A SOIL CONDITIONING INDEX FOR CROPLAND MANAGEMENT SYSTEMS

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Soil organic matter or soil carbon *is significantly correlated with soil productivity and soil quality.*

Soil Organic Matter

- Storehouse for Nutrients
- Increases Chemical & Biological Activity
- Reduces Effects of Compaction
- Builds Better Structure
- Increased Water Infiltration & Retention
- Buffers pH Changes
- Energy for Biological Activity

Long term studies have shown that organic matter levels have declined under cultivation

Intensive tillage of agricultural soils has led to soil carbon losses ranging from 30 to 50 percent

Long Term Organic Matter Studies

- Morrow Plots @ Urbana, IL 118 years
  - OM declined from 3.7 % to 1.6 % w/ Continuous Corn - moldboard plow
  - OM declined from 3.7% to 2.5% w/ corn, oats, hay - moldboard plow

Long Term Organic Matter Studies

- Sandborn Field Columbia, MO
  - soil carbon declined from 4% to 0.8% w/ continuous corn and wheat - clean tilled
  - soil carbon declined from 4% to 1.2 % even with the addition of manure

Long Term Organic Matter Studies

- Columbia Plateau plots - 50 years
  - soil carbon declined from 2% to 1.6% under wheat fallow - moldboard plow and intensive tillage during the fallow year
  - fallowing is especially detrimental since biological oxidation is enhanced due to tillage during the time when no crop residue is added

Observations:

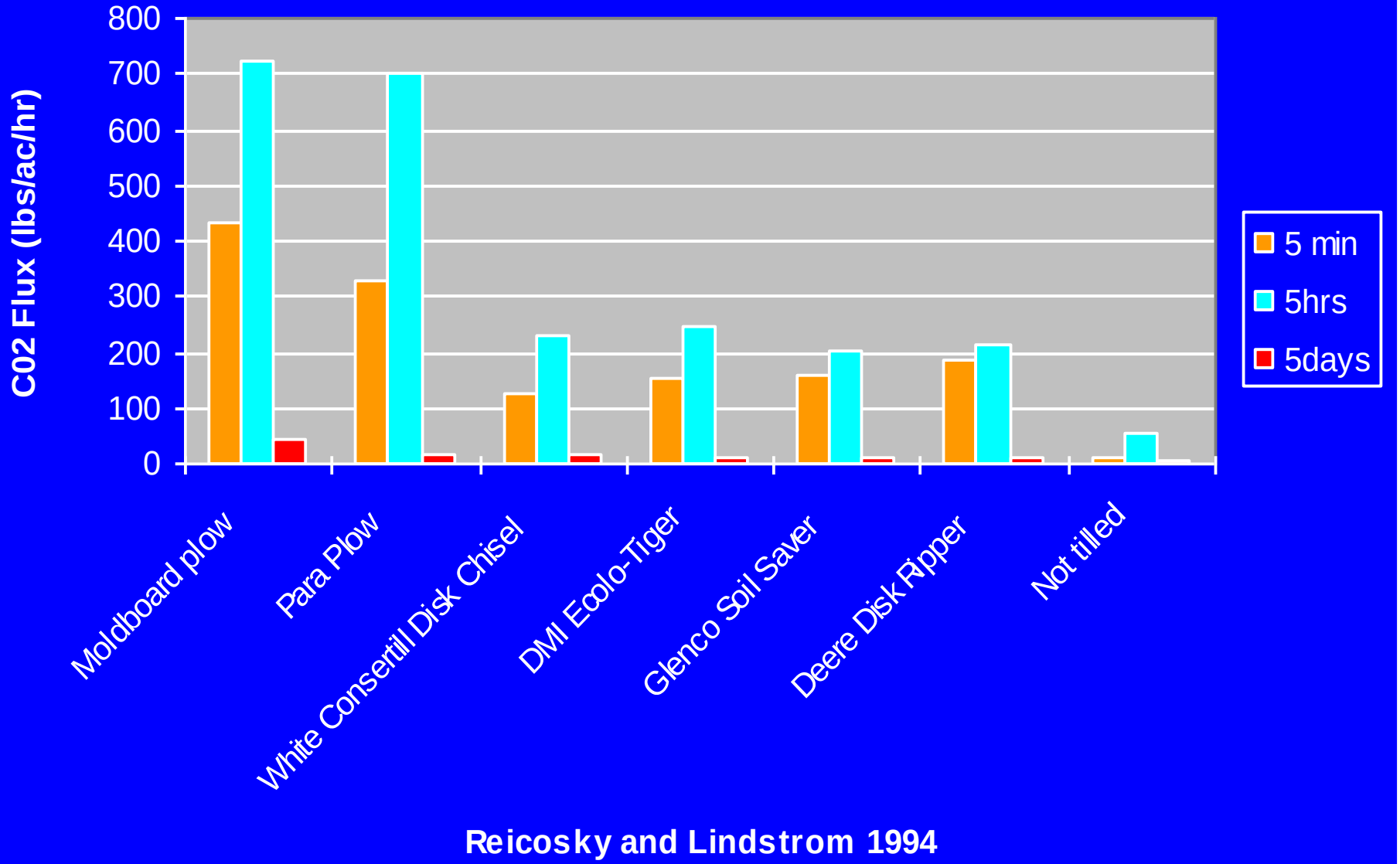
Organic matter levels seemed to rise under reduced tillage and no-till systems

Why does organic matter decline with intensive tillage?

It escapes from the soil in the form of carbon dioxide gas.

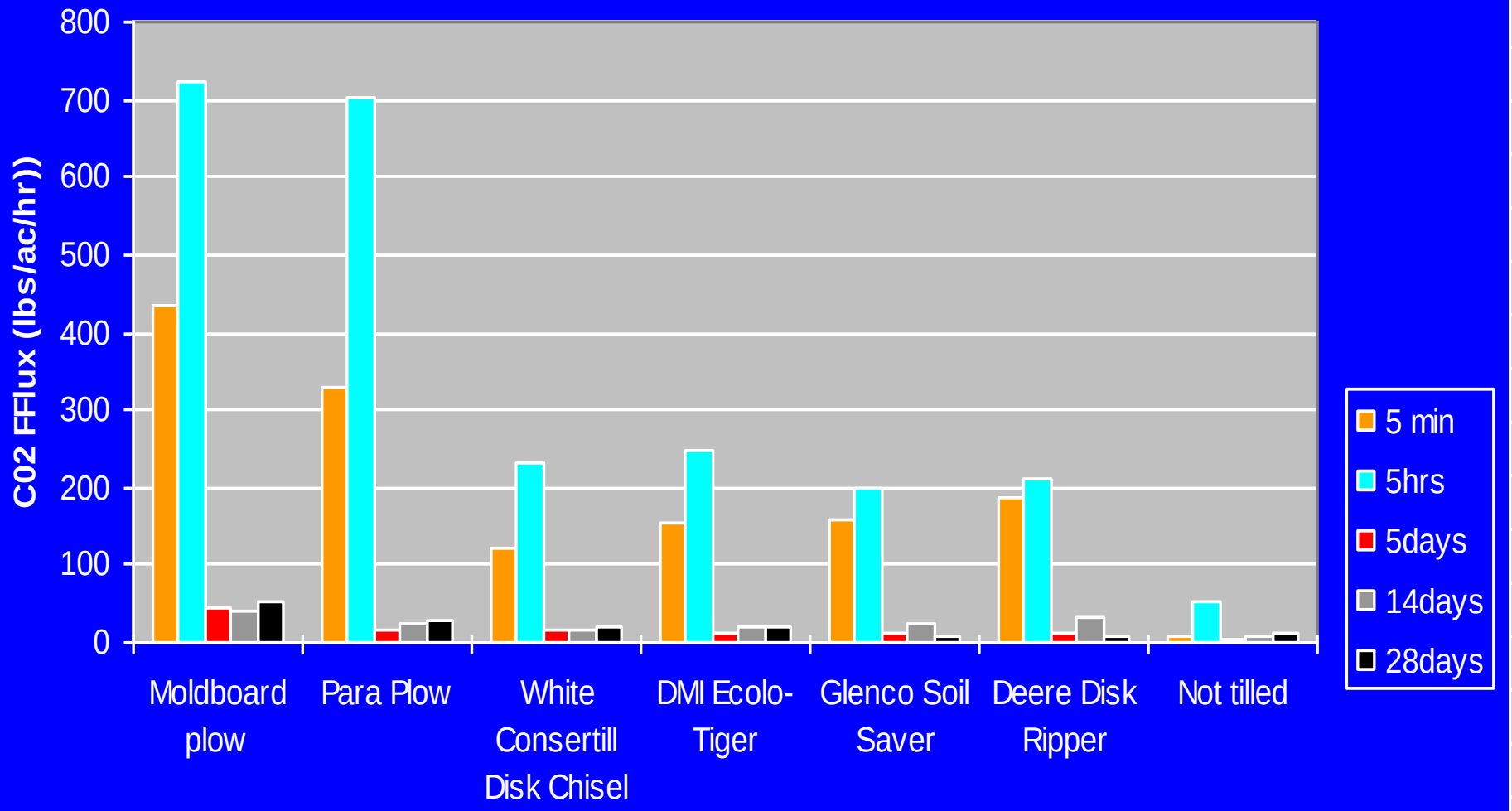
Think of it as a big belch.

CARBON DIOXIDE LOSS FOLLOWING TILLAGE



Reicosky and Lindstrom 1994

CARBON DIOXIDE LOSS FOLLOWING TILLAGE



Reicosky and Lindstrom, ARS, 1994

The Soil Conditioning Index:

- Is based on long term studies at Renner Texas which identified a steady state of soil organic matter under a known cropping and tillage system and erosion rate.
- Is indexed to other locations by utilizing the RUSLE model to quantify the climate effects on residue decomposition.

The Soil Conditioning Index :

- Provides a means to evaluate and design conservation systems that maintain or improve soil condition.
- Expresses the effects of the system on organic matter trends as a primary indicator of soil condition.
- Estimates the combined effect of three variables on trends in organic matter.

The form of the Soil Conditioning Index Model is:

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

Where:

- **The OM component accounts for organic material returned to the soil.**
- **The FO component accounts for the effect of field operations which stimulate organic matter breakdown.**
- **The ER component accounts for the sorting and/or removal of surface soil material by sheet, rill and/or wind erosion processes.**

- **The OM component accounts for organic material returned to the soil.**

Calculate the OM subfactor value:

- OM =(RP - MA) / MA
- RP is average annual above and below ground biomass returned to the soil (including mulch or manure) expressed as REV (corn equivalent)
- MA is the maintenance amount expressed as REV from Table 1 for the location

CITY CODE	CITY	STATE	Maintenance Amt. Including Roots Reference Condition
43999	*RENNER	TX	5719
27497	LINCOLN	NE	5455
28002	LAS VEGAS	NV	1997
33003	RALEIGH	NC	5858
34001	BISMARK	ND	4339
34002	WILLISTON	ND	4084
34248	FARGO	ND	4749
35001	CLEVELAND	OH	5420

- **The FO component accounts for the effect of field operations which stimulate organic matter breakdown.**

Soil Tillage Intensity Rating (new)

- 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 disturbance between systems.
- The kind, severity and number of ground disturbing passes are evaluated for the entire cropping rotation as shown in the management description.

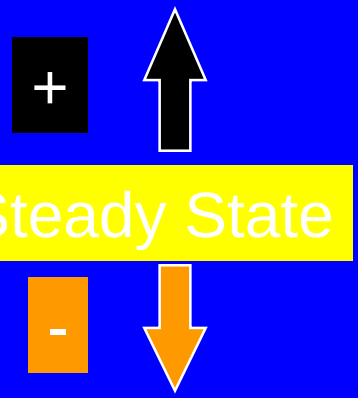
Table 2 Soil Tillage Intensity Ratings (STIR)

	B	C	D	F	G	H	
1	name	Recommended Operating Speed (MPH)	Tillage Type	Recommended tillage depth (inches)	Surface area disturbed (decimal)	Soil Tillage Intensity Rating	
48	Disk, tandem light finishing	5.0	0.8	3.0	1	19.50	
49	Disk, tandem secondary op.	5.0	0.8	5.0	1	32.50	
50	Do all	5.0	0.8	4.0	1	26.00	
51	Do all, on beds	5.0	0.8	3.0	0.8	15.60	
52	Drill or air seeder single disk openers 7-10 in spac.	5.0	0.8	2.5	**0.15**	2.44	C
53	Drill or air seeder single disk openers, + fert. opnrs 7-1	5.0	0.8	2.5	0.35	5.69	
54	Drill or air seeder tee slot openers 7-10 in spac.	5.0	0.8	2.0	0.15	1.95	
55	Drill or air seeder, hoe opener in hvy residue	5.0	0.8	4.0	0.65	16.90	
56	Drill or air seeder, hoe/chisel openers 12-15 in spac.	5.0	0.8	4.0	0.8	20.80	
57	Drill or air seeder, hoe/chisel openers 6-12 in spac.	5.0	0.8	4.0	**0.9**	23.40	C
58	Drill or airseeder, dble disk opnr w/ fluted coult 5x10 p	5.0	0.8	2.5	0.75	12.19	
59	Drill or airseeder, double disk	5.0	0.8	1.5	0.65	6.34	
60	Drill or airseeder, double disk opener, w/ fert openers	5.0	0.8	2.5	0.85	13.81	
61	Drill or airseeder, double disk, w/ fluted coulters	5.0	0.8	2.0	0.55	7.15	
62	Drill or airseeder, offset double disk openers	5.0	0.8	2.5	0.3	4.88	
63	Drill, air seeder, sweep or band opener	5.0	0.8	2.5	0.6	9.75	
64	Drill, deep furrow 12 to 18 in spacing	5.0	0.8	4.0	**0.9**	23.40	C
65	Drill, double disk, 7-8" packer C	5.0	0.8	2.0	**0.85**	11.05	C
66	Drill, heavy, direct seed, dbl disk opnr	5.0	0.8	3.0	**0.85**	16.58	C
67	Drill, heavy, direct seed, dbl disk opnr w/row cleaners	5.0	0.8	3.0	0.9	17.55	
68	Drill, range	4.0	0.8	2.0	0.6	6.24	
69	Drill, semi-deep furrow 12 to 18 in spacing	5.0	0.8	4.0	0.85	22.10	

STIR Workshoot Direct input | OPLIST

Table 3 FIELD OPERATIONS (FO) SUBFACTOR

AVERAGE ANNUAL DISTURBANCE RATING (SDR)	FIELD OPERATIONS SUBFACTOR VALUE (FO)
0-2	+1.00
3-7	+0.95
8-12	+0.90
13-17	+0.85
18-22	+0.80
23-27	+0.75
28-32	+0.70
33-37	+0.65
38-42	+0.60
43-47	+0.55
48-52	+0.50
53-57	+0.45
58-62	+0.40
63-67	+0.35
68-72	+0.30
73-77	+0.25
78-82	+0.20
83-87	+0.15
88-92	+0.10
93-97	+0.05
98-102	0.0
103-107	-0.05
108-112	-0.10
113-117	-0.15



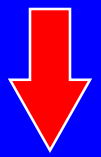
- The **ER** component accounts for the sorting and/or removal of surface soil material (erosion) by irrigation, sheet, rill, and wind erosion processes.

TABLE 4 EROSION (ER) SUBFACTOR

	D	E
	Table 4	
	Rate of Erosion	ER Subfactor
	0.00	1.00
	0.25	0.91
	0.50	0.82
	0.75	0.73
	1.00	0.64
	1.25	0.55
	1.50	0.45
	1.75	0.36
	2.00	0.27
	2.25	0.18
	2.50	0.09
	2.75	0.00
	3.00	-0.02
	3.25	-0.04
	3.50	-0.06
	3.75	-0.08
	4.00	-0.10
	4.25	-0.12
	4.50	-0.14
	4.75	-0.16
	5.00	-0.18
	5.25	-0.20
	5.50	-0.22
	5.75	-0.24
	6.00	-0.26

+

Steady State



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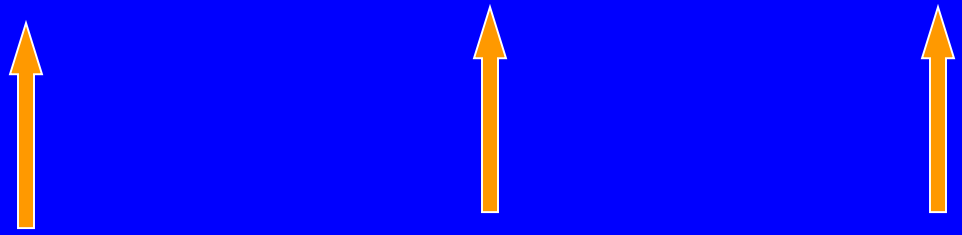
The SCI is the sum of the three sub-factor values weighted for their importance

Calculate the SCI:

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



Weighting factors

Analysis

- If the SCI value is negative, soil organic matter is predicted to be declining, and corrective measures should be planned.
- If the SCI value is zero or positive, soil organic matter is predicted to be stable or increasing.

Soil Conditioning Index Comparisons to Other Steady State Organic Matter Research

RESEARCH LOCATION	ORGANIC MATTER				FIELD OPERATIONS			EROSION		SOIL CONDITIONING INDEX
	Maintenance Amount lbs./acre	Crop Rotation	Average Annual Residue Equivalent Lbs. /ac.	OM Subfactor	Average Annual Soil Disturbance Rating	Tillage system	FO Subfactor	Erosion Rate	ER Subfactor	
Renner, TX	5526	WWheat,Cot,GS	5526	0	101	chisel, disk	0	0.8xT	0	0
Culbertson, MT	4121	S.Wheat, Fallow	753	-0.82	60	vee blade	0.4	0.2xT	0.75	-0.02
Clarinda, Ia	5482	Cont. Corn	6213	0.13	86	mb plow	0.15	1.2xT	-0.4	0.03

Soil Conditioning Index

- SCI is now part of RUSLE 2 (see the yellow folder on the profile screen)
- We will stop using the spreadsheet version as soon as all are trained in the use of RUSLE 2

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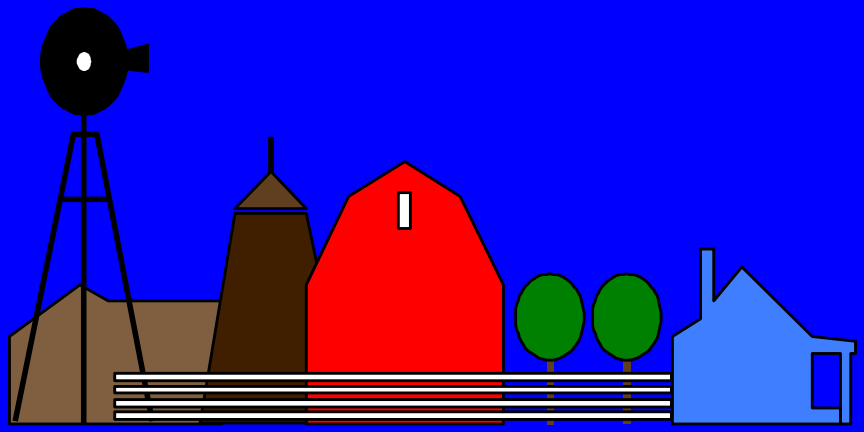

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