United States Department of Agriculture
NATURAL RESOURCES CONSERVATION SERVICE
Nutrient Management
Agronomy Technical Note No. 150.13 (Rev. 2)
August 2006

AGRONOMY TECHNICAL NOTE

SOIL CONDITIONING INDEX

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Background. Attempts to measure or rate the effects of crop management systems on soil quality first started in 1964 when "Soil Conditioning Rating Indices for Major Irrigated and Non-irrigated Crops Grown in the Western United States" was first published by the Natural Resources Conservation Service (NRCS). The technical note was revised several times from 1967 through 1986. A national version of the rating procedure has been completed and adapts the concept for use nationwide, by introducing the effects of climate on organic matter decomposition at various geographic locations.

The Soil Conditioning Index tool predicts the effects of management systems on soil organic matter. Soil organic matter level is a primary indicator of soil condition. It affects soil characteristics and processes as cation exchange, aggregate stability, water holding capacity, and soil biological activity. Soil condition is the degree to which a soil maintains the ability to accept, store and release water, nutrients, and energy, to promote and sustain root growth, soil biological and chemical processes, resist erosion, compaction, and other management impacts.

The important components of the Index (SCI) include:

- The amount of organic material returned to the soil,
- The effects of tillage and planting systems on organic matter decomposition, and
- The effect of predicted erosion associated with management systems

INTRODUCTION

The Concept

One area of growing concern in agriculture industry is degradation of soil quality through processes that are influenced by management, including the decline of organic matter. The Soil Conditioning Index is a tool to predict the consequences of management actions on the state of soil organic matter.

The Index predicts organic matter change qualitatively, not quantitatively. It predicts one of three outcomes - organic matter decline, organic matter increase, or organic matter equilibrium. The index considers organic material (biomass) produced and returned to the soil, the influence of climate on organic matter decay, the influence of tillage, and the influence of erosion.

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, reducing productivity and the ability of the soil to hold water. Excessive tillage accelerates erosion and organic matter decay 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 Soil Conditioning Index is: **SCI = OM + FO + ER**

The Soil Conditioning Index is where:

SCI is the Soil Conditioning Index. The Soil conditioning Index 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 is organic material. This component accounts for the effect of organic material returned to the soil. Organic material from plant or animal sources may be either grown or retained on site or imported to the site.

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

ER is erosion. This component accounts for the effect of removal or sorting, or both, of surface soil material by the sheet, rill, or wind erosion processes that 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.

Subfactor Values

The value = 0 is assigned for conditions at assumed equilibrium (soil organic matter maintained, neither increasing nor decreasing). Conditions that tend to decrease soil organic matter compared to the benchmark conditions are assigned negative values; those that tend to increase soil organic matter compared to the benchmark condition are assigned positive values.

CALCULATING THE SOIL CONDITIONING INDEX

Although the RUSLE2 program completes most of the calculations for you, the following are the steps taken:

(a) Determine the maintenance amount of crop residue at your location.

Maintenance Amounts (residue equivalent pounds) and Residue Equivalent Value Factors, give the maintenance of various locations throughout Montana.

(b) Evaluate the present cropping-management system.

Determine the Organic Material subfactor:

- The program determine the total amount of residue produced on the site by the crop rotation (crop yield x pounds per unit of yield x residue to yield ratio).
- The program adjusts for root mass.
- Residue amounts for each crop are converted to Residue Equivalent Value (REV)
- The total REV for the crop rotation is divided by the number of years in the rotation to determine average annual REV.

The program then calculates the Organic Material (OM) subfactor value.
[Residue returned (REV) – Maintenance Amount (REV)] x [1.0/Maintenance Amount (REV)].

Determine the Field Operations' subfactor:

- Considers all field operations (tillage, planting, fertilizing, cultivating, etc.).
- Determines the soil disturbance Rating (SDR) for each operation.
- Totals the Soil Disturbance Rating values and divide the cumulative total by the number of years in the rotation to determine average annual Soil Disturbance Rating.
- Calculates corresponding Field Operations (FO) sub-factor.

Determine the Erosion subfactor:

Planner must determine the predicted average annual erosion using RUSLE2 and WEQ.

Calculate the soil conditioning index (SCI):

From the sub-factors, the program calculates SCI:

SCI = (OM x 0.4) + (FO x 0.4) + (ER x 0.2)

If the SCI value is negative, soil organic matter is predicted to be decreasing, and that enhance soil conditions should be planned. If the SCI value is zero or positive, soil organic matter is predicted to be stable or increasing.

(c) To evaluate one or more alternative systems:

To formulate alternatives, plan changes in the cropping management system that will address negative subfactor values. For example:

- If the organic material (OM) subfactor is negative, plan for additional high residue crops in the rotation, and/or limit residue removal.
- If the field operations (FO) subfactor is negative, plan changes in the tillage/planting system to reduce the number and/or severity of field operations.
- If the erosion (ER) subfactor is negative, consider supporting practices such as terracing, strip cropping, etc., as well as changes in the crop rotation or field operations.

What is the Soil Conditioning Index?

The Soil Conditioning Index (SCI) is a Windows based model that runs simultaneously with RUSLE2, 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.

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., 328–Conservation Crop Rotation and 329–Crop Residue Management) 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.