USDA

MARYLAND'S RUSLE2

INSTRUCTIONS

AND

USER'S GUIDE

April 2017

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Welcome to RUSLE2

Version 2 of the Revised Universal Soil Loss Equation (**RUSLE2**) estimates soil loss from rill and interrill (sheet and rill) erosion caused by rainfall and its associated overland flow. **RUSLE2** uses six factors for climatic erosivity, soil erodibility, slope length, slope steepness, cover-management, and support practices to compute soil loss.

RUSLE2 is a powerful tool for conservation planning, inventorying erosion rates over large areas, and estimating sediment production that might become sediment yield in watersheds. It can be used on cropland, pastureland, rangeland, disturbed forestland, construction sites, mined land, reclaimed land, landfills, military lands, and other areas where surface overland flow occurs because rainfall is greater than infiltration.

About RUSLE2

The structure of the revised universal soil loss equation **RUSLE2** is based on the Universal Soil Loss Equation (USLE), which is given by:

$$A = R\ K\ L\ S\ C\ P$$

where **A** = average annual soil loss from rill and interrill erosion caused by rainfall and its associated overland flow (tons ac^{-1} yr^{-1}), **R** = the factor for climatic erosivity, **K** = the factor for soil erodibility measured under a standard condition, **L** = the factor for slope length, **S** = the factor for slope steepness, **C** = the factor for cover-management, and **P** = the factor for support practices. A value for soil loss **A** is computed by selecting values for each factor and multiplying them.

RUSLE2 PROGRAM SETUP

Create a RUSLE2 Shortcut Icon for Your Desktop

To create a RUSLE2 Shortcut Icon for your desktop, simply navigate to Start \ All Programs \ USDA Applications \ RUSLE2 \ RUSLE2 Erosion Protection. DO NOT LEFT CLICK, instead right click your mouse and go to "Send to", click desktop (Create Shortcut). This will place a shortcut on your desktop.

Open the RUSLE2 Program

You can open the RUSLE2 program by clicking on the RUSLE2 icon on the Desktop. Or by clicking on *Start > Programs > USDA Applications > RUSLE2*

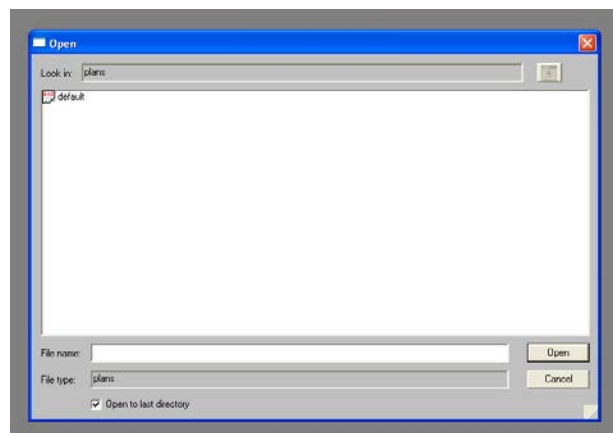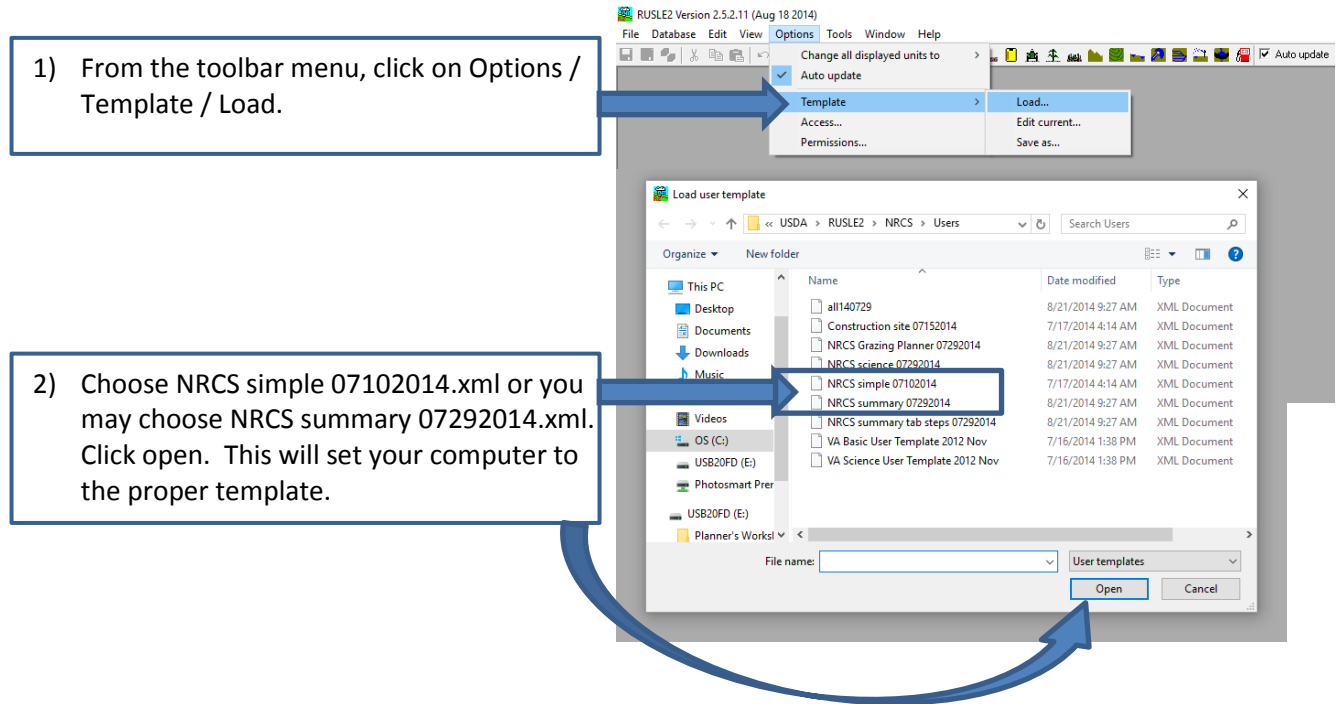## Choosing the correct template

1) This screen should appear when RUSLE2 is first opened. Choose the NRCS simple 07102014 template. You may also choose the NRCS summary 07292014 template to evaluate filter strips. Once you choose this template then simply click OK. This will set your RUSLE2 program to the correct template.
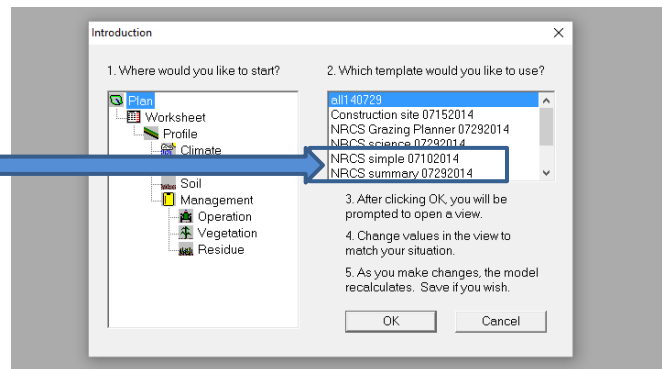
2) This screen may or may not appear. If it does appear, click *Cancel*.

If neither of the above screens appear, follow the steps below:

1) From the toolbar menu, click on Options / Template / Load.

2) Choose NRCS simple 07102014.xml or you may choose NRCS summary 07292014.xml. Click open. This will set your computer to the proper template.

Note: You do not need to set the template again each time you open RUSLE2 unless you wish to change it. Your RULSE2 program will automatically default to the template you choose each time you open the program.

Set your RUSLE2 Program to the Correct Database (FOR NRCS USERS ONLY)

When RUSLE2 is installed on your computer, the program automatically creates and defaults to an empty database located in your C:Drive. This database is called "moses". It is the database which stores all of your RUSLE2 data including crop rotations, managements and RUSLE2 calculations or farm data. For Conservation Planning and using RULSE2 you will need to re-direct the database to another database which is located on your Shared Drive. This will ensure you are working with the most up-to-date information when using RUSLE2 and that your work is saved to the Server each night.

**NOTE: It is EXTREMELY IMPORTANT that you use RUSLE2 with the correct database. Failure to use the correct database could result in loss of RUSLE2 field data.**

When RUSLE2 was installed on your computer, the program creates and automatically defaults to a "moses" database located on your C: drive. You will need to re-direct this database to your S: shared "county_moses" database. To do this simply complete the following steps:

1) At the top of the RUSLE2 screen click on Database, then choose Open Alternate. The following screen will appear.
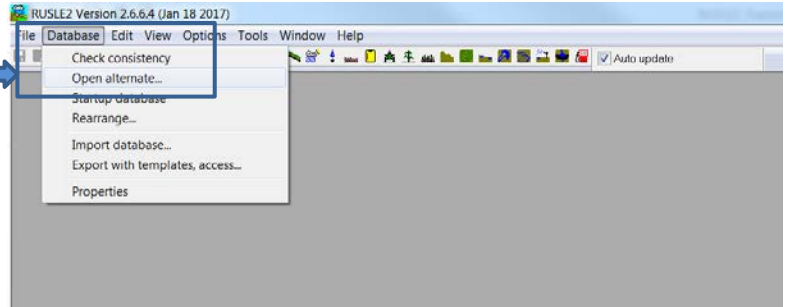
2) Click the drop down menu, navigate to your S:Drive and locate your shared "moses" database. Your shared "moses" database is located at S:\NRCS\RUSLE2. In there should be your specific county "moses" database. It should be named county_moses.
**Example: Kent_moses. Click once on your county specific "moses" database and then click "Open". This will re-direct your database to the shared drive. All existing files and information from your county field office that has been completed using RUSLE2 will now be available for your use and information.
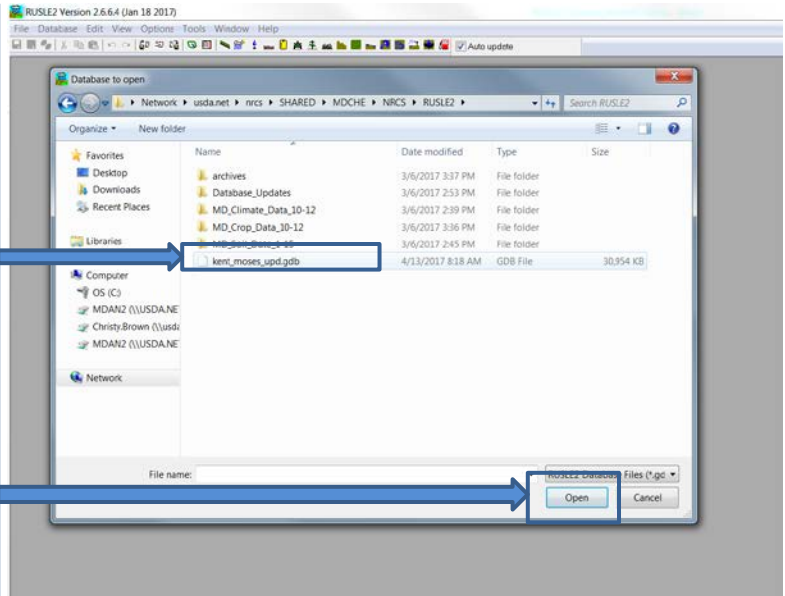
3) Set the shared "moses" database to always open to this database. To do this, simply go to menu toolbar and click on Database. Next, choose Startup Database. Click once on this and it will place a check to the left of Startup Database. This will ensure each time you boot up RUSLE2, you go to the correct shared "county_moses" database.
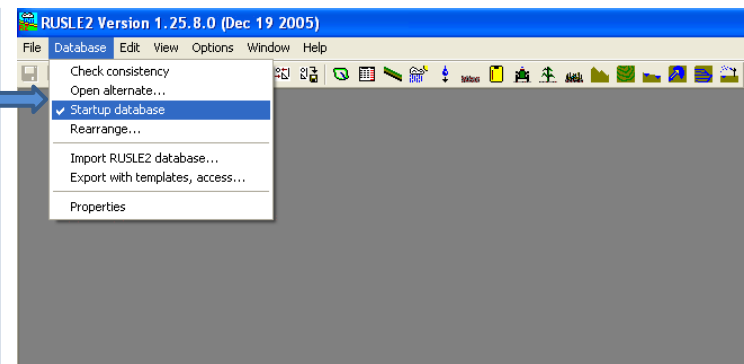
NOTE: Once you complete the above steps, there is no need to continue with the following steps for downloading and importing database sets. All Climate, Soils, and CMZ (Crop Management Zone) data sets are available on the County's shared drive. You many go directly to RUSLE2 Introduction on pages 13 through 28.

If you do not have an S: drive, shared "moses" database, you will need to complete the following steps to download and import the database sets.

Downloading RUSLE2 Databases

RUSEL2 Folder/Data Location

The RUSLE2 program itself is kept at *Computer > LocalDisk (C:) > Program Files (x86) > USDA > Rusle2 > NRCS*, however, the data for the program is kept at *Computer > LocalDisk (C:) > ProgramData > USDA > RUSLE2 > NRCS.* The *ProgramData* folder is a hidden folder and may not be seen on all computers until the view is setup correctly.

To unhide hidden folders:

1) Open the windows explorer and click on the "Organize" button at the top of the screen

2) Select "Folder and Search Options" from the menu.

3) The folder options screen will appear. Click on the middle tab that says "View"

4) The radio button that says "Show hidden files, folders, and drives" needs to be selected

5) Click "OK" and you will then be able to see the *ProgramData* file the next time windows explorer is opened
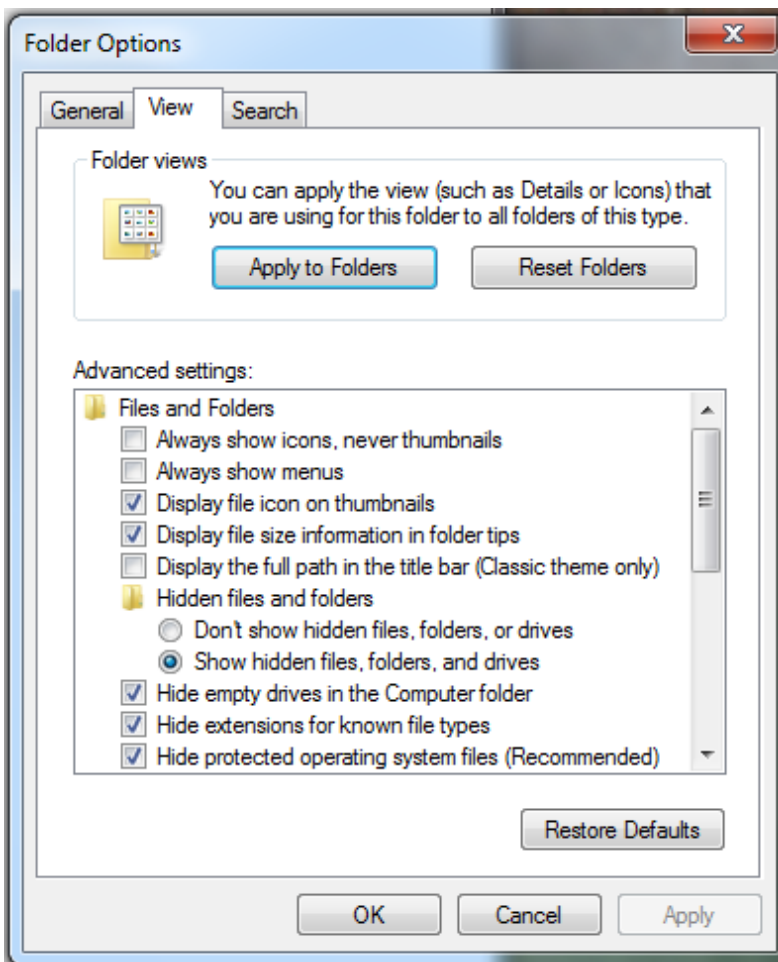
Download Base Database and Database Updates - NRCS USERS CAN SKIP THIS SECTION

1) From the RUSLE2 website, navigate to *Base Database & Misc Files > Download Files > Latest Base Database and Updates*
   http://fargo.nserl.purdue.edu/RUSLE2_ftp/NRCS_Base_Database/Latest%20Base%20Database%20and%20Updates/

2) Click on "NRCS Moses Updates 030104 to 01292015.zip"

3) A pop-up will appear at the bottom of the screen. Click on the arrow next to the "Save" button and "Save As" *Computer > LocalDisk (C:) > ProgramData > USDA > RUSLE2 > NRCS > Import*

Download Crop Management Zone (CMZ) Database - NRCS USERS CAN SKIP THIS SECTION

1) Determine which CMZ database you will need to import. The CMZ maps can be found here:
   http://fargo.nserl.purdue.edu/rusle2_dataweb/NRCS_Crop_Management_Zone_Maps.htm
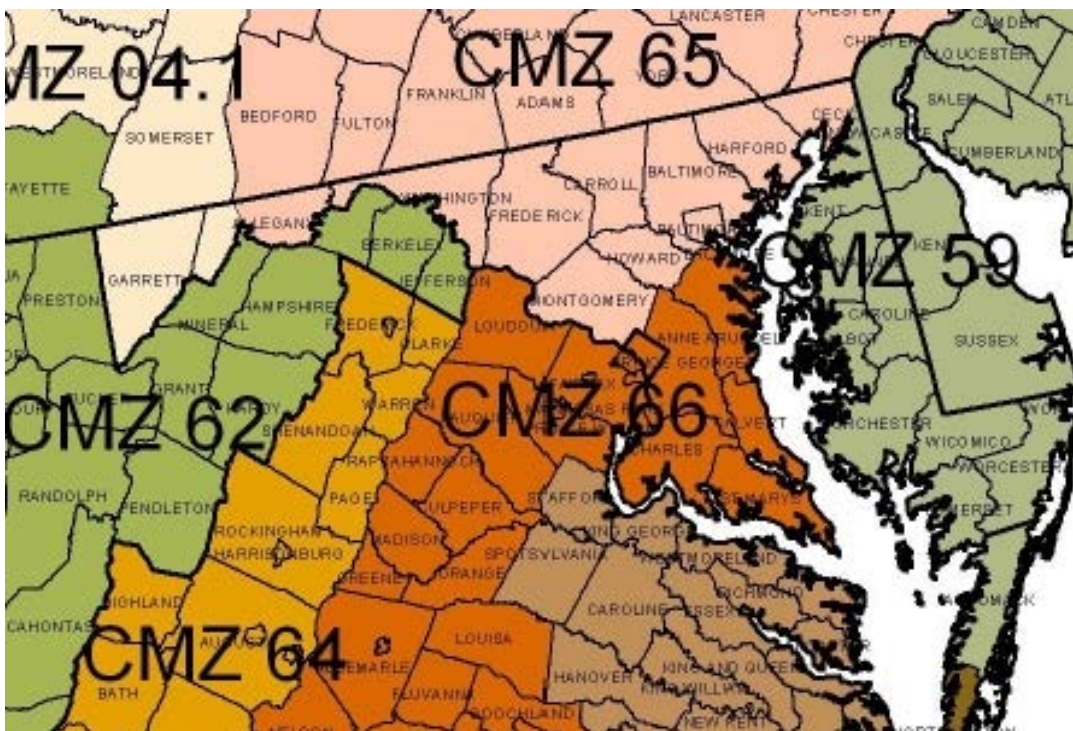
2) From the RUSLE2 website, navigate to *Crop Management Templates > Data Files*
   http://fargo.nserl.purdue.edu/RUSLE2_ftp/Crop_Management_Templates/

3) Click on the data files for the needed CMZ (CMZ 59, CMZ 66, CMZ65, or CMZ 04.1)

4) A pop-up will appear at the bottom of the screen. Click on the arrow next to the "Save" button and "Save As" *Computer > LocalDisk (C:) > ProgramData > USDA > RUSLE2 > NRCS > Import*

5) Save all needed to the same location

Download Soils Data - NRCS USERS CAN SKIP THIS SECTION

1) From the RUSLE2 website, navigate to *Soils Data > Data Files*
   http://fargo.nserl.purdue.edu/rusle2_dataweb/NRCS_Soils_Data_Files.htm

2) Navigate to the Maryland folder

To Download Soils for Individual Counties:

1) Right click on the county (ex. "Carroll County, Maryland.gdb") and click "Save Target As"
   Computer > LocalDisk (C:) > ProgramData > USDA > RUSLE2 > NRCS > Import

Download Climate Data - NRCS USERS CAN SKIP THIS SECTION

1) From the RUSLE2 website, navigate to *Climate Data > Data Files*
   http://fargo.nserl.purdue.edu/RUSLE2_ftp/Climate_data/

2) Click on "MD_clime042403.zip"

3) A pop-up will appear at the bottom of the screen. Click on the arrow next to the "Save" button and "Save As" *Computer > LocalDisk (C:) > ProgramData > USDA > RUSLE2 > NRCS > Import*

Importing Files
**NRCS USERS CAN SKIP THIS SECTION**

Extracting Files

1) Once all of the data files have been downloaded, Open windows explorer and navigate to the same location:
   Computer > LocalDisk (C:) > ProgramData > USDA > RUSLE2 > NRCS > Import

2) Right click on the downloaded CMZ file

3) Hoover over "WinZip" and click on "Extract to here" when the submenu appears

4) Repeat this steps 2 and 3 for every zip imported zip file (Note: If county soil files are in .gdb format, they are already unzipped)

5) Once all of the files have been unzipped and saved to the import folder, open the RUSLE2 program
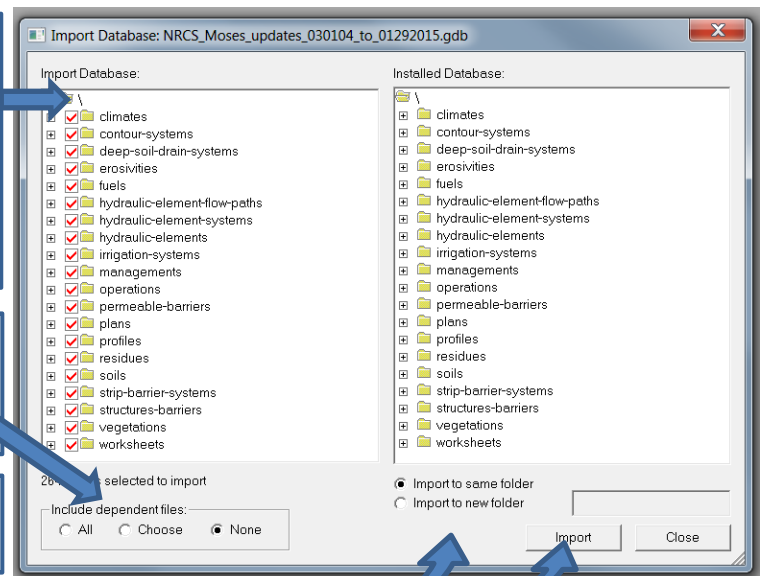
Base Database Update

1) Click on "Database" and "Import Database…"
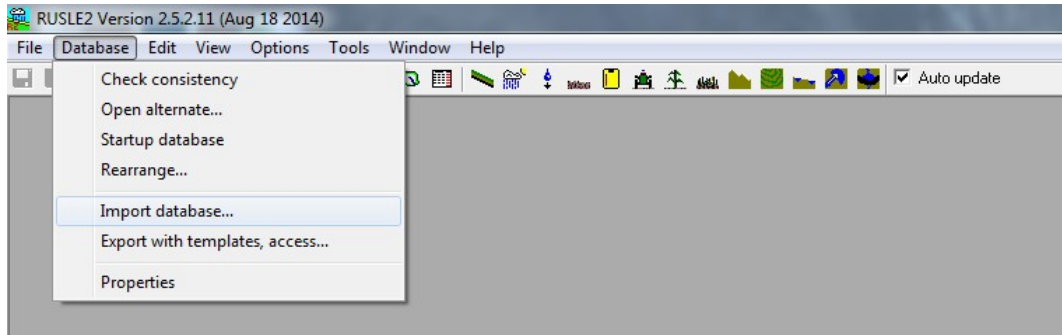
2) A new screen titled *Select import database* will appear with all of the available databases to import. Choose **NRCS_Moses_updates_030101_to_01292015.gdb**. Click open.
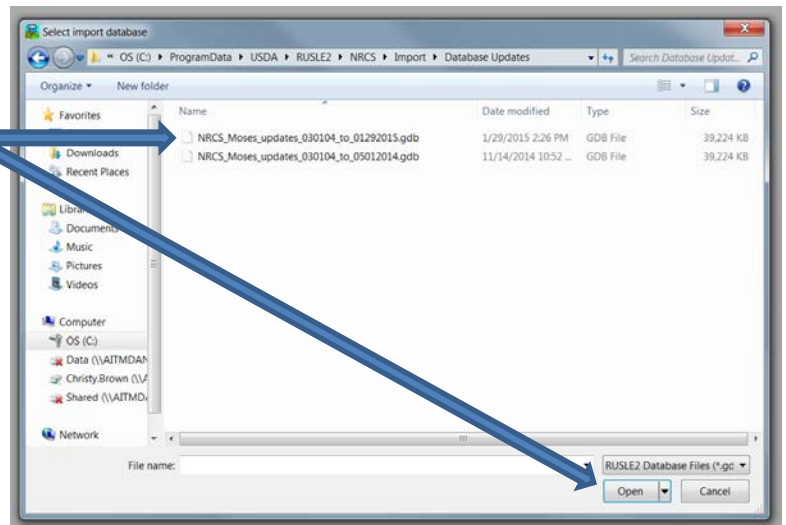
3) Click on the top left folder. This will automatically check all of the folders. **When importing a new master database or a master database update, it is important to click on the top left folder that will populate each folder with the appropriate files.**

4) Under the "Include dependent files" box, "All" checked at the default. You want this to be checked as "None"

7) Click on "Import to same folder" and click the "Import" button

6) A warning message will appear. Click "OK"

7) The database import will then run through a series of windows while the program downloads the files. Click "OK" when the import complete box pops up and click "OK" when a window appears saying the import has finished.
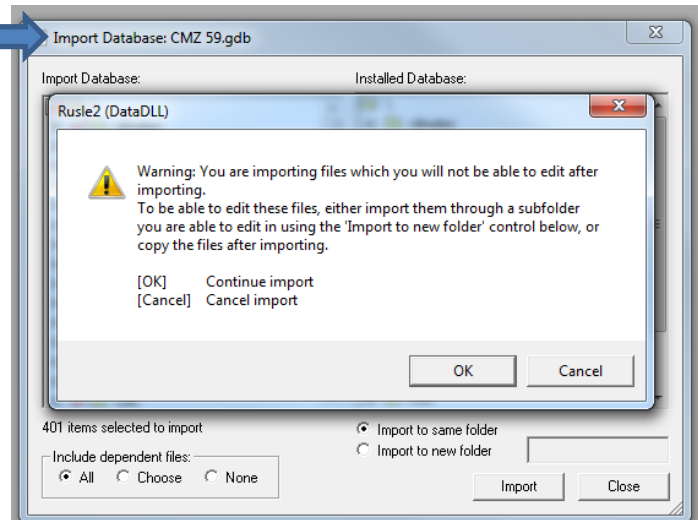
Crop Management Zones (CMZ), Soils, and Climate

1) Click on "Database" and "Import Database…"
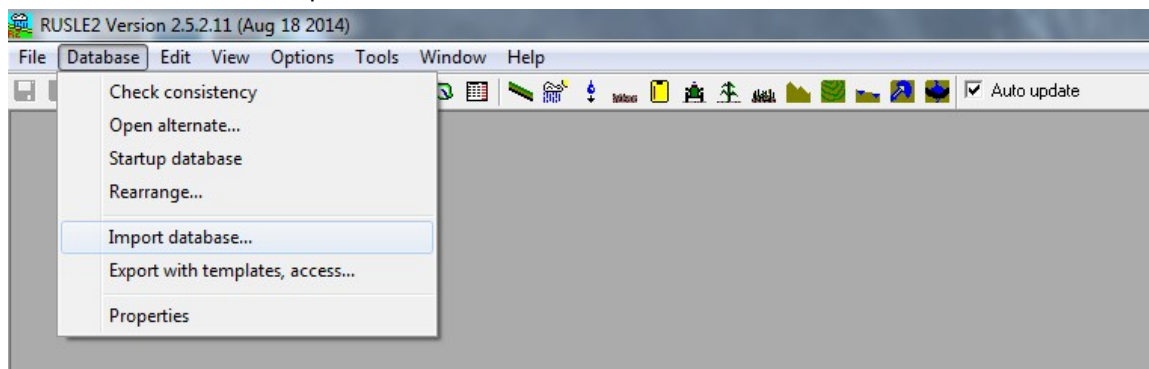
2) A new screen titled *Select import database* will appear with all of the available databases to import. Click the crop management zone (CMZ) you want to download. Click open.

** Soils - Choose the county and click open.

** Climate – Choose "MD clime042403.gdb" and click open.

3) Click on the managements folder (make sure the CMZ you want to download is checked).
** When importing soils data, click on the "soils" folder (make sure the county you want to download is checked).

 **when importing climate data, click on the "climates" folder.

4) Under the "Include dependent files" box, "All" checked at the default. You want this to be checked as "None"

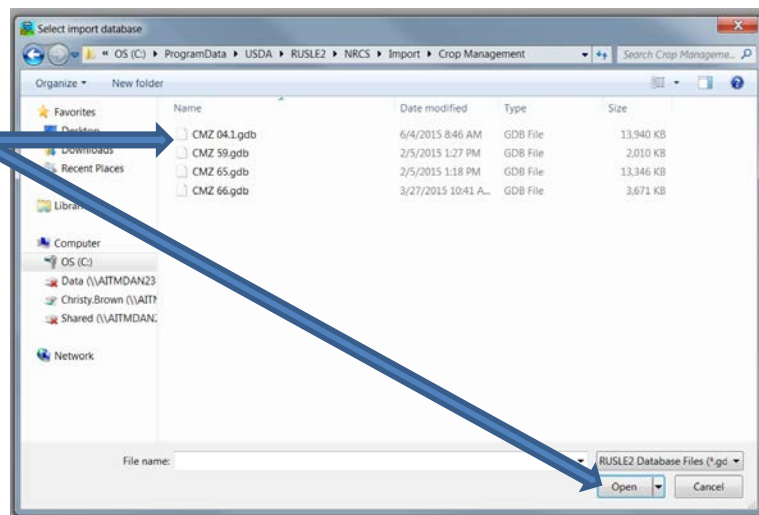5) Click on "Import to same folder" and click the "Import" button
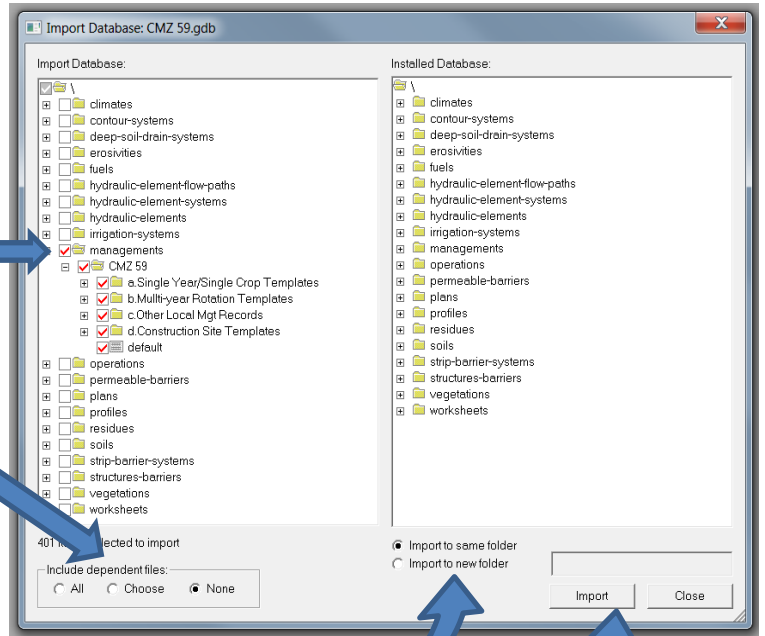
6) A warning message will appear. Click "OK"

7) The database import will then run through a series of windows while the program downloads the files. Click "OK" when the import complete box pops up and click "OK" when a window appears saying the import has finished.
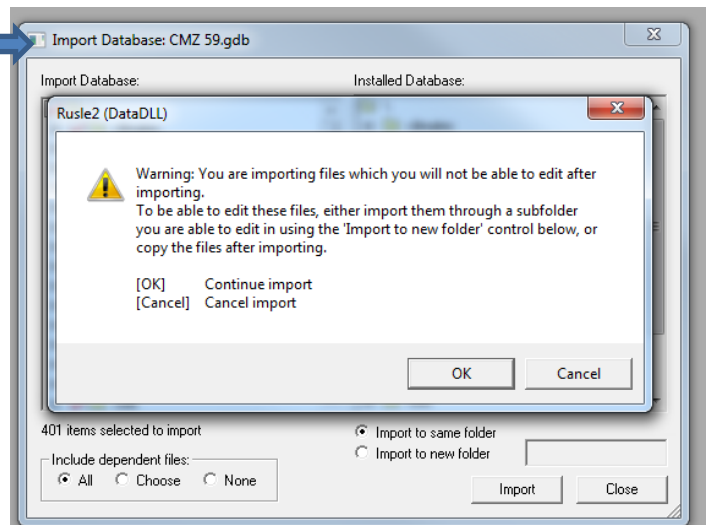
RUSLE2 INTRODUCTION

Program Feature Icons

Plan Description View – (Green Watershed Icon) This is the template to use to calculate soil loss for *multiple fields*. These calculations can be made for single systems or multiple alternatives. Use this view for whole farm conservation planning.

Field Worksheet View – (Data Sheet) This is the template to use to calculate soil loss alternatives for *one field or one slope*.

Profile View – (Green Sloping Line) This is the template for calculating soil loss for *one slope or one field*. Can only be used for single systems.
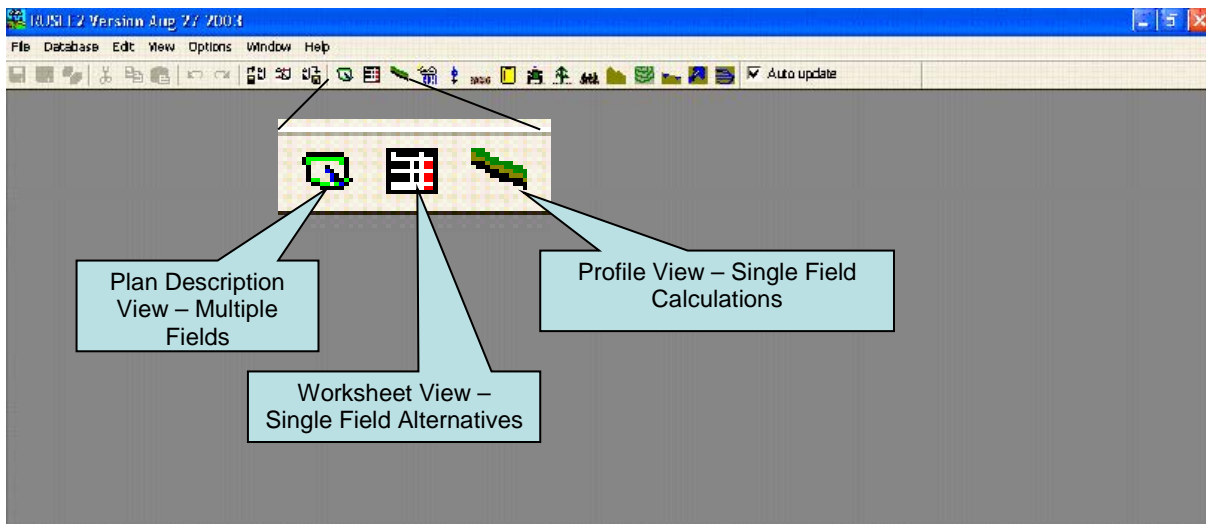
These icons below contain specific information for use when developing RUSLE2 crop rotations for soil loss calculations. Before use of these below, be sure to have had basic RUSLE2 training. Failure to do this may result in loss of data.
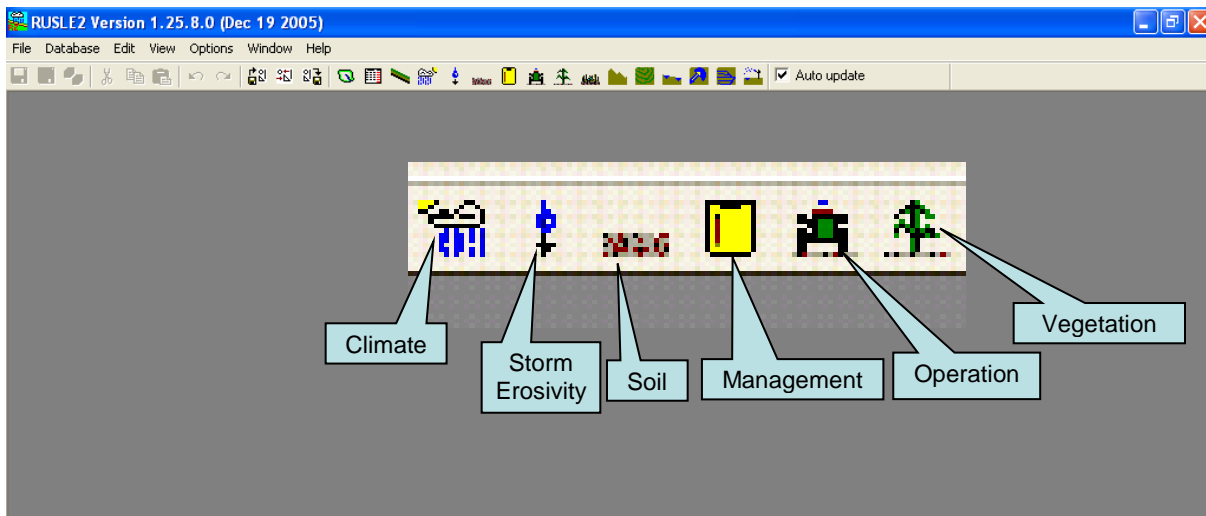
Climate
The climate object describes the weather information for the site. The information in this object includes data on annual erosivity, 10 yr EI storm, average monthly temperature, and average monthly precipitation. Information is cataloged in the database according to names of locations.

Storm Erosivity
Storm erosivity varies through the year depending on location. The information in the storm erosivity object describes how erosivity varies during the year as a function of zones or regions. Information is cataloged in the database according to a zone number.

Soil
The soil object includes information on soil erodibility, soil texture, hydrologic soil group, and rock cover. Also, this object includes the soil erodibility to compute a value for the soil erodibility factor if one is not available. Information is cataloged in the database according to a soil name, which could be a soil-mapping unit from an NRCS soil survey.

Management
The management object contains information on management practices. Each practice typically includes a list of dates and the operations, vegetation, and applied materials like mulch and manure associated with each date. Information is cataloged in the database according to a management name chosen by the user.

Operation
The operation object contains the information used to describe operations. A key component of the information used to describe an operation is processes including begin growth, kill vegetation, flatten standing residue, disturb surface, remove surface cover, and remove live biomass. Information is cataloged in the database according to an operation name chosen by the user.

Vegetation
The vegetation object contains the information used to describe live vegetation. This information includes a name for the residue to associate with the vegetation and data on yield, the relationship of above ground biomass to yield, how the vegetation slow runoff, and temporally varying values on root biomass, canopy cover, fall height, and live ground cover. Information is cataloged in the database according to a vegetation name chosen by the user.

Creating a RUSLE2 Rotation

1) Before opening the managements button, make sure the screen template is set at *NRCS simple 07102014* or
NRCS summary 07292014
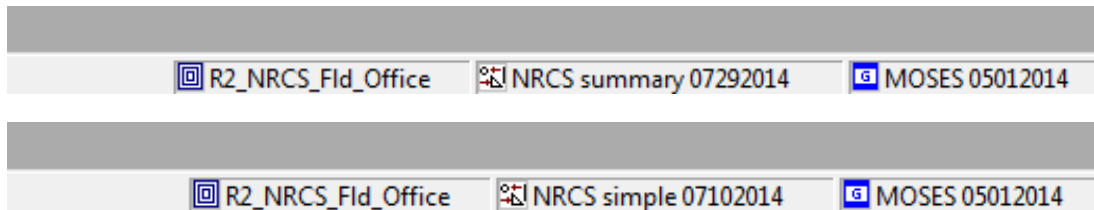
2) Click on the "Open management…" button

3) To create a new rotation, click on the default file when the *Open* screen pops up

4) When the default screen opens, click on "Open" folder button to the right of "View/edit rotation builder used to make this management"
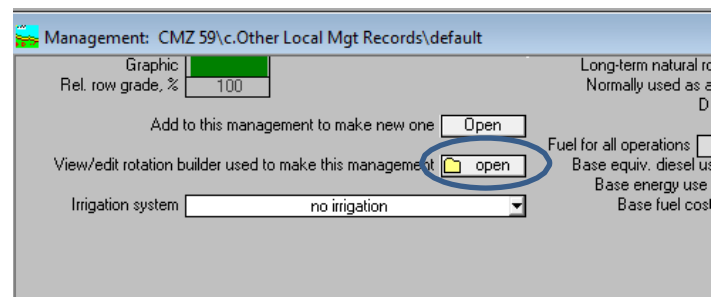
5) A new screen will appear that will allow you to build a base rotation using templates that can be edited to meet the exact rotation that is being used on the operation. The rotation to be used in this example is 2 years corn, tandem disc with coiled tine harrow, 1 year no-tilled wheat with no-tilled rye cover crop, 1 year soybeans, tandem disc with coiled tine harrow.

6) To create this rotation, add the first crop in the rotation by clicking on the down arrow under the "Management" column.
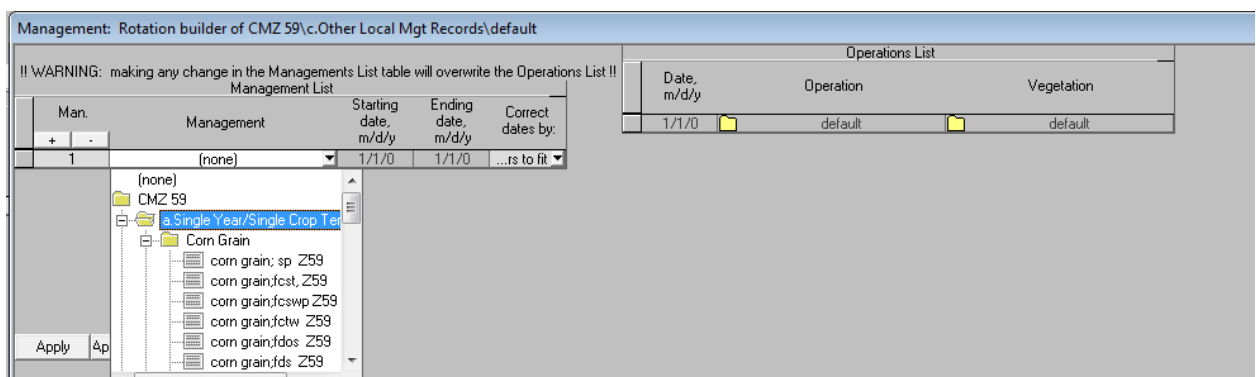
7) From the drop down menu, select the CMZ that you the rotation will be used in (CMZ59 in this example) > a. Single Year/Single Crop Templates > Corn Grain > corn grain;sdos

8) Crops can be added or deleted by highlighting the row and hitting the + or – buttons. If a row is highlighted and the + button is hit, another year of that same crop and management will be added below the highlighted row.
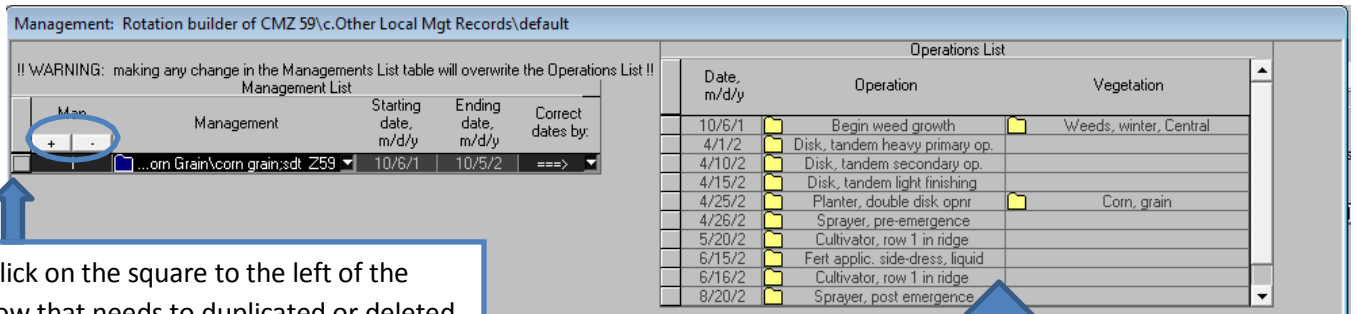
Click on the square to the left of the row that needs to duplicated or deleted and press the + or – buttons

An operations list of the current management will be seen to the right of the rotation builder, as more crops are added, the Operations List will adjust so you can view the management template before editing

9) Continue to add crops to the rotation by choosing the crops and management from the dropdown box

10) Once all of the crops in the rotation have been added, click the "Apply/Close" button at the bottom of the rotation builder screen
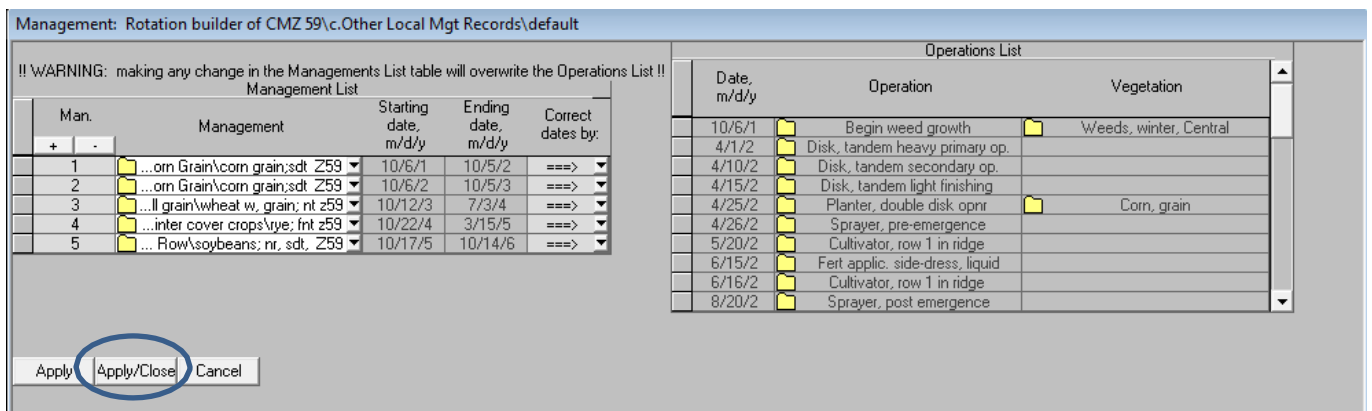
11) The rotation builder will close and a management screen will appear with the chosen crops and managements. From this screen, add or delete rows to make the rotation as close as possible to the actual management on the operation.

Changes to make: Producer only discs twice (RUSLE2 automatically populated three times), cultivator is not used, harrow is not included.

12) NEW Management View!

Management: CMZ 59\c.Other Local Mgt Records\2 yrs corn, grain, sdt; wheat, nt; rye cc, nt; soybeans, sdt;z59

Management STIR 280   Avg. annual STIR 47

How set crop year end/start?   set by user

The average STIR value is displayed as well as the Crop Year STIR values. Only the average will be displayed in the worksheet view, but refer to the Crop Year STIR values to make sure you are meeting the standard if planning 329/345.

Crop Year STIR Values

Crop year	STIR	Crop	Start date, m/d/y	End date, m/d/y
1	90	Weeds, winter, Central+Corn, grain	10/15/0	10/5/2
2	90	Weeds, winter, Central+Corn, grain	10/6/2	10/5/3
3	2.9	Wheat, winter 7in rows	10/6/3	7/3/4
4	97	...Weeds, winter, Central+Soybean, mw 7in rows	7/4/4	10/14/6

Operations | Info

Management Operations

Date, m/d/y	End/Start crop year?	Operation	Vegetation	Yield (harv. units), #/ac	Type of cover material	Cover matl add/remove, lb/ac	Cover from addition, %	Standing res. added by op. desc., lb/ac	Fuel used this operation
4/25/3	No	Planter, double disk opnr	Corn, grain	125					default
4/26/3	No	Sprayer, pre-emergence							default
6/15/3	No	Fert applic. side-dress, liquid							default
8/20/3	No	Sprayer, post emergence			weeds; 0-3 mo	250	14		default
10/5/3	Yes	Harvest, killing crop 50pct standing stubble				3500	73	3500	default
10/12/3	No	Fert applic. surface broadcast							default
10/13/3	No	Drill or air seeder single disk openers 7-10 in spac.	Wheat, winter 7in rows	50.0					default
3/3/4	No	Sprayer, post emergence and fert. tank mix			weeds; 0-3 mo	250	14		default
7/3/4	Yes	Harvest, killing crop 50pct standing stubble				2500	77	2500	default
10/22/4	No	Drill or air seeder single disk openers 7-10 in spac.	Rye, winter cover	2240					default
3/15/5	No	Sprayer, kill crop				25	1.5	480	default
10/17/5	No	Begin weed growth	Weeds, winter, Central	1120					default
5/1/6	No	Disk, tandem heavy primary op.				1000	32	0	default
5/5/6	No	Disk, tandem secondary op.							default
5/10/6	No	Disk, tandem light finishing							default
5/15/6	No	Drill or air seeder single disk openers 7-10 in spac.	Soybean, mw 7in rows	30.0					default
5/16/6	No	Sprayer, pre-emergence							default
6/15/6	No	Sprayer, post emergence			weeds; 0-3 mo	250	14		default
7/1/6	No	Sprayer, insecticide post emergence							default
10/14/6	Yes	Harvest, killing crop 50pct standing stubble				520	26	520	default

Double check the crop intervals so they are marked correctly. "YES" should be marked next to the operations where a harvest occurs. Many single year management templates will include weed growth. The program will most often recognize weed growth and cover crops and their own crop, which will need to be corrected. A crop interval is defined as the interval between the harvest of the previous crop to the harvest of the current crop.

13) Save your crop management template. Go to *File > Save As > CMZx > c. Other Local Mgt Records.* You will know if the changes in the template you are working on have been saved or not by the presence of a * at the end of the file name in the heading of the management view. Once the changes have been saved the * will disappear.

Creating a Plan in RUSLE2 – applying the crop rotation and calculating soil loss

1) Before opening the plan view, make sure the screen template is set at *NRCS simple 07102014* or *NRCS summary 07292014*
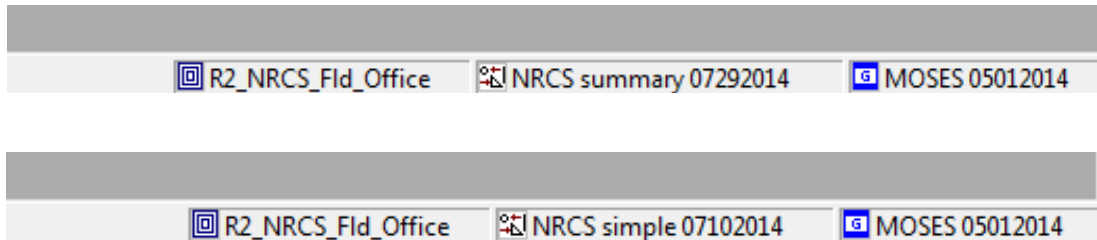
2) Click on the Plan View button

3) Any existing plans will appear in the screen. If you want to edit an existing plan, you can do so from here. If you would like to begin with a new plan, click on default (or county specific default, if one was created)

4) Enter the basic information needed to identify the plan. In the "Info" box, can type the description of the fields or treatment being evaluated.
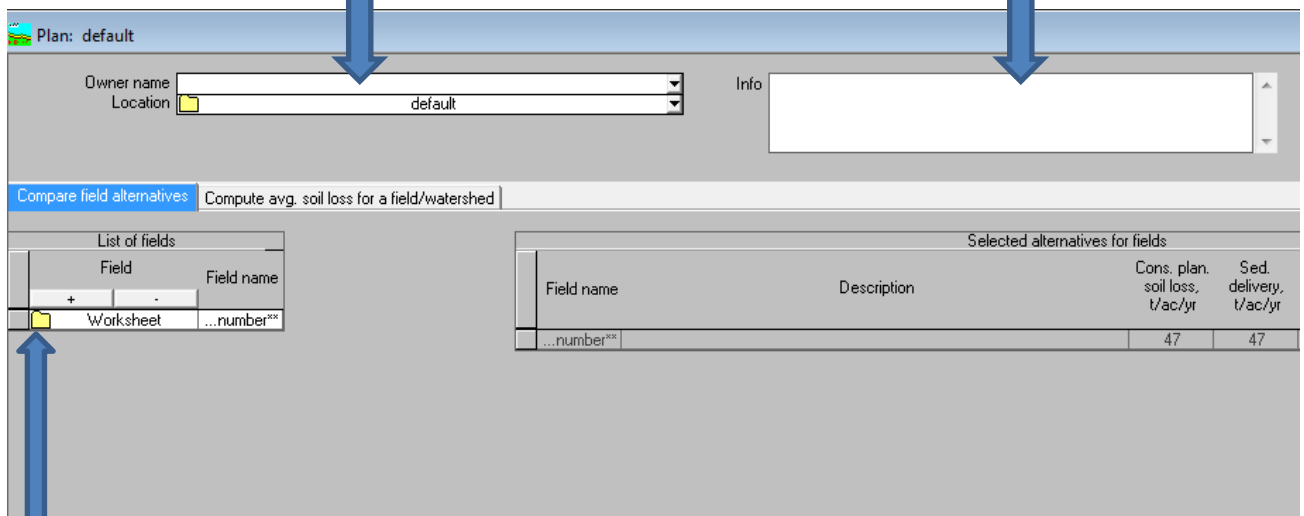
5) Click and open the folder to the right of the worksheet you want to work on

6) Enter information within the worksheet
   a. Enter the field name/number
   b. Choose the soil type
   c. Enter the slope length and steepness
   d. Choose management. If choosing a crop management template that was created, navigate to the correct CMZ file > c. Other Local Mgt   Records > and choose the existing or planned management. Can also choose an existing management located in a. Single Year/Single Crop Templates or b. Multi-year Rotation Templates
   e. Choose contouring - The row grade is the percent of grade off the contour. (e.g. Absolute row grade-1% means the contouring is actually on a 1% grade across the slope)
   f. Yields – To adjust crop yields, click the yellow folder next to "Yields". Another box will open, type in the desired yield for each crop and then click the red X to close the box.

Enter the field name (number)

Choose soil type

T Value

NEW: Color coded "SCI value OK?"
Red = SCI is below -0.2
Yellow = SCI is between -0.2 and 0.2
Green = SCI is above 0.2

Enter slope length and slope steepness

Adjust Yields

Choose management, navigate to the CMZ, c. Other Local Mgt. Records

Choose contouring

Actual soil loss over the rotation

NEW: Color coded "Soil loss OK?"
Red = over 2T
Yellow = between T and 2T
Green = T or below T
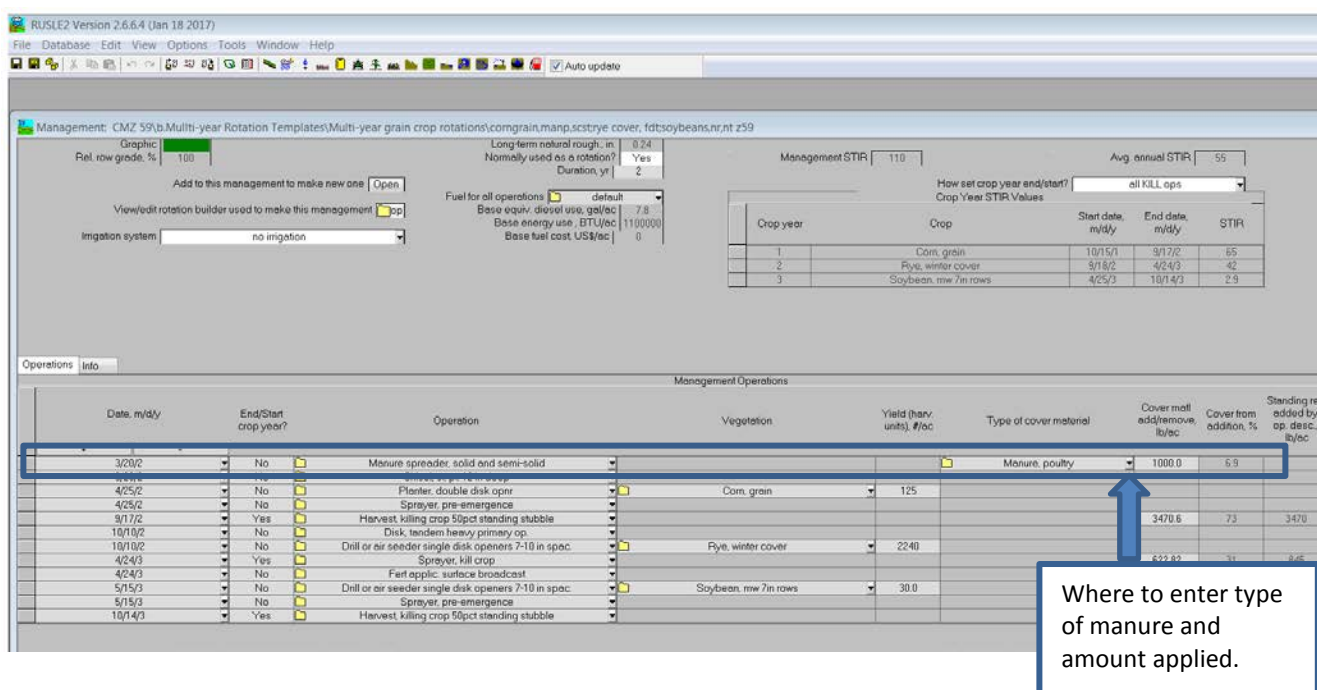
7) Compare the T value with the Cons. plan soil loss t/ac/yr. The bar next to this number will toggle from green to yellow to red, with red indicating the management did not meet the tolerable soil loss.

8) Look at the SCI value. If this value is under 0.0, the producer is depleting the soil organic matter faster than it can be rebuilt. The bar next to the   SCI will toggle from green to yellow to red depending on the value.

9) To add a new scenario to this field's worksheet, press the + button to add a new   row. Any information from the top row will be automatically copied to the row below when the + button is used.

Incorporating Manure into Crop Management File

RUSLE2 describes the effect of manure additions to soil by considering how much biomass is incorporated and how much is left on the surface. The solids of the material left on the surface are treated as ground cover subject to decay. The organic material incorporated is treated like incorporation of crop residue and is subject to decay. Knifing manure into the soil is treating as a soil disturbance that is described in the same way that a tillage operation is described.

Manure is treated as a residue in RUSLE2, and values for the properties for manure are entered in the residue database. Add manure to a crop rotation in the management screen of RUSLE2 (see illustration below). Enter the manure operation in the operations section, then choose the type of manure under **"Type of Cover Material"**. Next, open the Type of Cover Material choice (click yellow folder next to residue type) and choose the correct amount of residue applied. Amounts are listed by coverage vs. mass.

Where to enter type of manure and amount applied.

When manure application is included in the operation of the Crop Management File you will need to include the manure operation. When you select the manure operation in RUSLE2 a dialog box will appear to the right of the operation that requires you to include the type of manure that you are applying.

RUSLE2 requires that inputs for the amount of manure added to a field be input as mass/ac dry weight. A method to convert the fresh or wet weights of manure to dry weight is shown below.

Laboratory data should be used in lieu of these conversion methods where available. Moisture content estimates are also available in the Agricultural Waste Management Handbook for various manure classes.

Equations to Convert to Pounds Dry Matter

(A) For liquids and slurries

(gals /ac) X (8.34 lbs/gal) X (% solids as a decimal) = lbs dry matter

Sample calculations:
(10,000 gal /ac) X (8.34 lbs/gal) X (0.02) = 1668 lbs/ac dry matter
RUSLE2 Conversion: 1668 lbs/ac dry matter X 0.5 = 834 lbs/ac

(B) For semi-solids

(lbs /ac) X (% semi-solids as a decimal) = lbs dry matter

Sample calculations:
(8000 lbs /ac) X (0.15) = 1200 lbs/ac dry matter
RUSLE2 Conversion: 1200 lbs/ac dry matter X 0.5 = 600 lbs/ac

(C) For solids

(lbs /ac) X (% solids or semi-solids as a decimal) = lbs dry matter

Sample calculation:
(8000 lbs /ac) X (0.55) = 4400 lbs/ac dry matter

Recommendations for Types of Manure in RUSLE2 Database:

- Manure, liquid - (swine from confinement, holding ponds and municipal sewage): Use Equation A
- Manure, semi-solids - (includes beef, swine and dairy settling basin): Use Equation A
- Manure, open lots - (beef, swine, dairy manure from open lots and buildings and poultry manure): Use Equation B
- Manure, solids or with bedding - (horse, sheep packs including straw and shredded newspaper): Use Equation C

Irrigation

RUSLE2 cannot be used to compute soil loss from surface irrigation, but it can be applied to surface irrigated land to compute soil loss from natural rainfall. Since irrigation leaves the soils wetter and thus produces more runoff from natural rainfall than without irrigation, the permeability code in the soil erodibility nomograph can be adjusted one step to a less permeable soil. However, in climates where little rainfall occurs during the irrigation season, this adjustment is unnecessary.

The other consideration given to surface irrigated land is that these lands are frequently graded to produce long gentle slopes. Slope lengths for these fields can be much longer than slope lengths on similar fields that have not been graded.
There are three ways to enter irrigation. Rate, Depth and Monthly. All values are entered in the Management Screen. See below for each.

Enter irrigation application by rate
To enter the irrigation application by rate, you will need to choose the amount of irrigation in inches on a per day basis.

Enter irrigation application by Depth
By entering the irrigation application by Depth, you can bracket the irrigation period. See example below.

Enter irrigation application by Month
This method allows the user to enter the total amount of irrigation for the crop in inches on a month to month basis. See below.

1) Click the drop down menu and choose the correct method of application (Application rate, application depth, or monthly application depth)

2) Click the yellow folder.
   Application Rate: enter date of application and amount of water applied (inches). Note: click the + sign for additional dates
   Application Depth: enter irrigation amount (inches) by period.
   Monthly Application Depth: enter irrigation amount (inches) by month for each crop.
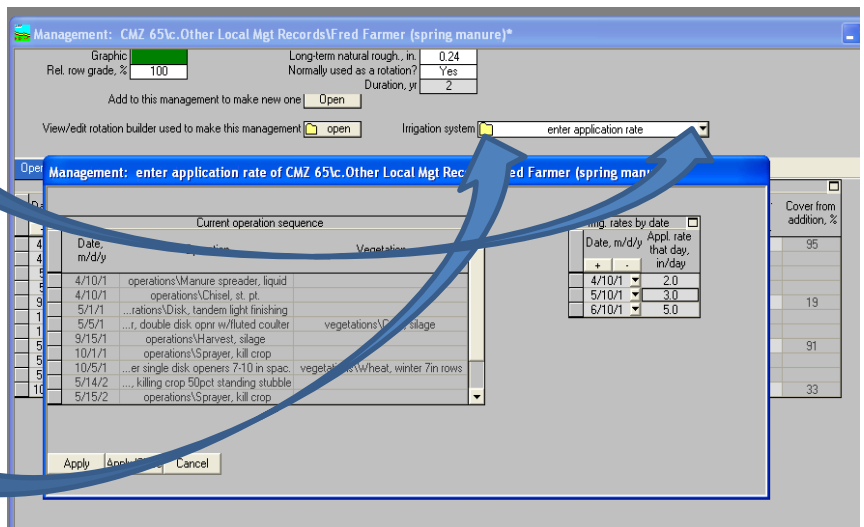
Strips/Barriers
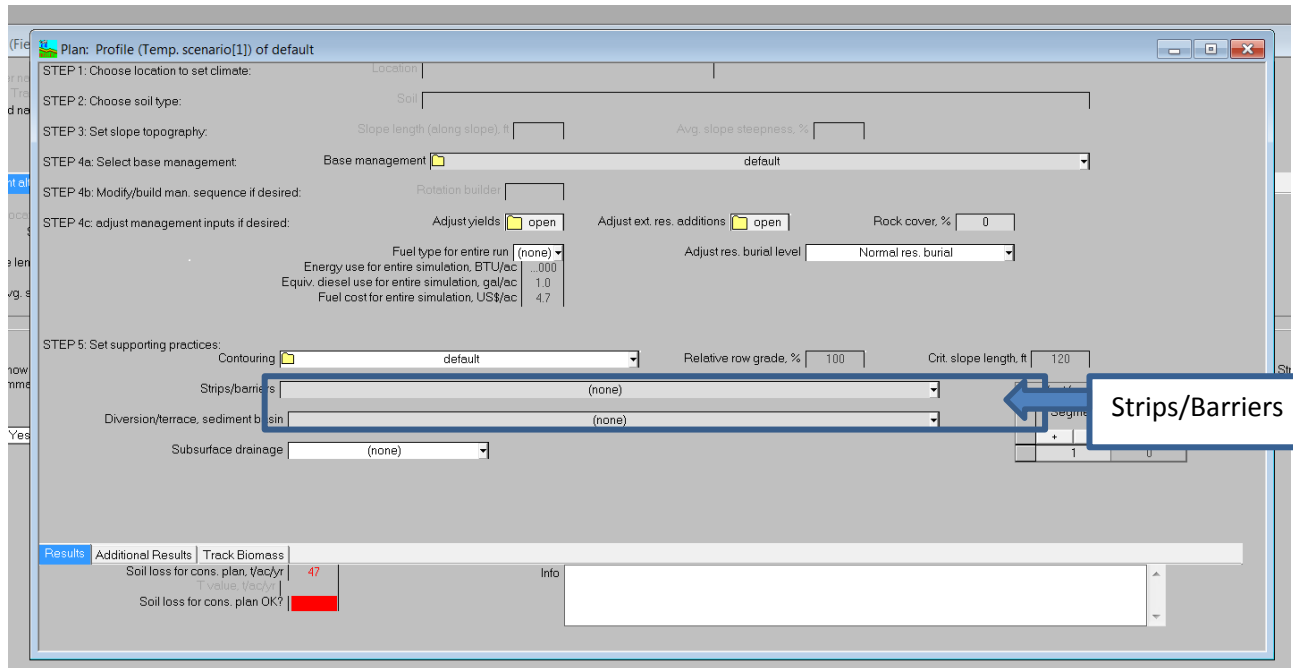
Select the correct strip cropping choice:

Unless your slope length is longer than 200 feet, you probably only have (2) strips on the "Length" (L).

In the choices 2 Strip rotational 0-1 means: 2 strips on the "L" and the 0-1 means the 1st and 2nd crop in the rotation are next to each other (this would be a two year rotation).
In a 0-2 means the 1st and 3rd crops in the rotation are strips next to each other (this would be a four year rotation like such as corn-wheat-hay-hay where corn 1st year and hay are adjacent or wheat and 2nd year hay are adjacent to each other.

Selecting Filter Strips

 (This applies if a filter strip is located at the bottom of the "L"):
   • Two Main Choices Are Available – Actual Width or Percent of the "Length".
   • Select the width and the type of cover. If you do not find the exact match select a similar choice – most produce very similar results.

Selecting Contour Buffer Strips

   1st Select the actual width of the buffer
   2nd Select the number of strips in "L"
   3rd Select the type of cover

Adjust Rock Cover - Guidelines for Estimating Rock Cover in the Field

Introduction: The RUSLE2 computer program has an input box on the Profile view screen for *"Rock cover, %"*. This document offers guidelines for making estimates in the field for the percent cover from rock, rock fragments, or coarse fragments. Coarse fragments on the soil surface effect the Cover and Management factor in RUSLE2. Rock cover does not effect the Soil Erodibility factor.

> Click on the yellow folder and the window to the left will open. The percent rock cover can be entered here.
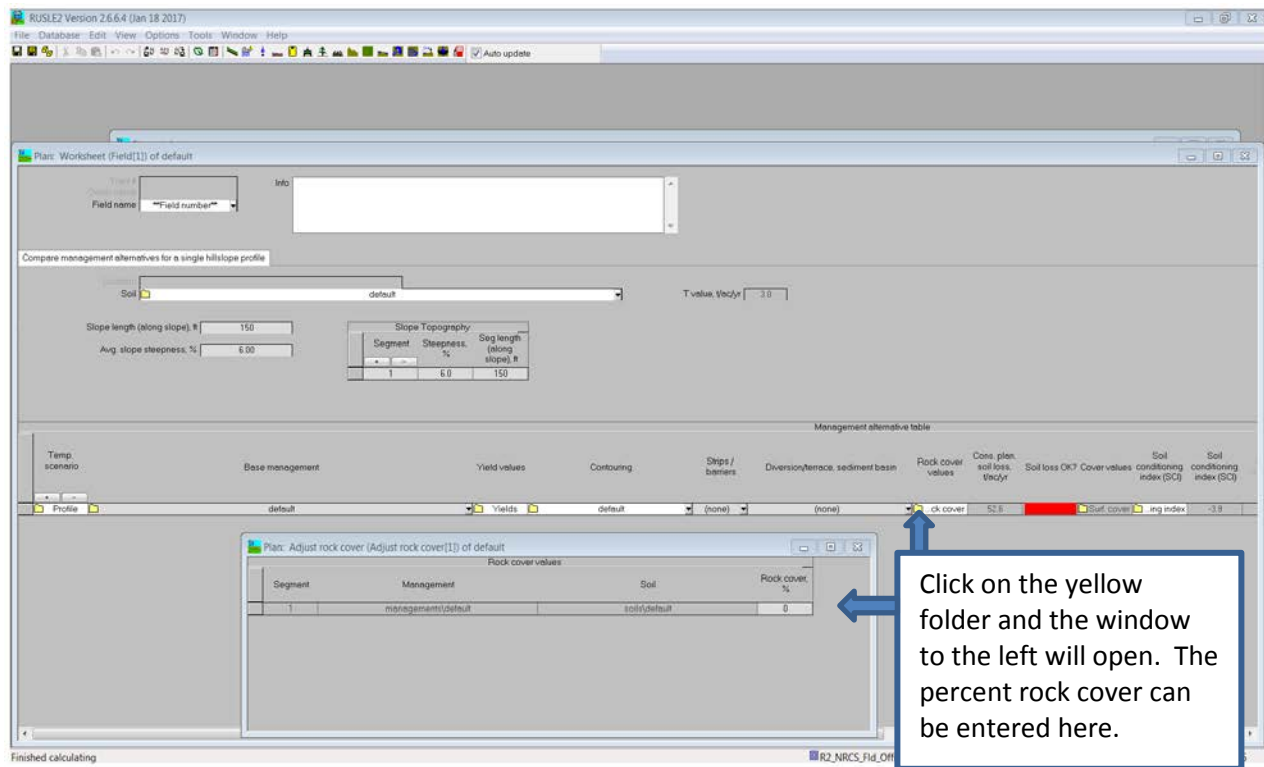
Caution - Use Good Judgment: Research data shows that the presence of rock cover can significantly reduce soil erosion, and the RUSLE2 model accounts for this effect. However, users should be cautioned to exercise good judgment when developing conservation planning alternatives that reflect the presence of surface rock fragments. For example, a rock cover entry in RUSLE2 that reduces soil loss to acceptable levels should be re-considered if the hillslope shows clear evidence of severe, active erosion.

RUSLE2 uses the Kf (rock free) soil erodibility factor.
If surface rock fragments are present and not entered, erosion is over predicted.

RUSLE rock fragments are defined as those greater than 3/8 of an inch in size.

The following are guidelines to use in RUSLE2, if the surface rock fragment cover is not measured in the field.

Surface Texture Modifier	Rock Fragment Content Range	Amount to use if no field measurement
No Texture Modifier	0-15	3
channery, shaly, gravelly, cobbly, cherty, flaggy	15-35	15
very channery, very shaly, very gravelly, very cobbly, very cherty, very flaggy	35-60	35

Estimating Soil Erosion with Ridges and Beds

Ridges and Beds, Defined for Purpose of RUSLE2 Applications

For the purpose of RUSLE2 application, ridges are a series of reoccurring ridges and furrows left by tillage implements such as chisel plows, hippers and disk hillers. The top of these ridges are not flat for any appreciable length. Beds, for the purpose of RUSLE2 application, differ from ridges in that the raised areas (top of the beds) are commonly several feet across the top, and must be at least one foot wide across.

Representing Beds Using RUSLE2

RUSLE2 does not calculate soil loss in the furrows of these beds. Therefore, the topographic inputs must represent the flow path across the bed, then down the side of the bed to the furrow.

This implies that either 1) RUSLE2 provides reasonably good erosion and sediment yield results when minimal erosion occurs in furrows because of high residue cover in the furrows or low furrow grades; or 2) the furrow carries excessive runoff and experiences excessive erosion, a process more closely resembling concentrated flow erosion, a process that RUSLE2 does not currently model.

When Beds are Generally Up-Down the Hillslope:
Represent the cross-section from the middle of one bed to the middle of the next bed. The RUSLE2 output represents runoff and erosion from the middle of the bed to the furrow. Typically, water does not run along the top of the bed for any appreciable length, and instead will run off the side and into the furrow. In the table below, the top of one bed is represented with a 1% grade and 2-ft length, and the sideslope of that bed is represented with a 50% grade and 1-ft length. The adjacent bed across the furrow is represented with similar, but negative values.

SEGMENT	STEEPNESS (%)	LENGTH (ft)
1	1	2
2	50	1
3	-50	1
4	-1	2

When Beds are On or Near the Contour:
Represent the flow path across a bed and down the bed's sideslope to the furrow. An example is illustrated in the table below in which runoff across the top of the bed is represented with a 2% grade and a 4-ft length; and runoff down the bed's sideslope to the furrow is represented with a 50% grade and 1-ft length.

SEGMENT	STEEPNESS (%)	LENGTH (ft)
1	2	4
2	50	1

Representing Ridges Using RUSLE2
Represent the topography up-and-down the hillslope in the path the runoff would follow if the soil surface were flat (as if ridges were not present). If the ridges are on contour/near contour, select the row grade from the drop-down menu for *Contouring*.

NOTE: The science in RUSLE2, in most instances, is adequate to represent ridge-furrow systems because it is based on research data on ridge-furrow systems with a "normal spacing." But RUSLE2 does not adequately represent "abnormally" wide beds, and the subsequent wider spacing of furrows because runoff comes from a larger area on the bed and flow concentrates in the furrow.

A Ridge factor built into RUSLE2 "enhances" erosion when ridges are up-down but "diminishes" it with contouring.

Sediment Delivery in Furrows
RUSLE2 will model sediment deposition in the furrow resulting from low channel grade, but not deposition resulting from increased roughness such as from high residue in the furrow. Currently we have no way of modeling the channel shape and roughness, and the effects of different residue levels in the furrow compared to the ridge or bed.

In eroding landscapes, furrow grades are often too steep for deposited sediment to remain in the furrows. Therefore the sediment delivery value is the same as the soil loss value. However, if the furrow grade is sufficiently flat (often associated with low runoff and/or residue in the furrow), sediment delivery to the end of the furrow will be less than the soil loss value.

Plastic Mulch on Beds and Ridges
Select the Plastic Mulch Application Operation that best represents the percent cover provided by the plastic mulch to the <u>field</u>. So, the estimate of percent cover must include the furrow areas as well as the beds or ridges.

Results of RUSLE2 Calculations

There are several items of information that RUSLE2 provides. Some of these items are very important and needed for certain conservation programs such as the Conservation Security Program. Soil loss, Soil Conditioning Index (SCI) and the Soil Tillage Intensity Rating (STIR) are just a few of RUSLE2 ratings.

Soil Loss for Conservation Planning, recorded in tons/acre/year

The soil loss for conservation planning is the average soil loss over the length of the slope, where partial credit is given if deposition occurs on the slope. It is the value for slope detachment (mass of sediment produced on the slope) reduced by the credit given for the deposition that occurs on the slope. Units (e.g. tons/acre per year) are expressed in terms of mass of sediment, divided by the area determined by the slope length used in the RUSLE2 computation.

Soil Conditioning Index (SCI) and Average Annual Soil Tillage Intensity Rating (STIR)

Click the **Additional Results** tab, click the yellow folder next to Soil Conditioning Index.
The SCI is the Soil Conditioning Index rating. If the calculated index is a negative value, soil organic matter levels are predicted to decline under that production system. If the index is a positive value, soil organic matter levels are predicted to increase under that system.

The STIR value is the Soil Tillage Intensity Rating. It utilizes the speed, depth, surface disturbance percent and tillage type parameters to calculate a tillage intensity rating for the system used in growing a crop or a rotation. STIR ratings tend to show the differences in the degree of soil.

(See next page for example)
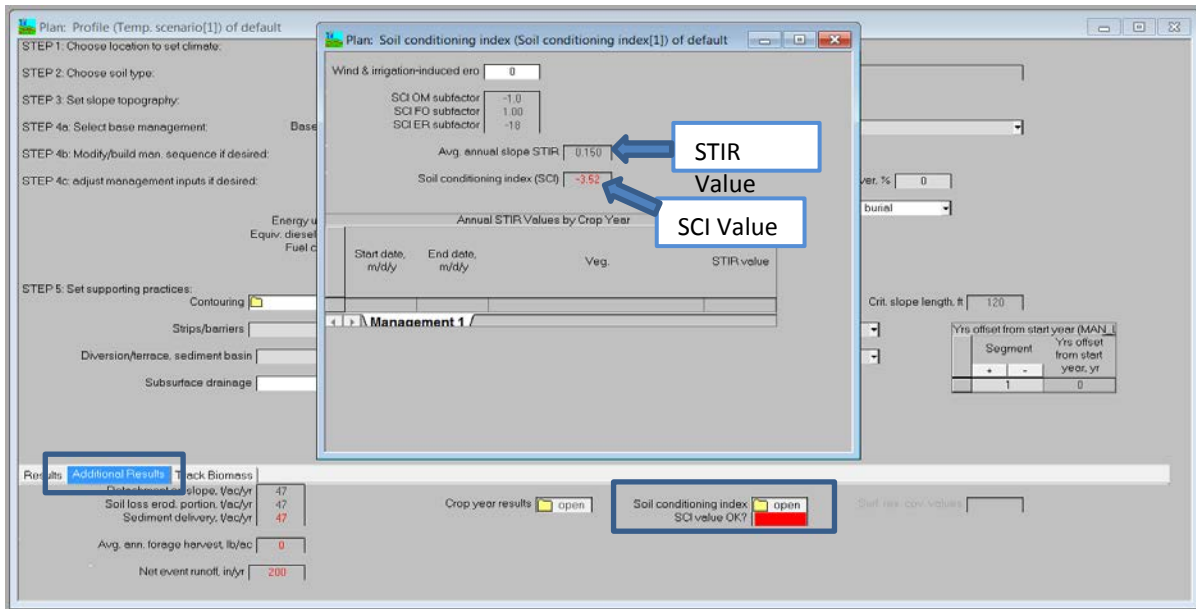
Printing Reports

After you have completed data entry and the results are displayed in either the WORKSHEET, PLAN, or PROFILE view, you can print the results for viewing and saving as a permanent record. The record can be saved anywhere in your file directory.

Note: The instructions below can be used for either the WORKSHEET, PLAN, or PROFILE view.

1) Click on File on the menu toolbar. Select **Print Report**.
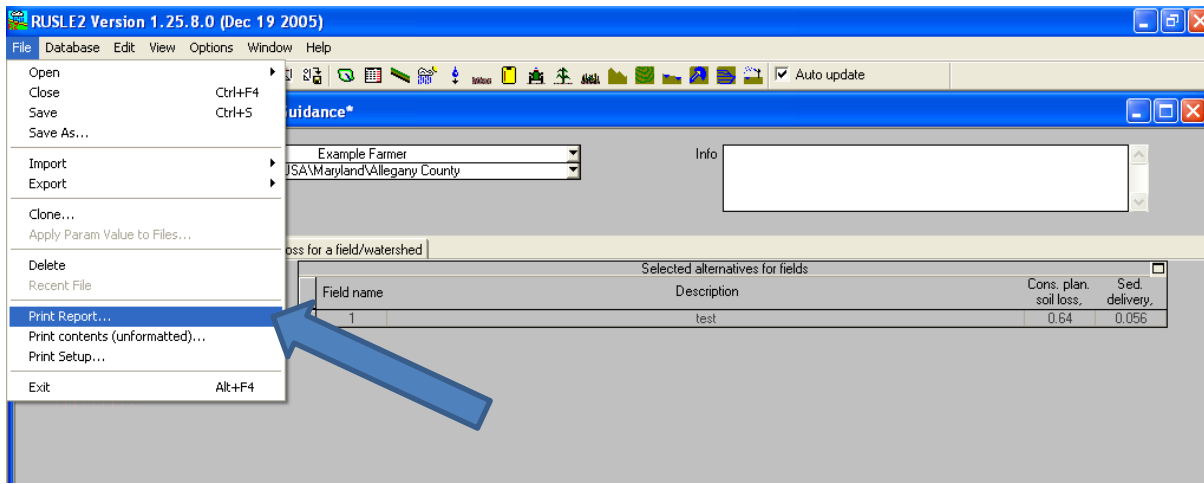
2) After the dialogue box appears, choose a print template that will display the SCI and STIR value. For example in Plan View, choose MD NRCS RUSLE@ Plan Record short 06062013.pln.dot or MD RUSLE2 Plan Record Detail.pln.dot. After selecting the appropriate template, click "Open". MS Word will open and display your record of results. At this point, you have the option of printing and/or saving the document in your file directory. If you want to save this RUSLE2 run, click the File menu, and do a Save As. Give it a name and Save.
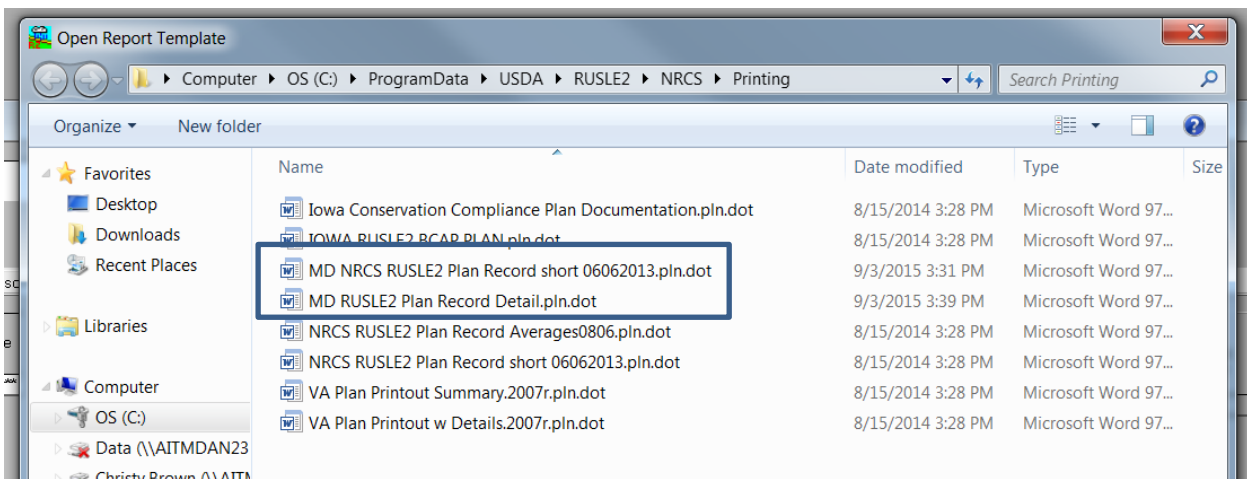
Help Screens

Version 2 of RUSLE has been outfitted with various help screens to aid the user when developing soil loss calculations. To access the help screens, follow the example below.

In this example we chose Base Management. Place cursor over the section you would like help on and right click. Choose "Help".
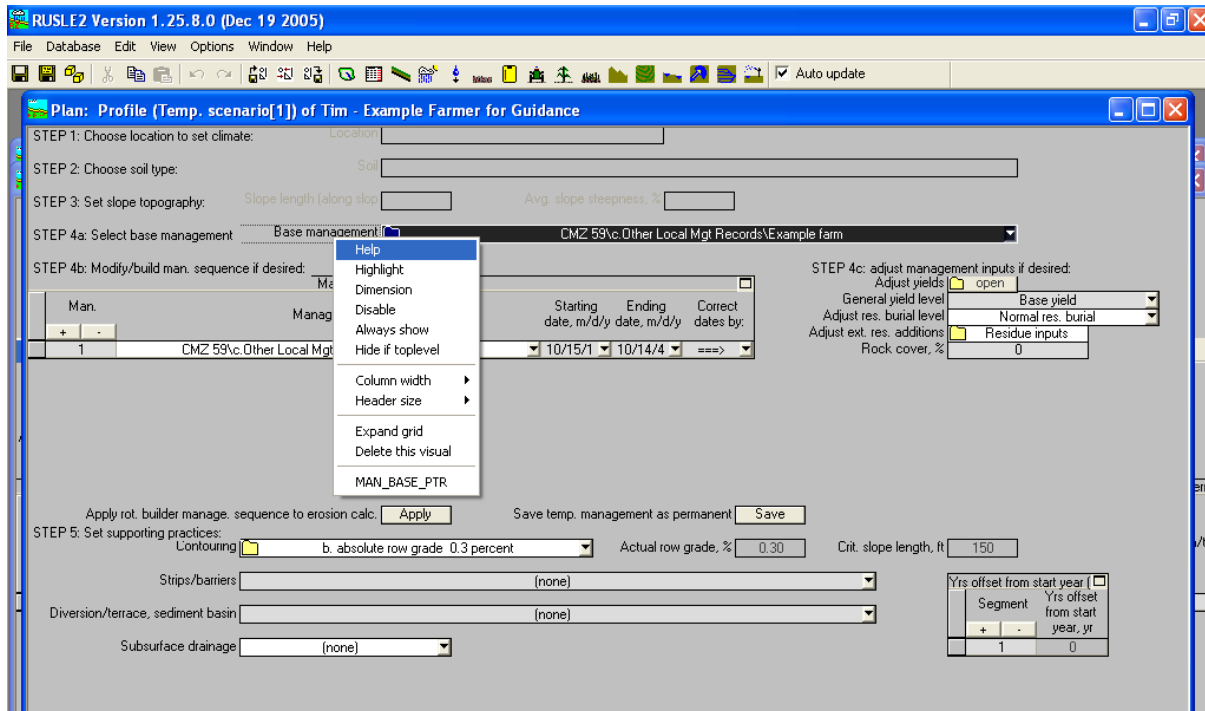
The following help screen will appear.
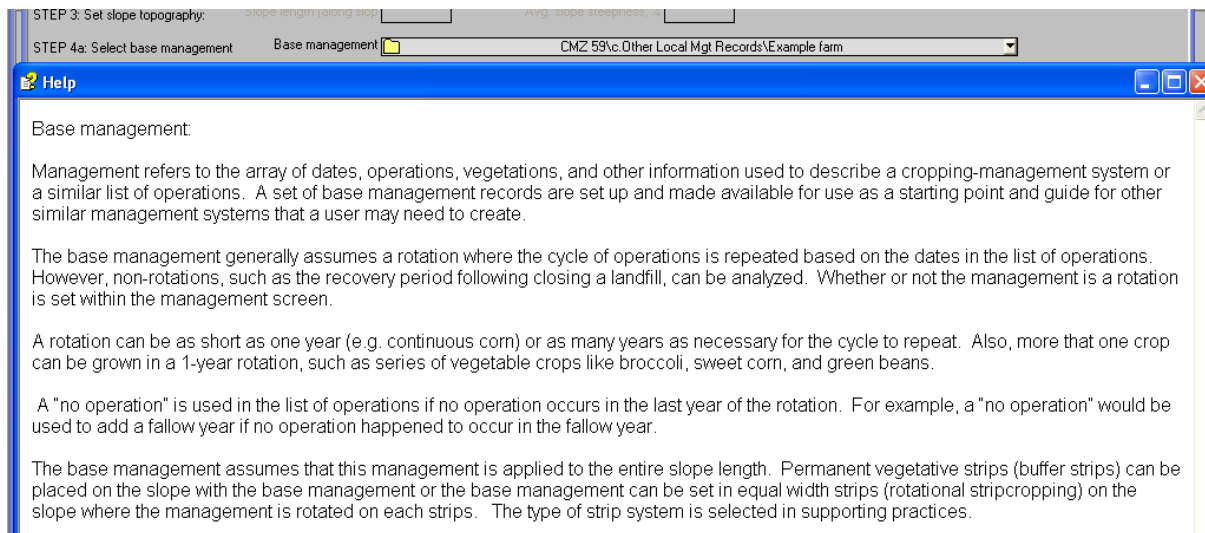
Abbreviations – Arranged Alphabetically

bd	broadcast method of seeding, usually cover crop
dc	double cropping such as corn or soybeans following small grain, or corn following hay harvest; mostly in south-central and south-eastern PA
dcnr	same as above but planted with a drill
fc1	field cultivator equipped with sweeps – one pass
fc2 passes	field cultivator equipped with sweeps – two
fcst	chisel with straight shanks – moderately aggressive chisel
fcswp	chisel with sweeps – less aggressive chisel
fctw chisel fdos	chisel with twisted shanks – most aggressive offset disk – most aggressive disk
fds	light tandem disk – less aggressive disk
fdt	heavy tandem disk – moderately aggressive disk
fnts	strip till – no till where a strip of soil is disturbed by a chisel point in the fall prior to planting, and by coulters mounted on the planter or on a tool bar in front the planter
fp	fall moldboard plow
fs	fall seeded
gr	harvested for grain
inj	manure injected
int or intsd	inter-seeded by air into the standing crop
manb	manure bedded
maninjhd	manure liquid injected with high disturbance injector
maninjld	manure liquid injected with low disturbance injector
manl	manure liquid
manp	manure poultry
manss	manure slurry
nr	narrow row crops generally drilled at 7 inch spacing
	note: corn is wide row (30 inch spacing), unless specified as nr, which is 18 inches; small grains are always narrow row (and not specified)
nt	no till

Abbreviations – Arranged Alphabetically cont.

nts   strip till – no till where a strip of soil is disturbed by a chisel point in the spring prior to planting, and by coulters mounted on the planter or on a tool bar in front the planter

ntz   zone till – no till where a strip of soil is disturbed by fluted coulters mounted on the planter or on a tool bar in front of the planter

oatcc   oat cover crop

p   moldboard plow

pc   plastic culture for vegetables

rc   row cultivator used during the growing season, primarily for weed control

rt   ridge till – row crops are planted on ridges formed during the prior growing season; not common in PA

sc1   field cultivator equipped with sweeps – one pass
sc2   field cultivator equipped with sweeps – two passes

scst   chisel with straight shanks – moderately aggressive chisel
scswp   chisel with sweeps – less aggressive chisel

sctw   chisel with twisted shanks – most aggressive chisel
sdos   offset disk – most aggressive disk

sds   light tandem disk – less aggressive disk

sdt   heavy tandem disk – moderately aggressive disk
si or sil   harvested as silage

sp   spring moldboard plow

ss   spring seeded

wgcc   winter grain cover crop

wr   wide row crops generally planted with a planter at 30 inch spacing

                          note: corn is wide row (30 inch spacing), unless specified as nr, which is 18 inches; small grains are always narrow row (and not specified)

Abbreviations – Arranged by Category

Crops and cropping

dc	double cropping such as corn or soybeans following small grain, or corn following hay harvest; mostly in south-central and south-eastern PA
dcnr	same as above but planted with a drill
gr	harvested for grain
pc	plastic culture for vegetables
si or sil	harvested as silage
oatcc	oat cover crop
wgcc	winter grain cover crop

Manure and manure management

inj	manure injected
manb	manure bedded
maninjhd	manure liquid injected with high disturbance injector
maninjld	manure liquid injected with low disturbance injector
manl	manure liquid
manp	manure poultry
manss	manure slurry

Planting and related operations

bd	broadcast method of seeding, usually cover crop
int or intsd	inter-seeded by air into the standing crop
fs	fall seeded
nr	narrow row crops generally drilled at 7 inch spacing note: corn is wide row (30 inch spacing), unless specified as nr, which is 18 inches; small grains are always narrow row (and not specified)
nt	no till
fnts	strip till – no till where a strip of soil is disturbed by a chisel point in the fall prior to planting, and by coulters mounted on the planter or on a tool bar in front the planter
nts	strip till – no till where a strip of soil is disturbed by a chisel point in the spring prior to planting, and by coulters mounted on the planter or on a tool bar in front the planter
ntz	zone till – no till where a strip of soil is disturbed by fluted coulters mounted on the planter or on a tool bar in front of the planter
rc	row cultivator used during the growing season, primarily for weed control
rt	ridge till – row crops are planted on ridges formed during the prior growing season; not common in PA
ss	spring seeded
wr	wide row crops generally planted with a planter at 30 inch spacing note: corn is wide row (30 inch spacing), unless specified as nr, which is 18 inches; small grains are always narrow row (and not specified)

Tillage

Below the tillage types, are the codes and abbreviations in **bold**, i.e., **fp**, that are part of the crop template name. Primary tillage types are listed. Under the secondary tillage, are the operations used in preparation of the crop templates. A listing of the same piece of equipment more than one time indicates more than one pass over the field with that implement.

PRIMARY TILLAGE	SECONDARY TILLAGE
Moldboard Plow　　**fp** (fall) **sp** (spring)	Disk, tandem heavy primary Disk, tandem light finishing Harrow, coiled tine
Chisel, twisted **fctw** (fall) **sctw** (spring) 　　(high tillage/low residue)	Disk, tandem heavy primary Disk, tandem light finishing
Chisel, straight **fcst** (fall) **scst** (spring) 　　(moderate tillage/moderate residue)	Disk, tandem heavy primary Disk, tandem light finishing
Chisel, sweeps **fcswp** (fall) **scswp** (spring) 　　(low tillage/high residue)	Cultivator, field 6-12" sweeps
Disk, heavy/offset　　**fdos** (fall) **sdos** (spring) 　　(high tillage/low residue)	Disk, tandem heavy primary Disk, tandem light finishing
Disk, tandem heavy　　**fdt** (fall) **sdt** (spring) 　　(moderate tillage/moderate residue)	Disk, tandem heavy primary Disk, tandem light finishing
Disk, tandem　　　　**fds** (fall) **sds** (spring) 　　(low tillage/high residue)	Disk, tandem secondary
Cultivator, field; 6-12" sweeps* **ffc1** (fall**) sfc1** (spring)	none
Cultivator, field; 6-12" sweeps* **ffc2** (fall**) sfc2** (spring)	Cultivator, field; 6-12" sweeps

*1 & 2 in symbol denotes the number of implement passes

Seedbed Conditioner – is <u>Vertical-Till</u> or Turbo-Till High residue crop

Manure Operations – Abbreviations and Descriptions

The following is a list of manure operation abbreviations and their descriptions, as used in the preparation of crop templates for Crop Management Zones 4.1, 62 (intermediate planting dates), and 65. The manure types are the codes that are part of the crop template name for all templates where manure is used. The spreaders are specifically selected because of the properties included in the databases. The manure types were selected to represent the most common types of manure used in each of the multi- state CMZs. The decomposition rates are included in the database. The table shows the average dry matter that is applied for each method. The dry matter rates are based on average N- and P-based nutrient management plan rates for typical yields of grain and silage corn.

MANURE	TYPE MANURE SPREADER	LBS. DRY MATTER
LIQUID		1000
manl	Liquid spreader (50% infiltration)	6000 gal @ 2% dry matter
maninjhd	Injector – high disturbance 30" (50%)	6000 gal @ 2% dry matter
maninjld	Injector – low disturbance 15" (30%)	6000 gal @ 2% dry matter
MANURE, MODERATE BEDDING		3000
manb	Manure spreader, solid & semi-solid	6 tons @ 25% solids
MANURE, POULTRY		3000
manp	Manure spreader, solid & semi-solid	6 tons @ 50% solids
MANURE, SEMI-SOLID & SLURRY		3000
manss	Manure spreader, slurry	10 tons @ 15% solids or 5000 gal @ 7% solids

Example Cropping System Worksheet

Producer: John Smith

Tract No: 943   Fields: 1, 2, 3, & 4

Crop Rotation

1st Year	Corn/Grain	4th Year	Winter Wheat
2nd Year	Fallow	5th Year	Alfalfa (7 years)
3rd Year	Bean	6th Year	

Tillage Operations and Yield | Yield (5-year Average Normal Precipitation)

Crop 1:   Corn - 130 bu yield

Date:	Operations:
4/1	Moldboard Plow
4/15	Tandem Disk
4/20	Chisel w/sweeps
5/1	Double-disk Planter - 30" rows
6/15	Row Cultivate
7/1	Row Cultivate
10/1	Harvest for Grain

Crop 4:   Barley - 70 bu yield

Date:	Operations:
3/15	Disk Offset
4/1	Cultipacker, roller
4/5	Double-disk Drill - 10" row
7/1	Harvest
9/1	Graze Wheat Stubble

Crop 2:   Fallow

Date:	Operations:
5/15	Offset Disk
6/15	Chisel Plow Sweeps
7/20	Chisel Plow Sweeps
9/1	Chisel Plow

Crop 5:   Alfalfa - 4 ton yield

Date:	Operations:
4/1	Moldboard Plow
4/15	Offset Disk
4/20	Tandem Disk
5/15	Double-disk Drill - 10" rows
7/1	Harvest
9/1	Harvest
10/1	Graze Alfalfa Aftermath

Crop 3:   Beans - 20 cwt yield

Date:	Operations:
3/1	Grazed Corn Stubble
5/1	Moldboard Plow
5/15	Tandem Disk
5/20	Chisel with Sweeps
6/1	Double-disk Planter - 30" rows
7/1	Row Cultivate
9/10	Harvest

Crop 6:

Date:	Operations:

Cropping System Worksheet

Producer: _____

Tract No: _____ Fields: _____

Crop Rotation

1st Year	_____	4th Year	_____
2nd Year	_____	5th Year	_____
3rd Year	_____	6th Year	_____

Tillage Operations and Yield   **Yield (5-year Average Normal Precipitation)**

Crop 1: _____   **Crop 4:** _____

Date: **Operations:**   **Date:**   **Operations:**

____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____

Crop 2: _____   **Crop 5:** _____

Date: **Operations:**   **Date:**   **Operations:**

____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____

Crop 3: _____   **Crop 6:** _____

Date: **Operations:**   **Date:**   **Operations:**

____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____
____ _____   ____ _____

Equipment Worksheet

Check the boxes below for Field Equipment used in your farming operation:

Planter

☐	Double-disk opener with or without fluted coulter
☐	Double-disk opener, 18" rows
☐	Furrow opener in 4", 6", or 8" deep furrows
☐	In-row subsoiler
☐	Narrow slot w/smooth or rippled coulter
☐	Runner opener
☐	Ridge till attachments
☐	Strip till attachments

Fertilizer Applicators

☐	Coulter, high pressure injector, 12" spacing
☐	Anhydrous knife, 12" spacing
☐	Shank low disturbance, 12" spacing
☐	Deep placement heavy shank
☐	Surface broadcast spreader
☐	Anhydrous knife, 30" spacing
☐	Strip till, 30" spacing

Tillage/Cultivation Equipment

☐	Field cultivator, field, 6-12" shovels
☐	Chisel, sweep shovel
☐	Field cultivator, field, 6-12" sweeps
☐	Chisel, twisted shovel
☐	Field cultivator, field w/ spike points
☐	Disk, offset, heavy
☐	Disk, tandem, heavy primary
☐	Disk, tandem, light finishing
☐	Mulch finisher (one pass)
☐	Residue, row cleaner
☐	Rodweeder
☐	Rotary hoe
☐	Row cultivation
☐	Seedbed Conditioner
☐	Subsoiler
☐	Subsoiler ripper, 24-40" deep
☐	Harrow, coiled tine
☐	Harrow, heavy or rotary
☐	Harrow, spike tooth or tine on beds
☐	Power mulcher bed conditioner
☐	Plow, disk
☐	Plow, moldboard

Drill or Air Seeder

☐	Tee slot openers, 7-10" rows
☐	Hoe/chisel openers, 12-15" rows
☐	Hoe/chisel openers, 6-12" rows
☐	Sweep or band opener
☐	Offset double-disk openers
☐	Double-disk openers
☐	Single-disk openers, 7-10" rows
☐	Double-disk opener w/fluted coulter
☐	Double-disk opener w/fert. openers
☐	Single-disk openers + fert. openers, 7-10" rows/spacing
☐	Deep or semi-deep furrow, 12-18" spacing
☐	Heavy, direct-seed, double-disk opener with or w/o row cleaners
☐	Double-disk, 7-8" packer

Manure Application

☐	Liquid high disturb, 30" spacing
☐	Liquid low disturb, 30" spacing
☐	Liquid low disturb, 15" spacing
☐	Dry manure spreader

Combine

☐	Rotary with residue spreader
☐	Rotary without residue spreader
☐	Non-rotary with residue spreader
☐	Non-rotary without residue spreader

Stalk Shredding Equipment

☐	Shredder, flail or rotary
☐	Shredder, rotary mower
☐	Stalk chopper, rotary
☐	Other shredding equipment

Other Equipment

☐	
☐	
☐	
☐	