is determined by adding the average suspension and saltation/creep soil losses (Fig. 5.12). In general, the maximum average soil loss occurs at a field length at which both the saltation/creep and suspension components are contributing significant net soil loss. On far downwind portions of long fields, the increases in the soil discharge comes mainly from suspended soil, so the average soil loss may decrease somewhat with field length. Thus, on long fields, suspension soil loss typically exceeds the saltation/creep loss. Of course, if the mobile soil is composed mainly of sand larger than suspension size (> 0.1 mm diameter), then saltation/creep will remain the dominant form of soil loss.

Smooth, loose fields often have a length at which there is a maximum soil loss, and the average loss then decreases beyond that field length (Fig. 5.12a). In this scenario, very short field lengths are necessary to control wind erosion. Thus, on all fields subject to wind erosion, planners should consider using other erosion controls in combination with strip cropping.

Suspended soil lost from long eroding fields can be considerable and is subject to long-range transport. Other detrimental effects also accompany this soil loss. These include an increase in sorting of the initial soil so that the removed soil is enriched in nutrients, organic matter, clay and silt fractions- the productive elements of the soil. The increased abrasion and breakage processes on long fields also increase the PM10 content (particulate matter <10 microns diameter) that is regulated as a health hazard. Thus, not only the amount, but also the quality and size distribution of the removed soil, changes as field length increases.

For simplicity, the Wind Erosion Equation (WEQ) predicts that average soil loss on long fields approaches a constant value. In WEPS, on the other hand, the average soil loss may increase or decrease on long fields, depending on whether creep/saltation or suspension is the dominant transport mode. Both the WEPS and WEQ models show that, for effective erosion control, the field length along the prevailing wind erosion direction needs to be significantly less than the distance to the point of maximum soil loss. The effect of reducing field length on erosion is not linear, but varies approximately with the logarithm of the distance to transport capacity.

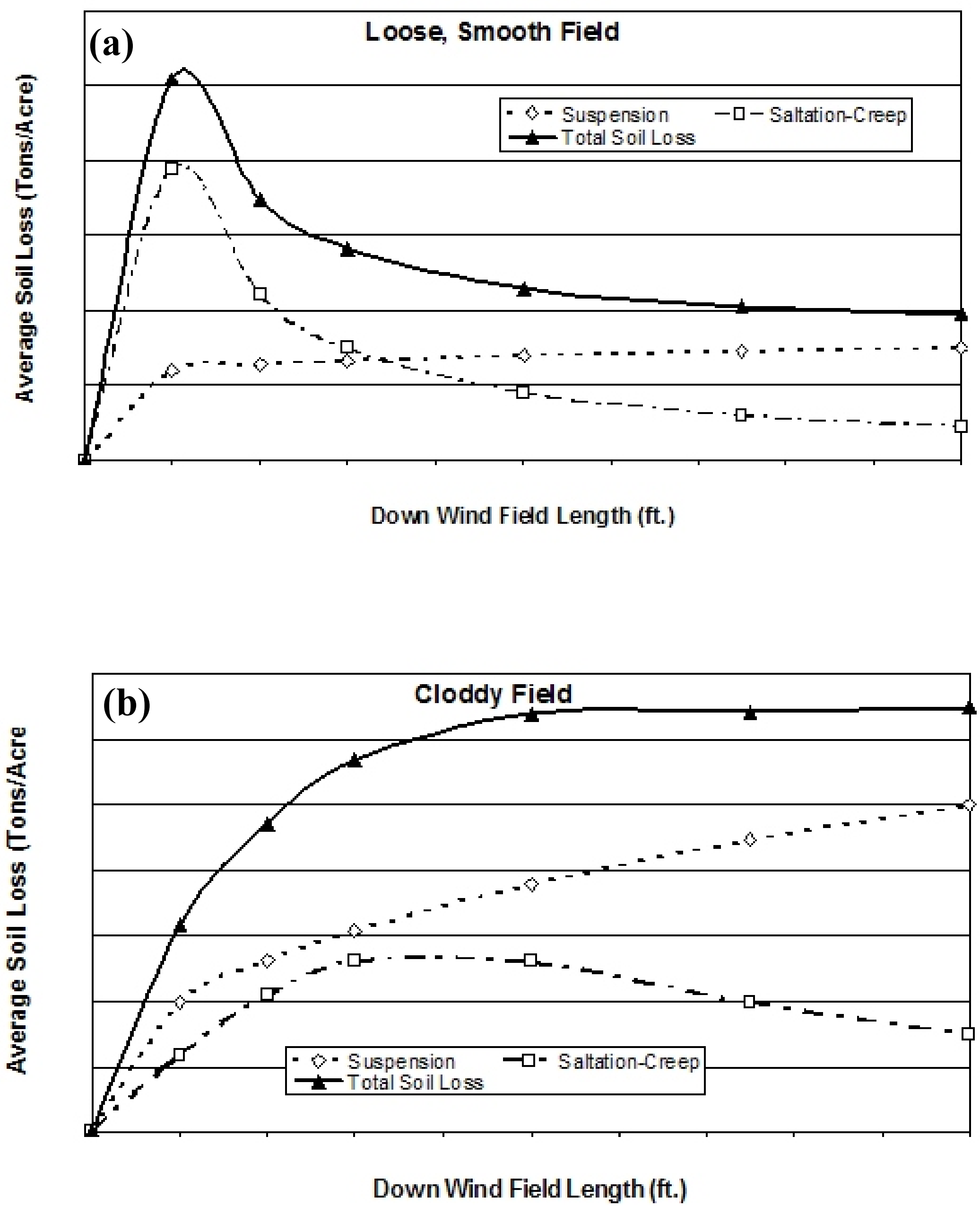


Figure 5.12. Comparison of average soil loss at various downwind distances on (a) a smooth, loose field and (b) a cloddy field.

Designs to Enhance Erosion Control

On fields susceptible to large amounts of erosion or fields with inclusions of highly erodible soil, conventional strip crop systems such as that shown in Figure 5.8b may not provide the needed extent of erosion control. It is then the task of those designing erosion controls to recommend additional measures. There are a number of ways to enhance a strip crop system to provide additional control, and several of these are illustrated.

Reduce Strip Width
One control option is to reduce the strip width in critical areas (Fig. 5.13). Wind erosion often begins within areas of a field that include a soil highly susceptible to wind erosion or in areas exposed to accelerated wind speeds. Saltating aggregates from these areas abrade downwind areas and break down immobile clods and crusts, thus increasing erodibility of the entire downwind area. On stripped fields there is potential to cover part of the problem area with a protective crop every year and thereby reduce the source area. In addition, the downwind area subject to abrasion may also be reduced. One may estimate the effect of strip width on these problem areas by choosing a soil representative of the problem area in the WEPS simulation.

Reduce Strip Width with Barriers.
A second option to reduce effective strip width is to employ wind barriers (Fig. 5.14). Correctly oriented barriers serve to shelter part of the erosive strip (Fig. 5.14a). They may also be used to divide the erosive strips to trap moving soil and further reduce the unsheltered lengths (Fig. 5.14b). If the barriers are short in height, relative to the unsheltered distance (e.g., herbaceous barriers), the latter design will reduce the unsheltered length by about one-half. When barriers or cross-wind strips trap moving saltation/creep, they effectively create a new non-erodible (stable) boundary. WEPS evaluates field conditions on each individual strip or field interval between barriers. Therefore, various field designs can be easily evaluated in WEPS by changing the field strip width and adding appropriate wind barriers as model inputs.

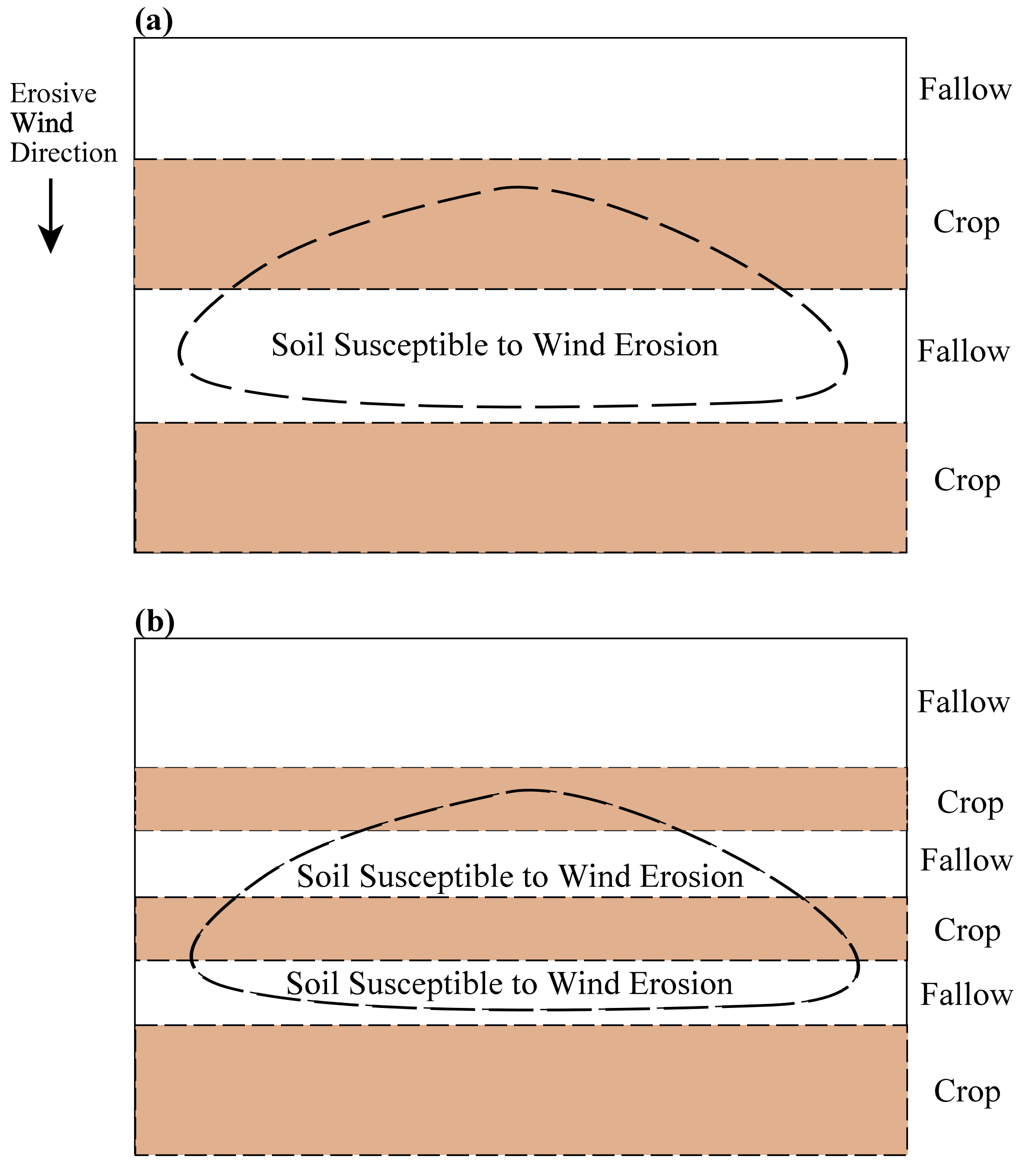
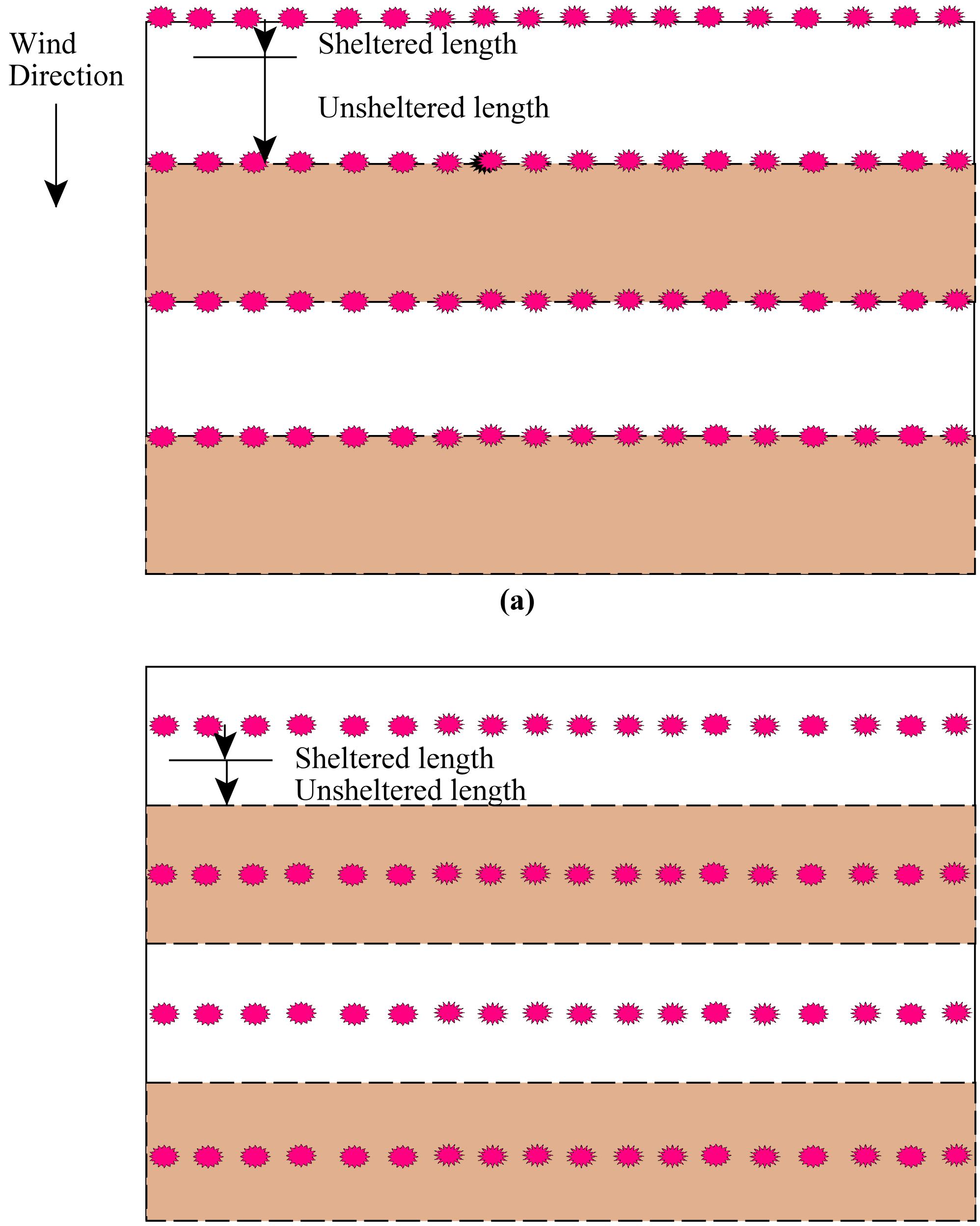


Figure 5.13. Erosion control designs illustrating (a) strips on erodible soils and (b) using narrow strips in critical areas with soils highly susceptible to wind erosion.



(a)

(b)

Figure 5.14. Erosion control designs using wind barriers (a) on strip borders and (b) in the middle of all strips.

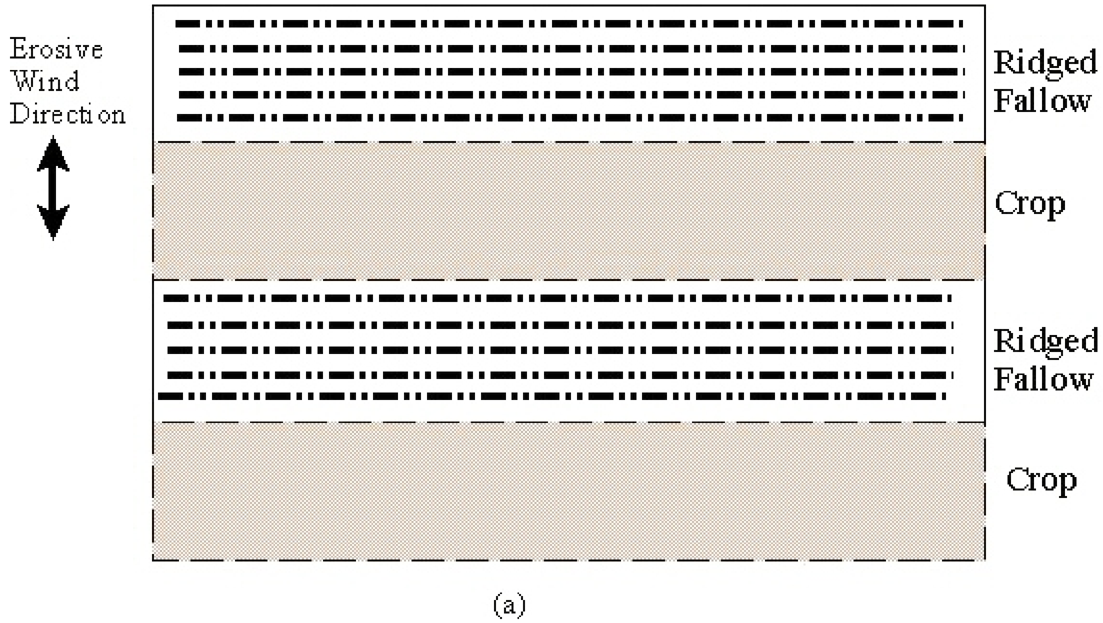
Surface Roughness

Another option to enhance strip effectiveness is to employ surface roughness such as tillage ridges (Fig. 5.15). Adding tillage ridges provides additional trapping capacity for mobile soil (Fig. 5.15a). But it is often useful to orient ridges so they are not parallel to the long side of the strip, because this provides some erosion control when wind directions are parallel to the strip (Fig. 5.15b). As a starting point, consider orienting ridges about 30 degrees from parallel to the strip and along the direction of the least erosive winds during critical wind erosion periods. For example, in Figure 15b, we assumed that the southeast-northwest winds were less erosive than southwest-northeast winds. WEPS can be used to help optimize design of these systems by comparing various tillage directions.

Other Options

Other options are particularly useful when there are erosive winds parallel to conventional strips. These options include avoiding long, straight tillage ridges (Fig. 5.16a). Saltation along the furrows parallel to tillage ridges often undercuts the ridge crust, which reduces the ridge effectiveness and leaves an accumulation of mobile material. Periodically changing ridge direction can provide sheltered accumulation zones for saltating soil. Furrow diking is also highly effective in reducing saltation/creep parallel to ridges. Field strips may also be designed with curvature (Fig. 5.16b and Fig. 5.17). In terraced farming systems, curvature of strips is usually a necessity, but the practice can often be useful in other systems. The curvature of the strip provides trapping areas for eroding soil moving along a given wind direction. WEPS can be used to evaluate these systems by inputting the strip width and then estimating the length between zones where saltation/creep material is trapped.

In summary, strip cropping is most effective when appropriate strip width and orientation are determined and combined with other wind erosion control practices such as maintaining a rough, cloddy surface and residue cover or cover crop.



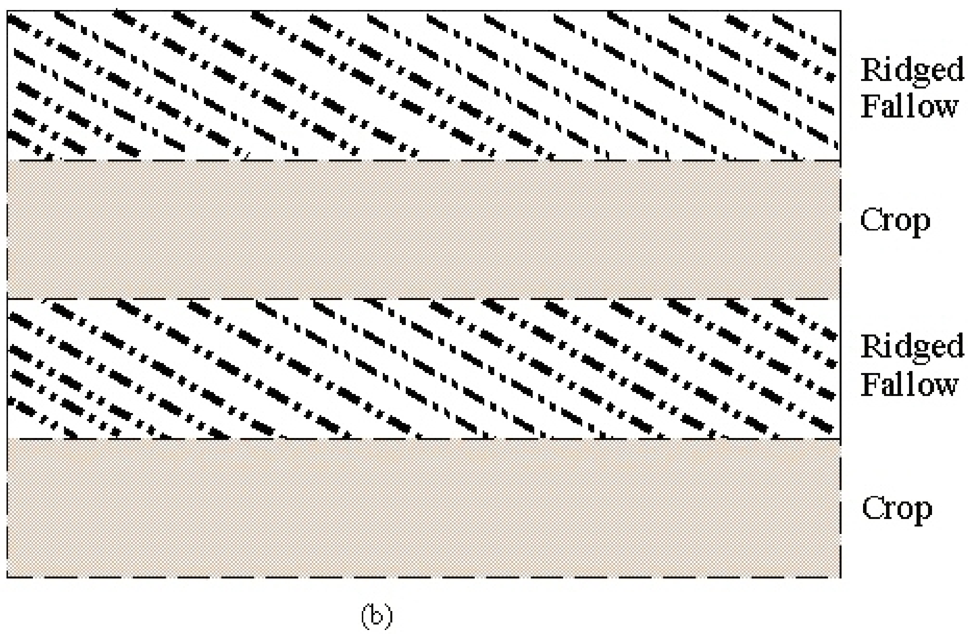
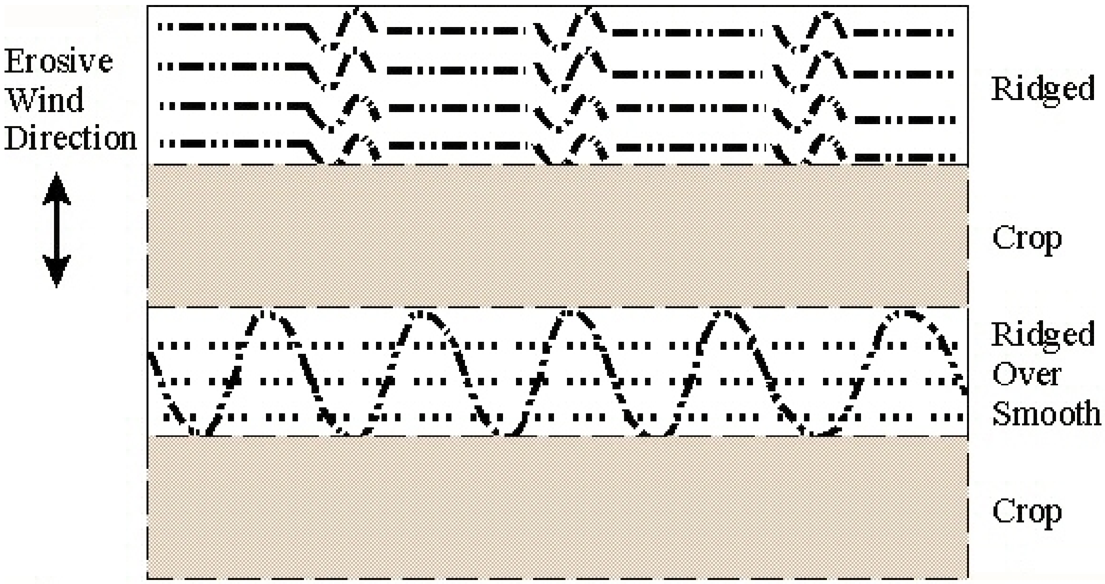
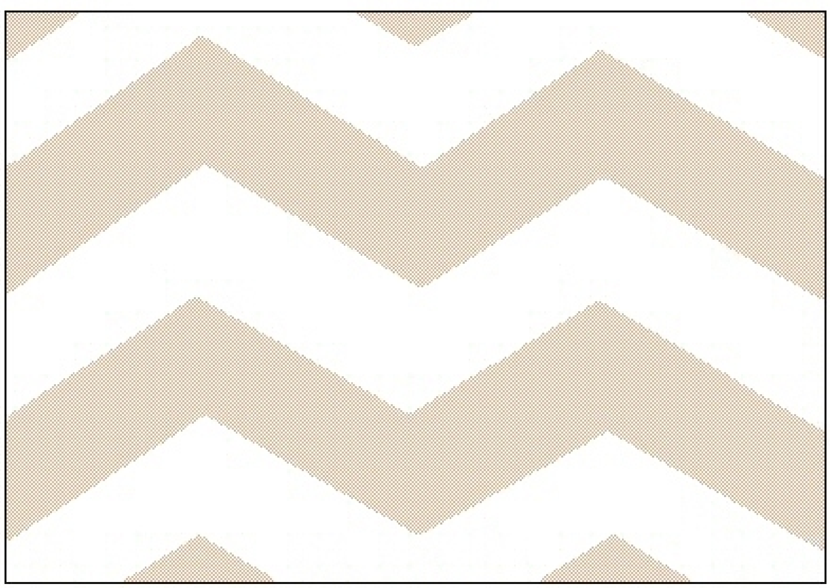


Figure 5.15. Designs using (a) parallel tillage ridges and (b) angled tillage ridges.



(a)



(b)

Figure 5.16. Erosion control designs using (a) variations of curved ridges and (b) curved strips.

Figure 5.17. Example of field strips designed with curvature.

Examples of Strip Cropping Using WEPS

The WEPS model can be used to evaluate strip cropping for the reduction of soil loss by wind. Here, some example simulation runs are provided, which illustrate the procedure and effectiveness of breaking up a large field into narrow strips.

No Strip Cropping
The beginning scenario for this example (Fig. 5.18) is defined as follows:

- Farm is located near Saint Francis in Cheyenne County, Kansas
- Soil is silt loam
- Wheat-fallow rotation as shown in the MCREW screen (Fig. 5.19)
- Field size of 2640' x 2640', 160 acres
- No barriers, 0.0 degree field orientation (North-South)

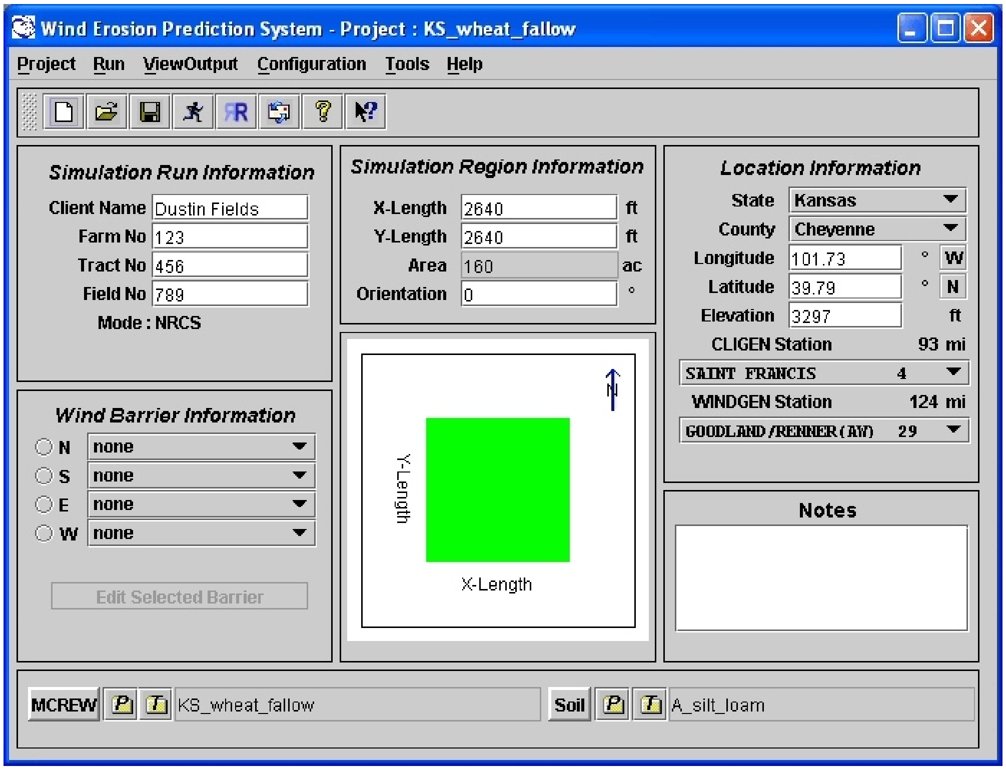


Figure 5.18. Main screen showing setup for non-strip cropped field.

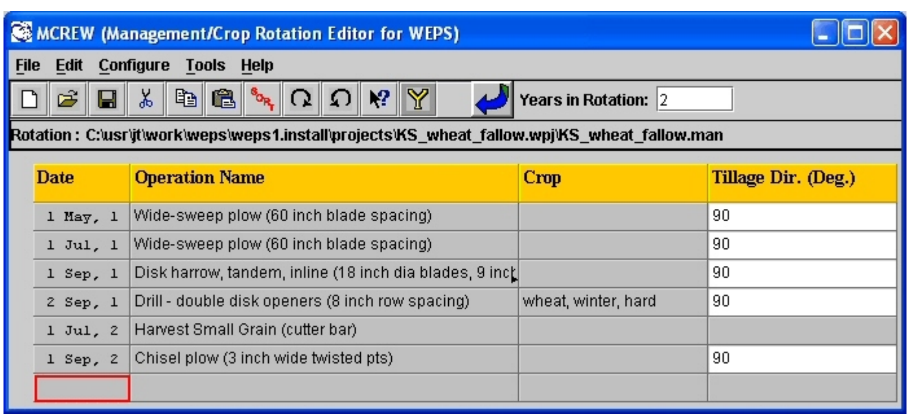


Figure 5.19. Management Crop Rotation Editor for a conventional wheat fallow rotation.

As can be seen in the Run Summary Report (Fig. 5.20), the simulation run for this non-strip cropped scenario resulted in an annual average soil loss of 21.2 tons /acre/year, with 26.9 tons/acre/year lost during the first year (fallow) of the rotation and 15.4 tons/acre/year lost during the second year (wheat) of the rotation. Note that because no barriers are present to affect loss across the field, the gross loss is equal to the net soil loss for the field. In addition, the amount of creep/saltation and suspension soil loss are presented. Notice that the suspension made up a majority of the field and boundary loss (Fig. 5.21) on the non-stripped field because the field was probably wide enough to allow creep/saltation to approach transport capacity and suspension material to continually diffuse into the atmosphere (Figs. 5.10 and 5.11).

The soil loss in this scenario would generally be considered an unacceptable amount, and conservation measures should be recommended. To determine if strip cropping would be effective, the user should first view the Boundary Loss summary report for the non-stripped field as shown in Figure 5.21. In this example, almost all of the eroding soil mass is crossing the south and east field boundaries, indicating northerly and westerly prevailing wind directions. Most of the mass is crossing the southern field border, so dividing the field in east-west oriented strips will shorten the field length in the direction having the most loss.

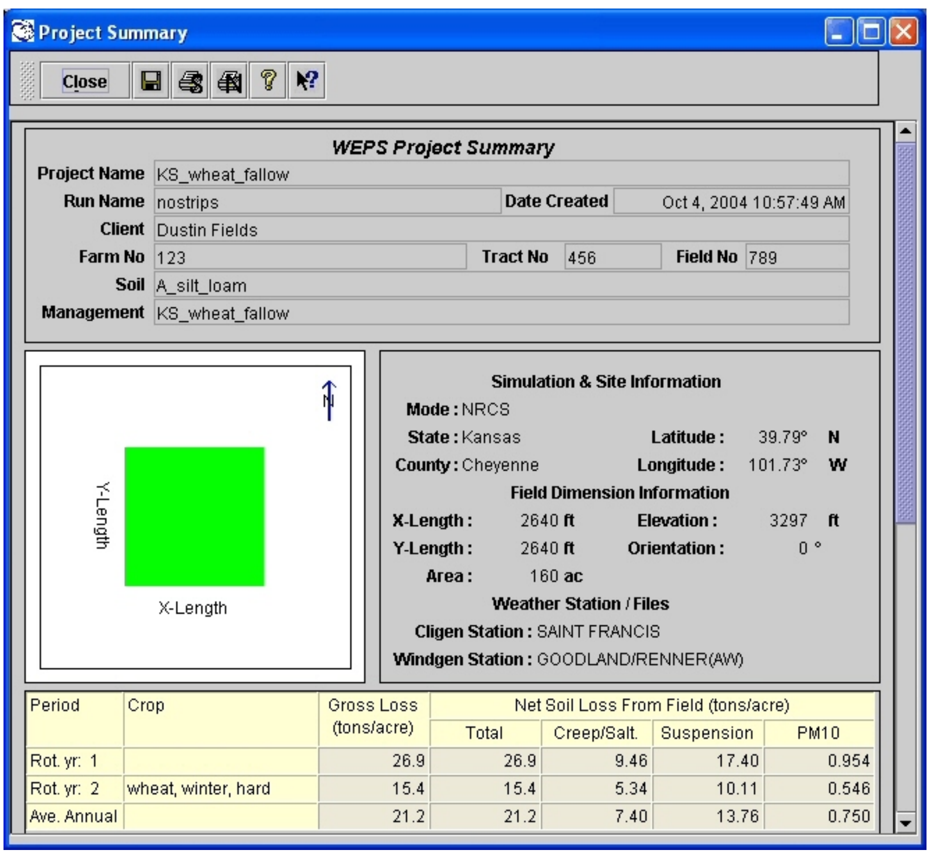


Figure 5.20. Run Summary for the non-stripped scenario.

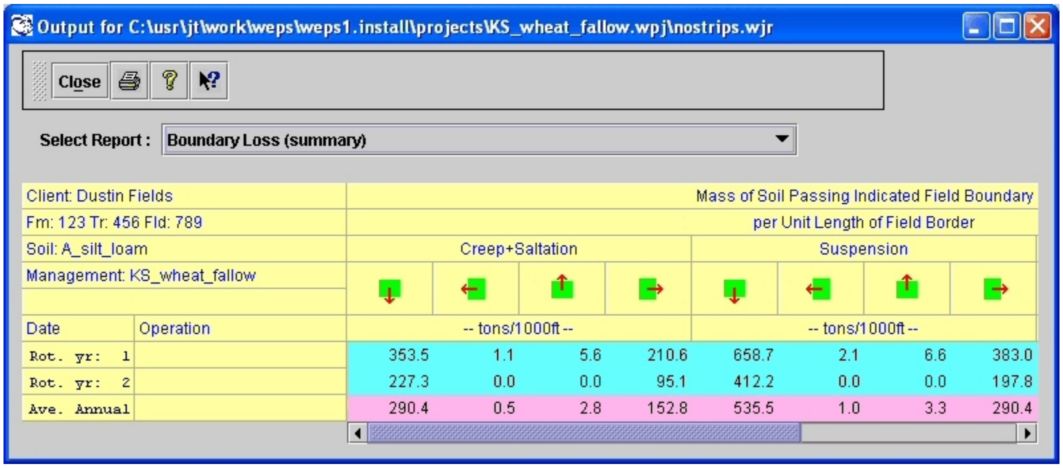


Figure 5.21. Boundary Loss summary for the non-stripped scenario.

Strip Crop

In an attempt to reduce soil loss along the direction having the greatest loss, the field is divided into eight 330-foot-wide strips (20 rods each) with strips alternating the wheat and fallow part of the rotation (Fig.5.22). The strips are oriented with the long sides aligned east-west. We simulate one strip of the field, with the wheat fallow management rotation. All other conditions remain the same as the original non-stripped field.

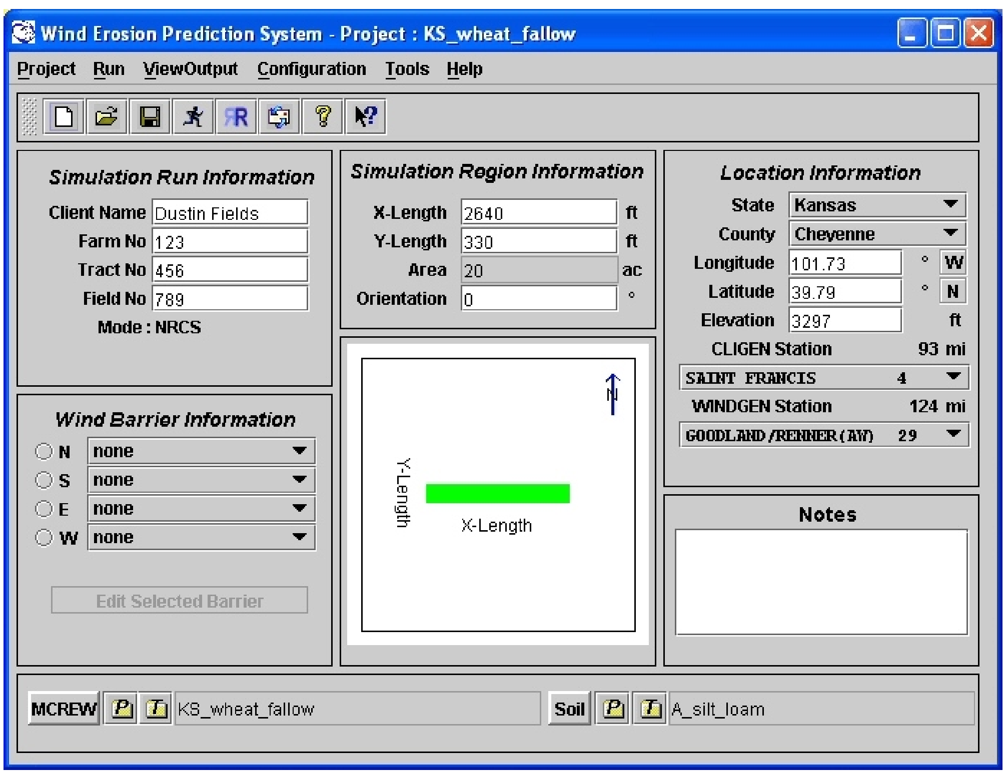


Figure 5.22. Main screen showing the setup for a strip-cropped field.

As can be seen in the Run Summary report (Fig. 5.23), breaking the field into strips reduced the annual average soil loss to 1.7 tons/acre/year, with 2.1 tons/acre/year lost during the first year (fallow) of the rotation and 1.4 tons/acre/year lost during the second year (wheat) of the rotation. Because loss is reported on a per acre basis, the loss for the strip represents the loss rate per acre for the entire field.

The Run Summary report also shows that suspension loss was less than the creep/saltation loss on the stripped field. Recall that suspension made up a majority of the loss on the non-stripped field (Fig. 5.20). Because the processes of creep/saltation increase downwind, so an increasing amount of suspension is generated (Figs. 5.10 and 5.11). Limiting the field length therefore, limits these suspension-generating processes.

On stripped fields, creep/saltation-sized aggregates will be deposited within the alternating strips that have adequate wheat or residue cover to stop the movement. This deposition of creep/saltation material in adjacent strips is not modeled within WEPS, but can be estimated from creep/saltation crossing the strip boundaries and should be considered in control strategies.

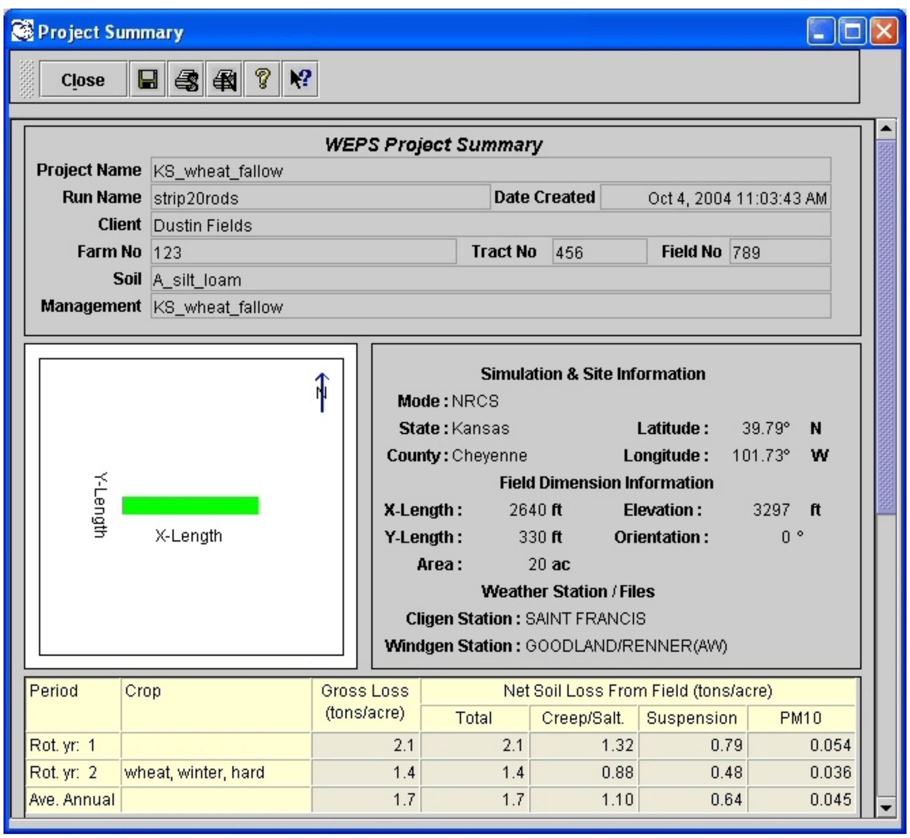


Figure 5.23. Run Summary report for the strip-cropped scenario.

The Boundary Loss summary (Fig. 5.24) shows that, although field length was unchanged in the east-west direction, a significant reduction in loss still occurred on the eastern boundary. This indicates that much of the original soil loss on the eastern boundary was the result of winds that were not directly out of the west. Therefore, some winds deviated from the westerly direction, causing soil loss across the east boundary. As a result of this deviation, stripping the field provided some reduction in field length along the wind direction, resulting in a reduction of soil loss in the eastern direction.

Although the Boundary Loss for creep/saltation generally stays on the field within the adjacent strip, suspension boundary loss can potentially leave the field area. Therefore, the suspension boundary loss along the long field border should be multiplied by the number of strips to determine total suspension boundary loss for the total 160-acre field. **Note!** In our example the suspension loss for the South border would be 3.2 x 8 or 25.6 tons/1000 ft and for the ease border, it would be 12.7 x 8 or 101.6 tons/ 1000 ft.

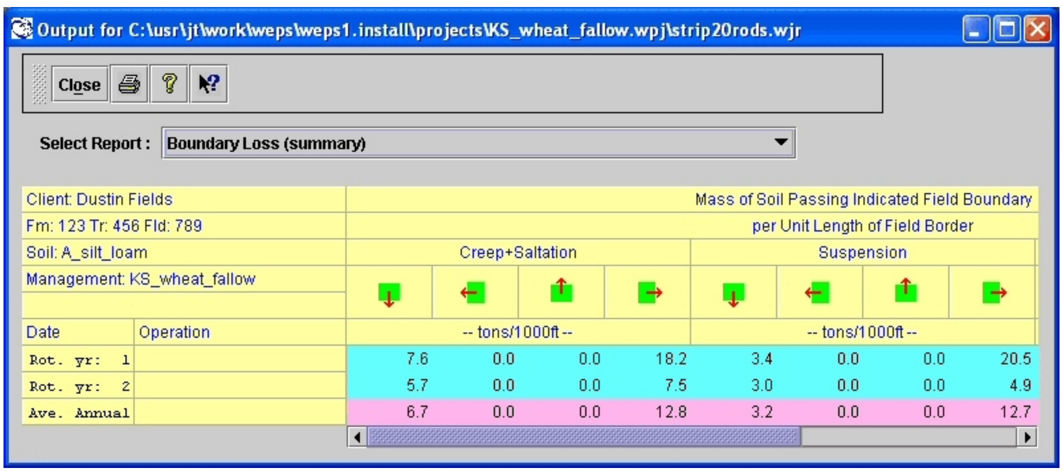


Figure 5.24. Boundary Loss summary for the strip cropped scenario.

Strip Crop with Grass Barriers

Even though stripping the field significantly reduced erosion rates, additional reduction can be obtained by adding a herbaceous barrier between the strips. An example of strip cropping with herbaceous barriers is illustrated in Figure 5.25, and the WEPS main screen setup for this scenario is shown in Figure 5.26. In this example, we added a one-row grass barrier on each side of the strip (height = 3.0 ft., width = 1.6 ft., and porosity = 0.3).

Figure 5.25. Example of field strip-cropped with herbaceous barriers.

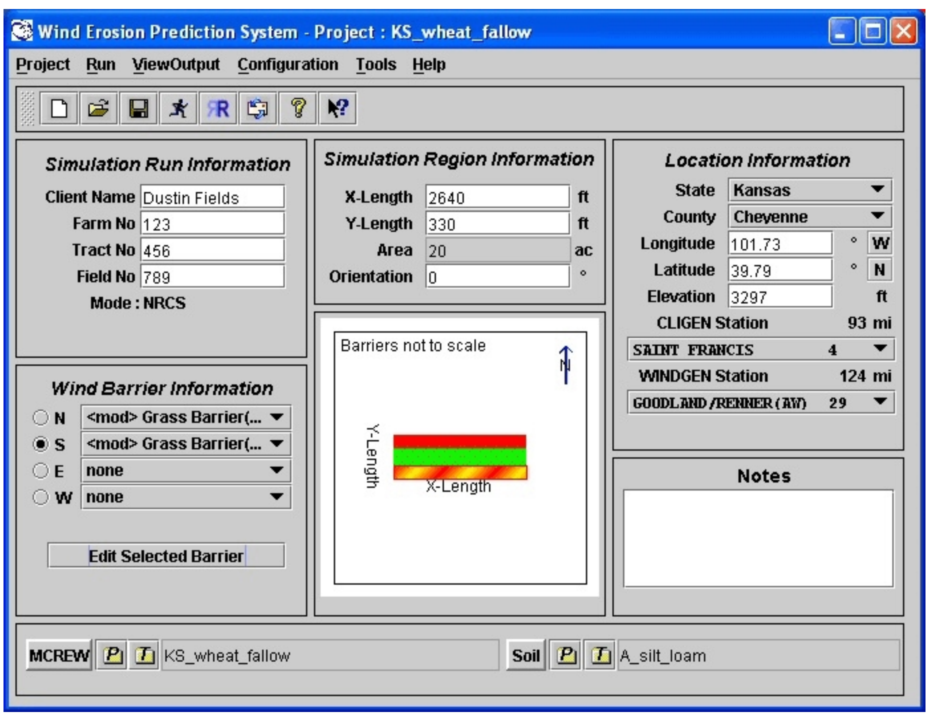


Figure 5.26. Main screen showing the setup for a field strip-cropped with grass barriers.

As can be seen by the Run Summary (Fig. 5.27), adding a barrier on each side of the strip further reduced average gross loss for the rotation to 0.9 tons/acre/year. The loss for first year (fallow) of the rotation was reduced to 1.2 and for the second year (wheat) it was reduced to 0.6 tons/acre/year. Note in this scenario that because barriers are present, the net loss is less than the gross soil loss for the field. This difference is due to deposition that occurs just before the downwind barrier. The net creep/saltation was reduced to 0.18 tons/acre/year, and suspension was reduces to 0.28 tons/acre/year. Again, creep/saltation deposition in adjacent strips is not modeled within WEPS. Because almost no creep/saltation is available to generate suspension-size material, one can conclude that most of the suspension is from loose suspension-size material on the surface.

The boundary loss for this scenario is shown is Figure 5.28. Both creep/saltation and suspension leaving the field were significantly reduced on the south boundary, compared with strip-cropping without the barriers. Loss on the eastern boundary was only slightly reduced.

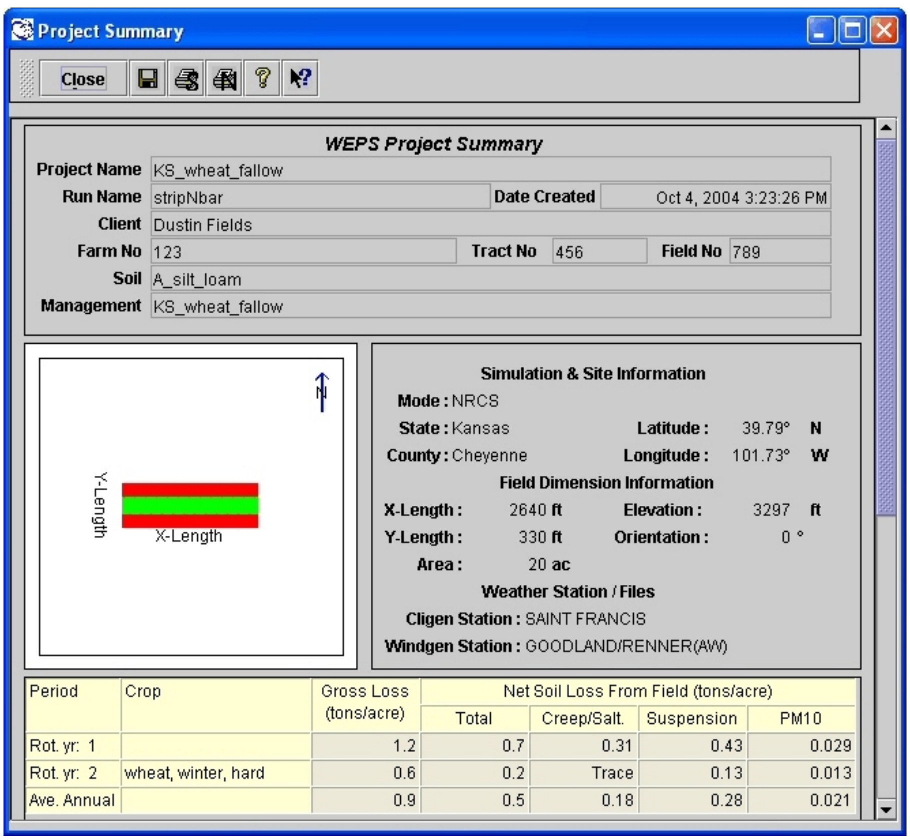
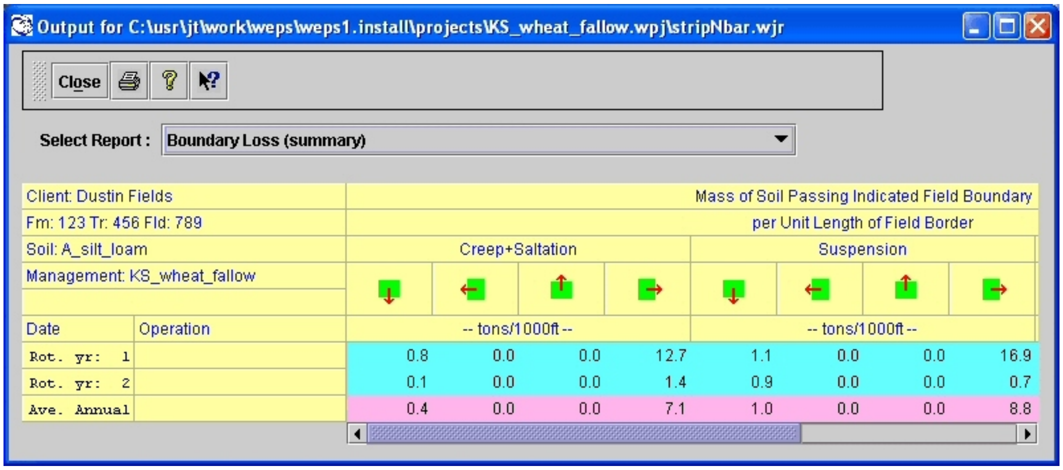


Figure 5.27. Run Summary report for the strip-cropped field with barriers.



Date	Creep+Saltation ↓	←	↑	→	Suspension ↓	←	↑	→
	-- tons/1000ft --				-- tons/1000ft --			
Rot. yr: 1	0.8	0.0	0.0	12.7	1.1	0.0	0.0	16.9
Rot. yr: 2	0.1	0.0	0.0	1.4	0.9	0.0	0.0	0.7
Ave. Annual	0.4	0.0	0.0	7.1	1.0	0.0	0.0	8.8

Figure 5.28. Boundary Loss summary for the strip-cropped field with barriers.

Strip Cropping on a Soil with Excessive Erosion

This set of examples contains field and management conditions that are the same as the previous examples, except that the soil is a loamy sand, which is susceptible to large amounts of erosion. The Run Summary for the non-stripped scenario (Fig. 5.29) indicates an annual average loss of 96.0 tons/acre/year, with an average of greater than150 tons/acre/year being lost in the first year (wheat) of the rotation. Note the net loss for creep/saltation is 22.53 tons/acre/year and suspension is 73.40 tons/acre/year. Again, the boundary loss (Fig. 5.30) shows that the most loss passes the southern boundary, so shortening the field in the north-south direction by stripping is a control strategy that should be considered.

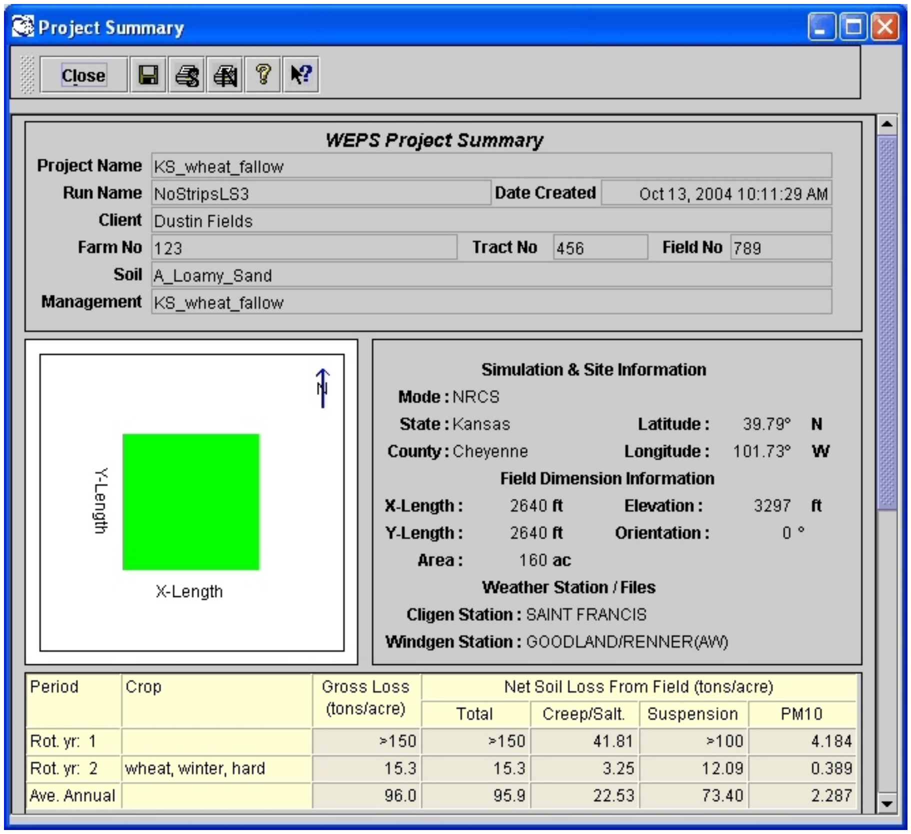


Figure 5.29. Run Summary for the non-stripped scenario with a loamy sand soil.

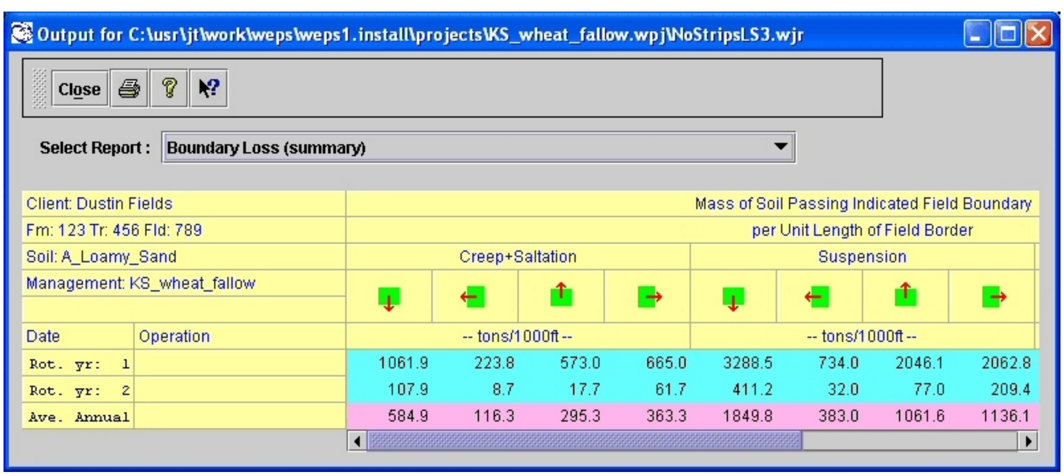


Figure 5.30. Boundary Loss summary for the non-stripped field with a loamy sand soil.

To observe the effects of strip width on this loamy sand field, we begin with a field divided into thirty-two, 82- foot-wide strips (5 rods each) with the long sides aligned in the east-west direction in an attempt to reduce soil loss. All other conditions for the field remain constant for the simulation. We continue to successively double the width of the strips (i.e., 82, 165, 330, 660, 1320, 2640 ft.) and simulate the soil loss as strips get wider. The results of these simulations are shown in Table 5.1 and indicate that average annual total loss continually increases with increases in the strip width. The net creep/saltation loss, however, shows an increase as width increases from the narrow-stripped scenario to a maximum loss at 660 ft width. As widths become wider than 660 ft., the creep/saltation loss decreases.

Table 5.1. Change in soil loss with changing strip width.

Strip Width		Average Net Loss from Field (tons/acre/year)			South Boundary Loss (tons/1000 ft.)	
feet	rods	Total	Creep/Salt.	Suspension	Creep/Salt.	Suspension
82	5	35.1	25.77	10.31	32.6	10.6
165	10	48.9	33.67	15.24	84.6	33.5
330	20	68.1	43.13	24.99	204.4	111.1
660	40	88.7	46.23	42.46	404.2	359.8
1320	80	95.1	34.52	60.59	539.4	917.8
2640 (no strip)	160	95.9	22.53	73.40	584.9	1849.8

To discuss these changes in loss with field length, it is important to review the concepts of "net loss" and "discharge". The model simulates a horizontal discharge (i.e.,amount removed up to a downwind distance) of mobile saltation/creep (Fig. 5.10) and suspension-size aggregates (Fig. 5.11). On long erodible fields, the saltation/creep discharge may reach transport capacity. **Transport capacity** is defined as the maximum horizontal discharge of saltation/creep possible for a given wind speed and surface condition. At transport capacity, the deposition of saltation/creep from the air stream per unit area equals the amount entrained into the air stream. There generally is still a net removal of saltation/creep aggregates from the surface to replace those lost by breakage to suspension size. In this scenario, saltation-creep can only approach transport capacity. In contrast, the suspended discharge is not limited by transport capacity, because these particles continually diffuse into the atmosphere. As a consequence, the mass of suspended material increases over the entire length of eroding fields, with the rate of increase controlled by the erosion processes. Remember to add the suspension soil loss from all the strips to the total loss.

Conservation planners often design control systems based on average soil loss (i.e., amount removed per area). Total horizontal discharge at any downwind distance divided by the upwind field length represents the average soil loss over the upwind area. Using this calculation, one can illustrate the effects of field length on soil loss. Depending upon field surface conditions, the erosion processes cause differing patterns of horizontal soil discharge and, consequently, causing differing soil loss for the saltation/creep-size (Fig. 5.10) and the suspension size soil (Fig. 5.11). After saltation/creep reaches transport capacity, dividing the nearly-constant transport capacity by field length to give average soil loss shows that there is a steady decrease in loss per unit area with increasing field length (i.e., area increases, whereas transport remains essentially the same). In contrast, there is generally a large net loss of suspension-size soil over the entire field length. Total soil loss for any field length is determined by adding the average suspension and saltation/creep soil losses (Fig. 5.12). In general, the maximum average soil loss occurs at a field length at which both the saltation/creep and suspension components are contributing significant net soil loss. On far downwind portions of long fields, the increases in the soil discharge come mainly from suspended soil, so the average soil loss may decrease somewhat with field length. Thus, on long fields, suspension soil loss typically exceeds the saltation/creep loss. Of course, if the mobile soil is composed mainly of sand larger than suspension size (> 0.1 mm diameter), then saltation/creep will remain the dominant form of soil loss.

Smooth, loose fields often have a length at which there is a maximum soil loss, and the average loss then decreases beyond that field length (Fig. 5.12a). In this example, very short field lengths are necessary to control wind erosion. Thus, on all fields subject to wind erosion, planners should consider using other erosion controls in combination with strip cropping. Cross wind ridges, cover crops, and residue management are good examples.

Suspended soil lost from long eroding fields can be considerable and is subject to long-range transport. Other detrimental effects also accompany this soil loss. These include an increase in sorting of the initial soil so that the removed soil is enriched in nutrients, organic matter, clay and silt fractions- the productive elements of the soil. The increased abrasion and breakage processes on long fields also increase the PM10 content (particulate matter <10 microns diameter) that is regulated as a health hazard. Thus, not only the amount, but also the quality and size distribution of the removed soil, changes as field length increases.

For simplicity, the Wind Erosion Equation (WEQ) predicts that average soil loss on long fields approaches a constant value. In WEPS, on the other hand, the average soil loss may increase or decrease on long fields, depending on whether creep/saltation or suspension is the dominant transport mode. Both the WEPS and WEQ models show that, for effective erosion control, the field length along the prevailing wind erosion direction needs to be significantly less than the distance to the point of maximum soil loss. The effect of reducing field length on erosion is not linear, however, but varies approximately with the logarithm of the distance to transport capacity.

Recall that, in the current version of WEPS, individual field strips are modeled as a single field. The initial increase in creep/saltation loss, as the loamy sand field get wider (Table 5.1), is a result of large increases in discharge relative to small increases in field area (i.e., left part of curve in Figure 5.10a and 5.10b for the loose, smooth field). But at some point downwind on wide fields, the creep/saltation discharge reaches transport capacity, and loss and deposition are equal (i.e., where Figure 5.10a becomes nearly flat for the loose, smooth field). Thus, an increase in field width from that point does not result in any further net discharge of creep/saltation-size material (Fig. 5.10a) and actually shows a decrease in loss of creep/saltation material as strips get wider (Fig. 5.10b and 5.12a). This decrease in loss as strips get wider occurs because net loss is calculated by dividing the constant discharge (transport capacity) by the increasing area (tons/acre). This decrease in creep/saltation loss as wide fields get wider may, under some field conditions, even occur with the total net loss from the field. In the present example, however, even though the creep/saltation rate increased as wide strips got narrower, the suspension was continually reduced. The reduction in suspension was more than enough to compensate for the increase in creep/saltation and, thus, the total loss rate was reduced as strip width decreased.

It is very important to note that the boundary loss for the south boundary (Table 5.1) shows a significant reduction in both the creep/saltation and suspension leaving the field as width decreases. Notice that there was not an increase in boundary loss of creep/saltation with field distance on wide strips, as there was with the field loss. This is because boundary loss is divided by a constant distance (tons/1000 ft) as strips get wider. The boundary loss represents the amount leaving the field boundary and illustrates the value of dividing the field into strips to control erosion by wind, especially on fields susceptible to large amounts of erosion.

Adding a grass barrier on each side of a 330-foot strip, as in the previous example, further reduces soil loss over the similar-size strip without barriers (Fig. 5.31). Total gross loss was reduced to 21.2 tons/acre/year. Note that again the net loss was cut almost in half because of deposition just before the downwind barrier within the simulated strip. But, this erosion rate is still unacceptable, and much more aggressive control strategies should be examined. More aggressive residue retention with a stubble mulch system will be attempted next.

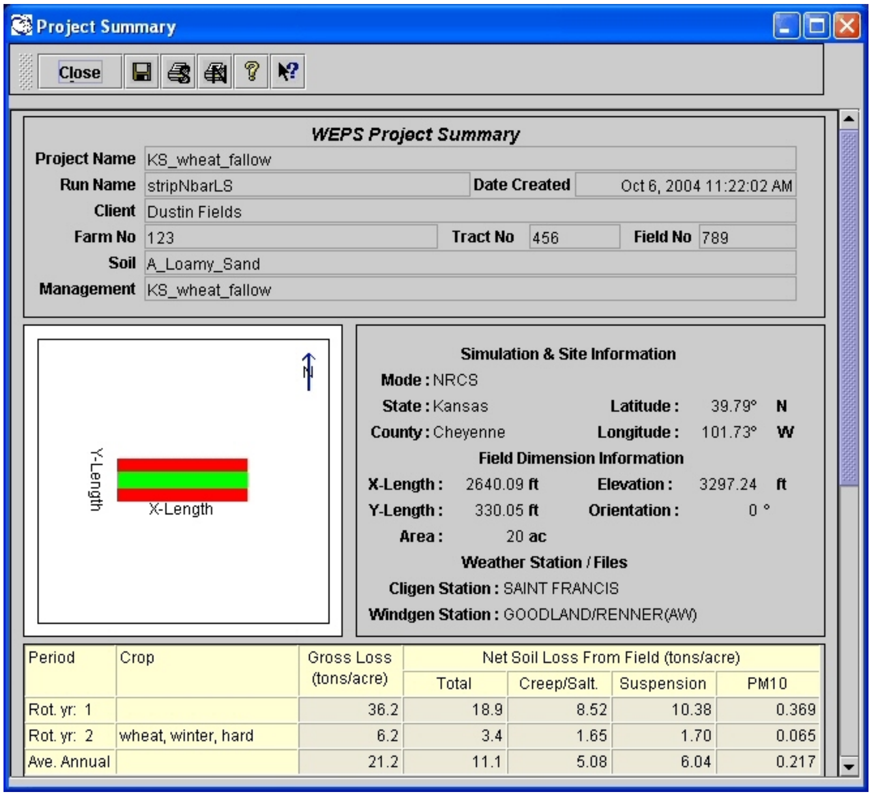


Figure 5.31. Run Summary for the strip-cropped scenario of loamy sand with barriers.

Finally, to further reduce erosion loss the management used on the previous example is changed to a stubble mulch system designed to retain more crop residue throughout the rotation. The modified management is shown in Figure 5.32 and was created by delaying the sweep operations and eliminating a chisel operation in the fall of the second year.

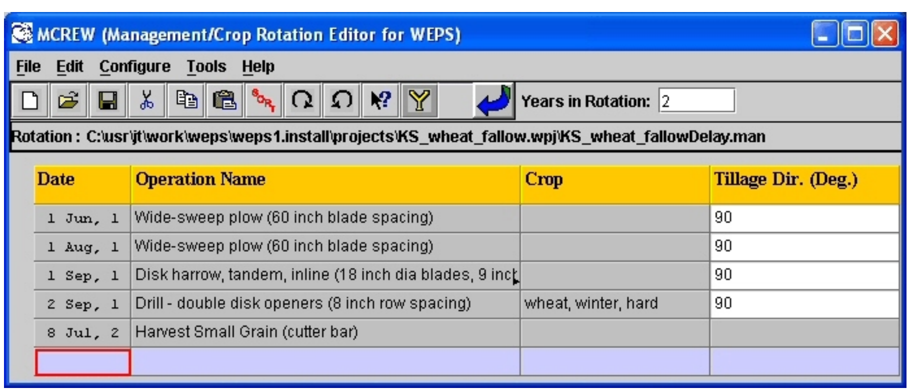


Figure 5.32. Management Crop Rotation Editor for a conventional wheat fallow rotation.

Switching to a stubble mulch in addition to a grass barrier on each side of a 330 ft strip, as in the previous example, further reduces gross soil loss to 7.0 tons/acre/year on the field with a loamy sand. The net loss, however, was reduced to 3.8 tons/acre/year (Fig. 5.33). Note that again the net loss was cut almost in half because of deposition just before the downwind barrier within the simulated strip. This erosion rate is still unacceptable, and more intensive control strategies should be examined. To reduce loss even further, more aggressive residue retention should be tried; even the retirement of the land into permanent grass should be considered.

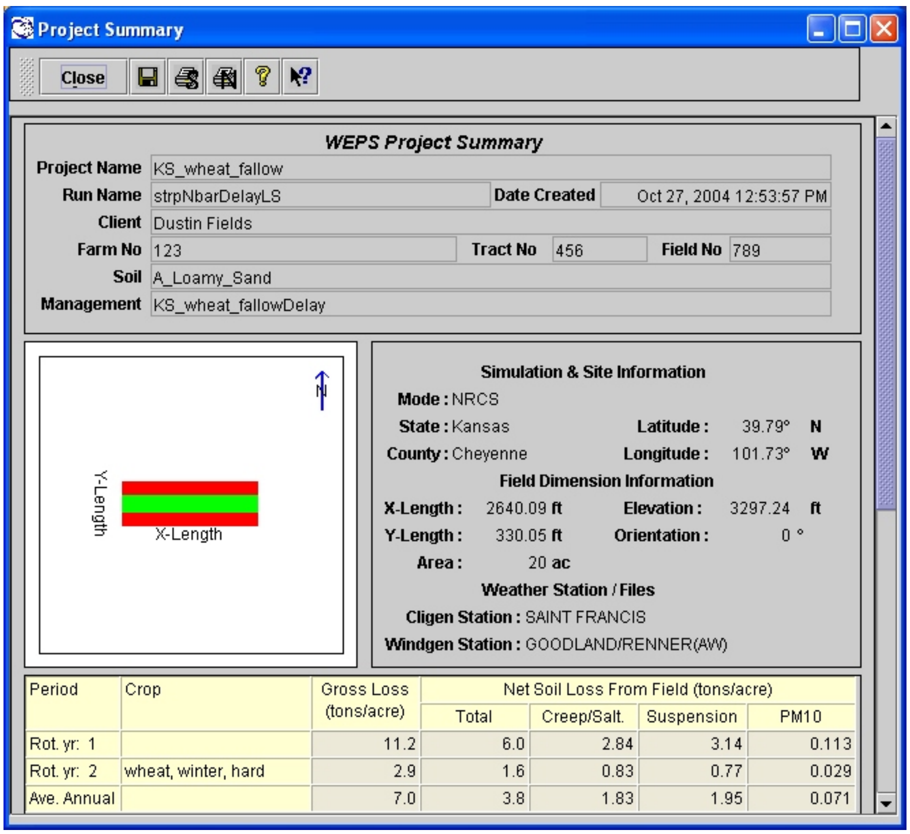


Figure 5.33. Run Summary for the strip-cropped field with barriers and a stubble mulch management system.

WEPS How To Guide

Crop Database Record Development

Introduction

In the plant growth submodel of the Wind Erosion Prediction System (WEPS), biomass is converted from solar radiation and partitioned to root and shoot parts (Fig. 5.34). The shoot mass is partitioned into leaf, stem, and reproductive masses. Finally, the reproductive mass is partitioned into grain and chaff parts. Development of the crop in WEPS is a function of the heat-unit index, which is the ratio of the heat units (growing degree days) at any time during the growing season to the total amount of heat units required to grow a crop from planting to maturity. The heat-unit index is 0 at planting, and the crop reaches maturity when the heat-unit index is 1.

To perform these and other operations, crop growth in WEPS is configured by a set of parameters that define and drive the growth processes represented in the model code. Reasonable crop growth in different environments is achieved by setting the appropriate parameter values for the type of crop being grown. The purpose of this guide is to define and describe the process of obtaining reasonable parameter values based on knowledge of crop characteristics.

After estimating a parameter value, specific WEPS output can be examined to see if the parameter setting gives reasonable results. Not all WEPS output is available through the WEPS interface output reports. Therefore, the user is sometimes referred to other output files, such as 'crop.out' which contains daily output for many crop variables and 'decomp.out', which contains daily output for many decomposition variables. A parameter should be adjusted if a related simulated variable does not look reasonable. After adjusting the parameter(s), run WEPS again and inspect the variable again to see if it matches what is expected. If not, continue to adjust the parameter values on this trial-and-error basis. Be sure to look at simulation output for more than one growing season.

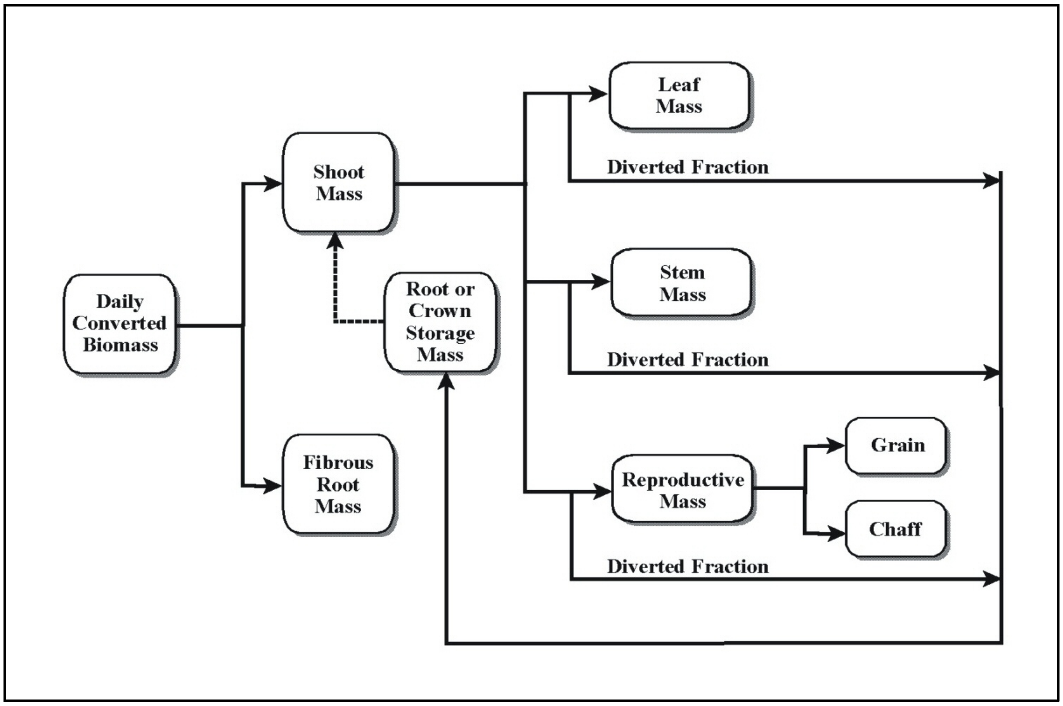


Figure 5.34. Schematic of biomass partitioning in WEPS. Biomass is converted from solar radiation and partitioned to 'fibrous root' and 'shoot' parts. The shoot mass is partitioned into leaf, stem, and reproductive masses, with some fraction of these masses diverted into a storage pool for crop regrowth. Finally, the reproductive mass is partitioned into grain and chaff parts.

Crop Database Structure Files and Definitions

Crop database records are stored in an XML format file with the extension ***.crop*** for use by the WEPS interface. Supporting files that define the database structure are part of the MCREW configuration files. New individual crop database records are most directly created by using MCREW to edit an existing crop file and saving it to a new name. New files can also be created with a text editor to edit the ***.crop*** file directly. The parameter descriptions herein provide the keys to enable the reader to know which parameter is being edited by either method.

The parameters are defined with units and are identified by a **Parameter Prompt**, which is the text that appears in the MCREW Crop drill-down screen. Some parameters have **Parameter Choices**, a list of choices that will be displayed when the parameter is defined as a discrete set of values, often integer flags. The parameters are grouped according to similar function, just as they are grouped by tabs on the Crop drill-down screen. Some parameters have both primary and alternate units which, along with a conversion factor, are given in Table 5.2.

Note that for NRCS most parameter choices will not be editable by Field Office Users. NRCS will use a database manager to adjust and distribute new or revised database file.

Table 5.2. Parameters having both primary and alternate units. The WEPS science model uses the primary units. Alternate units are used if English units are selected in the WEPS configuration. To convert from primary units to alternative units multiply by the given conversion factor (and add 32 where indicated).

Parameter Prompt	*Primary Units*	*Alternative Units*	*Conversion Factor*
Plant population	$\#/m^2$	#/acre	4046.7
Planted mass, dry weight	mg/plant	ounce/plant	$3.5274*10^{-5}$
Root storage mass required for each regrowth shoot	mg/shoot	ounce/shoot	$3.5274*10^{-5}$
Heat units to maturity	°C day	°F day	1.8
Minimum temperature for plant growth	°C	°F	1.8 + 32
Optimum temperature for plant growth	°C	°F	1.8 + 32
Maximum growth diameter of a single plant	m	ft	3.281
Residue : Yield intercept	kg/m^2	lb/acre	8921.8
Maximum root depth	m	ft	3.2808
Maximum crop height	m	ft	3.2808
Lower temperature	°C	°F	1.8 + 32
Higher temperature	°C	°F	1.8 + 32
Stalk diameter	m	inches	39.3696
Mass to cover factor	m^2/kg	acre/lb	0.00011209

Crop Parameter Definitions

Shoot Tab

The emergence of plant shoots, from either seeds, stored root mass, or the pseudo emergence of transplants, is controlled by four crop parameters: "Planted mass, dry weight", m_p , "Root storage mass required for each regrowth shoot", m_{sh}, "Ratio of leaf mass/stem mass in shoot", r_{ls}, and "Ratio of stem diameter to stem length", r_{dl}, and two parameters described later in this document: "Stem silhouette area coefficient *a*" and "Stem silhouette area coefficient *b*". Note that the "Root storage mass required for each regrowth shoot" is mostly used in regrowth calculations. If the "Planted mass, dry weight" is greater than the "Root storage mass required for each regrowth shoot", then multiple shoots per plant will be generated. The number of shoots per plant, n_{sh}, that will grow from the planted (stored) mass, is calculated from:

$$n_{sh} = \max\left[1, \min\left[n_{ms}, \frac{m_p}{m_{sh}}\right]\right]$$
$$N_{sh} = N_p n_{sh} \quad \textbf{(5.1)}$$

where n_{ms} is the "Maximum number of shoots per plant" and N_{sh} is the number of shoots per square meter. Note that n_{sh} does not have to be an integer. The shoot growth subroutines assume a 70% conversion efficiency from stored to live biomass. When growth is from seed or a transplant, 40% of growth biomass will become roots. The stem length at full extension is calculated as:

$$m_{st} = \frac{0.7(1-0.4)m_p}{(r_{ls}+1)}$$
$$A_{st} = a\left(\frac{m_{st}}{10^6}\frac{N_{sh}}{N_p}\right)^b \frac{N_p}{N_{sh}} \quad \textbf{(5.2)}$$
$$l_{st} = \sqrt{\frac{A_{st}}{r_{dl}}}$$

where m_{st} is the mass of stem generated in the complete emergence process, A_{st} is the silhouette area of a single stem, and l_{st} is the length of stem generated at full extension. Full extension has been realized when all of the planted (stored) mass (m_p) has been converted to generated shoot mass. Emergence occurs when l_{st} is greater than the "Starting depth of growing point". An error message is generated if emergence never occurs.

Parameter Prompt: Crop Type
Parameter Choices: 1 - Warm-season legume (soybeans, etc.)
2 - Cool-season legume (peas, etc.)
3 - Perennial legume (alfalfa, etc.)
4 - Spring seeded and warm-season annuals (spring wheat, cotton, sunflowers, corn, etc.)
5 - Cool-season annuals (winter wheat, winter canola)
6 - Perennials (pasture, etc.)

This selection determines crop growth processes, such as vernalization (crop types 2 and 5 implement a vernalization delay to overwinter heat-unit accumulation), and the ability to regrow after cutting (crop types 3 and 6 will regrow if sufficient root or crown storage has been accumulated).

Parameter Prompt: Transplant or Seed flag
Parameter Choices: 0 - Seeds planted in field
1 - Transplants planted in field (mass immediately divided into root, leaf, stem).

This flag is set to indicate that plant growth begins with a transplant or with a seed being placed in the field. If growth begins with a transplant (as opposed to grown from seed), a number of additional parameters need to be adjusted: the length of the growing season will need to be shortened, by either days or heat-units, to represent the time from transplant to maturity; the planted mass, dry weight, should be adjusted to represent the size of the transplant; and the heat-unit index at (pseudo) emergence, should be adjusted to represent a reasonable transplant-shock recovery time.

Parameter Prompt: Plant population, N_p (#/m^2)
The number of plants expected in a normal stand. This should be the estimated plant population after germination. If the maximum number of shoots per plant (next parameter) is set to one, then this is the total number of stems expected.

Parameter Prompt: Maximum number of shoots per plant, n_{ms} (#/plant)
Growth of multiple shoots occurs when this value is greater than one and root (crown) storage mass is greater than “Root storage mass required for each regrowth shoot” at the time regrowth commences. The number of stems produced can be examined by viewing the number of stems per square meter (the variable ‘#stems' in the output file ‘crop.out’) and comparing it with the “Plant Population” (previous parameter).

Parameter Prompt: Starting depth of growing point (m)

Crop growth begins at this depth in the soil. Root extension proceeds downward from this depth, while shoot extension proceeds upward from this depth at equal rates. It is necessary that the shoot growth parameters result in a shoot length greater than this depth or seedlings will not emerge. This depth is used as the depth from which regrowth begins for crop types 3 and 6 at all times. For crop types 1 and 4, the growing point is moved to the surface at the completion of seedling emergence. For crop types 2 and 5, the growing point is moved to the surface after the initiation of spring growth.

Parameter Prompt: Planted mass, dry weight, m_p (mg/plant)

At planting time, total plant biomass is initialized to this value. From the time of growth initialization until the completion of emergence, this mass is allocated to roots, stems, and leaves. For a crop grown from a seed, the mass should be set to the individual seed weight. For a crop that is placed in the field as a transplant, the total plant dry weight, including roots, should be entered.

Parameter Prompt: Root storage mass required for each regrowth shoot, m_{sh} (mg/shoot)

As described previously, the number of shoots that grow from stored root mass is calculated based on this parameter. For crops that can regrow from stored root or crown mass, this value is used, along with the "Maximum number of shoots per plant" and the stored root mass of the crop to determine how many shoots will re-sprout. The partitioning of mass to be stored for regrowth is set by using the parameters "Fraction of leaf mass partitioning diverted to root storage", "Fraction of stem mass partitioning diverted to root storage", and "Fraction of standing store mass partitioning diverted to root storage". The quantity stored varies depending on growth conditions.

Parameter Prompt: Ratio of leaf mass/stem mass in shoot, r_{ls}

This is the ratio at full extension. When the growth of a shoot from stored mass occurs, as in germination, regrowth after cutting, or the pseudo growth used to initialize a transplant, mass is divided into leaf and stem according to this ratio. This value should be large enough to generate the leaf area required to get crop growth started. If a crop does not grow adequately, examine the variable 'eff_lai' in the output file 'crop.out'. It should show a value of 0.01 or greater at the heat-unit index at emergence.

Parameter Prompt: Ratio of stem diameter to stem length, r_{dl}

This is the ratio at full extension. When the growth of a shoot from stored mass occurs, as in germination, regrowth after cutting, or the pseudo growth used to initialize a transplant, stem length is calculated from stem mass according to this ratio. This parameter is the prime candidate for adjustment to ensure that plant emergence occurs when growing from seed.

Parameter Prompt: Heat-unit index at emergence

Setting this value to zero will cause the program to fail.

Growth Tab

Parameter Prompt: Crop maturity measurement method

Parameter Choices: 0 - Crop matures on average in Days shown

1 - Crop matures in Heat Units shown

For some types of crops, corn being the best example, the length of the growing season is genetically manipulated, and the average length of the crop growth period for that area is expressed in days, not heat units. When this option is set to 0, the average weather for the location being simulated is used to find the heat unit accumulation from the planting day through the number of days shown in the "Days to maturity" parameter. The simulation is then run using this heat unit total as the season length. For option 1, the value entered for "Heat units to maturity" is used directly, regardless of location. Because the effect of vernalization on the calculation of average heat units is not implemented, all crop types 2 (cool season legumes like peas) and 5 (cool season annuals like winter wheat and winter canola) should be configured to use option 1.

Parameter Prompt: Days to maturity (days)

For annual grain crops, the average number of days from planting to maturity of seed. For vegetable, fruit, and root crops; sugarcane; and tobacco, it is the number of days from planting (or ratooning) to harvest. For perennials (e.g., alfalfa), it is the number of days from spring growth to maturity of seed.

Parameter Prompt: Heat units to maturity (ºC day)

For annual grain crops, the average seasonal heat units from planting to maturity of seed. For vegetable, fruit, and root crops; sugarcane; and tobacco, it is the average seasonal heat units from planting (or ratooning) to harvest. For perennials (e.g., alfalfa), it is the average seasonal heat units from spring growth to maturity of seed.

Parameter Prompt: Heat unit index at start of senescence (fraction)

This is the fraction of the growing season (expressed as heat-unit index) during which plant senescence begins. Examine the variable 'eff_lai' in the output file 'crop.out' to see the effect of adjusting this parameter.

Parameter Prompt: Minimum temperature for plant growth (ºC)

The average daily air temperature below which the model will not allow plant growth (full temperature stress). This is commonly known as the minimum cardinal growth temperature and forms the base temperature for calculating heat-unit accumulation.

Parameter Prompt: Optimum temperature for plant growth (ºC)
The average daily air temperature at which the model will allow maximum growth (no temperature stress). This is commonly known as the maximum cardinal growth temperature and forms the upper temperature for calculating heat unit accumulation. When the average daily air temperature exceeds this value, heat-units accumulate at the maximum rate for the day, and temperature stress increases.

Geometry Tab

Parameter Prompt: Maximum growth diameter (m) of a single plant
Some cropping systems use plant densities that do not result in canopy closure. In these systems, the plant will grow to cover a ground area that is characteristic of the plant. WEPS assumes that the covered ground area is round. This parameter is the diameter of the circle that encloses the covered area. Biomass production is reduced by the decrease in intercepted light (some of the light reaches the soil), unless the reduced densities are used to reduce water stress for the remaining plants.

Parameter Prompt: Stem silhouette area coefficient a

Parameter Prompt: Stem silhouette area coefficient b
For many crops, the relationship of stem silhouette area to its mass is described well by a 2-parameter power function, which is used to compute stem silhouette area from stem mass: $SSA = a M^b$, where SSA is stem silhouette area (m^2 / plant), M is stem mass (kg / plant), and a and b are coefficients. Retta and Armbrust (1995) obtained values for alfalfa, corn, sorghum, oat, winter wheat, and soybean.

Parameter Prompt: Specific leaf area (m^2 / kg)
For many crops, the relationship of leaf area to its mass is described well by a linear relationship, which is used to compute leaf area from leaf mass: $LA = a M$, where LA is leaf area (m^2 / plant), M is leaf mass (kg / plant), and a is specific leaf area (m^2 / kg).

Parameter Prompt: Light extinction coefficient
Canopy light utilization is specified by an exponential relationship for the attenuation of light with distance into the canopy. Combined with the leaf-area index, this coefficient determines the amount of light interception by the canopy according to the relationship:

$$fraction = 1 - \exp^{-k\ LAI} \qquad (5.3)$$

where fraction is the ratio of photosynthetically active radiation (PAR) that is intercepted by the crop and total PAR received above the crop canopy, k is light extinction coefficient, and LAI is leaf area index (Fig. 5.35). A higher number indicates more light interception by a given leaf area index, as occurs with broadleaf plants with a horizontal leaf orientation, such as cotton. A lower number indicates decreased light interception by a given leaf area index, as occurs with narrow leaf plants with a vertical leaf orientation, such as the grasses.

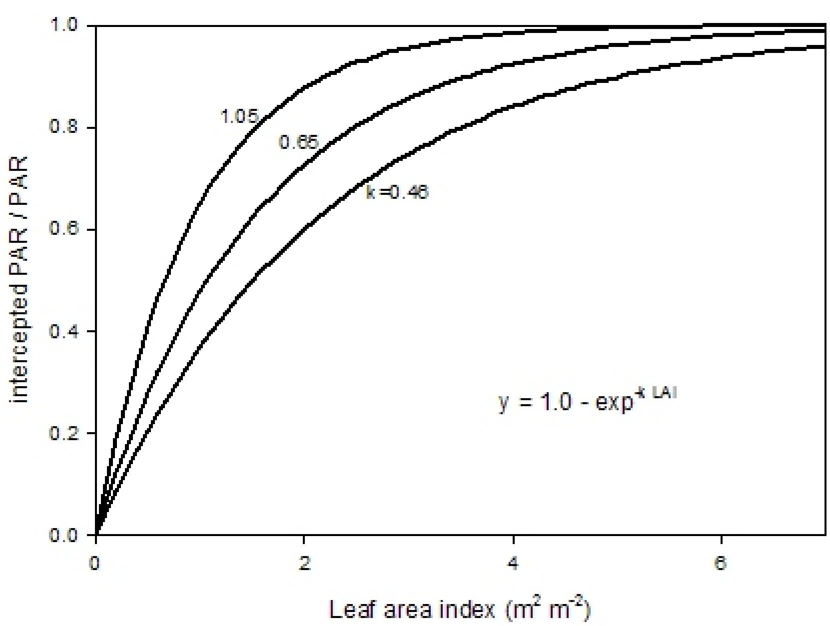


Figure 5.35. Relationship between leaf-area index and fraction of light intercepted (intercepted PAR / PAR) for three different values of the light extinction coefficient k. WEPS uses k = 1.05 for cotton; k = 0.65 for corn, soybean, potato and sugar beet; and k = 0.46 for sorghum and millet.

Parameter Prompt: Biomass Conversion Efficiency (t/ha) / (MJ/m^2)

The unstressed (potential) growth rate per unit of intercepted photosynthetically active radiation. EPIC values were used as a starting point for the major crops. Literature searches revealed that this value is difficult to measure exactly. This parameter is key to making the crop grow correctly.

Partitioning Tab

The daily converted (grown) biomass is partitioned between root and shoot mass (Figure 5.34). The shoot mass (above-ground biomass) is further partitioned into leaf, stem, and reproductive mass (Figure 5.36). Both the leaf curve and the reproductive curve are defined by a 4-parameter function. The remaining mass is considered stem mass. The three fractions always add to 1.0.

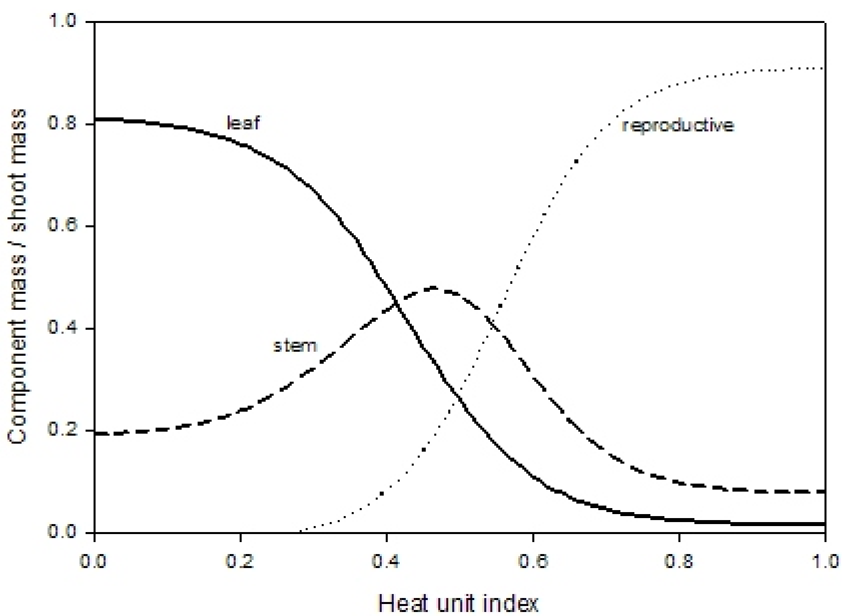


Figure 5.36. Partitioning of shoot mass (above-ground biomass) into component mass for winter wheat. Components are leaf, stem, and reproductive mass. By definition, these three fractions always add to 1.0.

Specify the four parameters for the leaf curve (Figure 5.37):

Parameter Prompt: Leaf fraction coefficient a
The lower asymptote.

Parameter Prompt: Leaf fraction coefficient b
The range between the upper and lower asymptote.

Parameter Prompt: Leaf fraction coefficient c
The heat-unit index at the inflection point. The leaf mass / shoot mass ratio at the inflection point is half way between the lower and upper asymptote (a + b/2).

Parameter Prompt: Leaf fraction coefficient d

Determines the slope of the curve. A negative d produces a descending curve (leaf) and a positive d gives an ascending curve (reproductive).

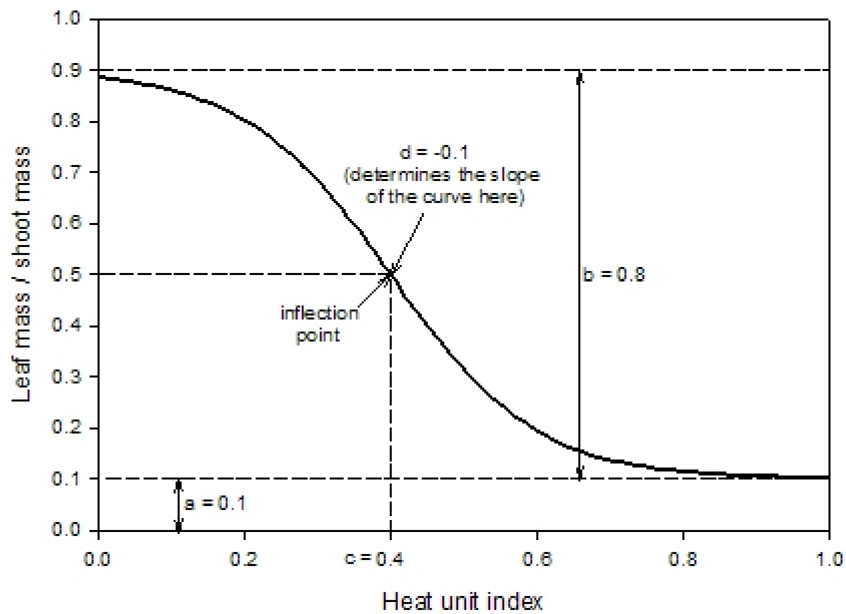


Figure 5.37. Partitioning of shoot mass into leaf mass. In this example, a = 0.1, b = 0.8, c = 0.4, and d = -0.1. The leaf mass / shoot mass ratio at the inflection point = a + b/2 = 0.5.

Specify the four parameters for the reproductive curve:

Parameter Prompt: Reproductive mass coefficient a
The lower asymptote.

Parameter Prompt: Reproductive mass coefficient b
The range between the upper and lower asymptote.

Parameter Prompt: Reproductive mass coefficient c
The heat-unit index at the inflection point.

Parameter Prompt: Reproductive mass coefficient d
Determines the slope of the curve at the inflection point.

For a new crop, the four leaf parameters can be adjusted on the basis of total leaf mass development (the variable 'total leaf' in the output file 'crop.out'). Check total stem mass development by inspecting the variable 'total stem' in the output file 'crop.out'. If stem mass development seems unsatisfactory, adjust both leaf and reproductive parameters to change the stem partitioning curve.

Reproductive mass should be equal to zero before time of flowering. This may be used as a point on the reproductive partitioning curve. Inspect the variable ‘standing store' in the output file ‘crop.out’. If ‘standing store’ is greater than zero before flowering is expected, partitioning to reproductive mass starts too early in the growing season. Adjust the reproductive parameters accordingly.

By default (option Y1), WEPS does not use the reproductive parameters. WEPS will only use them if the Y0 option is specified. If using the reproductive parameters for partitioning then harvest index is also something to look at. Adjust partitioning parameters if the harvest index seems incorrect. Remember that adjusting leaf and/or reproductive parameters will automatically affect stem mass partitioning.

The default method for partitioning and to calculate crop yield from total above-ground biomass uses parameters *r* and *b* to specify the relationship between yield and residue, where yield (at market-standard moisture content) plus residue (dry weight) equals total above-ground biomass. The equation is:

$$residue = r \ x \ yield + b \qquad \textbf{(5.4)}$$

where b is the minimum above ground biomass required for a crop to generate any yield, and r is the incremental increase in residue for each additional unit of yield in excess of the minimum. The two parameters were estimated for the major crops from field data gathered for this purpose.

Parameter Prompt: Residue : Yield ratio (kg/kg)

Parameter *r*. As defined for the residue equation, this is the incremental increase in residue for each additional unit of yield in excess of the minimum (i.e., yield mass / residue mass).

Parameter Prompt: Residue : Yield intercept (kg/m^2 or lbs/ac)

Parameter *b*. As defined for the residue equation, this is the minimum biomass required for a crop to generate any yield.

Biomass is estimated to be stored in the root (or crown) storage pool on the basis of the values of the following three parameters. They are tied to the three biomass partitioning components (leaf, stem, reproductive) of plant growth, allowing the modeling of plants that store biomass during different periods of the growing season (Fig. 5.34).

Parameter Prompt: Fraction of leaf mass partitioning diverted to root storage

For crops that store biomass early in the growth season, set this value greater than zero.

Parameter Prompt: Fraction of stem mass partitioning diverted to root storage

For crops that store biomass in the middle of the growth season, set this value greater than zero.

Parameter Prompt: Fraction of reproductive mass partitioning diverted to root storage

For crops that store biomass late in the growth season, set this value greater than zero. For root crops, this value should be very close to 1, indicating that most reproductive biomass is stored below ground.

Size Tab

Parameter Prompt: Maximum root depth (m)

The maximum depth of roots attained by the crop under ideal (unstressed) growth conditions. The main modeling impact of this value is the depth of soil water extraction. Examine the variable ‘rootd’ in the output file ‘crop.out’ to see the effect of adjusting this parameter.

Parameter Prompt: Maximum crop height (m)

The maximum height attained by the crop under ideal (unstressed) growth conditions. For a new crop, this parameter can be adjusted based on the crop height (the variable ‘height' in the output file ‘crop.out’). If WEPS simulates a crop that is too tall (inspect ‘height’), then decrease the parameter value. After adjustment, inspect the height variable again to see if it matches what is expected. If not, continue to adjust the parameter values on this trial-and-error basis. Be sure to look at simulation output for more than one growing season. Note that the crop height at the end of the growing season will usually be less than this maximum crop height. Only if the crop grows under unstressed conditions for the entire growing season will the crop height at the end of the season be equal to the maximum crop height.

Crop height development through the growing season, as it would be without any stresses (potential), is defined by a 2-parameter function (Figure 5.38). This curve should be in harmony with the partitioning curves discussed earlier (i.e., the greatest increase in plant height should coincide with the greatest stem partitioning ratio).

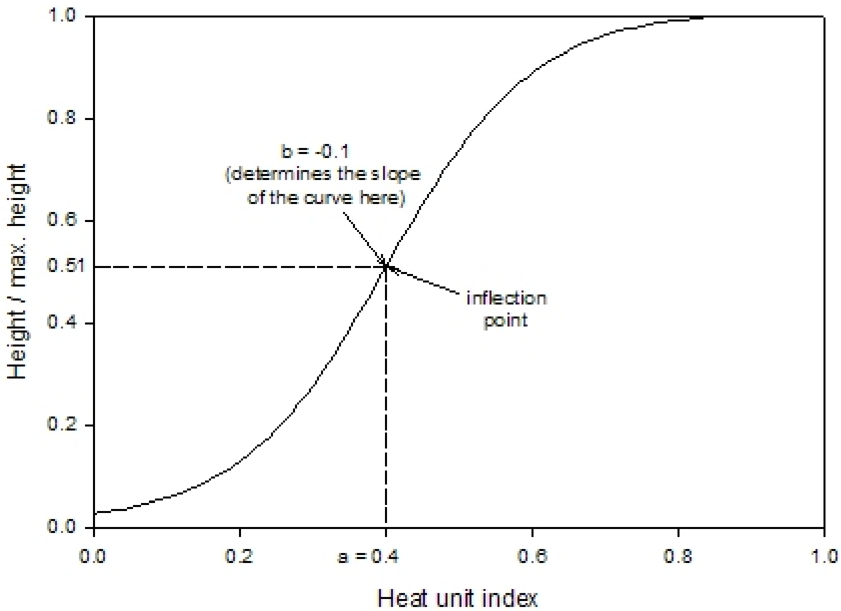


Figure 5.38. Crop height development function as it would be without any stresses. In this example, a = 0.4 and b = -0.1. The height ratio at the inflection point = 0.51.

Specify the two parameters for the crop height development curve (Figure 5.38):

Parameter Prompt: Crop height coefficient a
The heat unit index at the inflection point.

Parameter Prompt: Crop height coefficient b
Determines the slope of the curve at the inflection point. A negative b produces an ascending curve.

For a new crop, the two crop height parameters can be adjusted based on the crop height (the variable 'height' in the output file 'crop.out'). If WEPS simulates a crop that is too tall too early in the growing season (inspect 'height'), then increase the "a" parameter value. If WEPS simulates too gradual a crop height increase (inspect 'height'), then increase the "b" parameter value (make b less negative). Changing a and/or b may cause the final crop height to change. This can be adjusted by changing the maximum plant height.

Cold Tab

In WEPS, freezing temperatures can reduce green leaf area. This reduction is calculated from a curve (Figure 5.39). For example, using Figure 5.39, if the daily minimum temperature of the top soil layer equals -15 ºC, the green leaf area is reduced by 95% on this day.

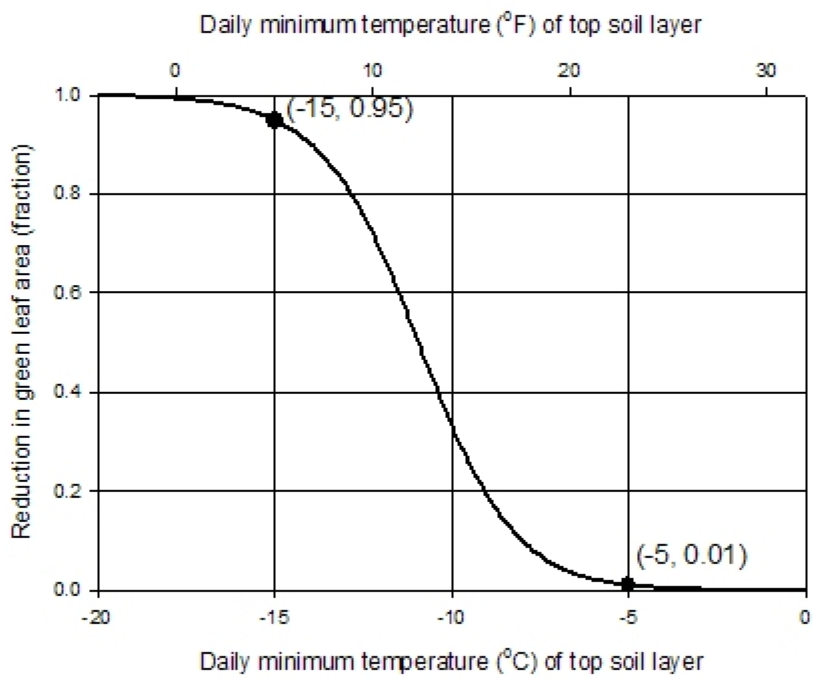


Figure 5.39. Reduction in green leaf area due to frost damage for corn.

The user can specify the frost damage curve by specifying two points on the curve. The curve for corn in Figure 5.39 is specified by the points (-5, 0.01) and (-15, 0.95). Use the Excel spreadsheet tool to visualize the curve after specifying two points on the curve. The following four parameters specify the two points:

Parameter Prompt: Higher temperature (ºC)
This is -5 ºC (23 ºF) for the example in Figure 5.39.

Parameter Prompt: Reduction in green leaf area at higher temperature (fraction)
This is 0.01 (1%) for the example in Figure 5.39.

Parameter Prompt: Lower temperature (ºC)
This is -15 ºC (5 ºF) for the example in Figure 5.39.

Parameter Prompt: Reduction in green leaf area at lower temperature (fraction)

This is 0.95 (95%) for the example in Figure 5.39.

For a new crop, these four parameters can be adjusted based on the green leaf area (the variable 'eff_lai' in the output file 'crop.out'). Example: the new crop is a winter crop. If WEPS simulates too much reduction in green leaf area over the winter (inspect eff_lai), then adjust the four parameter values so that there is less reduction in green leaf area for the same freezing temperatures.

Parameter Prompt: Thermal delay coefficient pre-vernalization

For winter annual crops (crop types 2 and 5), the rate of heat-unit accumulation is reduced if the plants have not been exposed to cool temperatures. The method implemented is from Ritchie, J.T. (1991). For crops that do not experience vernalization, the value is set to 0.0. A crop requiring a high degree of vernalization would have a value around 0.04. Examine the variable 'hu_del' in the output file 'crop.out' to see the effect of adjusting this parameter. This variable is 0.0 when vernalization has not yet started, and it is 1.0 when the crop is fully vernalized.

Harvest Tab

Parameter Prompt: Which plant component is (partly) harvested?

Parameter Choices:
- 0 - constant fraction of reproductive mass (grain+)
- 1 - increasing fraction of reproductive mass (grain)
- 2 - all or fraction of aboveground biomass
- 3 - all or fraction of the leaf mass
- 4 - all or fraction of the stem mass
- 5 - all or fraction of underground mass

Crop harvesting operations remove parts of plants that are not explicitly specified as a plant part in the model. To compensate for this, a mass fraction can be specified (see parameter "Harvested fraction of plant component") to divide the plant component into harvested fraction (fraction removed from the field) and fraction left in the field. For example, the reproductive component of wheat is divided into grain and chaff during harvest, and only the grain is removed from the field. This entry specifies the plant component that will be divided if that plant component is harvested. Choice 1 specifies a type of crop in which early-season reproductive development is all chaff and awns, not grain. If the crop is harvested before maturity, grain development is incomplete. The model internally, increases the actual harvested fraction from zero early in the season, until the value entered in "Harvested fraction of plant component" is reached at maturity.

Examples:

0 - Stripper cotton, for which all the reproductive mass is removed from the field. In this instance, the "Harvested fraction of plant component" for this example would be set to 1. Expression of final yield in bales of lint then requires accounting for the amount of trash and seed in the yield conversion factor;
1 - harvested grains, such as wheat, oats, barley, milo, corn. For a crop like corn, ear corn would have a larger value for the "Harvested fraction of plant component" than shelled corn has, for which the cob is left in the field;
2 - hay or forage crops, green vegetable crops. The "Harvested fraction of plant component" in most instances would be 1.0, indicating that all above-ground biomass above the cutting height is removed from the field. It should be less than 1.0 for a crop in which significant portions of the above-ground biomass above the cutting height are left behind in the field. This comment also applies to choices 3 and 4.
3 - tobacco and similar crops;
4 - Sugarcane and similar crops;
5 - Potatoes, peanuts, sugar beets.

In all crops, this setting and the corresponding "Yield fraction of harvested yield component" should be used to divide mass removed from mass left in the field, NOT mass removed from mass actually counted as yield. The parameter "Harvested yield conversion factor" should be used to account for post-harvest processing into marketable components.

Parameter Prompt: Harvested fraction of plant component (grain fraction etc.)
See parameter "Which plant component is (partly) harvested" for a full explanation.

Parameter Prompt: Units for reporting harvested yield
This field contains the units label that will be displayed for yield reporting. It should match the "Harvested yield conversion factor (kg/m^2 to units shown)" value that is entered.

Parameter Prompt: Moisture content for reporting harvested yield (%)
In WEPS, all biomass values are tracked as oven-dry weight. Crop yields are normally reported at a "standard" moisture content other than oven dry weight. For yield reporting, oven-dry weight is converted to the moisture content entered in this field. To match yield numbers from other sources, this value should be the "standard" moisture content used for this product.

Parameter Prompt: Harvested yield conversion factor (kg/m^2 to units shown)
This parameter should match the "Units for reporting harvested yield" value that is entered. The conversion factor is applied to the WEPS internal yield amount units

(which is in kilograms per square meter) to report the yield in the units that are specified. This conversion is applied directly to the material removed from the field, as defined in “Which plant component is (partially) harvested?” and “Harvested fraction of plant component” and implemented by the appropriate harvest operation. If the component removed from the field is post-processed into a marketable product and a byproduct, and the yield reported in units of marketable product (cotton lint yield is an excellent example), the fraction of marketable product should be included in this conversion factor.

Decomposition Tab

For a better understanding of the decomposition parameters, also consult the Residue Decomposition Sub-model technical documentation.

Parameter Prompt: Residue size/toughness class
Parameter Choices: 1 - Fragile, very small residue (e.g., soybeans)
2 - Moderately tough, short residue (e.g., wheat)
3 - Non-fragile, medium residue (e.g., corn)
4 - Woody, large residue (sticks, hard wood)
5 - Gravel, rock

This class is used to determine what percentage of residue should be buried by certain management operations. For example, a tillage operation such as disking will bury a larger percentage of small, fragile residue and a smaller percentage of large, woody residue.

Parameter Prompt: Decomposition days after which stalks begin to fall (day)
The Number of days after which stalks begin to fall under optimum moisture and temperature conditions. After this threshold has been reached, stalks will begin to fall at the rate discussed. Example: a threshold of 20 decomposition days means that standing stalks begin to fall 20 days after harvest if moisture and temperature conditions are optimum during these 20 days. If conditions are not optimum, the number of days that stalks remain standing increases.

For a new crop, this parameter can be adjusted based on the number of stalks in residue pool 1 (the variable ‘stem1' in the output file ‘decomp.out’). Example: the new crop is a winter crop that is harvested in July. It is known that, on average, stalks begin to fall down in the middle of October. If WEPS simulates that stalks begin to fall down only in the next Spring (inspect stem1), then decrease the parameter value to start stem fall earlier. Increase the parameter value if WEPS makes the stalks fall too early.

Parameter Prompt: Fall rate for standing stalks (day^{-1})

The rate at which standing stalks fall to a flattened (horizontal) position on the soil surface. A larger number means that stalks fall faster. Only after a threshold has been reached, will stalks begin to fall at this rate. Example: a fall rate of 0.12 day^{-1} means that 12% of the total number of standing stalks fall down per day if moisture and temperature conditions are optimum on this day. If conditions are not optimum, the fall rate is reduced.

For a new crop, this parameter can be adjusted based on the number of stalks in residue pool 1 (the variable 'stem1' in the output file 'decomp.out'). Example: the new crop is a winter crop that is harvested in July. There is a fallow period of 14 months in which it is known that, on average, 50% of the stalks fall down. If WEPS simulates that less than 50% falls down (inspect stem1), then increase the parameter value to increase stem fall. Decrease the parameter value if WEPS makes the stalks fall too fast. Adjust 'Decomposition days after which stalks begin to fall' before adjusting this parameter.

Parameter Prompt: Decomposition rate for standing stalks ($kg\ kg^{-1}\ day^{-1}$)

The rate at which standing stalks decompose under optimum conditions. A larger number means faster decomposition. Example: a decomposition rate of 0.02 $kg\ kg^{-1}\ day^{-1}$ means a 2% standing stalk mass loss per day if moisture and temperature conditions are optimum for decomposition on this day. If conditions are not optimum, the rate is reduced. Leaves, if any are present, decompose at 3 times the rate of stalks, and reproductive material, if any is present, decomposes at 1.5 times the rate of stalks. Other models, such as WEPP and RUSLE, simulate the effect of moisture and temperature on decomposition differently from WEPS (see WEPS technical documentation). Thus, the same parameter value results in different rates of decomposition. Therefore, if a new WEPS crop already exists in one of these other models, this parameter value should not be used in WEPS.

For a new crop, this parameter can be adjusted based on the amount of standing residue biomass in residue pool 1 (the variable 'stand1' in the output file 'decomp.out'). Be sure to look at this variable only before stalks start falling. After stalks start falling, stand1 decreases due to two things: decomposition and stem fall. Example: the new crop is a winter crop that is harvested in July. It is known that, on average, stalks begin to fall down in the middle of the next April. Inspect stand1 between July and April. If stand1 is decreasing too rapidly, then decrease the parameter value. Increase the parameter value if stand1 decreases too slowly.

Parameter Prompt: Decomposition rate for surface (flat) stalks (kg kg^{-1} day^{-1})

The decomposition rate (under optimum conditions) of stalks that have fallen to a flattened (horizontal) position on the soil surface. For a new crop, this parameter can be adjusted based on the amount of flat residue biomass in residue pool 1 (the variable 'flat1' in the output file 'decomp.out'). Be sure to only look at this variable before stalks start falling. After stalks start falling, flat1 is affected by two things: decomposition and stem fall. It will actually increase if the mass received from the standing pool exceeds the flat mass that is decomposed. Example: the new crop is a winter crop that is harvested in July. It is known that, on average, stalks begin to fall down in the middle of the next April. Inspect flat1 between July and April. If flat1 is decreasing too rapidly, then decrease the parameter value. Increase the parameter value if flat1 decreases too slowly.

Parameter Prompt: Decomposition rate for buried stalks (kg kg^{-1} day^{-1})

The decomposition rate (under optimum conditions) of stalks that have been buried below the soil surface by tillage. For a new crop, this parameter can be adjusted based on the amount of buried residue biomass in residue pool 1 (the variable 'belo1' in the output file 'decomp.out').

Parameter Prompt: Decomposition rate for roots (kg kg^{-1} day^{-1})

The rate at which roots decompose under optimum conditions. For a new crop, this parameter can be adjusted based on the amount of root residue biomass in residue pool 1 (the variable 'root1' in the output file 'decomp.out').

In WEPS, the four parameters (decomposition rate for standing, flat, buried, and root mass) currently have the same values for a given crop. It is recommended to also do this for new crops, unless there is solid research data to do otherwise. For these six decomposition parameters, be sure to look at a no-till situation, because tillage operations will also make stalks fall down.

Parameter Prompt: Stalk diameter (m)

Stalk diameter at the base (at the soil surface) of a fully grown plant.

Parameter Prompt: Mass to cover factor (m^2 kg^{-1})

WEPS calculates soil cover from flat residue mass:

$$C_f = 1 - \exp^{-b\, M_f} \tag{5.5}$$

where C_f is flat residue cover (m^2 m^{-2}), b is mass-to-cover factor (m^2 kg^{-1}), and M_f is flat residue mass (kg m^{-2}) (Figure 5.40, 43).

Use the Excel spreadsheet to estimate a b value for a new crop, comparing with curves for crops that already exist in WEPS. If reliable mass and cover data are available for the new crop, the spreadsheet can be used to calculate a b value from this data.

RUSLE also uses the mass-to-cover equation to calculate soil cover from flat residue mass. Therefore, if a new WEPS crop already exists in RUSLE, and there is a high degree of confidence in the value of the RUSLE b parameter, this value could be used in WEPS.

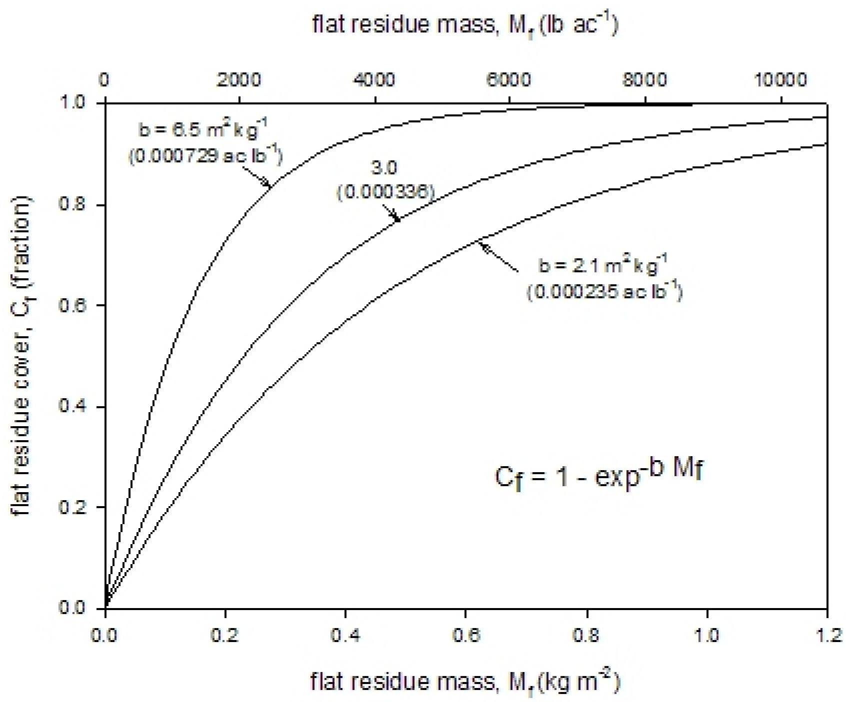


Figure 5.40. Relationship between flat residue mass and the cover provided by this flat residue for three different values of the mass-to-cover factor b. WEPS uses b = 6.5 m^2 kg^{-1} for wheat, barley, oats, rye, and triticale; b = 3.0 m^2 kg^{-1} for corn, sorghum, and millet; and b = 2.1 m^2 kg^{-1} for cotton and sunflower.

Crop residue laying flat on the soil surface has the effect of reducing the water evaporation rate from the soil surface. Research done by Steiner (1989) showed that the effect varied for different crops. The data from Steiner for cotton, sorghum, and wheat, was refit to an exponential power relationship

$$r_e = \exp^{(a_e M_f^{b_e})} \quad (5.6)$$

where r_e is the ratio of evaporation from residue covered soil to bare soil evaporation and M_f is flat residue mass (kg/m^2). This equation has better mathematical properties than the curve used by Steiner. If additional research is available, intermediate curves can be developed by using the "evaporation suppression" tab within the spreadsheet "howtopcropdb.xls" (available from WERU). Otherwise, use the numbers for the crop that most closely characterize the evaporation-suppression characteristics of the crop you are developing.

Parameter Prompt: Residue Evaporation Suppression multiplier coefficient a

Parameter Prompt: Residue Evaporation Suppression multiplier coefficient b

<u>Calibration Tab</u>

Parameter Prompt: Crop growth calibration selection
Parameter Choices: 0 - Crop NOT selected for calibration
1 - Select Crop for calibration to match target harvested yield

This flag is only effective when the model is run in calibration mode. It should be set to zero for all crop records.

Parameter Prompt: Target harvested yield
This value is only used when the model is run in calibration mode. It should be set to 0 for all crop records. NRCS will add RUSLE yield values as a starting point for calibration.

Parameter Prompt: Biomass adjustment factor
Multiplier used with the "Yield/biomass ratio adjustment factor" to enhance or suppress the conversion of solar radiation to biomass. This is the factor that is automatically adjusted when calibrating a crop. When developing a new crop record, this value should be set to 1.0. Locally adjusted records can be saved with numbers other than 1.0.

Parameter Prompt: Yield/biomass ratio adjustment factor
Intended use has not been implemented. Was to allow adjusting the ratio between total yield and total biomass for calibration purposes. Set to 1.0 for all crop records.

We created a new crop (flax), and documented the process in Appendices A and B. Appendix A is a list of questions about flax that was given to people with knowledge about how flax grows. Some questions are directly related to a parameter; others are more indirectly related. Appendix B shows how the answers to these questions were used to determine parameter values for flax.

References

Retta, A. and D.V. Armbrust. 1995. Estimation of leaf and stem area in the Wind Erosion Prediction System (WEPS). Agron. J. 87:93-98.

Ritchie, J.T. 1991. Wheat Phasic development. *In*: J. Hanks and J.T. Ritchie eds. Modeling plant and soil systems. Agronomy Monograph 31, pp. 34-36.

Steiner, J.L. 1989. Tillage and surface residue effects on evaporation from soils. Soil Sci. Soc. Am. J. 53:911-916.

Appendix A: Flax (seed) questions for WEPS crop growth model

The Wind Erosion Prediction System (WEPS) includes a crop-growth model that simulates a few dozen crops (Table 5.3). It does not yet include flax (seed). The USDA-NRCS has requested the inclusion of flax in WEPS. The following questions are meant to give information needed to include flax (seed) in the WEPS model. For these questions, we are always asking for the average, if not specified otherwise (e.g., average plant population, average planting depth, etc). Similar questions can be asked if other crops are developed for the WEPS model.

In general, which one of the current WEPS crops (Table 5.3) is flax (seed) most similar to? Please list only one crop.

For the following questions, you may not always know the answer (value) in an absolute sense, but you may know it in a relative sense. For this reason, we always ask: Which of the current WEPS crops are similar to flax (seed) regarding the aspect being discussed? Please list more than one current WEPS crop if applicable. Even if you know the answer in an absolute sense, please also list current WEPS crops that are similar.

What is the plant population ($\#/m^2$)? Please give the number of plants expected in a normal stand. This should be the estimated plant population after germination. Which of the current WEPS crops have a similar plant population?

What is the planting depth? Which of the current WEPS crops have a similar planting depth?

Dry weight of one planted seed? Which of the current WEPS crops have a similar dry weight per planted seed?

What is the ratio **leaf mass/stem mass** in the shoot after seed mass has been converted to root and shoot? Which of the current WEPS crops have a similar ratio?

What is the ratio **stem diameter/stem length** after seed mass has been converted to root and shoot? Which of the current WEPS crops have a similar ratio?

How many days after planting (DAP) do plants emerge?

Does the crop regrow? If yes:
- At what growth stage will it regrow?
- What do regrowth shoots look like (size, length)?
- What is the maximum number of shoots per plant?

Number of days from planting to maturity of seed? Which of the current WEPS crops have a similar number of days?

When (DAP) does senescence start (when do green leaves start to turn yellow/brown)?

Minimum temperature for plant growth? Which of the current WEPS crops have a similar minimum temperature?

Optimum temperature for plant growth? Which of the current WEPS crops have a similar optimum temperature?

Some cropping systems use plant densities that do not result in canopy closure. In these systems, the plant will grow to cover a ground area that is characteristic of the plant. WEPS assumes that the covered ground area is round. What is the diameter of the circle that encloses the area covered by a full-grown plant? Which of the current WEPS crops have a similar diameter?

Ratio of leaf area to leaf mass (m^2 / kg)? Which of the current WEPS crops have a similar ratio?

Ratio of stem silhouette area to stem mass (m^2 / kg)? Which of the current WEPS crops have a similar ratio?

Canopy light utilization is specified by an exponential relationship for the attenuation of light with distance into the canopy. Combined with the leaf area index, this coefficient determines the amount of light interception by the canopy, according to the relationship:

$$fraction = 1 - \exp^{-k\ LAI} \qquad \textbf{(5.7)}$$

where fraction is the ratio of photosynthetically active radiation (PAR) that is intercepted by the crop and total PAR received above the crop canopy, k is light extinction coefficient, and LAI is leaf area index. A larger number indicates increased light interception by a given leaf area index, as occurs with broadleaf plants with a horizontal leaf orientation, such as cotton. A smaller number indicates decreased light interception by a given leaf area index, as occurs with narrow-leaf plants with a vertical leaf orientation, such as the grasses.

What is k? Which of the current WEPS crops have a similar k (similar light interception at a given amount of leaf area)?

Biomass conversion efficiency (t/ha) / (MJ/m^2) is the unstressed (potential) growth rate per unit of intercepted photosynthetically active radiation. What is the biomass conversion efficiency? Which of the current WEPS crops convert light (PAR) to biomass with a similar efficiency?

Throughout the growing season, the above-ground biomass is partitioned into leaf, stem, and reproductive mass. In the beginning of the season most, of the above-ground biomass is allocated to leaf mass, and at the end of the season most is allocated to reproductive mass. Which of the current WEPS crops show a similar pattern of partitioning?

What are the growth stages? How many days for each of these stages?

What is the harvest index? Which of the current WEPS crops have a similar harvest index?

We use the equation:

$$residue = r \; x \; yield + b \tag{5.8}$$

where yield plus residue equals total above-ground biomass, b is the minimum above-ground biomass required for a crop to generate any yield, and r is the incremental increase in residue for each additional unit of yield in excess of the minimum. Do you have field data that can be used to estimate r and b? Which of the current WEPS crops have a similar relationship (similar r and b)?

The maximum depth of roots attained by the crop under ideal (unstressed) growth conditions? Which of the current WEPS crops have a similar rooting depth?

The maximum height attained by the crop under ideal (unstressed) growth conditions? Which of the current WEPS crops have a similar height?

When (DAP) does the crop reach 25%, 50%, 75% of its final height? Which of the current WEPS crops have a similar pattern of crop height development through the growing season?

In WEPS, freezing temperatures can reduce green leaf area. Which of the current WEPS crops experience a similar amount of damage caused by freezing temperatures?

Fraction of reproductive mass that is harvested (grain fraction)? Which of the current WEPS crops have a similar grain fraction?

Market-standard moisture content? Which of the current WEPS crops have a similar market-standard moisture content?

How many pounds per bushel at market-standard moisture content?

Residue size/toughness class?

Choices:
1 - Fragile, very small residue (e.g., soybeans)
2 - Moderately tough, short residue (e.g., wheat)
3 - Non fragile, medium residue (e.g., corn)
4 - Woody, large residue (sticks, hard wood)
5 - Gravel, rock

Which of the current WEPS crops have a similar residue size/toughness?

Which of the current WEPS crops have a similar rate of residue decomposition?

Stem diameter at the base (at the soil surface) of a fully grown plant? Which of the current WEPS crops have a similar stem diameter?

Crop residue laying flat on the soil surface provides a certain amount of cover to the soil surface. Which of the current WEPS crops provide a similar amount of soil surface cover for a given mass of flat (not standing) residue?

Crop residue laying flat on the soil surface has the effect of reducing the water evaporation rate from the soil surface. Which of the current WEPS crops cause a similar amount of evaporation reduction for a given mass of flat (not standing) residue?

Please contact us if you have any questions. Thank you very much for helping us to include flax (seed) in our model.

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Table 5.3. Crops currently simulated by the WEPS crop submodel.

Alfalfa
Asparagus
Barley, spring
Barley, winter
Bean, field, dry
Bean, green snap
Bean, lima
Beans, garbonzo
Bluestem, old world
Brassicas, forage
Broccoli
Bromegrass
Buckwheat
Cabbage
Camelina
Canola, spring
Canola, winter
Cantaloupe, Muskmelon, Honeydew
Carrot
Cauliflower
Celery
Chickpea
Chile, green, direct seed
Chile, green, transplant
Clover, alsike
Clover, red
Clover, sweet
Collard, greens
Corn, grain
Corn, pop
Corn, silage
Corn, sweet
Cotton
Cucumber
Eggplant
Flax
Garlic
Grama, sideoats
Grass seed, cool season
Grass seed, warm season

Horseradish
Lentils
Lettuce, head
Lettuce, leaf
Millet, foxtail
Millet, proso
Mint
Mustard seed, spring
Mustard, cover crop
Mustard, greens
Oats, fall
Oats, spring
Oats, winter
Onion
Peanut, runner
Peas, field, dry
Peas, forage
Peas, green
Peppers, bell
Peppers, chili
Pineapple, transplants
Potato, early, harvest
Potato, late, harvest
Potato, sweet
Pumpkin
Radish
Rice
Rye, cereal
Rye, spring
Rye, winter,cover
Rye, winter, grain
Rye, winter, silage
Safflower
Sorghum, forage
Sorghum, grain
Sorghum, sudangrass
Soybean, group 0 and I
Soybean, group II, III and IV
Soybean, groups V, VI, VII, and VIII
Spinach
Squash
Strawberry

Sugarbeet, sugar
Sugarcane
Sunflower
Switchgrass, biomass prod
Tall Fescue
Timothy
Tobacco, burley
Tobacco, dark
Tobacco, flue cured
Tomato
Triticale
Turfgrass
Vetch, hairy
Watermelon
Wheat, spring
Wheat, winter

Appendix B. Documentation of crop parameter values for flax (seed)

This appendix documents crop parameter values for flax (seed) and describes how knowledge about flax is used to determine flax parameter values. We started the database record for flax with a copy of the record for spring oats (Myers, 2005). Whenever there are no flax parameter values shown in the example, we use the same value as for spring oats.

We used the WEPS DB Viewer to create the flax crop from spring oats:
Select Spring Oats
Right click
Select 'Create a copy of this crop'
You are prompted to give it a name. Enter: 'flax'
You have now a crop named 'flax' with the same parameter values as spring oats.
To be able to change parameter values, select Options - Allow Changes on the menu.

<u>Shoot Tab</u>

Parameter Prompt: Crop type: 4 - Spring Seeded

Parameter Prompt: Transplant or Seed flag: 0 - Seeds planted in field

Parameter Prompt: Plant population: 3,000,000/ac
3,040,000/ac (Tanaka, 2005)
2,800,000 (Myers, 2005)
3,500,000/ac (Berglund, 2005)
30-70/ft^2 (Berglund and Zollinger, 2002)
(70/ft^2 = 3,050,000/ac)

Parameter Prompt: Maximum number of shoots per plant, n_{ms} (#/plant)
no regrowth (Berglund, 2005)

Parameter Prompt: Starting depth of growing point: 2 cm planting depths:
- 1 in (Berglund, 2005)
- 0.75-1.5 in (Tanaka, 2005)
- <= 1 in (Martin et al., 1976)
- 0.75-1.5 in (Berglund and Zollinger, 2002)
- 2.5-3.2 cm (Duke, 1983)
-

At first, the simulated crop did not emerge. A flax seed is much smaller than a wheat seed. To ensure emergence, a value of 2 cm was used. Also, the value for 'Ratio of stem diameter to stem length' was adjusted, by using the Excel spreadsheet, to ensure emergence.

Parameter Prompt: Planted mass, dry weight: 5.5 mg/plant
180 seeds/g for flax seed (Martin et al., 1976)
5.7 mg/seed (Tanaka, 2005)
5 mg/seed (Myers, 2005)
3-12 g/1000 seeds (Duke, 1983)
3.8-7.0 g/1000 seeds (Martin et al., 1976)

Parameter Prompt: Root storage mass required for each regrowth shoot, m_{sh} (mg/shoot)
no regrowth (Berglund, 2005)

Parameter Prompt: Ratio of leaf mass/stem mass in shoot: 0.111
ratio = 1/9 = 0.111 (Myers, 2005)

Parameter Prompt: Ratio of stem diameter to stem length: 0.01
Reduced 0.015 (spring oats) to 0.01 to ensure emergence. See comments under 'Starting depth of growing point'
diameter = 1-2 mm, stem length = 25 mm (Myers, 2005). This would translate to a ratio of 1.5/25 = 0.06, but we don't get emergence with this value.
Parameter Prompt: Heat unit index at emergence: 0.05
Plants emerge 5 - 10 days after planting (Berglund, 2005)
Plants emerge 7 - 14 days after planting (Tanaka, 2005)
Plants emerge 5 - 8 days after planting (Myers, 2005)
The USDA-NASS (1997) planting and harvest dates were used for Foster County, ND (east-central ND, in the heart of flax growing country [Martin et al., 1976]). Ten (10) cycles of the crop were simulated. The simulated emergence date can be found by finding the first day that the crop height (variable 'height' in the output file 'crop.out') is greater than 0.0. For 10 cycles, the earliest emergence date was 5 days after planting and the latest, 10 days after planting. Thus, the parameter value of 0.05 for spring oats works for flax.

Growth Tab

Parameter Prompt: Crop maturity measurement method: 0 - Crop matures, on average, in days shown

Parameter Prompt: Days to maturity (days): 100
95 days (Berglund, 2005)
110 days (Tanaka, 2005)
110 days (Myers, 2005)
50+25+35 = 110 days (Berglund and Zollinger, 2002)
90 to 120 days (Duke, 1983)

planting date:

- 25 May for North Dakota (USDA-NASS, 1997)
- desired: April or early May for Minnesota and North Dakota (Duke, 1983)
- desired: same as wheat (Duke, 1983)
- as soon after possible after planting of small grains is completed (Duke, 1983)
- desired: late April (Berglund and Zollinger, 2002)

harvest date: 17 Sept. for North Dakota (USDA-NASS, 1997)

In all 10 simulated cycles, the crop reached maturity before being harvested (the variable 'heatui' in the output file 'crop.out' reached 1.0 before being harvested). Also, the crop was not harvested too late: the earliest maturity date (variable 'doy') was 245, the latest was 254, with a harvest date 260 (17 Sept.). Thus, 100 days for 'days to maturity' works well. Note that, on the basis of the planting date of 25 May (day 145), we would expect the crop to mature, on average, on day 245. But the simulations show an average maturation date of about 250 (range is from 245 to 254). This discrepancy is caused by different methods of heat-unit calculation in WEPS. So, to get this parameter value correct, do not only look at the planting and harvest dates. Always inspect 'crop.out', as discussed here.

Parameter Prompt: Heat units to maturity (ºC day)

Parameter Prompt: Heat-unit index at start of senescence: 0.85
Senescence starts 85 to 90 days after planting (Tanaka, 2005)
Leaves stay green long. In North Dakota, senescence starts late July or early August (Myers, 2005)
With the 0.85 value in our simulations for North Dakota, senescence started, on average, 80 days after planting (variable 'eff_lai' is at a maximum). This is in the middle of August.

Parameter Prompt: Minimum temperature for plant growth: 40 ºF
40 ºF (Berglund, 2005)
similar to spring wheat (Tanaka, 2005)

Parameter Prompt: Optimum temperature for plant growth: 70 ºF
65 -75 ºF (Berglund, 2005)
similar to spring wheat (Tanaka, 2005)

<u>Geometry Tab</u>

Parameter Prompt: Maximum growth diameter (m) of a single plant: 0.3 m
1 ft (Myers, 2005)

Parameter Prompt: Stem silhouette area coefficient a
Parameter Prompt: Stem silhouette area coefficient b

Parameter Prompt: Specific leaf area: 20.6 m^2 / kg
like crimson clover (Myers, 2005)

Parameter Prompt: Light extinction coefficient: 0.45
This coefficient (k) is much lower than that of any small grain. There is never complete shading (Myers, 2005).

Simulated biomass production is very sensitive to k. Using the default k-value of spring oats resulted in yield and residue values similar to those of spring wheat. But, field data shows that flax yield and residue is about half that of spring wheat yield and residue (Tanaka et al., 2001; USDA-NASS, 2005). Using a k of 0.45 resulted in simulated biomass that matches this observation. Using a k of 0.40 resulted in too little biomass.

Parameter Prompt: Biomass Conversion Efficiency (t/ha) / (MJ/m^2)

<u>Partitioning Tab</u>

Parameter Prompt: Leaf fraction coefficient a: 0.0006
Parameter Prompt: Leaf fraction coefficient b: 0.7149
Parameter Prompt: Leaf fraction coefficient c: 0.4297
Parameter Prompt: Leaf fraction coefficient d: -0.072
Parameter Prompt: Reproductive mass coefficient a: -0.0195
Parameter Prompt: Reproductive mass coefficient b: 0.995
Parameter Prompt: Reproductive mass coefficient c: 0.5077
Parameter Prompt: Reproductive mass coefficient d: 0.0849
Partitioning is like spring canola (Myers, 2005)
50 days vegetative + 25 days flowering + 35 days maturing (Berglund and Zollinger, 2002)

Parameter Prompt: Residue : Yield ratio (kg/kg): 0.82
Parameter Prompt: Residue : Yield intercept (kg/m^2): 0.168
Used values of spring wheat (none available for flax, spring canola, or spring oats)

Parameter Prompt: Fraction of leaf mass partitioning diverted to root storage
no regrowth (Berglund, 2005)

Parameter Prompt: Fraction of stem mass partitioning diverted to root storage
no regrowth (Berglund, 2005)

Parameter Prompt: Fraction of reproductive mass partitioning diverted to root storage
no regrowth (Berglund, 2005)

Size Tab

Parameter Prompt: Maximum root depth: 40 in
40 in (Berglund and Zollinger, 2002)
short, flax gets its moisture largely from the top 2 ft (Martin et al., 1976)
shallow rooted (Duke, 1983)
not deep, like spring canola (Myers, 2005)

Parameter Prompt: Maximum crop height: 36 in
36 in (Berglund and Zollinger, 2002)
30 in for flax seed (Martin et al., 1976)
30 in (Myers, 2005)

Parameter Prompt: Crop height coefficient a
Parameter Prompt: Crop height coefficient b

Cold Tab

Parameter Prompt: Higher temperature: -5 ºC
Parameter Prompt: Reduction in green leaf area at higher temperature: 0.01
Parameter Prompt: Lower temperature: -15 ºC
Parameter Prompt: Reduction in green leaf area at lower temperature: 0.95
Freeze damage similar to that of spring canola (Myers, 2005)

Parameter Prompt: Thermal delay coefficient pre-vernalization: 0

Harvest Tab

Parameter Prompt: Which plant component is (partly) harvested: 1 - increasing fraction of reproductive mass (grain)

Parameter Prompt: Harvested fraction of plant component (i.e., grain fraction): 0.9
grain fraction = 90% (Myers, 2005)

Parameter Prompt: Units for reporting harvested yield: bu/ac

Parameter Prompt: Moisture content for reporting harvested yield: 8%
7.1-8.3% (Carter, 2005)
8-9% (Berglund, 2005)
10% (Tanaka, 2005)
8% (Myers, 2005)

Parameter Prompt: Harvested yield conversion factor (kg/m^2 to units shown): 159.4 Pounds per bushel at market standard moisture content:
56 lbs/bu (Martin et al., 1976)
56 lbs/bu (Berglund, 2005)

Using 56 lbs/bu:

$$1\frac{kg}{m^2} = 1\frac{kg}{m^2} \; 2.205\frac{lb}{kg} \; \frac{1}{56}\frac{bu}{lb} \; 4047\frac{m^2}{ac} = 159.4\frac{bu}{ac}$$

Decomposition Tab

Parameter Prompt: Residue size/toughness class: 3
3 - Non fragile, medium residue (e.g., corn) (Berglund, 2005; Myers, 2005).
2 - Moderately tough, short residue (e.g., wheat) (Tanaka, 2005)

Parameter Prompt: Decomposition days after which stalks begin to fall (day)
Parameter Prompt: Fall rate for standing stalks (day^{-1})
Parameter Prompt: Decomposition rate for standing stalks (kg kg^{-1} day^{-1})
Parameter Prompt: Decomposition rate for surface (flat) stalks (kg kg^{-1} day^{-1})
Parameter Prompt: Decomposition rate for buried stalks (kg kg^{-1} day^{-1})
Parameter Prompt: Decomposition rate for roots (kg kg^{-1} day^{-1})
Parameter Prompt: Stalk diameter (m)

Parameter Prompt: Mass to cover factor: 3.0 m^2 kg^{-1}
like proso millet (Myers, 2005)

Parameter Prompt: Residue Evaporation Suppression multiplier coefficient a: -1.20379
Parameter Prompt: Residue Evaporation Suppression multiplier coefficient b: 0.604887
like proso millet (Myers, 2005)

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WEPS How To Guide

Management Operation Database Record Development

Introduction
In the Wind Erosion Prediction System (WEPS), changes in the "state" of the surface, soil, and biomass (residue and live vegetation) during a simulation are modeled, because they have a direct impact upon a site's susceptibility to wind erosion. Cultural practices applied during management of a site can significantly influence a site's "surface, soil, and biomass" state over time. It is an important variable because it is the primary factor that a land manager can most easily change in the field to affect a site's susceptibility to wind erosion. Therefore, WEPS simulates many management practices, which typically include operations like tillage, cultivation, planting, harvesting, irrigation, residue burning, etc.

WEPS can represent a wide range of typical management operations used on agricultural crop land. It does so by defining each operation as an ordered list of "processes", which represent physical actions like residue burial, soil loosening and mixing, etc., that occur when that operation is performed on the field. By simulating these physical processes, WEPS can reflect the changes made by an operation to a site's "surface, soil, and biomass" state.

The purpose of this guide is to describe the process of: a) developing accurate WEPS representations of management operations as correctly ordered lists of processes or actions; b) obtaining reasonable parameter values for the list of individual processes describing each management operation, based upon knowledge of that operation's characteristics; and c) providing a reference description for each of the physical "processes" simulated by WEPS.

Operation Database Records
WEPS management operation database records are stored in an XML file format with the extension ***.oprn*** for use by the WEPS interface. Supporting files, which define the database structure are part of the MCREW (Management/Crop Rotation Editor for WEPS) configuration files. New individual operation database records can be created in several ways: 1) using a text editor to edit the ***.oprn*** file (operation record) directly; 2) using MCREW to edit an existing operation record, via its "operation drill-down" feature, and saving it to a new name; or 3) using the WEPS crop/op database viewer/editor program. We will be focusing on the use of the WEPS crop/op database viewer/editor program here because it provides the best user environment for creating and editing WEPS management operation records. Note that for NRCS most parameter choices will not be editable by Field Office Users. NRCS will use a database manager to adjust and distribute new or revised database file.

Each operation record is simply an ordered list of "actions" or "processes" that represent the physical effects that a management operation is to perform. An example operation record for a springtooth harrow is shown in Figure 5.41.

Mozilla

Operation Database Record

Harrow, Springtooth

Id	Code	Operation/Group/Process Name	Parameters (variable names and values)
01	O	Direction and Speed	ospeed: 9.655617; odirect: 0.0; ostdspeed: 9.655617; ominspeed: 4.8278084; omaxspeed: 11.264886; op_notes1: Enter Operation notes here
01	G	Tillage	gtdepth: 50.800102; gtilint: 0.50; gtilArea: 1.0; gtstddepth: 50.800102; gtmindepth: 25.400051; gtmaxdepth: 76.20015
01	P	Break Crust	
02	P	Random Roughness from tool	rroughflag: 1; rrough: 10.160021
05	P	Ridges and Dikes	rdgflag: 2; rdghit: 0.0; rdgspac: 0.0; rdgwidth: 0.0; dkhit: 0.0; dkspac: 0.0
11	P	Aggregate Crushing	asdf: 3.0; crif: -0.22
12	P	Soil Loosening	soilos: 0.7
13	P	Layer Mixing	laymix: 0.3
31	P	Kill or Defoliate Growing Crop	kilflag: 2

Done

Figure 5.41. Partial WEPS definition of a springtooth harrow tillage operation.

Note in Figure 5.41 that the definition of the operation simply consists of a list of parameters that are grouped under an "operation", "group" or "process" name. An "operation" line, which is labeled with a code letter of "O", contains parameters that apply to the operation as a whole. For example, the direction and speed of travel are specified by the parameters "odirect" and "ospeed". Each operation will contain a single "operation" line in its definition. There are several types of valid "operation" lines defined for WEPS operations, each of which has a unique identification number. All the valid operation lines are listed and defined later.

The second line in Figure 5.41 is a "group" line. To explain the purpose of a "group" line, we must first define the "process" lines that follow. WEPS attempts to simulate the "physical effects" a management operation has on the soil, surface, and vegetation. Within WEPS, the individual, specific identified actions that represent an operation are simulated in the order specified in the management operation record. In this example, the springtooth harrow performs the following actions in the given order: 1) breaks surface crust if it exists; 2) creates a specified random roughness on the surface; 3) removes any ridges and dikes that may be present before to this tillage operation; 4) breaks down (crushes) soil aggregates, resulting in a new distribution of the aggregate sizes; 5) reduces the soil bulk density (loosens the soil); 6) does some mixing of the soil within the depth of tillage; and 7) kills any growing vegetation.

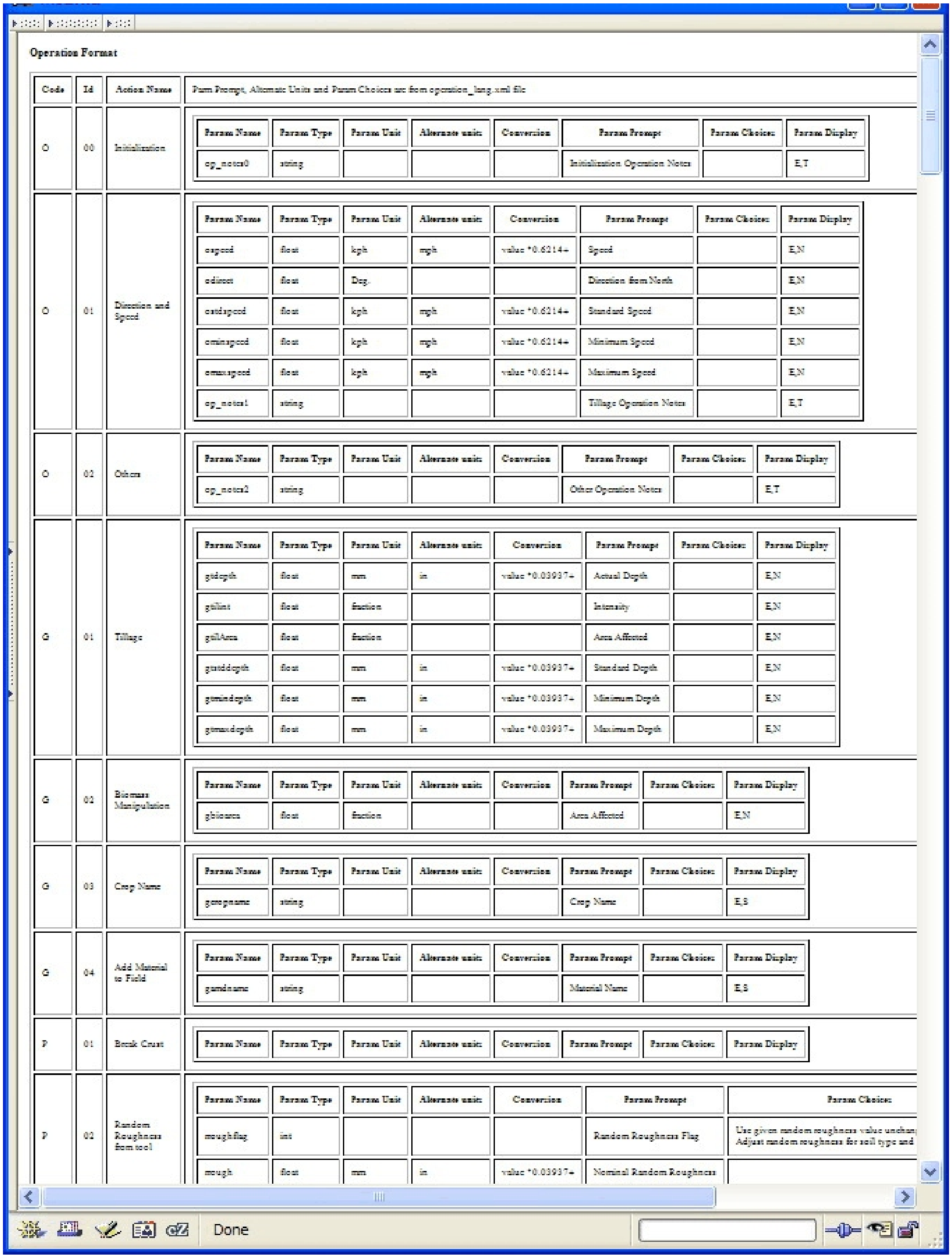
Therefore, each "process" line may contain one or more parameters required for WEPS to simulate the particular physical process or action represented by that line in the model. Some of these physical processes may require additional parameters needed by other, related processes. For example, the "Layer Mixing" and the "Soil Loosening" process lines represent the physical loosening and mixing of the soil by the springtooth. The parameter values "soilos" and "laymix" define the degree of mixing and loosening of soil that will occur. To properly simulate these physical actions, however we need the depth of tillage so that we know how deep the mixing and loosening of the soil will occur. That information is provided in the "group" line by the variable "gtdepth". Thus, the "shared" tillage depth parameter value required to simulate both the mixing and loosening actions is made available in one place, because it will have the same value for both the mixing and loosening actions being simulated. This is desirable because there is only one tillage depth parameter whose value needs to be changed if the tillage depth is altered for the operation.

So, in summary, each WEPS management operation will consist of a single "operation" line and one or more "process" lines, where each "process" line typically represents a single physical action or event that the operation does on the field. If specific "process" lines require additional "shared" parameters for WEPS to simulate the physical action they represent, then the appropriate "group" line containing those parameters will be specified before those "process" lines. Because WEPS simulates the physical actions represented by the “process” lines in the order they are specified in the management operation record, the order of the listed “process” lines is important and must be correct for WEPS to properly simulate the operation’s total effect on the field.

Operation Database Structure Files and Definitions

The parameter descriptions provide the keys to enable the user to know which parameter is being edited. A current reference table is easily viewed by opening the ***operation_defn.xml*** file in the ***mcrew_cfg*** directory using a web browser, as seen in Figure 5.42.

The parameters defined in this section are described by a **Parameter Prompt**, the text that appears in MCREW; **Parameter Unit**, the named unit that the WEPS science model expects the parameter value to be in; **Conversion Factor**, the combination of multiplier and additive terms that will convert the parameter value from the default Parameter Units; **Param Units** (SI), to the specified Alternate Units, **Alternate Units** (English), the named unit that values will be displayed in, given the selection of units in the WEPS configuration; and **Parameter Choices**, a list of choices displayed when the parameter is defined as a discrete set of values, often integer flags. The parameters are grouped according to the specific “process”, “group”, or “operation” line they pertain to.



Operation Format

Param Prompt, Alternate Units and Param Choices are from operation_lang.xml file

Code	Id	Action Name	Param Name	Param Type	Param Unit	Alternate units	Conversion	Param Prompt	Param Choices	Param Display
O	00	Initialization	op_notes0	string				Initialization Operation Notes		E,T
O	01	Direction and Speed	ospeed	float	kph	mph	value *0.6214+	Speed		E,N
			odirect	float	Deg.			Direction from North		E,N
			ostdspeed	float	kph	mph	value *0.6214+	Standard Speed		E,N
			ominspeed	float	kph	mph	value *0.6214+	Minimum Speed		E,N
			omaxspeed	float	kph	mph	value *0.6214+	Maximum Speed		E,N
			op_notes1	string				Tillage Operation Notes		E,T
O	02	Others	op_notes2	string				Other Operation Notes		E,T
G	01	Tillage	gtdepth	float	mm	in	value *0.03937+	Actual Depth		E,N
			gtilint	float	fraction			Intensity		E,N
			gtillArea	float	fraction			Area Affected		E,N
			gtstddepth	float	mm	in	value *0.03937+	Standard Depth		E,N
			gtmindepth	float	mm	in	value *0.03937+	Minimum Depth		E,N
			gtmaxdepth	float	mm	in	value *0.03937+	Maximum Depth		E,N
G	02	Biomass Manipulation	gbioarea	float	fraction			Area Affected		E,N
G	03	Crop Name	gcropname	string				Crop Name		E,S
G	04	Add Material to Field	gamdname	string				Material Name		E,S
P	01	Break Crust								
P	02	Random Roughness from tool	roughflag	int				Random Roughness Flag	Use given random roughness value unchan Adjust random roughness for soil type and	
			rough	float	mm	in	value *0.03937+	Nominal Random Roughness		

Done

Figure 5.42. Partial listing of a WEPS "operation_defn.xml" file that defines management operation actions, their parameters, and their various attributes.

Management Operation Parameter Definitions

O 00: Initialization

The "Initialization" operation line represents a special type of operation. It is intended to be used when one needs to "initialize" a WEPS simulation run in a special manner. Therefore, any operation defined with an "Initialization" operation line will only be executed once, during the initialization cycle, and will not be repeated like other normal operations. This type of operation will usually only be created and used by researchers or for special WEPS uses.

Parameter Prompt: Initialization Operation Notes

The "Initialization" operation line contains only this one parameter. It allows the user to document the specific purpose of the operation, special considerations specific to its use, creation date, author, any subsequent changes, etc.

O 01: Direction and Speed

In many management events, like tillage operations, the actual speed of the operation and/or the direction in which the operation is performed on the field can influence the degree to which it impacts the physical state of the soil, surface, and vegetation. These types of management events will be defined with the "Direction and Speed" operation line.

Parameter Prompt: Speed

Actual speed at which the operation is performed.
Parameter Unit: m/s
Conversion factor: mph = 2.237 * (m/s)
Alternate units: mph

Parameter Prompt: Direction from North

This parameter defines the principle direction, relative to north, in which the operation is performed. Zero (0.0) degrees represents a north/south direction. 90.0 degrees represents an east/west direction. This parameter defines the predominant direction of tillage ridges and/or planted rows. It is important because oriented surface roughness and row direction relative to wind direction affect the susceptibility of the field to wind erosion.
Parameter Unit: degrees

Parameter Prompt: Standard Speed

Speed at which some of the physical processes, like residue burial efficiency, have coefficients specified. In WEPS, many of these coefficients are then adjusted internally based upon actual travel speed, as well as other parameters.

Parameter Unit: m/s
Conversion factor: mph = 2.237 * (m/s)
Alternate units: mph

Parameter Prompt: Minimum Speed

Minimum speed at which the operation would typically be performed. This speed value is used to determine the lower limit at which WEPS will adjust certain process-specific parameters that are influenced by travel speed.

Parameter Unit: m/s
Conversion factor: mph = 2.237 * (m/s)
Alternate units: mph

Parameter Prompt: Maximum Speed

Maximum speed at which the operation would typically be performed. This speed value is used to determine the upper limit at which WEPS will adjust certain process-specific parameters that are influenced by travel speed.

Parameter Unit: m/s
Conversion factor: mph = 2.237 * (m/s)
Alternate units: mph

Parameter Prompt: Tillage Operation Notes

This parameter allows the user to document the specific purpose of the operation, special considerations specific to its use, creation date, author, any subsequent changes, etc.

O 02: Others

Management events that are not influenced by speed of operation or direction of travel. Examples would be most grain-harvest, herbicide-spraying, baling, burning, and irrigation operations.

Parameter Prompt: Other Operation Notes

This parameter allows the user to document the specific purpose of the operation, special considerations specific to its use, creation date, author, any subsequent changes, etc.

G 01: Tillage

Many tillage operations perform several physical processes as they modify the soil and surface condition (e.g., loosening the soil, mixing soil properties within the tillage zone, burial of residue, etc.). All of these physical processes require some information that is common among them. These "shared" parameter values, like tillage depth, surface area disturbed, etc., have been grouped together into a single "group" line so that they don't have to be specified repeatedly as parameters for each individual process that needs them. This allows one to conveniently make a single change to a "shared" parameter listed in a group line and have it impact all the succeeding processes that require it. But it also requires one to ensure that any process line that requires a "shared" parameter has the appropriate "group" line specified before the process line in the definition file of that operation.

Often, a tillage operation may contain multiple tillage tool components on a single implement (e.g., disk gang, followed by a row of chisel shanks) or consist of a several individual implements one behind the other (e.g. a springtooth harrow with a straight tine drag harrow behind it). These types of tillage operations/implements can be represented as a single operation in WEPS by specifying the physical processes each tillage tool component performs on the soil/surface/vegetation. Often, this is done by specifying a "Tillage" group line, followed by the appropriate "process" lines to represent the tillage/residue burial effects of the individual tillage tool components. Thus, multiple tillage "group" lines, followed immediately by several "process" lines, will be used to represent multi-tool and multi-implement tillage operations in WEPS.

Parameter Prompt: Actual Depth

Actual tillage depth of the implement or tillage tool component represented.

Parameter Unit: mm

Conversion factor: inches = 0.03937 * (mm)

Alternate units: inches

Parameter Prompt: Intensity

Tillage intensity of the implement or tillage tool component represented. It can have a value from 0.0 to 1.0, where zero represents no soil disturbance and 1.0 would represent maximum soil disturbance. This parameter value impacts the soil layer "mixing" process simulated within WEPS, as well as soil loosening. An example of a tool with a high tillage intensity would be a rotary tiller.

Parameter Unit: fraction

Parameter Prompt: Area Affected

The fractional surface area affected by the tillage processes. It can have a value from 0.0 to 1.0, where zero would represent no surface area disturbed. A value of 1.0 would mean that the tillage processes occurred across the entire width of the

implement. A value between 0.0 and 1.0 would mean that only a fraction of the surface and the soil below would be disturbed, (e.g., a row crop cultivator may only till the soil between the plant rows).
Parameter Unit: fraction

Parameter Prompt: Standard Depth
Tillage depth at which some of the physical processes, like residue burial efficiency, have coefficients specified. In WEPS, many of these coefficients are then internally adjusted based upon actual tillage depth, as well as other parameters.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Minimum Depth
Minimum tillage depth at which the operation would typically be performed. This depth value is used to determine the lower limit at which WEPS will adjust certain process-specific parameters that are influenced by tillage depth.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Maximum Depth
Maximum tillage depth at which the operation would typically be performed. This depth value is used to determine the upper limit at which WEPS will adjust certain process specific parameters which are influenced by tillage depth.
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

G 02: Biomass Manipulation

The “Biomass Manipulation” group contains a “shared” parameter that is required by many WEPS processes that simulate the manipulation of biomass (e.g., the removal of biomass, flattening of standing residue, etc.). This “group” line is commonly used for operations that do not affect (till) the soil, where the “shared” parameters dealing with tillage depth in the “Tillage” group are not required. Examples of operations that would use this group line are harvesting and spraying operations.

Parameter Prompt: Area Affected

The fractional surface area affected by the tillage processes. It can have a value from 0.0 to 1.0, where zero would represent no surface area disturbed. A value of 1.0 would mean that the biomass manipulation processes occurred across the entire width of the implement. A value between 0.0 and 1.0 would mean that only a fraction of the surface and biomass would be affected (e.g., a grain harvesting operation in which 1/3 of the crop was to be left in the field for wildlife purposes or in which the implement's wheel tracks flattened a fraction of the standing residue during the operation).

Parameter Unit: fraction

<u>G 03: Crop Name</u>

The "Crop Name" group consists of a single parameter, the name of a crop being planted or transplanted. It is required by the planting/seeding and transplanting processes.

Parameter Prompt: Crop Name

This parameter specifies the name of the crop being planted/seeded or transplanted.

<u>G 04: Add Material to Field</u>

The "Add Material to Field" group consists of a single parameter, the name of the residue type being applied. It is required by the "Add Residue" and "Set Residue" processes.

Parameter Prompt: Material Name

This parameter specifies the name of the type of residue added to the field.

<u>P 01: Break Crust</u>

If this process is specified, it means that the operation will physically remove any crust on the soil surface. No process-level parameters are required for the simulation of this effect in WEPS. It does require a shared, group-level parameter that specifies the fraction of the surface area to which this effect applies.

<u>P 02: Random Roughness</u>

Parameter Prompt: Random Roughness Flag

Some tillage operations will create a specific random surface roughness, regardless of the pre-existing soil surface/biomass conditions, and others are highly dependent upon the soil type, pre-tillage surface cloddiness, and quantity of buried residue present. To allow for these differences, a “Random Roughness Flag” is used to specify how WEPS should treat a specific tillage tool.

Parameter Choices: 0 - Always use specified random roughness value
1 - Allow WEPS to auto-adjust random roughness value

Parameter Prompt: Nominal Random Roughness

If the “Random Roughness Flag” is set to zero (0), then this value is the Allmaras random roughness value that the soil surface will have after using this tillage tool.

If the “Random Roughness Flag” is set to one (1), then this is to be the typical Allmaras random roughness value expected on a silt loam soil with lots of buried residue present. Internally, WEPS will use the “shared” group parameter values of “tillage intensity”, soil type, and residue quantity to determine the actual surface roughness created by the tillage tool. In general, a high tillage intensity value will mean that the “Nominal Random Roughness” will not be affected much by the pre-tillage surface roughness. A low tillage intensity value would affect the final random roughness. In general, a sandier soil will result in a lower random roughness value, and a soil with more clay will create a surface with a higher random roughness value. Because most field conditions are performed with less residue than specified for the “Nominal Random Roughness” value, the resulting surface roughness will be less than the specified value.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

P 05: Ridges and Dikes

Parameter Prompt: Ridge Flag

Tillage operations will either: a) leave existing ridges alone; b) create a specified ridged and/or diked surface, regardless of pre-existing surface conditions; or c) create a specific ridged and/or diked surface based upon tillage depth. The “Ridge Flag” specifies which of these situations should represent how WEPS should treat a specific tillage tool.

Parameter Choices: 0 - Pre-existing ridges/dikes left unchanged
1 - Ridges/dikes set to specified values
2 - Ridges/dikes set, based upon tillage depth

Parameter Prompt: Ridge Height

Ridge height is measured from the top of the ridge to the bottom of the furrow.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Ridge Spacing

Ridge spacing is measured from ridge top to ridge top across the furrow.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Ridge Top Width

Ridge width is measured across the top of the ridge.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Dike Height

Dike height is measured from the top of the dike to the bottom of the furrow.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Dike Spacing

Dike spacing is measured from dike top to dike top down the furrow.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

P 11: Aggregate Crushing

Parameter Prompt: Aggregate Size Distribution Factor

Parameter Unit: unitless

Parameter Prompt: Crushing Intensity Factor

Parameter Unit: unitless

P 12: Soil Loosening

Parameter Prompt: Soil Loosening Factor

Specifies degree to which air is added to the soil layers within the tillage zone. A minimum value of zero (0.0) means no change in soil layer bulk density occurs. A maximum value of 1.0 means the soil layers reach their "loosest" state (i.e., the lowest bulk density possible for the soil type, based upon the pre-tilled bulk density value).

Parameter Unit: fraction

P 13: Soil Layer Mixing

Parameter Prompt: Layer Mixing Factor

Specifies degree of mixing among soil layer properties. A minimum value of zero (0.0) means no mixing occurs, and a maximum value of 1.0 means full mixing occurs, (i.e., all layers within the tillage zone become homogeneous).

Parameter Unit: fraction

P 14: Soil Layer Inversion

Specifies that the current tillage tool inverts the soil layers within the specified tillage zone. This process line has no parameter values.

P 24: Flatten Standing Biomass

This process specifies the degree to which standing crops and/or residue are flattened. There are "flattening coefficients" specified for each type of "residue", on the basis of its "toughness/size". The five types of residue classes are:

fragile	- Residue that is easily broken down (e.g., soybean residue)
moderately tough	- Similar to size and toughness of wheat residue
non-fragile/large	- Similar to size and toughness of corn residue
woody	- Similar to size and toughness of woody brush residue
small stones/gravel	- Non-decomposing material

Parameter Prompt: Flatten Biomass Flag

This parameter specifies which type of biomass is flattened, the "growing crop" and/or the standing crop residue remaining after previous crop harvests.

Parameter Choices: 0 - Flatten crop and residue
1 - Flatten crop only

14 - Flatten residue only

Parameter Prompt: Mass Flattened (fragile residue)
Fraction of standing crop and/or residue flattened, if considered "fragile residue".
Parameter Unit: fraction

Parameter Prompt: Mass Flattened (moderately tough residue)
Fraction of standing crop and/or residue flattened, if considered "moderately tough residue".
Parameter Unit: fraction

Parameter Prompt: Mass Flattened (non-fragile/large residue)
Fraction of standing crop and/or residue flattened, if considered "non-fragile/large residue".
Parameter Unit: fraction

Parameter Prompt: Mass Flattened (woody residue)
Fraction of standing crop and/or residue flattened, if considered "woody residue".
Parameter Unit: fraction

Parameter Prompt: Mass Flattened (small stones/gravel residue)
Fraction of standing crop and/or residue flattened, if considered "small stones/gravel residue". Tire traffic areas should be included in this fraction.
Parameter Unit: fraction

P 25: Bury Flat Biomass

This process specifies distribution and the degree to which crops and/or residue are buried. There are "burial coefficients" specified for each type of "residue", on the basis of its "toughness/size". The five types of residue classes are specified under "Flatten Standing Biomass". The burial distribution pattern by depth is specified based upon the "Bury Biomass Flag" values. The five types of burial distribution patterns are:

Uniform	- Biomass is buried uniformly by depth
Mixing and inversion	- Biomass is inverted and mixed during burial
Mixing	- More biomass is buried near the soil surface
Inversion	- Biomass buried at bottom of tillage zone
Lifting, fracturing	- Biomass buried similar to a chisel plow

Parameter Prompt: Bury Biomass Flag
This parameter specifies how residue is buried into the tillage zone.
Parameter Choices: 0 - Uniform burial distribution

1 - Mixing and inversion burial distribution
2 - Mixing burial distribution
3 - Inversion burial distribution
4 - Lifting/fracturing burial distribution

Parameter Prompt: Mass Buried (fragile residue)
Fraction of above ground crop and/or residue buried, if considered "fragile residue".
Parameter Unit: fraction

Parameter Prompt: Mass Buried (moderately tough residue)
Fraction of above ground crop and/or residue buried, if considered "moderately tough residue".
Parameter Unit: fraction

Parameter Prompt: Mass Buried (non-fragile/large residue)
Fraction of above ground crop and/or residue buried, if considered "non-fragile/large residue".
Parameter Unit: fraction

Parameter Prompt: Mass Buried (woody residue)
Fraction of above ground crop and/or residue buried, if considered "woody residue".
Parameter Unit: fraction

Parameter Prompt: Mass Buried (small stones/gravel residue)
Fraction of above ground crop and/or residue buried, if considered "small stones/gravel residue".
Parameter Unit: fraction

P 26: Resurface Buried Biomass

This process specifies the degree to which buried residue are brought back to the surface. There are "re-surfacing coefficients" specified for each type of "residue", on the basis of its "toughness/size". The five types of residue classes are specified under "Flatten Standing Biomass".

Parameter Prompt: Mass Resurfaced (fragile residue)
Fraction of below-ground crop and/or residue resurfaced, if considered "fragile residue".
Parameter Unit: fraction

Parameter Prompt: Mass Resurfaced (moderately tough residue)
Fraction of below ground crop and/or residue resurfaced, if considered "moderately tough residue".
Parameter Unit: fraction

Parameter Prompt: Mass Resurfaced (non-fragile/large residue)
Fraction of below ground crop and/or residue resurfaced if, considered "non-fragile/large residue".
Parameter Unit: fraction

Parameter Prompt: Mass Resurfaced (woody residue)
Fraction of below ground crop and/or residue resurfaced, if considered "woody residue".
Parameter Unit: fraction

Parameter Prompt: Mass Resurfaced (small stones/gravel residue)
Fraction of below ground crop and/or residue resurfaced, if considered "small stones/gravel residue".
Parameter Unit: fraction

<u>P 31: Kill or Defoliate Growing Crop</u>

This process determines whether a growing crop is defoliated or killed, based upon the type of crop (perennial or annual).

Parameter Prompt: Kill/Defoliate Flag
This parameter specifies how different crop types are treated (e.g., killed or defoliated).
Parameter Choices: 1 - Annual crop killed, perennial crop regrows
2 - All crop types are killed
3 - Crop defoliated

<u>P 32: Cut/Remove Biomass to Height</u>

This process cuts the specified standing biomass (crop and residue if present) to the specified height. This process is also a harvest process if components of the cut material are removed from the field as specified by the removal parameter values. Based upon the "Cut Biomass Flag" setting, the cut height is measured from the ground up or from the top of the crop down.

Parameter Prompt: Cut Biomass Flag

This parameter specifies how the cut height is determined.

Parameter Choices: 0 - Cut Value = Height of standing stubble remaining
1 - Cut Value = Length of standing plant stalks removed

Parameter Prompt: Cut Value

Either the cutting height or the length (height) of crop removed, based upon the "Cut Biomass Flag" value.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Cut Yield Removed

Mass fraction of crop yield removed during the "Cut/Remove Biomass to Height" process.

Parameter Unit: fraction

Parameter Prompt: Cut Plant Removed

Mass fraction of "cut" crop biomass removed during the "Cut/Remove Biomass to Height" process.

Parameter Unit: fraction

Parameter Prompt: Cut Standing Residue Removed

Mass fraction of "cut" standing residue removed during the "Cut/Remove Biomass to Height" process.

Parameter Unit: fraction

P 33: Cut/Remove Biomass by Fraction

This process cuts the specified standing biomass (crop and residue if present) to a fraction of the crop height. This process is also a harvest process if components of the cut material are removed from the field as specified by the removal parameter values.

Parameter Prompt: Plant Height Removed

Fraction of crop (and residue if present) height removed during the "Cut/Remove Biomass by Fraction" process.

Parameter Unit: fraction

Parameter Prompt: Cut Yield Removed

Mass Fraction of crop yield removed during the “Cut/Remove Biomass by Fraction” process.

Parameter Unit: fraction

Parameter Prompt: Cut Plant Removed

Mass fraction of “cut” crop biomass removed during the “Cut/Remove Biomass by Fraction” process.

Parameter Unit: fraction

Parameter Prompt: Cut Standing Residue Removed

Mass fraction of “cut” standing residue removed during the “Cut/Remove Biomass to Height” process.

Parameter Unit: fraction

P 34: Change Standing Biomass Fall Rate

This process allows an operation to modify the fall rate of decay for standing residue stalks. The purpose is to simulate the effects of undercutting the supporting roots, which decreases the ability of residue stalks to remain standing over time.

Parameter Prompt: Select Biomass Pool Type

This parameter specifies how the cut height is determined.

Parameter Choices: 1 - Crop
2 - Temporary
3 - Crop and Temporary
4 - Residue
5 - Crop and Residue
6 - Temporary and Residue
7 - Crop, Temporary and Residue

Parameter Prompt: Standing Biomass Fall Rate Multiplier (fragile residue)

Multiplier value to increase or decrease the fall rate value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Rate Multiplier (moderately tough residue)

Multiplier value to increase or decrease the fall rate value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Rate Multiplier (non-fragile/large residue)
Multiplier value to increase or decrease the fall rate value for the specified type of residue.
Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Rate Multiplier (woody residue)
Multiplier value to increase or decrease the fall rate value for the specified type of residue.
Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Rate Multiplier (small stones/gravel residue)
Multiplier value to increase or decrease the fall rate value for the specified type of residue.
Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (fragile residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.
Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (moderately tough residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.
Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (non-fragile/tough residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.
Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (woody residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.
Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (small stones/gravel residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.
Parameter Unit: multiplier

P 37: Thin Biomass to Population

This process reduces the crop plant population to the specified value. This process is also a harvest process if components of the "thinned" plants are removed from the field as specified by the removal parameter values.

Parameter Prompt: Thinning Value
Resulting plant population desired.
Parameter Unit: #/m^2
Conversion factor: #/ft^2 = 0.0929 * (#/m^2)
Alternate units: #/ft^2

Parameter Prompt: Thinned Yield Removed
Mass fraction of "thinned" crop yield removed during the "Thin Biomass to Population" process.
Parameter Unit: fraction

Parameter Prompt: Thinned Plant Removed
Mass fraction of "thinned" crop plants removed during the "Thin Biomass to Population" process.
Parameter Unit: fraction

Parameter Prompt: Thinned Standing Residue Removed
Mass fraction of "thinned" standing residue removed during the "Thin Biomass to Population" process.
Parameter Unit: fraction

P 38: Thin Biomass by Fraction

This process reduces the crop plant population by the specified value. This process is also a harvest process if components of the "thinned" plants are removed from the field as specified by the removal parameter values.

Parameter Prompt: Thinning Value
Reduction factor to reach desired population.
Parameter Unit: fraction

Parameter Prompt: Thinned Yield Removed
Mass fraction of "thinned" crop yield removed during the "Thin Biomass by Fraction" process.
Parameter Unit: fraction

Parameter Prompt: Thinned Plant Removed
Mass fraction of "thinned" crop plants removed during the "Thin Biomass by Fraction" process.
Parameter Unit: fraction

Parameter Prompt: Thinned Standing Residue Removed
Mass fraction of "thinned" standing residue removed during the "Thin Biomass by Fraction" process.
Parameter Unit: fraction

P 40: End Crop Biomass Manipulation

This process is required after all "crop" related biomass manipulation processes have been completed, for WEPS to correctly account for changes in vegetation pools within the simulation. There are no parameters associated with this process line.

P 50: Set Crop Residue Amounts

Parameter Prompt: Number of Standing Residue Stems
Desired residue standing stem population.
Parameter Unit: #/m^2
Conversion factor: #/ft^2 = 0.0929 * (#/m^2)
Alternate units: #/ft^2

Parameter Prompt: Standing Residue Height
Desired standing residue height.
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Standing Residue Mass
Desired standing residue mass.
Parameter Unit: kg/m^2
Conversion factor: lb/acre = 8921.8 * (kg/m^2)
Alternate units: lb/acre

Parameter Prompt: Flat Surface Residue Mass

Desired flat residue mass.

Parameter Unit: kg/m^2
Conversion factor: lb/acre = 8921.8 * (kg/m^2)
Alternate units: lb/acre

Parameter Prompt: Residue Size/toughness Class

This flag specifies the "class" of residue on the basis of its relative size and toughness.

Parameter Choices: 1-Fragile, very small residue (e.g., soybeans)
2-Moderately tough, short residue (e.g., wheat)
3-Non fragile, medium residue (e.g., corn)
4-Woody, large residue
5-Gravel, rock

Parameter Prompt: Buried Residue Mass

Desired buried residue mass (not roots).

Parameter Unit: kg/m^2
Conversion factor: lb/acre = 8921.8 * (kg/m^2)
Alternate units: lb/acre

Parameter Prompt: Buried Residue Depth

Desired buried residue depth.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Root Residue Mass

Desired root residue mass.

Parameter Unit: kg/m^2
Conversion factor: lb/acre = 8921.8 * (kg/m^2)
Alternate units: lb/acre

Parameter Prompt: Root Residue Depth

Desired root residue depth.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Decomposition Rate for Standing Stalks

The rate at which standing stalks decompose under optimum conditions. Example: a decomposition rate of 0.02 kg kg^{-1} day^{-1} means a 2% standing stalk mass loss per day if moisture and temperature conditions are optimum for decomposition on this day. If conditions are not optimum, the rate is reduced. Leaves, if any are present, decompose at 3 times the rate of stalks, and reproductive material, if any is present, decomposes at 1.5 times the rate of stalks.

Parameter Unit: kg kg^{-1} day^{-1}

Parameter Prompt: Decomposition Rate for Surface (flat) Stalks

The decomposition rate of stalks that have fallen to a flattened (horizontal) position on the soil surface. See comments for standing stalks.

Parameter Unit: kg kg^{-1} day^{-1}

Parameter Prompt: Decomposition Rate for Buried Stalks

The decomposition rate of stalks that have been buried below the soil surface by tillage. See comments for standing stalks.

Parameter Unit: kg kg^{-1} day^{-1}

Parameter Prompt: Decomposition Rate for Roots

See comments for standing stalks.

Parameter Unit: kg kg^{-1} day^{-1}

Parameter Prompt: Fall Rate for Standing Stalks

The rate at which standing stalks fall to a flattened (horizontal) position on the soil surface. Only after a threshold has been reached, stalks will begin to fall at this rate. Example: a fall rate of 0.12 day^{-1} means a 12% of the total number of standing stalks fall down per day if moisture and temperature conditions are optimum on this day. If conditions are not optimum, the fall rate is reduced.

Parameter Unit: day^{-1}

Parameter Prompt: Average Stalk Diameter

Parameter Unit: m

Conversion factor: inches = 39.3696 * (m)

Alternate units: inches

Parameter Prompt: Decomposition Days After Which Stalks Begin to Fall

Only after this threshold has been reached, stalks will begin to fall at the rate previously discussed. Example: a threshold of 20 decomposition days means that standing stalks only begin to fall after 20 days after harvest if moisture and temperature conditions are optimum, during these 20 days. If conditions are not optimum the number of days increases.

Parameter Unit: day

Parameter Prompt: Mass to Cover Factor

Soil cover from flat residue mass is predicted by:

$$C_f = 1 - \exp^{-b\, M_f} \quad \textbf{(5.10)}$$

where C_f is flat residue cover ($m^2\ m^{-2}$), b is mass-to-cover factor ($m^2\ kg^{-1}$), and M_f is flat residue mass ($kg\ m^{-2}$) (Figure 5.40, 43).

Parameter Unit: $m^2\ kg^{-1}$

Conversion factor: value * 0.00011209

Alternate units: acres lb^{-1}

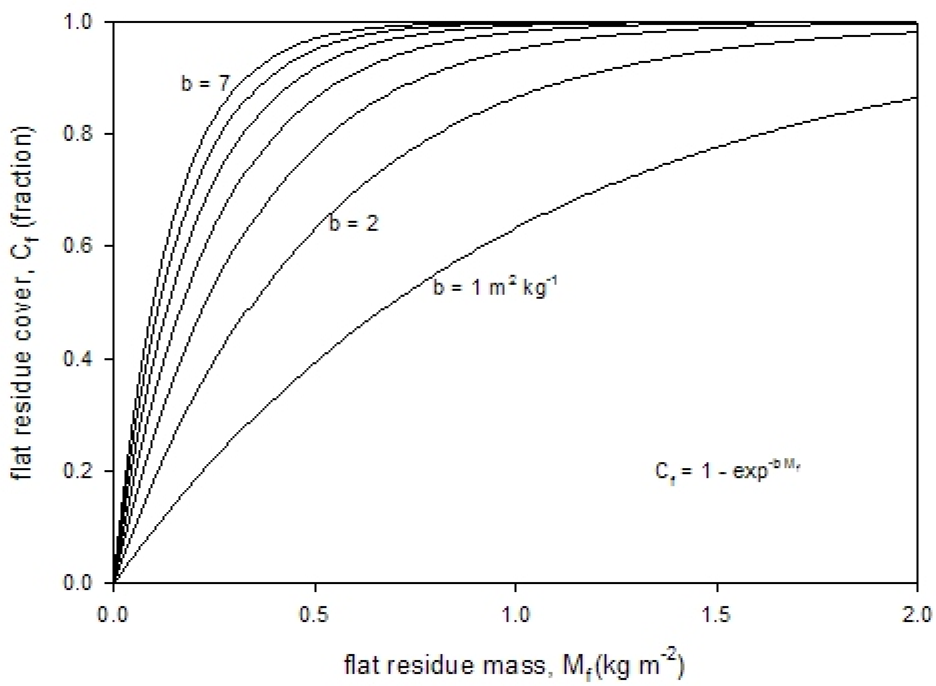


Figure 5.43. Relationship between flat residue mass and the cover provided by this flat residue.

Parameter Prompt: Residue Evaporation Suppression Multiplier Coefficient a

Parameter Unit: eratio = resevapa(kg/m²)**resevapb

Parameter Choices:

Parameter Prompt: Residue Evaporation Suppression Multiplier Coefficient b

Parameter Unit: eratio = resevapa(kg/m²)**resevapb

P 51: Seeding Configuration

Parameter Prompt: Type of Planting
Specifies how the crop is being planted.
Parameter Choices: 0-Broadcast Planting
2-Use Implement Ridge Spacing
3-Use Specified Row Spacing

Parameter Prompt: Crop Row Spacing
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Seed Placement (ridge/furrow)
Specifies where seed is to be placed when planting in rows.
Parameter Choices: 0-Seed row placed in bottom of furrow.
2-Seed row placed on ridge top.

Parameter Prompt: Plant Population
Parameter Unit: #/m^2
Conversion factor: #/acre = 4046.7 * (#/m^2)
Alternate units: #/acre

Parameter Prompt: Maximum number of Tillers (stems) per Plant
Parameter Unit: #/plant

NOTE: All remaining process 51 parameters consist of the “crop” database record parameters. They are fully defined in the crop “how to” guide. One normally would not need to deal with those parameters when defining/modifying an operation record, so they are not individually listed here.

P 61: Remove Plant/Residue Material

Parameter Prompt: Select Plant/residue Material
This flag specifies the “location” of the biomass to be removed.
Parameter Choices: 1-Standing with Roots
2-Flat
3-Standing with Roots and Flat
4-Buried
5-Standing with Roots and Buried

6-Flat and Buried
7-Standing with Roots, Flat and Buried

Parameter Prompt: Select Plant/residue Material
This flag specifies the biomass pool type(s) to be removed.
Parameter Choices: 1-Crop
2-Temporary
3-Crop and Temporary
4-Residue
5-Crop and Residue
6-Temporary and Residue
7-Crop, Temporary and Residue

Parameter Prompt: Grain (fruit) Removed
Parameter Unit: fraction

Parameter Prompt: Leaf Removed
Parameter Unit: fraction

Parameter Prompt: Stem Removed
Parameter Unit: fraction

Parameter Prompt: Storage Root Removed
Parameter Unit: fraction

Parameter Prompt: Fibrous Roots Removed
Parameter Unit: fraction

P 71: Irrigation

This process simulates the application of water.

Parameter Prompt: Irrigation Application Method
This flag specifies the type of irrigation method.
Parameter Choices: 1-Sprinkler
2-Other

Parameter Prompt: Depth of Water Applied
Parameter Unit: mm
Conversion factor: inches = 0.3937 * (mm)
Alternate units: inches

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