TECHNICAL NOTES

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SOIL CONDITIONING INDEX FOR CROPLAND MANAGEMENT SYSTEMS

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Introduction

The Soil Conditioning Index (SCI) is a conservation planning assessment tool to predict the effect of cropland management systems on soil organic matter. The organic matter content of a soil is a primary indicator of its condition because it affects such soil properties as cation exchange capacity, aggregate stability, water holding capacity, and soil biological activity. Soil condition is defined as the degree to which a soil maintains its ability to: (1) accept, store and release water, nutrients, and energy, (2) promote and sustain root growth, (3) sustain soil biological and chemical processes, and (4) resist erosion, compaction, and other management impacts.

The SCI evaluates the effect of farming practices on soil organic matter. The index predicts whether the crop rotation, soil disturbing operations, erosion rates, and other management inputs will cause an increase or decrease in soil organic matter under a given climatic regime.

Similar to the way in which soil erosion models are used to assess the effects of management systems on water and wind erosion, the SCI is a tool to estimate the effect of the cropland management systems on the physical condition of the soil resource. Like erosion models, the SCI considers the entire cropland management system, but can be used to evaluate how changes in single practices will influence the condition of the soil resource.

Since erosion rates are one of the variables considered in the SCI, erosion estimates using the Revised Universal Soil Loss Equation (RUSLE) and/or the Wind Erosion Equation (WEQ) are required to calculate the index. Guidance for using the RUSLE and WEQ erosion models is in Section I of the Field Office Technical Guide - Erosion Prediction.

Components of cropland management systems that are designed to maintain or improve soil condition may include the following:

- Use of high-residue crops in the rotation, supplemented as needed by additional sources of organic matter such as cover crops, green manure crops, or animal manure.

- Use of grasses and legumes or grass seed crops in the rotation.
- Management of crop residues to maintain or improve soil condition, including limitations on residue removal by any means including grazing.
- Management of field operations to maintain or improve soil condition by limiting the number of tillage operations and the degree of soil disturbance by each operation.
- Any combination of practices that reduce soil erosion will help conserves soil organic matter. These systems may include any of the practices discussed above, as well as supporting practices such as terraces, stripcropping, or windbreaks.

Components of the Soil Conditioning Index

A combination of effects causes degradation of soil condition. Wind and water erosion remove fine soil particles, organic matter, and plant nutrients, thus reducing productivity and the ability of the soil to hold water. Excessive tillage accelerates erosion and organic matter oxidation, and causes compaction. Crop rotations which produce low amounts of residue, and/or which involve extensive residue removal, result in inadequate amounts of organic material returned to the soil.

The form of the Soil Conditioning index is: **SCI = OM + FO + ER**, where:

SCI = Soil Conditioning Index. The SCI estimates the combined effect of three variables on trends in soil organic matter. Soil organic matter trends are assumed to be an indicator of improvement or degradation of soil condition.

OM = Organic Material. This component accounts for the effect of organic material returned to the soil. Organic material from plant or animal sources may be produced on the site, or imported to the site from outside sources such as manure or mulch applications.

FO = Field Operations. This component accounts for the effect of field operations that stimulate organic matter decomposition and oxidation. Tillage, planting, fertilizer application, spraying and harvesting operations crush and shatter plant residues and aerate or compact the soil. These operations increase the rate of residue decomposition and affect the placement of organic material in the soil profile.

ER = Erosion. This component accounts for the effect of removal and sorting of surface soil material by the sheet, rill, and wind erosion processes, which are predicted by water and wind erosion models. It does NOT account for the effect of concentrated flow erosion such as ephemeral or classic gullies. Erosion contributes to loss of organic matter and decline in long-term productivity.

If the calculated index is a negative value, the system is predicted to have declining soil organic matter. If the index is a positive value, the system is predicted to have increasing soil organic matter.

Additional Information

A detailed description of the Soil Conditioning Index will be published in the revised National Agronomy Manual, Part 508, Subpart C. This description provides background information on how the SCI was developed and validated using data from long-term cropland management system research projects.

Instructions for Using the Soil Condition Index Worksheet

A computerized worksheet has been developed which operates in Microsoft Excel 5.0 or higher. Using the Excel worksheet and built in list boxes, the user enters information describing the cropland management system in the appropriate cells of the worksheet. The worksheet uses the variable lookup function in Excel to retrieve text and data in order to minimize operator data entry and automate calculations. The lookup tables can be viewed by clicking on the appropriate table listed on the worksheet menu bar at the bottom of the Excel screen.

Once selections are made from the choice lists, the computer looks up the data, copies it into worksheet, makes the calculations, and returns the SCI for the chosen cropland management system. Scenarios can be quickly modified if the user wants to evaluate the effects of changes in crops, tillage or erosion rates. Worksheets can be saved for typical systems and quickly modified with more site specific producer information.

Step by step instructions:

1. Create a directory (folder) on your computer hard drive named "SCI".
2. Copy the contents of the program file to your hard drive in the SCI directory. The program file name uses the following convention: sci.OR(*version no.*).xls (Example - sci.OR4.1.xls). Periodic updates of the program file will be available for download from the NRCS Oregon State Office FTP site.
3. Start the Excel program and load the SCI program file. Click on the "Enable Macros" button. Immediately save as a new file name for the cropland management system being evaluated.
4. Enter information only in the cells shaded yellow. Cells with a red triangle in the corner contain call-out boxes with additional instructions that can be viewed by placing the mouse cursor on the triangle.
5. **Part A - Site Information**: Click on the list button in cell H-8 and select a climate location for the site. The climate location selected should have similar precipitation amounts and distribution, and similar air temperatures as the climate at the site being evaluated (see Appendix 1). Some stations also have a selection for an irrigated condition – these are designated with "IRR" within the station name. Use a station designated with "IRR" for irrigated cropland. Excel uses a variable lookup function to find the associated information. This will bring in the data for this location from the "Cities" lookup table. The RUSLE factors for R (or Req), Kf, and LS can be entered to have the worksheet calculate soil loss, or these cells can be left blank and RUSLE soil loss estimates can be entered manually in Part F.

6. **Part B - Management Information**: Enter the number of years in the crop rotation in cell C-18. Cells for describing the rotation and tillage system and producer information are not required, and not used by the spreadsheet for calculations, but are useful to document the system being evaluated. The RUSLE C and P factors can be entered to have the worksheet calculate soil loss.
7. **Part C - Organic Matter (OM)**: Using the drop-down lists on each line, select crops and yield levels from the "Crops" lookup table. An alternative method to select crops is to enter the "Crop #" in column A instead of using the drop-down lists. Be sure to account for all crops grown. If additional mulch or manure is applied or residue is removed, show it in column J as a (+) or (-) entry in pounds per acre. If the numbers of years in the rotation was entered in cell C-18, the OM sub-factor for this cropping system should now be calculated.
8. **Part D - Field Operations (FO)**: Using the drop-down lists, select all the operations performed for one complete cycle of the rotation. Data from each operation will be inserted from the "Operations" lookup table. An alternative method to select operations is to enter the "Op #" in column A instead of using the drop-down lists. If the number of years in the rotation was entered in cell C-18, the FO sub-factor should now be calculated.
9. **Part E – Erosion (ER)**: If the RUSLE factors were completed in Parts A and B, the soil loss from sheet and rill erosion is automatically calculated for RUSLE. If not, the RUSLE soil loss estimate can be entered manually in the cell labeled RUSLE Manual. If wind or irrigation induced erosion is also present, directly enter the soil loss in the labeled cells. All soil loss rates should be expressed in units of tons/acre/year. Soil losses from various sources are added together for the SCI Erosion Subfactor.
10. **Part F - Soil Conditioning Index:** The SCI value should now be displayed. If the calculated index is a negative value, the system is predicted to have declining soil organic matter. If the index is a positive value, the system is predicted to have increasing soil organic matter.
11. **Part G – Notes**: This section is provided to record notes about the cropping system or any other related information.
12. **Part G – Recommendations**: If the SCI Value is negative, the user can record management practice recommendations that will conserve or increase soil organic matter. These may include conservation practices that reduce erosion, practices that reduce tillage intensity, or changes to the crop rotation to include crops that produce greater amounts of biomass.
13. A "macro" that is initiated by the keystroke Ctrl-C, is attached to the SCI worksheet to allow clearing all data entries to start over. Press the "c" key while holding down the Ctrl key to clear all data entries. Prior to clearing, the file should be saved with a unique file name if the user wants to retain the cropping system scenario.

Appendix 1 – Oregon Climate Stations for the Soil Conditioning Index

Climate Station Name	Maintenance Amount (REV) (Lbs/ac/year) [1]	Mean Annual Precipitation (inches) [2]	Mean Annual Air Temp (°F)	Freeze-free days/year
BAKER FAA AP	3356	10.9	46.0	103
BAKER FAA AP IRR	4300	18.6	46.0	103
CONDON	3643	13.8	47.1	124
CORVALLIS	4742	42.7	52.0	188
CORVALLIS IRR	5069	51.9	52.0	188
DUFUR	3214	12.5	49.3	122
ELGIN	4059	22.9	47.3	83
GRANTS PASS	4354	30.7	55.1	169
GRANTS PASS IRR	4772	35.6	55.1	169
HERMISTON	2911	9.0	52.5	163
HERMISTON IRR	4376	21.9	52.5	163
HOOD RIVER EXP	3961	30.6	50.5	159
JOHN DAY	3902	13.4	48.7	118
KLAMATH FALLS AG	3055	12.8	47.7	114
KLAMATH FALLS AG IRR	4180	19.6	47.7	114
LAGRANDE	4033	16.8	48.8	125
LAGRANDE IRR	4604	25.6	48.8	125
LAKEVIEW	3402	15.5	46.3	106
LAKEVIEW IRR	4221	22.3	46.3	106
LONGCREEK	3775	14.7	45.7	74
MADRAS 1 NW	3329	11.8	49.3	122
MADRAS 1 NW IRR	4037	18.7	49.3	122
MALHEUR EXP STA	2902	10.1	50.3	152
MALHEUR EXP IRR	4536	23.8	50.3	152
MEDFORD EXP	4211	20.8	52.2	140
MEDFORD EXP IRR	4749	27.5	52.2	140
MIKKALO RANCH	3199	10.1	51.7	180
MILTON FREEWATER	3989	14.3	53.5	186
MILTON FREEWATER IRR	4725	21.3	53.5	186
MORO	3083	11.1	48.6	144
NEWPORT	5182	71.8	50.5	227
PENDLETON EXP STA	3940	16.1	50.3	125
PENDLETON AIRPORT	3522	12.0	52.3	185
PILOT ROCK	3919	13.6	51.0	139
PRINEVILLE	3245	10.4	47.3	56
ROSEBURG KQEN	4666	32.5	54.2	209
ROSEBURG KQEN IRR	4846	35.4	54.2	209
SQUAW BUTTE	3106	10.7	45.5	83
SQUAW BUTTE IRR	4579	22.4	45.5	83
WALLOWA	3915	17.3	45.6	80
WALLOWA IRR	4450	22.7	45.6	80

[1] The Residue Equivalent Value (REV) is the amount of crop residue that must be returned to the soil each year to maintain soil organic matter content when the tillage operations and erosion rate are the same as the Renner, Texas reference site.

[2] Mean annual precipitation for irrigated sites (stations ending in "IRR") includes natural precipitation plus the normal amount of irrigation water used for small grains (Oregon Engineering Handbook Irrigation Guide).