USDA United States Department of Agriculture

Natural Resources Conservation Service

Guide for Using RUSLE2 in Organic Systems

August 2016

NRCS
www.nrcs.usda.gov

Oregon Tilth
www.tilth.org

Acknowledgements

Authors Ben Bowell (Oregon Tilth) and and Giulio Ferruzzi (NRCS)

Reviewers and contributors Glen Abney (KY-NRCS), Thomas Akin (MA-NRCS), Alice Begin (ME-NRCS), Sarah Brown (Oregon Tilth), Lindsay Haines (NRCS), Andrew Loganbill (CA-NRCS), Denise Troxell (OR-NRCS), Rafael Vega (IN-NRCS), and Jennifer Walser (CA-NRCS)

Photos Ben Bowell (Oregon Tilth) unless otherwise noted.

Image 1. (front cover) Compost (photo: USDA NRCS).

Image 2. (above) Diversified organic vegetable operation with berries and vegetables.

Please contact Ben Bowell (Benjamin.Bowell@por.usda.gov or 503-580-4767) with questions or to improve this guide.

Purpose

Due to the complex nature of many organic cropping systems, NRCS planners and TSPs may find the use of RUSLE2 to calculate soil loss challenging. This document provides guidance on:

- How soil loss should be calculated by selecting appropriate tillage operations.
- Planning in fields with a diversity of crops.
- Considerations for high tunnels, low tunnels and mulches.
- Incorporating cover crops in the rotation.
- Incorporating manure, compost and other soil amendments

This guide may also be useful in working with non-certified organic clients such as those with diverse or specialty crop operations. For general information visit the Official NRCS RUSLE2 Program page:

http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm

Gathering Information

The first step in developing a successful RUSLE2 run is collecting accurate and adequate information about a producer's operation. As with any producer, focus on the specific farming activities and note that it is an organic system. Be sure to understand what crops they plant (i.e. small grains or vegetables), what they do (i.e. tillage operations like discing), when they do it (i.e. March 10th and September 25th), and how they do it (i.e. type of equipment, depth and angle of implement). Variations (i.e. heavier or lighter discing) can result in significant changes in the soil loss estimate and other RUSLE2 estimates. See Appendix: RUSLE2 Information Gathering for more information.

Example

A producer may provide the following information about their operation: The producer farms 14 acres of certified organic cropland split up in 18 fields/parcels. The fields rotate from onion/lettuce, squash/cucumber, carrots, parsley, tomatoes, root crops, brassicas, pumpkins, corn, strawberries, melons, and fallow block. In a typical crop year the producer plows down the majority of the fields and plants a cover crop in the fall after the first rains. One or two blocks are usually left for winter crops like kale. In the early spring they disk the cover crop to incorporate it into the soil following with a compost application. Often crops will be harvested and tilled and replanted in a block during the growing season (multiple successions). The growing season is completed by tilling residual crops after harvest and then planting a cover crop.

This information provides a great starting point, but more is needed to ensure the operation is modeled accurately in RUSLE2, for example:

- When (date) did the producer: plow and plant the cover crop, disk the cover crop, till the residue and plant a cover crop?
- How much residue (percent of soil surface) was left on the surface after planting a crop?
- How many successions of crops were planted and harvested; and when (dates)?
- When tilling, what type of implement is used, what is the depth and how much surface area is disturbed?
- What is the rate of compost application and when?
- What species of cover crop was planted and what was its biomass?
- Do weeds or mulch provide cover in any of the fields? When and how long?

Tillage Operations

As with all farming systems, it is important to select the correct equipment to ensure soil disturbance is measured correctly. Without broad-spectrum herbicides, organic crop production is often more reliant on tillage and cultivation for weed management and seedbed preparation. Organic producers may use a wider range of implements, some of which may not be commonly used by other operations in the region. These resources provide videos, pictures and descriptions of equipment used in organic systems:

Video Clips on Organic Weed Management (eOrganic)
http://www.extension.org/pages/59487/video-clips-on-organic-weed-management

Steel in the Field: A Farmer's Guide to Weed Management Tools (SARE)
http://www.sare.org/Learning-Center/Books/Steel-in-the-Field

Farm Equipment Presentation (Official NRCS RUSLE2 Program)
http://fargo.nserl.purdue.edu/RUSLE2_ftp/NRCS_Base_Database/Farm%20Equipment%20presentation/

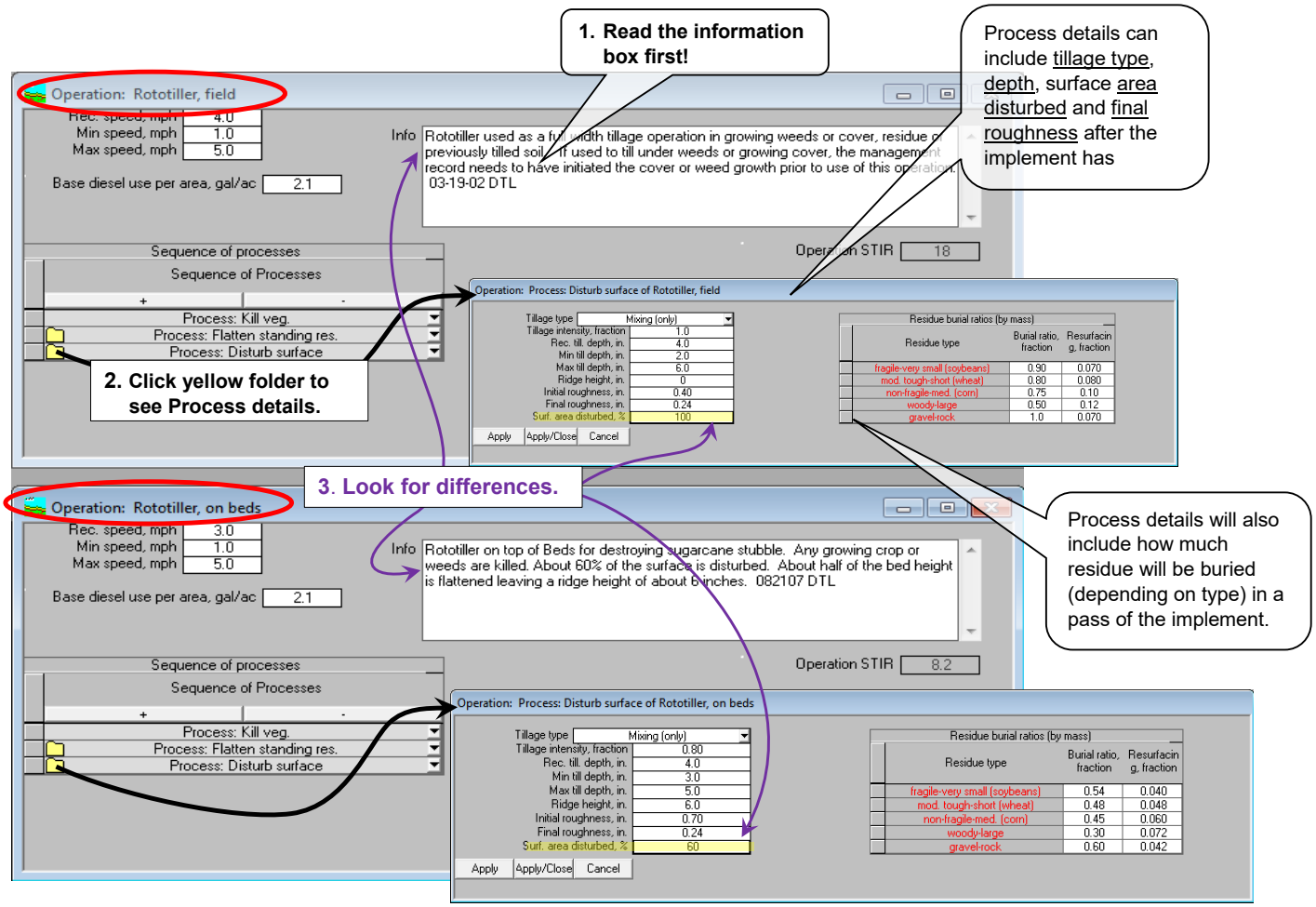
When selecting equipment in RUSLE2, open the operation record and read the information box and operational parameters to ensure it aligns correctly with the way the producer is using the equipment. Confirm that the sequence is correct, see if the operation is killing vegetation or not. If applicable, look at the tillage depth for the implement selected. If it is not correct, select an implement that more closely aligns with the producer's activities. Some operations do account for tillage that does not disturb the full field. For example, the operation for "rototiller on beds" accounts for disturbance of only 60% of the soil in the field.

Image 3. The roller crimper is used to terminate a cover crop and leave it as a mulch on the surface.

Image 4. Basket weeder for smaller weeds.

Tillage Operations, continued

Figure 1. When comparing between two potential tillage operations, be sure to look at all the information available in the records to determine which operation best describes how the client is using the tillage implement in their field.



Diversity of Crops

Farms growing specialty crops can be complex operations growing 40 crops or more, often through staggered and sequential plantings. These highly diverse systems can be very difficult and time consuming to model in RUSLE2. It is not necessary to model every crop grown in these systems. Pick a representative rotation. Simplify the operation by grouping plants (i.e. perhaps just model one leafy green vegetable when five or ten are grown). Focus on ensuring the biomass and yields are accurate as they have the greatest impact in RUSLE2. Especially with smaller scale growers, be sure to convert their harvest measurement unit to pounds or tons per acre as requested by RUSLE2 (see resource below). In operations with sequential plantings, create separate managements (i.e. perhaps each a month apart for early, middle and late plantings). Then divide the field into sections and assign the plantings. If plantings occur regularly, do not model each, but pick a representative planting to model. For example, if a producer plants lettuce every other week (weeks 1, 3 and 5) in a portion of the field, only model the one planting in week 3 to represent the three plantings.

To learn more about crop rotations in organic systems, see this resource which includes groupings of crops by families: Crop Rotation on Organic Farms: A Planning Manual (SARE, Natural Resource, Agriculture, and Engineering Service (NRAES)) http://www.sare.org/Learning-Center/Books/Crop-Rotation-on-Organic-Farms

This resource describes how to estimate vegetable yields, convert to lb/A and gives approximate yields for many crops: Estimating Vegetable Yields (Cooperative Extension services of New England, New England Vegetable Management Guide) https://nevegetable.org/cultural-practices/estimating-vegetable-yields

Image 5. Diversified organic vegetable operation (Photo: Sarah Brown, Oregon Tilth).

Image 6. Organic farm growing a range of vegetable crops (Photo: Sarah Brown, Oregon Tilth).

Mulches and High Tunnels

Mulches are commonly used in organic systems to suppress weeds. Make sure the mulch—including residue from a cover crop—is captured. Select mulches appropriately and pay attention to permeability (straw, plastic mulch, cloth, etc). If the producer uses an impervious mulch and removes it after the crop is harvested (as required under USDA organic regulations[1]), be sure to remove it at the end of the season in RUSLE2. If the mulch is not removed in RUSLE2, it may underestimate soil loss. Be sure to consider the space between rows of mulch as well.

If a producer is growing in a high tunnel, low tunnel or other plastic hoop covering the crop production area be sure to capture this as it will impact erosion calculations. Simply add a line to the management at the beginning. Then add an operation to reflect this such as "plastic hoop tunnel installation 100 percent cover." By adding this operation to the beginning of the management, it will apply to the full management. However, the erosion risk inside a high tunnel is generally low and often not measured with RUSLE2 (review program requirements to see when a RUSLE2 run is required).

High tunnels, low tunnels and impervious mulches can result in erosion from runoff outside that is not captured by RUSLE2 which models rill and sheet erosion. Encourage producers who are using these impervious surfaces to address potential runoff and erosion risks. For example, some producers seed grass between rows of plastic mulch.

1 Plastic or other synthetic mulches must be removed from the field at the end of the growing or harvest season. §205.206 Crop pest, weed, and disease management practice standard. http://www.ecfr.gov/cgi-bin/text-idx?SID=274778bc50552915631c51b6fc08a488&mc=true&node=pt7.3.205&rgn=div5#se7.3.205_1206

Image 7. Organic strawberries grown with plastic weed barrier.

Image 8. Organic vegetables grown in a high tunnel.

Cover Crops

Organic producers use cover crops for many purposes—such as to fix nitrogen, add organic matter, reduce erosion, suppress weeds, disrupt pest cycles, and provide habitat for beneficial organisms—and thus use a range of species and mixes. RUSLE2 may not have the exact mix or species. In that case, think about the role of that cover crop (i.e. a grass and a legume) and select something similar. In mixes with many species, think about how the biomass behaves. Make a selection based on the residue and how it will break down (i.e. appropriate mix of forbs, legumes, and grasses). This resource describes many cover crops used in organic and specialty crop systems:

Managing Cover Crops Profitably, 3rd edition (SARE)
http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

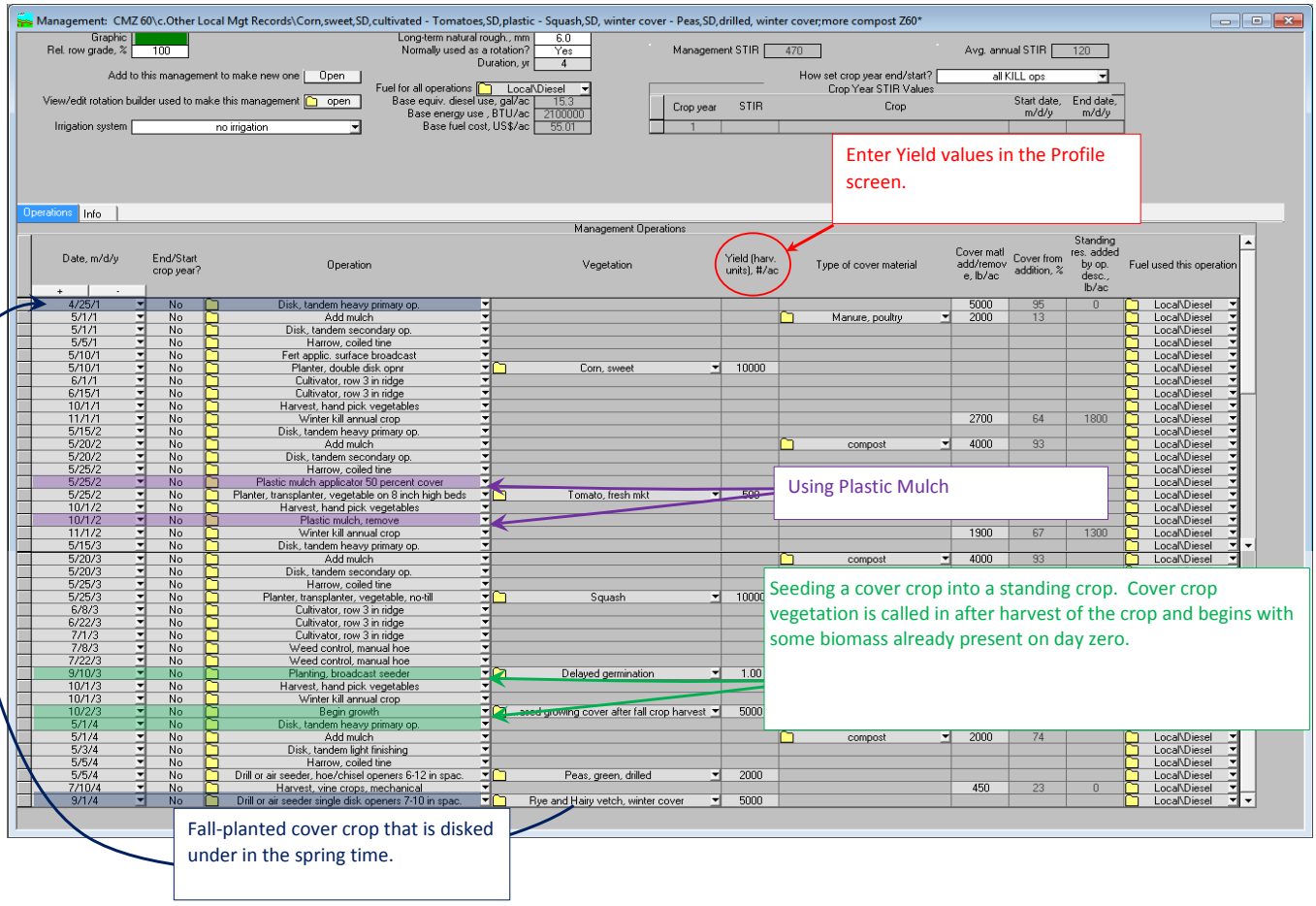
Of all the parameters in RUSLE2, yield has one of the largest impacts on soil loss because yield determines biomass which determines residue. It is important to look closely at the yields to see that the actual biomass in the field is correct. If the biomass estimate in RUSLE2 doesn't seem correct based on what is in the field, adjust the yields to make sure the dry weight estimate in RUSLE2 is accurate. A cover crop mix designed for building organic matter may have significant amounts of biomass. Some organic producers are growing cover crops to roll down and then plant into. These systems may have a very thick mat of cover crop residue.

Image 9. Sudan cover crop grown to add biomass.

Image 10. Mixture of oats and clover cover crop.

Cover Crops, continued

Figure 2. There are several ways that cover crops are managed and thus modeled in RUSLE2. Below is an example of a rotation with a fall-planted cover crop after cash crop harvest (blue) and a fall seed cover crop that was interseeded with the cash crop (green). In the management screen below, there are values for crop and cover crop yields (red) but ultimately, those values must be set in the profile screen for your respective runs. Mulches (purple) should be modeled as closely as possible to how they are applied to the field. Pay special attention to the amount of exposed soil left in the field after the mulch is applied and choose the appropriate RUSLE2 operation.

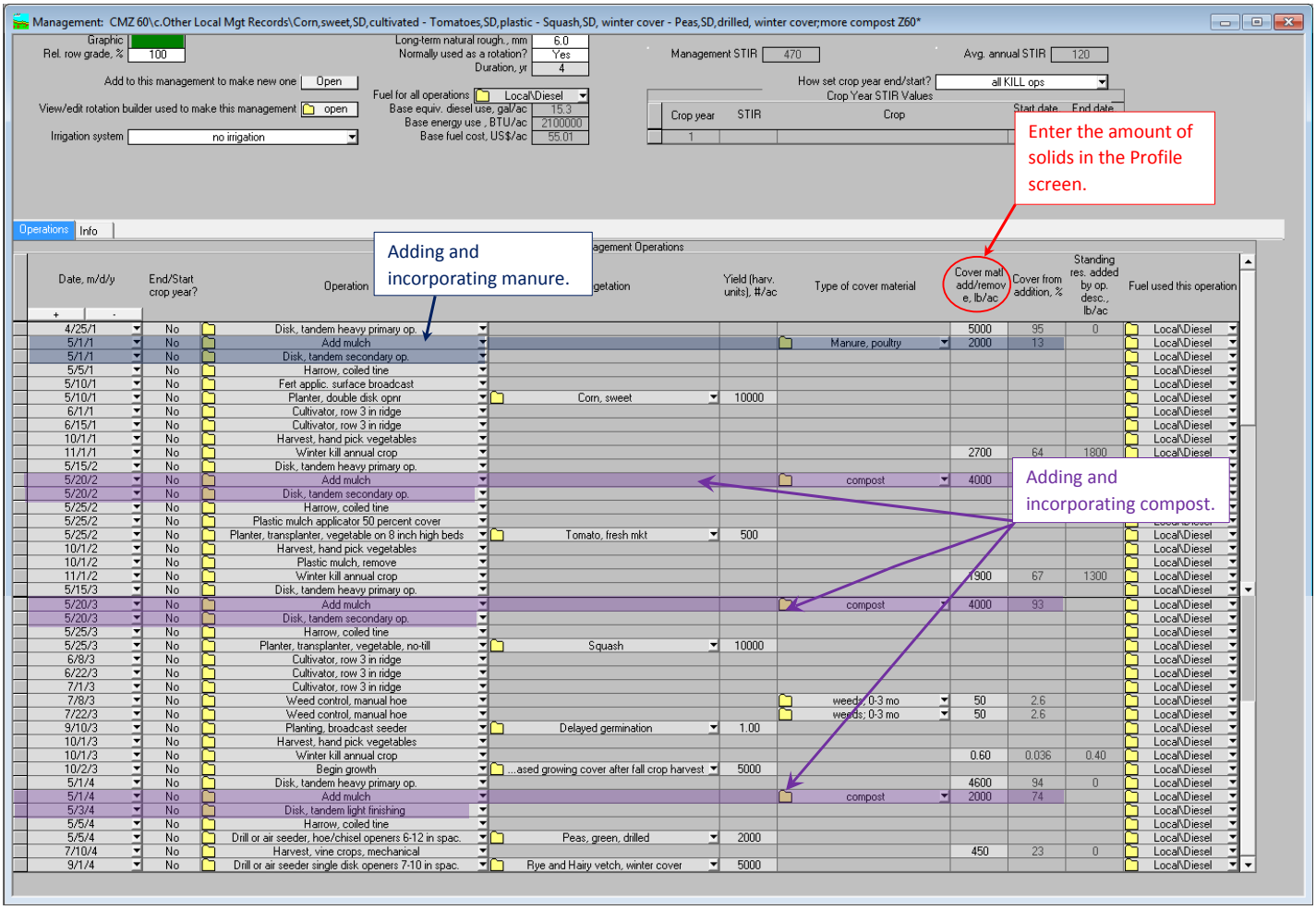


Manure and Compost

Many organic producers apply compost and manure for fertility and to increase soil organic matter. It is important to accurately include these applications in RUSLE2 as they are treated like residue and will impact soil loss results. To enter the correct amount of manure applied, follow the instructions in this document which provides separate calculations if the manure is liquid or solid:

Manure Dry Matter Calculations (Official NRCS RUSLE2 Program)
http://fargo.nserl.purdue.edu/RUSLE2_ftp/NRCS_Base_Database/Manure%20drymatter%20calclations/

Figure 3. Make sure the amount of solids in the manure is accurately calculated so that the entry in RUSLE2 will produce the most accurate effect.



Soil Conditioning Index

Certified organic operations must maintain or improve soil organic matter[1]. Organic regulations focus on the method employed to achieve this standard (i.e. use of cover crops or manure) and are not required to use a quantitative measure. However, organic producers working with NRCS may be interested in tools to predict the impact of their management. RUSLE 2 does not track soil organic matter, but estimates the impact based on soil disturbance and mitigating factors such as the amount of residue and rate of breakdown. The soil conditioning index (SCI) gives an overall rating based on these components. If the rating is a negative value, the system is predicted to have declining soil organic matter. If the rating is a positive value, the system is predicted to have increasing soil organic matter. An SCI factor above 0.2 indicates the management is increasing soil organic matter. (See Figure Appendix 5 for a screen shot of the SCI in RUSLE2). Although the SCI is an only an estimate, producers may consider a number of techniques to increase the SCI: in-field practices such as strip cropping, terraces, mid-slope buffers or contour farming; altering the timing of tillage events or substitute tillage implements; incorporating cover crops into the rotation when there is little cover or residue; or including more high residue cash crops in the rotations.

1 USDA organic regulations Section 205.203 soil fertility and crop nutrient management practice standard. http://www.ecfr.gov/cgi-bin/text-idx?SID=8998f1b7ee99bb33b7d44bfc6c300410&mc=true&node=pt7.3.205&rgn=div5#se7.3.205_1203

Image 11. Oats grown as a cover crop to add residue and increase organic matter.

Image 12. Compost from manure and other materials (Photo: USDA NRCS).

Conclusion and Resources

While RUSLE2 is a useful tool to predict erosion and assess the impacts of farm management decisions, it does have limitations. For example, many producers are interested in soil ecology and microbiology which are not addressed by RUSLE2. As described above, complex and highly diverse operations are very difficult and time consuming to model completely. The numerous factors (crops, dates of planted successions, etc) involved should not be included. The challenge, therefore, is to create an abstract management that is representative.

Additional Resources

RUSLE2 in Organic Systems webinar
Giulio Ferruzzi, Agronomist, NRCS West National Technology Support Center
http://www.conservationwebinars.net/webinars/rusle2-in-organic-systems/?searchterm=organic

Mitigating Soil Disturbance in Organic Systems webinar
Giulio Ferruzzi, Agronomist, NRCS West National Technology Support Center
http://www.conservationwebinars.net/webinars/mitigating-soil-disturbance-in-organic-systems/?searchterm=organic

Agronomy Technical Note No. 2: Using RUSLE2 for the Design and Predicted Effectiveness of Vegetative Filter Strips (VFS) for Sediment
http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=18578.wba

Image 13. Tomatoes grown on a diverse organic vegetable operation. (Photo: USDA NRCS)

Appendix: RUSLE 2 Information Gathering

General Questions

Answer all these questions and then input values into RUSLE2 to get the MOST ACCURATE results from RUSLE2 for soil loss, SCI and STIR. Answer N/A to questions that do not apply to your client's situation.

General Questions are referenced on Figure Appendix 1

1. What is the total average annual rainfall at the location you are modeling?
2. Is the crop planted up-and-down the slope, on the contour or off contour at some degree (i.e., what is the row grade)?
3. If the slope is consistent for the entire length of the surface water flow (i.e. the RUSLE2 transect) what is the length and % slope? [Use this option for general conservation planning.]
4. If the slope is complex, what are the lengths and % slope for each component segment of the entire RUSLE2 transect? [Use this option for modeling of filter strip design or water quality purposes.]

segment	length (ft)	% slope
1		
2		
3		
4		
5		
6		
etc		

5. What is the dominant, critical soil type in the field along the transect that you are modeling? [Use this option for general cons. planning.]
6. If there are significant amounts of distinctly different soil types along the transect then what are they and where are they located on the slope?

segment	length (ft)	soil type
1		
2		
3		
4		
5		
6		
etc		

7. What is the rotation that the grower follows?

Management Questions

Select the RUSLE2 management template that best describes the client's crop or rotation and check each line of the record you selected and answer the following question. Questions are referenced on Figure Appendix 2.

1. Are the dates of the selected operations correct? If not, make it so. **
2. Are the operations selected in the correct order? If not, make it so. **
3. Are the operations selected correct? Check information by clicking the yellow folders for details. What you are looking for here is that, for example, if a farmer is using a "tandem disk" ensure that the implement operation depth and residue burial value observed in the field operation is the same as that stated in the "tandem disk" record you choose from the RUSLE2 database. **
4. Is/are the correct vegetation(s) selected? (see 6. for more detail) **
5. Is/are the yield(s) reported in the RUSLE2 vegetation record and the field yield consistent?**
6. Is the correct vegetation record selected? This can be checked by graphing the % canopy of the vegetation selected and matching it up with the vegetation in the field. Note: vegetation records have a % canopy value for each day of the record and an associated total yield value. Changing the yield value will change canopy values. **
7. Is the field irrigated? If yes, enter irrigation information in the management record if you are modeling an irrigated crop.
8. If external residues (e.g. manure, mulch, compost, etc.) are being applied, what rate is it being applied and when (i.e. which crop(s))? T/Ac.

**Note: If you are looking at a "Single year/Single Crop Template" management record, save any changes you make to the record by selecting "Save as" into the c. folder and name the modified record appropriately. If you are looking at a "Multiyear Rotation Template" then, open the appropriate component "Single year/Single Crop Template" records, edit and save as above then, follow the rotation builder instructions to build a new rotation that describes what the client is doing.

Details

RUSLE2 is more accurate than any previous manifestation (i.e. USLE or RUSLE1.XX) of the model. Part of the reason it is more accurate is that the science is better and the other part of the reason is that more information is used to calculate soil loss. More information, of course, means YOU need to put the information in. Do not consider this additional information as "non-essential". In fact, this additional information is what ensures the program's accuracy for your client. Answer the following questions to the best of your and your client's knowledge. Questions are referenced on Figures Appendix 3-5.

1. In conservation planning, it may be beneficial to see the effects of adding a buffer strips, filter strips or vegetative barriers to the field. This can be done by selecting the appropriate vegetative strip/barrier from the "Strips/barriers" drop-down menu. If a strip/barrier already exists in the field that you are modeling and it does not match up with the options in the "Strips/barriers" drop-down menu, then manually insert the strip/barrier into the management layer of the graphic or the management tab in the summary view of the Profile screen. (Figure Appendix 3 D1)
2. Again, in conservation planning, it may be beneficial to see the effects of adding a diversion, terrace or sediment basin to the field. This can be done be selecting the appropriate practice from the "Diversion/terrace, sediment basin" drop-down menu. If a diversion, terrace or sediment basin already exists in the field that you are modeling and it does not match up with the options in the "Diversion/terrace, sediment basin" drop-down menu, then remember that the slope length will be end were concentrated flow begins which is at the diversion, terrace or ditch feeding the sediment basin. (Figure Appendix 3 D2)
3. Is there subsurface drainage in the field? (Figure Appendix 3 D3)
4. If there is exposed rock at the soil surface, what percent of the surface is covered with rock? Use the line-intercept method to determine this value as you would residue cover. (Figure Appendix 3 D4)
5. Check the values for Live Biomass and Surface Residue Cover and ensure that these are consistent with observed field values. Are they consistent? If not you may need to adjust yields, change vegetation records or modify other parameters. (Figure Appendix 4 D5)
6. Enter irrigation/wind induced erosion values in the SCI folder to get the SCI value for the field you are modeling. (Figure Appendix 5 D6)

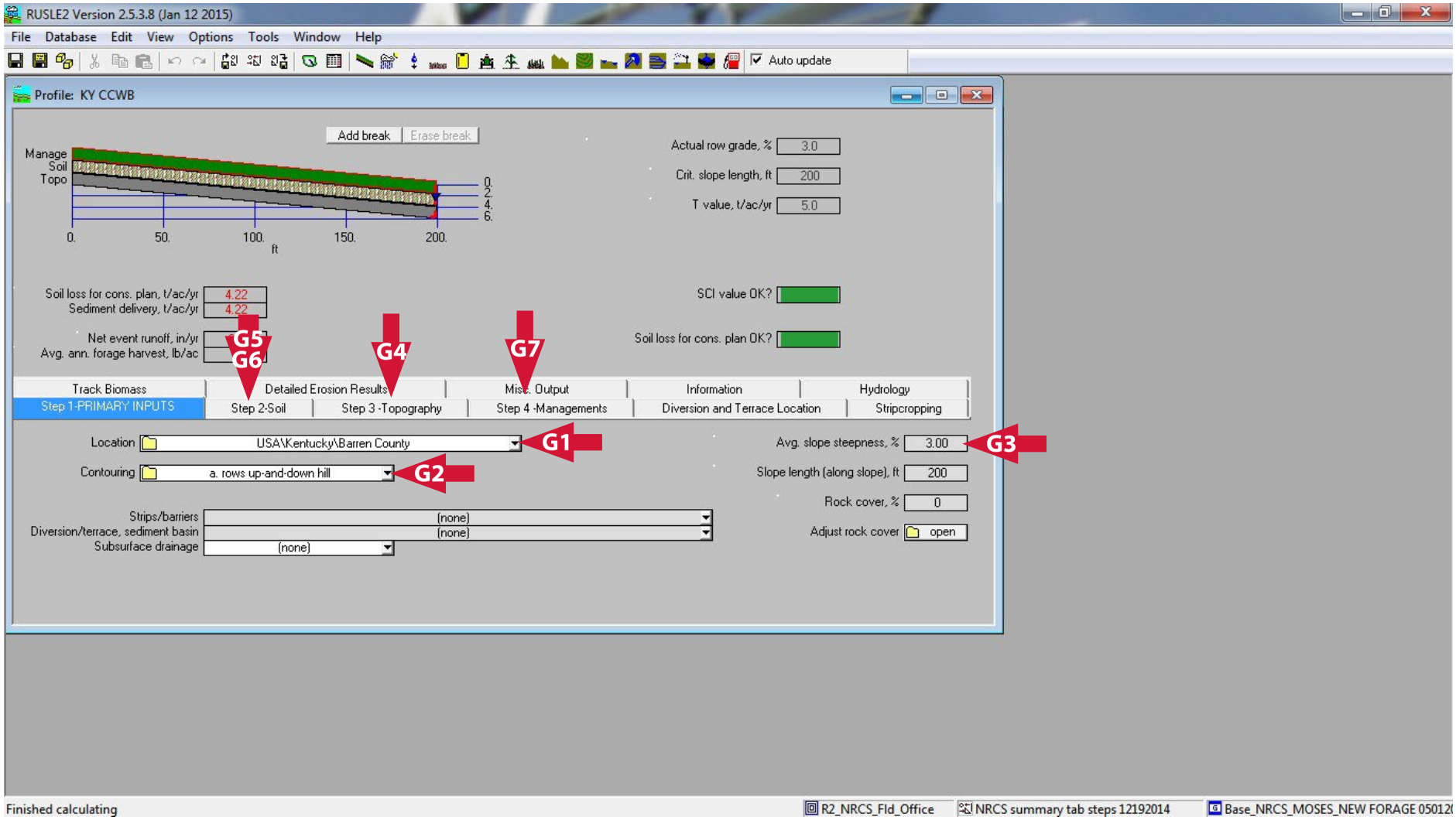


Figure Appendix 1

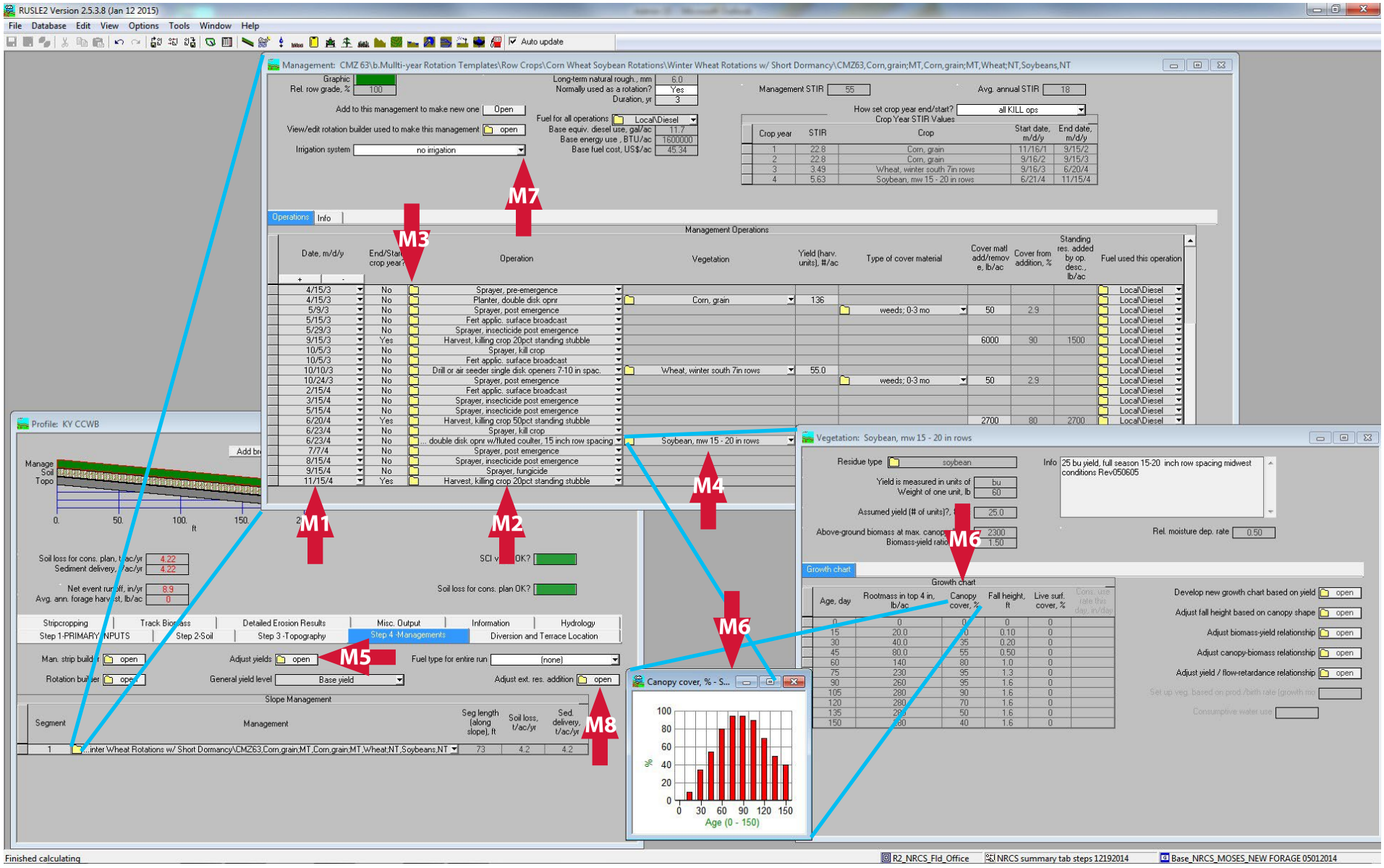


Figure Appendix 2

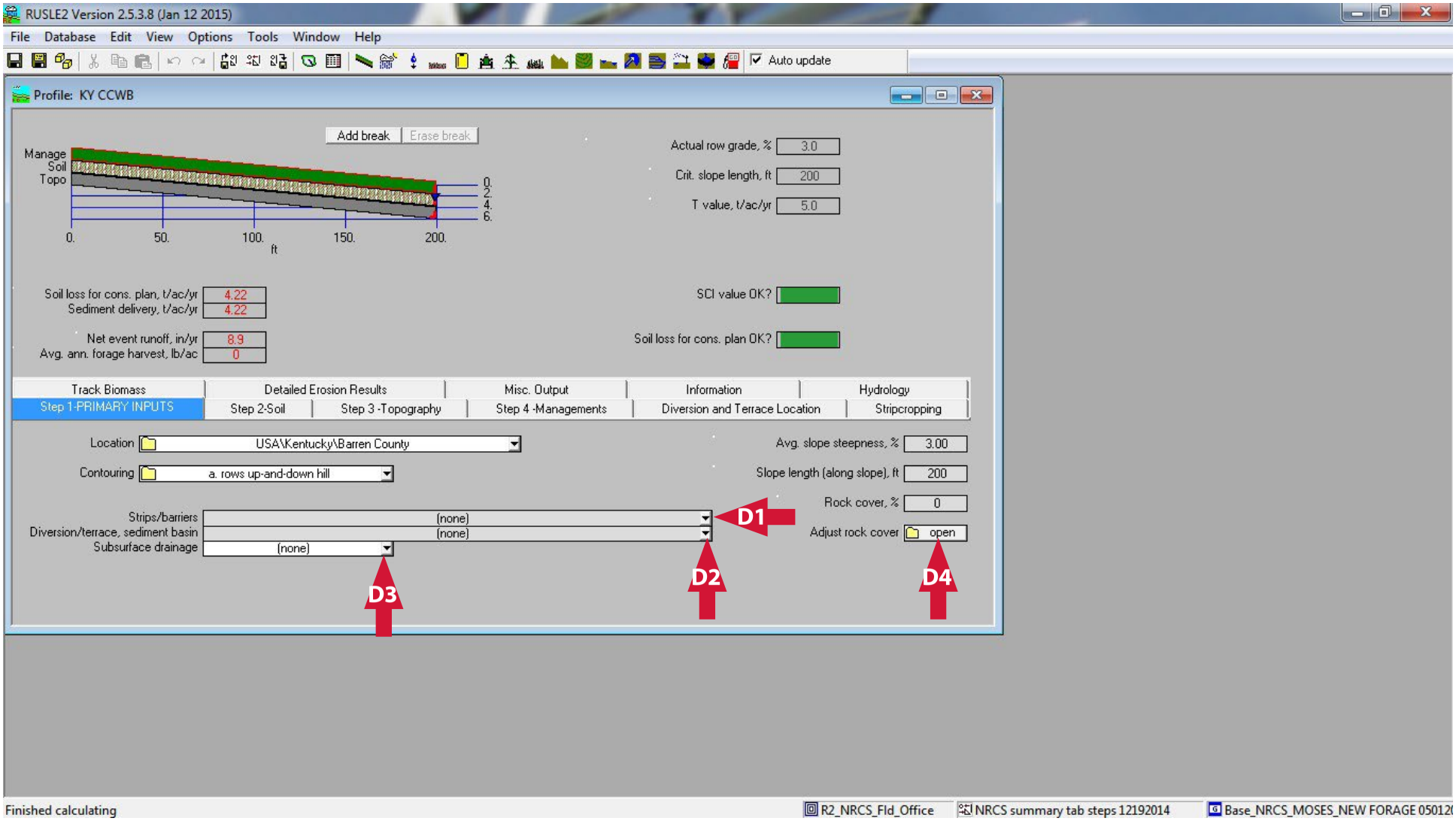


Figure Appendix 3

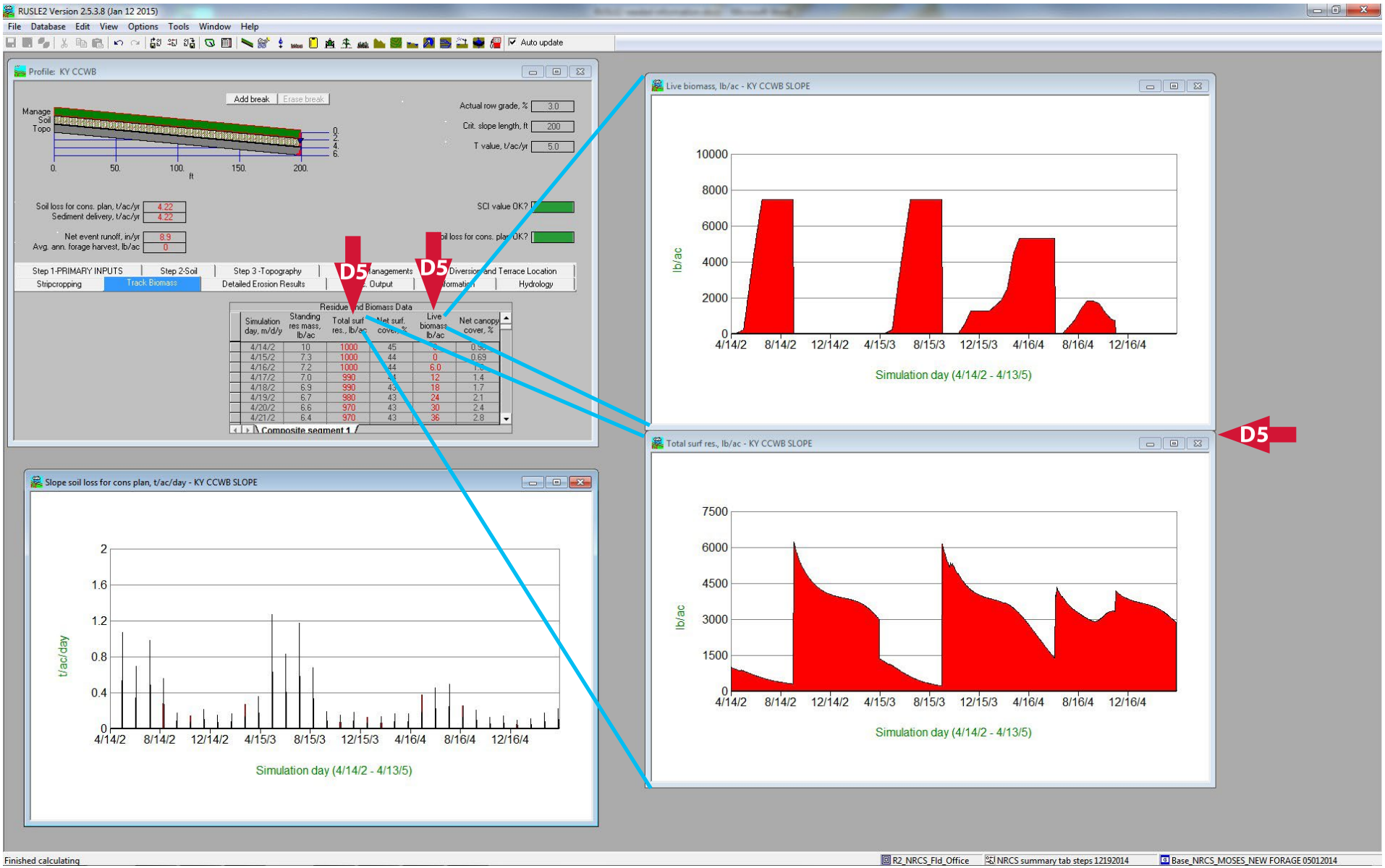


Figure Appendix 4

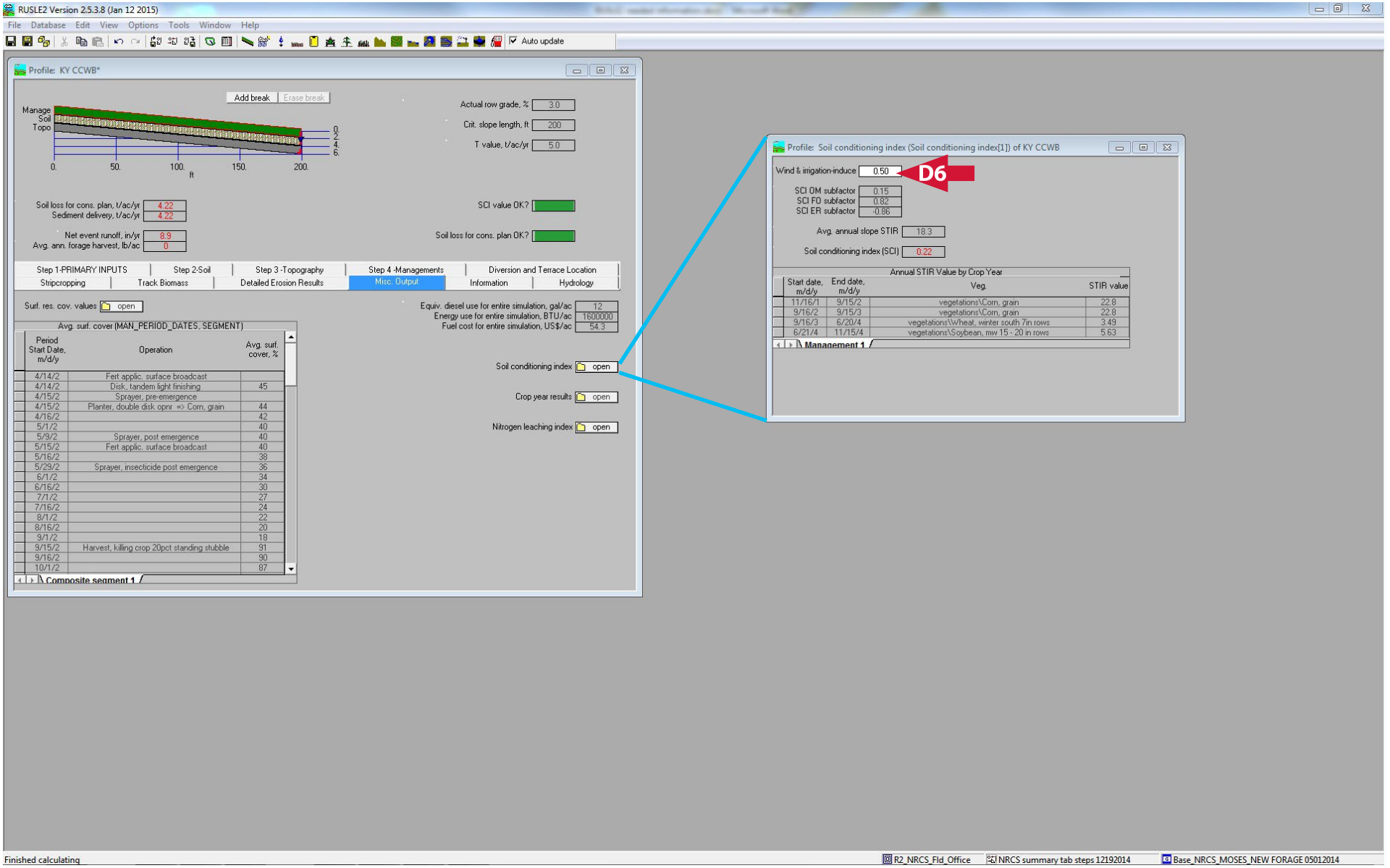


Figure Appendix 5