The Wind Erosion Prediction System

WEPS 1.0

User Manual DRAFT

USDA-ARS
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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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Acknowledgments

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The contribution of the NRCS state and field offices and other individuals who participated in the WEPS validation studies is also recognized.

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.

An index to the WEPS User Manual is also available. Finally, the "Appendices" contains information for more advanced users. For users interested in more details on the interface and science behind WEPS, Appendix 1, '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 Appendix 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 appendix 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.

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. 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:

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An Overview of the Wind Erosion Prediction System

Introduction

The Wind Erosion Prediction System (WEPS) 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 (WEQ) (Woodruff and Siddoway, 1965) as a prediction tool for those who plan soil conservation systems, conduct environmental planning, or assess offsite impacts caused by wind erosion.

WEPS development involves an ARS led, national, multi-disciplinary team of scientists. It has a multi-agency commitment consisting of the Agricultural Research Service (ARS), Natural Resource Conservation Service (NRCS), and Forest Service (FS) from the U.S. Department of Agriculture, along with the Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers, and Bureau of Land Management (BLM).

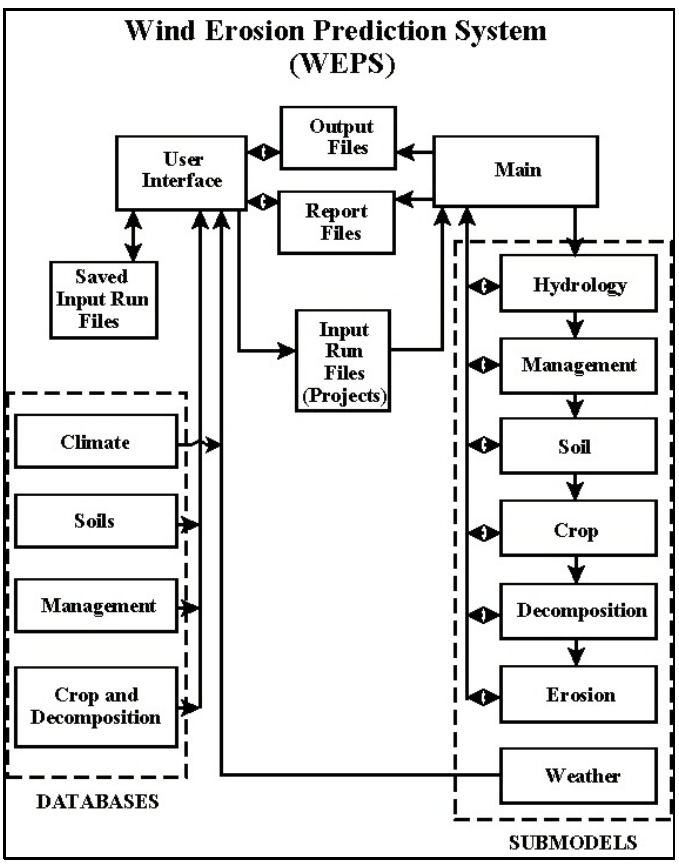

Figure 1.1. Structure of the WEPS model.

Objectives

The purposes of WEPS are to improve assessment of soil loss by wind from agricultural fields and to provide new capabilities such as assessing plant damage, calculating suspension loss, and estimating PM-10 emissions from the field.

Background

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 speed and the evolution of the surface condition. Because WEPS is a continuous, daily time-step model, it simulates not only the basic wind erosion processes, but also the processes that modify a soil's susceptibility to wind erosion.

The structure of WEPS is modular and consists of a user interface, a science model including seven submodels, and four databases (Fig. 1.1). The user interface is used to create input files using information from the databases and the weather generator. In a practical application, new input files will usually be created by using previous input files as templates modified within the user-interface.

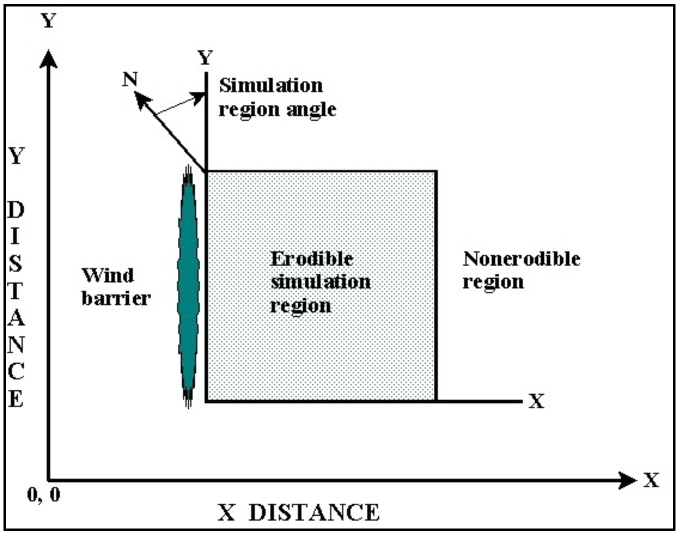

Figure 1.2. WEPS simulation geometries.

Simulation Region

In WEPS, the simulation region is a field (Fig. 1.2). Users must input the geometry of the simulation region. Initial conditions must also be specified for the surface and soil layers. WEPS can output soil loss/deposition over selected time intervals from the simulation region. WEPS also provides users with individual soil loss components of creep-saltation, suspension, and PM-10 size fractions. The soil loss components are useful as an aid in estimating off-site impacts of wind erosion.

Discrete Time and Space

The time step is controlled within the main program. 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. Submodels are called by the MAIN program (Tatarko, 1995) in the order shown in Fig. 1.1. Each individual submodel controls the sequence of calculations within itself. In addition, in the MANAGEMENT submodel, field operations are simulated sequentially according to the order in which they appear in the management plan. Management plans usually cover at least a single year and may cover multiple years. WEPS simulates conditions and soil loss on homogeneous simulation regions. "Homogeneous" means that the soil type, biomass, and management are similar over a subregion.

Weather Simulated from Climate Databases

WEPS requires wind speed and direction to simulate the process of soil erosion by wind. These and other weather variables are needed to drive temporal changes in hydrology, soil erodibility, crop growth, and residue decomposition in WEPS. The weather generator consists of the programs WINDGEN and CLIGEN (Tatarko et al., 1995).

WINDGEN simulates wind speed and direction for WEPS (Skidmore and Tatarko, 1990; Wagner et al., 1992). It was developed specifically for use with WEPS, and stochastically (i.e., randomly based on historical weather) simulates wind direction and sub-daily wind speeds. A compact database (Skidmore and Tatarko, 1990, 1991) developed for WINDGEN was derived from historical monthly summaries of wind speed and wind direction contained in the Wind Energy Resource Information System (WERIS) database at the National Climatic Data Center in Asheville, North Carolina.

CLIGEN is the weather generator developed for the Water Erosion Prediction Project (WEPP) erosion model (Nicks et al., 1987). It is used with WEPS to generate an average annual air temperature, as well as daily precipitation, maximum and minimum temperatures, solar radiation, and dew-point temperature. Average daily air temperature and elevation for the site are used to calculate average daily air density within WEPS. Air density is an important factor in calculating wind energy available for erosion. Dew-point temperature is used to calculate relative humidity. CLIGEN and its database are described fully in the WEPP documentation (Nicks and Lane, 1989).

Field Conditions Simulated

The HYDROLOGY submodel (Durar and Skidmore, 1995) estimates soil surface wetness, accounts for changes in soil temperature; and maintains a soil-water balance based on daily amounts of snow melt, runoff, infiltration, deep percolation, soil evaporation, and plant transpiration. Snow melt depends on maximum daily air temperature and initial snow water content. Runoff is calculated from rainfall rate greater than infiltration, adjusted for ponding and surface flow velocity. Water is infiltrated and distributed according to Darcy's Law. Potential evapotranspiration is calculated using a revised combination method of Van Bavel. Total daily potential evapotranspiration then is partitioned, on the basis of crop leaf area index, into potential soil evaporation and plant transpiration. Hourly potential soil evaporation rates are estimated from the daily value, based on soil water availability.

A soil's aggregation and surface state can dramatically affect susceptibility to wind erosion. Thus, changes in soil and surface temporal properties are simulated daily by the WEPS SOIL submodel (Hagen et al., 1995b) in response to various weather processes like wetting/drying, freeze/drying, freeze/thawing, precipitation amount and intensity, and time. Soil layer properties such as bulk density, aggregate size distribution, and dry aggregate density are maintained on a daily basis. Surface properties, such as random and oriented roughness; crust generation, coverage fraction, density, stability, and thickness; and loose erodible material on crusted surfaces also are accounted for in the SOIL submodel.

The presence of live or dead biomass on the soil surface influences the quantity of soil that can be removed by wind erosion. Therefore, the CROP submodel (Retta and Armbrust, 1995) simulates the growth of crop plants. Weed growth is not simulated in WEPS 1.0. The crop growth model was adapted from the Erosion Productivity Calculator (EPIC) crop growth model (Williams et al., 1990), which simulates a variety of crops and plant communities while accounting for water stresses. It calculates daily production of root mass, leaves, stems, and reproductive organs and also calculates leaf and stem areas. Additional capabilities and modifications have been incorporated into the CROP submodel to meet the need for predicting effects of a growing crop on wind erosion. Some of the factors that affect wind erosion are the flexibility and arrangement of individual plant parts, distribution of plant parts by height, and number of plants per unit area (Shaw and Periera, 1982). Thus, leaves and stems are accounted for separately because: 1) stems of young seedlings are roughly 10 times more effective than leaves, on a per-unit-area basis, in depleting wind energy; 2) leaves are more sensitive to sandblast damage than are stems; and 3) decomposition rates of stems and leaves are different.

The DECOMPOSITION submodel (Steiner et al., 1995) for WEPS simulates the decrease in crop residue biomass from microbial activity. The decomposition process is modeled as a first-order reaction, with temperature and moisture as driving variables. Standing residue is significantly more effective than flat residue at reducing wind energy at the soil surface. Hence, it is maintained separately from flat residue, and the conversion from standing to flat is simulated. The quantities of biomass remaining after harvest are partitioned into standing, surface, buried, and root pools, with below ground biomass decomposition calculated for each soil layer. Because crop residue decomposition rate varies by type and changes with residue age, each pool is subdivided further into 1) the most recently harvested crop pool, 2) the next-to-last crop pool, and 3) a "generic" crop pool that contains all older residue mass.

WEPS is expected to reflect the effects of various management practices upon wind erosion, and that is done by the MANAGEMENT submodel (Wagner and Ding, 1995). All major management operation classes are represented, such as primary and secondary tillage, cultivation, planting/seeding, harvesting, irrigation, fertilization, and burning. Each individual operation is simulated within the MANAGEMENT submodel as a series of physical processes. Those processes include 1) soil mass manipulation (changes in aggregate size distribution, soil porosity, mixing soil and residue by depth, and soil layer inversion); 2) surface modification (creation or destruction of ridges and/or dikes that form oriented surface roughness, changes in surface random roughness, and destruction of surface crusts); 3) biomass manipulation (burying and resurfacing residue, cutting standing residue, flattening standing residue, killing live crop biomass, and biomass removal); and 4) soil amendments (residue addition, planting, and irrigation).

Erosion Processes Simulated

The EROSION submodel (Hagen, 1995) decides if erosion can occur based on the current soil surface roughness (oriented and random), flat and standing biomass, aggregate size distribution, crust and rock cover, loose erodible material on a crust, and soil surface wetness. If the maximum daily wind speed reaches 8 m/s at 10m and snow depth is less than

20mm, the surface condition is evaluated on a sub-hourly basis to determine if erosion can occur. The EROSION submodel simulation performs the following functions: 1) calculates friction velocities based on the aerodynamic roughness of the surface, 2) calculates static threshold friction velocities, 3) computes soil loss/deposition within each grid cell, and 4) updates soil surface variables to reflect changes in soil surface "state" caused by erosion.

Summary Comparison of WEPS and WEQ

Users of wind erosion prediction technology encounter a wide range of challenging environmental problems that require solutions. WEQ was unable to meet some of these needs. After extensive consultations with users, the WEPS structure was designed with the capabilities to meet the needs identified. As such, WEPS represents new technology and is not merely an improvement and recoding of WEQ technology. Also, WEPS contains many simplifications to maintain reasonable computation times. Because many users are familiar with WEQ, a brief comparison of WEPS and WEQ follows to facilitate understanding of WEPS modeling techniques.

WEQ predicts average erosion along line-transects across the field, whereas WEPS treats the field as two-dimensional. The WEPS EROSION submodel simulates soil loss/deposition for grid areas over the entire simulation region. This feature allows users a more detailed, two-dimensional view of the erosion process by displaying the area of deposition within the simulation region.

WEQ predicts only long-term, average, soil loss. WEPS calculates on a daily basis and allows users to specify the output intervals. Thus, users can obtain outputs ranging from single storms to multiple years. By simulating for multiple years, the probability of various amounts of erosion during any period of a rotation also can be determined.

The largest contrast between the two technologies is that WEPS simulates a wide range of processes to describe field surface conditions and wind erosion, whereas WEQ depends on users to input correct estimates of the field surface conditions. Erosion, unfortunately does not vary linearly with residue cover and other temporal field conditions. Therefore, simply specifying average field conditions as inputs likely will not yield the best estimates of long-term average erosion.

The WEQ contains no feedback loop that modifies the field in response to weather or erosion. In WEPS, the driving forces of weather cause surface temporal properties of the field to change. Thus, in a year with high rainfall, the field soil roughness may be reduced below average, whereas above average biomass production prevents erosion. In a drought year however, biomass and aggregate size may both be below average, but tillage ridges may then be the primary control against soil erosion.

Various modeling techniques are used to simulate processes in WEPS. The WEATHER submodel generates stochastic simulated weather variables. Mechanistic and statistical relationships are used to represent processes in the other submodels. But, a structured design methodology was used in the development of WEPS. First, the major wind erosion processes, such as emission, abrasion, and trapping, were identified. Next, the individual temporal soil and biomass properties that affect the wind erosion processes were selected. Then, WEPS submodels were designed to simulate the general processes that control both the surface temporal properties and the erosion processes. Finally, parameters from the databases were used to make the simulation of various processes unique for specific soil, crop, and management actions.

Implementation

The current WEPS model is coded in FORTRAN conforming to the ANSI FORTRAN 77 and Fortran 95 standard. The coding guidelines used, with some minor modifications for WEPS, are outlined in the "Water Erosion Prediction Project (WEPP) Fortran-77 Coding Convention" (Carey et al., 1989). The model can be run in a Windows, Unix, or Linux environment. WEPS science code and implementation is documented fully in the WEPS Technical Description (Hagen et al., 1995a).

WEPS Updates

The WEPS model is continually being improved with periodic updates. The USDA-ARS Wind Erosion Research Unit (WERU) has established several means for obtaining the latest release of the WEPS model, databases, documents, and other related information as they become available.

For users with Internet access, WERU has established a World Wide Web site. The URL for WEPS downloads is: *http://weru.ksu.edu/weps*. This site contains all the information on WEPS. Specific WEPS information also can be obtained through E-Mail at: *weps@weru.ksu.edu* .

Users without Internet access can obtain WEPS update information by contacting:

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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>WEPS 1.0"). The WEPS 1.0 main screen will then appear.

A Simple Simulation

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 Project Summary" screen will appear.

WEPS Project Summary
The Project 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 Project 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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E-mail: weps@weru.ksu.edu
Web: http://www.weru.ksu.edu/weps

INTERFACE REFERENCE

WEPS Interface Main Screen

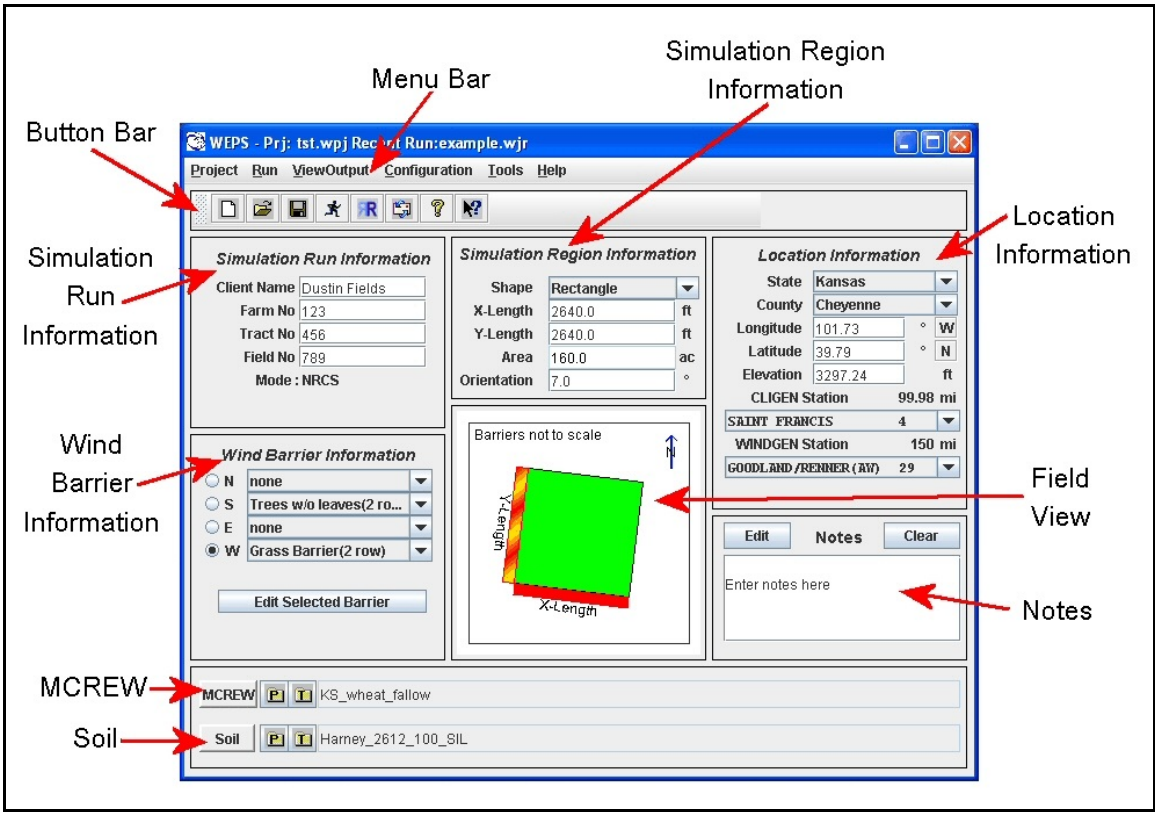


Figure 2.1. Main screen of the Wind Erosion Prediction System.

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).
- **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).

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).
  - 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).
  - 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 - default directory for the management templates.
  - Man Skeleton - default directory for the management skeleton files.
  - Man Op DB - default directory for the management operation database files.
  - Crop DB - default directory for the crop database files.
  - MCREW Dir - default directory for MCREW configuration files.
  - Soil DB - either the default directory for "ifc" soil database files or the name of a SSURGO Microsoft Access database file, including the path. If an "ifc" directory is entered, the 'Soil DB spec' field below should be left blank.
  - Soil DB spec - the JDBC:OBDC driver specification for accessing SSURGO soil data in a Microsoft Access database file. This field should be left blank if the "Soil DB" field specifies a directory containing "ifc" soil files.
  - Projects Dir - default directory for WEPS projects.
  - MCREW config - default directory for MCREW configuration file.
  - MCREW Data Config. - default file for MCREW configuration parameters.

- '**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:
  - Sender Addr - enter the default email address of the sender.
  - SMTP Server - enter your mailhost SMTP server address.
  - Comments - default recipient for comments to WEPS developers.
  - Bugs - default recipient for a bug report.
- ‘**Run**’ - opens a tab with run options:
  - 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.
  - 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 or browse for the file by clicking the folder icon  on the main 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:
  - Display either Metric or English units on WEPS screens.
  - Enter the number of time steps used for the daily distribution of simulated wind speed.
  - 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.
  - 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.
  - Check box to display the elevation field in the ‘**Location Information’** panel on the Main screen. Un-check the box to hide this field.
  - 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.
  - 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.

- Maximum 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 delays 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.

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) and the station elevation (m) 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/m2/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.

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).

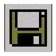
Button Bar

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.

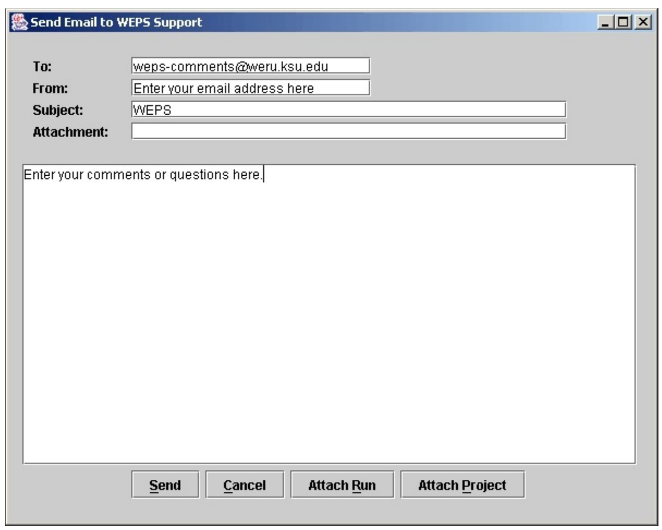

This button saves the currently displayed WEPS project to its current file name. This has the same function as selecting ‘**Save**’ under ‘**Project**’ on the menu bar.

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 ‘**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.

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 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.

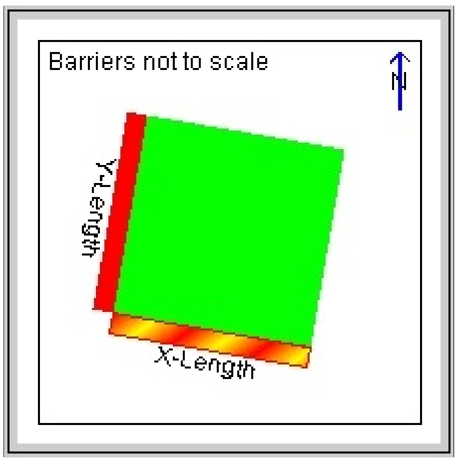


Figure 2.2. Field View panel for a rectangular field.

When a full, half, or quarter circular filed 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 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.

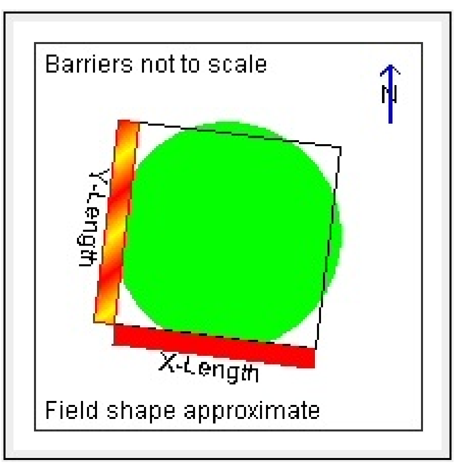


Figure 2.3. Field View panel for a circular field.

Simulation Run Information

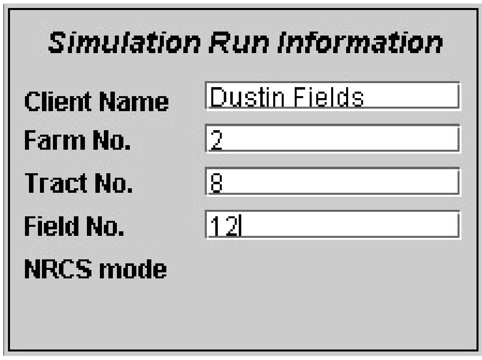


Figure 2.4. Simulation Run Information panel.

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

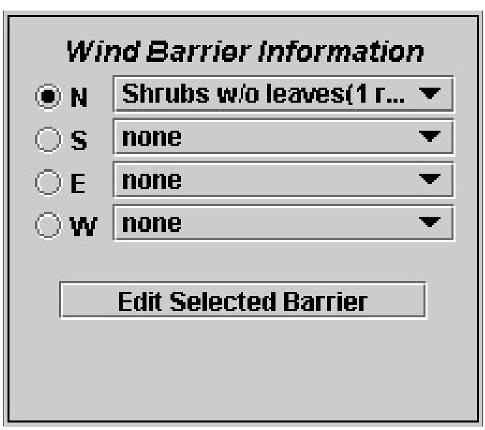


Figure 2.5. Wind Barrier Information panel.

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

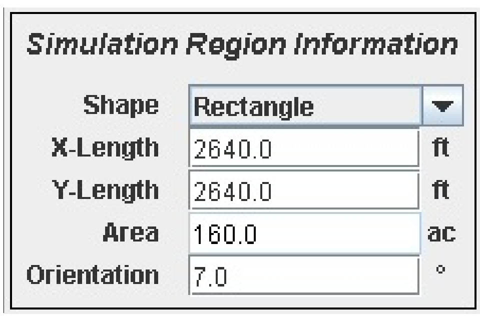


Figure 2.6. Simulation Region Information panel with rectangular field selected.

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

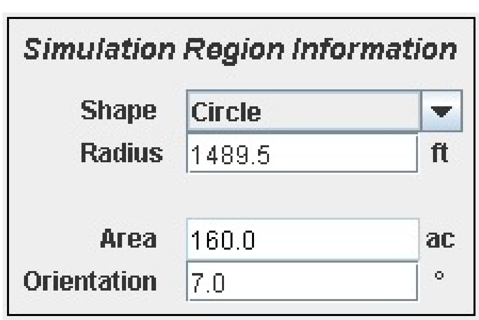


Figure 2.7. Simulation Region Information panel with circular field selected.

(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).

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.

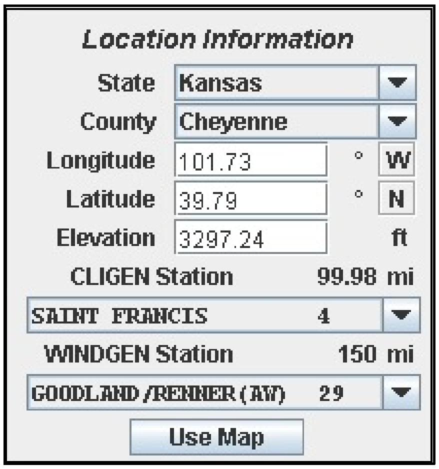


Figure 2.8. 'Location Information' panel.

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 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.

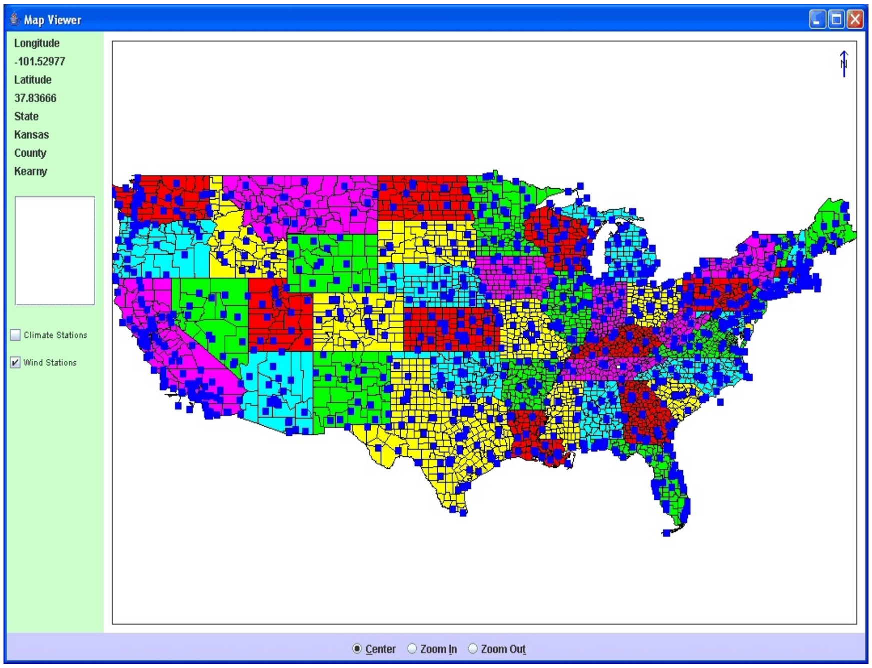


Figure 2.9. WEPS Map Viewer with wind stations displayed.

Notes

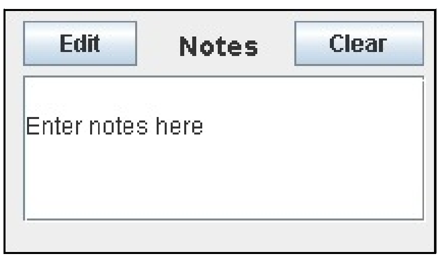


Figure 2.10. 'Notes' panel.

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 '**MCREW**' button on the left side of the bottom panel of the WEPS main screen (Fig 2.11).

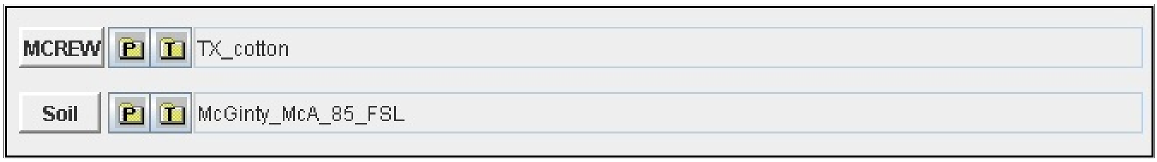


Figure 2.11. Bottom panel of the WEPS main screen with the MCREW box at the top.

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 '**MCREW**' button MCREW , 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.

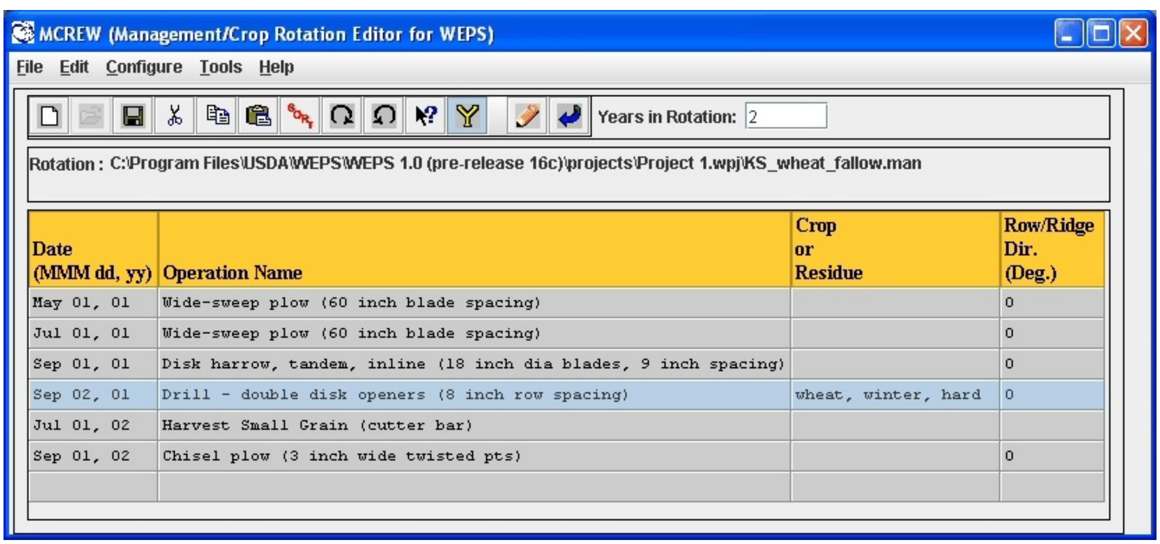


Figure 2.12. Management/Crop Rotation Editor for WEPS (MCREW) window.

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.

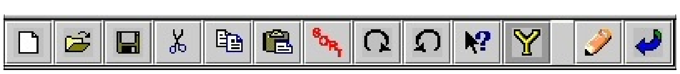
Using MCREW

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:

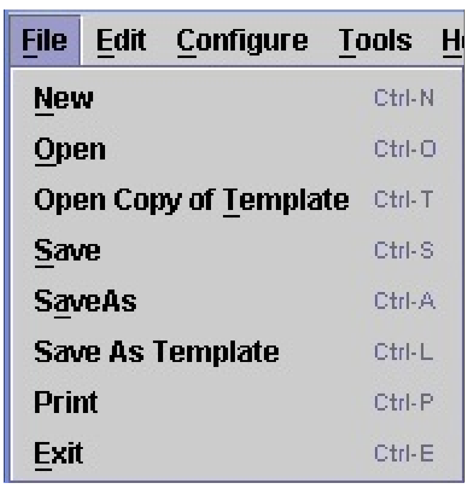
1. In the “Management Templates” directory.
   This is the location in which complete or partial (single or multi-crop year) management rotation files are kept. Files in this directory always show up on the management rotation selection choice lists. Management rotation files to

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.

- **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.

- **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'**.

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.

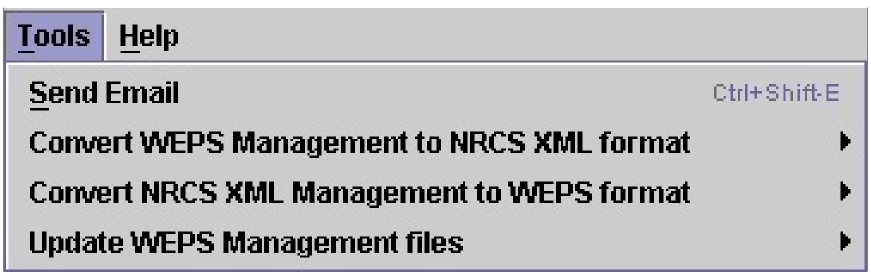
- **Configuration**
  Intended to display a "configuration" window. This is not functioning in the current version.

- **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.

- **Calibration Toggle** Ctrl-G
  Toggles the calibrate yield option on and off. Instructions for making a WEPS yield calibration run are given in the User Manual section "Making a WEPS Run".

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.

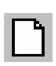
Help

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

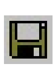
- **Help Topics** Ctrl-H
  Opens a window containing the MCREW online help system.

- **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

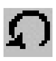
the same function as selecting ‘**Cut Row(s)**’ under ‘**Edit**’ on the menu bar.

 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

If the table cell can be directly edited on the table (indicated by a white background in the table cell), then a left mouse button selection will select the individual cell and immediately allow the user to manually edit the value in the cell. For example, left clicking in a “Tillage Dir.” cell with a white background activates that cell for editing.

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 (or row) 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.)
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

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

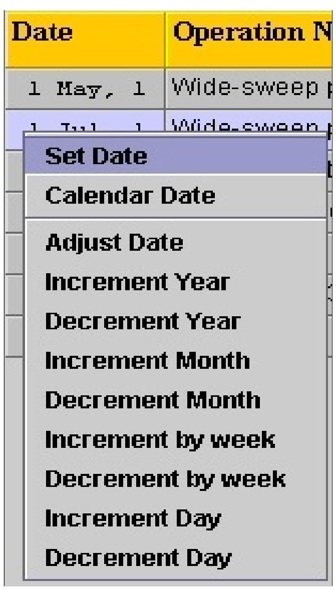
The "**Sort by Date**" function sorts the management operations by ascending date order.

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.

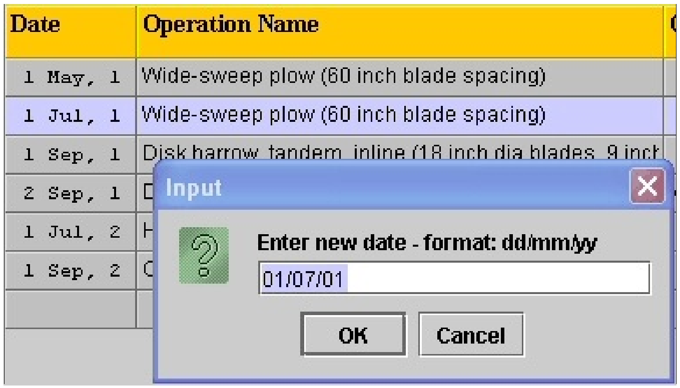
MCREW will not allow the user to save a WEPS management file without the operations being listed in date order. The user is given the options to automatically sort them, if they are not sorted during a management file save operation, or to go back to the editor and allow the user to correct the problem(s)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

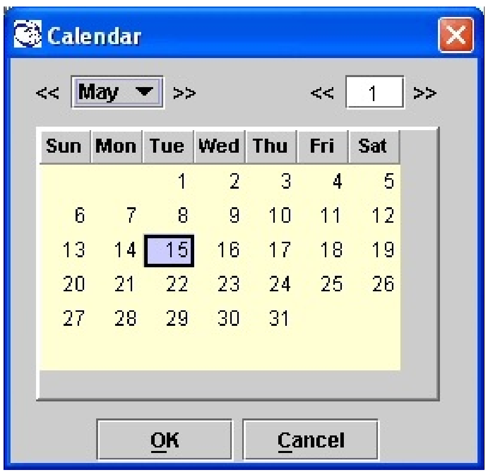
Date Column Editing Functions



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.



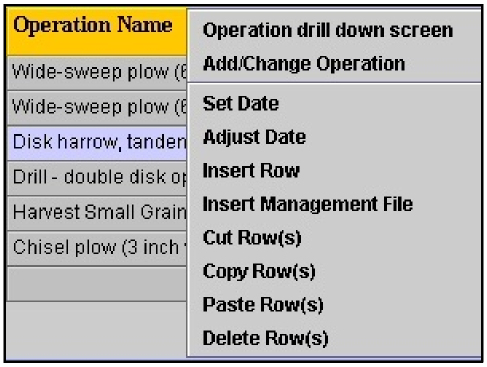
Selecting the **"Set Date"** option will display a dialog box that allows the user to type in a specific date (day/month/rotation year) for the selected operation row (highlighted in blue). The figure to the left shows an example of "**Set Date**" popup window.



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.

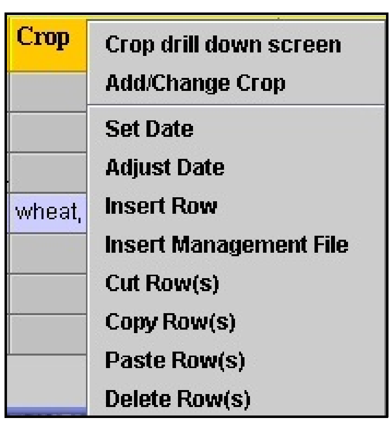
Operation Column Editing Functions



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 two items above the line (‘Operation drill down screen’ and ‘Add/Change Operation’) are 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. This is accomplished 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 "**Add/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 Column Editing Functions



Editing functions for the Crop 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 next.

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 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 "**Add/Change Crop**" menu option via the right mouse menu (described earlier under "Row Editing Functions"). Other crop 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.

Operation and Crop Dialog Drill-Down Screens

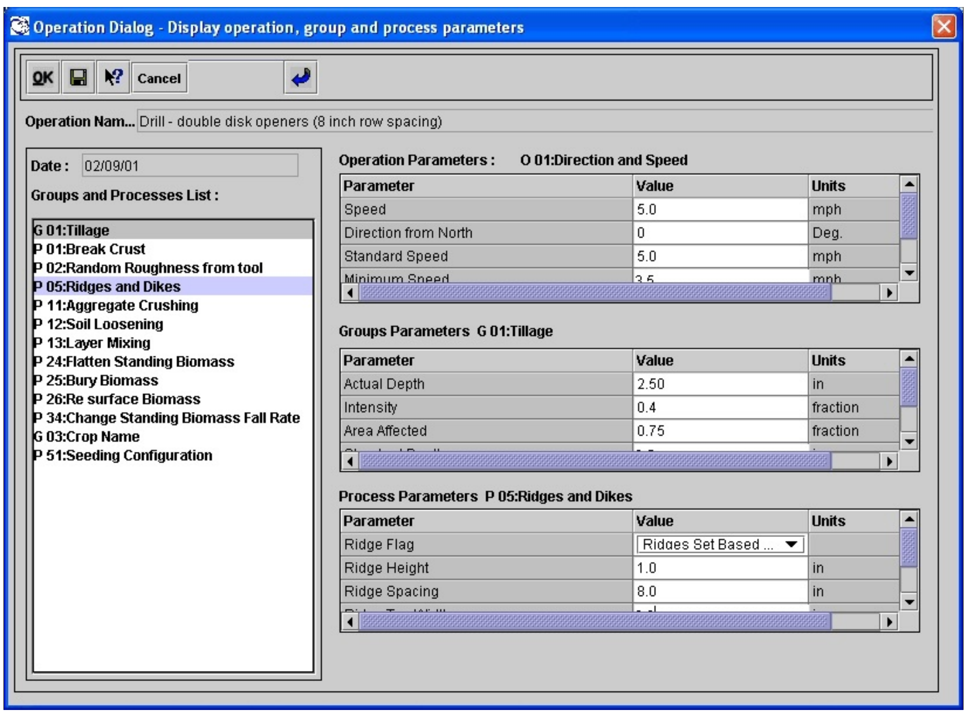


Figure 2.13. Example Operation Dialog drill-down screen.

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 2.13 and 2.15.

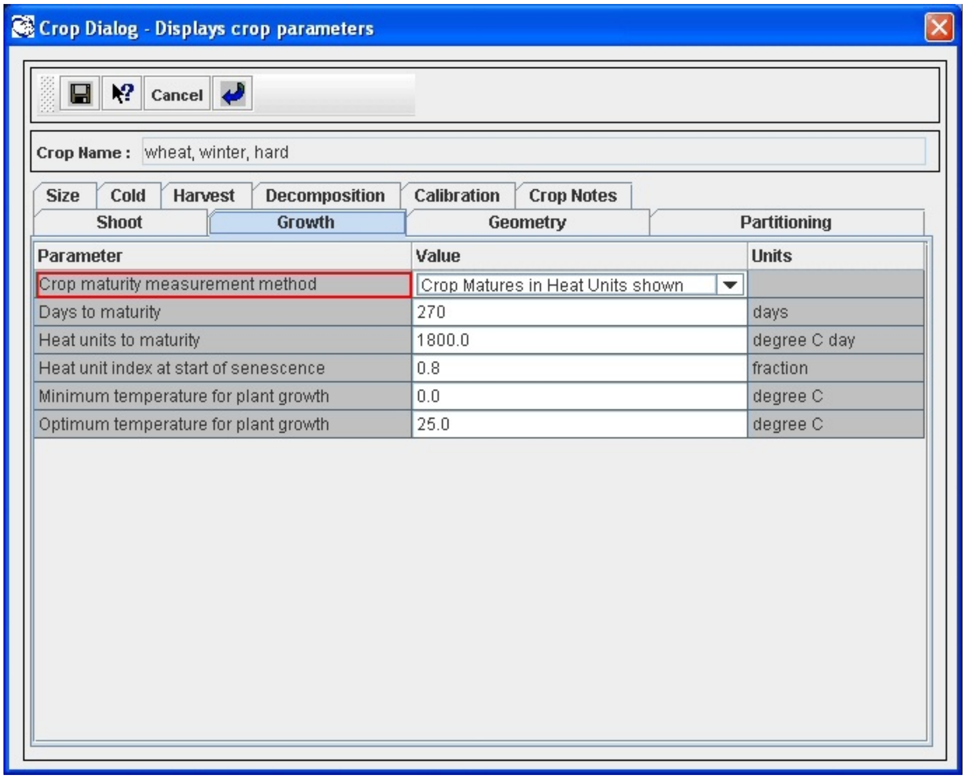


Figure 2.14. Example Crop Dialog drill-down screen.

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.

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. 2.15).

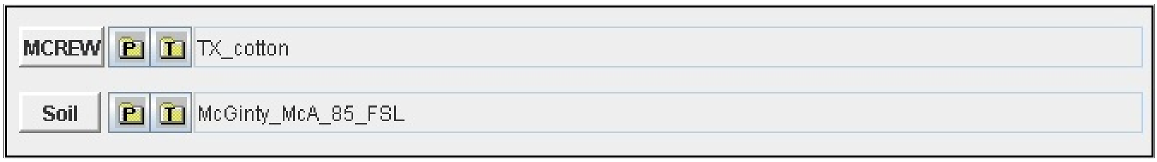


Figure 2.15. Bottom panel of the WEPS main screen with the Soil box on the bottom.

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.

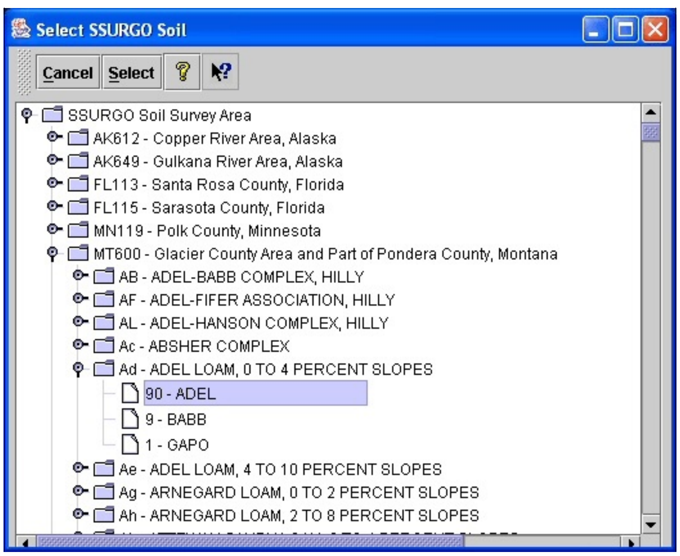


Figure 2.16. The 'Select SSURGO Soil' window.

Clicking on the **'Template'** folder opens a window titled '**Select SSURGO Soil**' (Fig. 2.16). 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 top 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. The '**Question**' button opens the general help system for WEPS. The '**Context Help**' button provides help for a particular item on the toolbar of the '**Select SSURGO Soil**' screen. Clicking the '**Context Help**' button and then clicking on an item on the toolbar displays a help screen for that item.

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. 2.17).

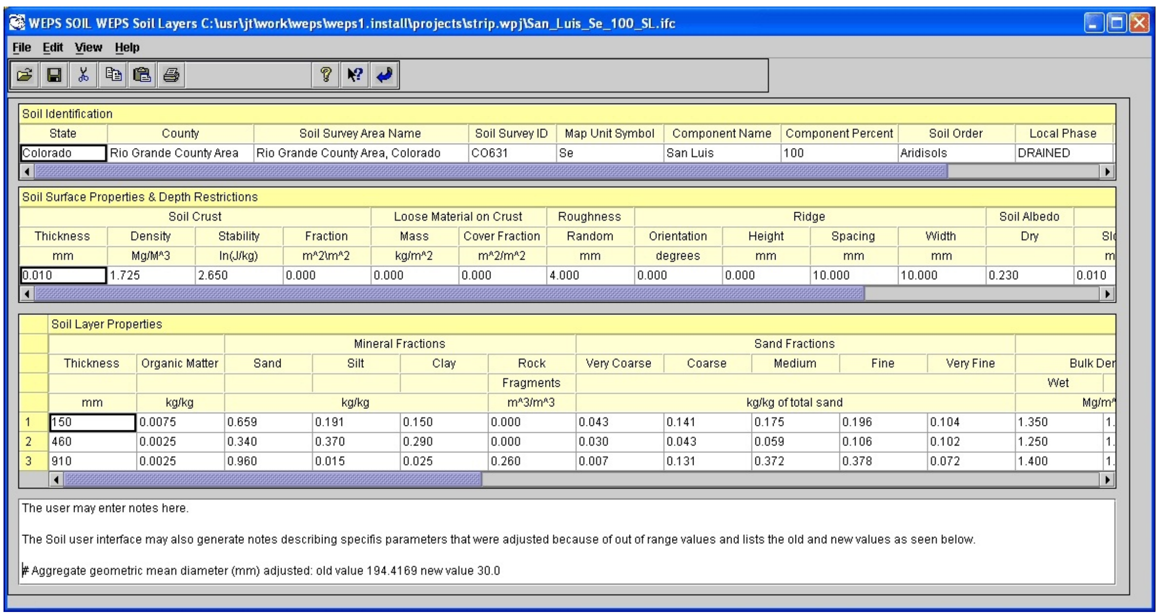


Figure 2.17. WEPS Soil User Interface screen.

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. 2.16) 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.

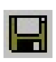
- **Help Topics** Ctrl-H
  Opens a window containing the Soil User Interface online help system.

- **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.

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 or 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. 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. 2.18). 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).

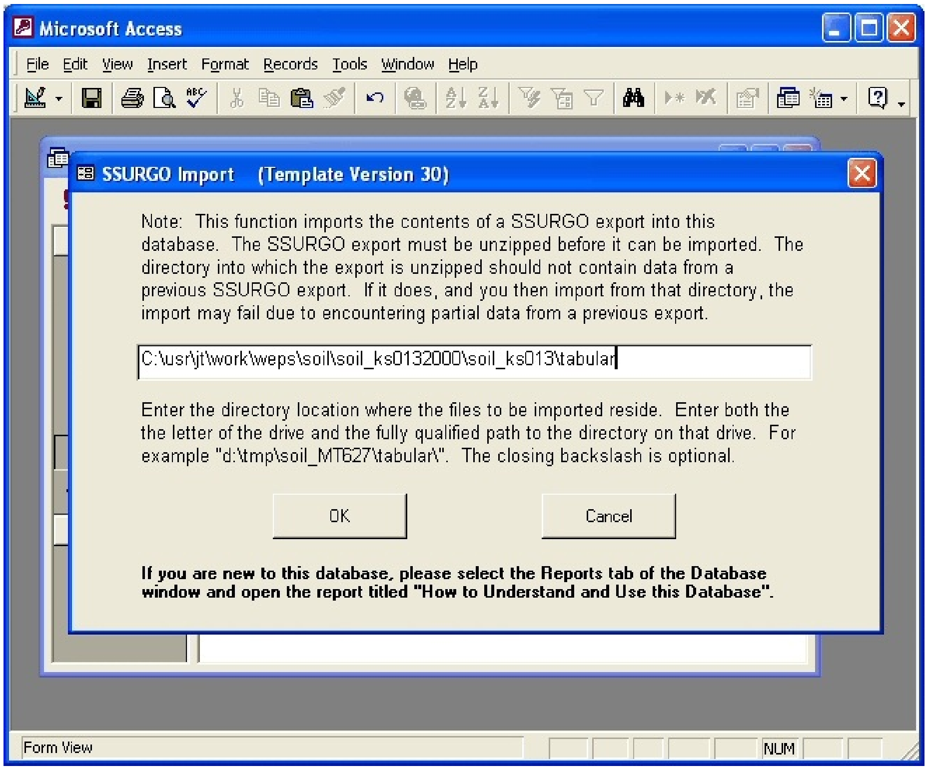


Figure 2.18. WEPS Soil User Interface screen.

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

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. 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.

Making a WEPS Run

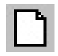
WEPS Projects

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, rename, 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

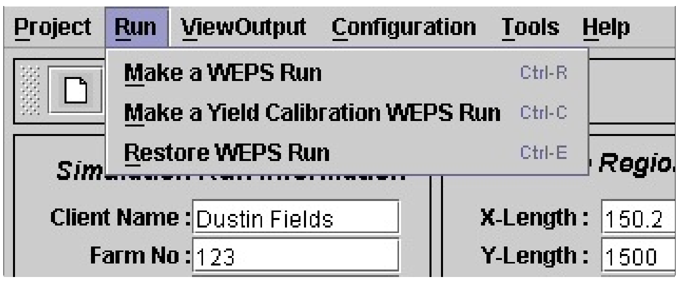


Figure 2.19. The run menu of the main screen.

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. 2.19), begins a WEPS simulation run. One can also click the run button on the button bar to begin a WEPS simulation run.

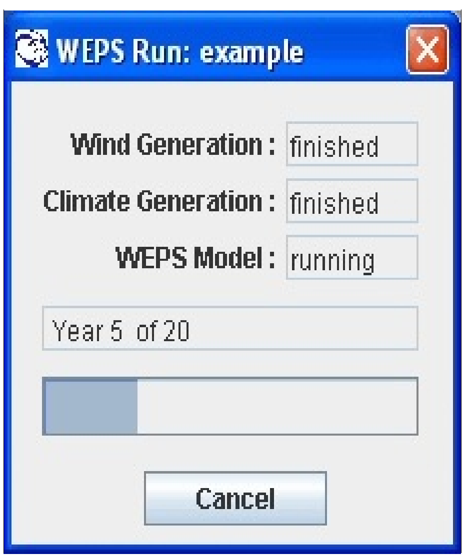


Figure 2.20. WEPS run status window.

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. 2.20). 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 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 setting the '**Yield Calib. flg**' column value to '**Select Crop for calibration .....**' for the respective row the crop planting operation is in. Be sure to "tab" or press "enter" after putting that number in the cell to 'register' the flag.

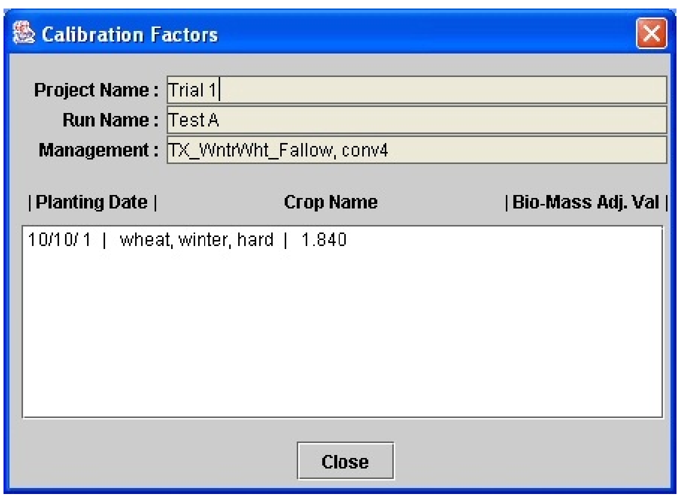
c) Fill in the desired '**Target Yield**' for the selected crop(s). Note that the units and the moisture content in which this yield will be reported are displayed. (Do NOT change the yield units or yield water content values. Doing so will not have the desired affect within the model at this time. In the future, we expect that this functionality might be made available to the end user). Again, be sure to "tab" or press "enter" after entering the desired target yield value into the cells.

NOTE: More than one crop can be selected for simultaneous yield calibration in a WEPS calibration run, but the algorithms used do not guarantee that a solution will be found when multiple crops are specified for calibration. In practice though, we have found it to work well in most situations.

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. 2.19). 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 must then enter these values back into the management file via MCREW and save the management file to make the calibration factors permanent. Remember to press the yield calibration button to display the extra crop calibration parameter columns. For each crop that had been "calibrated", enter the new values into the '**Biomass Adj. Factor**' column. The biomass adjustment factor determined for each crop is also written into the 'notes' file for the calibration run.

h) To save these changes into a "newly calibrated" crop record file, one must use the "drill-down" feature in the appropriate crop cell to display the list of crop parameters. The user can then save these parameter values to a new "crop record" file using the '**Save As**' function. Appropriately rename the newly calibrated crop record. Once saved, the crop record can be selected and inserted into any WEPS management file using MCREW.

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. 2.19). 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. 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. See the section of the WEPS User Manual titled '**WEPS Output**' for more detailed description of WEPS outputs.

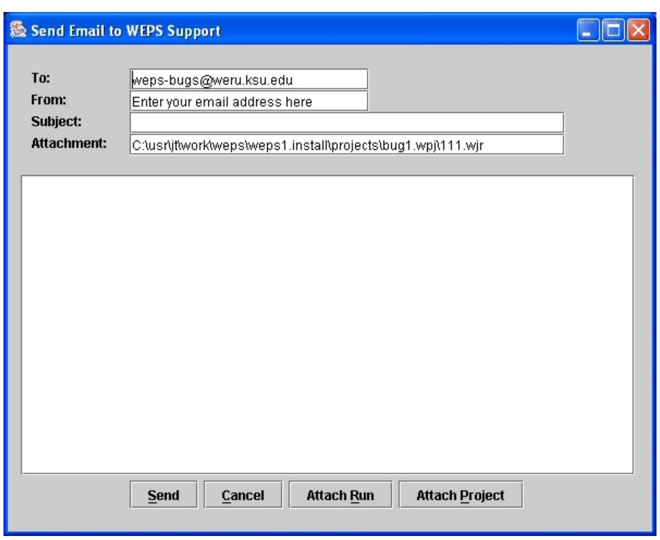


Figure 2.21. E-mail error report window.

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. 2.21). 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

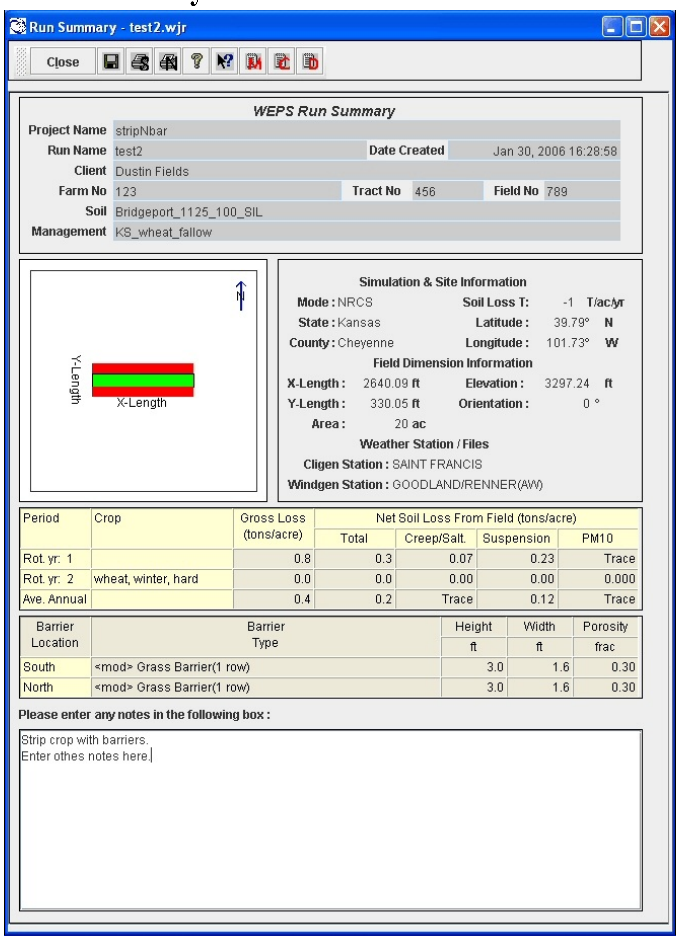


Figure 2.22. The WEPS Run Summary screen.

The Run Summary report screen (Fig. 2.22) 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

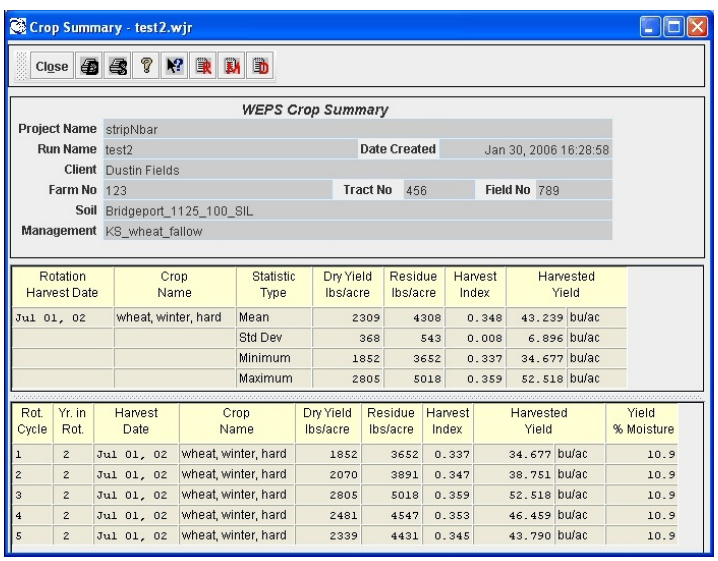


Figure 2.23. The WEPS Crop Summary screen.

The Crop Summary report screen (Fig. 2.24) 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

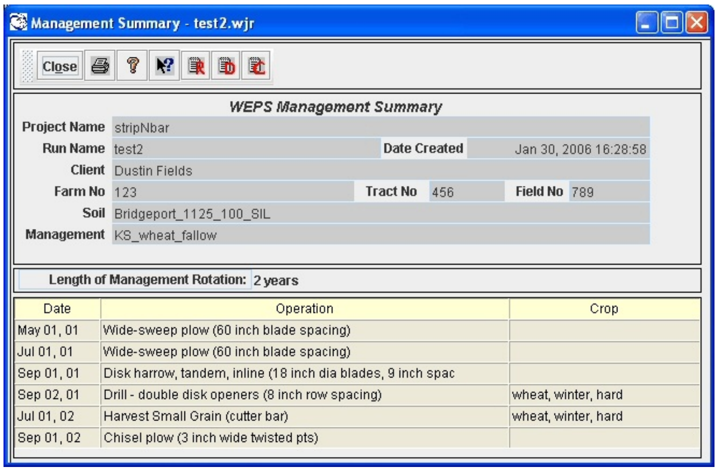


Figure 2.24. The WEPS Management Summary screen.

The Management Summary report screen (Fig. 2.24) 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

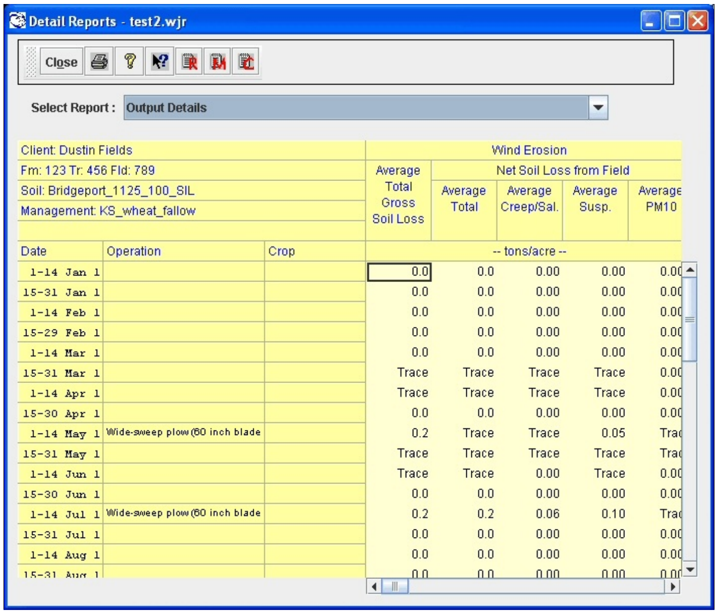


Figure 2.25. The WEPS Detailed Reports screen showing the drop down report list.

The Detail Reports screen (Fig. 2.26) 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 Rreport**' 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.

<u>Output Details</u>

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 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/Sal. - 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 Susp. - 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).

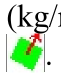
Average PM10 - The quantity of PM10 (particulate matter less than 10 microns) material leaving the field for the period, averaged across the field grid areas, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

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.

Saltation 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 ($KJ/m^2/day$).

Average Snow Cover > 20 mm - The total average fraction of time that snow cover on the field which is greater than 20 mm 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 & 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).

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).

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).

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 greater than 0.84 mm. Aggregates > 0.84 mm are generally considered to be non-erodible. This is the value at the period end, averaged over the simulation years in each rotation year.

Aggregate Stability	- The aggregate stability, 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.

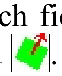
The last row in the output form contains the average annual values for the complete crop rotation.

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

<u>Field Loss (summary)</u>
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.

<u>Field Loss (details)</u>
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 (details)
The crop 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.

Residue (details)
The 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.

Biomass (details)
The 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.

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.

Debugging Reports

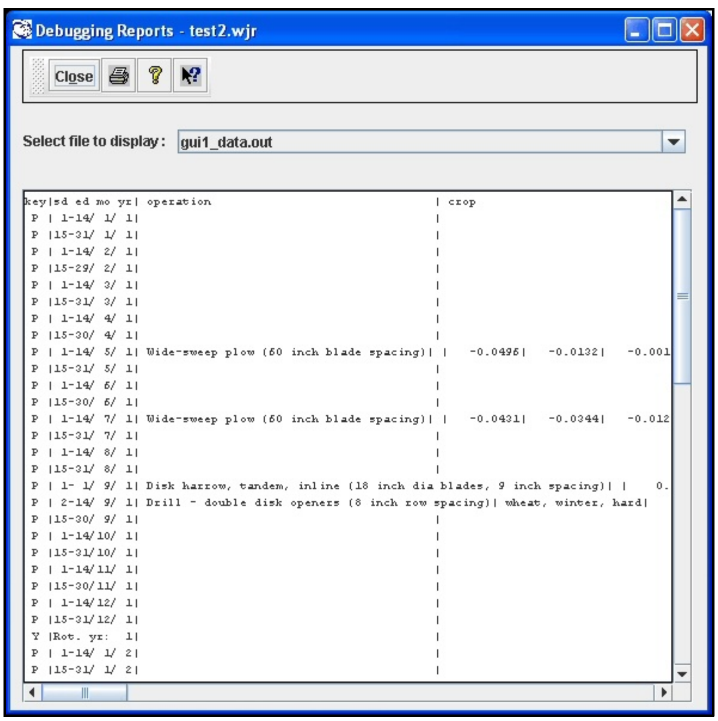


Figure 2.26. The WEPS Debugging Reports screen showing the drop down report list.

The Debugging Reports screen (Fig. 2.26) 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, 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. Because of runtime issues, it is recommended that, for early comparisons, no more than five rotations cycles be used for a simulation. This will allow relative soil loss values for comparisons. Once one or two scenarios are selected, more 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 following section outlines the content of the "Output Details" screen.

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 **rows** in the Output Details screen vary 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 first two weeks and the 15th to the last day of each month 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 which 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 which occurred on the specified date. It is the management operation or the date of operation which most users will modify to affect field conditions and thus wind erosion.

Crop

This column lists any crops planted on the date shown. Crop is obviously another choice which the land manager may change to control wind erosion.

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), 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.

Average Total Gross Soil Loss
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).

Net Soil Loss from Field
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. Total is the average total net loss from the field; Creep/Sal is the average creep plus saltation net loss from the field; Susp is the average suspension net loss from the field; and PM10 is the average PM10 net loss from the field.

Mass Passing Indicated Field Boundary
These columns  contain the mass per unit length of various sized material which 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 way wash the material in to 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 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 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.

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

Average Snow Cover
If the field is covered with snow, it will be 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), 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 soil

loss.

Oriented 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.

Random Roughness
This column contains soil surface random roughness which is 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 management operations are listed in Table 3.1. Photographs (Figs. 3.1 - 3.9) 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 greater than 0.84 mm in diameter are generally considered to be non-erodible. Dry stability is related to abrasion resistance where harder, more stable aggregates result in a lower erodibility of the soil.

Crust Cover
A soil crust will resist abrasion and erosion more than a loose finely divides soil surface. Generally, the more of the surface is covered by a crust, the lower the erosion that occurs. Crust are transient and generally represent a degraded soil quality and therefore should not be relied upon to control erosion by wind. However a high crust cover may explain a lower erosion amount that would normally be expected.

Table 3.1. Random roughness values for typical management operations based on a silt loam soil (Ag. Handbook 537).

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 3.1. Random roughness of 0.25 inches (6 mm).

Figure 3.2. Random roughness of 0.40 inches (10 mm).

Figure 3.3. Random roughness of 0.65 inches (17 mm).

Figure 3.4. Random roughness of 0.75 inches (19 mm).

Figure 3.5. Random roughness of 0.85 inches (22 mm).

Figure 3.6. Random roughness of 1.05 inches (27 mm).

Figure 3.7. Random roughness of 1.60 inches (41 mm).

Figure 3.8. Random roughness of 1.70 inches (43 mm).

Figure 3.9. 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.

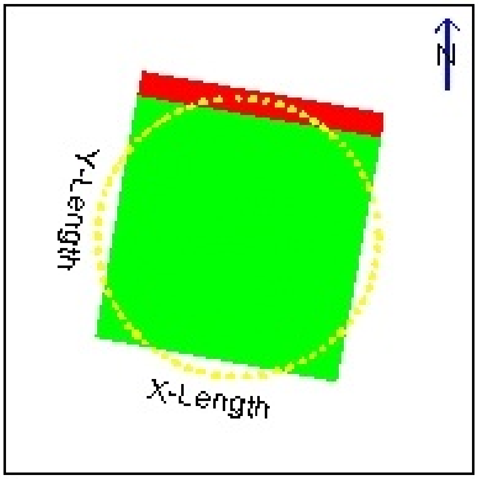


Figure 3.10. Example of using a square field shape to approximate a circle.

Circular Fields. A circular field can be simulated using a square field of equal area. Figure 3.10 illustrates how this would be visualized. Note that the yellow dashed circle is shown here to illustrate the circular field and cannot be placed over the field within the WEPS 1.0 interface. For such fields, barriers should be added and the field rotated to best simulate the actual field configuration.

Irregular Field Shapes. Other field shapes can also be simulated with WEPS 1.0. A half circle can be represented with a rectangle as illustrated in Figure 3.11. Figure 3.12 illustrates how an irregular field may be visualized for a field along a stream with filter strips along the North and East sides.

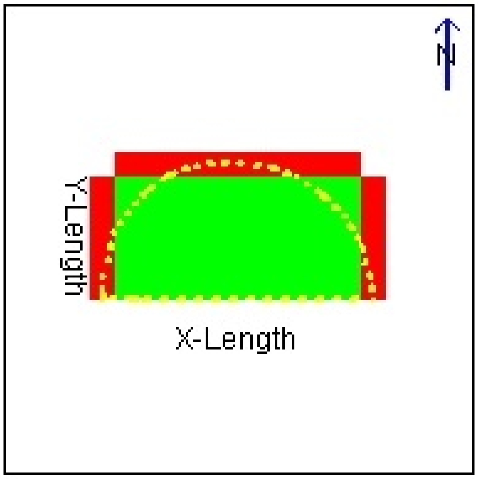


Figure 3.11. Example of using a rectangular field to simulate a half circle.

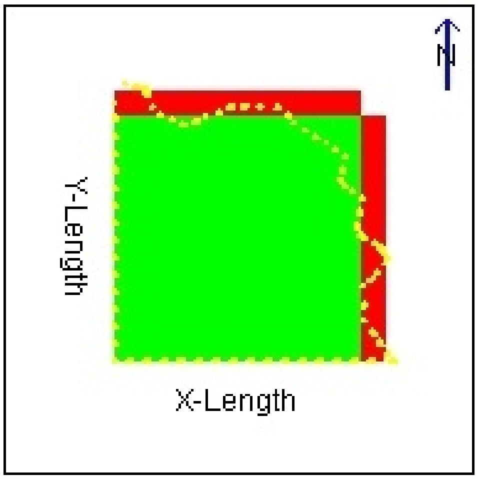


Figure 3.12. Example of using a square field to simulate a field with a stream with buffers along two sides.

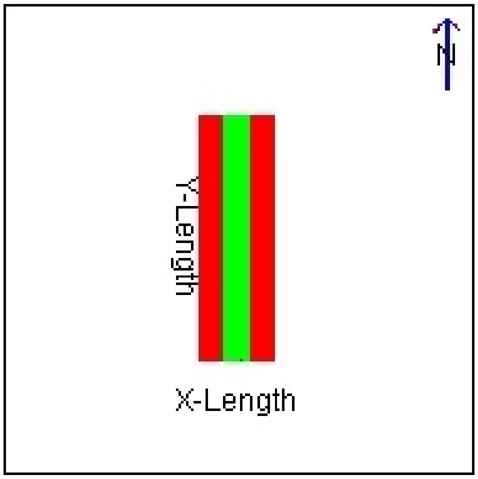


Figure 3.13. Example field layout for simulating strip cropping or grass barriers.

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. Ideally, a tract of land where strips are installed will be equally stripped, thus shorting the 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 "Field and 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 field borders (e.g., Northwest/Southeast). In other words, multiple tillage directions such as where the operator tills parallel to each border of the field in a spiraling pattern, or a circular tillage pattern, cannot be simulated with WEPS 1.0. Observing the effects that tillage direction may have for the particular simulation may illustrate the need to alter tillage directions in the actual field to control wind erosion.

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 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.

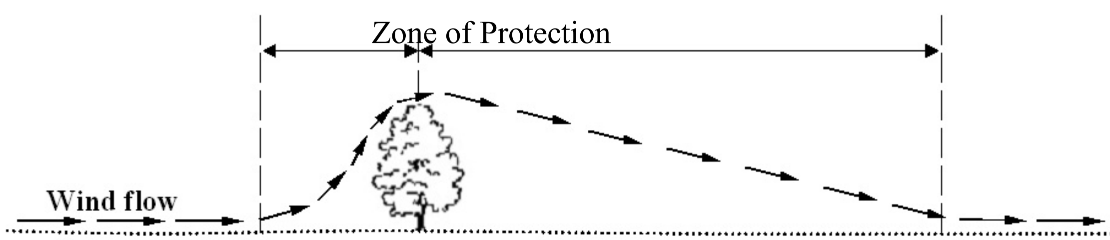


Figure 3.14. Diagram showing wind flow pattern over a barrier.

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. However, 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 below.

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, or for artificial barriers, 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.

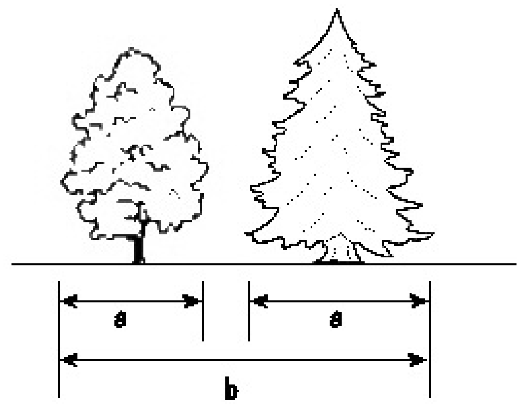


Figure 3.15. Barrier width for single (a) and multiple (b) row barriers.

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).

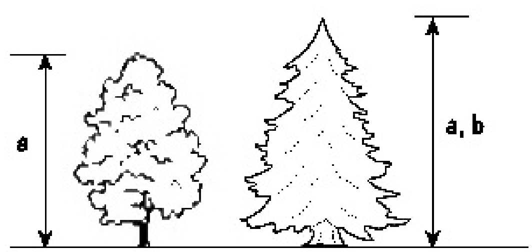


Figure 3.16. Barrier height for single (a) and multiple (b) row barriers.

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 percent of the total area (ie., (1.0 - silhouette area) x 100). WEPS 1.0 does not "grow" living barriers.

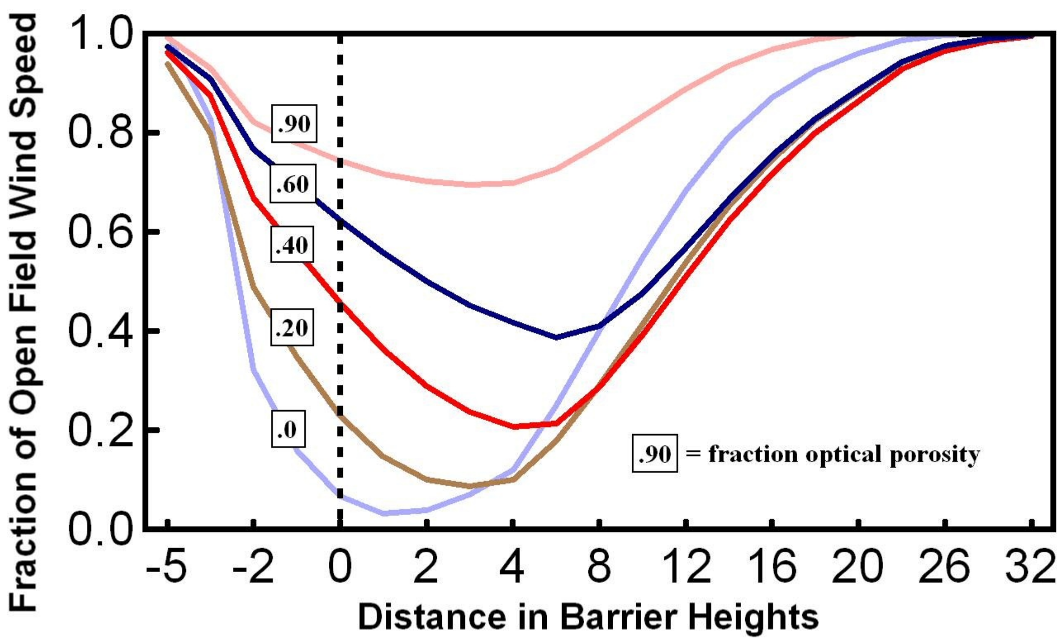


Figure 3.17. Effect of the fraction of optical porosity on near surface wind speed along the wind direction relative to barrier.

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.

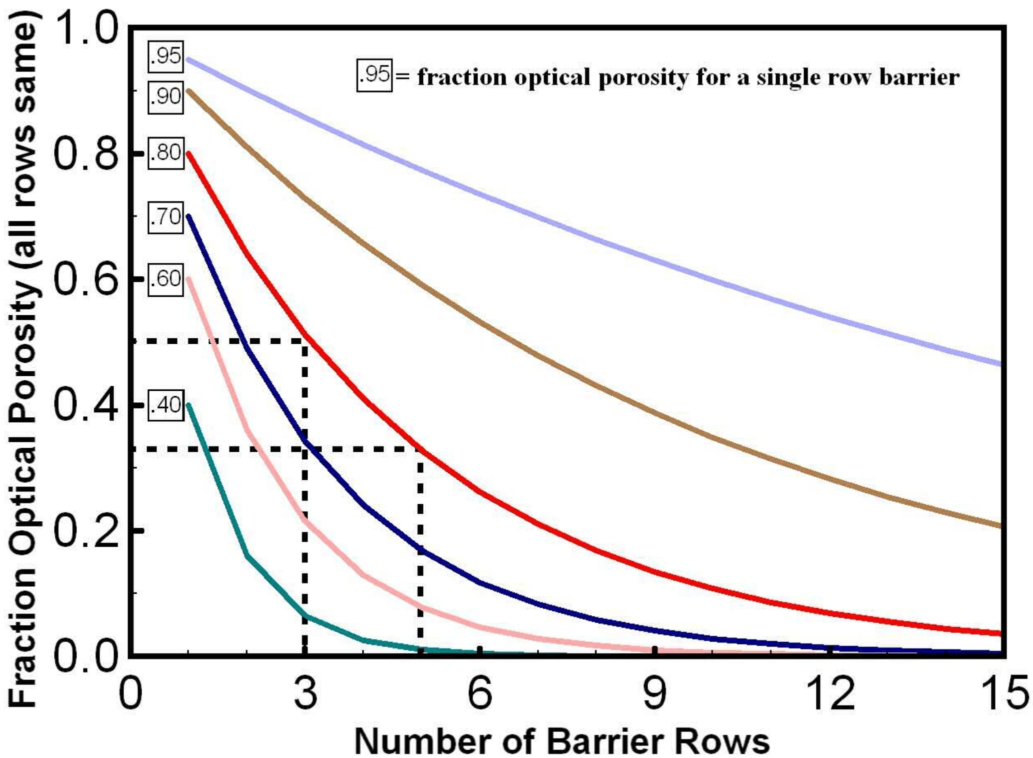


Figure 3.18. Effect of number of barrier rows on optical porosity where all barrier rows are the same.

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 while five rows of corn have an optical porosity of 0.33.

Exercises

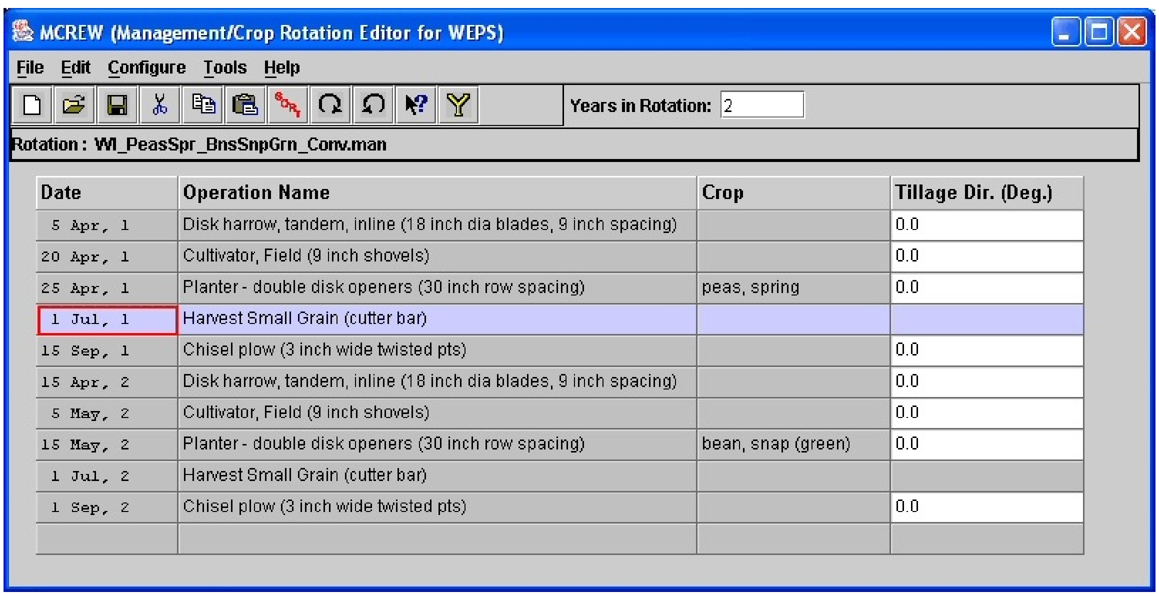
EVALUATING WIND EROSION PROBLEMS WITH WEPS

This is an example that we will use to evaluate a wind erosion problem in the Stevens Point area of central Wisconsin.

The scenario for the problem is:

- 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 **MfB-Mecan-100-LS**
- The original two year Cropping system is **Spring Peas** and **Snap Beans (green)**
- The field size is 2640' X2640', 160 acres
- The WEPS evaluation of the cropping system will be run for **20 rotation cycles**

Below (Fig. 3.19) is the two year rotation of Spring Peas and Snap Beans (green) including the dates and field operations. Following evaluation of the erosion rates on the two year rotation, it has been decided to set up a three year rotation to include early potatoes.

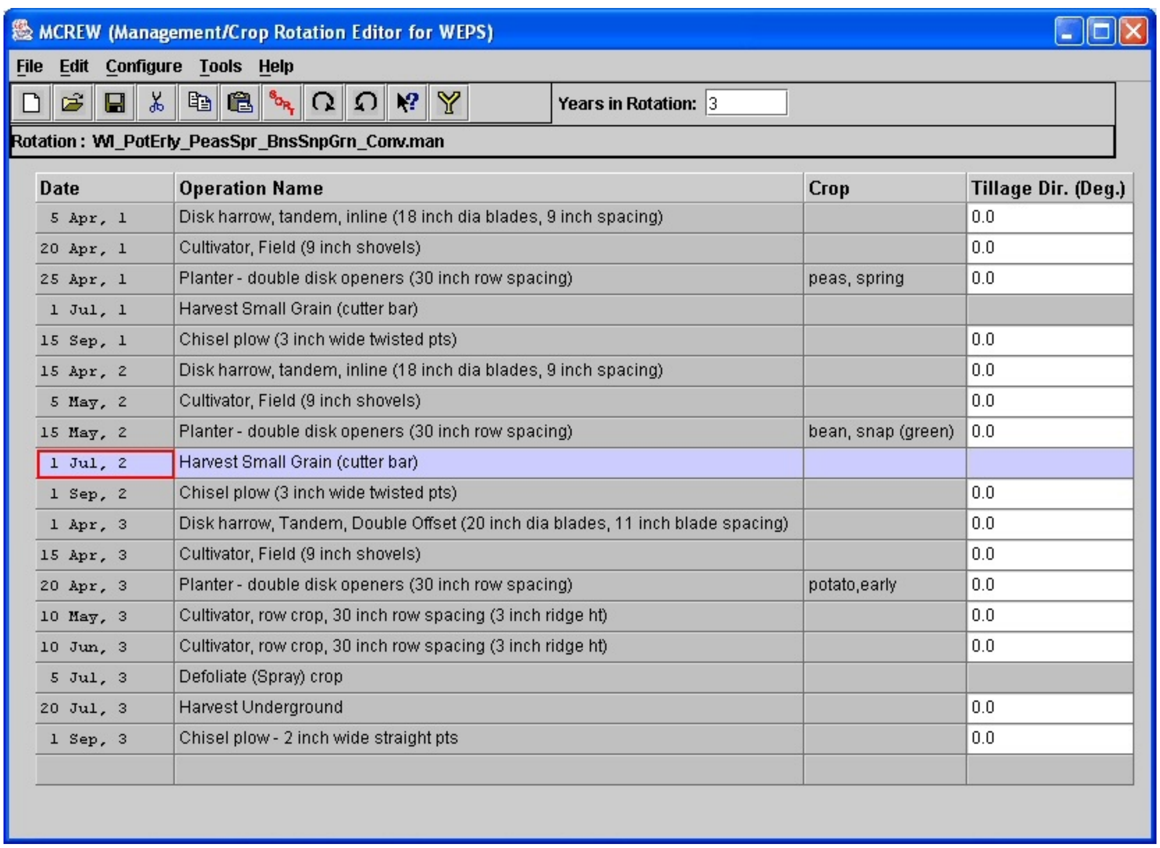


Date	Operation Name	Crop	Tillage Dir. (Deg.)
5 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
20 Apr, 1	Cultivator, Field (9 inch shovels)		0.0
25 Apr, 1	Planter - double disk openers (30 inch row spacing)	peas, spring	0.0
1 Jul, 1	Harvest Small Grain (cutter bar)		
15 Sep, 1	Chisel plow (3 inch wide twisted pts)		0.0
15 Apr, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
5 May, 2	Cultivator, Field (9 inch shovels)		0.0
15 May, 2	Planter - double disk openers (30 inch row spacing)	bean, snap (green)	0.0
1 Jul, 2	Harvest Small Grain (cutter bar)		
1 Sep, 2	Chisel plow (3 inch wide twisted pts)		0.0

Figure 3.19. A two year rotation of spring peas and snap beans (green).

When we expand the two year rotation to include Early Potatoes, we can add the operations, dates of operation, and the potato crop directly to the two year rotation or we can build a separate template for Early Potatoes and then insert the new template in the rotation. We recommend the option of building a separate template for Early Potatoes and then inserting it into the existing rotation. The new single year template for Early Potatoes begins when in MCREW by clicking on "File", then click on "New" and this will drop a clean MCREW screen down. With the clean MCREW screen we enter dates and operations as instructed in the section on MCREW. The single year cropping scenario for early Potatoes should be saved as a template. We will save it by clicking on "file" and then "save as a template". The list of management files will drop down and we will go to the window on the bottom of the list called "File name", remove the * and then type in the name single crop scenario we are saving. To finalize we click "Save" on the bottom right of the window. We now have a new single year template and will add it to our two year rotation.

Below (Fig. 3.20) is the three year rotation of Early Potatoes, Spring Peas, and Snap Beans (green) including the dates and field operations. Following evaluation of the erosion rates on the three year rotation, it has been decided to set up a four year rotation to include Sweet Corn.

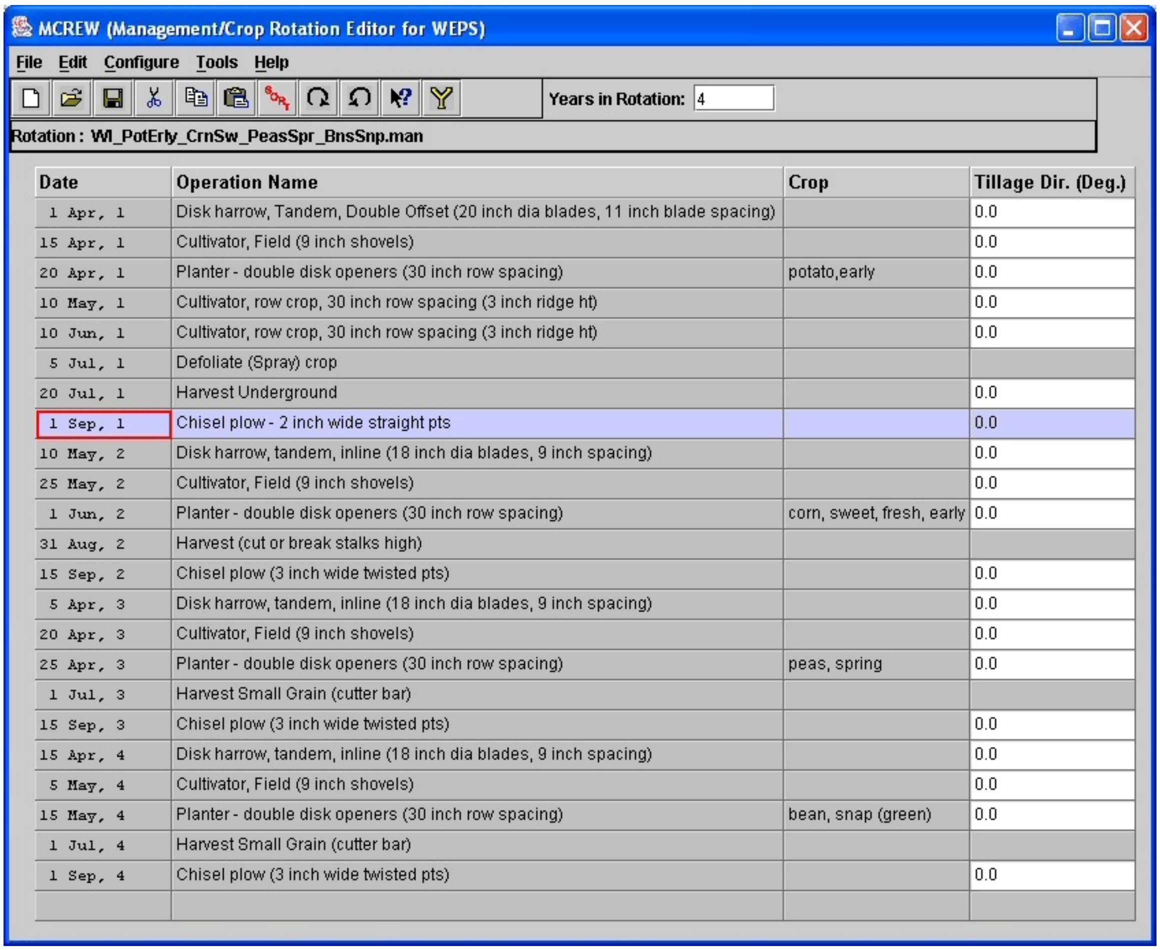


Date	Operation Name	Crop	Tillage Dir. (Deg.)
5 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
20 Apr, 1	Cultivator, Field (9 inch shovels)		0.0
25 Apr, 1	Planter - double disk openers (30 inch row spacing)	peas, spring	0.0
1 Jul, 1	Harvest Small Grain (cutter bar)		
15 Sep, 1	Chisel plow (3 inch wide twisted pts)		0.0
15 Apr, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
5 May, 2	Cultivator, Field (9 inch shovels)		0.0
15 May, 2	Planter - double disk openers (30 inch row spacing)	bean, snap (green)	0.0
1 Jul, 2	Harvest Small Grain (cutter bar)		
1 Sep, 2	Chisel plow (3 inch wide twisted pts)		0.0
1 Apr, 3	Disk harrow, Tandem, Double Offset (20 inch dia blades, 11 inch blade spacing)		0.0
15 Apr, 3	Cultivator, Field (9 inch shovels)		0.0
20 Apr, 3	Planter - double disk openers (30 inch row spacing)	potato,early	0.0
10 May, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
5 Jul, 3	Defoliate (Spray) crop		
20 Jul, 3	Harvest Underground		0.0
1 Sep, 3	Chisel plow - 2 inch wide straight pts		0.0

Figure 3.20. A three year rotation of early potatoes, spring peas, and snap beans (green).

When we expand the three year rotation to include Sweet Corn, we again, can add the operations, dates of operation, and the Sweet Corn crop directly to the three year rotation or we can build a separate template for Sweet Corn and insert the new template into the rotation. We again recommend the option of building a separate template for Sweet Corn and insert it into the existing rotation. Follow the same instruction used above for Early Potatoes to add Sweet Corn.

Below (Fig. 3.21) is the four year rotation of Early Potatoes, Sweet Corn, Spring Peas, and Snap Beans (green) including the dates and field operations. Following evaluation of the erosion rates on the four year rotation, it has been found acceptable.



Date	Operation Name	Crop	Tillage Dir. (Deg.)
1 Apr, 1	Disk harrow, Tandem, Double Offset (20 inch dia blades, 11 inch blade spacing)		0.0
15 Apr, 1	Cultivator, Field (9 inch shovels)		0.0
20 Apr, 1	Planter - double disk openers (30 inch row spacing)	potato,early	0.0
10 May, 1	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 1	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
5 Jul, 1	Defoliate (Spray) crop		
20 Jul, 1	Harvest Underground		0.0
1 Sep, 1	Chisel plow - 2 inch wide straight pts		0.0
10 May, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
25 May, 2	Cultivator, Field (9 inch shovels)		0.0
1 Jun, 2	Planter - double disk openers (30 inch row spacing)	corn, sweet, fresh, early	0.0
31 Aug, 2	Harvest (cut or break stalks high)		
15 Sep, 2	Chisel plow (3 inch wide twisted pts)		0.0
5 Apr, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
20 Apr, 3	Cultivator, Field (9 inch shovels)		0.0
25 Apr, 3	Planter - double disk openers (30 inch row spacing)	peas, spring	0.0
1 Jul, 3	Harvest Small Grain (cutter bar)		
15 Sep, 3	Chisel plow (3 inch wide twisted pts)		0.0
15 Apr, 4	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
5 May, 4	Cultivator, Field (9 inch shovels)		0.0
15 May, 4	Planter - double disk openers (30 inch row spacing)	bean, snap (green)	0.0
1 Jul, 4	Harvest Small Grain (cutter bar)		
1 Sep, 4	Chisel plow (3 inch wide twisted pts)		0.0

Figure 3.21. A four year rotation of early potatoes, sweet corn, spring peas, and snap beans (green).

EVALUATING WIND EROSION PROBLEMS WITH WEPS

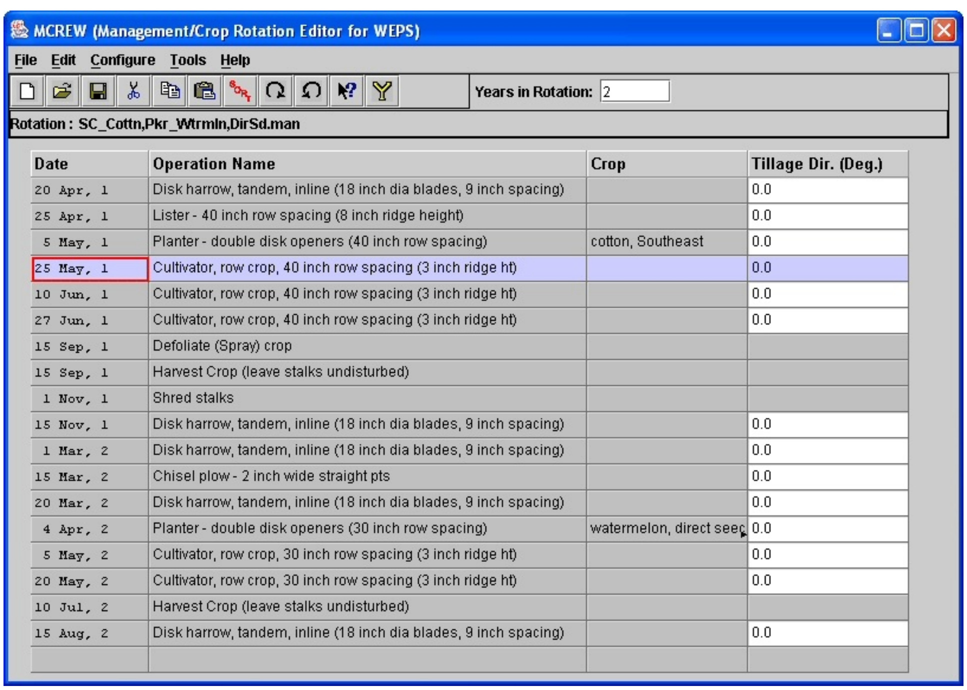
Following are some example problems that we will use to evaluate some wind erosion problems in Marlboro and Charleston Counties, South Carolina.

Situation 1 -2 year rotation developing into a 4 year rotation

The scenario for the problem is:

- The farm is located in **Marlboro County, South Carolina**
- The **Cligen** station is **McColl** and the **Windgen** station is **Florence Regional**
- The **Soil Map Unit** used in the evaluation is**: NoA - Norfolk LS**
- The original 2 year cropping system is **Cotton and Watermelons**
- The field size is: **x axis - 3500 ft.; y axis - 2000 ft.**
- Orientation of field operations and rows is **-45 degrees**
- Operations are performed parallel to x axis
- The early WEPS evaluations will be run for **5 rotation cycles**
- **Barriers** - Woods along the NW and NE field borders (trees w/leaves 4 rows)

Below is a 2 year rotation of **upland cotton** and **watermelons**, including the dates and field operations (Fig. 3.22).



Date	Operation Name	Crop	Tillage Dir. (Deg.)
20 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
25 Apr, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
5 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, Southeast	0.0
25 May, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
27 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Sep, 1	Defoliate (Spray) crop		
15 Sep, 1	Harvest Crop (leave stalks undisturbed)		
1 Nov, 1	Shred stalks		
15 Nov, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 2	Chisel plow - 2 inch wide straight pts		0.0
20 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
4 Apr, 2	Planter - double disk openers (30 inch row spacing)	watermelon, direct seec	0.0
5 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
20 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jul, 2	Harvest Crop (leave stalks undisturbed)		
15 Aug, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0

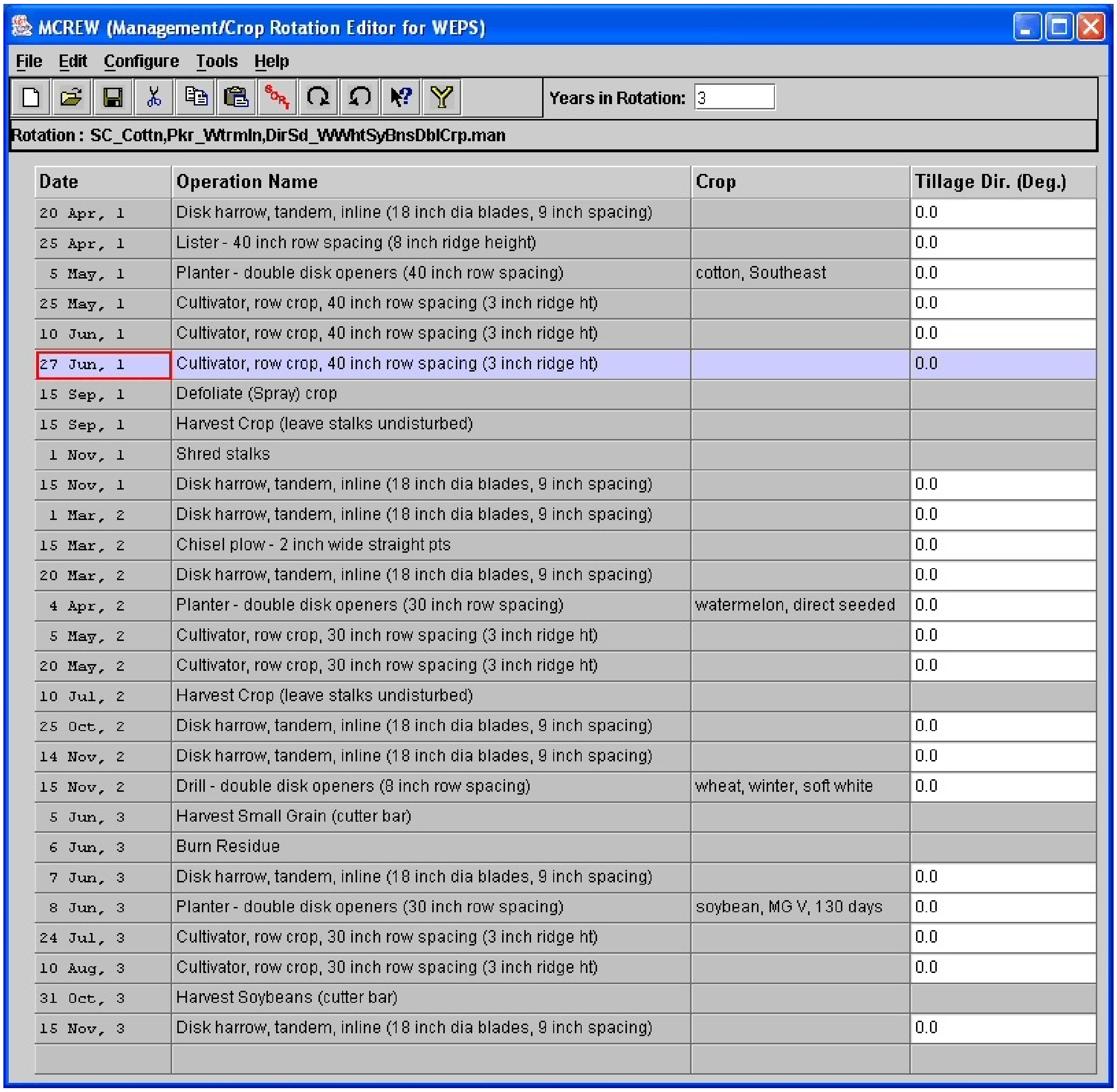
Figure 3.22. A two year rotation of upland cotton and watermelons.

***Cotton, Southeast** (700 lbs. lint yield)
04/20/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/25/01 Lister - 40 inch row spacing (8 inch ridge height)
05/05/01 Planter double disk openers (40 inch row spacing) – **Cotton, Southeast**
05/25/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/10/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/27/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
09/15/01 Defoliate (Spray) crop
09/15/01 Harvest crop (leave stalks undisturbed)
11/01/01 Shred stalks

*** Watermelons, direct seeded**
11/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/01/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/15/02 Chisel plow - 2 inch wide straight pts.
03/20/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/04/02 Planter - double disk openers (30 inch row spacing) - **Watermelon, direct seeded**
05/05/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
05/20/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
07/10/02 Harvest crop (leave stalks undisturbed)
08/15/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

When we expand the 2 year rotation to include winter wheat /soybeans (double cropped), we can add the operations, dates of operation, and the crops winter wheat /soybeans directly to the 2 year rotation or we can build a separate template for winter wheat /soybeans (double cropped). The new template can then be inserted into the rotation. We recommend the option of building the separate template for winter wheat /soybeans (double cropped) and the template will then be available the next time you are building a rotation that includes that crop.

Below is the 3 year rotation of Cotton, picker; Watermelons; and winter wheat /soybeans (double cropped), including the field operations and the dates they were performed (Fig. 3.23).



Date	Operation Name	Crop	Tillage Dir. (Deg.)
20 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
25 Apr, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
5 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, Southeast	0.0
25 May, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
27 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Sep, 1	Defoliate (Spray) crop		
15 Sep, 1	Harvest Crop (leave stalks undisturbed)		
1 Nov, 1	Shred stalks		
15 Nov, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 2	Chisel plow - 2 inch wide straight pts		0.0
20 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
4 Apr, 2	Planter - double disk openers (30 inch row spacing)	watermelon, direct seeded	0.0
5 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
20 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jul, 2	Harvest Crop (leave stalks undisturbed)		
25 Oct, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
14 Nov, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Nov, 2	Drill - double disk openers (8 inch row spacing)	wheat, winter, soft white	0.0
5 Jun, 3	Harvest Small Grain (cutter bar)		
6 Jun, 3	Burn Residue		
7 Jun, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
8 Jun, 3	Planter - double disk openers (30 inch row spacing)	soybean, MG V, 130 days	0.0
24 Jul, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Aug, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
31 Oct, 3	Harvest Soybeans (cutter bar)		
15 Nov, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0

Figure 3.23. A three year rotation of picker cotton, watermelons, and 130 day corn.

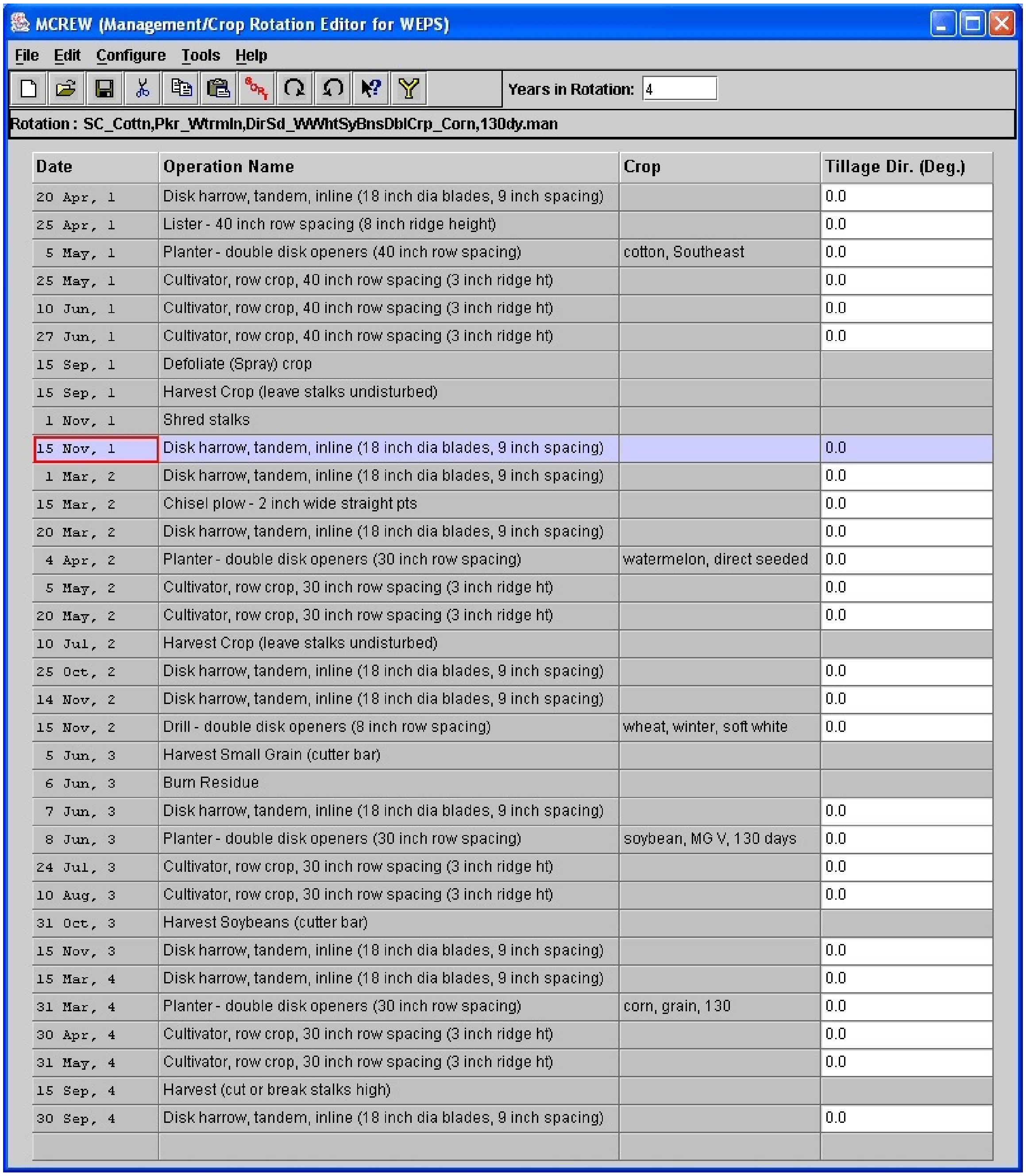
***Cotton, Southeast** (700 lbs. lint yield)
04/20/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/25/01 Lister - 40 inch row spacing (8 inch ridge height)
05/05/01 Planter double disk openers (40 inch row spacing) – **Cotton, Southeast**
05/25/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/10/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/27/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
09/15/01 Defoliate (Spray) crop
09/15/01 Harvest crop (leave stalks undisturbed)
11/01/01 Shred stalks

*** Watermelons, direct seeded**
11/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/01/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/15/02 Chisel plow - 2 inch wide straight pts.
03/20/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/04/02 Planter - double disk openers (30 inch row spacing) - **Watermelon, direct seeded**
05/05/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
05/20/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
07/10/02 Harvest crop (leave stalks undisturbed)

***Wheat, winter, soft white**
10/25/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
11/14/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
11/15/02 Drill - double disk openers (8 inch row spacing) – **wheat, winter, soft white**
06/05/03 Harvest Small Grain (cutter bar)
06/06/03 Burn residue (approximately 800 lbs of residue/acre left on surface)

***Soybeans**
06/07/03 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
06/08/03 Plant, double disk openers (30 inch row spacing) - **soybean, MG V, 130 days**
07/24/03 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
08/10/03 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
10/31/03 Harvest Soybeans (cutter bar)
11/20/03 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

Below is the 4 year rotation of picker cotton, watermelons, wheat-soybeans (double cropped); and corn, 130 day; including the field operations and the dates they were performed (Fig. 3.24).



Date	Operation Name	Crop	Tillage Dir. (Deg.)
20 Apr, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
25 Apr, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
5 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, Southeast	0.0
25 May, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
10 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
27 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Sep, 1	Defoliate (Spray) crop		
15 Sep, 1	Harvest Crop (leave stalks undisturbed)		
1 Nov, 1	Shred stalks		
15 Nov, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 2	Chisel plow - 2 inch wide straight pts		0.0
20 Mar, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
4 Apr, 2	Planter - double disk openers (30 inch row spacing)	watermelon, direct seeded	0.0
5 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
20 May, 2	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Jul, 2	Harvest Crop (leave stalks undisturbed)		
25 Oct, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
14 Nov, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Nov, 2	Drill - double disk openers (8 inch row spacing)	wheat, winter, soft white	0.0
5 Jun, 3	Harvest Small Grain (cutter bar)		
6 Jun, 3	Burn Residue		
7 Jun, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
8 Jun, 3	Planter - double disk openers (30 inch row spacing)	soybean, MG V, 130 days	0.0
24 Jul, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
10 Aug, 3	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
31 Oct, 3	Harvest Soybeans (cutter bar)		
15 Nov, 3	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 4	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
31 Mar, 4	Planter - double disk openers (30 inch row spacing)	corn, grain, 130	0.0
30 Apr, 4	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
31 May, 4	Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)		0.0
15 Sep, 4	Harvest (cut or break stalks high)		
30 Sep, 4	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0

Figure 3.24. A four year rotation of picker cotton, watermelons, wheat-soybeans (double cropped), and corn, 130 day.

***Cotton, Southeast** (700 lbs. lint yield)
04/20/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/25/01 Lister - 40 inch row spacing (8 inch ridge height)
05/05/01 Planter double disk openers (40 inch row spacing) – **Cotton, Southeast**
05/25/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/10/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/27/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
09/15/01 Defoliate (Spray) crop
09/15/01 Harvest crop (leave stalks undisturbed)
11/01/01 Shred stalks

*** Watermelons, direct seeded**
11/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/01/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/15/02 Chisel plow - 2 inch wide straight pts.
03/20/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/04/02 Planter - double disk openers (30 inch row spacing) - **Watermelon, direct seeded**
05/05/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
05/20/02 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
07/10/02 Harvest crop (leave stalks undisturbed)

***Wheat, winter, soft white**
10/25/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
11/14/02 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
11/15/02 Drill - double disk openers (8 inch row spacing) – **wheat, winter, soft white**
06/05/03 Harvest Small Grain (cutter bar)
06/06/03 Burn residue (approximately 800 lbs of residue/acre left on surface)

***Soybeans**
06/07/03 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
06/08/03 Plant, double disk openers (30 inch row spacing) - **soybean, MG V, 130 days**
07/24/03 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
08/10/03 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
10/31/03 Harvest Soybeans (cutter bar)
11/20/03 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

***Corn, 130 day**
03/15/04 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/01/04 Plant, double disk openers (30 inch row spacing) - **corn, grain, 130**
05/01/04 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)

05/21/04 Cultivator, row crop, 30 inch row spacing (3 inch ridge ht)
09/15/04 Harvest (cut or break stalks high)
10/15/04 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

<u>Situation 2</u> - Continuous Tomatoes

This is another example problem that we will use to evaluate a wind erosion problem in Charleston County, SC.

The scenario for the problem is:

- The farm is located in **Charleston County, SC**
- The **Cligen station is Charleston** and the **Windgen station is Charleston**
- The **Soil Map Unit** used in the evaluation is: **NoA - Norfolk LS**
- The continuous cropping system is **Tomatoes**
- The **field size** is: x axis - 2000 ft.; y axis - 1500 ft.
- Orientation of field operations and rows is **-45 degrees**
- Operations are performed parallel to x axis
- The early WEPS evaluations will be run for **5 rotation cycles**
- **Barriers** - Woods along the NW and NE field borders (trees w/leaves 4 rows)

Below is the 1 year rotation of Tomatoes, including the dates and field operations (Fig. 3.25).

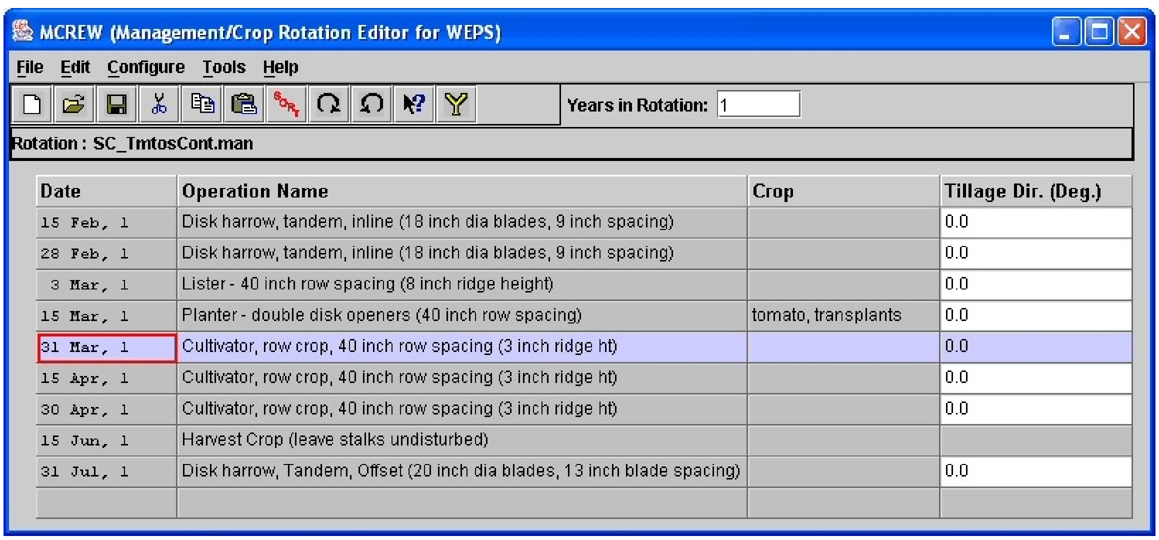


Figure 3.25. A one year rotation of tomatoes.

***Tomatoes**
02/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/01/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
03/03/01 Lister - 48 inch row spacing (8 inch ridge height)
03/12/01 transplant - **tomato, transplants**
04/01/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)

04/15/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
05/01/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/15/01 Harvest crop (leave stalks undisturbed)
07/25/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

Situation 3 - Continuous Cotton

This is an example problem that we will use to evaluate a wind erosion problem in Marlboro County, SC.

The scenario for the problem is:

- The farm is located in **Marlboro County, SC**
- The **Cligen station is McColl** and the **Windgen station is Florence**
- The **Soil Map Unit** used in the evaluation is: **FaB - Faceville LS**
- The continuous cropping system is **Cotton, picker**
- The **field size** is: x axis - 3500 ft.; y axis - 2000 ft.
- Orientation of field operations and rows is **-45 degrees**
- Operations are performed parallel to x axis
- The early WEPS evaluations will be run for **5 rotation cycles**
- **Barriers** - Woods along the NW and NE field borders (trees w/leaves 4 rows)

Below is the 1 year rotation of **Cotton, Picker** including the dates and field operations (Fig. 3.26).

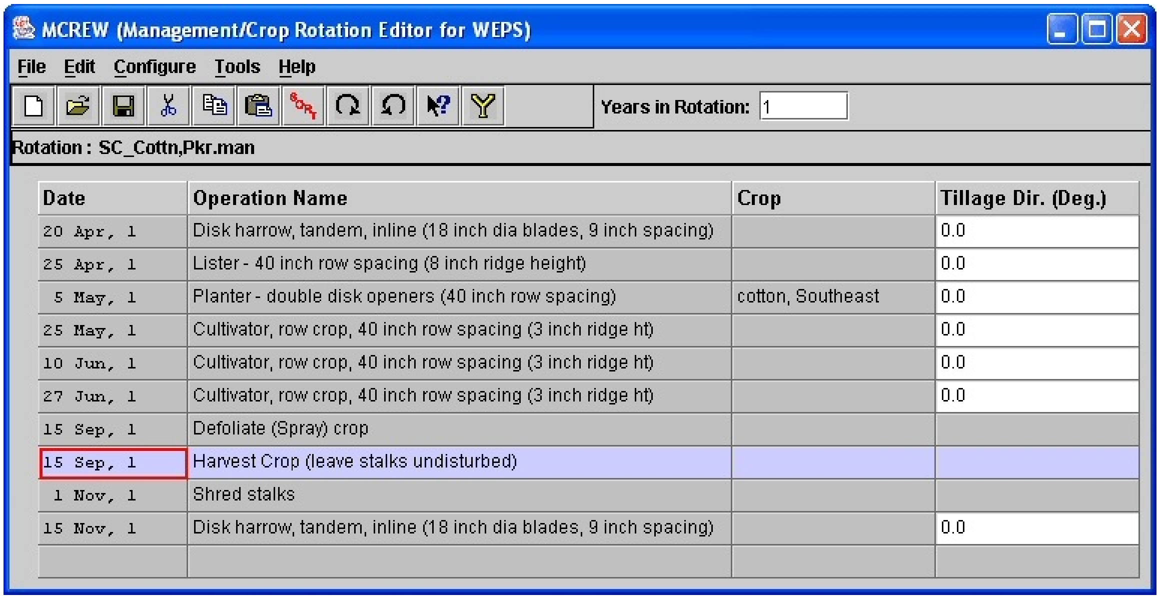


Figure 3.26. A one year rotation of picker cotton.

***Cotton, Southeast** (700 lbs. lint yield)
04/20/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)
04/25/01 Lister - 40 inch row spacing (8 inch ridge height)
05/05/01 Planter double disk openers (40 inch row spacing) – **Cotton, Southeast**
05/25/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/10/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
06/27/01 Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)
09/15/01 Defoliate (Spray) crop
09/15/01 Harvest crop (leave stalks undisturbed)
11/01/01 Shred stalks
11/15/01 Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)

EVALUATING WIND EROSION PROBLEMS WITH WEPS

Following are some example problems that we will use to evaluate some wind erosion problems in Haakon County, South Dakota.

<u>Situation 1</u> -2 year rotation

The scenario for the problem is:
- The farm is located in **Haakon County, South Dakota**
- The **Cligen** station is **Milesville** and the **Windgen** station is **Pierre Municipal**
- The **Soil Map Unit** used in the evaluation is**: Craft Cv 85 VFSL**
- The original 2 year cropping system is **Winter Wheat-Fallow**
- The field size is: **x axis - 2600 ft.; y axis - 2600 ft.**
- Orientation of field operations and rows is – **North (0 or 360 degrees)**
- Operations are performed parallel to x axis
- The early WEPS evaluations will be run for **5 rotation cycles**
- Barriers - None

Below is the 2 year rotation of **Winter Wheat** and **Fallow**, including the dates and field operations (Fig. 3.27).

*__Winter Wheat__ (32 bu. yield) – **Fallow** (Conventional)

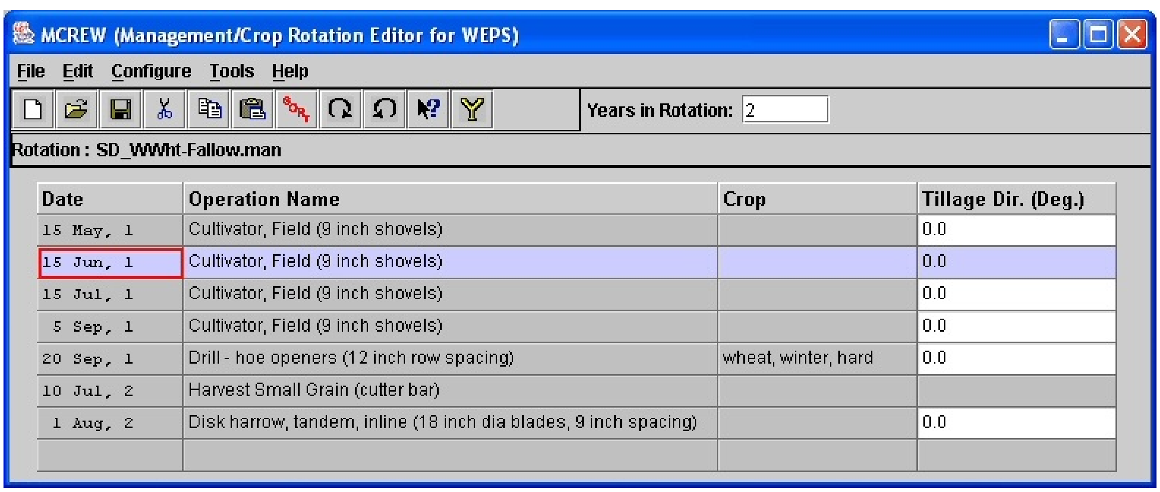
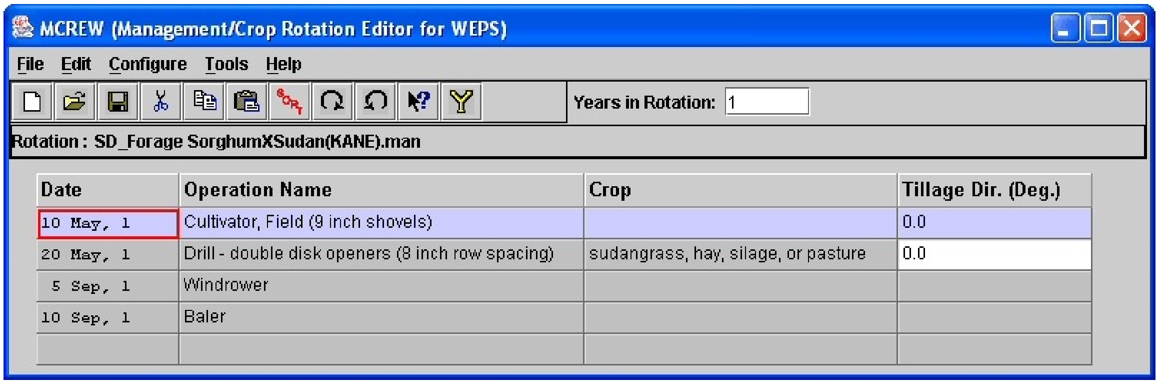


Figure 3.27. A two year rotation of winter wheat and fallow.

When we expand the 2 year rotation to include Forage Sorghum/Sudan Grass Cross (Kane) (Fig. 3.28), we can add the operations, dates of operation, and the Kane crop directly to the

2 year rotation or we can build a separate template for Kane. The new template can then be inserted into the rotation. We recommend the option of building the separate template for Kane and the template will then be available the next time you are building a rotation that includes that crop.

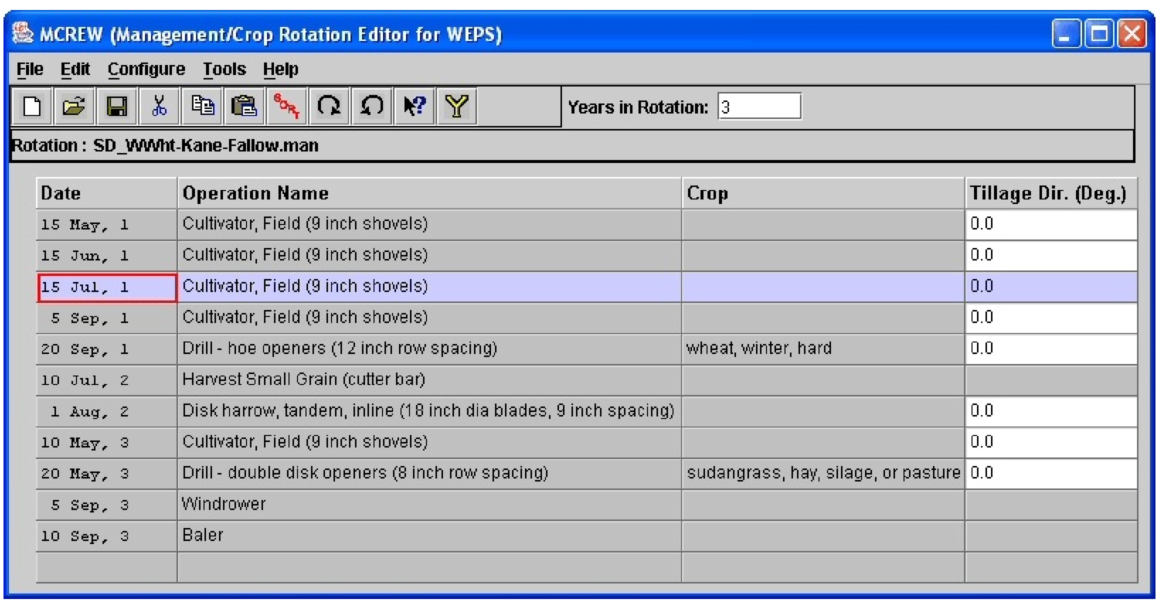


Date	Operation Name	Crop	Tillage Dir. (Deg.)
10 May, 1	Cultivator, Field (9 inch shovels)		0.0
20 May, 1	Drill - double disk openers (8 inch row spacing)	sudangrass, hay, silage, or pasture	0.0
5 Sep, 1	Windrower		
10 Sep, 1	Baler		

Figure 3.28. A one year rotation of forage sorghum/Sudan grass cross (kane).

Below is the 3 year rotation of Winter Wheat; Fallow; and Kane, including the field operations and the dates they were performed (Fig. 3.29).

***Winter Wheat** (32 bu. yield) – **Fallow** (Conventional) and **Kane** (~ 6000 lbs.)



Date	Operation Name	Crop	Tillage Dir. (Deg.)
15 May, 1	Cultivator, Field (9 inch shovels)		0.0
15 Jun, 1	Cultivator, Field (9 inch shovels)		0.0
15 Jul, 1	Cultivator, Field (9 inch shovels)		0.0
5 Sep, 1	Cultivator, Field (9 inch shovels)		0.0
20 Sep, 1	Drill - hoe openers (12 inch row spacing)	wheat, winter, hard	0.0
10 Jul, 2	Harvest Small Grain (cutter bar)		
1 Aug, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
10 May, 3	Cultivator, Field (9 inch shovels)		0.0
20 May, 3	Drill - double disk openers (8 inch row spacing)	sudangrass, hay, silage, or pasture	0.0
5 Sep, 3	Windrower		
10 Sep, 3	Baler		

Figure 3.29. A three year rotation of winter wheat, fallow, and kane.

EVALUATING WIND EROSION PROBLEMS WITH WEPS

Following are some example management scenarios that we will use to evaluate a wind erosion problem in the Northwest area of Texas.

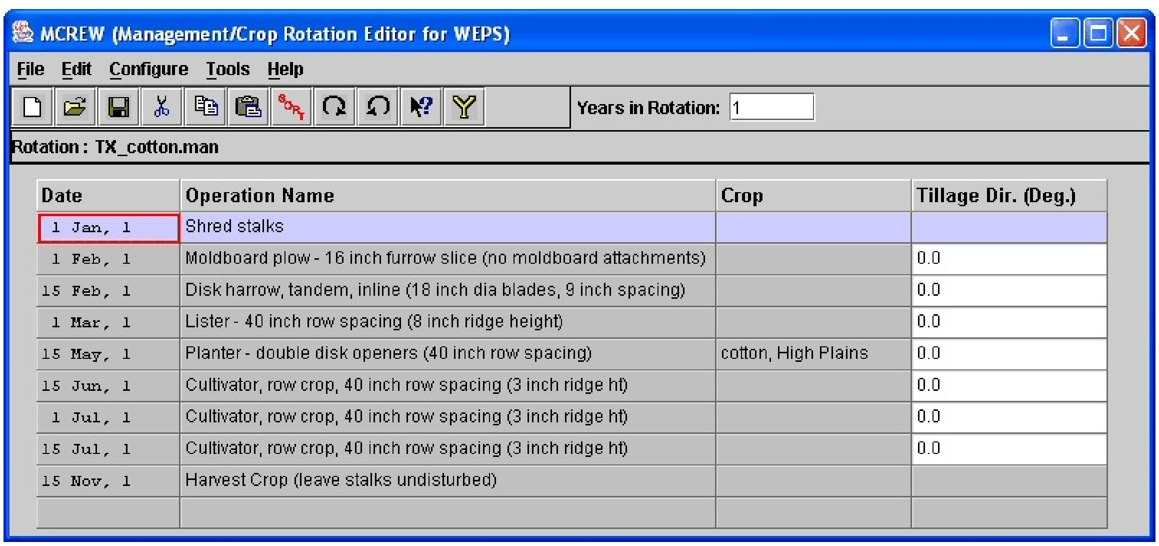
<u>Situation 1</u> – Continuos Cotton rotation

The management scenario to be evaluated is:

- The **farm** is located in **Lubbock County, Texas**
- The **Cligen Station** is **Lubbock** and the **Windgen Station** is **Lubbock**
- The **Soil Map Unit** used in the evaluation is **Amarillo_4_100_LFS**
- The original Cropping system is **Continuos Cotton, stripper**
- The **field size** is 2640' X 2640' (160 acres)
- The WEPS evaluation of the cropping system will be run for **5 rotation cycles**

Below is the **Continuos Cotton** rotation including the **dates** and **field operations** (Fig. 3.30).

Cotton (Yield of ½ Bale)



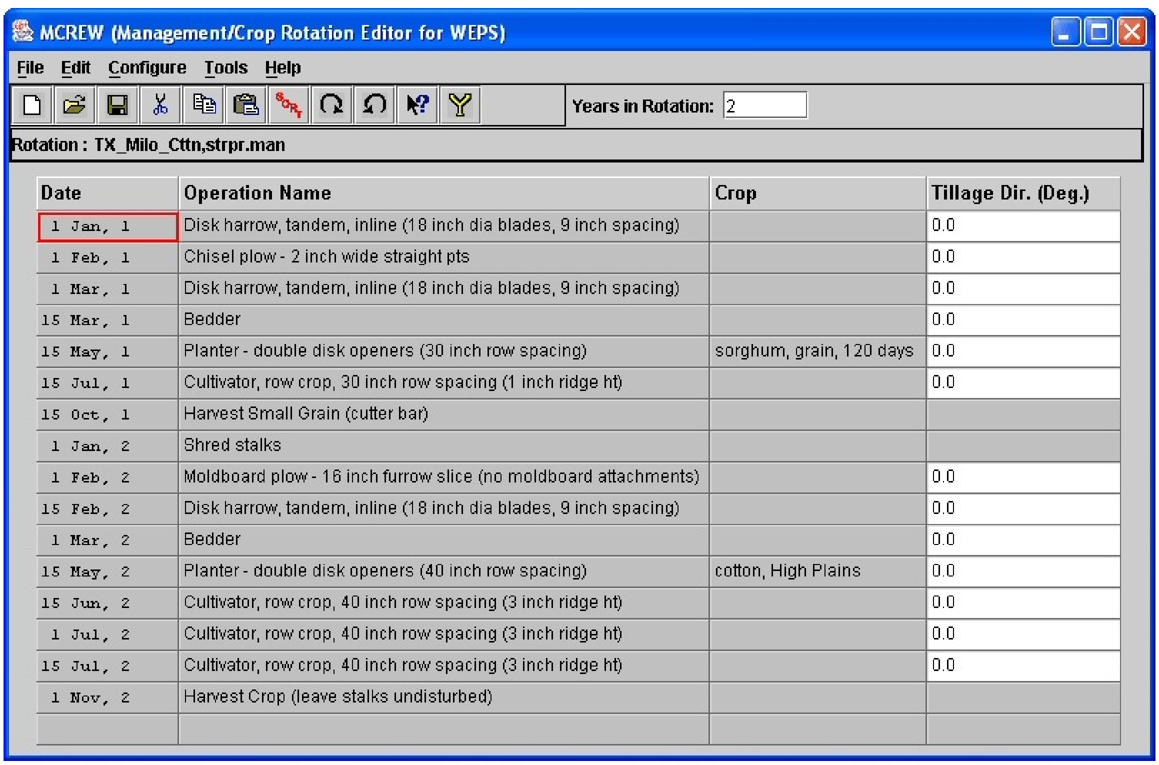
Date	Operation Name	Crop	Tillage Dir. (Deg.)
1 Jan, 1	Shred stalks		
1 Feb, 1	Moldboard plow - 16 inch furrow slice (no moldboard attachments)		0.0
15 Feb, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 1	Lister - 40 inch row spacing (8 inch ridge height)		0.0
15 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, High Plains	0.0
15 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
1 Jul, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Jul, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Nov, 1	Harvest Crop (leave stalks undisturbed)		

Figure 3.30. A continuos rotation of cotton.

<u>Situation 2</u> – Cotton_Milo rotation

When we expand the 1 year cotton rotation to include **Milo**, we can add the operations, dates of operations, and the **Milo** crop directly to the original **Cotton rotation** or we can build a separate template for **Milo** and then insert the new template in the rotation. We recommend the option of building a separate template for **Milo** and then inserting it into the existing **Cotton rotation**. The new **single year template** for **Milo** begins by opening **MCREW**, clicking on **"File**", then click on **"New"** and this will drop a clean **MCREW** screen down. With the clean **MCREW** screen we just start entering dates and operations as instructed in the earlier lessons on **MCREW**. The single year cropping scenario for **Milo** should be saved as a template. Saving a template begins by clicking on **"file"** and then **"save as a template"**. The list of dot man folders and files will drop down. Here we can open a folder before saving, or we can go directly to the window on the bottom of the list called **"File name",** remove the ***** and then type in the name of the new template we are saving. To finalize we click **"Save"** on the bottom right. We now have a new single year **Milo** template and will add it to our existing **Cotton scenario**.

Below is the **2 year rotation** of **Milo_Cotton**, including the dates and field operations (Fig. 3.31).

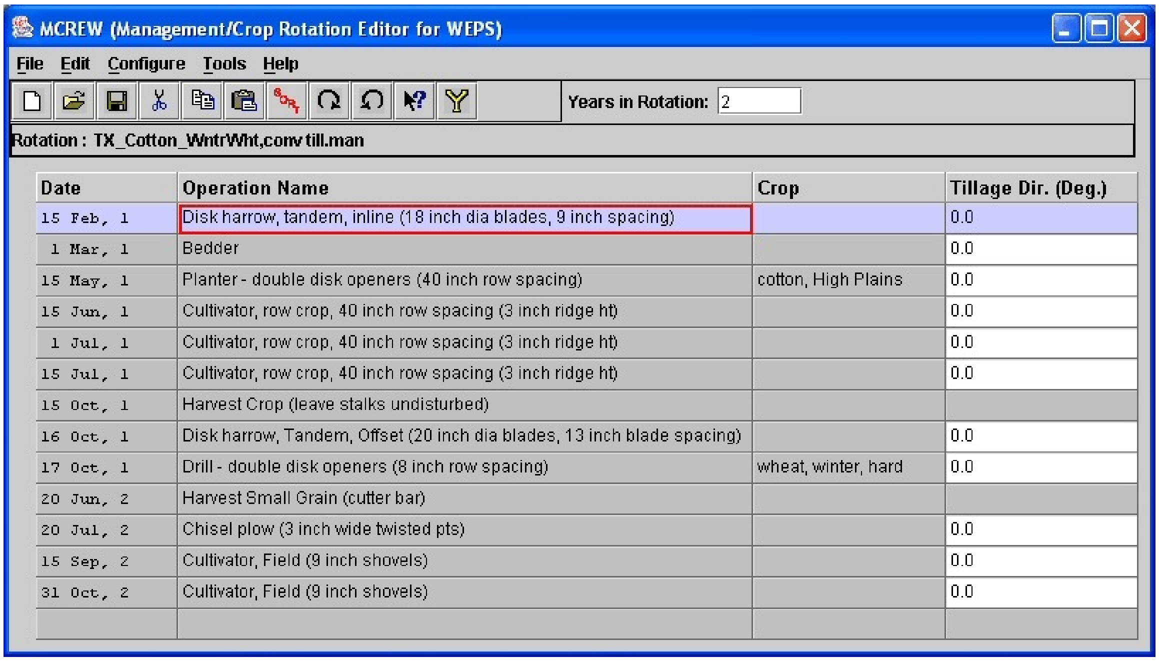


Date	Operation Name	Crop	Tillage Dir. (Deg.)
1 Jan, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Feb, 1	Chisel plow - 2 inch wide straight pts		0.0
1 Mar, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
15 Mar, 1	Bedder		0.0
15 May, 1	Planter - double disk openers (30 inch row spacing)	sorghum, grain, 120 days	0.0
15 Jul, 1	Cultivator, row crop, 30 inch row spacing (1 inch ridge ht)		0.0
15 Oct, 1	Harvest Small Grain (cutter bar)		
1 Jan, 2	Shred stalks		
1 Feb, 2	Moldboard plow - 16 inch furrow slice (no moldboard attachments)		0.0
15 Feb, 2	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 2	Bedder		0.0
15 May, 2	Planter - double disk openers (40 inch row spacing)	cotton, High Plains	0.0
15 Jun, 2	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
1 Jul, 2	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Jul, 2	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
1 Nov, 2	Harvest Crop (leave stalks undisturbed)		

Figure 3.31. A two year rotation of milo and cotton.

Situation 3 – **Cotton_Winter Wheat rotation**

Below is the 2 year rotation of **Cotton_Winter Wheat** including the dates and field operations (Fig. 3.32). We recommend the option of building the rotation using separate templates of **Cotton** and **Winter Wheat**. However, once you have a template of **Cotton_Winter Wheat**, you can use it directly from your dot man files.



Date	Operation Name	Crop	Tillage Dir. (Deg.)
15 Feb, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spacing)		0.0
1 Mar, 1	Bedder		0.0
15 May, 1	Planter - double disk openers (40 inch row spacing)	cotton, High Plains	0.0
15 Jun, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
1 Jul, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Jul, 1	Cultivator, row crop, 40 inch row spacing (3 inch ridge ht)		0.0
15 Oct, 1	Harvest Crop (leave stalks undisturbed)		
16 Oct, 1	Disk harrow, Tandem, Offset (20 inch dia blades, 13 inch blade spacing)		0.0
17 Oct, 1	Drill - double disk openers (8 inch row spacing)	wheat, winter, hard	0.0
20 Jun, 2	Harvest Small Grain (cutter bar)		
20 Jul, 2	Chisel plow (3 inch wide twisted pts)		0.0
15 Sep, 2	Cultivator, Field (9 inch shovels)		0.0
31 Oct, 2	Cultivator, Field (9 inch shovels)		0.0

Figure 3.32. A two year rotation of cotton and winter wheat.

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APPENDICES

Appendix 1: 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 5.1. A detailed description of how to operate the WEPS 1.0 User Interface is described later in this document (Chapter, 'How to Operate WEPS').

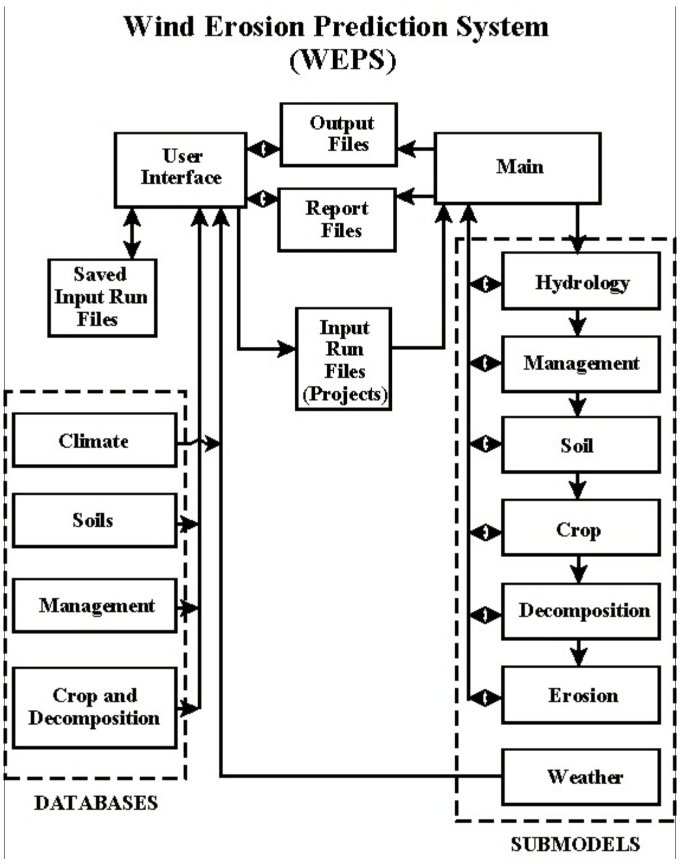

Figure 5.1. A flow diagram of the WEPS science model and User Interface.

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. Although 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 later in this document (Chapter, 'How to Operate WEPS'). 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 above. 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 which controls the initialization and execution of a WEPS simulation run. It calls subroutines that read input data and outputs the general report. 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), 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 which describes the field shape and barriers, simulation period, location of other input files, and types of output ; b) an initial field conditions file which describes soil conditions at the start of a simulation; d) a tillage/management file which 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. However, 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 standard. 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 in order to simulate the process of soil erosion by wind. These and other weather variables (precipitation, air temperature, 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, since 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, which is the length of a typical WEPS simulation run. In addition, the measured data require much more computer disk space than wind summary statistics combined with a stochastic wind generator. Therefore, a stochastic wind generator is often more appropriate for use with WEPS than 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 in order 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 wee 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 speed used were 0.5, 1.5, 2.5, ..., 20.5, 25.5, ..., 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 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, 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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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. However, estimating soil wetness at the soil-atmosphere interface is emphasized, because it significantly influences the susceptibility of the soil to wind erosion.

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

$$SWC = SWCI + (PRCP + DIRG) + SNOW - RUNOFF - ETA - DPRC \quad \textbf{(5.1)}$$

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 5.1 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 5.1.

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 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 Resource. 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 cropland by land managers makes this a daunting task. However, WEPS must adequately simulate typical cultural practices to accurately assess their affects upon wind erosion control. The MANAGEMENT submodel is assigned the task of handling the cultural practices applied by land managers which affect the soil/surface "state" within WEPS.

Purpose
All cultural practices applied by land managers 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 vary 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 following tillage.

2. Tillage depth is assumed to not 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 which 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 following defined management categories as listed in Table 5.1.

Table 5.1. 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. Usually after-harvest tillage operations fall in this category.
Secondary tillage	Tillage typically performed in preparation for seeding or planting operations. Usually these operations 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 5.2.

Table 5.2. 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 physical law based representations, 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. However, 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 prior to 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 higher 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 GDDs from planting to physiological maturity; and b) the relative GDDs 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 GDDs equal the potential GDDs 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, soil removal or deposition caused by wind erosion, which can influence germination, seedling emergence, survival, and growth.

Biomass Production
Biomass production is determined based upon: 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 for 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. SWCS WEPP/WEPS Symposium. 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. Since 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 in order 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, and 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. The purpose of this paper is to provide 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).

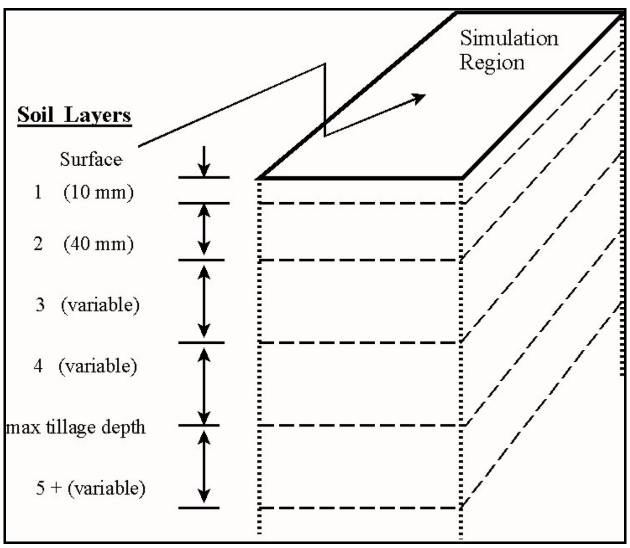

Figure 5.2. Diagram representing the spatial domain of the Soil submodel.

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. 5.2). 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 based upon the relative wetness of adjacent layers. Crop estimates plant growth 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 based upon 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.Try to get the first three layers to be 10, 40 and 50 mm.

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 5.3. 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 using mean and standard deviation 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 5.3. 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 5.3 in response to the occurrence of the various driving processes.

References

Hagen, L.J., T.M. Zobeck, E.L. Skidmore, and I. Elminyawi. 1995b. WEPS technical documentation: soil submodel. SWCS WEPP/WEPS Symposium. Ankeny, IA

Erosion Submodel

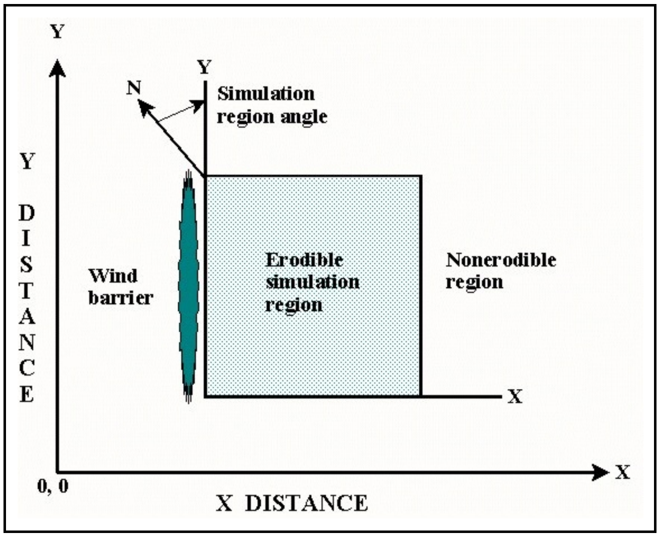

Figure 5.3. Schematic of simulation region geometry. Field orientation, end points of barriers, and opposite corners of the rectangular simulation region are input to the Erosion submodel.

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. 5.3). 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. The purpose of this paper is to provide 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).

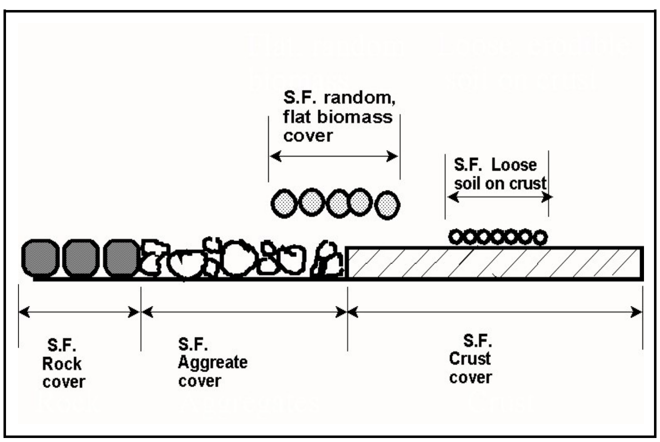

Figure 5.4. Diagram illustrating components of flat surface cover inputs to the Erosion submodel.

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. 5.4). In the first level, surface rock, aggregates and crust comprise 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.

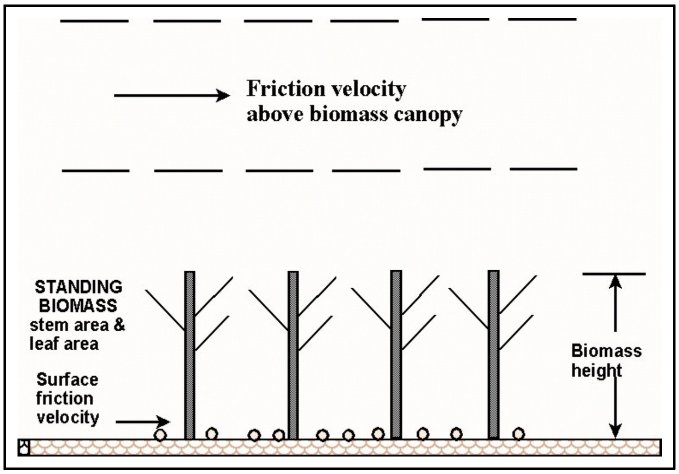

Figure 5.5. Diagram illustrating friction velocity above standing biomass that is reduced by drag of stems and leaves to the surface friction velocity below the standing biomass.

Uniformly distributed, standing biomass is 5 to 10 times more effective in controlling wind erosion than flat biomass, and thus, 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. 5.5). Leaves are represented by a leaf area index and stems by a stem silhouette area index.

Erosion Processes Simulated

Soil transport during wind erosion occurs in three modes: creep-size aggregates, 0.84-2.0 mm (0.033 - 0.079 in.) in diameter roll along the surface, saltation-size aggregates, 0.10 - 0.84 mm (0.004 - 0.033 in.) in diameter hop over the surface, and suspension-size aggregates, < 0.01 mm (0.004 in.) in diameter move above the surface in the turbulent flow. Obviously, variations in friction velocity, aggregate density and sediment load 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 that is regulated as a health hazard.

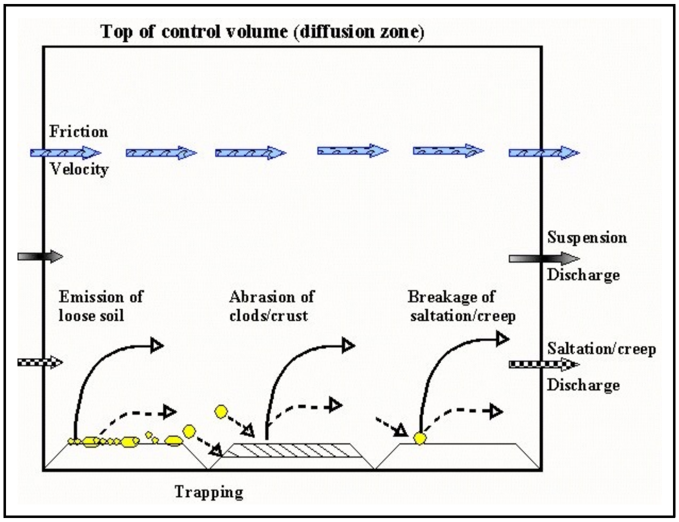

Figure 5.6. Diagram illustrating processes simulated by the Erosion submodel on a bare soil surface in an individual grid cell.

Multiple, physical erosion processes are simulated in the erosion submodel, and these are illustrated for a single grid cell in Fig. 5.6. 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 based on 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 to 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.

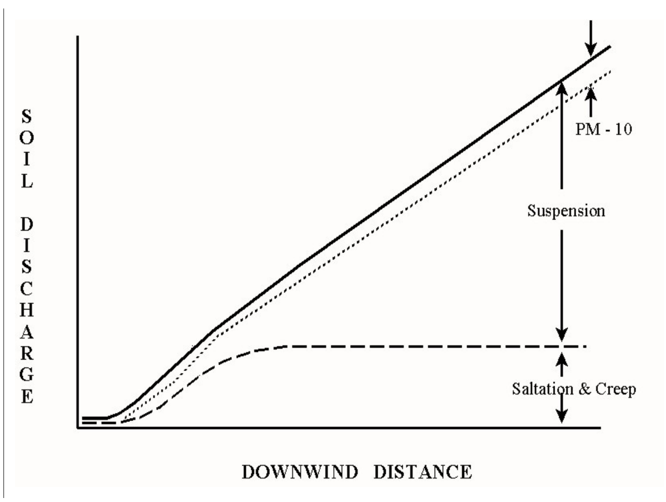

Figure 5.7. Diagram illustrating downwind transport capacity for saltation & creep, but a continuing increase in transported mass of suspension-size soil downwind.

Typical behavior of the downwind soil discharge simulated along a line transect for the saltation/creep and suspension components is illustrated in Fig. 5.7. 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 and 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 based on 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. IN Proc. of the WEPP/WEPS Symposium. Soil and Water Conserv. Soc., Des Moines, IA.

Appendix 2: 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 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)

Wind station WBAN code number 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 (NOTE that I haven't verified them - lew):

-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), "-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 (NOTE that I haven't verified them - lew):

-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 below.

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 calc
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 parms) (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 prior to 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 the "-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 prior to executing the WEPS science model.

Those that can be added to the command line and should work within WEPS 1.0 are (NOTE that I haven't verified them - lew):
  -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

-?

Appendix 3: 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 5.8. 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 herin 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 (ie., ((1.0 - silhouette area) x 100).

Figure 5.8. 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:

$$Ue = \sum_{i=1}^{k} (Si * \sin Ti) \qquad [5.1]$$

$$Un = \sum_{i=1}^{k} (Si * \cos Ti) \qquad [5.2]$$

$$Tu = \arctan \frac{Ue}{Un} \qquad [5.3]$$

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 5.9 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 5.9. 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, etal., 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 5.10 shows an example CLIGEN file.

CLIGEN File Parmeters:

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-milimeters).

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 5.10. 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 (C)
  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 (C)
 -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)               (C)   (C) (l/d) (m/s)(Deg)   (C)
 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
 4  2    1   0.0  0.00 0.00   0.00  13.0   1.1 307.  5.1  146. -18.0
```

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 Appendix) to simulate single storms using measured vlalues. 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 5.11.

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 etal. (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 (m3/m3).

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 / (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 = (aggr. gsd)^{p} * (aggr. gmd) + 0.84
where p = 1.52 * (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 5.11. 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.

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. 5.12).

Figure 5.12. 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 (meteres)
#                         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, Fock 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 5.13 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 5.13. 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/m---------------------
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 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 also reduce wind speed to a lesser extent upwind of the barrier (Fig. 6.1).

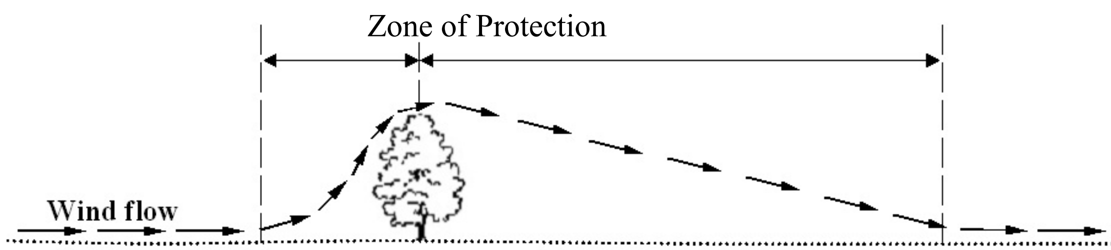


Figure 6.1. Diagram showing wind flow pattern over a barrier.

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. However, 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 below.

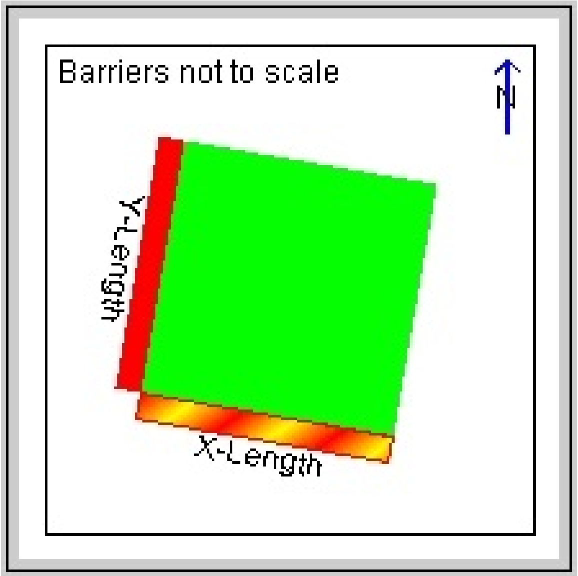


Figure 6.2. Field View Panel.

Adding and Removing Barriers Using the Interface

The Field View Panel (Fig. 6.2), 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.

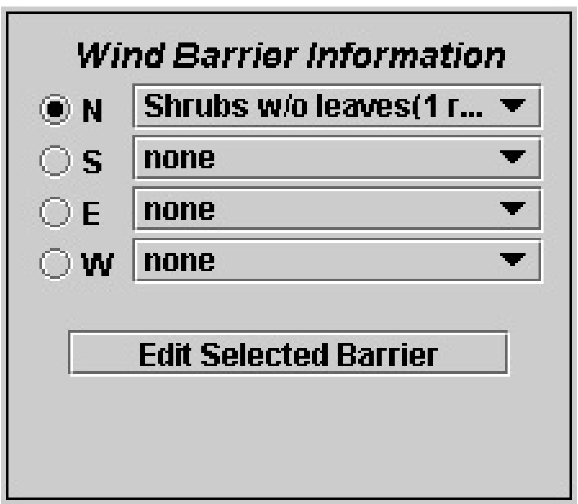


Figure 6.3. Simulation Run Information Panel.

The wind barrier panel (Fig. 6.3) 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 where 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 only if 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 shown below. 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. 6.4). 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. 6.4. For multiple row barriers, the width is the distance from one side of the barrier to the other as illustrated by "b" in Fig. 6.4.

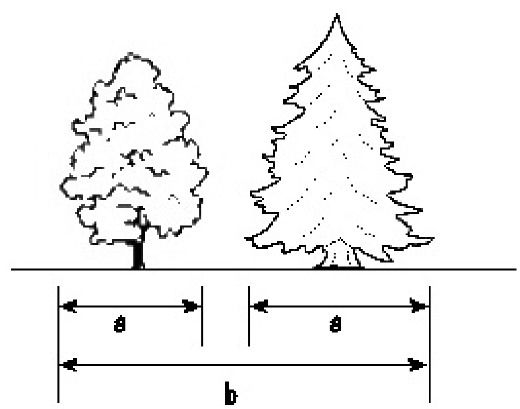


Figure 6.4. Barrier width for single (a) and multiple (b) row barriers.

Height The height of a barrier is the average height of individual elements (e.g. trees) in the barrier ("a" in Fig. 6.5 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. 6.5).

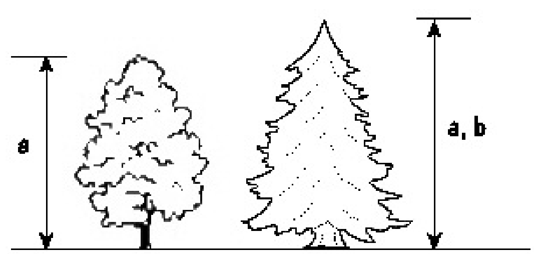


Figure 6.5. Barrier height for single (a) and multiple (b) row barriers.

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 percent 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 6.6 illustrates the effect of porosity on the near surface wind speed relative to an open field without a barrier (see also Figure 6.1).

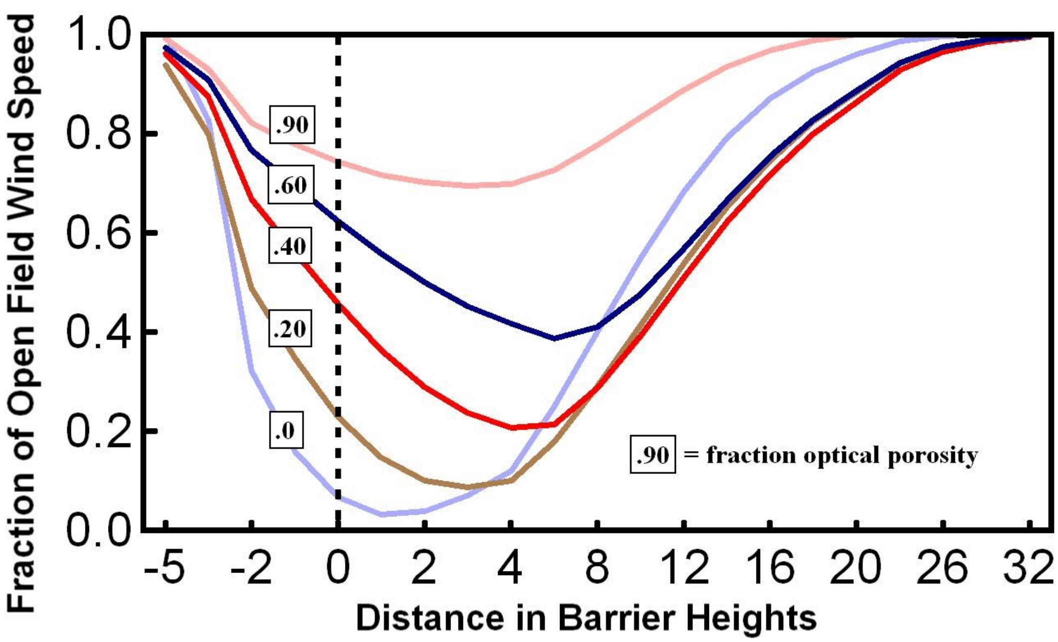


Figure 6.6. Effect of the fraction of optical porosity on near surface wind speed along the wind direction relative to barrier. The "Distance in Barrier Heights" refers to the distance from the barrier at 0, measured in multiples of the barrier height.

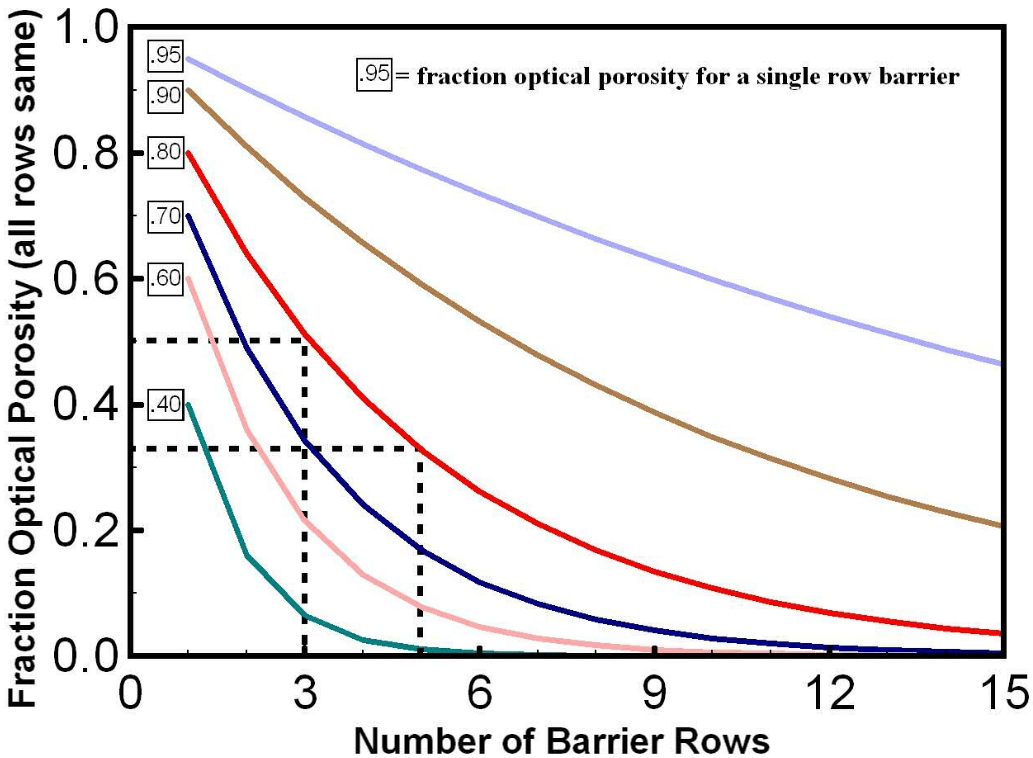


Figure 6.7. Effect of number of barrier rows on optical porosity where all barrier rows are the same.

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 6.7. 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 while 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 6.8 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), 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.). However 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 6.8. 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
```

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. However, 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 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 6.8. 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 illustrate 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. Using WEPS, the saltation/creep crossing eroding strip boundaries may be used to estimate the soil gain on adjacent non-eroding strips.

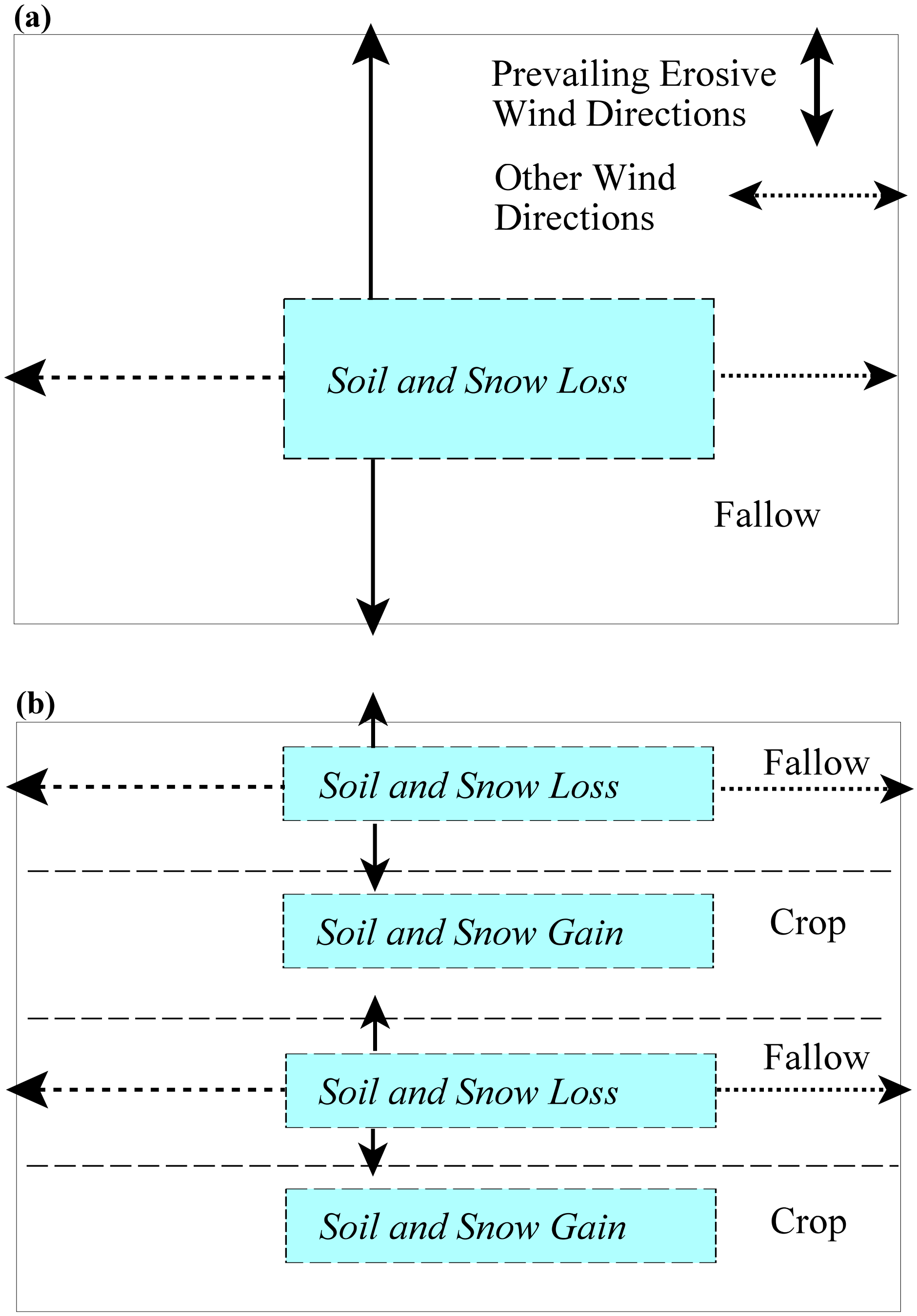


Figure 6.8. Comparison of (a) large fallow field and (b) the same field strip cropped with alternating crop and fallow strips.

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. 6.9). 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. 6.10) and suspension-size aggregates (Fig. 6.11). 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. Generally, there 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, since these particles continually diffuse into the atmosphere. Consequently, the mass of suspended material increases over the entire length of eroding fields, with the rate of increase controlled by the erosion processes.

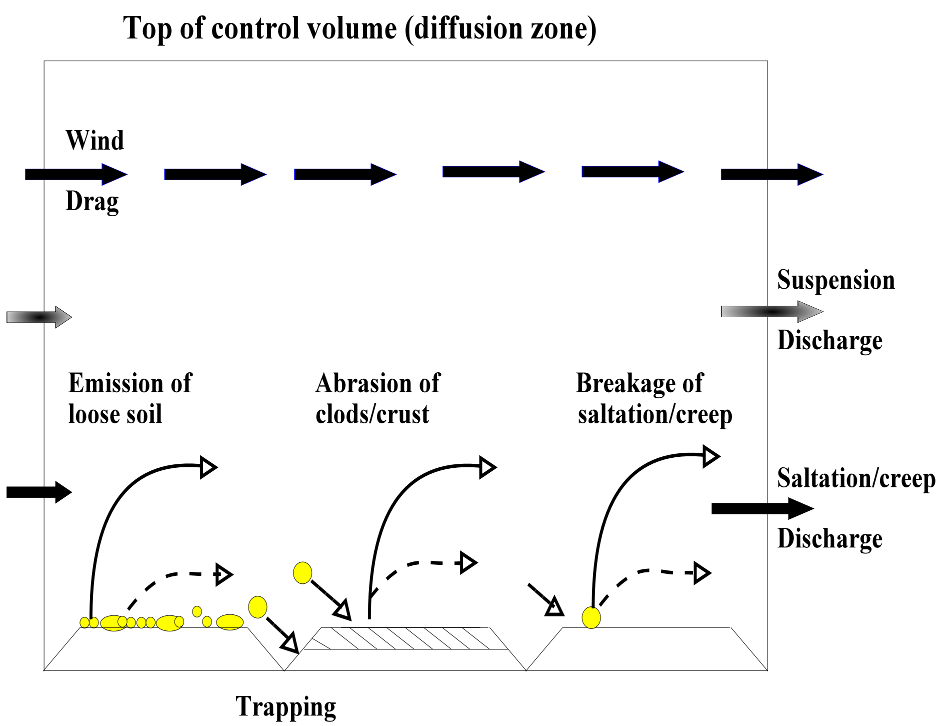


Figure 6.9. Wind erosion processes on a bare field simulated in WEPS.

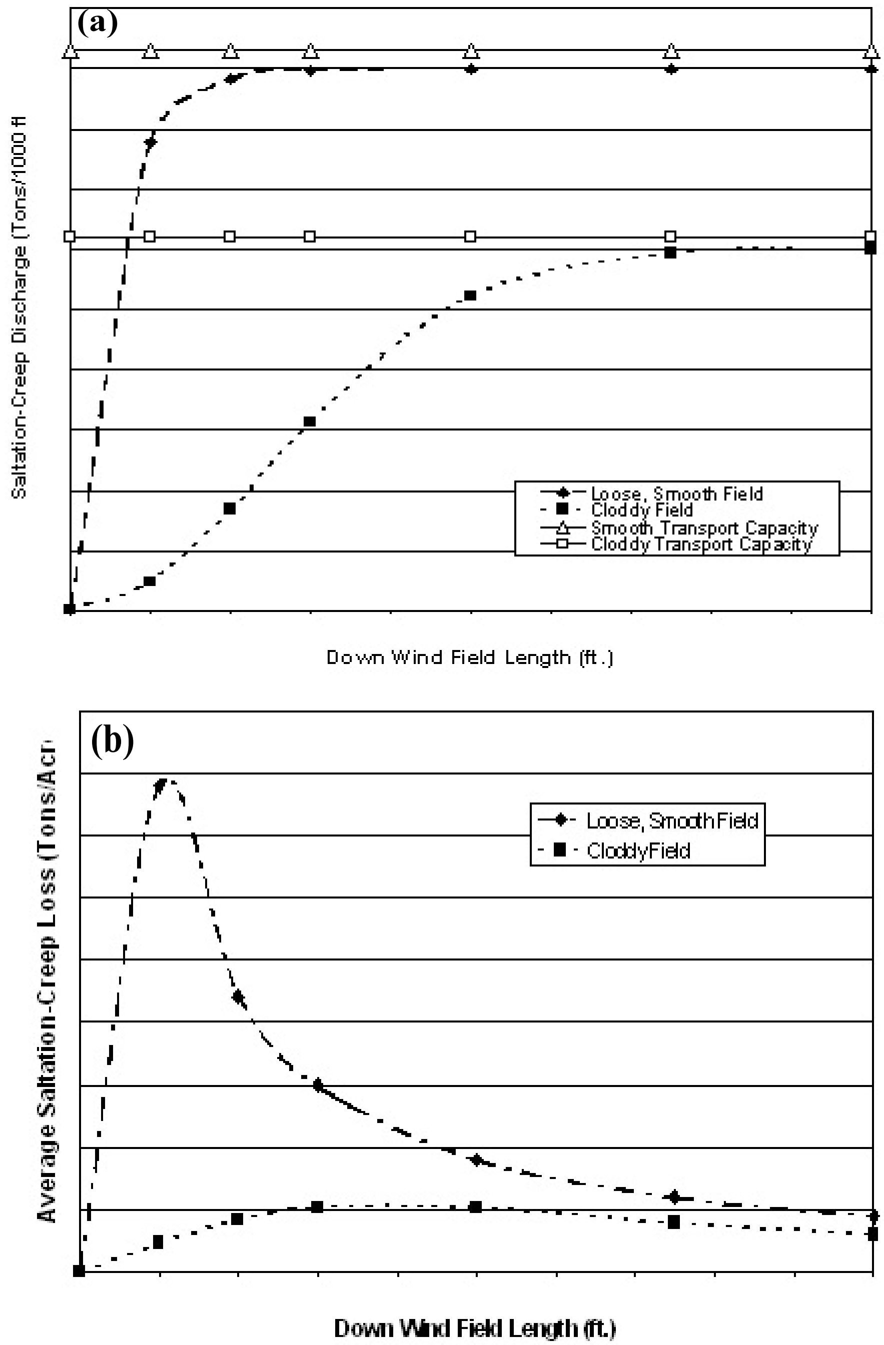


Figure 6.10. Comparison of (a) downwind discharge per 100 ft. of border width and (b) average soil loss for saltation-creep.

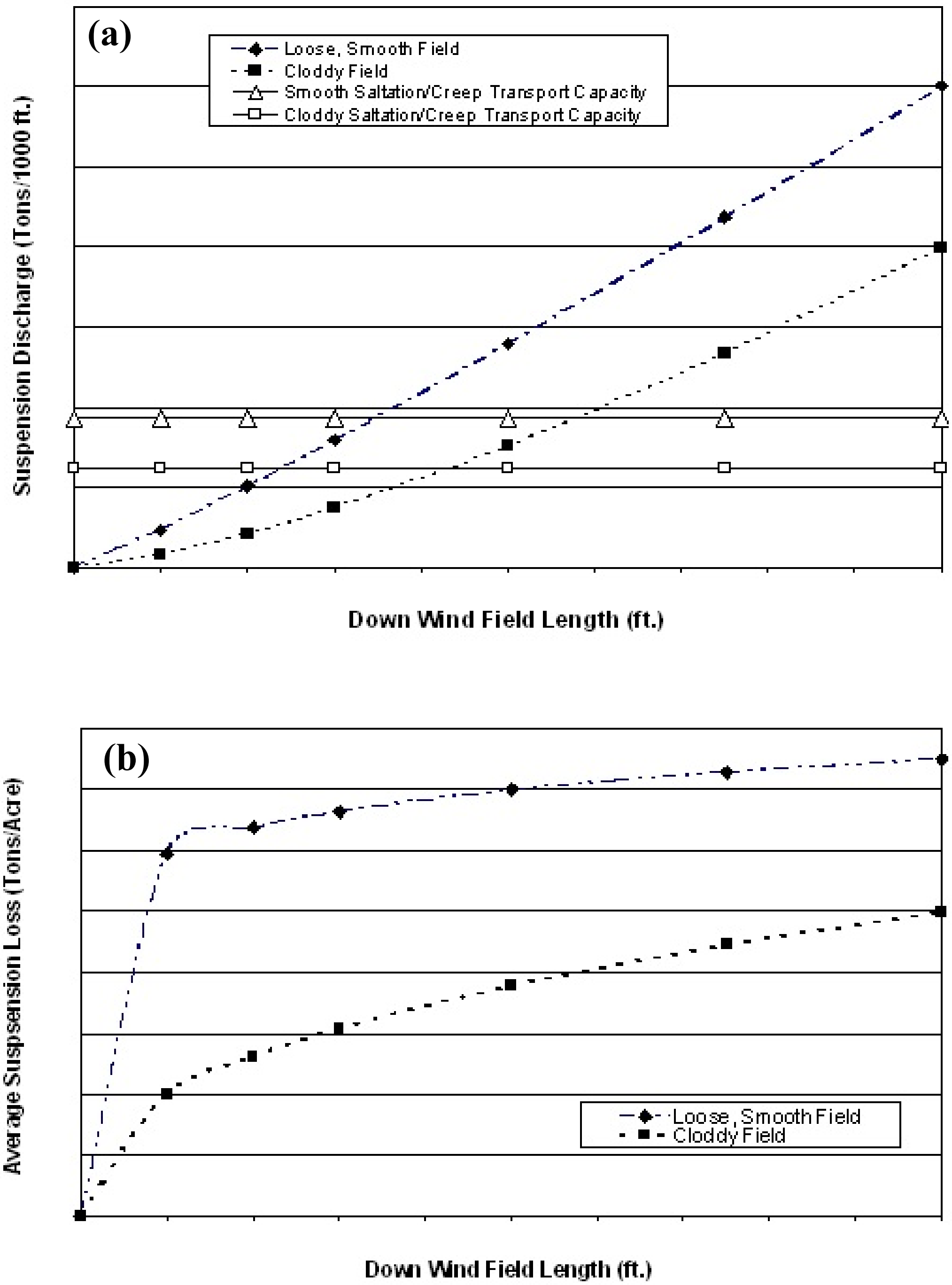


Figure 6.11. Downwind (a) discharge per 100 ft. of border width and (b) average soil loss of suspended soil.

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 varying field length 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. 6.10) and the suspension-size soil (Fig. 6.11). After saltation/creep reaches transport capacity, dividing the nearly-constant transport capacity by field length to give average soil loss shows there is a steady decrease in loss per unit area with increasing field length (i.e., area increases while 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. 6.12). Generally, the maximum average soil loss occurs at a field length where 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 where there is a maximum soil loss and the average loss then decreases beyond that field length (Fig. 6.12a). In this case, 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. On the other hand in WEPS, 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. However, the effect of reducing field length on erosion is not linear, but varies approximately with the logarithm of the distance to transport capacity.

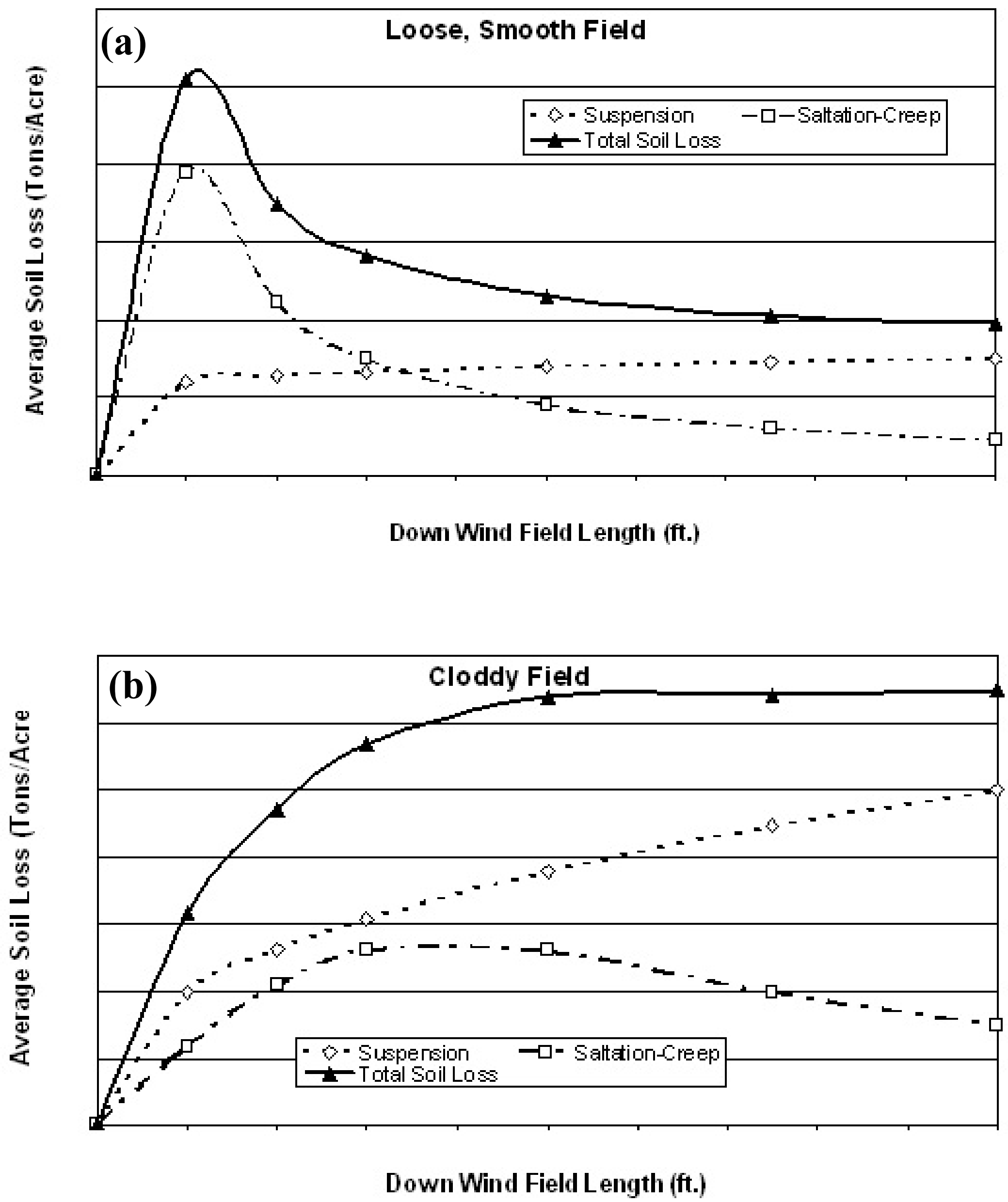


Figure 6.12. Comparison of average soil loss at various downwind distances on (a) a smooth, loose field and (b) a cloddy field.

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 6.8b, may not provide the needed level of erosion control. It is then the task of those designing erosion controls to recommend additional measures. Fortunately, there are a number of ways to enhance a strip crop system in order to provide additional levels of control, and several of these are illustrated.

One control option is to reduce the strip width in critical areas (Fig. 6.13). 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 and thus, increase 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.

A second option to reduce effective strip width is to employ wind barriers (Fig. 6.14). Correctly oriented barriers serve to shelter part of the erosive strip (Fig. 6.14a). They may also be used to divide the erosive strips to trap moving soil and further reduce the unsheltered lengths (Fig. 6.14b). 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.

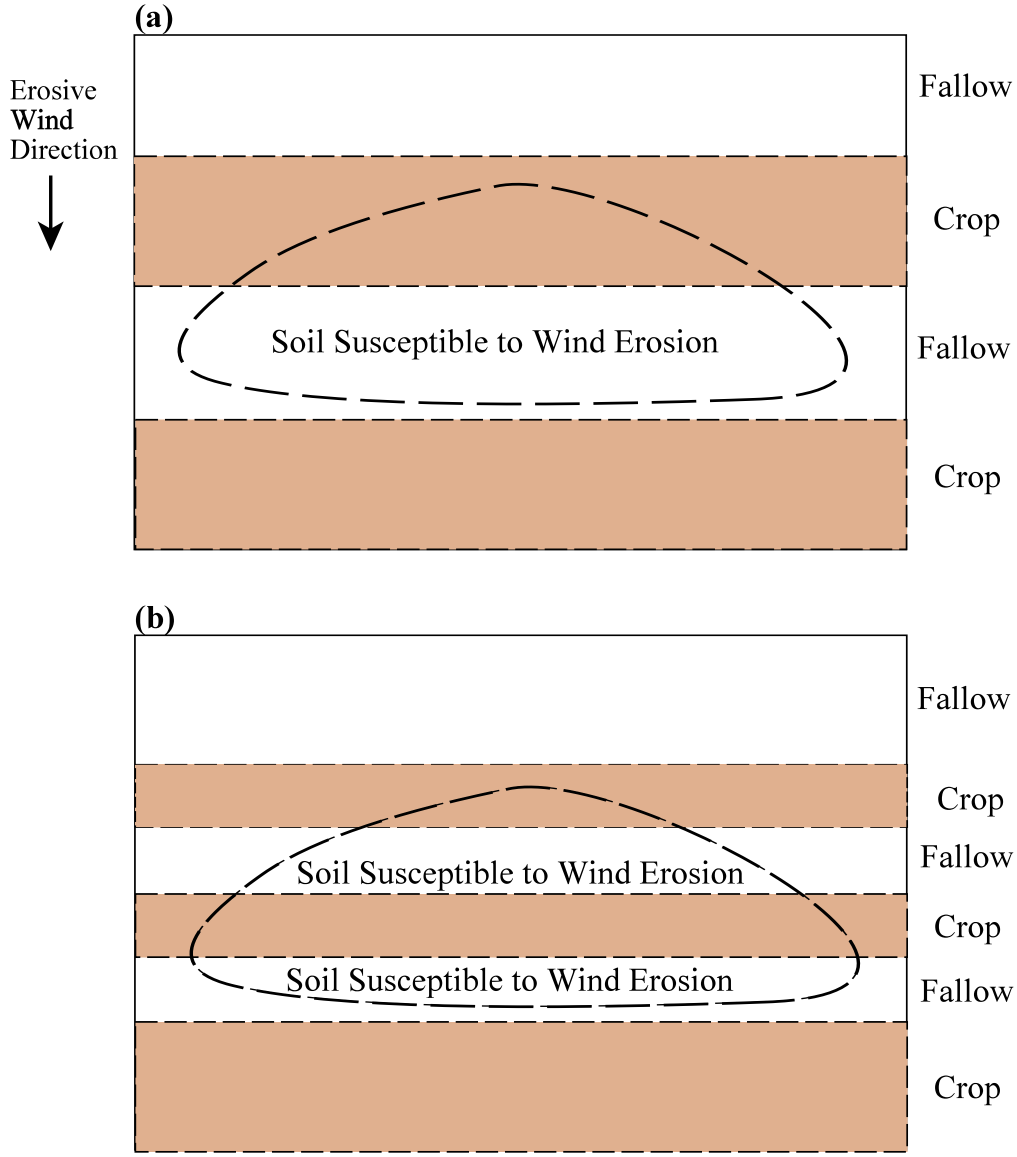


Figure 6.13. Erosion control designs illustrating (a) strips on erodible soils and (b) using narrow strips in critical areas with soils highly susceptible to wind erosion.

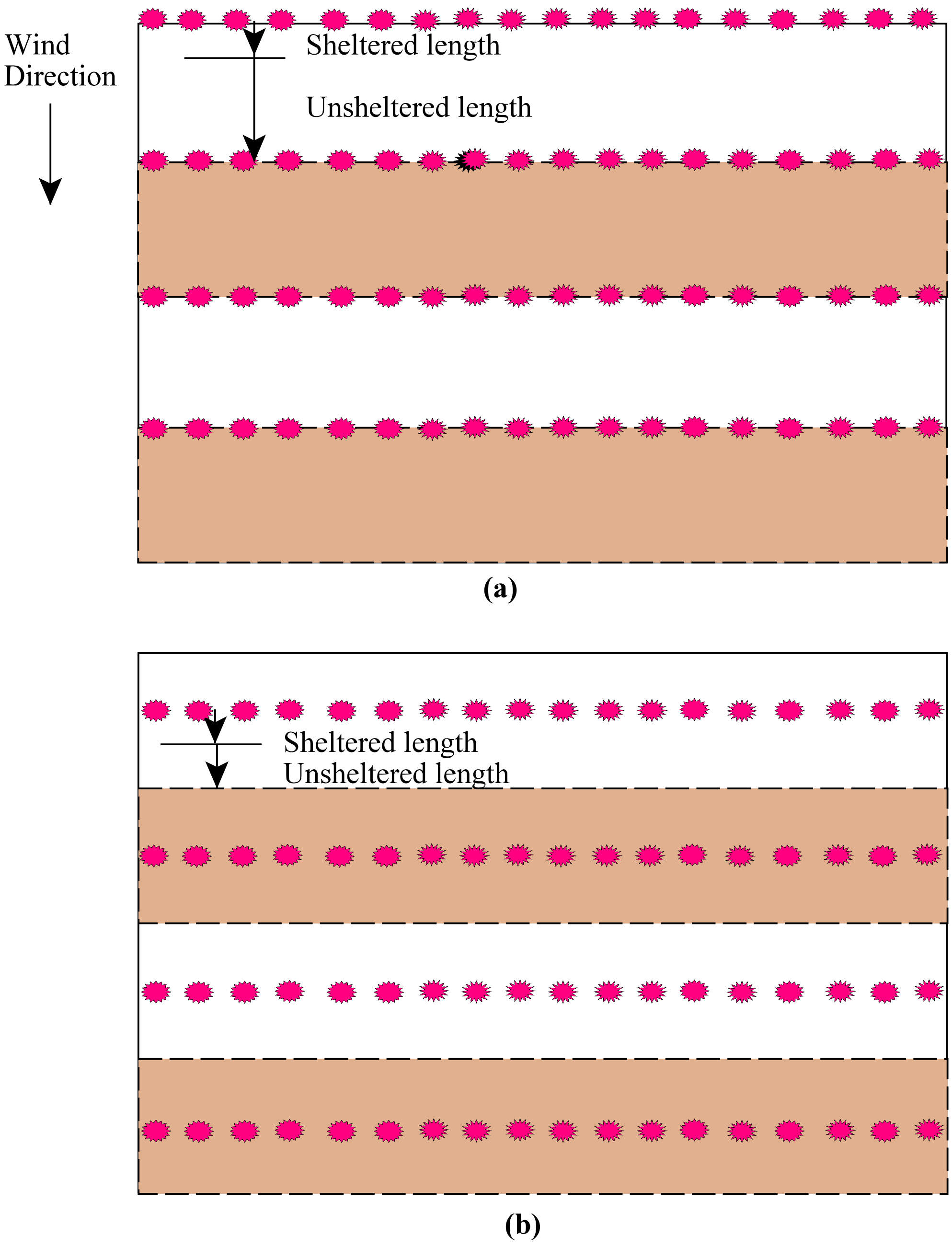


Figure 6.14. Erosion control designs using wind barriers (a) on strip borders and (b) in the middle of all strips.

Another option to enhance strip effectiveness is to employ surface roughness such as tillage ridges (Fig. 6.15). Adding tillage ridges provides additional trapping capacity for mobile soil (Fig. 6.15a). But it is often useful to orient ridges so they are not parallel to the long side of the strip as this provides some erosion control when wind directions are parallel to the strip (Fig. 6.15b). 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 are particularly useful when there are erosive winds parallel to conventional strips. These options include avoiding long, straight tillage ridges (Fig. 6.16a). Saltation along the furrows parallel to tillage ridges often undercuts the ridge crust which lowers 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. 6.16b and Fig. 6.17). 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.

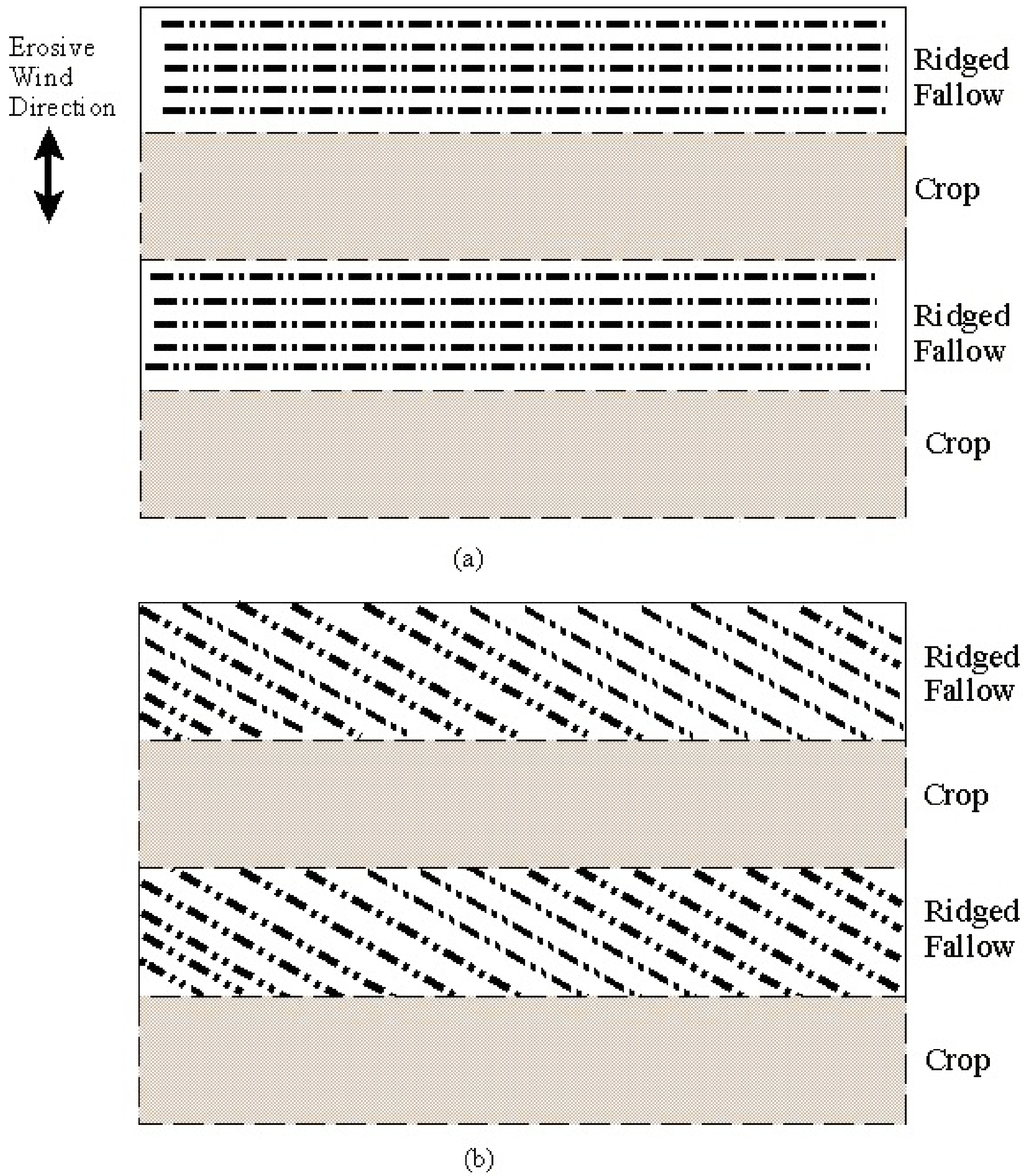
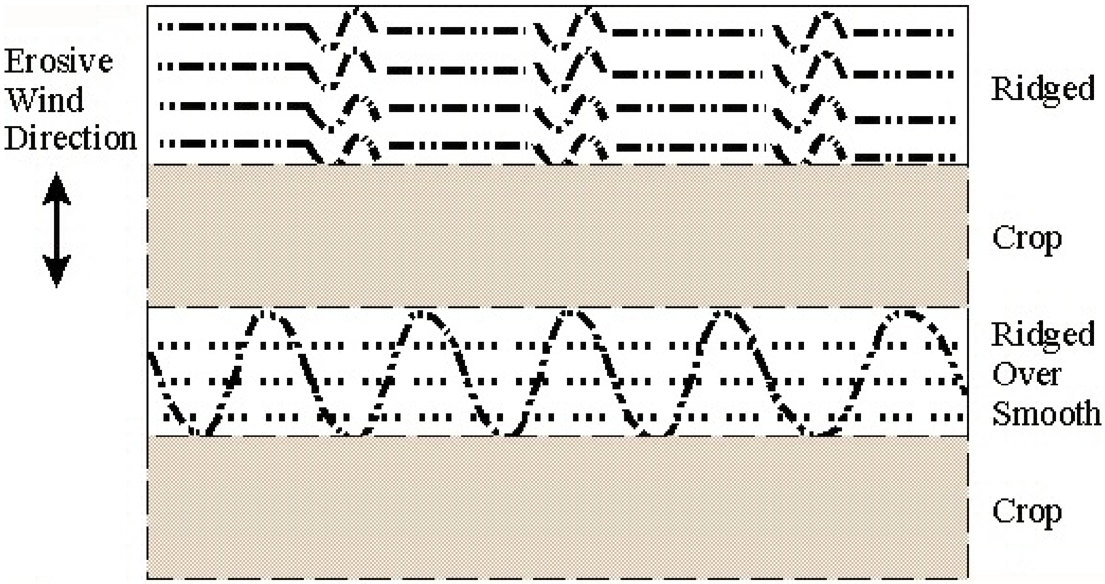
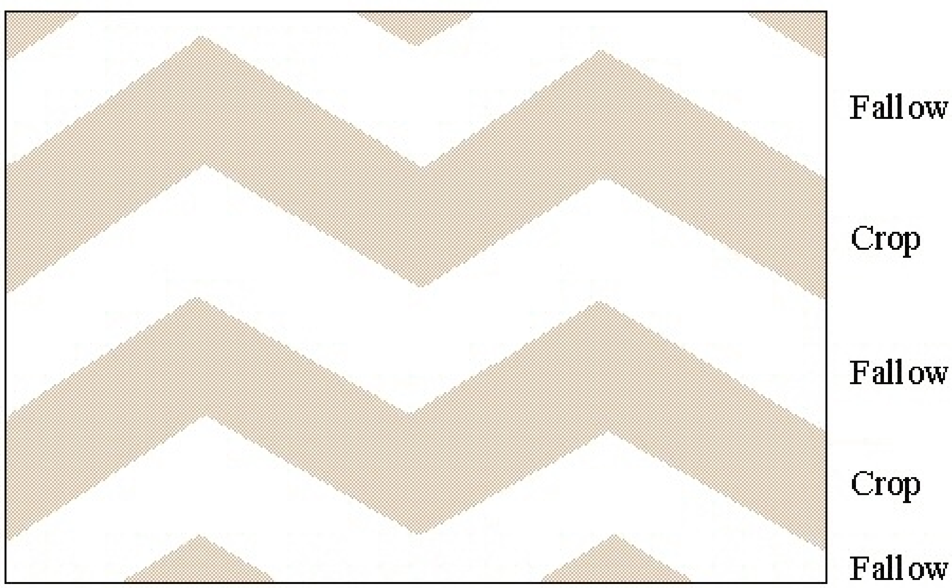


Figure 6.15. Designs using (a) parallel tillage ridges and (b) angled tillage ridges.



(a)



(b)

Figure 6.16. Erosion control designs using (a) variations of curved ridges and (b) curved strips.

Figure 6.17. 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. 6.18) 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. 6.19)
- Field size of 2640' x 2640', 160 acres
- No barriers, 0.0 degree field orientation (North-South)

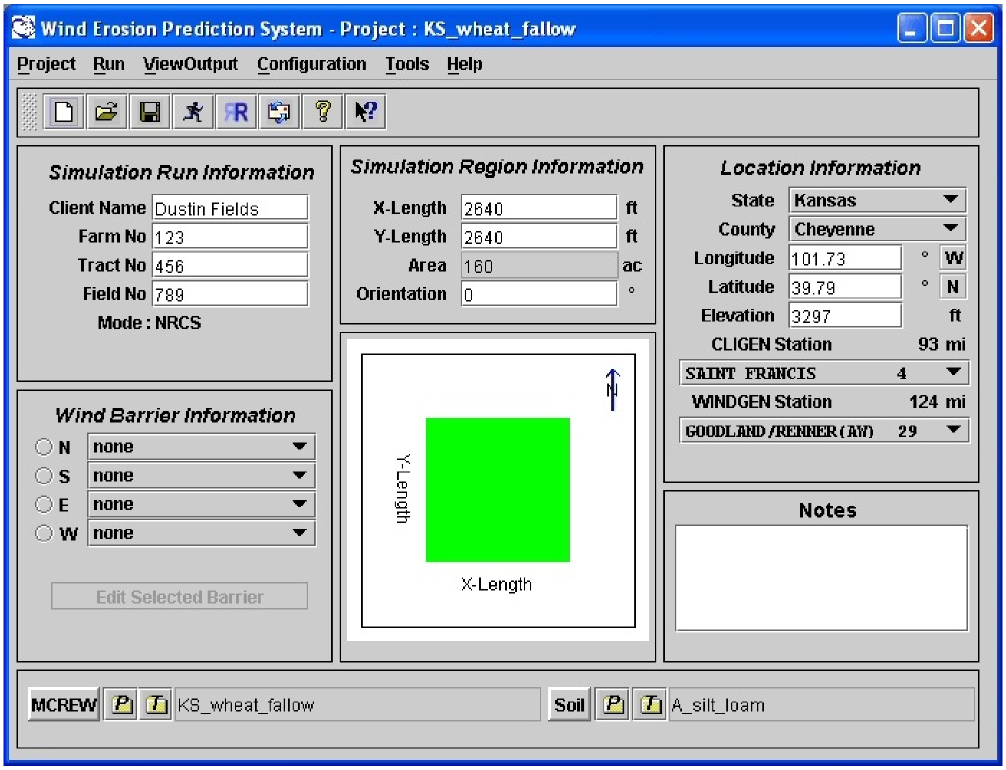
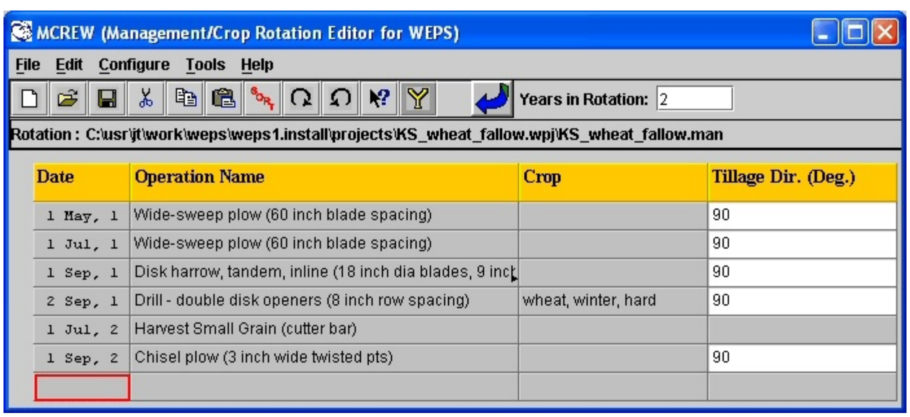


Figure 6.18. Main screen showing setup for non-strip cropped field.



Date	Operation Name	Crop	Tillage Dir. (Deg.)
1 May, 1	Wide-sweep plow (60 inch blade spacing)		90
1 Jul, 1	Wide-sweep plow (60 inch blade spacing)		90
1 Sep, 1	Disk harrow, tandem, inline (18 inch dia blades, 9 inc		90
2 Sep, 1	Drill - double disk openers (8 inch row spacing)	wheat, winter, hard	90
1 Jul, 2	Harvest Small Grain (cutter bar)		
1 Sep, 2	Chisel plow (3 inch wide twisted pts)		90

Figure 6.19. Management Crop Rotation Editor for a conventional wheat fallow rotation.

As can be seen in the Run Summary Report (Fig. 6.20), 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 since 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. 6.21) 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. 6.10 and 6.11).

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 6.21. In this case, almost all of the eroding soil mass is crossing the south and east field boundaries, indicating northerly and westerly prevailing wind directions. Since most of the mass is crossing the southern field border, dividing the field in east-west oriented strips will shorten the field length in the direction having the most loss.

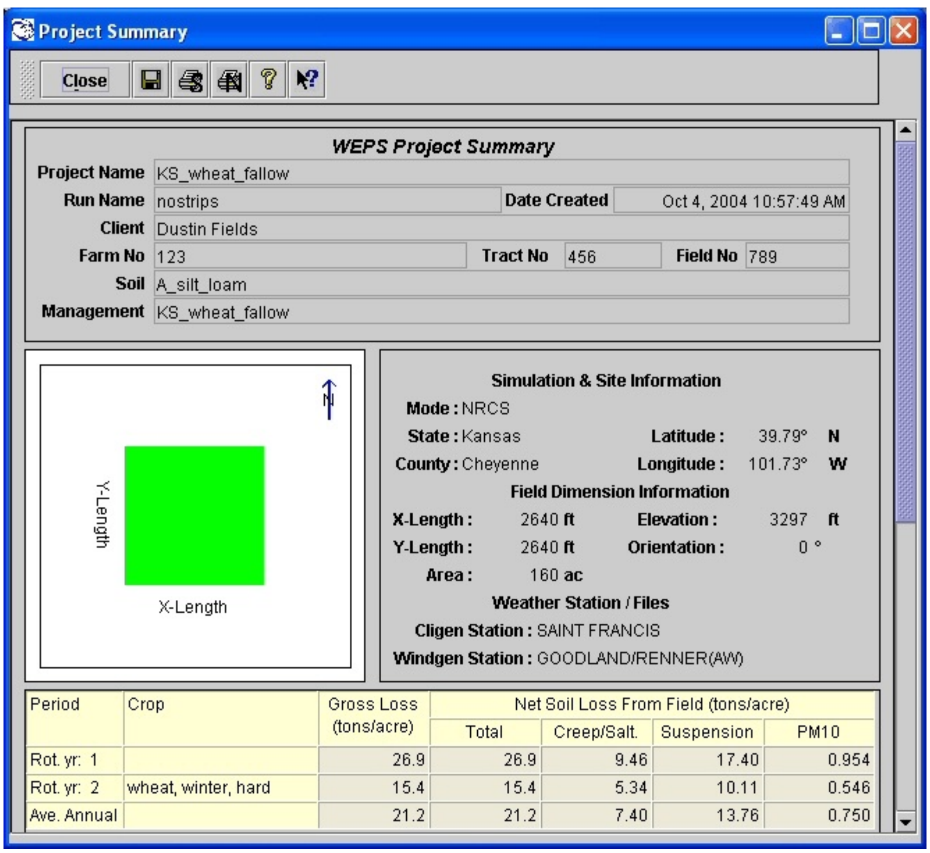


Figure 6.20. Run Summary for the non-stripped scenario.

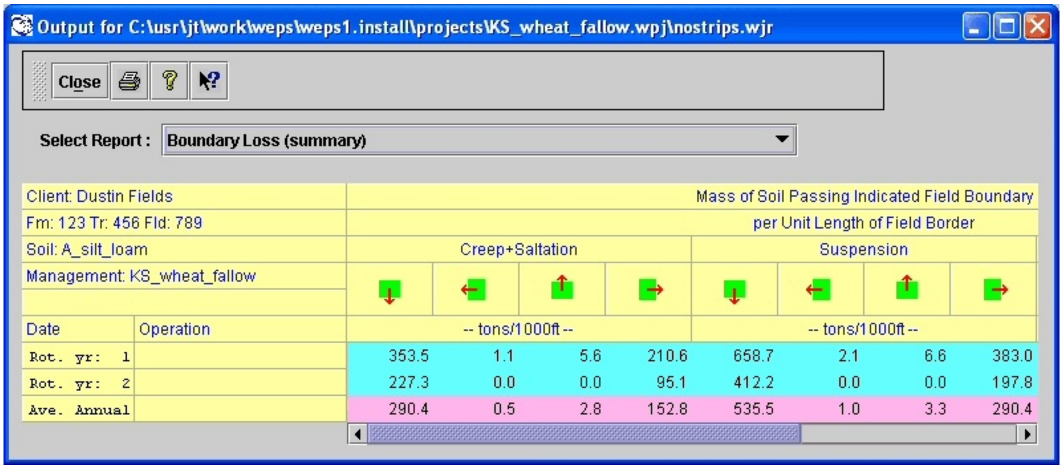


Figure 6.21. Boundary Loss summary for the non-stripped scenario.

<u>Strip Crop</u>

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.6.22). 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.

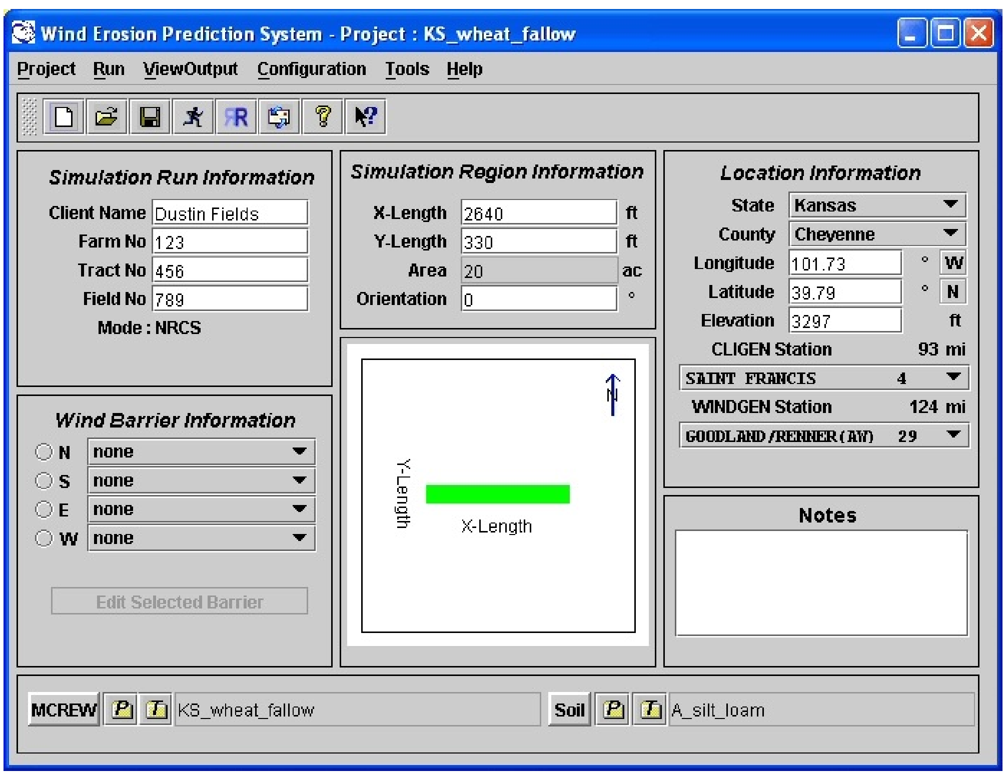


Figure 6.22. Main screen showing the setup for a strip cropped field.

As can be seen in the Run Summary Report (Fig. 6.23), 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. Since 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. 6.20). Since the processes of creep/saltation increase downwind, an increasing amount of suspension is generated (Figs. 6.10 and 6.11). 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.

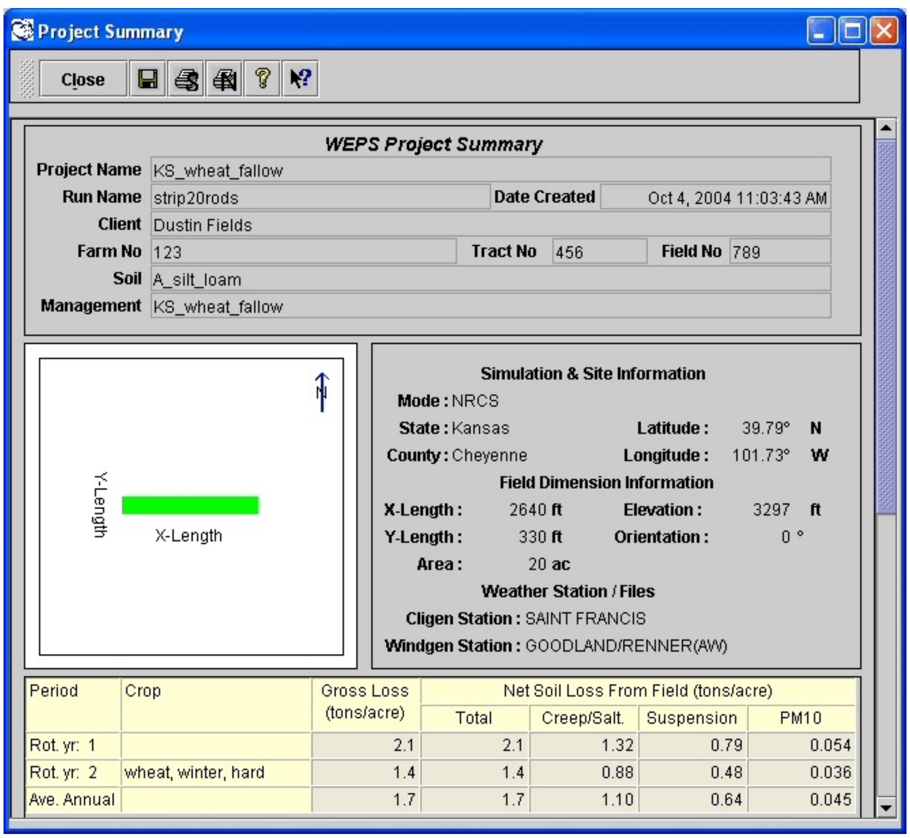
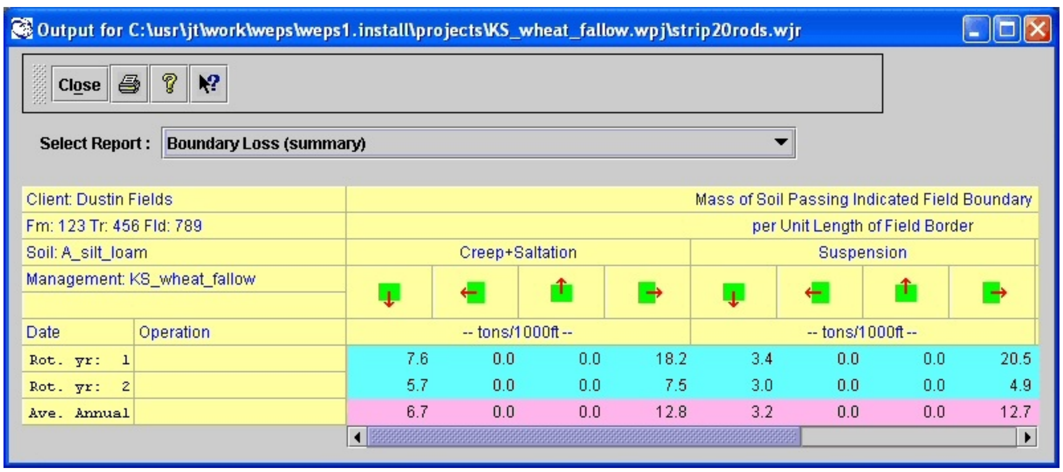


Figure 6.23. Run Summary report for the strip cropped scenario.

The Boundary Loss summary (Fig. 6.24) 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.



Client: Dustin Fields Fm: 123 Tr: 456 Fld: 789 Soil: A_silt_loam Management: KS_wheat_fallow		Mass of Soil Passing Indicated Field Boundary per Unit Length of Field Border							
		Creep+Saltation				Suspension			
		↓	←	↑	→	↓	←	↑	→
Date	Operation	-- tons/1000ft --				-- tons/1000ft --			
Rot. yr: 1		7.6	0.0	0.0	18.2	3.4	0.0	0.0	20.5
Rot. yr: 2		5.7	0.0	0.0	7.5	3.0	0.0	0.0	4.9
Ave. Annual		6.7	0.0	0.0	12.8	3.2	0.0	0.0	12.7

Figure 6.24. 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 6.25 and the WEPS main screen setup for this scenario is shown in Figure 6.26. 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 6.25. Example of field, strip cropped with herbaceous barriers.

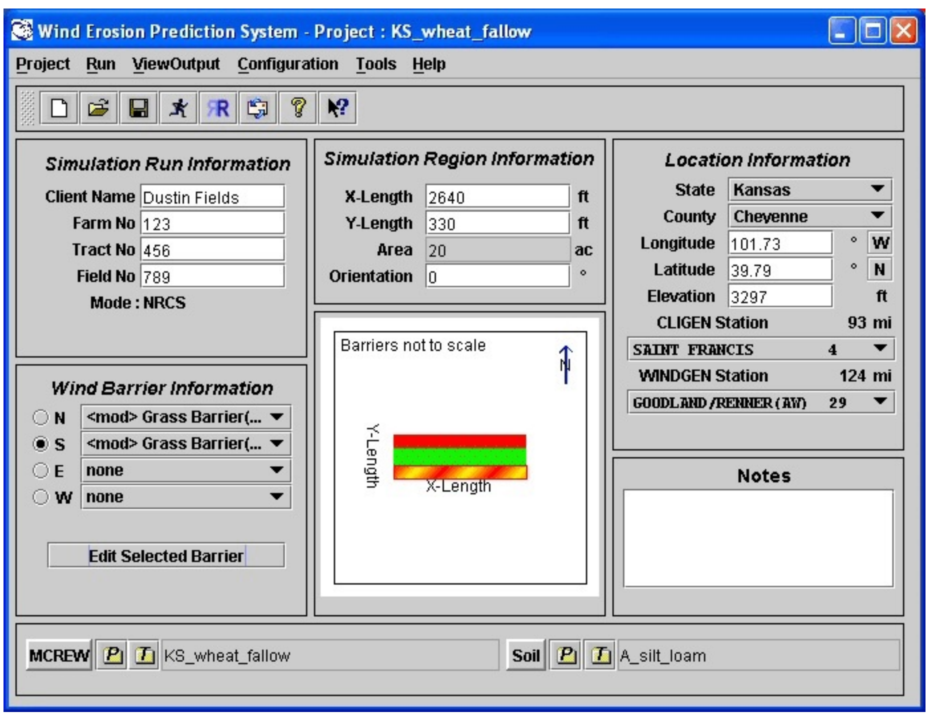


Figure 6.26. Main screen showing the setup for a field, strip cropped with grass barriers.

As can be seen by the Run Summary (Fig. 6.27), 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 since 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. Since almost no creep/saltation is available to generate suspension size material one can conclude that most of the suspension is from loose suspension sized material on the surface.

The boundary loss for this scenario is shown is Figure 6.28. Both creep/saltation and suspension leaving the field were significantly reduced on the south boundary compared to the stripped without barrier case. Loss on the eastern boundary was only slightly reduced compared to the stripped without barriers.

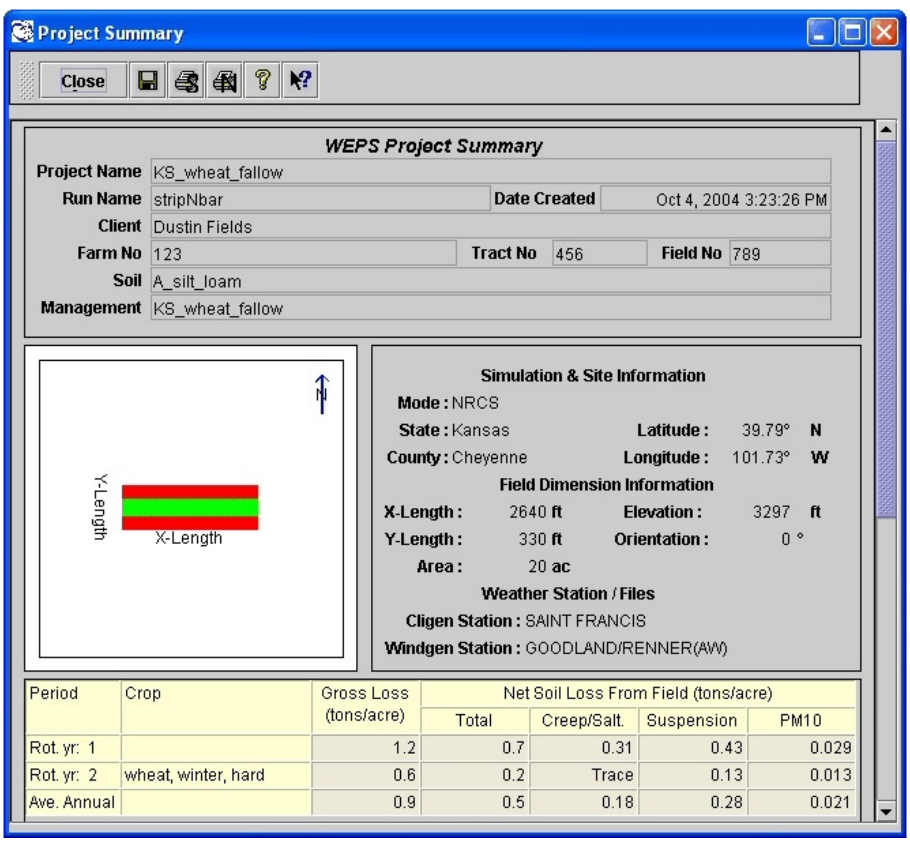
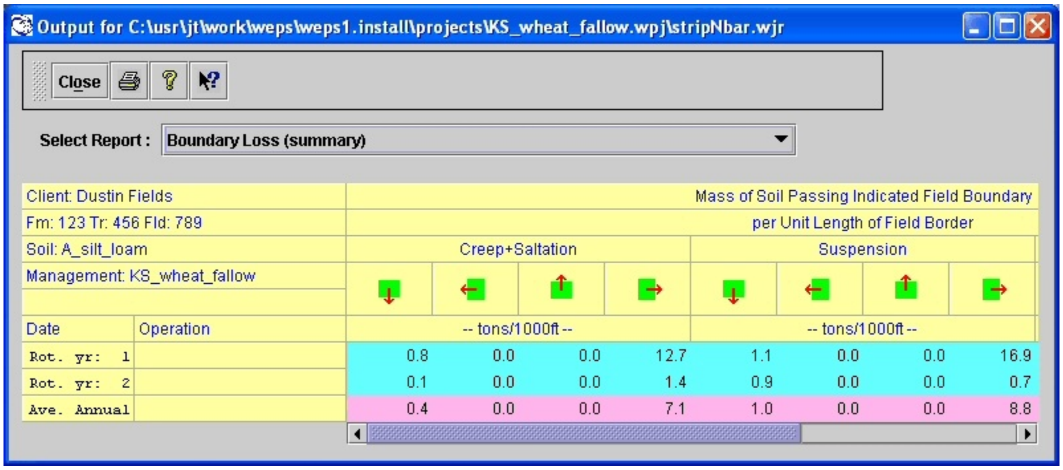


Figure 6.27. Run Summary report for the strip cropped with barriers scenario.



Client: Dustin Fields		Mass of Soil Passing Indicated Field Boundary							
Fm: 123 Tr: 456 Fld: 789		per Unit Length of Field Border							
Soil: A_silt_loam		Creep+Saltation				Suspension			
Management: KS_wheat_fallow		↓	←	↑	→	↓	←	↑	→
Date	Operation	-- 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 6.28. Boundary Loss summary for the strip cropped with barriers scenario.

Strip Cropping on a Soil with Excessive Erosion

This set of examples contain 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. 6.29) indicates an annual average loss of 96.0 tons/acre/year with and 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. 6.30) shows that the most loss passes the southern boundary and so shortening the field in the north-south direction by stripping is a control strategy that should be considered.

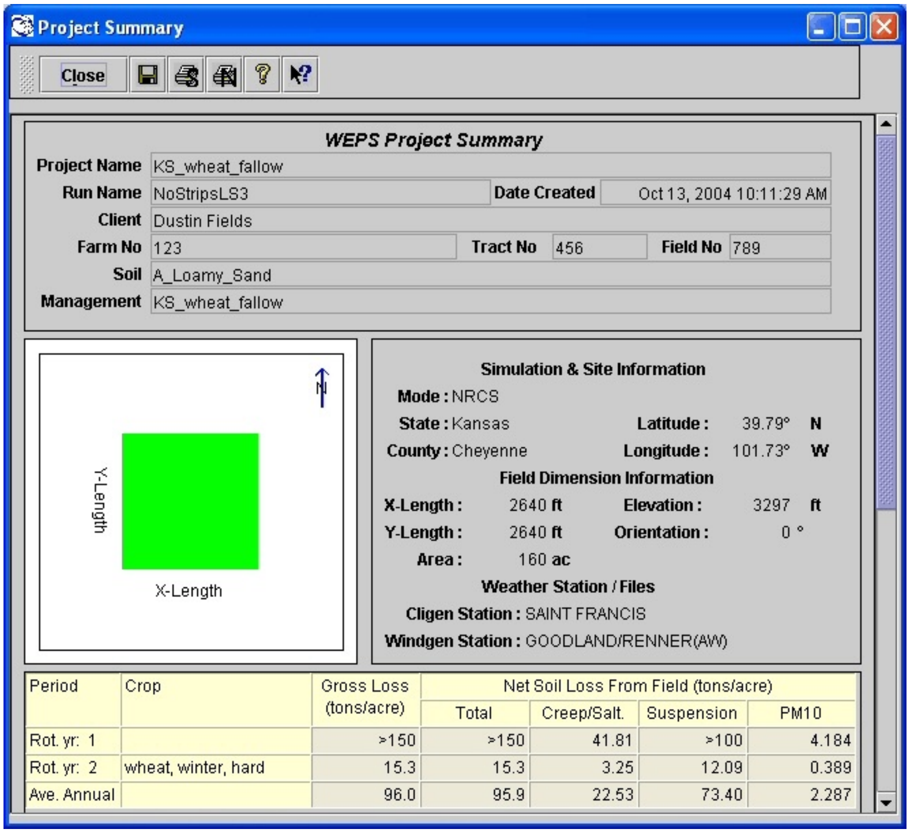


Figure 6.29. Run Summary for the non-stripped scenario with a loamy sand soil.

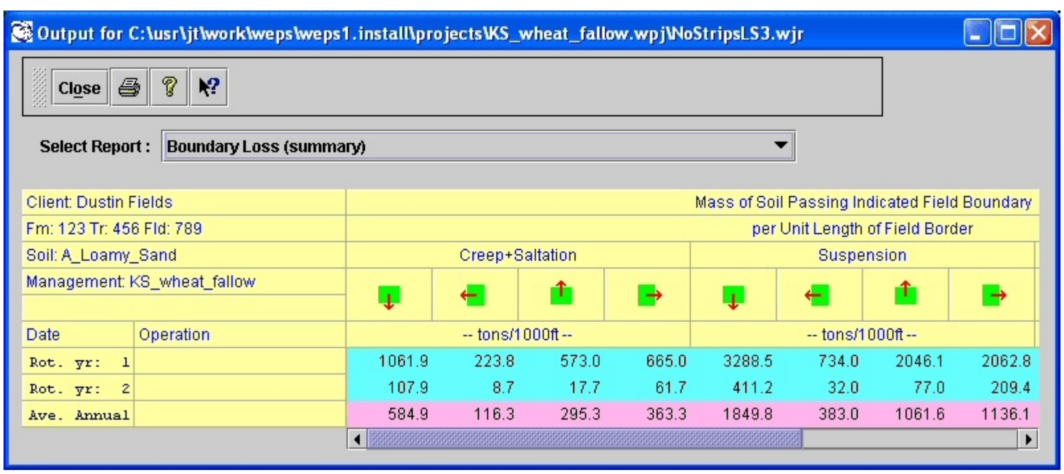


Figure 6.30. Boundary Loss summary for the non-stripped field with a loamy sand soil.

To observe the effects of strip width on this loamy sand field, we begin with a field divided into thirty two, 82 feet 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 6.1 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 6.1. 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. 6.10) and suspension-size aggregates (Fig. 6.11). 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. Generally, there 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, since these particles continually diffuse into the atmosphere. Consequently, the mass of suspended material increases over the entire length of eroding fields, with the rate of increase controlled by the erosion processes.

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 varying field length 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. 6.10) and the suspension-size soil (Fig. 6.11). After saltation/creep reaches transport capacity, dividing the nearly-constant transport capacity by field length to give average soil loss shows there is a steady decrease in loss per unit area with increasing field length (i.e., area increases while 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. 6.12). Generally, the maximum average soil loss occurs at a field length where 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 where there is a maximum soil loss and the average loss then decreases beyond that field length (Fig. 6.12a). In this case, 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. On the other hand in WEPS, 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. However, the effect of reducing field length on erosion is not linear, 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 6.1), is a result of large increases in discharge relative to small increases in field area (i.e., left part of curve in Figure 6.10a and 6.10b for the loose, smooth field). However at some point down wind on wide fields, the creep/saltation discharge reaches transport capacity where loss and deposition are equal (i.e., where Figure 6.10a 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. 6.10a) and actually shows a decrease in loss of creep/saltation material as strips get wider (Fig. 6.10b and 6.12a). 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 case 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 6.1) 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 ft strip, as in the previous example, further reduces soil loss over the similar size strip without barriers (Fig. 6.31). 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. However, 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.

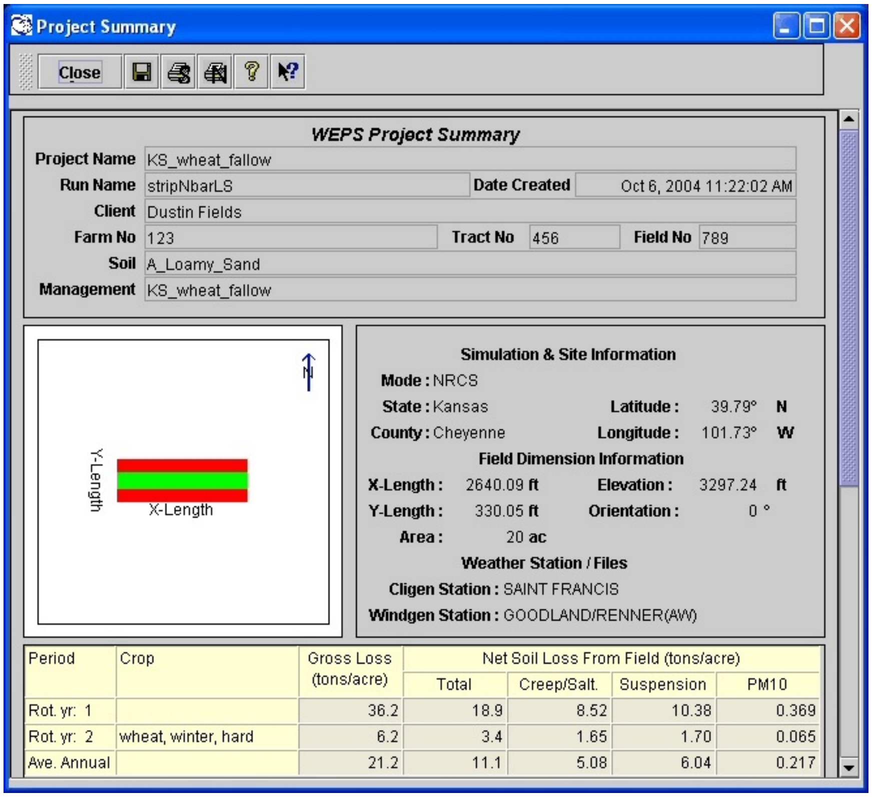


Figure 6.31. Run Summary for the strip cropped scenario of loamy sand with barriers.

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 6.32 and was created by delaying the sweep operations and eliminating a chisel operation in the fall of the second year.

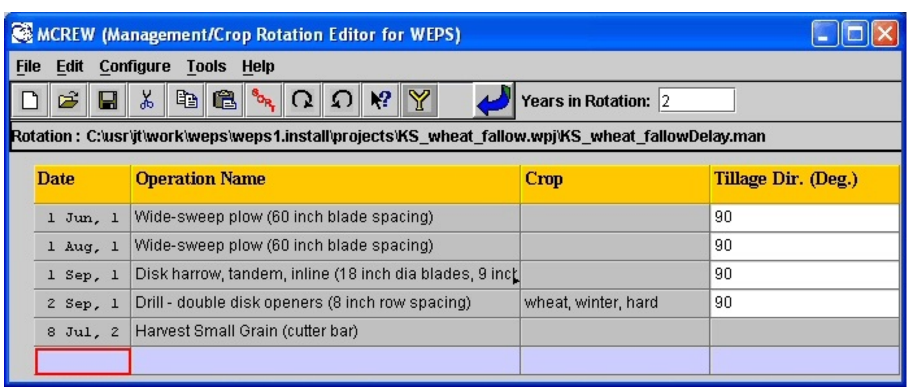


Figure 6.32. Management Crop Rotation Editor for a conventional wheat fallow rotation.

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. 6.33). Note that again the net loss was cut almost in half because of deposition just before the downwind barrier within the simulated strip. However, 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 or even the retirement of the land into permanent grass should be a possible consideration.

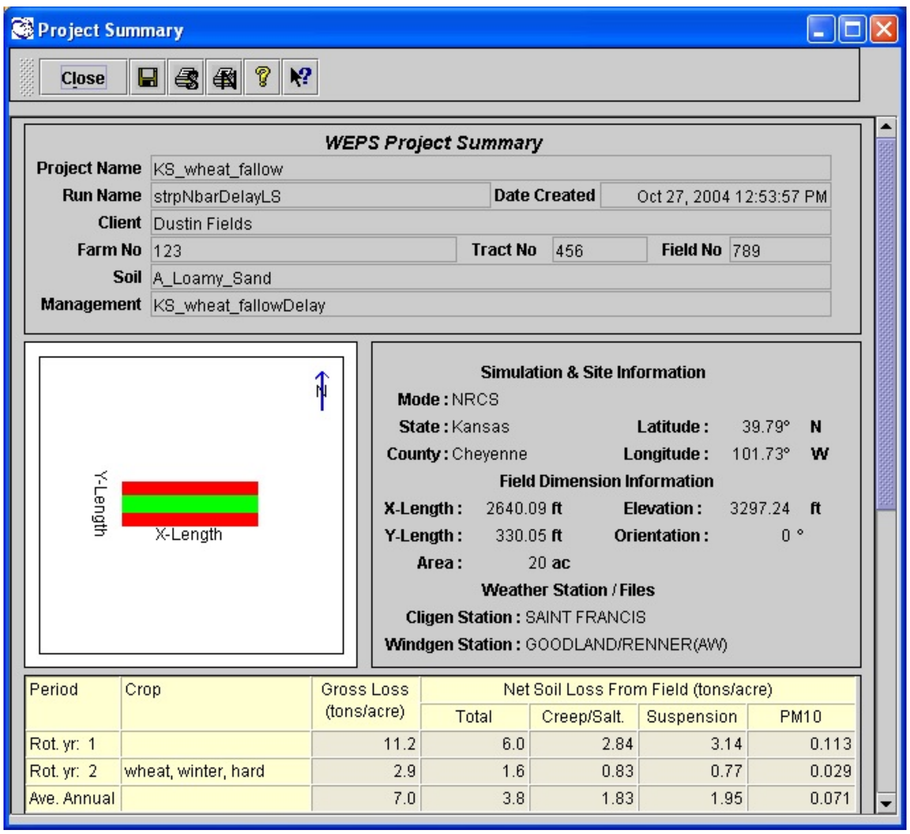


Figure 6.33. Run Summary for the strip cropped with barriers and a stubble mulch management system.

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. 6.34). 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.

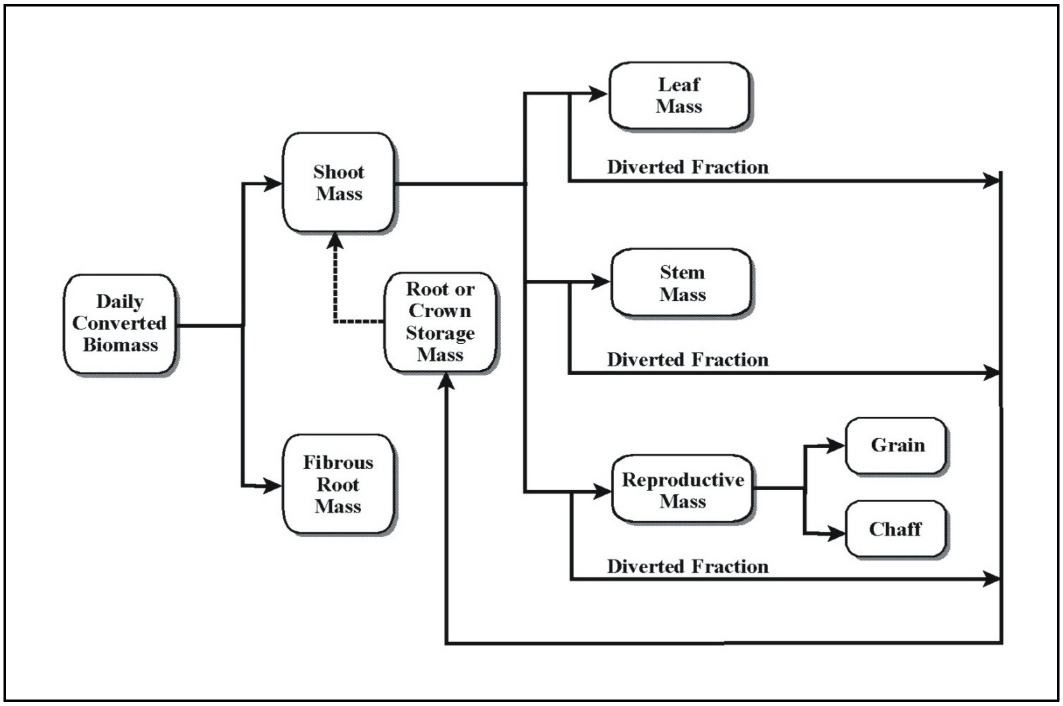


Figure 6.34. Schematic of biomass partitioning in WEPS. Biomass is converted from solar radiation and partitioned to 'fibrous root' and 'shoot' parts. The shoot mass is partitioned into leaf, stem, and reproductive masses, with some fraction of these masses diverted into a storage pool for crop regrowth. 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 which define the database structure are part of the MCREW configuration files. New individual crop database records are most directly created using MCREW to edit an existing crop file and saving it to a new name. New files can also be created using a text editor to edit the ***.crop*** file directly. The parameter descriptions below provide the keys to enable the reader to know which parameter he is editing using either method.

The parameters are defined below 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**, which is 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 6.2.

Table 6.2. 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 alternate units multiply by the given conversion factor (and add 32 where indicated).

Parameter Prompt	*Primary Units*	*Alternate 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}, "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}, which will grow from the planted (stored) mass, is calculated from:

$$\begin{aligned} n_{sh} &= \max\left[1, \min\left[n_{ms}, \frac{m_p}{m_{sh}}\right]\right] \\ N_{sh} &= N_p n_{sh} \end{aligned} \qquad \textbf{(6.1)}$$

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:

$$\begin{aligned} m_{st} &= \frac{0.7(1-0.4)m_p}{(r_{ls}+1)} \\ A_{st} &= a\left(\frac{m_{st}}{10^6}\frac{N_{sh}}{N_p}\right)^b \frac{N_p}{N_{sh}} \\ l_{st} &= \sqrt{\frac{A_{st}}{r_{dl}}} \end{aligned} \qquad \textbf{(6.2)}$$

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 - Cold 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, either days or heat units to represent the time from transplant to maturity; the planted mass, dry weight, to represent the size of the transplant; and the heat unit index at (pseudo) emergence, 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 to 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 below 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 above, 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 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 using 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 using this ratio. This parameter is the prime candidate for adjustment to insure 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 of the effect of vernalization on the calculation of average heat units is not implemented, all crop types 2 and 5 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 (°C 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
This is the fraction of the growing season (expressed as heat unit index) when 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 (°C)
The average daily air temperature below which the model will not allow plant growth (full temperature stress). This is commonly know as the minimum cardinal growth temperature and forms the base temperature for calculating heat unit accumulation.

Parameter Prompt: Optimum temperature for plant growth (°C)

The average daily air temperature at which the model will allow maximum growth (no temperature stress). This is commonly know 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:

$$fraction = 1 - \exp^{-k\ LAI} \tag{6.3}$$

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. 6.35). 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.

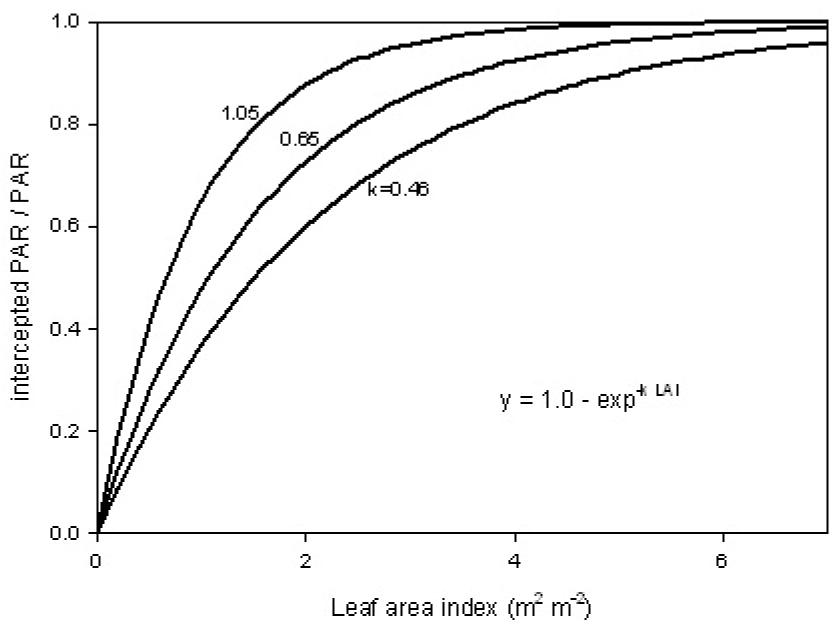


Figure 6.35. Relationship between leaf area index and fraction of light intercepted (intercepted PAR / PAR) for three different values of the light extinction coefficient k. WEPS uses k = 1.05 for cotton; k = 0.65 for corn, soybean, potato and sugar beet; and k = 0.46 for sorghum and millet.

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.

Partitioning Tab

The daily converted (grown) biomass is partitioned between root and shoot mass (Figure 6.34). The shoot mass (above ground biomass) is further partitioned into leaf, stem, and reproductive mass (Figure 6.36). 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.

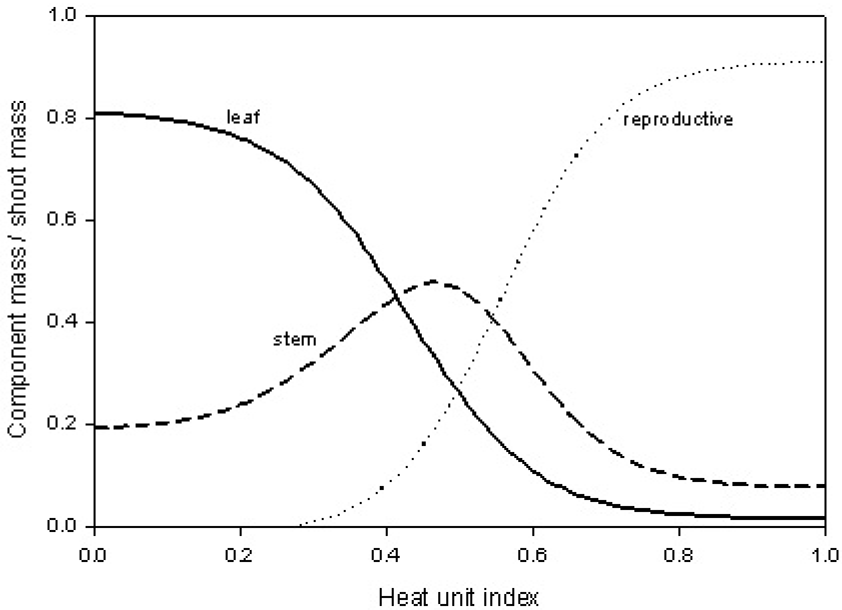


Figure 6.36. Partitioning of shoot mass (above ground biomass) into component mass for winter wheat. Components are leaf, stem, and reproductive mass. By definition, these three fractions always add to 1.0.

Specify the four parameters for the leaf curve (Figure 6.37):

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).

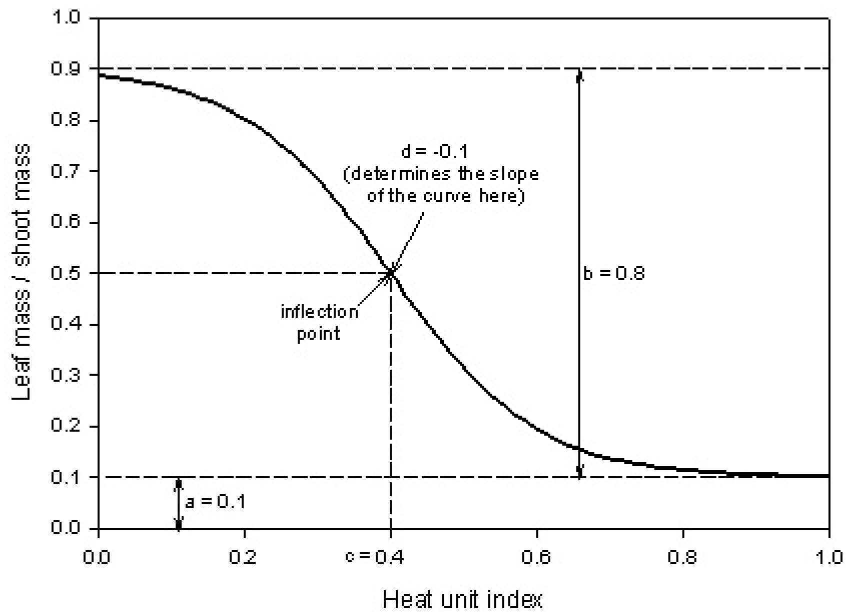


Figure 6.37. Partitioning of shoot mass into leaf mass. In this example, a = 0.1, b = 0.8, c = 0.4, and d = -0.1. The leaf mass / shoot mass ratio at the inflection point = a + b/2 = 0.5.

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 based on 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 the two parameters below 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:

$$residue = r \times yield + b \qquad \textbf{(6.4)}$$

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 above 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 equation above, this is the incremental increase in residue for each additional unit of yield above the minimum.

Parameter Prompt: Residue : Yield intercept (kg/m^2)

Parameter *b*. As defined for the equation above, this is the minimum biomass required for a crop to generate any yield.

Biomass is stored in the root (or crown) storage pool based on 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 which store biomass during different periods of the growing season (Fig. 6.34).

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
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 too high a crop (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 6.38). 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.

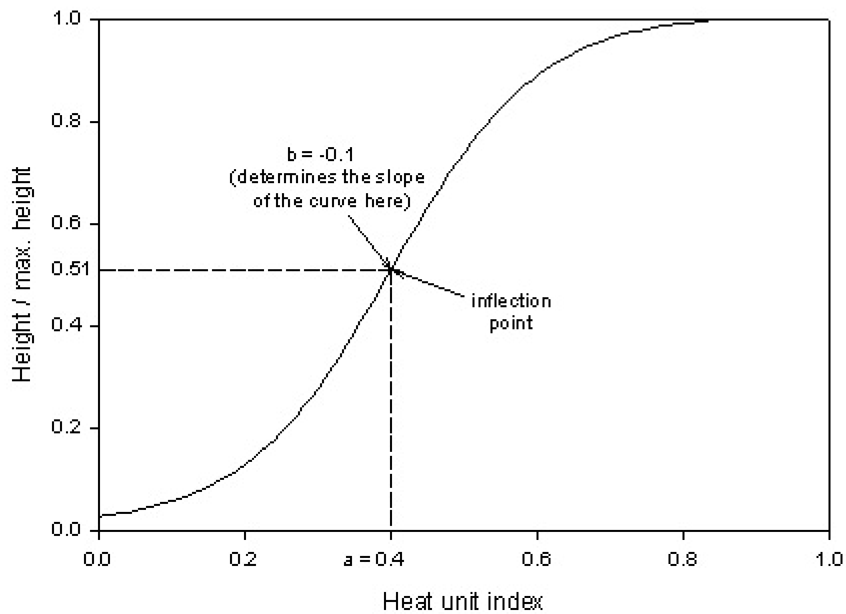


Figure 6.38. Crop height development function as it would be without any stresses. In this example, a = 0.4 and b = -0.1. The height ratio at the inflection point = 0.51.

Specify the two parameters for the crop height development curve (Figure 6.38):

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 parameters above can be adjusted based on the crop height (the variable ‘height' in the output file ‘crop.out’). If WEPS simulates too high a crop 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 result in 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 6.39). For example, using Figure 6.39, if the daily minimum temperature of the top soil layer equals -15 ºC, the green leaf area is reduced by 95% on this day.

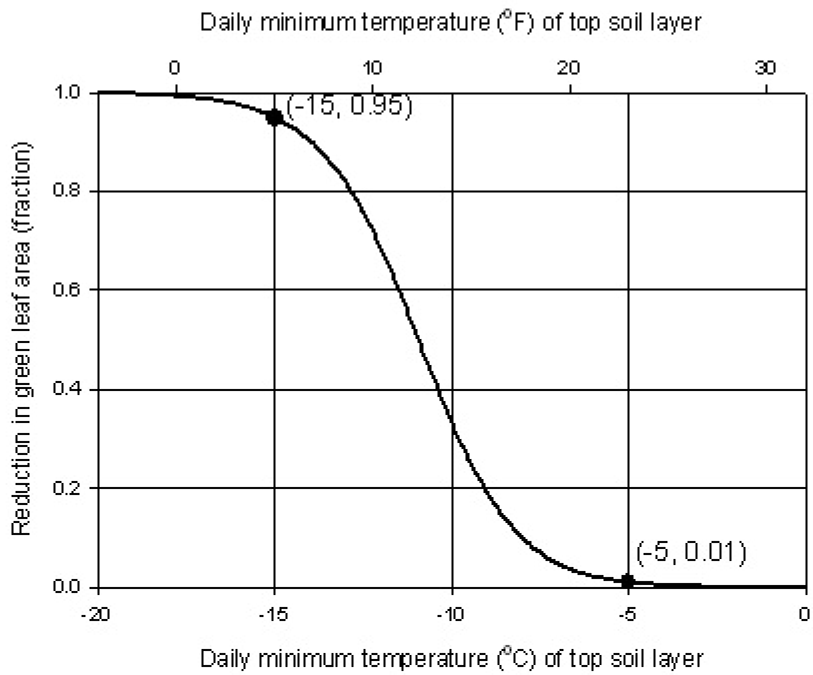


Figure 6.39. Reduction in green leaf area due to frost damage for corn.

The user can specify the frost damage curve by specifying two points on the curve. The curve for corn in Figure 6.39 is specified by the points (-5, 0.01) and (-15, 0.95). Use the Excel spreadsheet 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 6.39.

Parameter Prompt: Reduction in green leaf area at higher temperature
This is 0.01 (1%) for the example in Figure 6.39.

Parameter Prompt: Lower temperature (ºC)
This is -15 ºC (5 ºF) for the example in Figure 6.39.

Parameter Prompt: Reduction in green leaf area at lower temperature

This is 0.95 (95%) for the example in Figure 6.39.

For a new crop, the four parameters above 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 which 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 (partially) 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 which are not explicitly specified as a plant part in the model. To compensate for this, a mass fraction can be specified (see "Harvested fraction of plant component" below) 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 which will be divided if that plant component is harvested. Choice 1 specifies a type of crop where early season reproductive development is all chaff and awns, not grain. If the crop is harvested before maturity, grain development is incomplete. Internally, the model 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, where all the reproductive mass is removed from the field. In this case, 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 below;

1 - harvested grains, such as wheat, oats, barley, milo, corn. For a crop like corn, ear corn would have a higher value for the "Harvested fraction of plant component" than shelled corn, where the cob is left in the field;

2 - hay or forage crops, green vegetable crops. The "Harvested fraction of plant component" in most cases would be 1.0, indicating that all aboveground biomass above the cutting height is removed from the field. It should be less than 1.0 for a crop where significant portions of the aboveground biomass above the cutting height are left behind in the field. This comment also applied to choices 3 and 4.

3 - tobacco and similar crops;

4 - Sugarcane and similar crops;

5 - Potatoes, peanuts, sugar beets.

In all cases, 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 "Harvested yield conversion factor" (see below) should be used to account for post harvest processing into marketable components.

Parameter Prompt: Harvested fraction of plant component (grain fraction etc.)

See "Which plant component is (partially) 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 below.

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 above. 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 which 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 higher percentage of small, fragile residue and a lower 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 below. 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 greater number means that stalks fall faster. Only after a threshold has been reached (see above), stalks will 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’ (see above) 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 greater 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 cannot 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 only look at this variable 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').

Currently in WEPS, the four parameters above (decomposition rate parameters for standing, flat, buried and root mass) 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 the six parameters above, be sure to look at a no-till situation, since 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:

$$C_f = 1 - \exp^{-b\, M_f} \qquad \textbf{(6.5)}$$

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 6.40, 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 equation above 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.

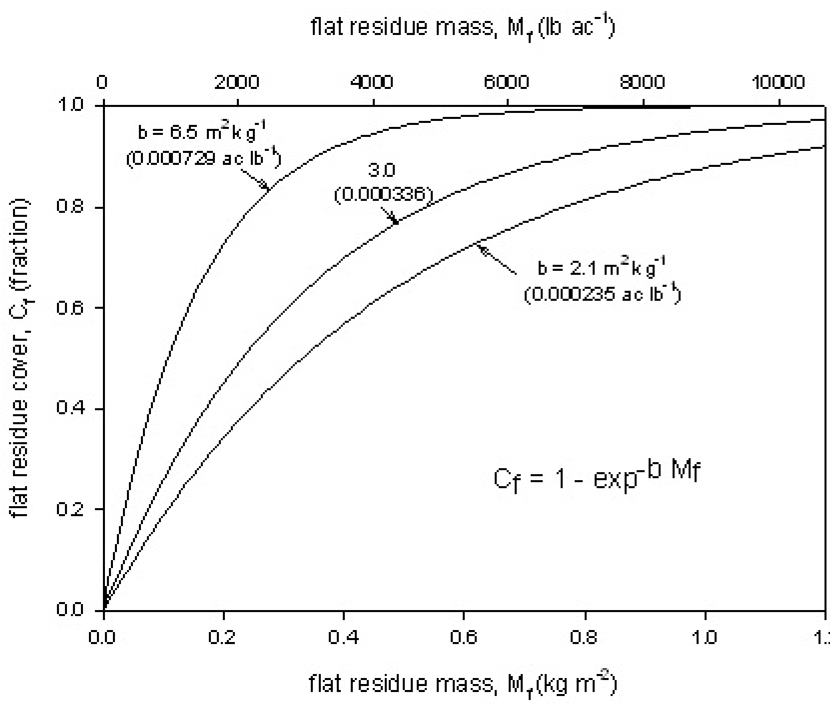


Figure 6.40. Relationship between flat residue mass and the cover provided by this flat residue for three different values of the mass to cover factor b. WEPS uses b = 6.5 $m^2\ kg^{-1}$ for wheat, barley, oats, rye and triticale; b = 3.0 $m^2\ kg^{-1}$ for corn, sorghum and millet; and b = 2.1 $m^2\ kg^{-1}$ 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 the paper for, cotton, sorghum and wheat, was refit to an exponential power relationship

$$r_e = \exp^{(a_e M_f^{b_e})} \quad \textbf{(6.6)}$$

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 in the paper. If additional research is available, intermediate curves can be developed using the "evaporation suppression" tab within the spreadsheet "howtopcropdb.xls" (available from WERU). Otherwise, use the numbers for the crop that most closely characterizes 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

Calibration Tab

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.

Parameter Prompt: Biomass adjustment factor
Multiplier used with biomass conversion efficiency (see below) 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.

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 Appendix 1 and 2. Appendix 1 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 2 shows how the answers to these questions were used to determine parameter values for flax.

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Appendix 1: 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 1). 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 us information needed to include flax (seed) in our model. We are always asking for the average, if not specified otherwise, e.g. average plant population, average planting depth, etc.

In general, which one of the current WEPS crops (Table 1) 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:

$$fraction = 1 - \exp^{-k\ LAI} \tag{6.7}$$

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 higher 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 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.
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 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:

$$residue = r \times yield + b \qquad (6.8)$$

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 above 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 me if you have any questions. Thank you very much for helping us to include flax (seed) in our model.

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Table 1. Crops currently simulated by the WEPS crop submodel.

alfalfa, seed
asparagus, crowns
asparagus, transplants
barley, spring
barley, winter
bean, dry, chickpea, garbanzo
bean, dry, navy or pea beans
bean, dry, pinto bean
bean, dry, red kidney
bean, snap (green)
broccoli, direct seeding
broccoli, transplant
cabbage,chinese,head,70-day, transplants
cabbage,chinese,pak choi,45-day
cabbage,head,120-day, transplants
cabbage,head,75-day, transplants
cabbage,head,90-day, transplants
canola, spring
canola, winter
cantaloupe, direct seeded
cantaloupe, transplants
carrot
cauliflower, direct seeding
cauliflower, transplants
clover, alsike, biomass
clover, alsike, seed
clover, red, biomass
clover, red, seed
clover, sweet, biomass
clover, sweet, seed
corn, grain, 100
corn, grain, 110
corn, grain, 120
corn, grain, 130
corn, grain, 90
corn, pop
corn, silage
corn, sweet, fresh, early
corn, sweet, fresh, late

corn, sweet, seed
cotton, High Plains
cotton, Southeast
cotton, West
cotton, pima
croplist.out
cucumbers, direct seeded
cucumbers, transplants
eggplant, transplants
grass, big bluestem, biomass
grass, big bluestem, seed
grass, blue grama, seed
grass, blue grama,biomass
grass, indian, biomass
grass, indian, seed
grass, little bluestem, biomass
grass, little bluestem, seed
grass, sideoats grama, biomass
grass, sideoats grama, seed
grass, smooth brome, biomass
grass, switch, biomass
grass, switch, seed
honeydew, direct seeded
honeydew, transplants
lentils
lettuce, head, transplants
lettuce, leaf, transplants
millet, foxtail, seed
millet, pearl, forage
millet, pearl, seed
millet, proso, grain
muskmelon, direct seeded
muskmelon, transplants
mustard, yellow
no crop
oats, spring
oats, winter
onions, bulb, direct-seeded, early
onions, bulb, direct-seeded, late
onions, bulb, transplants, early
onions, bulb, transplants, late

onions, green, direct-seeded, early
onions, green, direct-seeded, late
onions, green, transplants, early
onions, green, transplants, late
onions, seed, direct-seeded
pasture, spring
pasture, winter
peanuts
peas, green
peas, spring
peas, winter
peppers, bell, transplants
pineapple, transplants
potato, sweet
potato,early
potato,late
rice
rye, spring
rye, winter
safflower
sesbania, green manure
sorghum, grain, 100 days
sorghum, grain, 110 days
sorghum, grain, 120 days
sorghum, grain, 130 days
sorghum, grain, 90 days
sorghum, hay
sorghum, silage
soybean, MG 0, 95 days
soybean, MG I, 100 days
soybean, MG II, 110 days
soybean, MG III, 120 days
soybean, MG IV, 125 days
soybean, MG V, 130 days
soybean, MG VI, 140 days
soybean, MG VII, 160 days
spinach
strawberry, day-neutral, one season
strawberry, short-day; or day-neutral, multiple seasons
sudangrass, hay, silage, or pasture
sudangrass, seed

sugarbeet, seed
sugarbeet, sugar
sugarcane, hawaii (tropical)
sugarcane, mainland (semi-tropical)
sunflower
tobacco, leaf, transplants
tomato, direct seeded
tomato, transplants
triticale, spring
triticale, winter
watermelon, direct seeded
watermelon, transplants
wheat, durum
wheat, spring
wheat, winter, hard (forage)
wheat, winter, hard
wheat, winter, soft white

Appendix 2. Documentation of crop parameter values for flax (seed)

This appendix documents crop parameter values for flax (seed) and it describes how knowledge about flax is used to determine flax parameter values. We started flax with a copy of spring oats (Myers, 2005). Whenever there are no flax parameter values shown below, we use the same value as for spring oats.

We used the WEPS DB Viewer to create the flax crop from spring wheat:
Select Spring Wheat
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 wheat.
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, 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 with this value we don't get emergence.
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 (see below) 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 wheat is 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)
90-120 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)
- asap 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 for all ten cycles). 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, based on the planting date of 25 May (day 145), we would expect the crop to mature on average on day 245. However, 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 date. 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 85-90 days after planting (Tanaka, 2005)
Leaves stay green long. In North Dakota, senescence starts late July, early August (Myers, 2005)
Using 0.85 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. However, field data shows that flax yield and residue is about half 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 (partially) harvested: 1 - increasing fraction of reproductive mass (grain)

Parameter Prompt: Harvested fraction of plant component (grain fraction etc.): 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)

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 is a variable which can significantly influence a site's "surface, soil, biomass" state over time. It is an important variable because it is the primary factor which 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 cropland. 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., which 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, 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 drilldown" 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.

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 6.41.

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 6.41. Partial WEPS definition of a springtooth harrow tillage implement.

Note in Figure 6.41 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 have a unique identification number. All the valid operation lines are listed and defined later.

The second line in Figure 6.41 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 which represent an operation are simulated in the order specified in the management operation record. In this case, the springtooth harrow performs the following actions in the given order: 1) breaking surface crust if it exists; 2) creates a specified random roughness on the surface; 3) removes any ridges and dikes that may be present prior 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; 6) kills any growing vegetation; etc.

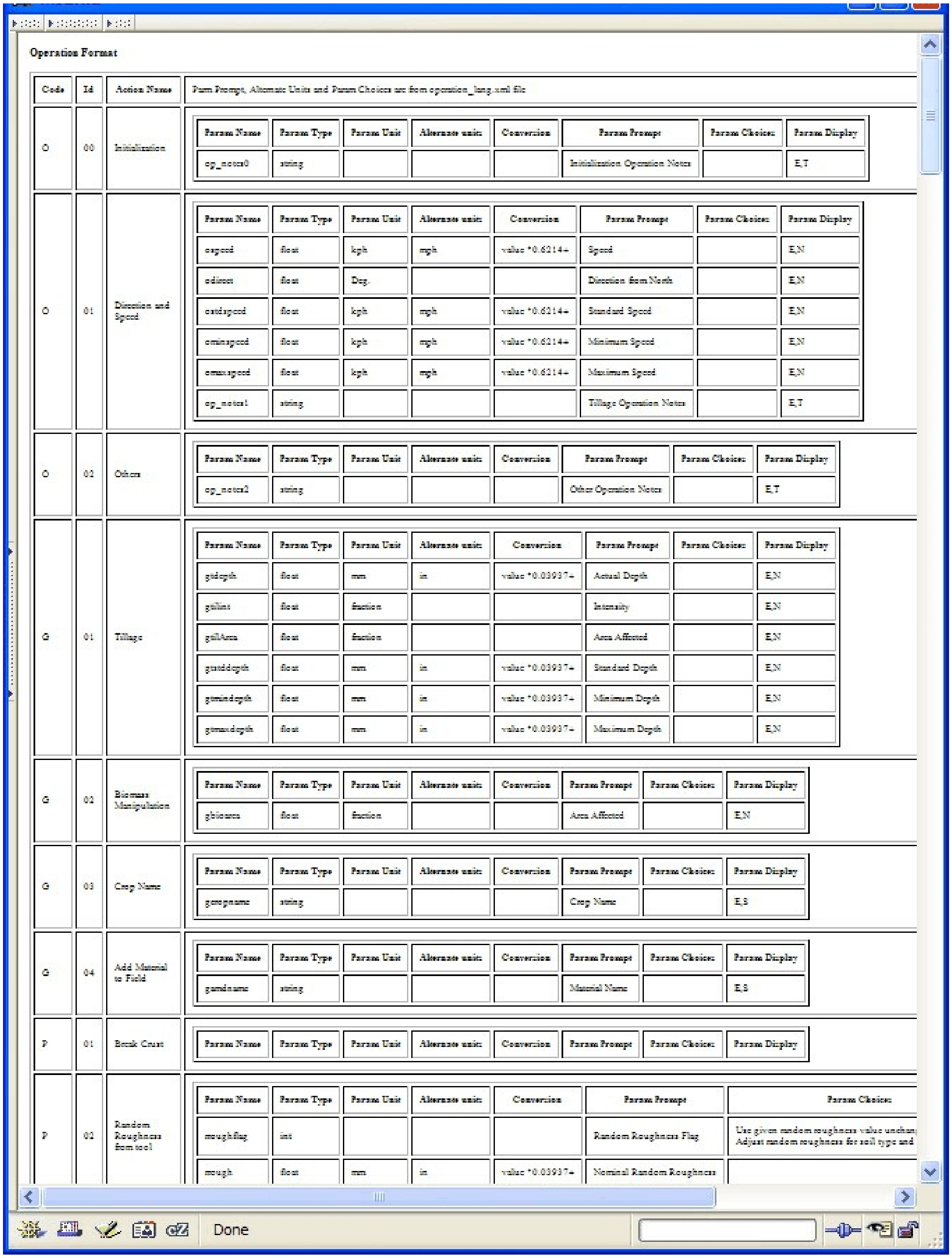
Therefore, each “process” line may contain one or more parameters required for WEPS to simulate the particular physical process or action represented by that line in the model. Some of these physical processes may require additional parameters which happen to be needed by other, related processes. For 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. However, to properly simulate these physical actions, 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. Since it will have the same value for both the mixing and loosening actions being simulated, it is made available in one location as a “shared” parameter. 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 prior to those "process" lines. Since 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 description below provides the keys to enable the reader to know which parameter he or she is editing. A current reference table is easily viewed by opening the ***operation_defn.xml*** file in a web browser as seen in Figure 6.42.

The parameters defined below are described by a **Parameter Prompt**, which is the text that appears in MCREW, **Parameter Unit**, which is the named unit that the WEPS science model expects the parameter value to be in, **Conversion Factor**, which is the combination of multiplier and additive terms which will convert the parameter value from the default Parameter Units, **Param Units** (SI), to the specified Alternate Units, **Alternate Units** (English), which is the named unit that values will be displayed in given the selection of units in the WEPS configuration, and **Parameter Choices**, which is a list of choices which will be 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

Parm 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
			gtilArea	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		

Figure 6.42. Partial listing of a WEPS "operation_defn.xml" file that defines management operation actions, their parameters and their various attributes.

Management Operation Parameter Definitions

<u>O 00: Initialization</u>

The “Initialization” operation line represents a special type of operation. It is intended to be used where 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.

<u>O 01: Direction and Speed</u>

Many management events, like tillage operations, where the actual speed and/or the direction 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 at.
> *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, that 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 affects 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. Internally in WEPS, many of these coefficients are then adjusted 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 which 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 which 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.

<u>O 02: Others</u>

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. However, it also requires one to ensure that any process line that requires a "shared" parameter to have the appropriate "group" line specified prior to 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 for example) 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. Internally in WEPS, many of these coefficients are then 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 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 which 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 where 1/3 of the crop was to be left in the field for wildlife purposes or where 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 which specifies the fraction of the surface area which this effect applies.

P 01: Random Roughness

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 become 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. Since 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

<u>P 11: Aggregate Crushing</u>

Parameter Prompt: Aggregate Size Distribution Factor

Parameter Unit: unitless

Parameter Prompt: Crushing Intensity Factor

Parameter Unit:
Conversion factor: 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 with which standing crops and/or residue are flattened. There are "flattening coefficients" specified for various types of "residue" based upon 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).

Parameter Unit: fraction

P 25: Bury Flat Biomass

This process specifies distribution and the degree with which crops and/or residue are buried. There are “burial coefficients” specified for various types of “residue” based upon its “toughness/size”. The five types of residue classes are specified above 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 with which buried residue are brought back to the surface.

There are “re-surfacing coefficients” specified for various types of “residue” based upon its “toughness/size”. The five types of residue classes are specified above 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

P 31: Kill or Defoliate Growing Crop

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

P 32: Cut/Remove Biomass to Height

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

<u>P 37: Thin Biomass to Population</u>

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 based upon 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 above 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 above for standing stalks.
Parameter Unit: kg kg^{-1} day^{-1}

Parameter Prompt: Decomposition rate for roots

See comments above 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 (see below), 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 discussed above. 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:

$$C_f = 1 - \exp^{-b\,M_f} \qquad \textbf{(6.10)}$$

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 6.40, 43).

Parameter Unit: $m^2\ kg^{-1}$
Conversion factor: value * 0.00011209
Alternate units: acres lb^{-1}

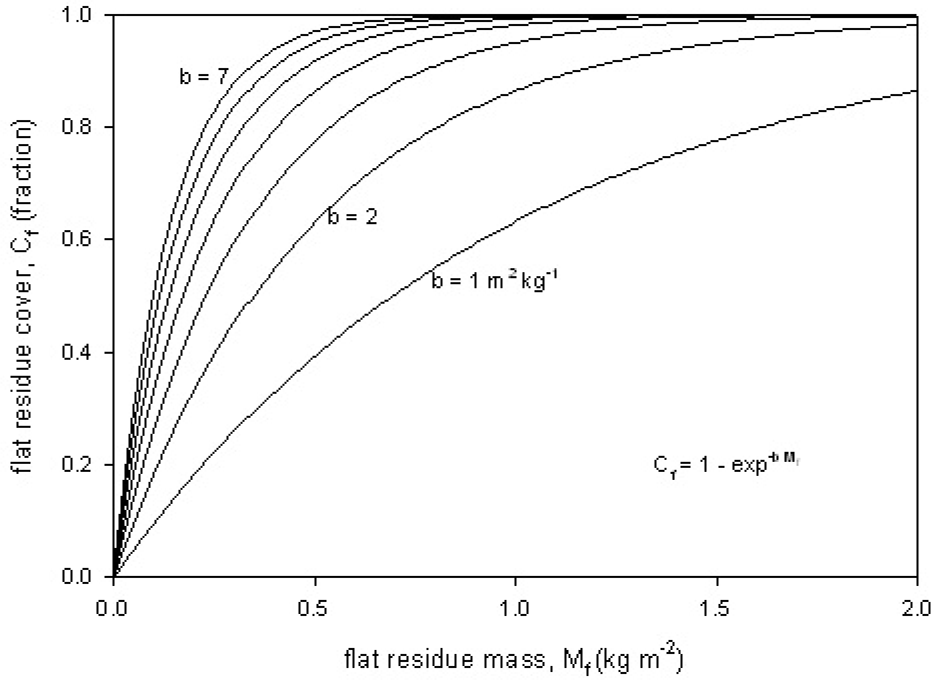


Figure 6.43. Relationship between flat residue mass and the cover provided by this flat residue.

Parameter Prompt: Residue Evaporation Suppression multiplier coefficient a

For

Parameter Unit: eratio = resevapa(kg/m^2)**resevapb

Parameter Choices:

Parameter Prompt: Residue Evaporation Suppression multiplier coefficient b

For

Parameter Unit: eratio = resevapa(kg/m^2)**resevapb

<u>P 51: Seeding Configuration</u>

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/modify 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