TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE   NATURAL RESOURCES CONSERVATION SERVICE

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AGRONOMY TECHNICAL NOTE NO. 1 (Revised)

The Soil Conditioning Index

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What is the Soil Conditioning Index?

The Soil Conditioning Index (SCI) is a Windows based model that can predict the consequences of cropping systems and tillage practices on the status of soil organic matter in a field. Soil organic matter is a primary indicator of soil quality and carbon sequestration. The Soil Conditioning Index has three main components including the amount of organic material returned to or removed from the soil, the effects of tillage and field operations on organic matter decomposition, and the effect of predicted soil erosion associated with the management system.

Why is the SCI important?

The SCI is a quick way to characterize the organic matter dynamics of a farming system. Organic matter is a critical component of soil function for several reasons. Surface residue protects soil from the impact of rain and wind. As residue decays, it feeds microbes that improve soil structure and infiltration, and thus reduces runoff. Soil organic matter contributes to nutrient and water holding capacities. Regular inputs of organic material foster a diverse microbial community that supports plant health and productivity.

Controlling erosion and building organic matter do not guarantee good soil quality, but in most cropping situations they are prerequisites to improving and protecting soil quality and productivity. The SCI combined with erosion prediction technology can help assess these two basic components of good soil management.

Getting started

When to use the SCI

The index is designed to help you plan and design Conservation Crop Rotations and Residue Management practices when low organic matter, poor soil tilth, surface crusting, or erosion are identified as concerns. You can run several "what if" scenarios with the client so farmers can see for themselves which changes will have more or less effect on improving the status of soil organic matter. Several Practice Standards (e.g., Conservation Crop Rotation (328) and Crop Residue Management (329)) require using the SCI to identify a cropping system that will achieve a specified purpose.

The SCI is not a soil quality index. It assesses only one component of soil quality (i.e., soil organic matter or SOM). It does not tell you what level of SOM you "ought" to have, but it will predict if a particular management system will have a positive or negative trend in SOM. Use the SCI to help you discuss and assess the effect of management choices on organic matter dynamics, but do not expect it to replace direct measures of SOM, or evaluations of other aspects of soil quality such as salinity, surface structure, runoff, or compaction.

Where to get the program

The latest version of the Soil Conditioning Index is available at the following ftp site:
ftp://ftp.nssc.nrcs.usda.gov/pub/agronomy/SCIfiles/latest_revisions
Download the file named <sciver23.xls> or the latest version with a higher number. SCI is a Microsoft Excel file. You will need Excel 5.0 or a later version to run it. Eventually, the Soil Conditioning Index will be linked to RUSLE2 and both models will run from the same input.

Information needed to run the SCI

You will need the following information about the field to be evaluated:

- ❑ Soil texture
- ❑ All crops in the crop rotation
- ❑ Typical yield for each crop
- ❑ Additional applications of organic matter, such as manure or compost, or removals of organic matter, such as baling of straw.
- ❑ All field operations. This includes tillage, fertilizer and manure application, and harvest.
- ❑ Rates of erosion

How to fill out the worksheet

General instructions

Pull-down lists: Most of the information can be entered into the spreadsheet by choosing items from pull-down lists (Figure 1).

To delete a crop or field operation from section C or D, select the crop or operation number in column A and press Delete.

To clear all the entries in the worksheet, press Ctrl+Q. This action cannot be undone, so be sure to save the scenario first if you want to retain it.

Moving around the worksheet: Use the tab key or Shift+tab to move the curser among the cells where information is entered. You can also use arrow keys or your mouse to move around. Information is only to be entered in shaded cells and cells with pull-down lists.

Figure 1: Pull–down lists

> Click on this triangle to reveal a list of choices. To select an item, click on it with your mouse, or use the arrow keys to move to the item and then press Enter.

Part A

The city you select determines the climate data used in the calculations. Choose a city with a climate most similar to the field being evaluated. If you irrigate, choose a city followed by "irr."

Select a soil texture to represent the dominant soils on the field being evaluated.

The program will calculate a maintenance amount. You do not need to fill in this cell. (For more information about the maintenance amount, see "What's Happening behind the scenes?")

Part B

You must enter the number of years in the crop rotation. Entries in the other cells of Part B are not used for calculations, but they appear in the summary report to help you document the system being evaluated.

Part C

Column B: Use the drop-down lists on as many lines as necessary to identify the crops raised. Be sure to account for all crops grown in the rotation, including cover crops, nurse crops, etc. The crop names are the same as those used in RUSLE2.

For forage crops, enter the best description of the crop as it stands in the fall. For example, "Alfalfa, spring seed senes y2 regrowth" means alfalfa was seeded in the spring, grew to senescence, and year 2 growth began.

Column C: For each crop enter the average yield for the site being evaluated.
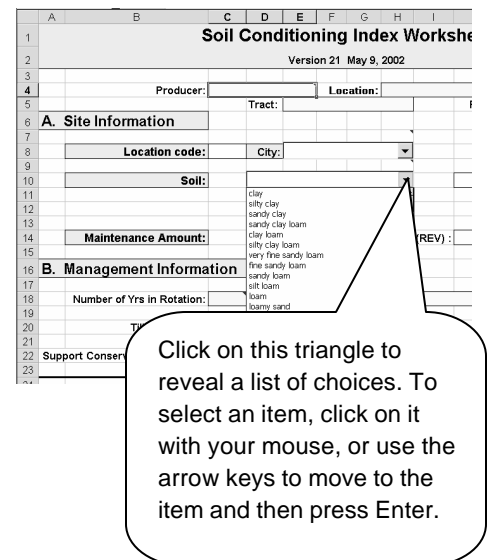
Columns D through I: These values are filled in automatically. The worksheet uses them to calculate the total contribution that a crop makes to soil organic matter levels.

Column J: Use this column if the crops listed in Column B do not account for all the organic matter added or removed from fields. For example, manure applications should be listed in column J as a positive number (in pounds/acre) and residue removal such as by baling of straw should be listed as a negative number.

As in RUSLE2, manure should be entered as pounds/ac dry weight. Use the method in Table 1 to convert the fresh or wet weights of four types of manure to dry weight. Laboratory data should be used in lieu of these conversion methods.

Table 1: Equations to convert manure wet weight to dry weight

Waste Consistency	Units Applied	Assume % solids	Equation
Liquid	(gal/ac)	2	(gal/ac manure) (8.33 lbs/gal) (0.02) = lbs/ac dry matter
Slurry	(gal/ac)	7	(gal/ac manure) (8.33 lbs/gal) (0.07) = lbs/ac dry matter
Semi-solid	(lbs/ac)	15	(lbs/ac manure) (0.15) = lbs/ac dry matter
Solid	(lbs/ac)	25	(lbs/ac manure) (0.25) = lbs/ac dry matter

Sample calculations:
(100,000 gal liquid/ac) (8.33 lbs/gal) (0.02) = 16,660 lbs/ac dry matter
(100,000 gal slurry/ac) (8.33 lbs/gal) (0.07) = 58,310 lbs/ac dry matter
(8000 lbs semi-solid/ac) (0.15) = 1200 lbs/ac dry matter
(8000 lbs solid/ac) (0.25) = 2000 lbs/ac dry matter

Recommendations for Types of Manure in RUSLE2 Database:
"Manure, poultry litter" (includes municipal sewage): liquid, 2% solids
"Manure, settling basin" (beef, swine, dairy lagoon wastes): slurry, 7% solids
"Manure, open lots" (beef, swine, dairy manure from open lots and buildings): semi-solid, 15% solids
"Manure, with bedding" (includes straw and shredded newspaper): solid, 25% solids

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Part D

You do not have to enter field operations in the order they occur. In Column E, enter the total number of passes of that implement over the course of the rotation.

Part E

Enter soil loss estimates in tons/acre using approved erosion prediction technology. Soil loss from various sources will be added together for the purposes of the SCI.

Part F

After you have completed Parts A-E, the overall Soil Conditioning Index value should show in Part F.

Part G

The recommendation statements that appear in Part G are determined by whether the SCI value or the sub-factors are positive or negative.

Part H

In this block, you can add your own notes about the scenario or about the recommendations.

What do the numbers mean?

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.

If the SCI value is negative, note which sub-factor(s) are influencing it the most. Modify the scenario by changing crops or field operations to develop alternatives for consideration by the producer. Be sure to change the erosion estimate as needed when you change the crops or field operations.

The results cannot be used to predict the amount of organic matter or the rate of change. For example, if you are comparing two scenarios and one generates an SCI value of 0.4 and the other generates an SCI of 0.2, you cannot say the first will store twice as much SOM or store it twice as fast as the second. You can say that carbon and organic matter levels under both systems will increase, and you can be more certain of seeing a significant increase under the first scenario.

The SCI does not indicate a desirable or target level of soil organic matter. For example, a near-zero SCI value indicates that soil organic matter levels are being maintained, but soil health may still be poor if the soil organic matter is being maintained at a low level.

If a farmer switches to a system that will improve soil organic matter levels, help the producer plan how to monitor the changes or explain what changes to expect. It may take several years to measure an increase in SOM, but soil aggregation, infiltration and the soil biological community are likely to improve more quickly.

Caution

Do not use the SCI as a sole assessment of soil quality or conservation planning. The SCI may produce misleading results when one of the components is near zero. For example, if you have very low erosion because of flat slopes or if you have extremely high yields that balance out the tillage losses of OM, you may get a positive SCI even though organic matter quality is poor and soil quality is poor. As with any model or assessment, the SCI should be used in combination with other observations and evaluations. If you see problems with infiltration, runoff, aggregation, or other soil quality concerns, the field evaluation should take precedence over the model, and conservation practices should be planned to address the soil quality problem.

Organic matter is an important factor determining soil quality in many systems, but it is not the only factor. Other important aspects of soil quality include quality of organic matter, salinity, sodicity, sedimentation, soil biota, nutrient management, contaminants, and effects of irrigation management. These are not reflected in the Soil Conditioning Index.

Viewing results

The summary report

A summary report is automatically generated on the second sheet of the workbook. (See Figure 4 for help finding other sheets in the workbook.) The report sheet can be printed on a single sheet of paper. However, as soon as you generate a new scenario, the report sheet will also change. To save the summary report sheet alone without the rest of the workbook, go to the File menu and select "Save as Webpage" or "Save as HTML." Choose a name and folder for the file. The resulting .htm file can then be opened in Excel and printed.

Figure 2: Split screen

"Splitting" the screen

You can split your screen to view two parts of the worksheet at the same time (Figure 2). This allows you to manipulate crops or tillage sequences and watch how they affect the SCI.
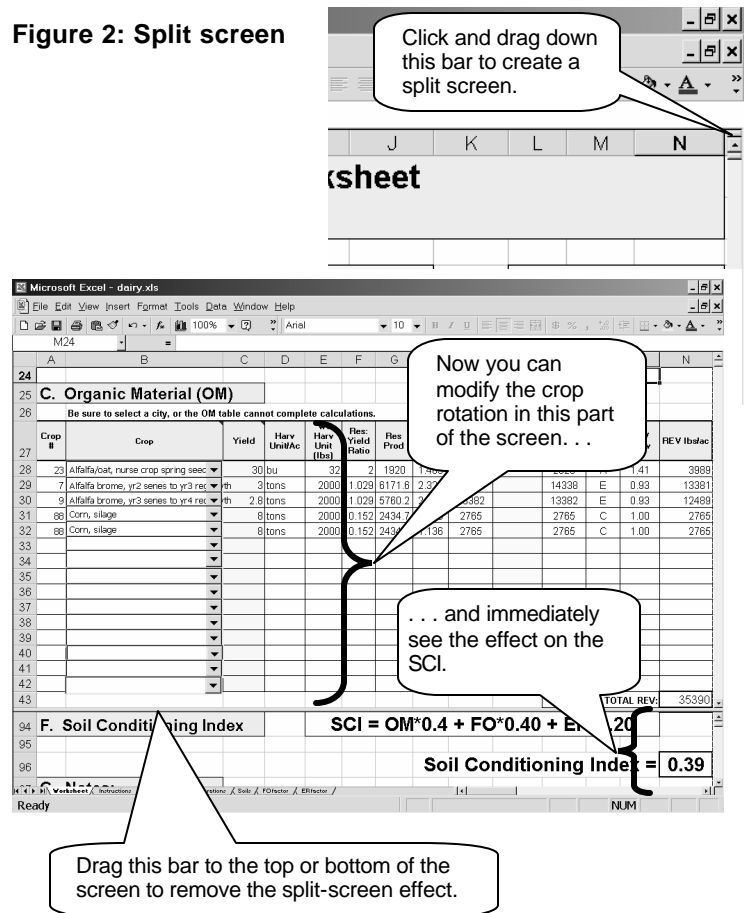
Managing files efficiently

Saving scenarios

To save a scenario, you can save a complete copy of the workbook with a new name (resulting in a 1MB file), or you can save just the summary report (<50KB) as described above. Figure 3 shows the different types of files you might collect related to the Soil Conditioning Index.

Save common scenarios as templates

You can save time by creating several worksheets representing typical farming systems in your area. These "templates" can then be modified to fit the specifics of a particular producer.

Figure 3: Sample file organization

- 📁 SCI
  - SCI.ppt
  - SCIguide.doc
  - SCIver23.xls
  - 📁 Templates
    - cornbeans.xls
    - notill.xls
    - dairy.xls
  - 📁 Producers
    - 📁 Johnson
      - scenario1.htm
      - scenario2.htm
    - 📁 Hernandez
      - scenario1.htm
      - scenario2.htm

Where to get more help

Small red triangles in the corner of some cells show where help is embedded directly in the worksheet. Move your cursor over one of the triangles to see information about that part of the worksheet.

The NRCS National Agronomy Manual contains text and tables explaining the background and components of the SCI. The manual is due out and will be available in the NRCS directives system at http://policy.nrcs.usda.gov/scripts/lpsiis.dll/Main/Home.htm

For further support for the model, assistance in developing additional database values, or help in eliminating database values that are irrelevant to your region, contact Dave Lightle, Conservation Agronomist, at the NRCS National Soil Survey Center in Lincoln, Nebraska (402) 437-4008, dave.lightle@nssc.nrcs.usda.gov

Common problems

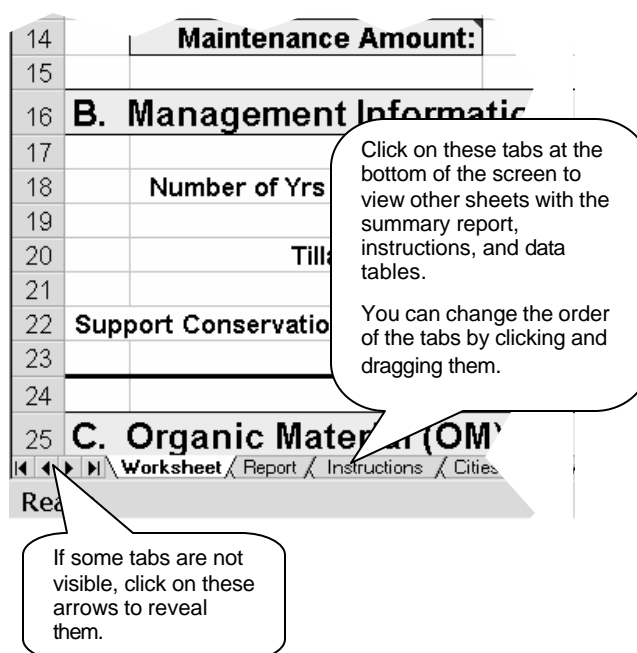| Problem	Possible solution
The worksheet does not calculate the sub-factors or the final index.	Be sure the number of years in rotation is entered in Part B.
"Insufficient system resources" error appears when scrolling in Part D.	Set the screen zoom to 100% and avoid using the scroll bar. Use page up/down and arrow keys, instead.
The "Ctrl-Q" macro does not work.	Check that macros are enabled. Go to: Tools/Macro/Security and set the Security Level to medium or low.

What's happening behind the scenes?

After you make a selection from a pull-down list, the worksheet uses the "variable lookup function" to retrieve text and data from several tables and to enter the data into the cells of the worksheet. You can view the tables by clicking on the tabs at the bottom of your screen (Figure 4).

Look-up tables

Cities

> This table includes climate data for over 800 locations in the US. You select a city and set of climate data in Part A of the worksheet. The data is used to determine the initial maintenance amount of organic matter needed each year to maintain soil organic matter levels (shown in Part A). It is also used to determine the value of the organic matter inputs from the crops listed in Part C.

Figure 4: Finding look-up tables

Click on these tabs at the bottom of the screen to view other sheets with the summary report, instructions, and data tables.

You can change the order of the tabs by clicking and dragging them.

If some tabs are not visible, click on these arrows to reveal them.

Crop

The crop table includes data on the amount of organic matter generated by over 300 crop variations. The data is used to determine the organic matter contributed by the crop rotation described in Part C.

Operations

The operations table includes soils disturbance ratings for almost 200 field operations. The data is used to estimate the effect of field operations on reducing soil organic matter levels.

Soil

When you choose a soil texture, a soil factor is selected from this table. The factor is multiplied by the Maintenance Amount in Part A to generate the adjusted maintenance amount used at the end of Part C to calculate the OM subfactor. Adjusting the maintenance amount for soil texture improves the accuracy of the SCI because organic matter degrades more quickly in better-aerated coarse soils compared to heavy soils.

FOfactor

The data in the FO factor table is used to convert the average Soil Disturbance Rating into the Field Operations subfactor in Part D.

ERfactor

The data in the ER factor table is used to convert the total soil erosion rate into the Erosion subfactor in Part E.

Maintenance amount

The "maintenance amount" refers to the amount of organic matter that must be added annually to maintain soil organic matter levels. It is based on the amount of soil organic matter that decays under the climate conditions you selected. The maintenance amount listed in Part C is adjusted for the soil texture you indicated in Part A because organic matter will decay more quickly in coarse soils than clayey soils.

The maintenance amount shown assumes that field operations and erosion rates are similar to conditions during the Blacklands Farming Systems Studies at Renner, Texas, 1948-59. If your field operations induce more or less decay than this standard, or if you have higher or lower erosion rates, this will be accounted for in the Field Operations and Erosion Subfactors.

Residue Equivalent Values (REV)

Various classes of crop residues decompose at different rates. Thus, a ton of corn residue will contribute more to soil organic matter levels than will a ton of tomato residue. To account for this, all residue amounts (e.g. the "maintenance amount") are adjusted to Residue Equivalent Values. To see the conversion factors associated with various crops and manure, see the "Cities" table in the worksheet or see Part 508C of the National Agronomy Manual.

Teaching others about the SCI

A PowerPoint presentation about the Soil Conditioning Index is available at
ftp://ftp.nssc.nrcs.usda.gov/pub/agronomy/SCIfiles/latest_revisions