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Staff Paper P94-23 December 1994

STAFF PAPER SERIES

User's Guide

General Weed Management Model
Version 1.0 - December 1994

Developed by
L.J. Wiles, Robert P. King, Donald W. Lybecker,
E.E. Schweizer, and Scott M. Swinton

Programming by
P.A. Held, L.J. Wiles, R.P. King, and D. Engel

DEPARTMENT OF AGRICULTURAL AND APPLIED ECONOMICS

COLLEGE OF AGRICULTURE

UNIVERSITY OF MINNESOTA

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Disclaimer

The University of Minnesota, U.S. Department of Agriculture-Agricultural Research Service, Michigan State University, and Colorado State University make no warranties, either expressed or implied, with respect to the GWM program's fitness for any purpose. GWM is available solely on an "as is" basis. The authors and these institutions reserve the right to revise and improve this program as they see fit without any obligation to notify any person or organization of such revision or changes.

Reference in this software and manual to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement is implied.

Availability

The GWM installation disk is not distributed with this manual. Use the order form on the last page of this manual to request copies of the installation disk. There is a $10 handling and postage charge for each installation disk. You may also use the order form to request additional copies of this manual.

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1. Overview

1.1 Introduction to the General Weed Management Model

The General Weed Management Model (GWM) is a software package that evaluates soil applied and postemergence weed control strategies for row crops. This initial release version of GWM is designed for use and evaluation by researchers. In the longer run, however, GWM is being developed as a support tool for professionals who advise farmers on weed management strategies. This version of the program is not intended for field use, however.

GWM is an outgrowth of weed management modeling research in Colorado and Minnesota. It has two major components:

1. A database management system that allows the user to enter, edit, and review model parameters, information on weed control treatments, data on farms and fields, and scouting information.

2. A decision module that simulates biological and economic performance in order to evaluate alternative weed management strategies.

The model is designed to allow for considerable flexibility in the way data are entered and in the representation of biological processes.

GWM is still being field tested. Experience to date indicates that recommendations based on the model are sensitive to user-defined parameters for crop and weed biology and for weed control efficacy. Experience has also shown that appropriate values for those parameters can differ considerably across sites.

A data set developed for field testing of GWM in Minnesota is included on the installation disk. You can use this data base to familiarize yourself with the model. Also, by modifying key parameters, you can explore the sensitivity of the model to changes in model assumptions. Caution should be exercised, however, in adapting the parameters in this data base for use in a new setting.

Appendix A of this manual provides some technical information on the internal structure of GWM and on the range of alternatives for parameterizing the model. It also includes definitions for key terms and concepts used in the model.

1.2 Using this Manual

This manual explains how to install and use GWM on a personal computer. With the exception of the material presented in Appendix A, this manual does not provide explanations of conceptual foundations for GWM.

This overview, along with Section 2 on installation, may be sufficient for the new user who is impatient to get started. Sections 3 through 7 provide more detailed discussions of program functions.

Conventions used in this manual:

Menu names are bold and in caps:	**RECOMMENDATIONS**
Screen names are bold:	**Weed Seedling Counts**
Command line options are in italics:	*Select*

This symbol (☞) indicates a section with procedural steps.

Text representing words on the computer screen appears like this:

```
< Please wait ... recommendations module loading ... >
```

2. Installing GWM on Your Computer

The installation disk distributed with this manual contains all the program and data files you will need to start using GWM. This section explains the computer system requirements for installing and running GWM, installation instructions, and the basics of running the program. It also provides instructions for configuring GWM to work best with your monitor.

2.1 System Requirements

To install and use GWM, you will need:

- an IBM PC, XT, AT, PS/2, or 100 percent compatible computer
- a minimum of 640K memory (RAM) with at least 510K free memory
- DOS (version 5.0 or later)
- a high density floppy disk drive (3-1/2")
- a hard disk with at least 2 megabytes of available storage space
- a printer

If you want to use the graphics capabilities of GWM, your computer must have a graphics adaptor. GWM supports CGA, EGA, VGA, and Hercules graphics cards.

NOTE: You may need to modify the CONFIG.SYS file on your computer to run GWM. Your CONFIG.SYS file should contain the following statements:

```
files   = 60
buffers = 15
```

The number of files and buffers can also be set to numbers higher than 60 and 15, respectively. If there are no **files =** and **buffers =** statements in your CONFIG.SYS file, add them. If files and buffers are set to lower numbers, raise them to at least 60 and 15, respectively.

2.2 Installation

The GWM installation program:

- creates a program directory on your hard disk and
- copies all program and start-up data files onto your computer's hard disk

You must run the installation program before starting to use GWM. The program will not run if you simply copy the contents of the disks onto your hard drive.

☞ *Running the installation program*

1. Insert the Installation Disk in the floppy drive of your computer.

2. Change the active drive of your computer to the floppy disk drive. For example, if the floppy disk drive is A, type **A:** and press <ENTER>.

3. Type **install** and press <ENTER>. In a few seconds the **GWM Installation** screen will appear.

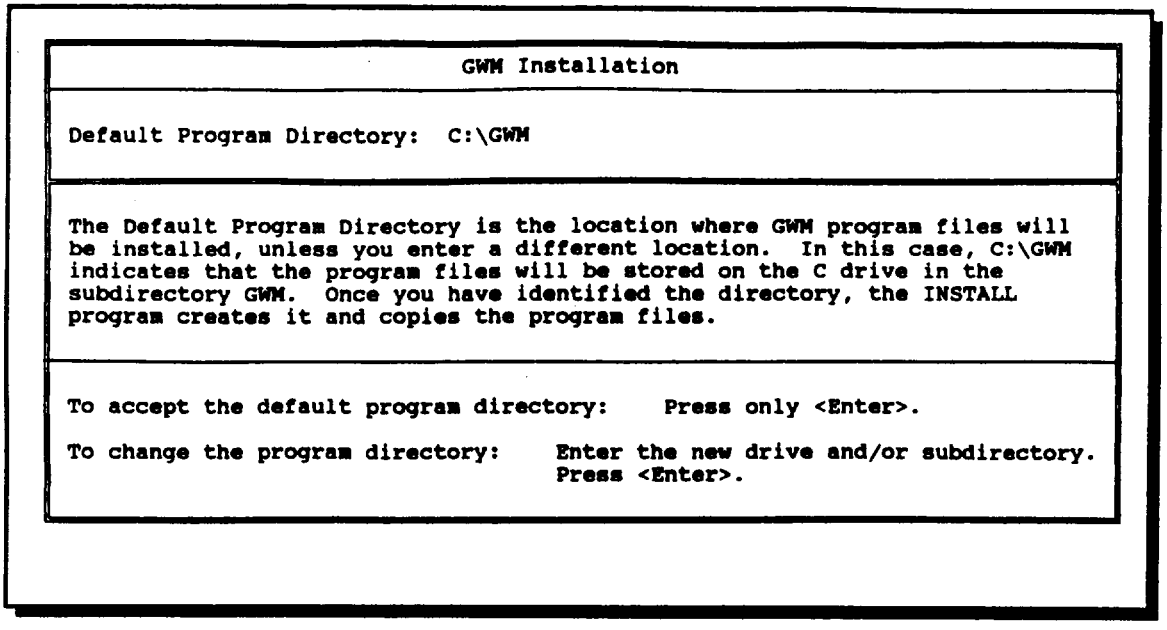
4. The default program directory for GWM is C:\GWM. To accept the default directory, press <ENTER>. To change the program directory, enter the new drive letter and/or directory name and press <ENTER>.

5. If the directory you have selected for installing GWM already exists, the following message will be displayed at the bottom of your screen.

   ```
   This directory already exists.  Do you want to
   overwrite it? (Yes/No)
   ```

   If you select **No**, you will be prompted to enter a new directory name. If you select **Yes** the program will proceed to copy the GWM files into the directory you have specified.

6. Once you have selected a program directory, the installation program will copy all the program and data files to appropriate locations on your hard disk. The names of the files being copied will be displayed on your screen.



2.3 *Starting Your First Session with GWM*

The first time you run GWM, you should familiarize yourself with the use of the menu system.

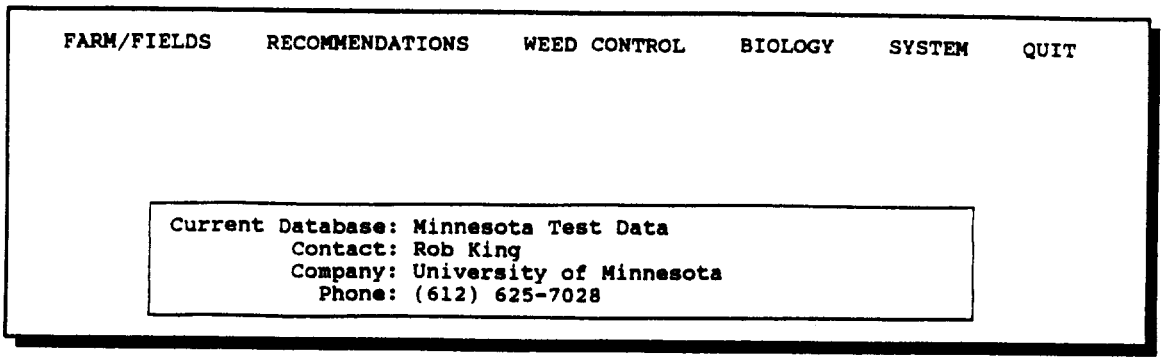
☞ *Starting GWM*

1. If necessary, change to the program directory. For example, if the program directory is C:\GWM, from the C:>prompt, type **CD\GWM** and press <ENTER>.

2. Type **GWM** and press <ENTER>.

3. In a few seconds, the title screen will appear. Press <ENTER> to continue.

4. The **Current Database** window shown at the top of the next page will appear next. GWM allows you to maintain multiple databases. For each database, you enter a descriptive name and information about a contact person who is maintaining the database.

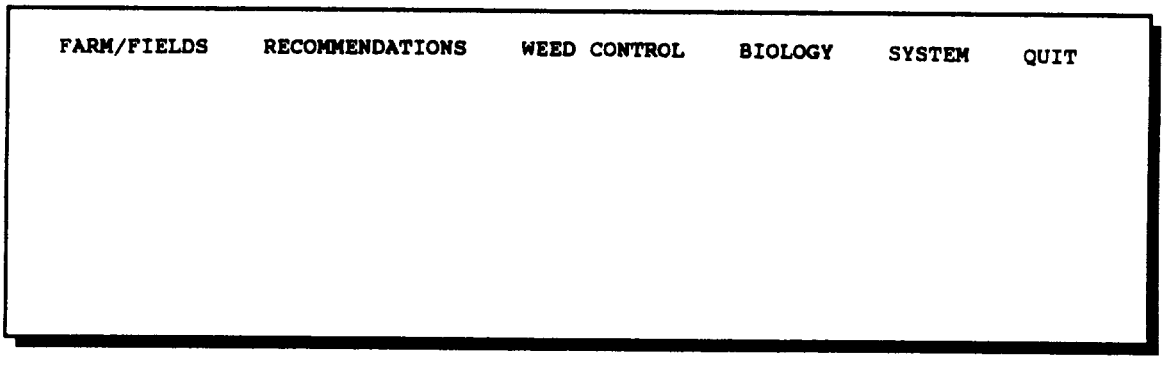


5. If you have defined multiple databases, the following question will appear on the command line:

   ```
   < Do you want to continue using the current
   database?  (Y/N) >
   ```

   Select **Y** if you want to continue using the current database. Otherwise, select **N** and select a database from the scrolling list.

The GWM main menu screen will appear next. This pull-down menu system is used to access all the features of GWM. There are six main menu categories displayed across the top of the screen: **FARM/FIELDS, RECOMMENDATIONS, WEED CONTROL, BIOLOGY, SYSTEM,** and **QUIT.** You can use the right and left arrow keys to move the highlight bar from one selection to another. You can press <ENTER> to view the pull-down menu for each main menu category.



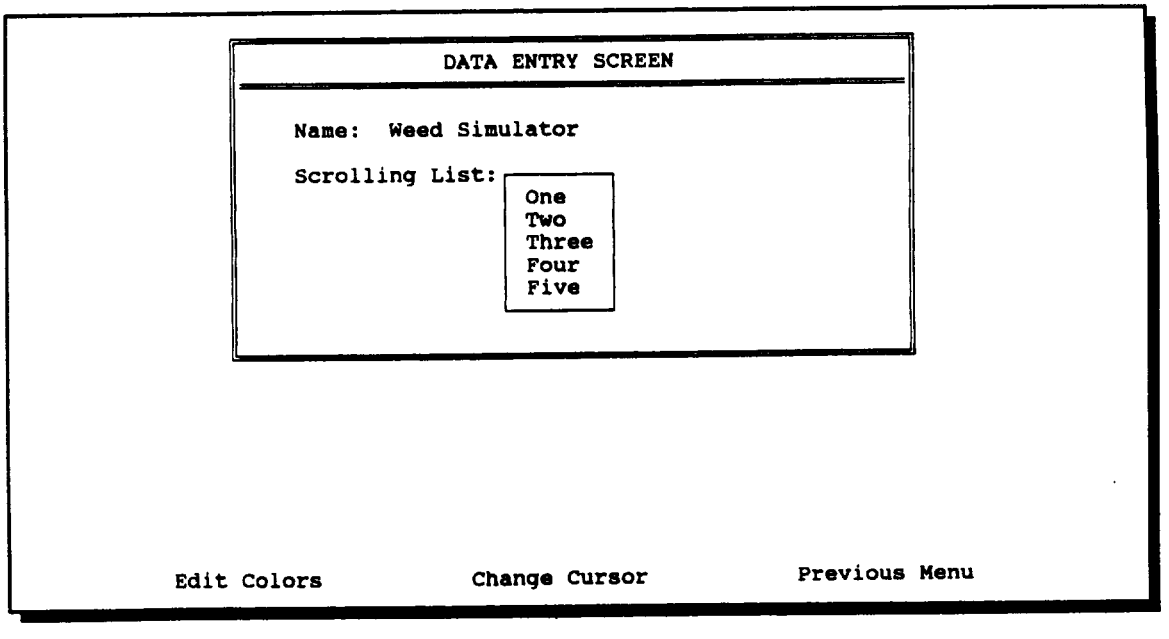
To end a session with GWM, move the main menu highlight bar to **QUIT.** If the pull-down menu is not already displayed, press <ENTER> to make it appear. Then press <ENTER> to confirm that you want to exit the program. All data files will be automatically updated and saved whenever data has been entered, so you need not be afraid of losing data when you end a session by exiting the program this way.

2.4 *Customizing Screen Colors*

The **Screen Colors** screen allows you to modify colors for data entry screens and scrolling lists and change the shape of the cursor.

☞ *Editing screen colors*

1. Select **SYSTEM** from the main menu.
2. Select **Colors** from the **SYSTEM** menu.
3. Select *Edit Colors* from the command line.
4. Select either *Data Entry* screen to change foreground and background colors of data entry screens or select *Scrolling List* to change foreground and background colors of scrolling lists.
5. Press ← → for foreground color changes. Press ↑ ↓ for background color changes.
6. Press <ENTER> to save current settings or <ESC> to restore original colors.
7. Select *Previous Menu* from the command line and then press <ENTER>.



☞ *Modifying the cursor*

1. Select **Colors** from the **SYSTEM** menu.

2. Select *Change Cursor* from the command line.

3. Press ↑ ↓ to change the cursor shape.

4. Press <ENTER> to save the current cursor or <ESC> to restore the original cursor.

5. Select *Previous Menu* from the command line and then press <ENTER>.

2.5 Tips for Running GWM

Some conventions are followed throughout much of the program to simplify the use of menus, scrolling lists, and data entry screens.

☞ *Using menus*

1. You can always move around menus or command lines by using the ↑ ↓ or ← → keys.

2. Alternatively, you can press the first letter of a menu selection to select that item.

3. Press <ESC> to return to previous menu.

☞ *Using scrolling lists*

1. You can use the ↑ ↓ keys as well as <Pg Up>, <Pg Dn>, and <HOME> or <END> keys to move within scrolling lists.

2. Alternatively, you can move through scrolling lists based on the first letter of the first word in the item. Pressing the same first letter again will advance you to the next occurrence.

3. Arrows at the top and/or bottom of a scrolling list indicate that there are more entries than there is space on the screen.

☞ *Entering data*

1. The ↑ ↓ arrow keys allow you to move around data entry screens without making changes.

2. Whenever a value is entered or changed, press <ENTER> to save the new value.

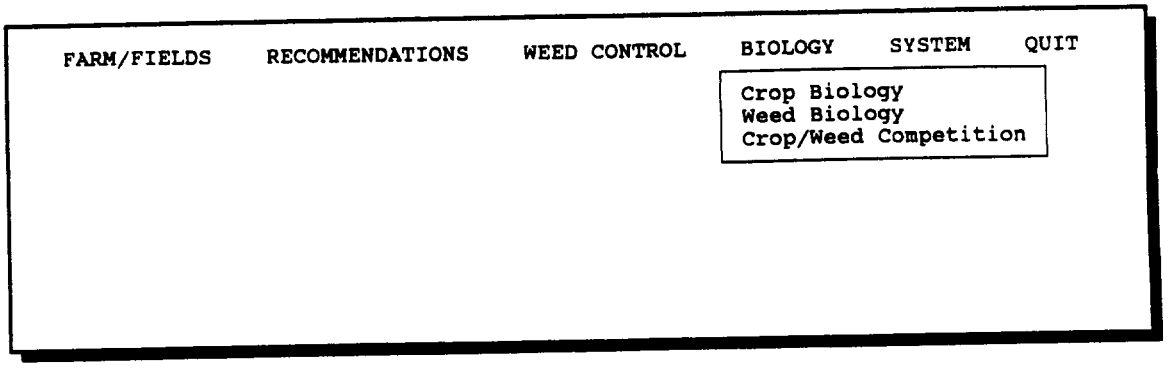
3. You can press <ESC> to end data entry without going to the end of the screen.

4. If you change a value and press <ESC> rather than <ENTER>, your last change will be lost and data entry will stop.

3. Crop and Weed Biology

GWM is a general model designed for use with row crops under a wide range of soil and environmental conditions. Therefore, users of GWM must enter parameters describing key biological relationships for each crop and weed to be included in the model.

The crop and weed biology section of GWM includes screens for entering biological parameters for a crop, biological parameters for a weed, and competitive indices used to describe crop/weed competition. These screens are accessed by selecting items from the pull-down menu under **BIOLOGY**.

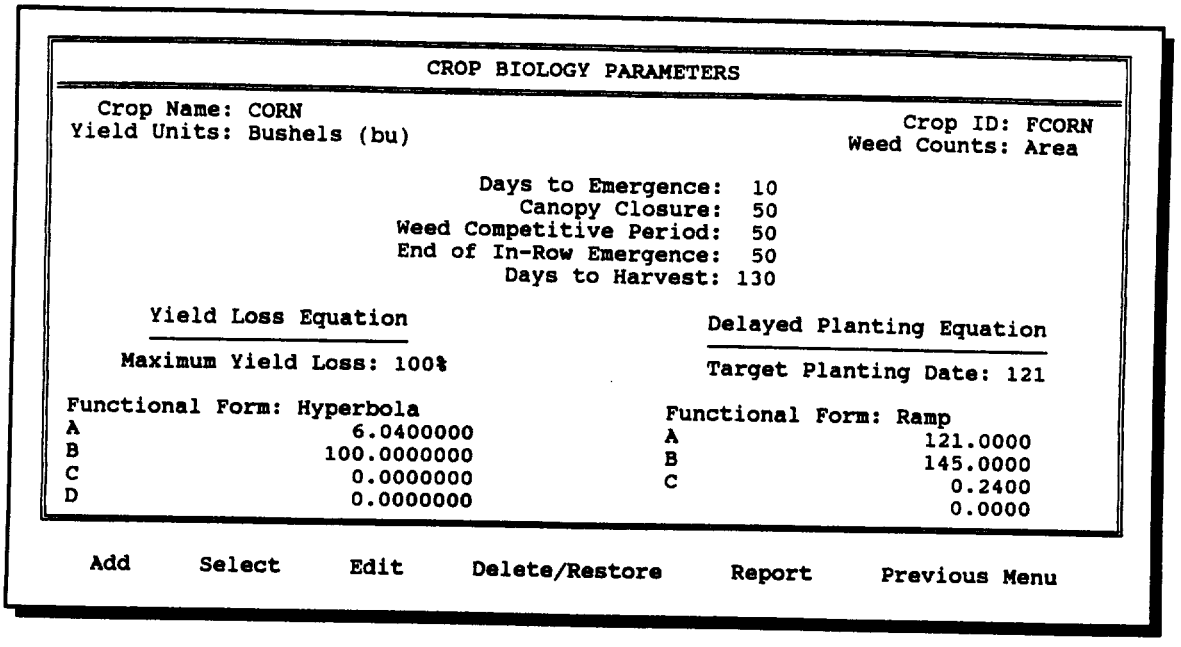


3.1 Crop Biology

Use the **Crop Biology Parameters** screen (shown on the following page) to add biological parameters for new crops to the GWM database, to edit biological parameters for a crop, to delete or restore crops from the database, and to print a report of biological parameters for a crop.

☞ *Adding a new crop to the database*

1. Select **Crop Biology** from the **BIOLOGY** menu.
2. Select *Add* from the command line.
3. Enter the crop name. A crop ID will be generated automatically by the program, but this can be modified if you wish. If you do change the crop ID, do not include any spaces in the new ID.
4. Select a yield unit from the scrolling list.



5. Select a weed count method from the scrolling list. The available choices are: Area--counts are made in an area that includes the area between rows; and Length--counts are made only within rows.

6. Enter values for Days to Emergence, Canopy Closure, Weed Competitive Period, End of In-Row Emergence, and Days to Harvest. All these parameters are measured in days after planting.

7. Enter information for the yield loss equation. Begin by specifying the maximum yield loss due to weed competition. Then select a functional form from the scrolling list and enter the parameters for that equation. Parameter definitions for the yield loss equations included in GWM are presented in Appendix A.

8. Enter information for the delayed planting equation. Begin by specifying the target planting date as a Julian date. Then select a functional form from the scrolling list and enter the parameters for that equation. Parameter definitions for the delayed planting equations included in GWM are presented in Appendix A.

9. When you have finished entering parameters for a crop, select *Save* from the command line to save the parameters you have entered; select *Edit* to edit the parameters you have entered; or select *Cancel* to cancel the data you have entered.

10. After you have saved or canceled the data for one crop, the following question will appear on the command line:

    `< Do you want to add another crop? (Y/N) >`

    Select **Y** to continue adding crops. Otherwise, select **N**.

☞ *Editing biological parameters for a crop*

The edit command can be used to correct the spelling of a crop name or to modify biological parameters for a crop.

1. Select **Crop Biology** from the **BIOLOGY** menu.
2. Use the *Select* command to choose a crop from the scrolling list.
3. Select *Edit* from the command line, and modify the parameters you wish to change.

☞ *Temporarily deleting/restoring a crop*

You may wish to delete a crop from the database without losing the biological parameters you have entered for it. This feature allows you to delete a crop and then restore it to the database at some future time.

1. Select **Crop Biology** from the **BIOLOGY** menu.
2. Select *Delete/Restore* from the command line. A scrolling list of crop names will be displayed. Use the arrow keys to move the highlight bar.
3. Press <DEL> to delete or restore the highlighted crop.
4. Press <ESC> to return to the previous menu.

☞ *Viewing or printing a report on crop biology parameters*

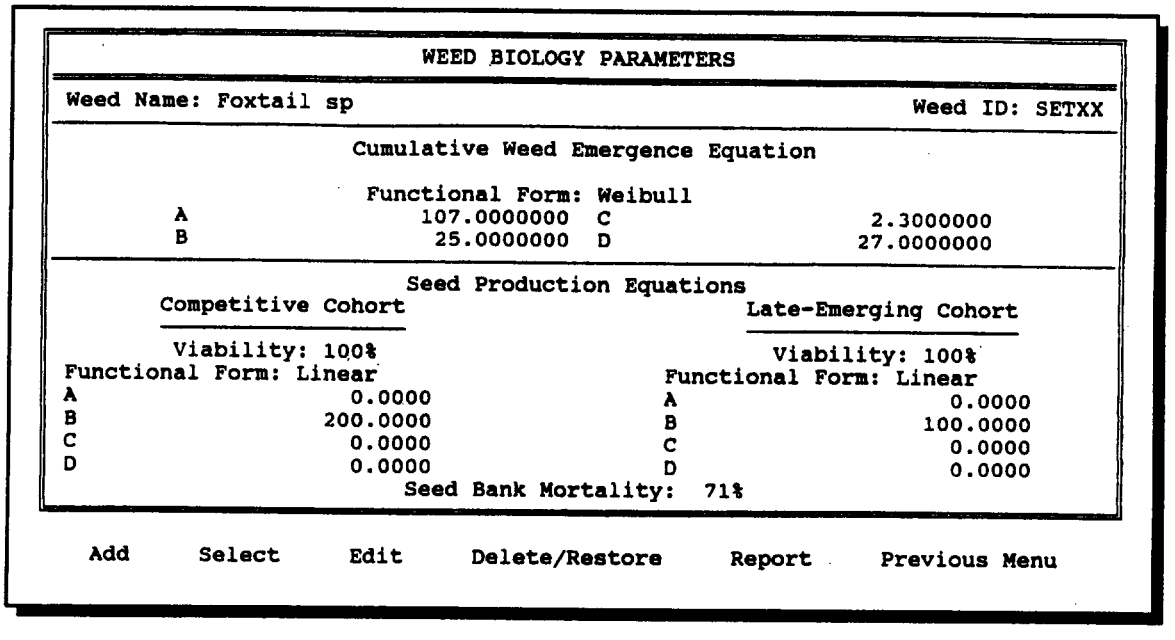
1. Select **Crop Biology** from the **BIOLOGY** menu.
2. Use the *Select* command to choose a crop from the scrolling list.
3. Select *Report* from the command line. A new set of selections will appear on the command line.

4. Select *View* to view the crop report on the screen.

5. Select *Report* to print the crop report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

3.2 Weed Biology

Use the **Weed Biology Parameters** screen to add biological parameters for new weeds to the GWM database, to edit biological parameters for a weed, to delete or restore weeds from the database, and to print a report of biological parameters for a weed.



☞ *Adding a new weed to the database*

1. Select **Weed Biology** from the **BIOLOGY** menu.

2. Select *Add* from the command line.

3. Enter the weed name. A weed ID will be generated automatically by the program, but this can be modified if you wish. If you do change the weed ID, do not include any spaces in the new ID.

4. Enter information for the cumulative weed emergence equation. Begin by selecting a functional form from the scrolling list. Then enter the parameters for that equation. Parameter definitions for cumulative weed emergence equations included in GWM are presented in Appendix A.

5. Enter information for seed production equations for the competitive and late emerging cohorts. For both equations, begin by selecting a functional form from the scrolling list. Then enter the parameters for that equation. Parameter definitions for the seed production equations included in GWM are presented in Appendix A.

6. Finally, enter the Seed Bank Mortality parameter, which is measured in percent.

7. When you have finished entering parameters for a weed, select *Save* from the command line to save the parameters you have entered; select *Edit* to edit the parameters you have entered; or select *Cancel* to cancel the data you have entered.

8. After you have saved or canceled the data for one weed, the following question will appear on the command line:

   ```
   < Do you want to add another weed? (Y/N) >
   ```

   Select **Y** to continue adding weeds. Otherwise, select **N**.

☞ *Editing biological parameters for a weed*

The edit command can be used to correct the spelling of a weed name or to modify biological parameters for a weed.

1. Select **Weed Biology** from the **BIOLOGY** menu.

2. Use the *Select* command to choose a weed from the scrolling list.

3. Select *Edit* from the command line, and modify the parameters you wish to change.

☞ *Temporarily deleting/restoring a weed*

You may wish to delete a weed from the database without losing the biological parameters you have entered for it. This feature allows you to delete a weed and then restore it to the database at some future time.

1. Select **Weed Biology** from the **BIOLOGY** menu.

2. Select *Delete/Restore* from the command line. A scrolling list of weed names will be displayed. Use the arrow keys to move the highlight bar.

3. Press <DEL> to delete or restore the highlighted weed.

4. Press <ESC> to return to the previous menu.

☞ *Viewing or printing a report on weed biology parameters*

1. Select **Weed Biology** from the **BIOLOGY** menu.

2. Use the *Select* command to choose a weed from the scrolling list.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

4. Select *View* to view the weed report on the screen.

5. Select *Report* to print the weed report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

3.3 Crop/Weed Competition

Crop/weed competition is described by competitive indices for each crop and weed combination. Use the **Crop/Weed Competition** screen to enter, edit, or review competitive indices in the GWM database.

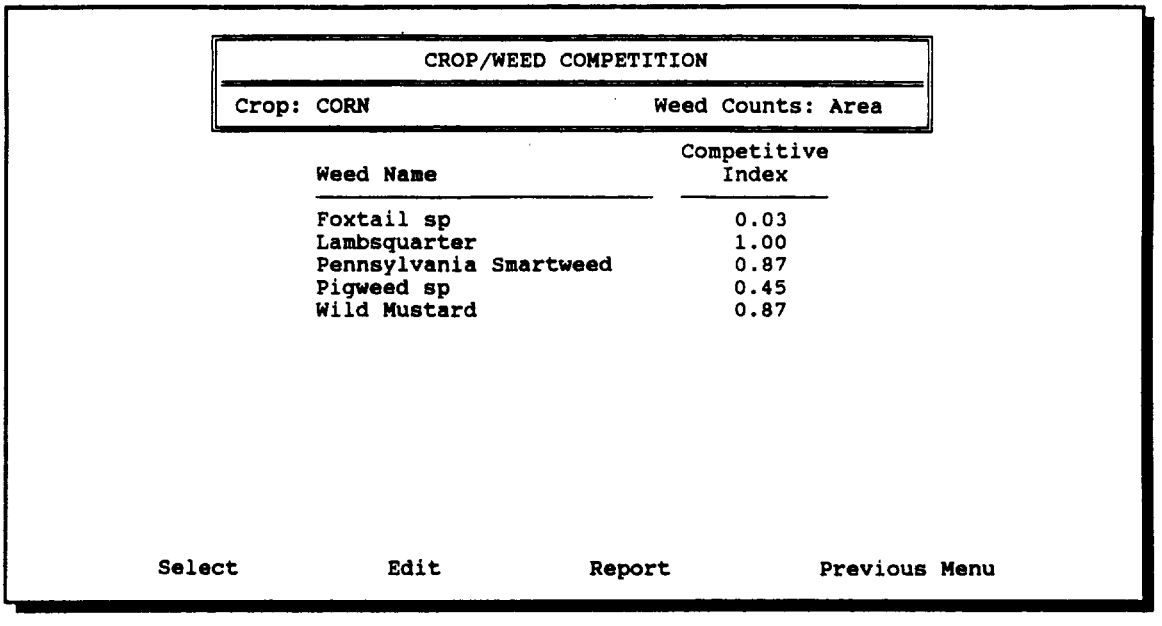
☞ *Entering or editing competitive indices*

1. Select **Crop/Weed Competition** from the **BIOLOGY** menu.

2. Use the *Select* command to choose a crop from the scrolling list. A list of all non-zero competitive indices will appear on the screen.

3. Select *Edit* from the command line. A scrolling window of weed names and competitive indices will appear on the screen.

4. Enter new competitive indices or edit current values for indices. Then press <ESC> when you are through editing.



☞ *Viewing or printing a crop/weed competition report*

1. Select **Crop/Weed Competition** from the **BIOLOGY** menu.

2. Use the *Select* command to choose a crop from the scrolling list. A list of all non-zero competitive indices will appear on the screen.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

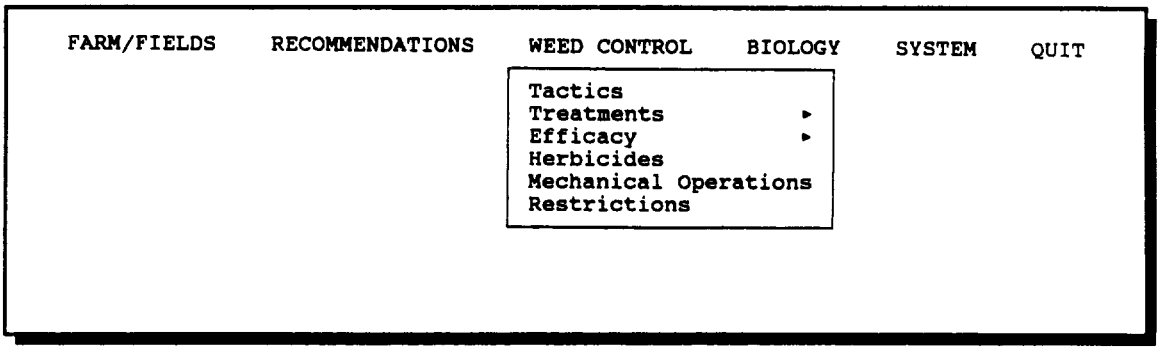
4. Select *View* to view the crop/weed competition report on the screen.

5. Select *Report* to print the crop/weed competition report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

4. Weed Control

GWM allows considerable flexibility in the specification of mechanical and chemical alternatives for weed control. Users of GWM must enter mechanical operations and herbicides used for weed control. These are the basic building blocks for the specification of weed control treatments and tactics. See Appendix A for definitions of terms related to weed control and for a description of required and optional data for describing weed control alternatives.

The weed control section of GWM includes screens for entering data on postemergence weed control tactics, soil applied and postemergence weed control treatments, weed control efficacy levels for soil applied and postemergence weed control treatments, herbicides, mechanical operations, and restrictions on weed control treatments. These screens are accessed by selecting items from the pull-down menu under **WEED CONTROL.**



Data on herbicides, mechanical operations, and restrictions must be entered before defining soil applied and postemergence treatments. Weed control treatments must be defined before data on their efficacy can be entered or before they can be used to define postemergence tactics. The organization of this section of the manual reflects this precedence in data entry activities.

4.1 Herbicides

Use the **Herbicide Description** screen to add herbicides and herbicide cost data to the GWM database, to edit herbicide names and unit prices, to delete or restore herbicides from the database, and to print a herbicide price list.

NOTE: Adjuvants and surfactants should also be included in the herbicide database.

☞ *Adding a new herbicide to the database*

1. Select **Herbicides** from the **WEED CONTROL** menu.

2. Select *Add* from the command line.

3. Enter the herbicide name. A herbicide ID will be generated automatically by the program, but this can be modified if you wish. If you do change the herbicide ID, do not include any spaces in the new ID.

4. Select an application unit from the scrolling list.

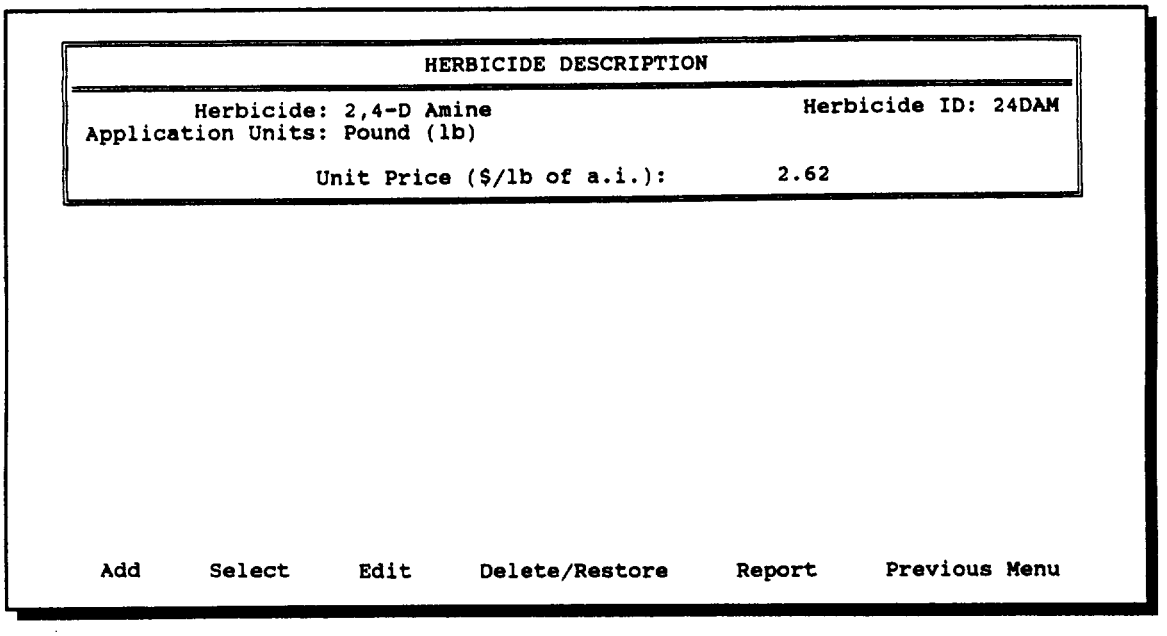
5. Enter the unit price for the new herbicide.

6. When you have finished data entry for a herbicide, select *Save* from the command line to save the data you have entered; select *Edit* to edit the data you have entered; or select *Cancel* to cancel the data you have entered.

7. After you have saved or canceled the data for one herbicide, the following question will appear on the command line:

   `< Do you want to add another herbicide? (Y/N) >`

   Select Y to continue adding herbicides. Otherwise, select N.



☞ *Editing a herbicide description*

The edit command can be used to correct the spelling of a herbicide name or to modify its unit price.

1. Select **Herbicides** from the **WEED CONTROL** menu.

2. Use the *Select* command to choose a herbicide from the scrolling list.

3. Select *Edit* from the command line. A new set of selections will appear on the command line.

4. Select *Herbicide Description* from the command line, and modify the spelling of the herbicide name or the unit price.

NOTE: Do not use the edit command to delete one herbicide from the database and add another by simply changing the herbicide name. This could lead to unexpected problems in the definition of treatments and tactics.

☞ *Editing the herbicide unit price list*

The edit command can also be used to update one or more prices in the herbicide unit price list. This feature is especially useful for annual updates of herbicide prices.

1. Select **Herbicides** from the **WEED CONTROL** menu.

2. Select *Edit* from the command line. A new set of selections will appear on the command line.

3. Select *Unit Price List* from the command line. A scrolling window of herbicide names and unit prices will appear on the screen.

4. Edit the unit prices you wish to change. Then press <ESC> when you are through editing.

☞ *Temporarily deleting/restoring a herbicide*

You may wish to temporarily delete a herbicide from the database. This feature allows you to delete a herbicide and then restore it to the database at some future time.

1. Select **Herbicides** from the **WEED CONTROL** menu.

2. Select *Delete/Restore* from the command line. A scrolling list of herbicide names will be displayed. Use the arrow keys to move the highlight bar.

3. Press <DEL> to delete or restore the highlighted herbicide.

4. Press <ESC> to return to the previous menu.

NOTE: Use this feature with caution. Deleting a herbicide that is used in the definition of a weed control treatment could lead to unexpected problems.

☞ *Viewing or printing a herbicide price report*

1. Select **Herbicides** from the **WEED CONTROL** menu.

2. Select *Report* from the command line. A new set of selections will appear on the command line.

3. Select *View* to view the herbicide price report on the screen.

4. Select *Report* to print the herbicide price report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

4.2 Mechanical Operations

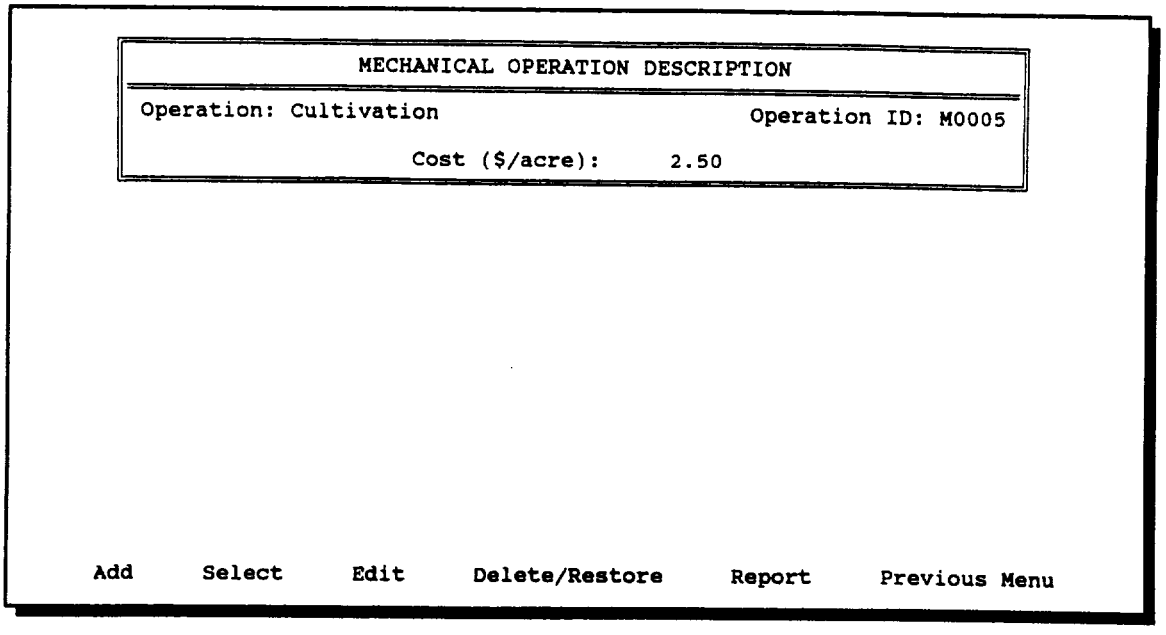
Use the **Mechanical Operation Description** screen to add mechanical operations and mechanical operation cost data to the GWM database, to edit mechanical operation names and costs, to delete or restore mechanical operations from the database, and to print a mechanical operations cost list.

☞ *Adding a new mechanical operation to the database*

1. Select **Mechanical Operations** from the **WEED CONTROL** menu.

2. Select *Add* from the command line.

3. Enter the operation name. An operation ID will be generated automatically by the program, but this can be modified if you wish. If you do change the operation ID, do not include any spaces in the new ID.



4. Enter the unit cost for the new operation.

5. When you have finished data entry for an operation, select *Save* from the command line to save the data you have entered; select *Edit* to edit the data you have entered; or select *Cancel* to cancel the data you have entered.

6. After you have saved or canceled the data for one operation, the following question will appear on the command line:

   `< Do you want to add another operation? (Y/N) >`

   Select **Y** to continue adding operations. Otherwise, select **N**.

☞ *Editing a mechanical operation description*

The edit command can be used to correct the spelling of an operation name or to modify its cost.

1. Select **Mechanical Operations** from the **WEED CONTROL** menu.

2. Use the *Select* command to choose an operation from the scrolling list.

3. Select *Edit* from the command line. A new set of selections will appear on the command line.

4. Select *Operation Description* from the command line, and modify the spelling of the operation name or the unit cost.

NOTE: Do not use the edit command to delete one operation from the database and add another by simply changing the operation name. This could lead to unexpected problems in the definition of treatments and tactics.

☞ *Editing the mechanical operation unit cost list*

The edit command can also be used to update one or more costs in the mechanical operation unit cost list. This feature is especially useful for annual updates of mechanical operation costs.

1. Select **Mechanical Operations** from the **WEED CONTROL** menu.

2. Select *Edit* from the command line. A new set of selections will appear on the command line.

3. Select *Unit Cost List* from the command line. A scrolling window of operation names and unit costs will appear on the screen.

4. Edit the unit costs you wish to change. Then press <ESC> when you are through editing.

☞ *Temporarily deleting/restoring a mechanical operation*

You may wish to temporarily delete an operation from the database. This feature allows you to delete an operation and then restore it to the database at some future time.

1. Select **Mechanical Operations** from the **WEED CONTROL** menu.

2. Select *Delete/Restore* from the command line. A scrolling list of operation names will be displayed. Use the arrow keys to move the highlight bar.

3. Press <DEL> to delete or restore the highlighted operation.

4. Press <ESC> to return to the previous menu.

NOTE: Use this feature with caution. Deleting an operation that is used in the definition of a weed control treatment could lead to unexpected problems.

☞ *Viewing or printing a mechanical operation cost report*

1. Select **Mechanical Operations** from the **WEED CONTROL** menu.

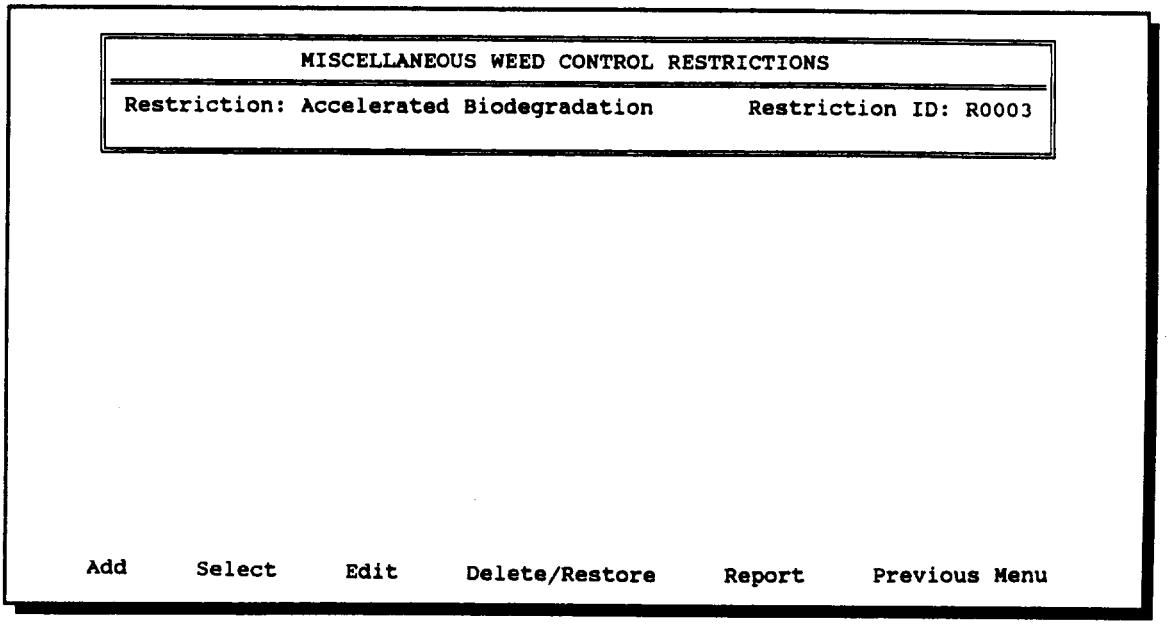
2. Select *Report* from the command line. A new set of selections will appear on the command line.

3. Select *View* to view the mechanical operation cost report on the screen.

4. Select *Report* to print the mechanical operation cost report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

4.3 Restrictions

Use the **Miscellaneous Weed Control Restrictions** screen to add new items to the list of possible restrictions on weed control treatment use, to edit restriction descriptions, to delete or restore restrictions from the database, and to print a list of possible restrictions.



☞ *Adding a new restriction to the database*

1. Select **Restrictions** from the **WEED CONTROL** menu.

2. Select *Add* from the command line.

3. Enter the restriction description. A restriction ID will be generated automatically by the program, but this can be modified if you wish. If you do change the restriction ID, do not include any spaces in the new ID.

4. When you have finished data entry for a restriction, select *Save* from the command line to save the data you have entered; select *Edit* to edit the data you have entered; or select *Cancel* to cancel the data you have entered.

5. After you have saved or canceled the data for one restriction, the following question will appear on the command line:

   `< Do you want to add another restriction? (Y/N) >`

   Select **Y** to continue adding restrictions. Otherwise, select **N**.

☞ *Editing a restriction description*

The edit command can be used to modify a restriction description.

1. Select **Restrictions** from the **WEED CONTROL** menu.

2. Use the *Select* command to choose a restriction from the scrolling list.

3. Modify the restriction description.

NOTE: Do not use the edit command to delete one restriction from the database and add another by simply changing the restriction description. This could lead to unexpected problems in the specification of restrictions on weed control treatments.

☞ *Temporarily deleting/restoring a restriction*

You may wish to temporarily delete a restriction from the database. This feature allows you to delete a restriction and then restore it to the database at some future time.

1. Select **Restrictions** from the **WEED CONTROL** menu.

2. Select *Delete/Restore* from the command line. A scrolling list of restriction descriptions will be displayed. Use the arrow keys to move the highlight bar.

3. Press <DEL> to delete or restore the highlighted restriction.

4. Press <ESC> to return to the previous menu.

NOTE: Use this feature with caution. Deleting a restriction that is used in the definition of a weed control treatment or in the crop plan for a field could lead to unexpected problems.

☞ *Viewing or printing a list of restrictions*

1. Select **Restrictions** from the **WEED CONTROL** menu.

2. Select *Report* from the command line. A new set of selections will appear on the command line.

4. Select *View* to view a list of possible restrictions on the screen.

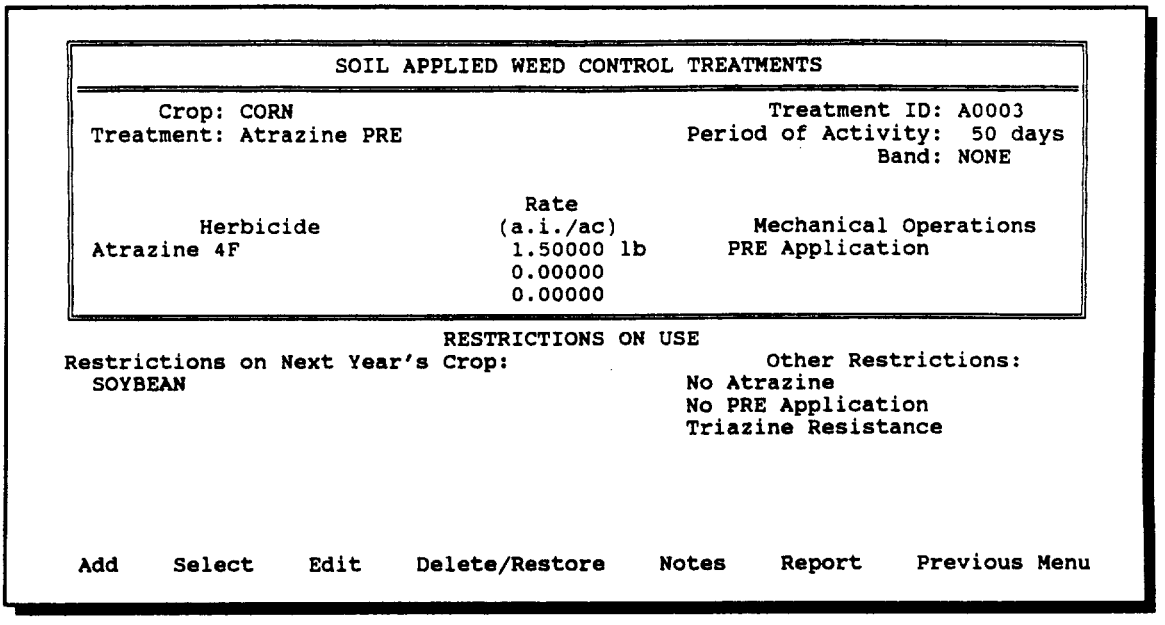
5. Select *Report* to print the list of restrictions. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

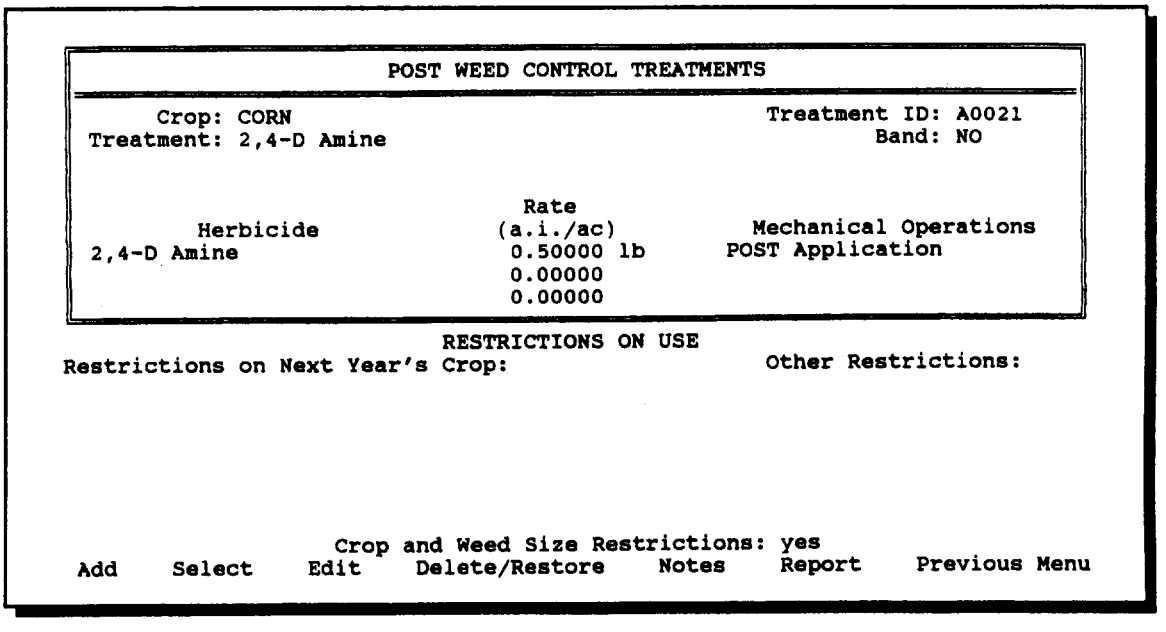
4.4 Weed Control Treatments

A weed control treatment is a control action that can be assigned a single efficacy level for each weed species. It may consist of up to three herbicides and three mechanical operations. Use the **Soil Applied Weed Control Treatments** and **Post Weed Control Treatments** screens to add new treatments to the GWM database, to edit treatment definitions and restrictions, to delete or restore treatments from the database, and to print descriptive reports for treatments. Data entry procedures for soil applied and postemergence weed control treatments are almost identical. Where relevant, differences between data entry for postemergence and soil applied treatments are noted.

☞ *Adding a new treatment to the database*

1. Select **Treatments** from the **WEED CONTROL** menu. Then select **Soil Applied** or **POST** from the submenu that appears to the side.


SOIL APPLIED WEED CONTROL TREATMENTS
Crop: CORN
Treatment: Atrazine PRE
Treatment ID: A0003
Period of Activity: 50 days
Band: NONE
Herbicide
Rate (a.i./ac)
Mechanical Operations
Atrazine 4F
1.50000 lb
PRE Application
0.00000
0.00000
RESTRICTIONS ON USE
Restrictions on Next Year's Crop:
SOYBEAN
Other Restrictions:
No Atrazine
No PRE Application
Triazine Resistance
Add
Select
Edit
Delete/Restore
Notes
Report
Previous Menu


POST WEED CONTROL TREATMENTS
Crop: CORN
Treatment: 2,4-D Amine
Treatment ID: A0021
Band: NO
Herbicide
Rate (a.i./ac)
Mechanical Operations
2,4-D Amine
0.50000 lb
POST Application
0.00000
0.00000
RESTRICTIONS ON USE
Restrictions on Next Year's Crop:
Other Restrictions:
Crop and Weed Size Restrictions: yes
Add
Select
Edit
Delete/Restore
Notes
Report
Previous Menu

2. Select *Add* from the command line.

3. Select a crop from the scrolling list of crop names.

4. Enter the treatment name. A treatment ID will be generated automatically by the program, but this can be modified if you wish. If you do change the treatment ID, do not include any spaces in the new ID.

5. For soil applied treatments, enter the period of activity. This is measured in days after application.

6. Select a banding option from the scrolling list. For soil applied treatments, options include NONE, PRE, PPI. For postemergence treatments, options are YES and NO.

7. Select up to three herbicides from the scrolling list of herbicides. To mark a herbicide for selection, use the arrow keys to highlight its name, then press the space bar. Herbicides that have been selected are "marked" by bold arrows on the right and left. To end herbicide selection, press <ENTER>. The scrolling box will close and the herbicides you have selected will be displayed.

   NOTE: It is not necessary for a treatment to include a herbicide application. If there are no herbicides in the treatment you are defining, simply press <ENTER> without selecting any herbicides.

8. Enter the application rate for each of the herbicides you have selected. Depending on the unit selections you have made for the current database, herbicide rate can be in English or metric units of active ingredient or actual product.

9. Select up to three mechanical operations from the scrolling list of operations. To mark an operation for selection, use the arrow keys to highlight its name, then press the space bar. Operations that have been selected are "marked" by bold arrows on the right and left. To end mechanical operation selection, press <ENTER>. The scrolling box will close and the operations you have selected will be displayed.

10. If there are crops that cannot be planted during the growing season after the treatment you are defining has been used, select them from the scrolling list of crop names. To mark a crop for inclusion on this list, use the arrow keys to highlight its name, then press the space bar. Crops that have been selected are "marked" by bold arrows on the right and left. To end selection of crops that restrict the use of this treatment, press <ENTER>. The scrolling box will close and the crops you have selected will be displayed.

NOTE: It is not necessary for a treatment to have any restrictions on next year's crop. If there are no such restrictions, simply press <ENTER> without selecting any crops.

11. If there are other restrictions on the use of the treatment you are defining, select them from the scrolling list of miscellaneous restrictions. To mark a restriction for inclusion on this list, use the arrow keys to highlight its name, then press the space bar. Restrictions that have been selected are "marked" by bold arrows on the right and left. To end selection of other restrictions on the use of this treatment, press <ENTER>. The scrolling box will close and the restrictions you have selected will be displayed.

    NOTE: It is not necessary for a treatment to have any of these miscellaneous restrictions on its use. If there are no such restrictions, simply press <ENTER> without selecting any.

12. For postemergence weed control treatments, the following question will appear just above the command line:

    ```
    < Are there crop and weed size restrictions? (Y/N)>
    ```

    Select **Y** if there are such restrictions for this treatment. Otherwise select **N**.

    If there are crop and weed size restrictions, a scrolling box will appear on the screen. Use the arrow keys to move the highlight bar to size and leaf number restrictions that need to be modified. All default minimums are set at zero. All default maximums are set at 999. To end data entry for crop and weed size restrictions, press <ESC>.

13. When you have finished data entry for a treatment, select *Save* from the command line to save the data you have entered; select *Edit* to edit the data you have entered; or select *Cancel* to cancel the data you have entered.

14. After you have saved or canceled the data for one treatment, the following question will appear on the command line:

    ```
    < Do you want to add another treatment for this
    crop? (Y/N) >
    ```

    Select **Y** to continue adding treatments. Otherwise, select **N**.

NOTE: A treatment definition applies only for a single crop. If a treatment can be used for more than one crop, it must be defined for each crop. The same treatment name can be used for each crop.

☞ *Editing a treatment description*

The edit command can be used to modify any of the data included in the description of a treatment.

1. Select **Treatments** from the **WEED CONTROL** menu. Then select **Soil Applied** or **POST** from the submenu that appears to the side.

2. Use the *Select* command to choose a crop and treatment from the scrolling list.

3. Select *Edit* from the command line, and modify any aspects of the description you wish to change.

NOTE: Do not use the edit command to define a new treatment by simply changing the description of an existing treatment. This could lead to unexpected problems in the definition of tactics and in strategy evaluation.

☞ *Temporarily deleting/restoring a treatment*

You may wish to temporarily delete a treatment from the database. This feature allows you to delete a treatment and then restore it to the database at some future time.

1. Select **Treatments** from the **WEED CONTROL** menu. Then select **Soil Applied** or **POST** from the submenu that appears to the side.

2. Select *Delete/Restore* from the command line. Select a crop from the scrolling list of crop names. A scrolling list of treatment names will be displayed. Use the arrow keys to move the highlight bar.

3. Press <DEL> to delete or restore the highlighted treatment.

4. Press <ESC> to return to the previous menu.

NOTE: Use this feature with caution. Deleting a postemergence treatment that is used in the definition of a weed control tactic could lead to unexpected problems.

☞ *Viewing or printing a treatment description report*

1. Select **Treatments** from the **WEED CONTROL** menu. Then select **Soil Applied** or **POST** from the submenu that appears to the side.

2. Use the *Select* command to choose a crop and treatment from the scrolling list.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

4. Select *View* to view the treatment description report on the screen.

5. Select *Report* to print the treatment description report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

4.5 Treatment Efficacy

Use the **Soil Applied Weed Control Treatment Efficacy** and **Post Weed Control Treatment Efficacy** screens (shown on the following page) to enter or edit data on weed control efficacy for soil applied and postemergence weed control treatments and to view or print reports on treatment efficacy. Data entry procedures for soil applied and postemergence weed control treatments are identical.

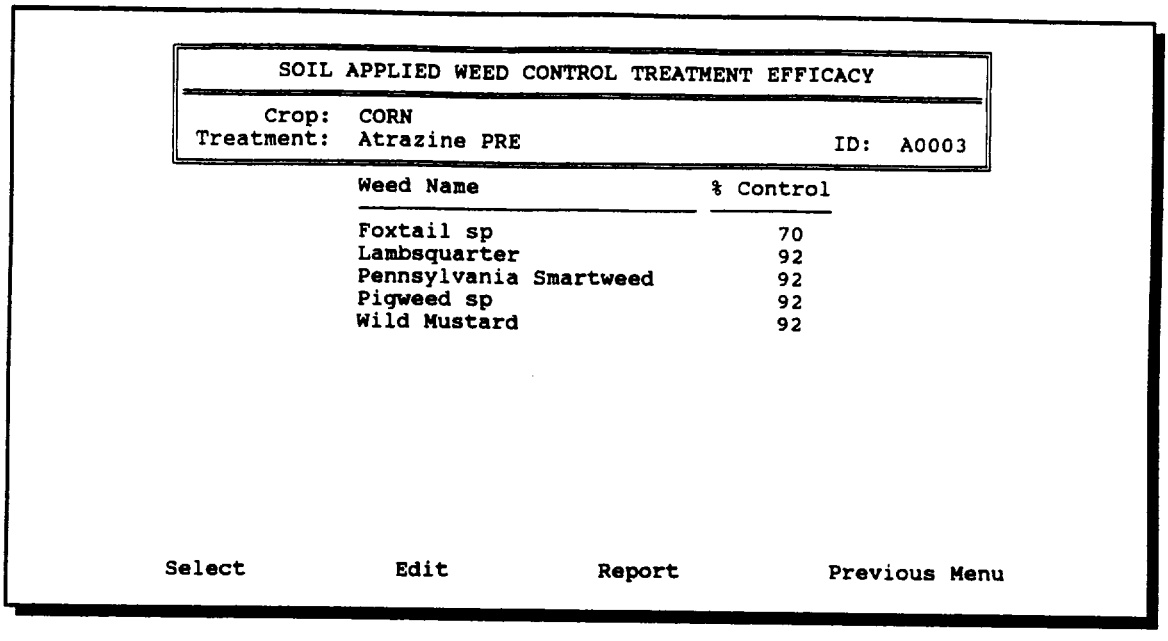
☞ *Entering or editing treatment efficacy levels*

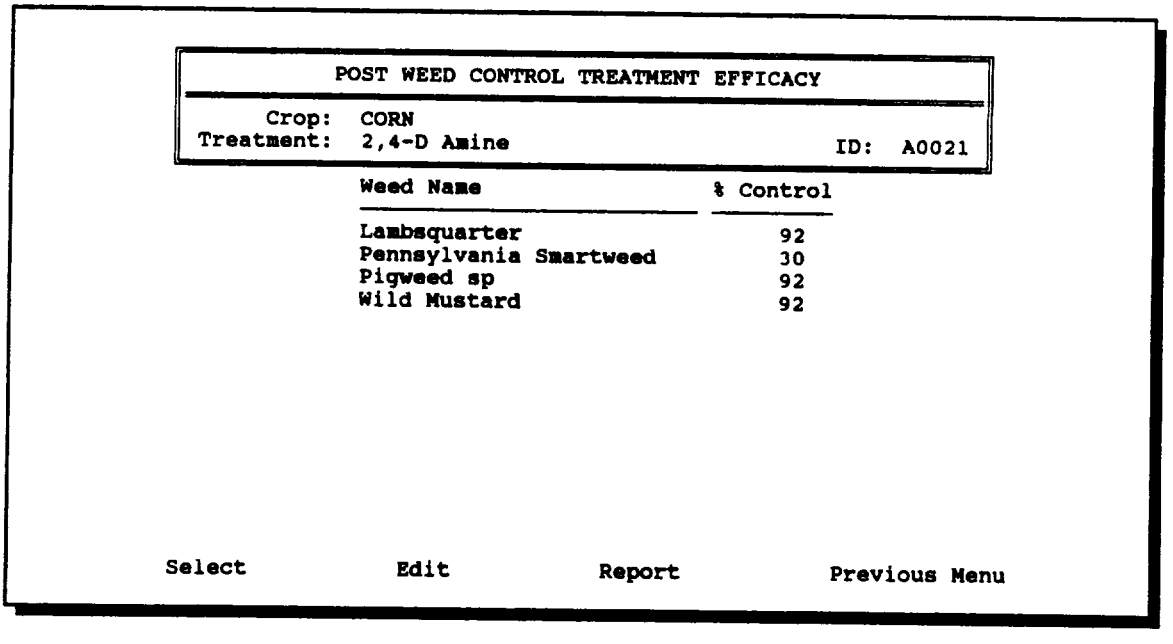
1. Select **Efficacy** from the **WEED CONTROL** menu. Then select **Soil Applied** or **POST** from the submenu that appears to the side.

2. Use the *Select* command to choose a crop and treatment from the scrolling lists. A list of weeds and percent control levels will appear for the weeds that are controlled by the treatment you have selected.

3. Select *Edit* from the command line. A scrolling window of weed names and percent control levels will appear on the screen.

4. Enter new efficacy levels or edit current values. Then press <ESC> when you are through editing.


SOIL APPLIED WEED CONTROL TREATMENT EFFICACY
Crop: CORN
Treatment: Atrazine PRE
ID: A0003
Weed Name
% Control
Foxtail sp 70
Lambsquarter 92
Pennsylvania Smartweed 92
Pigweed sp 92
Wild Mustard 92
Select
Edit
Report
Previous Menu


POST WEED CONTROL TREATMENT EFFICACY
Crop: CORN
Treatment: 2,4-D Amine
ID: A0021
Weed Name
% Control
Lambsquarter 92
Pennsylvania Smartweed 30
Pigweed sp 92
Wild Mustard 92
Select
Edit
Report
Previous Menu

☞ *Viewing or printing a treatment efficacy report*

1. Select **Efficacy** from the **WEED CONTROL** menu. Then select **Soil Applied** or **POST** from the submenu that appears to the side.

2. Use the *Select* command to choose a crop and treatment from the scrolling lists. A list of weeds and percent control levels will appear for the weeds that are controlled by the treatment you have selected.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

4. Select *View* to view the treatment efficacy report on the screen.

5. Select *Report* to print the treatment efficacy report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

4.6 Postemergence Tactics

A tactic is a set of weed control treatments applied in a specified time sequence. It may consist of up to three postemergence treatments. Efficacy, cost, and restrictions are not specified directly for a tactic. Rather, these are determined by the component treatments. Use the **Postemergence Tactics** screen to add new postemergence tactics, to edit tactic descriptions, to delete or restore tactics from the database, and to print descriptive reports for tactics.

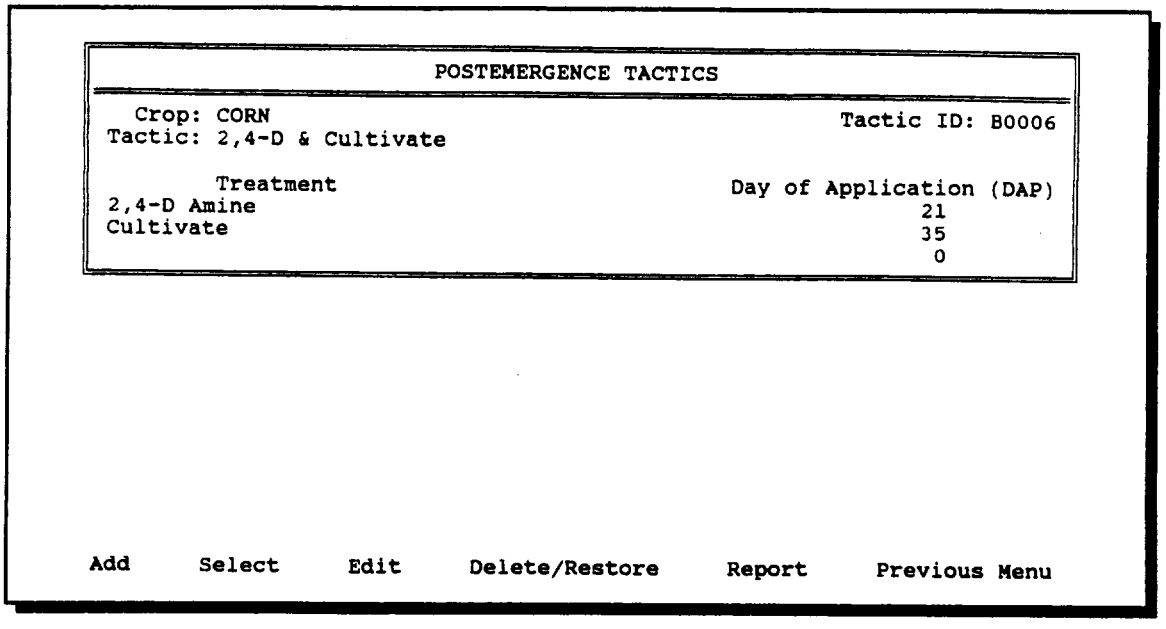
☞ *Adding a new tactic to the database*

1. Select **Tactics** from the **WEED CONTROL** menu.

2. Select *Add* from the command line.

3. Select a crop from the scrolling list of crop names.

4. Enter the tactic name. A tactic ID will be generated automatically by the program, but this can be modified if you wish. If you do change the tactic ID, do not include any spaces in the new ID.



5. Select a treatment from the scrolling list of post weed control treatments. Then enter its day of application, measured in days after planting. Continue this process until you have included up to three treatments in the tactic. If there are fewer than three treatments a tactic, press <ESC> when the scrolling list is displayed after you have entered the day of application for the last treatment.

   NOTE: A tactic must include at least one post weed control treatment. All restrictions on treatments are "inherited" by a tactic.

6. When you have finished data entry for a tactic, select *Save* from the command line to save the data you have entered; select *Edit* to edit the data you have entered; or select *Cancel* to cancel the data you have entered.

7. After you have saved or canceled the data for one tactic, the following question will appear on the command line:

   ```
   < Do you want to add another tactic for this crop?
   (Y/N) >
   ```

   Select **Y** to continue adding tactics. Otherwise, select **N**.

   NOTE: A tactic definition applies only for a single crop. If a tactic can be used for more than one crop, it must be defined for each crop. The same tactic name can be used for each crop.

☞ *Editing a tactic description*

The edit command can be used to modify any of the data included in the description of a tactic.

1. Select **Tactics** from the **WEED CONTROL** menu.

2. Use the *Select* command to choose a crop and tactic from the scrolling list.

3. Select *Edit* from the command line, and modify any aspects of the description you wish to change.

NOTE: Use the *Delete/Restore* command to delete treatments from a tactic.

NOTE: Do not use the edit command to define a new tactic by simply changing the description of an existing tactic. This could lead to unexpected problems in strategy evaluation.

☞ *Deleting a treatment from a tactic*

1. Select **Tactics** from the **WEED CONTROL** menu.

2. Use the *Select* command to choose a crop and tactic from the scrolling list.

3. Select *Delete/Restore* from the command line. A new set of selections will appear on the command line. Select *Delete Treatments*.

4. A scrolling list of treatments with the associated day of application for each will be displayed. Use the arrow keys to move the highlight bar.

5. Press <DEL> to delete or restore the highlighted treatment.

6. Press <ESC> to return to the previous menu.

☞ *Temporarily deleting/restoring a tactic*

You may wish to temporarily delete a tactic from the database. This feature allows you to delete a tactic and then restore it to the database at some future time.

1. Select **Tactics** from the **WEED CONTROL** menu.

2. Select *Delete/Restore* from the command line. A new set of selections will appear on the command line. Select *Modify Tactics* if you want to delete or restore tactics from the list of those considered in strategy evaluations.

3. Select a crop from the scrolling list of crop names. A scrolling list of tactics names will be displayed. Use the arrow keys to move the highlight bar.

4. Press <DEL> to delete or restore the highlighted tactic.

5. Press <ESC> to return to the previous menu.

☞ *Viewing or printing a tactic description report*

1. Select **Tactics** from the **WEED CONTROL** menu.

2. Use the *Select* command to choose a crop and tactic from the scrolling list.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

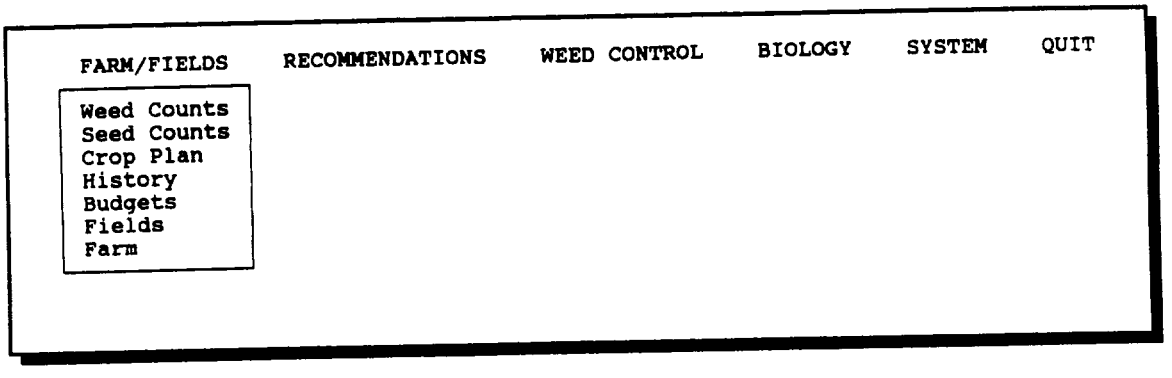
4. Select *View* to view the tactic description report on the screen.

5. Select *Report* to print the tactic description report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

5. Farm and Field Information

GWM supports the entry and retrieval of data related to weed management for multiple farms and fields. Users first enter descriptive information on farms and their associated fields. Then for any field in the database, users can enter crop plan information, weed seed and weed seedling count data, and historical data on actual weed control activities.

The farm and field information section of GWM includes screens for entering data on weed counts, seed counts, crop plans, field histories, crop budgets, and new farms. These screens are accessed by selecting items from the pull-down menu under **FARM/FIELDS.**



5.1 Farm Description

Use the **Farm Description** screen to add new farms to the GWM database, to edit descriptive information for a farm, to delete or restore farms from the database, and to print a report of descriptive information for a farm.

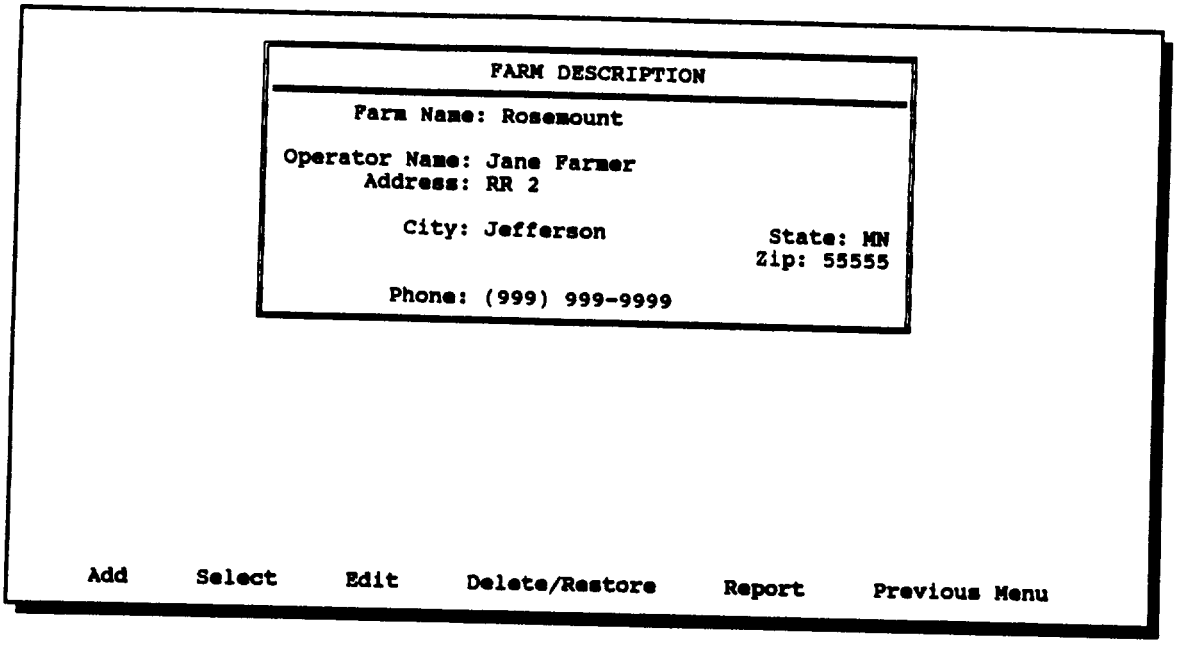
☞ *Adding a new farm to the database*

1. Select **Farm** from the **FARM/FIELDS** menu.
2. Select *Add* from the command line.
3. Enter the farm name. If you wish, also enter the operator's name, address, and phone number.
4. When you have finished entering information for a farm, select *Save* from the command line to save the information you have entered; select *Edit* to edit the information you have entered; or select *Cancel* to cancel the information you have entered.

5. After you have saved or canceled the data for one farm, the following question will appear on the command line:

   < Do you want to add another farm? (Y/N) >

   Select Y to continue adding farms. Otherwise, select N.



☞ *Editing descriptive information for a farm*

The edit command can be used to correct the spelling of a farm name or to modify descriptive information for a farm.

1. Select **Farm** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm from the scrolling list.

3. Select *Edit* from the command line. A new set of selections will appear on the command line.

4. Select *Farm Description* from the command line, and modify the information you wish to change.

☞ *Editing mechanical operation costs for a farm*

The edit command can also be used to edit mechanical operation cost information for a farm. This makes it possible to use different mechanical costs for each farm in your database. If you do not edit mechanical costs for a farm, the default values entered in the weed control section of GWM will be used.

1. Select **Farm** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm from the scrolling list.

3. Select *Edit* from the command line. A new set of selections will appear on the command line.

4. Select *Mechanical Costs* from the command line, and modify the information you wish to change.

☞ *Temporarily deleting/restoring a farm*

You may wish to delete a farm from the database without losing the descriptive information you have entered for it. This feature allows you to delete a farm and then restore it to the database at some future time.

1. Select **Farm** from the **FARM/FIELDS** menu.

2. Select *Delete/Restore* from the command line. A scrolling list of farm names will be displayed. Use the arrow keys to move the highlight bar.

3. Press <DEL> to delete or restore the highlighted farm.

4. Press <ESC> to return to the previous menu.

☞ *Viewing or printing a farm description report*

1. Select **Farm** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm from the scrolling list.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

4. Select *View* to view the farm description report on the screen.

5. Select *Report* to print the farm description report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

5.2 Field Description

Use the **Field Description** screen (shown on the following page) to add new fields to the GWM database, to edit descriptive information for a field, to delete or restore fields from the database, and to print a report of descriptive information for a field.

☞ *Adding a new field to the database*

1. Select **Fields** from the **FARM/FIELDS** menu.

2. Select *Add* from the command line.

3. Select a farm from the scrolling list of farm names.

4. Enter the new field name. If you wish, also enter the data on field size and soil characteristics. For soil characteristics, you can select a texture from the scrolling list or have texture calculated from the percentage analysis.

   NOTE: The total of percent clay, percent silt, and percent sand must be 100 percent. If the percentages you enter do not total to 100 percent, you will be prompted to modify the data you have entered.

5. When you have finished entering information for a field, select *Save* from the command line to save the information you have entered; select *Edit* to edit the information you have entered; or select *Cancel* to cancel the information you have entered.

6. After you have saved or canceled the data for one field, the following question will appear on the command line:

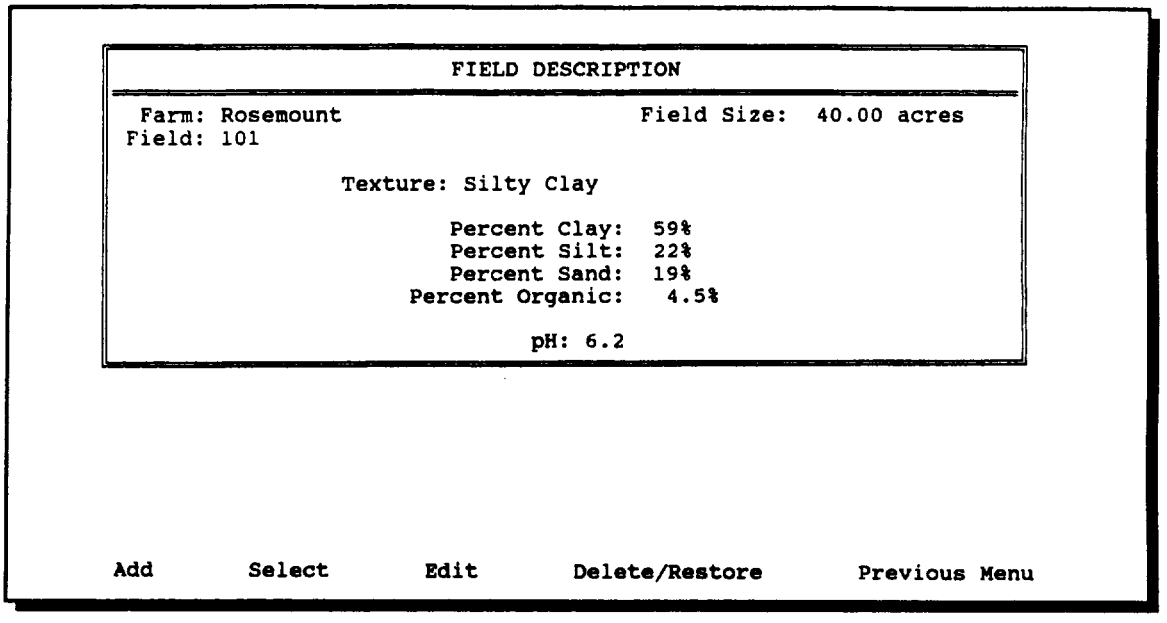
   ```
   < Do you want to add another field for this farm?
   (Y/N) >
   ```

   Select **Y** to continue adding fields for the farm you have selected. Otherwise, select **N**.

7. When you have finished adding fields for one farm, the following question will appear on the command line:

   ```
   < Do you want to add fields for another farm?   (Y/N) >
   ```

   Select **Y** to add fields for another farm. Otherwise, select **N**.



☞ *Editing descriptive information for a field*

The edit command can be used to modify descriptive information for a field.

1. Select **Fields** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a field from the scrolling list.

3. Select *Edit* from the command line, and modify the information you wish to change.

☞ *Temporarily deleting/restoring a field*

You may wish to delete a field from the database without losing the descriptive information you have entered for it. This feature allows you to delete a field and then restore it to the database at some future time.

1. Select **Fields** from the **FARM/FIELDS** menu.

2. Select *Delete/Restore* from the command line. A scrolling list of farm names and field ID's will be displayed. Use the arrow keys to move the highlight bar.

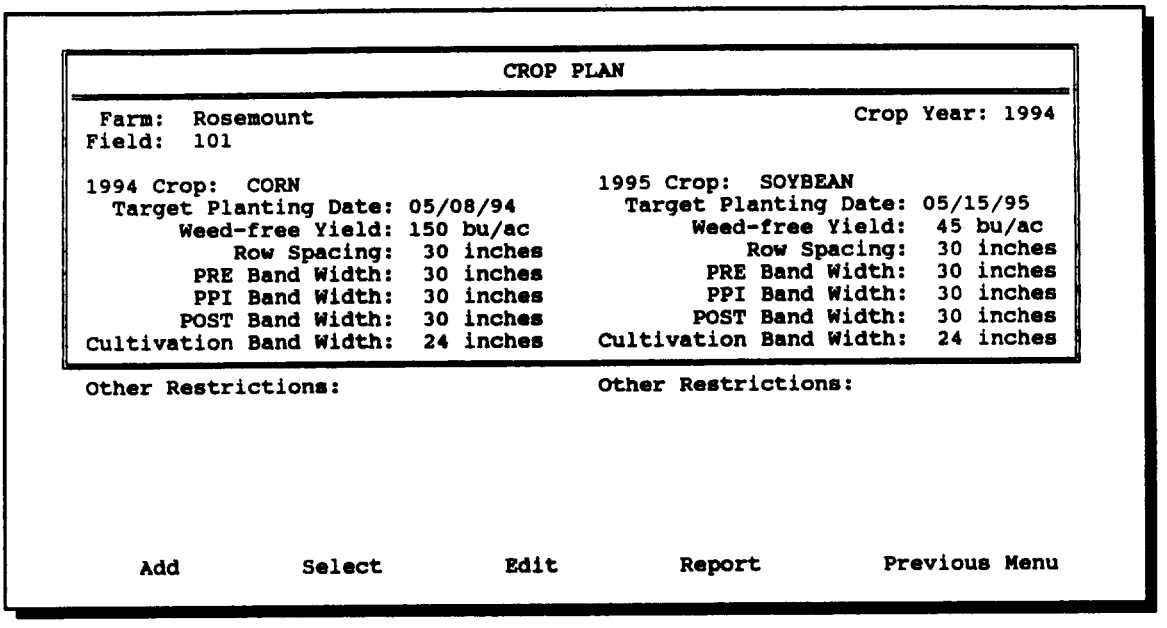
3. Press <DEL> to delete or restore the highlighted field.

4. Press <ESC> to return to the previous menu.

5.3 *Crop Plan*

A description of the crop plan for a field includes information on the crops to be grown in the current and next crop year, on target planting dates and cultural practices for each crop, and on restrictions on weed control treatments for each crop. This information is needed to make weed control recommendations.

Use the **Crop Plan** screen to enter, edit, or review information on the crop plan for a field.



☞ *Adding a new crop plan to the database*

1. Select **Crop Plan** from the **FARM/FIELDS** menu.

2. Select *Add* from the command line.

3. Select a farm from the scrolling list of farm names. Then select a field ID from the scrolling list of fields for that farm.

4. Enter the crop year for the plan to be added to the database.

5. Select a crop for the current year from the scrolling list of crops. Then enter the target planting date, weed-free yield, row spacing, and band width information for that crop.

6. A scrolling list of possible restrictions on weed control treatments for the current year crop will appear. To mark a restriction for inclusion on the list of restrictions for this crop, use the arrow keys to highlight its name, then press the space bar. Restrictions that have been selected are "marked" by bold arrows on the right and left. To end selection of these restrictions, press <ENTER>. The scrolling box will close and the restrictions you have selected will be displayed.

   NOTE: It is not necessary for there to be restrictions for a crop. If there are none, simply press <ENTER> without selecting any restrictions.

7. Do steps 5 and 6 for the next year's crop.

8. When you have finished entering information for a crop plan, select *Save* from the command line to save the information you have entered; select *Edit* to edit the information you have entered; or select *Cancel* to cancel the information you have entered.

☞ *Editing a crop plan*

The edit command can be used to modify descriptive information for a crop plan.

1. Select **Crop Plan** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and crop year from the scrolling lists.

3. Select *Edit* from the command line, and modify the information you wish to change.

☞ *Viewing or printing a crop plan report*

1. Select **Crop Plan** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field ID, and crop year from the scrolling lists.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

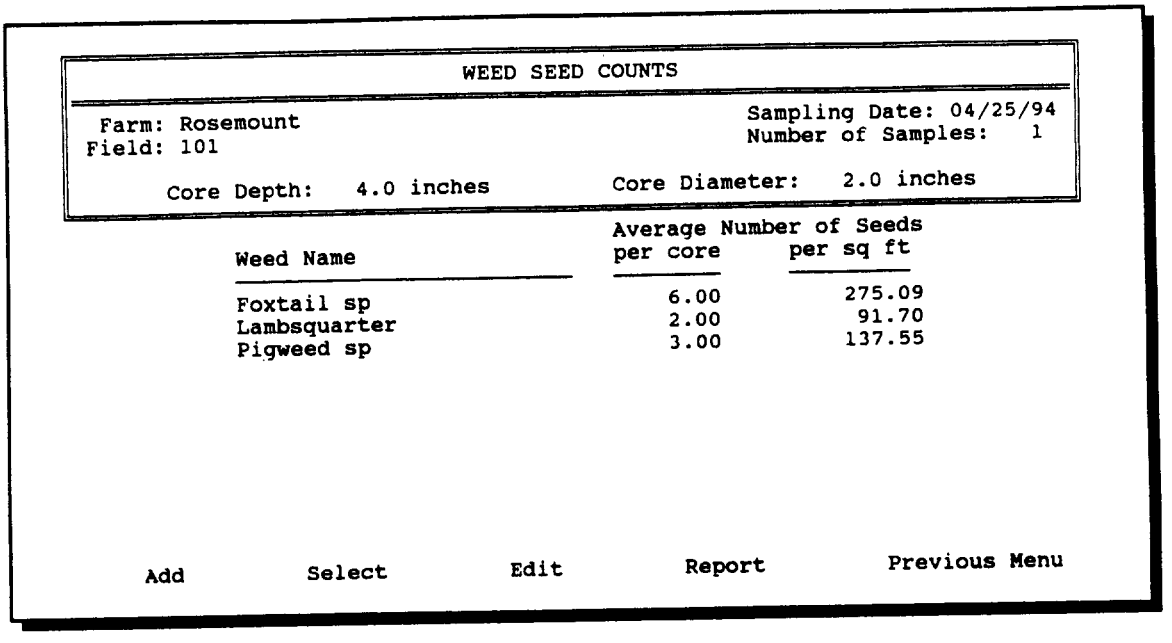
4. Select *View* to view the crop plan report on the screen.

5. Select *Report* to print the crop plan report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

5.4 Seed Counts

Weed seed counts are used in the evaluation of soil applied weed control strategies. GWM gives users considerable flexibility in the recording of weed seed counts.

Use the **Weed Seed Counts** screen (shown on the following page) to enter, edit, or review weed seed counts.



☞ *Adding new weed seed counts to the database*

1. Select **Seed Counts** from the **FARM/FIELDS** menu.
2. Select *Add* from the command line.
3. Enter the sampling date for this weed seed count.
4. Select a farm from the scrolling list of farm names. Then select a field ID from the scrolling list of fields for that farm.
5. Enter the number of separate samples analyzed for this count.

6. If you are entering weed seed count data for the first time, enter the core depth and diameter for the samples in this count. If you have already entered weed seed counts, all core sizes used in previous counts will have been recorded and will be displayed in a scrolling box. Select the core size used for this count from the scrolling list or select *Enter a new core size* to enter new values for core depth and diameter.

7. A scrolling window with all weeds in the database in the left column and a column for seed count per core for each sample will appear on the screen. Enter all non-zero weed seed counts, using the arrow keys to move from one field to another. Press <ESC> when you are through entering seed count data for all samples.

8. The scrolling window will close and average seed counts will be displayed on a per core and per standard unit for all weeds with a non-zero seed count in at least one sample. Select *Save* from the command line to save the seed count data you have entered; select *Edit* to edit the seed count data you have entered; or select *Cancel* to cancel the data you have entered.

9. After you have saved or canceled the data for a seed count, the following question will appear on the command line:

```
< Do you want to enter counts for another field on this
farm for MM/DD/YY  (Y/N) >
```

Where MM/DD/YY is the sampling date for the current seed count. Select **Y** to add counts for another field. Otherwise select **N**.

10. After you have finished entering data for one farm, the following question will appear on the command line:

```
< Do you want to enter counts for another farm for
MM/DD/YY  (Y/N) >
```

Where MM/DD/YY is the sampling date for the current seed count. Select **Y** to add counts for another farm. Otherwise select **N**.

11. After you have finished entering data for all farms, the following question will appear on the command line:

```
< Do you want to enter counts for another date (Y/N) >
```

Select **Y** to add counts for another date. Otherwise select **N**.

☞ *Editing weed seed counts*

The edit command can be used to modify seed count data you have already entered.

1. Select **Seed Counts** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and sampling date from the scrolling lists.

3. Select *Edit* from the command line. A scrolling window with all weeds in the database in the left column and a column for seed count per core for each sample will appear on the screen. Modify the seed counts you wish to change, using the arrow keys to move from one field to another.

4. Press <ESC> when you are through editing seed count data for all samples. Select *Save* from the command line to save the changes you have made, select *Edit* to continue editing the seed count data for this farm, field, and sampling date, or select *Cancel* to cancel the changes you have made.

☞ *Viewing or printing a weed seed count report*

1. Select **Seed Counts** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field ID, and sampling date from the scrolling lists.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

4. Select *View* to view the weed seed count report on the screen.

5. Select *Report* to print the weed seed count report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

5.5 Weed Seedling Counts

Weed seedling counts are used in the evaluation of postemergence weed control strategies. GWM gives users considerable flexibility in the recording of weed seedling counts.

Use the **Weed Seedling Counts** screen to enter, edit, or review weed seedling counts.

☞ *Adding new weed seedling counts to the database*

1. Select **Weed Counts** from the **FARM/FIELDS** menu.

2. Select *Add* from the command line.

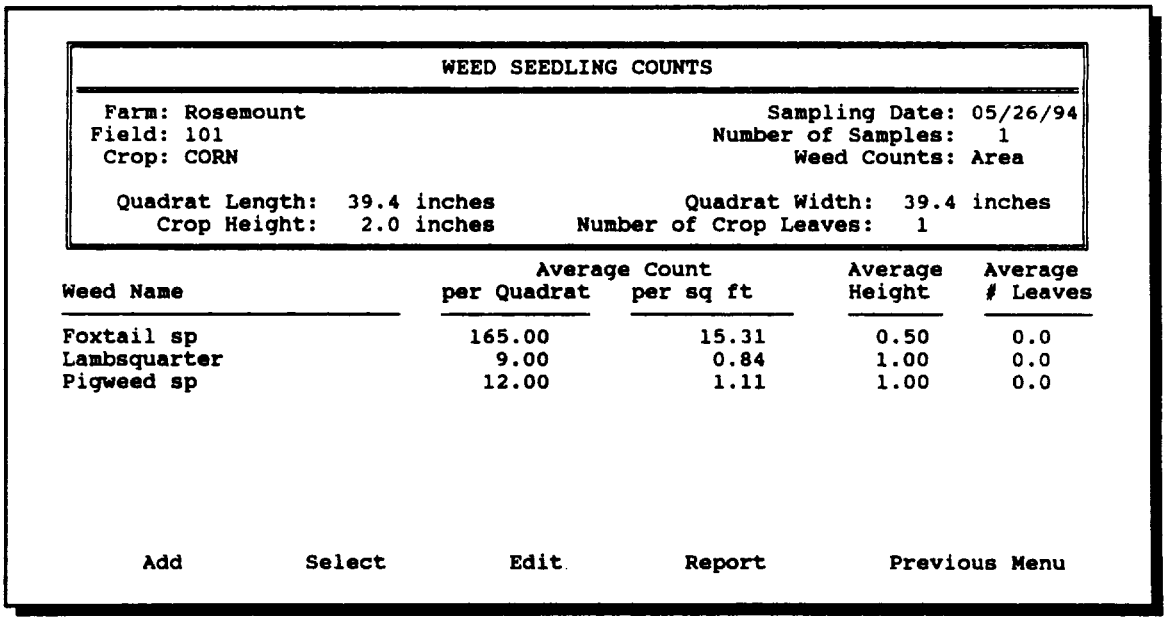
3. Enter the sampling date for this weed seedling count.

4. Select a farm from the scrolling list of farm names. Then select a field ID from the scrolling list of fields for that farm and a crop from the scrolling list of crops.

5. Enter the number of separate samples made for this count.

6. If you are entering weed seedling count data for the first time, enter the quadrat length and width for the samples in this count. If you have already entered weed seedling counts, all quadrat sizes used in previous counts will have been recorded and will be displayed in a scrolling box. Select the quadrat size used for this count from the scrolling list or select *Enter a new quadrat size* to enter new values for quadrat length and width.

7. Then enter the average height and number of leaves for the crop.



WEED SEEDLING COUNTS

Farm: Rosemount — Sampling Date: 05/26/94
Field: 101 — Number of Samples: 1
Crop: CORN — Weed Counts: Area

Quadrat Length: 39.4 inches — Quadrat Width: 39.4 inches
Crop Height: 2.0 inches — Number of Crop Leaves: 1

Weed Name	Average Count per Quadrat	Average Count per sq ft	Average Height	Average # Leaves
Foxtail sp	165.00	15.31	0.50	0.0
Lambsquarter	9.00	0.84	1.00	0.0
Pigweed sp	12.00	1.11	1.00	0.0

Add Select Edit Report Previous Menu

8. A scrolling window with all weeds in the database in the left column and columns for seedling count data per quadrat for each sample will appear on the screen. For each sample, there is a column for the number of seedlings, weed height, and the number of leaves. Enter all non-zero weed seedling counts, using the arrow keys to move from one field to another. Also enter height and/or number of leaf data for each weed with a non-zero count. Press <ESC> when you are through entering seedling count data for all samples.

9. The scrolling window will close and average seedling counts, weed height, and number of leaves will be displayed for all weeds with a non-zero seedling count in at least one sample. Seedling counts will be displayed on a per quadrat and per standard unit basis. Select *Save* from the command line to save the seedling count data you have entered; select *Edit* to edit the seedling count data you have entered; or select *Cancel* to cancel the data you have entered.

10. After you have saved or canceled the data for a seedling count, the following question will appear on the command line:

```
< Do you want to enter counts for another field on this
farm for MM/DD/YY  (Y/N) >
```

Where MM/DD/YY is the sampling date for the current seedling count. Select **Y** to add counts for another field. Otherwise select **N**.

11. After you have finished entering data for one farm, the following question will appear on the command line:

```
< Do you want to enter counts for another farm for
MM/DD/YY  (Y/N) >
```

Where MM/DD/YY is the sampling date for the current seedling count. Select **Y** to add counts for another farm. Otherwise select **N**.

12. After you have finished entering data for all farms, the following question will appear on the command line:

```
< Do you want to enter counts for another date (Y/N) >
```

Select **Y** to add counts for another date. Otherwise select **N**.

☞ *Editing weed seedling counts*

The edit command can be used to modify seedling count data you have already entered.

1. Select **Weed Counts** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and sampling date from the scrolling lists.

3. Select *Edit* from the command line. A scrolling window with all weeds in the database in the left column and columns for seedling count data per quadrat for each sample will appear on the screen. For each sample, there is a column for the number of seedlings, weed height, and the number of leaves. Modify the seedling counts you wish to change, using the arrow keys to move from one field to another.

4. Press <ESC> when you are through editing seedling count data for all samples. Select *Save* from the command line to save the changes you have made, select *Edit* to continue editing the seedling count data for this farm, field, and sampling date, or select *Cancel* to cancel changes you have made.

☞ *Viewing or printing a weed seedling count report*

1. Select **Weed Counts** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field ID, and sampling date from the scrolling lists.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

4. Select *View* to view the weed seedling count report on the screen.

5. Select *Report* to print the weed seedling count report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

5.6 Field History

Use the **Field History** screen (shown on the following page) to enter, edit, or review data on planting dates, harvest dates and yields, prices received, and weed control treatments for fields in the GWM database.

☞ *Entering or editing the planting date*

1. Select **History** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and crop year from the scrolling lists. The planned crop for the current crop year will be displayed below the crop year. Information already entered for that field and crop year will also be displayed.

3. Select *Plant* from the command line.

4. Enter or edit the planting date for this field and crop year.

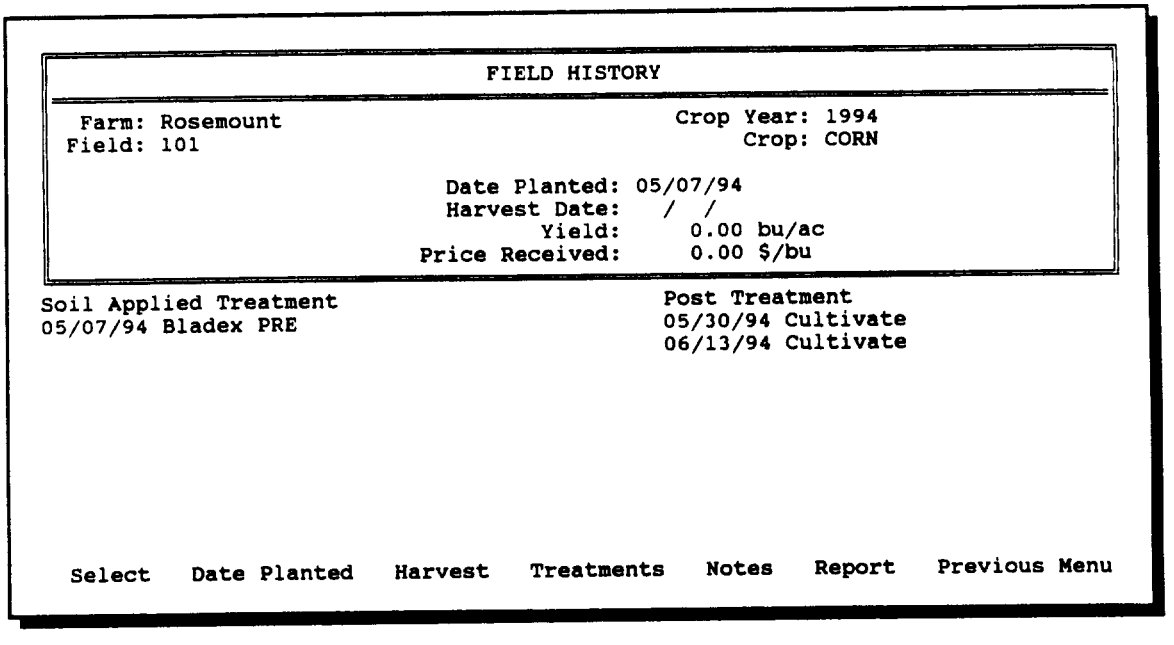
☞ *Entering or editing harvest data*

1. Select **History** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and crop year from the scrolling lists. The planned crop for the current crop year will be displayed below the crop year. Information already entered for that field and crop year will also be displayed.

3. Select *Harvest* from the command line.

4. Enter or edit the harvest date, actual yield, and price received for this field and crop year.



☞ *Recording weed control treatments*

Procedures for recording soil applied and postemergence weed control treatments are identical, except as noted below.

1. Select **History** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and crop year from the scrolling lists. The planned crop for the current crop year will be displayed below the crop year. Information already entered for that field and crop year will also be displayed.

3. Select *Treatments* from the command line. A new set of selections will appear on the command line.

4. Select *Soil Applied Treatment* or *Post Treatment* from the command line. A new set of selections will appear on the command line.

5. Select *Add* from the command line. A scrolling window of treatments in the category you have selected (Soil Applied or Post) will be displayed on the screen.

6. Select the treatment to be recorded from the scrolling list. Then enter the date this treatment was applied.

☞ *Editing weed control treatment dates*

Procedures for editing soil applied and postemergence weed control treatment dates are identical, except as noted below.

1. Select **History** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and crop year from the scrolling lists. The planned crop for the current crop year will be displayed below the crop year. Information already entered for that field and crop year will also be displayed.

3. Select *Treatments* from the command line. A new set of selections will appear on the command line.

4. Select *Soil Applied Treatment* or *Post Treatment* from the command line. A new set of selections will appear on the command line.

5. Select *Edit* from the command line. A scrolling window of treatments and treatment dates for the category you have selected (Soil Applied or Post) will be displayed on the screen.

6. Edit the treatment dates you wish to change. Then press <ESC> when you are through editing.

☞ *Deleting weed control treatments*

Procedures for deleting soil applied and postemergence weed control treatments are identical, except as noted below.

1. Select **History** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and crop year from the scrolling lists. The planned crop for the current crop year will be displayed below the crop year. Information already entered for that field and crop year will also be displayed.

3. Select *Treatments* from the command line. A new set of selections will appear on the command line.

4. Select *Soil Applied Treatment* or *Post Treatment* from the command line. A new set of selections will appear on the command line.

5. Select *Delete* from the command line. A scrolling window of treatments in the category you have selected (Soil Applied or Post) will be displayed on the screen. Use the arrow keys to move the highlight bar.

6. Press <DEL> to delete or restore the highlighted treatment.

7. Press <ESC> to return to the previous menu.

☞ *Recording or editing field notes*

This feature allows the user to make notes on factors that are not recorded under the more formal field history data entry procedures.

1. Select **History** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and crop year from the scrolling lists. The planned crop for the current crop year will be displayed below the crop year. Information already entered for that field and crop year will also be displayed.

3. Select *Notes* from the command line. A scrolling window for field notes will appear on the screen.

4. Enter or edit notes as you would with a simple word processor. If you have already entered some notes, move the cursor to the first blank line to begin recording new text.

5. When you are through entering or editing, press <Ctrl-W> to return to the previous menu.

☞ *Viewing or printing a field history report*

1. Select **History** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a farm, field, and crop year from the scrolling lists. The planned crop for the current crop year will be displayed below the crop year. Information already entered for that field and crop year will also be displayed.

3. Select *Report* from the command line. A new set of selections will appear on the command line.

4. Select *View* to view the field history report on the screen.

5. Select *Report* to print the field history report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

5.7 Crop Budgets

Crop budget information is the source of price information used in weed control strategy evaluations. Use the **Crop Budgets** screen to add annual crop budget information to the GWM database and to edit crop budget information.

☞ *Adding a new crop budget to the database*

1. Select **Budgets** from the **FARM/FIELDS** menu.

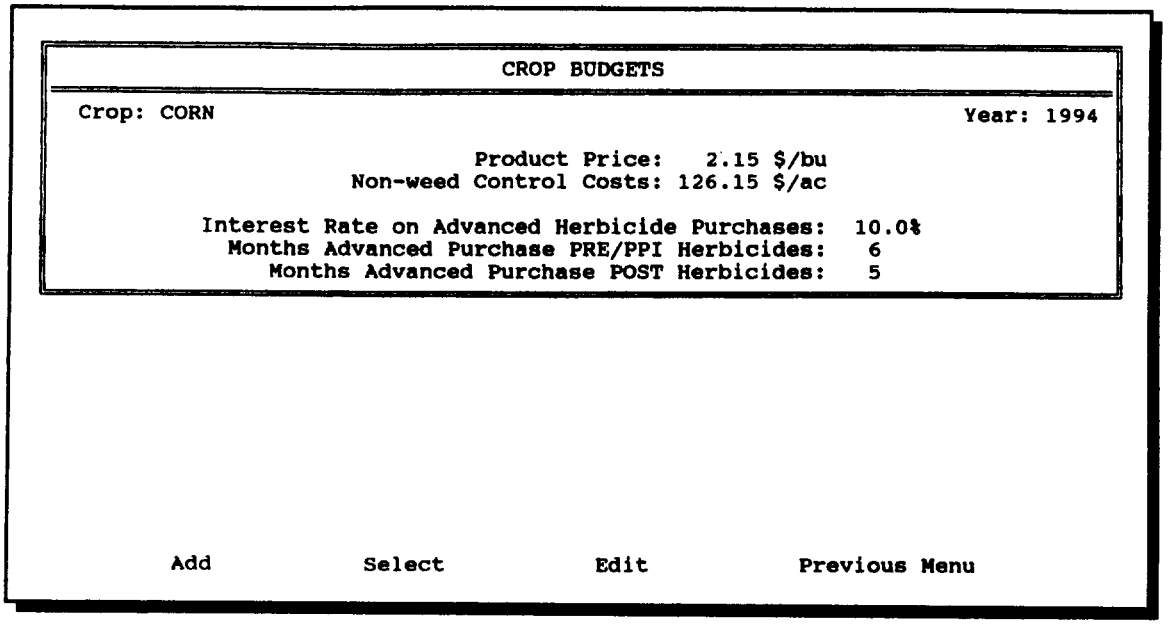
2. Select *Add* from the command line.

3. Select a crop from the scrolling list of crop names.

4. Enter the crop year, product price, and non-weed control costs for this crop and crop year.

5. Enter interest rate and timing information for herbicide purchases.

6. When you have finished entering budget information, select *Save* from the command line to save the information you have entered; select *Edit* to edit the information you have entered; or select *Cancel* to cancel the information you have entered.



☞ *Editing a crop budget*

1. Select **Budgets** from the **FARM/FIELDS** menu.

2. Use the *Select* command to choose a crop and crop year from the scrolling lists.

3. Select *Edit* from the command line.

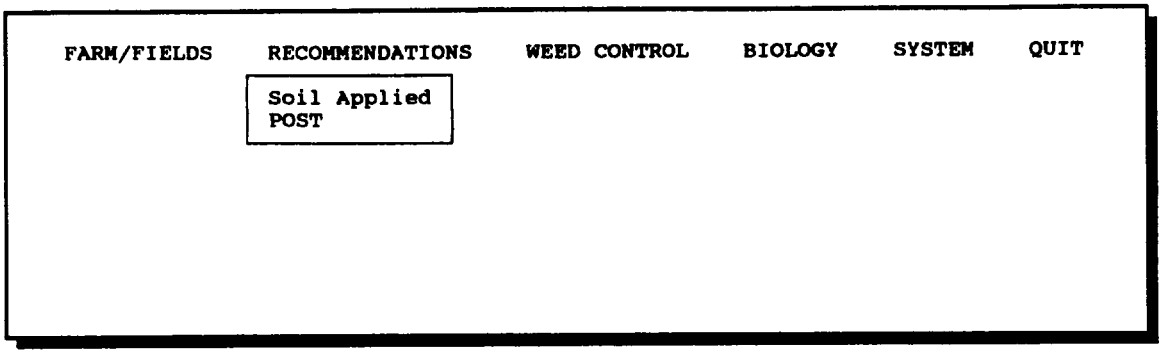
4. Edit the product price, non-weed control costs and herbicide purchase information for this crop and crop year.

6. Weed Control Recommendations

GWM uses data on crop and weed biology, weed control treatments and tactics, cropping plans, weed seed and weed seedling counts, and crop budgets as parameters in a flexible simulation model that evaluates soil applied and post-emergence weed control strategies. The bioeconomic model in the recommendations module simulates weed emergence and weed seed production, weed control through both mechanical and chemical weed control treatments, and crop yield. In the process, it also calculates the costs and benefits of alternative weed control strategies.

This section of the manual only describes the mechanics of using the recommendations module. See Appendix A for information on the conceptual foundations and model structure for the recommendations module.

The recommendations section of GWM includes screens for selecting fields for evaluation and for displaying the results of weed control strategy evaluations. These screens are accessed by selecting items from the pull-down menu under **RECOMMENDATIONS.**



6.1 Selecting Fields for Evaluation

GWM gives users the option of evaluating one field at a time or creating a list of fields for evaluation. In addition, GWM gives users the option of making temporary changes to field conditions for "what-if" analyses. In most cases, users will want to use actual weed seed or weed seedling counts in evaluations. Similarly, users will usually want to use the restrictions, target planting date, and weed-free yield level specified in the cropping plan for a field and the crop price specified in the crop budget for the current crop and crop year, but these can also be modified for "what-if" analyses. Modifications for "what-if" analyses are temporary and do not affect permanent records maintained in the farm and fields records section of GWM.

Use the **Soil Applied Weed Control Recommendations** and **Postemergence Weed Control Recommendations** screens to add fields to the list for evaluation, to edit the parameters and restrictions for fields on the evaluation list, to delete fields from the evaluation list, and to view or print reports on fields in the evaluation list. These screens are also used to access the recommendations module that evaluates weed control strategies. Data entry procedures for soil applied and postemergence weed control recommendations are almost identical. Where relevant, differences in procedures are noted.

☞ *Adding a new field to the evaluation list*

1. Select **Soil Applied or POST** from the **RECOMMENDATIONS** menu.

2. If you have evaluated weed control strategies in the past, the last evaluation list has been saved by GWM.. Select *Add* from the command line if you want to save the old evaluation list and add new fields to it. Select *Delete All* if you want to erase the old evaluation list and start a new one.

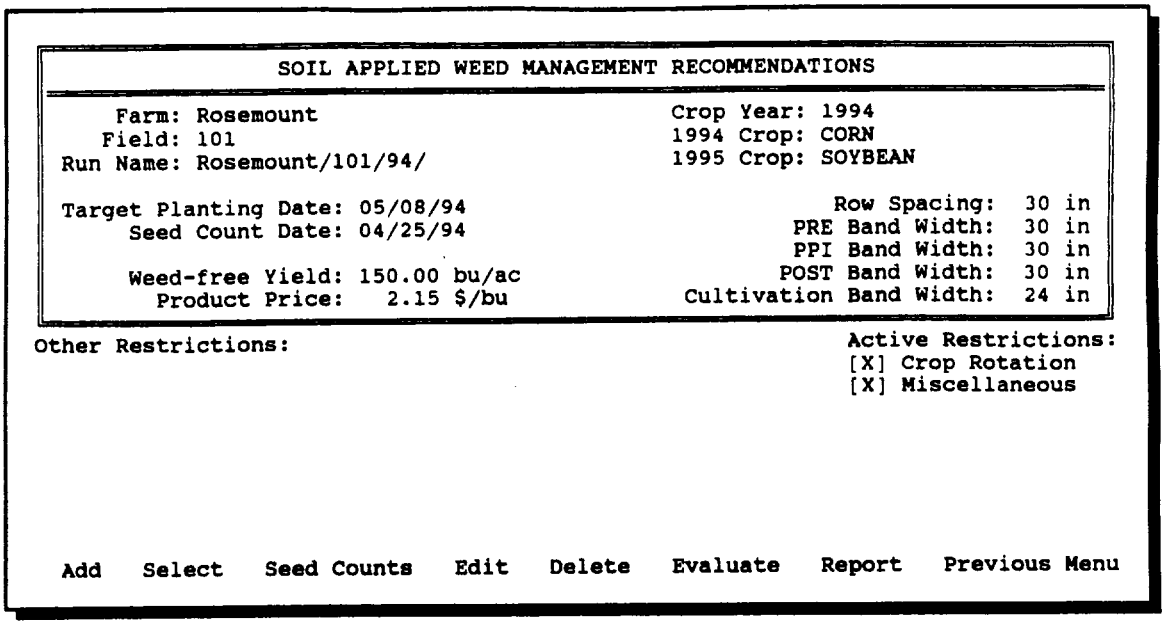
   NOTE: If there are no fields on the evaluation list, these menu selections will not be displayed.

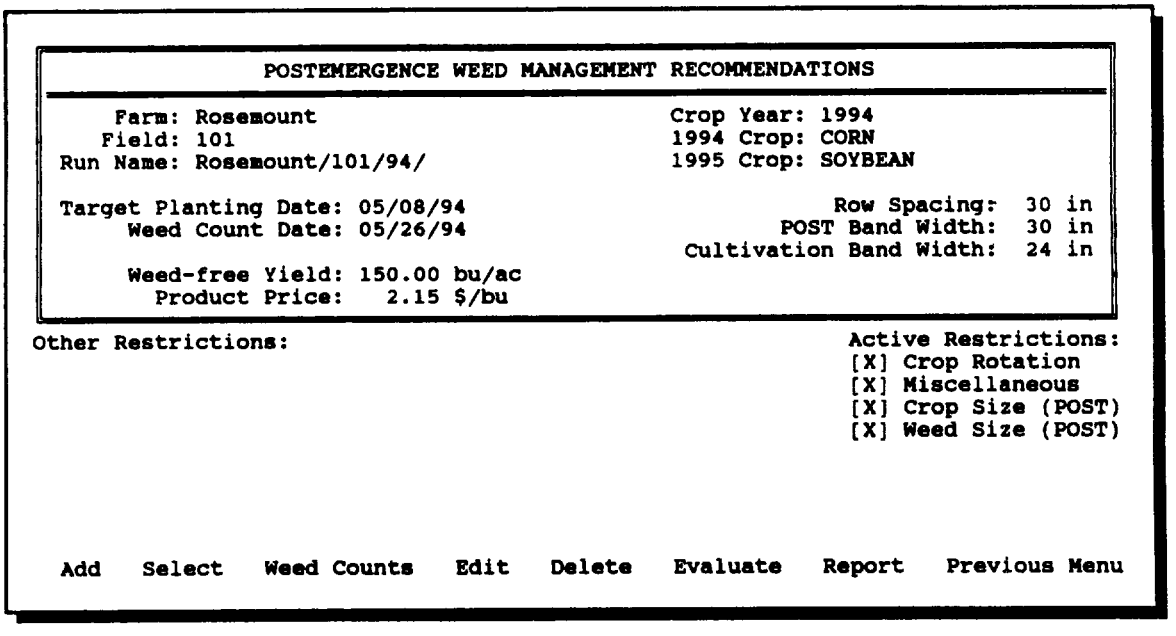
3. Select *Add* from the command line.

4. Select a farm from the scrolling list of farm names. Then select a field and crop year from the scrolling lists that are subsequently displayed. Finally, select a seed count or weed count date from the scrolling list of dates. The remaining information on the screen will be filled in automatically.

   NOTE: GWM automatically constructs a "Run Name" for the field you have selected. This is made up of up to ten characters from the farm name, the field ID, and the crop year. If you add the same farm/field/crop year combination to the evaluation list again, a letter will be appended to the run name. This allows multiple "what-if" evaluations for the same field.

   NOTE: If there are no applicable seed or weed counts in the database for the field you have selected, this will be indicated with a warning message. Fields cannot be evaluated without applicable count data.


SOIL APPLIED WEED MANAGEMENT RECOMMENDATIONS
Farm: Rosemount
Field: 101
Run Name: Rosemount/101/94/
Crop Year: 1994
1994 Crop: CORN
1995 Crop: SOYBEAN
Target Planting Date: 05/08/94
Seed Count Date: 04/25/94
Weed-free Yield: 150.00 bu/ac
Product Price: 2.15 $/bu
Row Spacing: 30 in
PRE Band Width: 30 in
PPI Band Width: 30 in
POST Band Width: 30 in
Cultivation Band Width: 24 in
Other Restrictions:
Active Restrictions:
[X] Crop Rotation
[X] Miscellaneous
Add Select Seed Counts Edit Delete Evaluate Report Previous Menu


POSTEMERGENCE WEED MANAGEMENT RECOMMENDATIONS
Farm: Rosemount
Field: 101
Run Name: Rosemount/101/94/
Crop Year: 1994
1994 Crop: CORN
1995 Crop: SOYBEAN
Target Planting Date: 05/08/94
Weed Count Date: 05/26/94
Weed-free Yield: 150.00 bu/ac
Product Price: 2.15 $/bu
Row Spacing: 30 in
POST Band Width: 30 in
Cultivation Band Width: 24 in
Other Restrictions:
Active Restrictions:
[X] Crop Rotation
[X] Miscellaneous
[X] Crop Size (POST)
[X] Weed Size (POST)
Add Select Weed Counts Edit Delete Evaluate Report Previous Menu

5. A scrolling list of restriction categories will appear. Select the restriction categories that will apply for this field. For soil applied recommendations, only crop rotation and miscellaneous restrictions can apply. For postemergence recommendations, crop and weed size restrictions can also apply. To activate or deactivate a restriction category, use the arrow keys to highlight its name. Then press the space bar to activate or deactivate it. Press <ENTER> when you have finished selecting restriction categories. The scrolling list will close and the active restrictions will be marked with an "X".

☞ *Editing parameters and restrictions for a field on the evaluation list*

The edit command can be used to change the target planting date, seed count date, weed-free yield, and/or product price for a field on the evaluation list. It also allows you to modify the list of "Other Restrictions" and to change the active restrictions for a field.

1. Select **Soil Applied or POST** from the **RECOMMENDATIONS** menu.

2. If you have evaluated weed control strategies in the past, the last evaluation list has been saved by GWM. Select *Add* from the command line if you want to save the old evaluation list and add new fields to it. Select *Delete All* if you want to erase the old evaluation list and start a new one.

   NOTE: If there are no fields on the evaluation list, these menu selections will not be displayed. You cannot use the edit command unless there are already fields on the evaluation list.

3. Use the *Select* command to choose a run name from the scrolling list.

4. Select *Edit* from the command line.

5. If there are multiple seed or weed counts that could be used in this evaluation, select a count date from the scrolling list, then edit the target planting date, weed-free yield, and product price.

6. A scrolling list of possible restrictions on weed control treatments will appear. To mark a restriction for inclusion for this run, use the arrow keys to highlight its name, then press the space bar. Restrictions that have been selected are "marked" by bold arrows on the right and left. To end the selection of other restrictions, press <ENTER>. The scrolling list will close, and the restrictions you have selected will be displayed.

NOTE: It is not necessary for there to be restrictions of this kind. If there are none, simply press <ENTER> without selecting any restrictions.

7. A scrolling list of restriction categories will appear. Select the restriction categories that will apply for this field. For soil applied recommendations, only crop rotation and miscellaneous restrictions can apply. For postemergence recommendations, crop and weed size restrictions can also apply. To activate or deactivate a restriction category, use the arrow keys to highlight its name. Then press the space bar to activate or deactivate it. Press <ENTER> when you have finished selecting restriction categories. The scrolling list will close and the active restrictions will be marked with an "X".

☞ *Editing or reviewing seed or weed counts for a field on the evaluation list*

For "what-if" analyses, you may want to modify seed or weed counts for a field. This is especially useful for learning how recommendations are affected by changes in field conditions.

1. Select **Soil Applied or POST** from the **RECOMMENDATIONS** menu.

2. If you have evaluated weed control strategies in the past, the last evaluation list has been saved by GWM. Select *Add* from the command line if you want to save the old evaluation list and add new fields to it. Select *Delete All* if you want to erase the old evaluation list and start a new one.

   NOTE: If there are no fields on the evaluation list, these menu selections will not be displayed. You cannot edit seed or weed counts unless there are already fields on the evaluation list.

3. Use the *Select* command to choose a run name from the scrolling list.

4. For soil applied recommendations, select *Seed Counts* from the command line. For postemergence recommendations, select *Weed Counts* from the command line.

5. A scrolling window with all weeds in the database in the left column and average count data in the remaining column(s) will appear. For seed counts, the only count data will be the average number of seeds. For weed counts, the count data will also include average weed height and number of leaves for each weed. Modify any count data you wish to change, using the arrow keys to move from one data field to another. Press <ESC> when you are through editing.

6. The scrolling window will close, and current values for weeds with non-zero count data will be displayed. Select *Save* from the command line to save the changes you have made for this run, select *Edit* to continue editing, or select *Cancel* to cancel the changes you have made.

NOTE: Editing count data makes temporary modifications that apply only for the run you have selected. The changes you make are not stored in the permanent seed and weed count database.

☞ *Deleting run names from the evaluation list*

You may wish to delete some but not all run names from an existing evaluation list. This feature allows you to select run names for deletion from the evaluation list.

1. Select **Soil Applied or POST** from the **RECOMMENDATIONS** menu.

2. If you have evaluated weed control strategies in the past, the last evaluation list has been saved by GWM. Select *Add* from the command line if you want to save the old evaluation list and add new fields to it. Select *Delete All* if you want to erase the old evaluation list and start a new one.

   NOTE: If there are no run names on the evaluation list, these menu selections will not be displayed. You cannot selectively delete run names from the evaluation list unless it includes some run names.

3. Select *Delete* from the command line. A scrolling list of run names will be displayed. Use the arrow keys to move the highlight bar.

4. Press <DEL> to delete or restore the highlighted run name.

5. Press <ESC> to return to the previous menu. The screen will clear, and you will need to select a run name before continuing.

☞ *Viewing or printing an evaluation list report*

1. Select **Soil Applied or POST** from the **RECOMMENDATIONS** menu.

2. If you have evaluated weed control strategies in the past, the last evaluation list has been saved by GWM. Select *Add* from the command line if you want to save the old evaluation list and add new fields to it. Select *Delete All* if you want to erase the old evaluation list and start a new one.

NOTE: If there are no fields on the evaluation list, these menu selections will not be displayed. You cannot view or print an evaluation list report unless there are already run names on the evaluation list.

3. Use the *Select* command to choose a run name from the scrolling list.

4. Select *Report* from the command line. A new set of selections will appear on the command line.

5. Select *View* to view the evaluation list report on the screen.

6. Select *Report* to print the evaluation list report. Make sure the paper in your printer is at the top of the page, then press any key to begin printing.

6.2 Strategy Evaluation

Selecting *Evaluate* from the command line of the soil applied or postemergence recommendations screen loads the recommendations module of GWM. The recommendations module allows you to select run names from the evaluation list and to evaluate weed control strategies for the parameters and conditions specified for that run name.

The user interface for the recommendations module differs slightly from that used in the rest of GWM. There is mouse support in the recommendations module. The mouse can be used to make selections from the command line or to select items on scrolling lists. If you do not use a mouse, menu selections are made by highlighting a command and pressing <ENTER>. You can move among menu selections using arrow keys or the tab key. Menu selections cannot be made by pressing the first letter of a command as in the rest of GWM.

Procedures for making soil applied and postemergence weed control recommendations are almost identical. Where relevant, differences in procedures are noted.

☞ *Accessing the recommendations module*

1. Select **Soil Applied or POST** from the **RECOMMENDATIONS** menu.

2. If you have evaluated weed control strategies in the past, the last evaluation list has been saved by GWM. Select *Add* from the command line if you want to save the old evaluation list and add new fields to it. Select *Delete All* if you want to erase the old evaluation list and start a new one.

NOTE: If there are no fields on the evaluation list, these menu selections will not be displayed. You cannot evaluate weed control recommendations unless there are already run names on the evaluation list.

3. Use the *Select* command to choose a run name from the scrolling list.

4. Select *Evaluate* from the command line. The following message will be displayed on the command line as the recommendations module is loading:

   ```
   < Please wait...recommendations module loading... >
   ```

   The screen will then go blank for an instant and the **Soil Applied Weed Control Recommendations** or the **Postemergence Weed Control Recommendations** screen will be replayed.

For the procedure that follows, it will be assumed that you have accessed the recommendations module.

☞ *Making an evaluation for a run name*

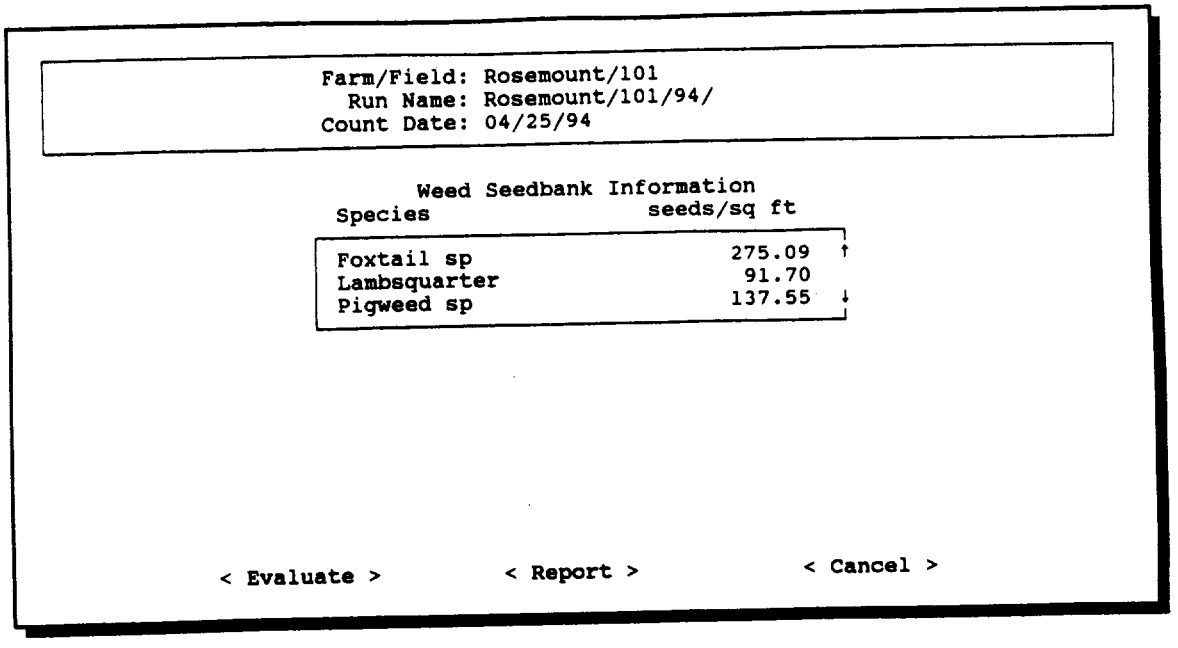
1. Use the *Select* command to select a run name from the scrolling list of run names on the evaluation list. After you have selected a run name, parameters and restriction information will be displayed automatically on the screen.

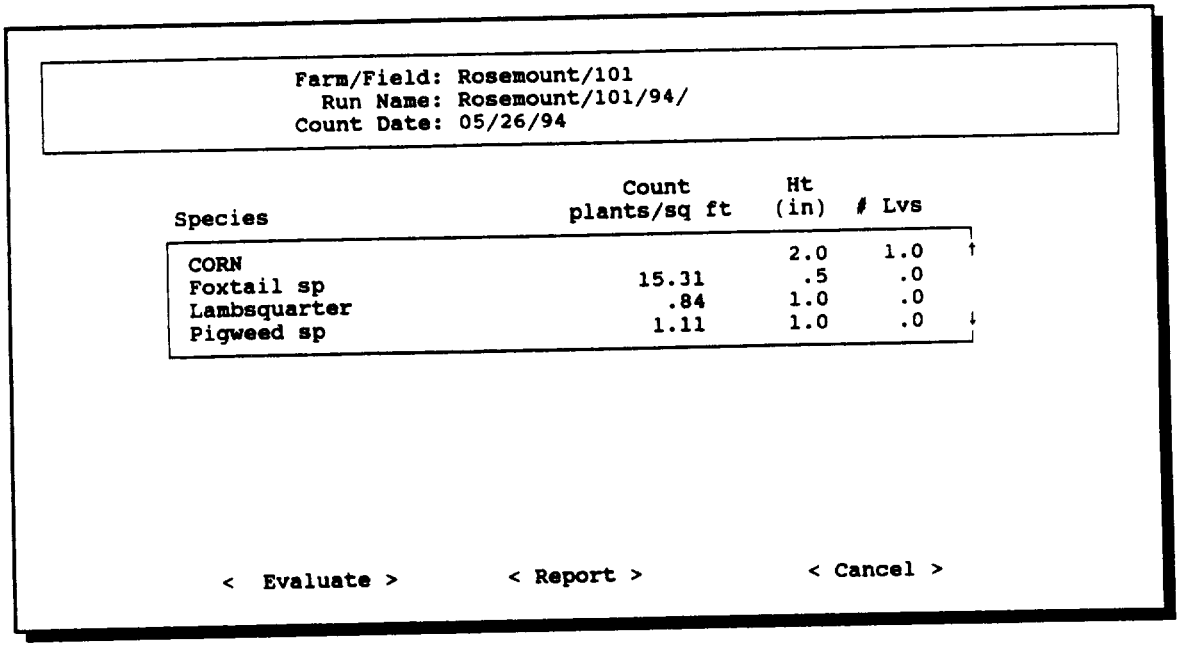
2. Select *Evaluate* from the command line.

3. The next screen to appear displays count information. For soil applied recommendations, weed seedbank information is displayed, as in the example at the top of the facing page.

   For postemergence recommendations, weed seedling densities and average weed height and number of leaves are displayed for each weed species, as in the example at the bottom of the facing page.

4. Select *Evaluate* from the command line to continue with the evaluation. Select *Report* to print the count information displayed on this screen. Select *Cancel* to cancel this evaluation and return to the previous screen.


Farm/Field: Rosemount/101
Run Name: Rosemount/101/94/
Count Date: 04/25/94
Weed Seedbank Information
Species
seeds/sq ft
Foxtail sp 275.09
Lambsquarter 91.70
Pigweed sp 137.55
< Evaluate >
< Report >
< Cancel >


Farm/Field: Rosemount/101
Run Name: Rosemount/101/94/
Count Date: 05/26/94
Species
Count plants/sq ft
Ht (in)
Lvs
CORN 2.0 1.0
Foxtail sp 15.31 .5 .0
Lambsquarter .84 1.0 .0
Pigweed sp 1.11 1.0 .0
< Evaluate >
< Report >
< Cancel >

RANKING OF STRATEGIES
Farm/Field: Rosemount/101
Run Name: Rosemount/101/94/

RANK	STRATEGY SOIL APPLIED	POST	NET GAIN $/ac
1	Bladex PRE	2,4-D & Cultivate	156.59
2	Bladex PRE	Banvel & Cultivate	153.18
3	Bladex PPI	2,4-D & Cultivate	153.17
4	Bladex PPI	Banvel & Cultivate	149.76
5	Eradicane PPI	2,4-D & Cultivate	148.03
6	Eradicane PPI	Banvel & Cultivate	144.61
7	Bladex PRE	Buctril & Cultivate	144.17
8	Bladex PRE	Bladex & Cultivate	141.17
9	Bladex PPI	Buctril & Cultivate	140.75
10	Bladex PRE	Cultivate Twice	139.78
11	Bladex PPI	Bladex & Cultivate	137.75
12	Bladex PPI	Cultivate Twice	136.36
13	Eradicane PPI	Buctril & Cultivate	135.96

< Continue > < Details > < Graphs > < Report>

RANKING OF POST TACTICS
Farm/Field: Rosemount/101
Run Name: Rosemount/101/94/

RANK	TACTIC	NET GAIN $/ac
1	Bladex & Cultivate	126.75
2	2,4-D & Cultivate	117.78
3	Banvel & Cultivate	114.37
4	Cultivate Twice	109.34
5	Buctril & Cultivate	105.84
6	Accent & Cultivate	101.96
7	Cultivate Once	63.57
8	No POST Management	.00

< Continue > < Details > < Graphs > < Report >

5. If you are continuing with the evaluation, a **Ranking of Strategies** screen will be displayed next. For soil applied recommendations, this screen will show net gain over no control for strategies defined by a soil applied treatment and a postemergence tactic. The strategies are sorted by net gain. This information is displayed in a scrolling window, so you can view results for more strategies than can be displayed on the screen at one time. The scrolling list will only include information for the top forty-nine options plus no control. A sample ranking screen for soil applied recommendations is shown at the top of the facing page.

   For postemergence recommendations, the **Ranking of Strategies** screen shows net gains over no control for strategies defined by a postemergence tactic. Again the strategies are sorted by gain and this information is displayed for the top forty-nine options in a scrolling window. A sample ranking screen for postemergence recommendations is shown at the bottom of the facing page.

6. From the **Ranking of Strategies** screen, you can view more detailed performance information for any of the strategies in the scrolling box. To do this, use the mouse or the arrow keys to move the highlight bar to a strategy. If you are using a mouse, click on *Details* on the command line. If you are not using a mouse, press <ENTER> to move the cursor to the command line, then use the arrow keys or tab key to highlight *Details* and press enter.

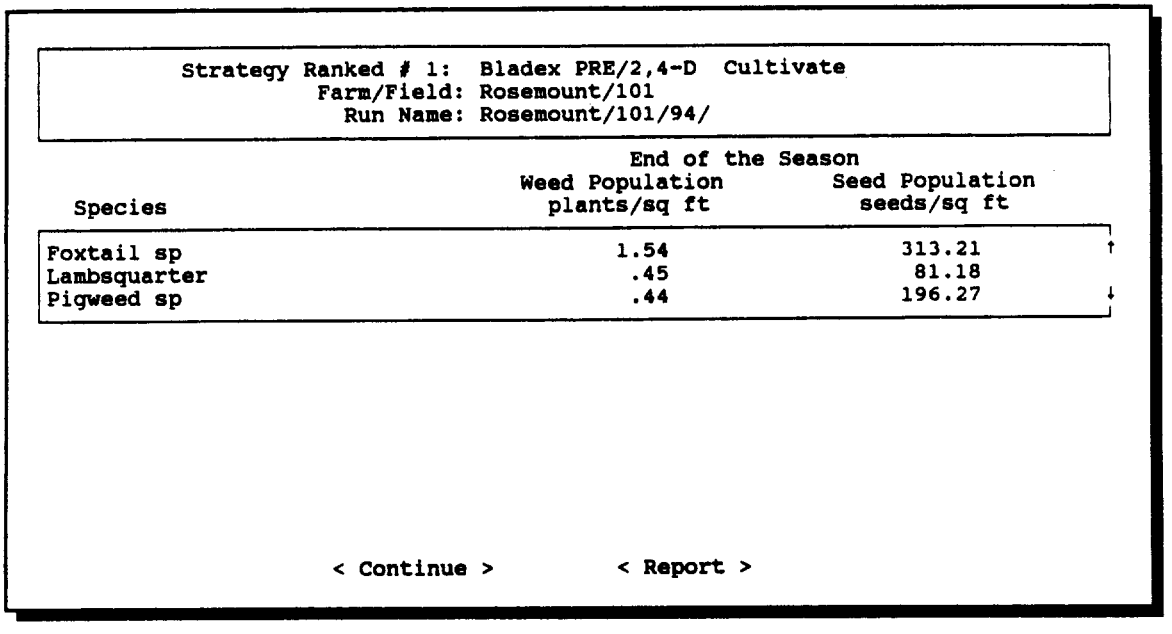
   Details screens for soil applied and postemergence strategies have the same structure. A sample soil applied detail screen is shown below.

```
                    MANAGEMENT STRATEGY RANKED #  1
                  Farm/Field: Rosemount/101
                    Run Name: Rosemount/101/94/

 Bladex PRE/2,4-D  Cultivate                          COST:$   25.28/ac
PRE/PPI   05/08/94 Bladex PRE                                    20.02
                     Bladex 90DF  3 lb ai/ac          18.62
                     PRE Application                   1.40
POST      05/29/94 2,4-D Amine                                    2.76
                     2,4-D Amine  .5 lb ai/ac         1.36
                     POST Application                  1.40
POST      06/12/94 Cultivate                                      2.50
                     Cultivation                       2.50

                      Profit: $  55.22/ac          Yield:  96.1 bu/ac
Net Gain from Weed Control: $ 156.59/ac      Yield Loss:  36 %

                              < Continue >
```

At the top of the screen is farm/field and run name information. The strategy name and overall cost is displayed between this and above a scrolling window with application dates, herbicides and mechanical operations, and cost information for all treatments applied under this strategy. At the bottom of the screen, the expected profit and net gain from weed control and the expected yield and percentage yield loss are displayed.

Press <ENTER> to continue to the next details screen, which displays predicted end of season weed and weed seed densities.

NOTE: Postemergence strategy evaluations do not use seed density information. Therefore, seed production, rather than ending seed density, is displayed on the second detail screen for postemergence strategies.



7. To print a detail report, select *Report* from the command line on the second screen.

8. Graphs showing net gain from weed control, end of season total weed counts, end of season weed population by species, and end of season seed bank (soil-applied evaluations) or weed seed production (postemergence evaluations) can be displayed for the strategies in the scrolling window on the **Ranking of Strategies** screen. To display graphs, select *Graphs* from the command line.

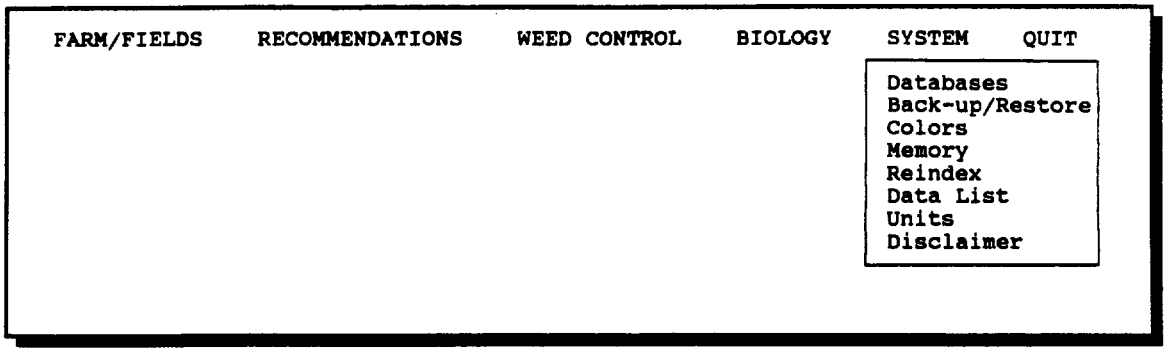
NOTE: The graphics routines in GWM do not work properly on some computers. In some cases, it may be necessary to restart your computer if the graphics routines fail. If this happens, do not use the graphics option.

9. To return to the main soil applied or postemergence recommendations screen and the main menu for the recommendations module, select *Continue* from the command line of the **Ranking of Strategies** screen.

10. To leave the recommendations module and return to the data management module of GWM, select *Quit* from the command line of the main menu.

7. System Management

The **SYSTEM** menu gives you access to six utilities that help you manage GWM and use it more effectively. These include backing up your data, changing screen colors, checking on available memory and disk space, reindexing files in the GWM database, generating a report that lists the structure and index keys for all files in the GWM database, and erasing all data from the GWM database. These utilities are accessed by selecting items from the pull-down menu under **SYSTEM.**



7.1 Selecting a Current Databases, Adding or Deleting a Database, or Editing a Database Description

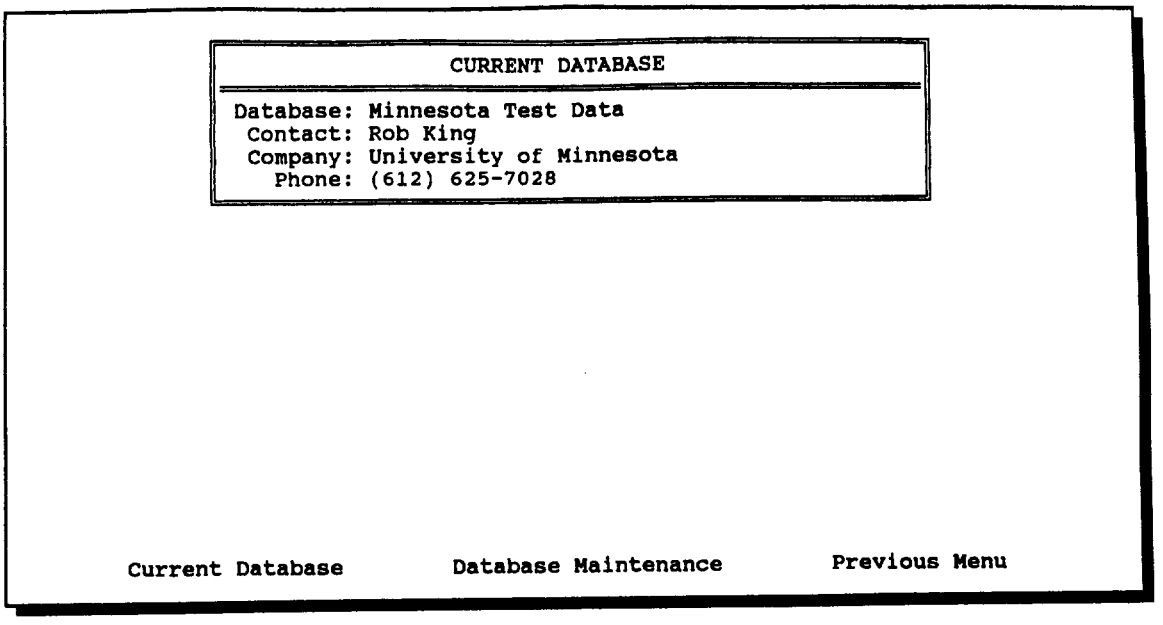
GWM allows you to maintain several weed management databases. Use the **Current Database and Database Maintenance** screens to select a database, add or delete a database, or edit a database description.

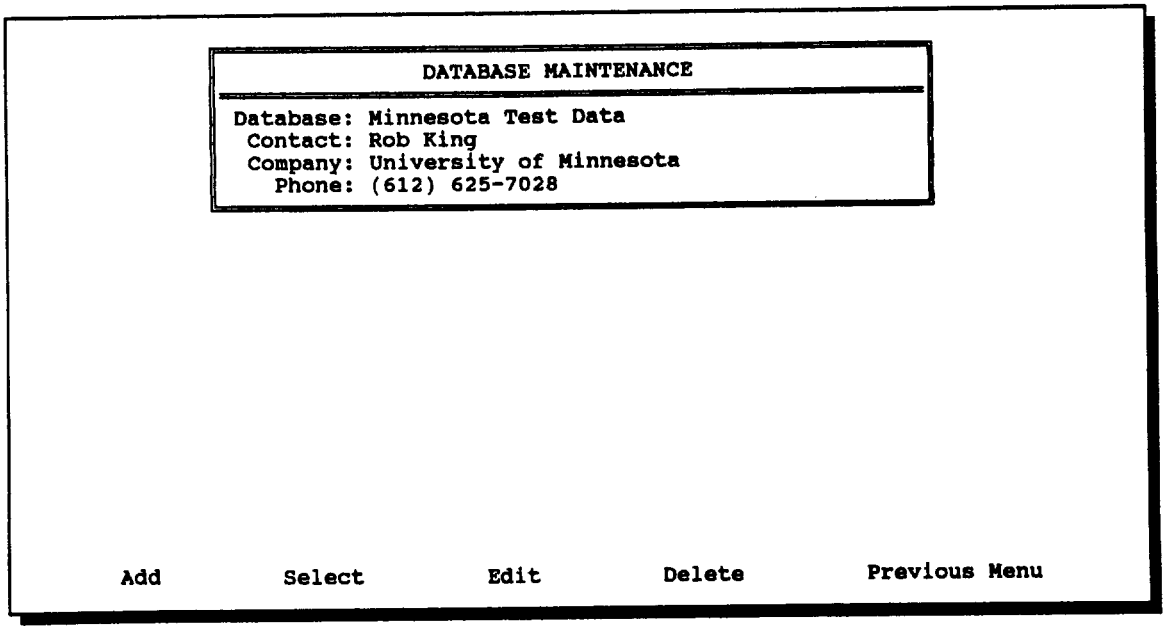
☞ *Selecting a current database for data entry*

1. Select **Databases** from the **SYSTEM** menu. The **Current Database** screen will appear.

2. Select *Current Database* from the command line.

3. Select the database you wish to use for data entry from the scrolling list.


CURRENT DATABASE
Database: Minnesota Test Data
Contact: Rob King
Company: University of Minnesota
Phone: (612) 625-7028
Current Database
Database Maintenance
Previous Menu


DATABASE MAINTENANCE
Database: Minnesota Test Data
Contact: Rob King
Company: University of Minnesota
Phone: (612) 625-7028
Add
Select
Edit
Delete
Previous Menu

☞ *Adding a database*

1. Select **Databases** from the **SYSTEM** menu. The **Current Database** screen will appear.

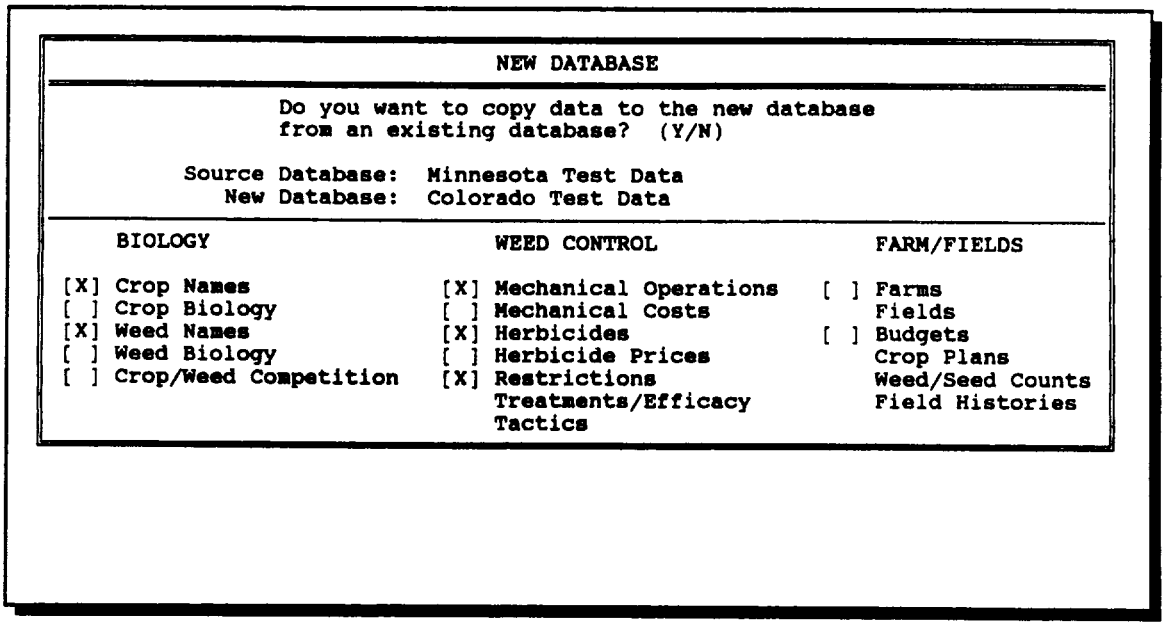
2. Select *Database Maintenance* from the command line. The **Database Maintenance** screen will appear.

3. Select the *Add* from the command line. The **New Database** screen will appear.

4. Answer the question at the top of the screen, selecting **Y** if you want to copy data from an existing database to the new database or selecting **N** if you do not want to copy data from an existing database.

5. If you are copying data from an existing database, select a database from the scrolling list.

6. A default database name will be displayed for the new database. In most cases, this should be replaced with a descriptive name for the new database.



7. The **Measurement Units** screen will appear. Use this screen to select the measurement system you will use for the new database--English or Metric. Also select a method of measuring pesticide rates--active ingredient (A.I.) or actual quantities (ACTUAL).

8. After you have selected measurement units, the following question will appear on the command line:

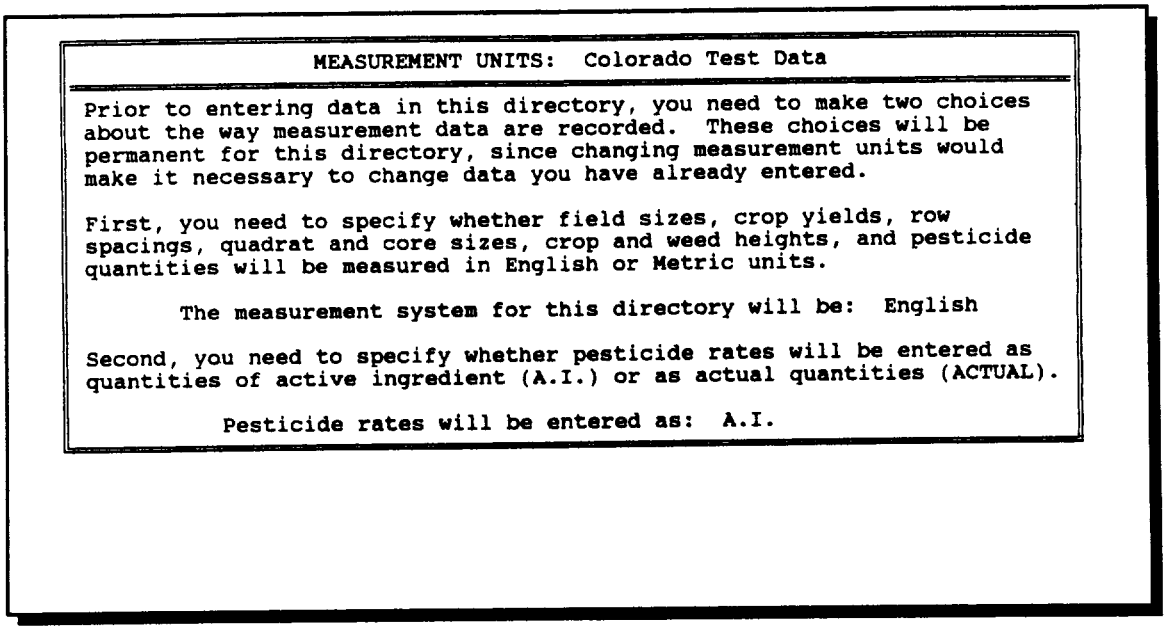
   `< Are these measurement units correct for this database? (Y/N)>`

   Select **Y** if they are correct. Select **N** if you want to edit them.

   NOTE: You will not be able to edit units after you leave this screen.

8. The **New Database** screen will appear again. If you are not copying data from an existing database, empty data files will be copied into the new database.

9. If you are copying data from an existing database, and the measurement units for the new database are the same as those for the source database, the following question will appear on the command line:



```
< Do you want to copy all the Biology, Weed
Control, and Farm/Field files from the source
database to the new database?  (Y/N)>
```

If you select **Y**, all files will be copied from the source database to the new database. If you select **N**, you can use the arrow keys and space bar to select or deselect specific data categories for copying to the new database. Press <ESC> when you have finished selecting data categories, and data files will be copied to the new database.

NOTE: Some data categories can be copied only if others have been selected. For example, Crop Biology data cannot be copied if Crop Names have not been selected. Also, some data categories cannot be copied if the source database and new database have different measurement units. GWM automatically restricts your choices to avoid such inconsistencies.

☞ *Editing a database description*

1. Select **Databases** from the **SYSTEM** menu.

2. Select *Database Maintenance* from the command line. The **Database Maintenance** screen will appear.

3. Use the *Select* command to choose a database from the scrolling list.

4. Select *Edit* from the command line, and modify the database description and/or contact person information.

☞ *Deleting a database*

1. Select **Databases** from the **SYSTEM** menu.

2. Select the *Database Maintenance* from the command line. The **Database Maintenance** screen will appear.

3. Use *Select* command to choose a database from the scrolling list.

4. Select *Delete* from the command line. The following question will appear on the command line:

```
< Are you sure you want to delete this database?
(Y/N) >
```

Select **Y** to continue with deletion of the database. Select **N** to cancel deletion of the database.

7.2 Back-up Data

Use the **Database Back-up and Restore** screen to protect against hard disk failure by backing up your data files on a floppy disk.

☞ *Backing up your data*

1. Select **Back-up/Restore** from the **SYSTEM** menu.
2. Select *Back-up* from the command line.
3. The name of the current database will be displayed. This is the database that will be backed up. Select the target drive for the back-up procedure from the scrolling list.
4. Insert a formatted diskette in the target drive and press any key to continue.

NOTE: All data will be erased from the target diskette before the current data files are backed up. Therefore, your back-up diskette should not contain any data you want to save.

☞ *Restoring your data*

1. Select **Back-up/Restore** from the **SYSTEM** menu.
2. Select *Restore* from the command line.
3. Select a database from the scrolling line.
4. Select a source drive from the scrolling line.
5. Insert the appropriate back-up diskette in the source drive and press any key to continue. If you press <ESC> the back-up procedure will be canceled.

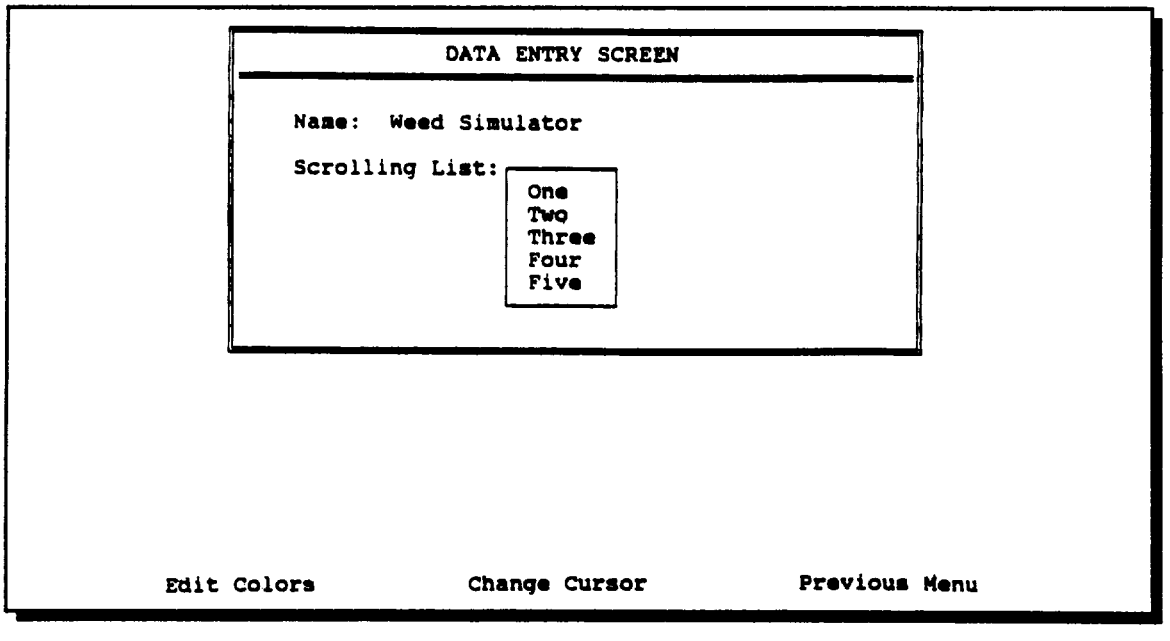
NOTE: All data in the selected database directory on your hard disk will be replaced by the data on the back-up disk. Restore data only when necessary, and be sure to use the most recent back-up disk for this operation.

7.3 Customizing Screen Colors

The **Screen Colors** screen allows you to modify colors for data entry screens and scrolling lists and change the shape of the cursor.

☞ *Editing screen colors*

1. Select **SYSTEM** from the main menu.
2. Select **Colors** from the **SYSTEM** menu.
3. Select *Edit Colors* from the command line.
4. Select either *Data Entry* screen to change foreground and background colors of data entry screens or select *Scrolling List* to change foreground and background colors of scrolling lists.
5. Press ← → for foreground color changes. Press ↑ ↓ for background color changes.
6. Press <ENTER> to save current settings or <ESC> to restore original colors.
7. Select *Previous Menu* from the command line and then press <ENTER>.



☞ *Modifying the cursor*

1. Select **Colors** from the **SYSTEM** menu.

2. Select *Change Cursor* from the command line.

3. Press ↑ ↓ to change the cursor shape.

4. Press <ENTER> to save the current cursor or <ESC> to restore the original cursor.

5. Select *Previous Menu* from the command line and then press <ENTER>.

7.4 Memory and Disk Space

Use the **Memory** utility to check available memory and disk space on your computer. This information may be useful if you are having problems running GWM.

☞ *Checking available memory and disk space*

1. Select **Memory** from the **SYSTEM** menu.

2. Available space on the hard disk where GWM is stored and free system memory will be displayed on your screen.

7.5 Reindexing Data Files

Use the **Reindex** utility to recreate the index files used to facilitate data access in the GWM database. This utility may be helpful if you are having problems running GWM. It should also be used if you modify data files outside of the GWM program.

☞ *Reindexing data files*

1. Select **Reindex** from the **SYSTEM** menu.

2. Messages will be displayed on the command line as the reindexing procedure progresses.

7.6 Listing Data File Structures and Index Keys

Use the **Data List** utility to create a listing of the data file structures and index keys in the GWM database. This utility may be helpful if you are having problems running GWM or if you want to develop an application that accesses GWM data files.

☞ *Listing data file structures and index keys*

1. Select **Data List** from the **SYSTEM** menu.

2. The following message will be displayed on the command line as the program creates a text file listing of database information. This is stored in a file named DATASTRU.TXT in the GWM program directory.

```
< Creating DATASTRU.TXT database file structure
listing ...Please Wait. >
```

7.7 Measurement Units for the Current Database

Use the **Units** utility to review the measurement units for the current database.

☞ *Reviewing measurement units for the current database*

1. Select **Units** from the **SYSTEM** menu.

2. Information on the measurement units for the current database will be displayed on your screen.

7.8 Viewing the GWM Program Disclaimer

Use the **Disclaimer** utility to view the GWM program disclaimer.

☞ *Viewing the GWM program disclaimer*

1. Select **Disclaimer** from the **SYSTEM** menu.

2. The disclaimer will be displayed on your screen.

Appendix A

This appendix describes the structure and conceptual basis of the recommendations module and the embedded bioeconomic simulation model. This information should be helpful in parameterizing GWM, however, the appendix is not meant to be a guideline for modeling weed management. Sections 1 through 3 give an overview of the recommendations module and bioeconomic simulations. Sections 4 and 5 provide more detail to help in selecting parameter values and functional forms for modeling processes.

A.1 Overview of the Recommendations Module

The recommendations module of GWM performs two functions for evaluating soil-applied and postemergence weed management (Figure 1). First, the module identifies which of the management options are feasible for the specified farm and field conditions. Then the module invokes a deterministic, event-driven simulation model to predict biological and economic outcomes for the feasible management options under the specified conditions. A single season is simulated.

Figure 2 illustrates the conceptual basis of the simulations. Biological processes simulated include weed/crop competition, management efficacy, weed emergence, seed production, and seed bank mortality. A full season is simulated to evaluate soil-applied weed management. Postemergence weed management is evaluated in simulations which begin with an estimate of the early-emerging weed seedling population. In the post-emergence only simulations, seed bank processes (emergence, mortality) are not simulated, but seed production may be modeled.

The weed population is divided into three cohorts for full season simulations: weeds emerging before planting (cohort 1), weeds emerging during the weed competitive period (cohort 2), and weeds emerging after the end of the competitive period (cohort 3). Only cohort 2 weeds compete with the crop in the simulations. All weeds are assumed to be in cohort 2 for postemergence simulations.

The output of the simulation model is a ranking of up to 49 feasible management options and no weed management. These options are ranked according to net gain from weed management. Net gain is calculated as the value of the yield loss prevented by weed management minus the cost of the management option. Additional output is expected profit, end of the season weed population, yield loss from weed competition, and either weed seed production (postemergence simulations) or end of the season weed seed bank (full season simulations).

A.2 Identifying Feasible Management Options

The model will only simulate management strategies and postemergence tactics that are "feasible." A strategy is a combination of a soil-applied treatment and a postemergence tactic. A strategy is feasible if both the tactic and treatment are feasible. A postemergence tactic is a series of postemergence treatments. A postemergence tactic is feasible only if all the treatments comprising that tactic are feasible. A treatment is feasible if it meets two conditions: 1) use of the treatment is not restricted by the specified field conditions and 2) efficacy is greater than zero for at least one species of the weed population. In addition, "no management" is always a feasible soil-applied treatment, postemergence treatment and tactic, and management strategy.

You can choose the types of restrictions that will be checked to determine feasibility of options in a particular evaluation. The three types of restrictions are crop rotation, miscellaneous, and crop and weed size. Crop and weed size restrictions are irrelevant in evaluations of soil-applied treatments because crop and weed morphology are not modeled. In postemergence evaluations, crop and weed size restrictions are checked against the estimates of average height and number of leaves of the crop and weeds. All treatments comprising a postemergence tactic will be checked against this information regardless of the specified time of application.

A.3 Bioeconomic Simulations

A.3.1 Calculation of initial weed populations

You can enter weed and seed counts for any size soil core or quadrat, but within the model the population is represented as plants or seeds per square meter or per meter of crop row. If you select English as the units for a database, all calculations will in metric units, but the results will be displayed in English units. This section describes the calculations to convert the average count to the appropriate metric units for the simulations.

Weed seedling populations

If weed count method is area:

$$\text{weeds/m}^2 = (\text{weeds/quadrat})/(\text{qlength} * \text{qwidth})$$

If weed count method is length:

$$\text{weeds/m of row} = (\text{weeds/quadrat})/\text{qlength}$$

where:

qlength = quadrat length (m)
qwidth = quadrat width (m)

Weed seed bank populations

Seed bank populations are calculated average seed counts, assuming the soil core is a cylinder. The area of the circle on the soil surface cut by the core is used in the calculations, but core depth is not. When weed count method is area, the population is calculated from the area of the core relative to a square meter. When weed count method is length, the population is extrapolated from the area of the core to the area of a quadrat one meter long and as wide as the weed band. The cultivation band width determines the weed band width.

The cultivation band width indicates the area between rows where cultivation, ditching, or another operation will control weeds and, therefore, you do not want management of these weeds simulated. The width of the band of weeds to be simulated is equal to the rowspacing minus the cultivation band width. Setting cultivation band width to zero indicates managing all in-row and between-row weeds in the field. Note that the only use of cultivation band width in the model is to calculate the seed bank population when the weed count method is length.

If weed count method is area:

$$\text{seeds/m}^2 = (\text{seeds/core})/(3.1416*(d/2)^2)$$

If weed count method is length:

$$\text{seeds/m of row} = ((\text{seeds/core})/ (3.1416*(d/2)^2))*(\text{rsp} - \text{cbnd})$$

where:

d = diameter of the soil core (m)
rsp = rowspacing (m)
cbnd = cultivation band width (m)

A.3.2 Progression through a season

The simulation model is event-driven. The model progresses through the season by updating state variables when "events" occur. There is a set of state variables for each weed species. These are number of seeds, number of individuals in each cohort, number of individuals emerged, and number of individuals controlled.

Events of the simulations and calculations for each event are described in Table 1. Figure 3 is a flow chart of the model for the full season simulations of soil-applied evaluations. Full season simulations begin with the event of "planting" and end with the event of "harvest." The model updates emergence and control by a soil-applied treatment, if necessary, before other calculations. Postemergence management simulations are simpler with only three types of events: planting, harvest, and postemergence treatment (Table 2).

A.3.3 Calculations for evaluating weed management options

Both biological and economic measures are predicted for each management strategy evaluated.

Weed population at harvest

For each species, the population at harvest is calculated as:

$$wds = Co2 + Co3$$

where:

- wds = weeds present at harvest (plants/m^2 or plants/m)
- Co2 = weeds in the second cohort that have not been controlled (plants/m^2 or plants/m)
- Co3 = weeds in the third cohort that have not been controlled (plants/m^2 or plants/m)

Seed bank at the end of the season

For each weed species, the seed bank is updated as:

$$sds_1 = sds_0*(1-m/100) - ewds + psds_{Co2} + psds_{Co3}$$

where:

- sds_1 = seed bank at the end of the season (seeds/m^2 or seeds/m)
- sds_0 = seed bank at the beginning of the season (seeds/m^2 or seeds/m)
- m = percent mortality ($0 \leq m \leq 100$)
- ewds = number of weeds that emerged (plants/m^{2}or plants/m)
- $psds_{Co2}$ = viable seed production by cohort 2 (seeds/m^2 or seeds/m)
- $psds_{Co3}$ = viable seed production by cohort 3 (seeds/m^2 or seeds/m)

For postemergence simulations, there is no seed bank to update, but viable seed production is displayed.

Expected yield

$$yld = wfyld*(1-yl_{wc})*(1-yl_{dp})$$

where:

- yld = expected yield (crop yield units/ac or ha)
- wfyld = estimated weed-free yield (crop yield units/ac or ha)
- yl_{wc} = proportion of yield lost from weed competition ($0 \leq y_{wc} \leq 1$)
- yl_{dp} = proportion of yield lost from delayed planting ($0 \leq y_{dp} \leq 1$)

Percent yield loss from weed competition

$$\%yl_{wc} = yl_{wc} * 100$$

where:

$\%yl_{wc}$ = percent yield loss ($0 \leq \%y_{wc} \leq 100$)
yl_{wc} = proportion of yield lost from weed competition ($0 \leq y_{wc} \leq 1$)

Expected profit

$$profit = p_s * yld_c - c_c - c_{oc}$$

where:

profit = expected profit ($/ha or $/ac)
p_s = selling price of the crop ($/crop yield units)
yld_c = yield with weed control (crop yield units/ac or ha)
c_c = cost of weed control ($/ac or $/ha)
c_{oc} = production costs unrelated to weed control ($/ac or $/ha)

Expected net gain

$$gain = (yld_c - yld_{nc}) * p_s - c_c$$

where:

gain = expected net gain ($/ac or $/ha)
yld_c = expected yield with weed control (crop yield units/ac or ha)
yld_{nc} = expected yield without weed control (crop yield units/ac or ha)
p_s = selling price of the crop ($/crop yield unit)
c_c = cost of weed control ($/ac or $/ha)

A.4 Specifying Weed Management Options

This section includes information to help in specifying weed management options so that the recommendations module can correctly identify feasible options and simulate their outcomes. Some information in this section is summarized in Table 3.

A.4.1 Treatments, tactics, and strategies

You must describe weed management options with a hierarchical structure of elements. The layers of the hierarchy, from bottom to top, are components, treatments, tactics, and strategies. Elements have characteristics defined by the user or inherited from the lower elements (Table 3).

Mechanical operations and herbicides are components. Postemergence and soil-applied treatments are combinations of components. A postemergence tactic is a series of postemergence treatments with a specified sequence of application. A strategy is a combination of a soil-applied treatment and a postemergence tactic.

You specify components, treatments, and tactics, while the recommendations module constructs strategies as all possible combinations of feasible soil-applied treatments and postemergence tactics. The recommendations module also automatically specifies "no management" as a feasible soil-applied treatment, postemergence tactic, and management strategy.

A.4.2 Restrictions on treatments

You may assign treatments one or more restrictions of three types. Both soil-applied and postemergence treatments may have crop rotation or miscellaneous restrictions. In addition, postemergence treatments may have crop and weed size restrictions. Crop rotation restrictions are crops that cannot be grown in the following season. A treatment is restricted, or not feasible, if a crop rotation restriction assigned to the treatment matches the crop specified for the next season.

Miscellaneous restrictions are conditions associated with a field that should prevent use of the treatment. A treatment is restricted if a miscellaneous restriction associated with that treatment matches a field condition specified on the crop plan screen. For example, accelerated biodegradation may make use of the herbicide A undesirable. Assigning herbicide A, the restriction of "accelerated biodegradation" would eliminate herbicide A as a feasible option for fields assigned the miscellaneous condition of "accelerated biodegration."

Crop and weed size restrictions may be expressed as maximum or minimum height or number of leaves. Weed or crop size restricts use of a treatment if any of the following is true:

$$lvs > maxlvs$$
$$lvs < minlvs$$
$$ht > maxht$$
$$ht < minht$$

where:

- lvs = average observed number of crop or weed leaves
- maxlvs = maximum number of crop or weed leaves for a treatment
- minlvs = minimum number of crop or weed leaves for a treatment
- ht = average observed crop or weed height
- maxht = maximum crop or weed height
- minht = minimum crop or weed height

A.4.3 Treatment efficacies

Efficacy is modeled as percent control by species. Depending on your interpretation of the equation for yield loss from competition, efficacy may estimate reduction of density or weed pressure. Postemergence treatments control weeds present on the day of application:

$$cwds = pwds(d_{pst})*(psteff/100)$$

where:

d_{pst} = day of postemergence treatment
cwds = number of weeds controlled (plants/m² or plants/m)
$pwds(d_{pst})$ = weeds present on day of postemergence treatment prior to treatment (plants/m² or plants/m)
psteff = efficacy of postemergence treatment ($0 \leq psteff \leq 100$)

Soil-applied treatments have a period of activity. Soil-applied treatments affect any weeds that emerge during the period of activity, and efficacy is assumed to be constant throughout this period:

$$cwds = (saeff/100)*(ewds(d_{ap})+ewds(d_{ap+1})+ewds(d_{ap+2})\ldots+ewds(d_{esa}))$$

where:

cwds = number of weeds controlled (plants/m² of plants/m)
ewds(d) = number of weeds emerging on day d (plants/m² of plants/m)
d_{ap} = day after planting
d_{esa} = last day of period of activity
saeff = efficacy of soil-applied treatment ($0 \leq saeff \leq 100$)

A.4.4 Banded herbicide treatments

You may include banded and broadcast soil-applied and postemergence treatments in a single evaluation. However, you are limited to one band width for each band type. Band types are preemergence (PRE), pre-plant incorporated (PPI), or postemergence (POST).

If you specify a treatment as banded, the program will adjust the cost of herbicide to reflect banding of the treatment. The adjustment depends on the values you entered for PRE, PPI and POST band width on the crop plan screen:

$$cost_h = p_h * rate_h * (hbnd/rsp)$$

where:

$cost_h$ = cost of herbicide for a banded treatment ($/ha or $/ac)
p_h = price of herbicide ($/application rate unit)
$rate_h$ = application rate of herbicide (application rate/ha or ac)
hbnd = PRE, PPI or POST band width (cm or in)
rsp = rowspacing (cm or in)

A.4.5 Advanced herbicide purchases

If you indicate on the budget screen that herbicides are purchased in advance, the program will add interest charges to the cost of herbicide for a treatment:

$$cost_h = cost_h * (1 + (Int/100) * (Mon/12))$$

where:

$cost_h$ = cost of herbicide of a treatment ($/ha or $/ac)
int = interest rate ($0 \leq int \leq 100$)
mon = months of advance purchase

A.5 Crop and Weed Biology

This section provides some details of how biological processes are modeled in GWM. The content of this section is summarized in Tables 4, 5, and 6.

A.5.1 Weed cohorts

You can choose to have two or three cohorts for evaluation of soil-applied treatments. Cohort 1 weeds emerge before or on the day of planting. Cohort 2 weeds emerge from the day after planting to the last day of the weed competitive period. Weeds of cohort 2 compete with the crop. You may want to include a third cohort to simulate late emerging weeds that do not compete with the crop and may have reduced seed production. These weeds emerge after the end of the weed competitive period.

Note that the end of cohort 2 is the same for all weed species since it is defined by a parameter of crop biology (Table 4). You can choose to have all weeds emerging after planting in cohort 2. To do this, set the end of the competitive period to a number greater than the days to harvest.

Weed emergence is not modeled in postemergence evaluations, and all weeds are assumed to be in cohort 2.

5.2. Weed emergence

Emergence of a species is described with an estimate of the percent of the initial seed bank that could emerge during the year and a cumulative distribution function. The cumulative distribution function models emergence over time (day of the year):

$$cewds(d) = (e/100)*f(d)*sds_o$$

where:

$cewds(d)$ = cumulative number of weeds that have emerged by day d (plants/m^2 or plants/m)
sds_0 = initial number of seeds in the seed bank (seeds/m^2 or seeds/m)
e = percent of the initial seed bank that could emerge ($0 \leq e \leq 100$)
f(d) = cumulative emergence function ($0 \leq f(d) \leq 1$)
d = day of the year ($1 \leq d \leq 365$)

Functional forms for the cumulative emergence function are linear, logistic, quadratic, uniform, and Weibull (Table 6). There is also an option to have all weeds emerge with the crop.

You can have crop development influence emergence. The model does not update emergence after the day for end of in-row emergence. You specify this parameter on the crop biology screen. Choose a value greater than the days until harvest to disable this feature of the model.

A.5.3 Weed/crop competition

Crop yield loss from weed competition is modeled with a set of competitive indices or normalizing factors and a function for calculating the proportion of yield lost:

$$yl_{wc} = f(ci_1 * Co2_1 + ci_2 * Co2_2 + ci_3 * Co2_3 ... + ci_n * Co2_n)$$

where:

n = number of weed species present
ci_j = competitive index of species j
$Co2_j$ = number of weeds in cohort 2 of species j remaining at the end of the season (plants/m^2 or plants/m)
f( ) = yield loss function ($0 \leq f( ) \leq 1$)

Forms for the yield loss function include linear, logistic, and hyperbolic (Table 6). Note that the maximum percent yield loss parameter entered on the crop biology screen is not used in the yield loss calculation in this version of GWM.

A.5.4 Yield loss from delayed planting

Delayed planting of a crop may reduce competition from weeds by shifting weeds from cohort 2 (the competitive cohort) to cohort 1 (the cohort destroyed by planting). However, delaying planting may reduce yield. This effect is modeled as a relationship between proportion of yield lost and planting date:

$$yl_{dp} = f(pd)$$

where:

pd = planting date as day of the year ($1 \leq pd \leq 365$)
f( ) = yield loss function ($0 \leq f( ) \leq 1$)

Choices for the form of the yield loss function include Weibull, ramp, scaled linear, linear, and quadratic (Table 6). There is also an option for no yield loss with delayed planting. Note that in this version of GWM the target planting date parameter on the crop biology screen is not used in calculating yield loss from delayed planting.

A.5.5 Weed seed production

Seed production is modeled by cohort for each species:

$$psds = (V_2/100)*f_2(Co2) + (V_3/100)*f_3(Co3)$$

where:

- psds = seeds produced (seeds/m^2 or seeds/m)
- V_2 = percent viability of seeds produced by cohort 2 ($0 \leq V_2 \leq 100$)
- $f_2( )$ = seed production function for cohort 2 ($0 \leq f_2$)
- V_3 = percent viability of seeds produced by cohort 3 ($0 \leq V_3 \leq 100$)
- $f_3( )$ = seed production function for cohort 3 ($0 \leq f_3$)
- Co2 = number of weeds in cohort 2 remaining at the end of the season (plants/m^2 or plants/m)
- Co3 = number of weeds in cohort 2 remaining at the end of the season (plants/m^2 or plants/m)

Functional forms for seed production include linear, logistic, scaled linear, and quadratic (Table 6). There is also an option for no seed production.

A.5.6 Seed bank mortality

Seed bank mortality is modeled by species with an estimate of the percent of the original seed bank which will die:

$$sds_d = sds_0 * (m/100)$$

where:

- sds_d = number of seeds that died (seeds/m^{2}or seeds/m)
- m = percent mortality ($0 \leq m \leq 100$)
- sds_0 = seed bank at the beginning of the season (seeds/m^{2}or seeds/m)

A.5.7 Additional functional forms

Functional forms currently included in GWM are shown in Table 6. Adding functional forms is easy, but involves some programming. Contact the corresponding author if you need other functional forms for your use of GWM.

Table 1. Events and associated calculations of full season simulations.

Event	Calculations[1]
Planting	Update emergence Calculate cohort 1
End of weed competitive period	Update emergence Update control from soil-applied treatment Calculate cohort 2
Crop canopy development prevents further weed emergence	Update emergence Update control from soil-applied treatment
End of period of activity for soil-applied efficacy	Update emergence Update control from soil-applied treatment
Postemergence treatment	Update emergence Update control from soil-applied treatment Calculate control from postemergence treatment
Harvest	Update emergence Update control from soil-applied treatment Calculate cohort 2 Calculate cohort 3 Calculate yield loss from delayed planting Calculate yield loss from competition Calculate yield Calculate seed bank mortality Calculate viable seed production Update seed bank Calculate profit Calculate net gain from weed management End simulation

[1] Calculations are listed in sequential order. Depending on the chronological order of events, not all calculations associated with an event may be done.

Table 2. Events and associated calculations of postemergence only simulations.

Event	Calculations[1]
Planting	None
Postemergence treatment	Calculate control with postemergence treatment
Harvest	Calculate cohort 2 Calculate yield loss from delayed planting Calculate yield loss from competition Calculate viable seed production Calculate profit Calculate net gain from weed management End simulation

[1] Calculations are listed in sequential order.

Table 3. Elements for describing management options.

Name	Type	Characteristics	
		User-defined	Inherited
Strategy		-	Name Cost ($/ha or $/ac) Species efficacies Period of activity for soil-applied efficacy Crop rotation restrictions Miscellaneous restrictions
Tactic	Postemergence	Name Treatments (up to 3) Timing of treatments (days after planting)	Cost ($/ha or $/ac) Species efficacies Crop rotation restrictions Miscellaneous restrictions Crop size restrictions Weed size restrictions
Treatment	Postemergence	Name Components (up to 3 each of herbicides and mechanical operations) Herbicide rates Species efficacies Crop rotation restrictions Miscellaneous restrictions Crop size restrictions Weed size restrictions	Cost ($/ha or $/ac)
	Soil-Applied	Name Components (up to 3 each of herbicides and mechanical operations) Herbicide rates Species efficacies Period of activity for efficacy Crop rotation restrictions Miscellaneous restrictions	Cost ($/ha or $/ac)
Component	Herbicide	Name Cost ($/ai or $/actual product)	-
	Mechanical operation	Name Cost ($/ha or $/ac)	-

Table 4. Parameters and functions of crop biology.

Name	Units	Definition/Explanation	Notes
Days to emergence	days after planting	Days to crop emergence	Not implemented
Canopy closure	days after planting	Days to crop canopy closure	Not implemented
End of weed competitive period	days after planting	Weeds emerging after this time are in cohort 3 and do not compete with the crop	Set to a number greater than days to harvest to have all weeds emerging after planting in cohort 2
End of in-row emergence	days after planting	No further weed emergence after this day	Set to later than harvest to disable this feature
Days to harvest	days after planting		Required; ends simulation
Maximum percent yield loss	-		Not required; maximum yield loss will not be exceeded only if it is a parameter of the yield loss equation
Yield loss equation	-	Describes proportion of yield lost due to competition with weeds	Required $y=f(x)$; $0 \leq y \leq 1$ x = total weed density/pressure
Target planting date	month and day	Optimal planting date for maximum crop yield	Not required
Delayed planting equation	-	Proportion of yield lost due to planting after the optimal date	May be set to none; $y=f(x)$; $0 \leq y \leq 1$ x = day of the year
Yield units	-	-	Choices will be English or metric depending on units selected for the directory
Weed units	-	Method for counting weed seedling population	'area' if weeds/unit area 'length' if weeds/length of crop row

Table 5. Parameters and functions of weed biology.

Name	Units	Definition/Explanation	Notes
Cumulative emergence equation	-	Distributes emergence over time	Required; may be set to assume all weeds emerge with the crop; $y = f(x)$; $0 \leq y \leq 1$ x = day of the year; $1 \leq x \leq 365$
Parameter D, Cumulative emergence equation	-	Potential weed emergence as percent of the seed bank	Required $0 \leq d \leq 100$
Seed production equation - Competitive cohort	seeds/m^2 or seeds/m	Equation for seed production for cohort 2 (weeds emerging during the weed competitive period)	Required $y = f(x)$; $0 \leq y$ x = weed density
Seed production equation - Late-emerging cohort	seeds/m^2 or seeds/m	Equation for seed production of cohort 3 (weeds emerging after the weed competitive period)	Required $y = f(x)$; $0 \leq y$ x = weed density
Viability	-	percent of newly produced seeds which are viable	Required $0 \leq y \leq 100$
Seed bank mortality	-	percent of initial seed bank that will die	$0 \leq y \leq 100$
Competitive Index*	-	Conversion or normalizing factor to transform weed density to appropriate variable for the crop yield loss equation	Required; $y \geq 0$

* On crop/weed competition screen.

Table 6. Functional forms currently included in GWM.

Name	Use*	Equation $y = f(x)$		Notes
Linear	Y, D, E, S	$y = A + B * x$		
Logistic	Y,E,S	$y = A/(1 + B * \exp(C * x))$		
None	D,S	$y = 0$		
Scaled linear	D,S	$y = A + B * C * x$		
Quadratic	E,S	$y = A + B * x + C * x^2$		
Ramp	D	$y = 0$ $y = C$ $y = C * (x - A)/(B - A)$	if $x < A$ if $x > B$ if $A \leq x \leq B$	
Uniform	E	$y = 0$ $y = (x - A)/(B - A)$ $y = 1$	if $x < A$ if $A \leq x \leq B$ if $x > B$	$0 \leq y \leq 1$
Hyperbola	Y	$y = (A * x)/(100 * (1 + x * A/B))$		
Weibull	E,D	$y = 0$ $y = 1 - \exp(-((x - A)/B)^C$	if $x < A$ if $x \geq A$	x = day of year; $1 \leq x \leq 365$ $0 \leq y \leq 1$
One day emergence	E	$y = 0$ $y = 1$	if $x <$ planting day if $x \geq$ planting day	All weeds are assumed to emerge with the crop

[1] Y = yield loss from competition; D = yield loss from delayed planting; E = cumulative emergence; and S = seed production.

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