unlock the SECRETS IN THE SOIL

SOM Management Focus on C instead of T

USDA United States Department of Agriculture

Natural Resources Conservation Service

Jerry Grigar NRCS MI State Agronomist CCA

Soil Health: the continued capacity of the soil to function

as a vital living ecosystem that sustains plants, animals, and humans

Tillage Erosion

- A form of erosion limited to movement of soil within a field.
- Topsoil is removed from the high points of fields and exposes subsoil.
- Total soil removed may exceed that of water erosion.

Gene Alexander, USDA-NRCS

Tillage Erosion

Three causes that move soil downslope:

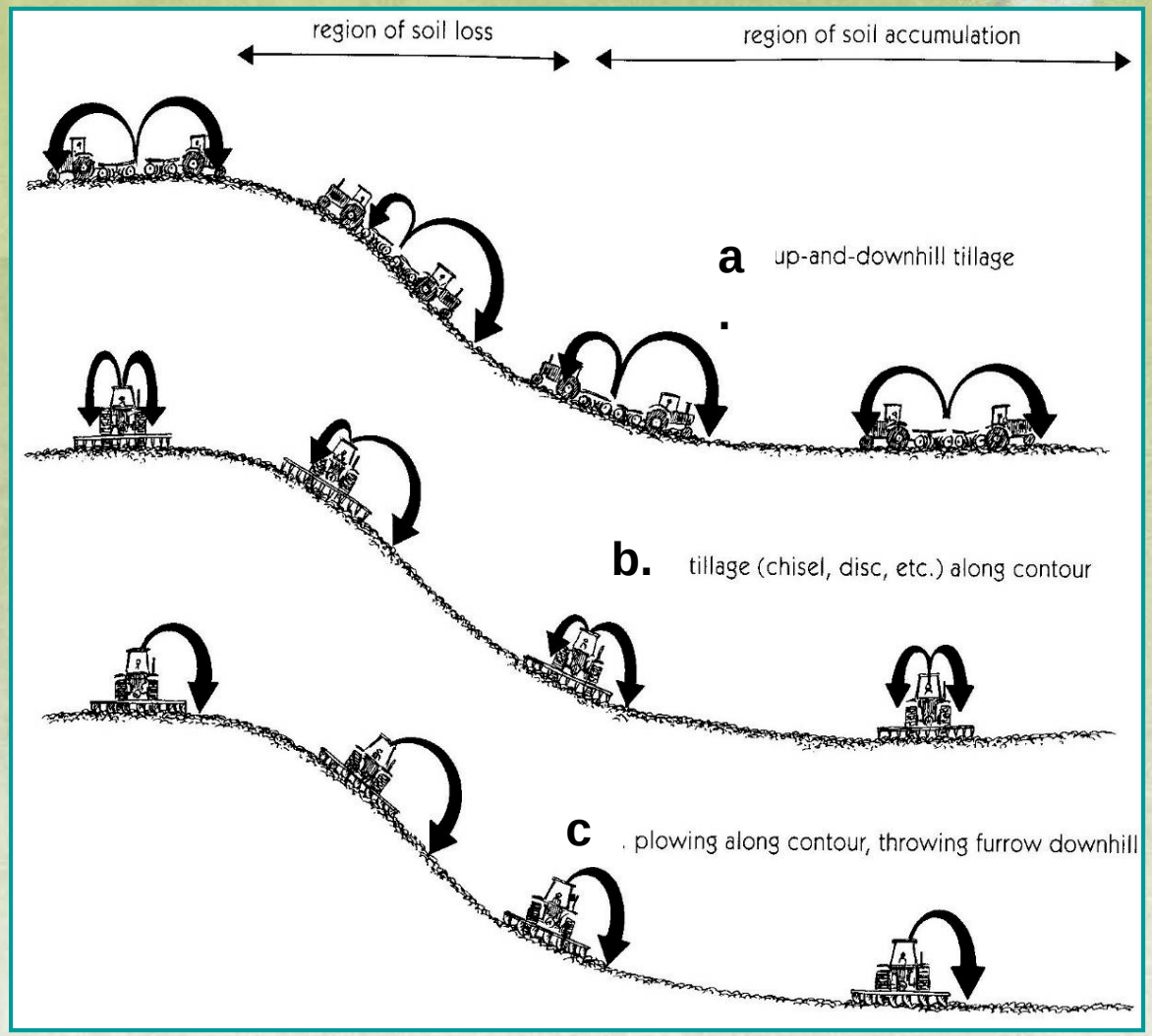
Tilling- ***up-and-down the slope***

Tilling- ***along the contour***

Moldboard Plowing- ***throws soil downslope***

All tillage is BS!

Burns up SOM!



Reprinted from Magdoff, F. and H. van Es. 2000. Building soils for better crops. 2nd edition. Sustainable Agriculture Publications, Burlington, VT, with permission from the Sustainable Agriculture Network (www.sare.org)].

Soil Organic Matter

Foundation of Productive Soil

- Promotes Healthy Crops
- Supplies Carbon
- Regulates water, air & nutrient supply
- Supplies ½ N & ¼ P
- Depleted by Tillage Erosion
- Key indicator for soil quality!

Water & Tillage Erosion- bald spots

Conservation Practices to Build SOM

1. Erosion control
2. Crop Rotation
3. No-till
4. Cover Crops
5. Manure or compost
6. Nutrient Mgt. (N)
7. Controlled Traffic systems
8. On-farm Adaptive Nutrient Mgt. Trials

Soils With Sufficient SOM

- Increased water holding capacity
- Need Less fertilizer
- Higher yields
- Suppress diseases

2015- 33 years

Zone tillage

Corn -270

Soys -70

Wheat- 100

SOM Foundation

Sustainable cropping systems

- Restore SOM

SOM primary influence of:

1. Physical
2. Biological
3. Chemical

For Healthy and Productive Soils

SOM & Soil Biology

- Habitat & Food source
- Disease suppression
- Soil aggregation
- Soil Chemistry
- Storehouse for Nutrients.

SOM Loss

- Tillage Induced CO_2 Loss
- Soil & Tillage Erosion
- Low Nitrogen Input
- High N Demand Crops (high C: N ratios)

- Soil addicted to fertilizer.
- SOM first to Erode!

Stable SOM (Humus)

Physically protected &
extremely resistant
to decomposition

Amount of HUMUS impacted by:

1. Residue removal
2. Burning
3. Tillage
4. Cover Cropping

Slow SOM Pool- Water Stable Aggregates

Less turnover time than Humus

SLOW SOM is:

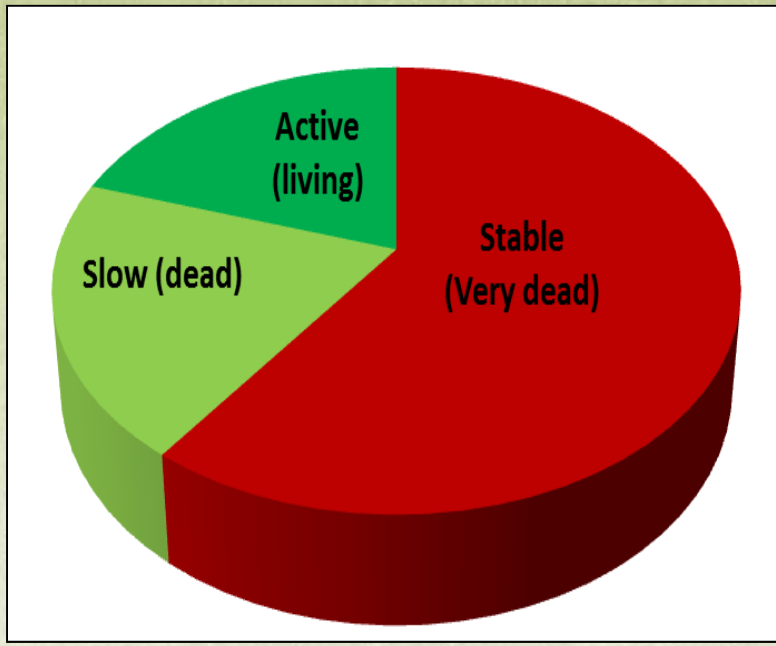
1. Decomposed materials
2. Crop residues / roots
3. Microbial products- glomalin
4. Protected – physically & biochemically
5. Interior of WSA

Active SOM Pool (LIVING)

Turnover time months to years

Includes soil microbes but

Primarily plant tissues



1. Faster turnover time
2. Important nutrient release
3. Helps develop slow pool

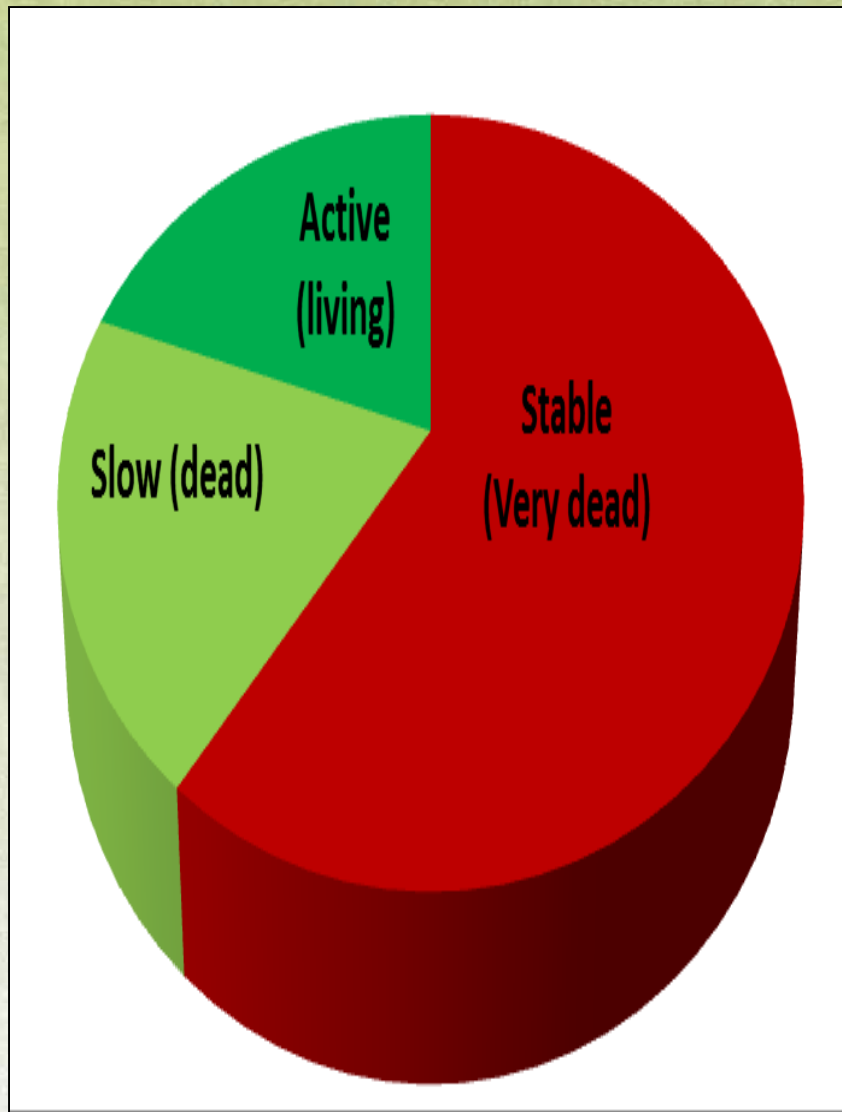
Legume Cover Crops- Active Pool

Needed for organic N release:

- Protein N
- Soluble C (sugars)

Nutrient Sources
needed to build SOM:

- Nitrogen
- Carbon



Crop Residue C:N ratio < 25

Promotes:

- Rapid decomposition
- Mineralization of N

C : N ratio measures N-enrichment & availability

Ex: Legume Cover crops & perennial legumes- alfalfa

Crop Residue C:N ratio > 25

- Additional N
- Persists longer
- Contributes more C

Continuous No-till

Corn:

- Immobilizes N
- Yield slump

Two ways to build SOM

1. Slow down SOM decomposition rates

   (Eliminate tillage)

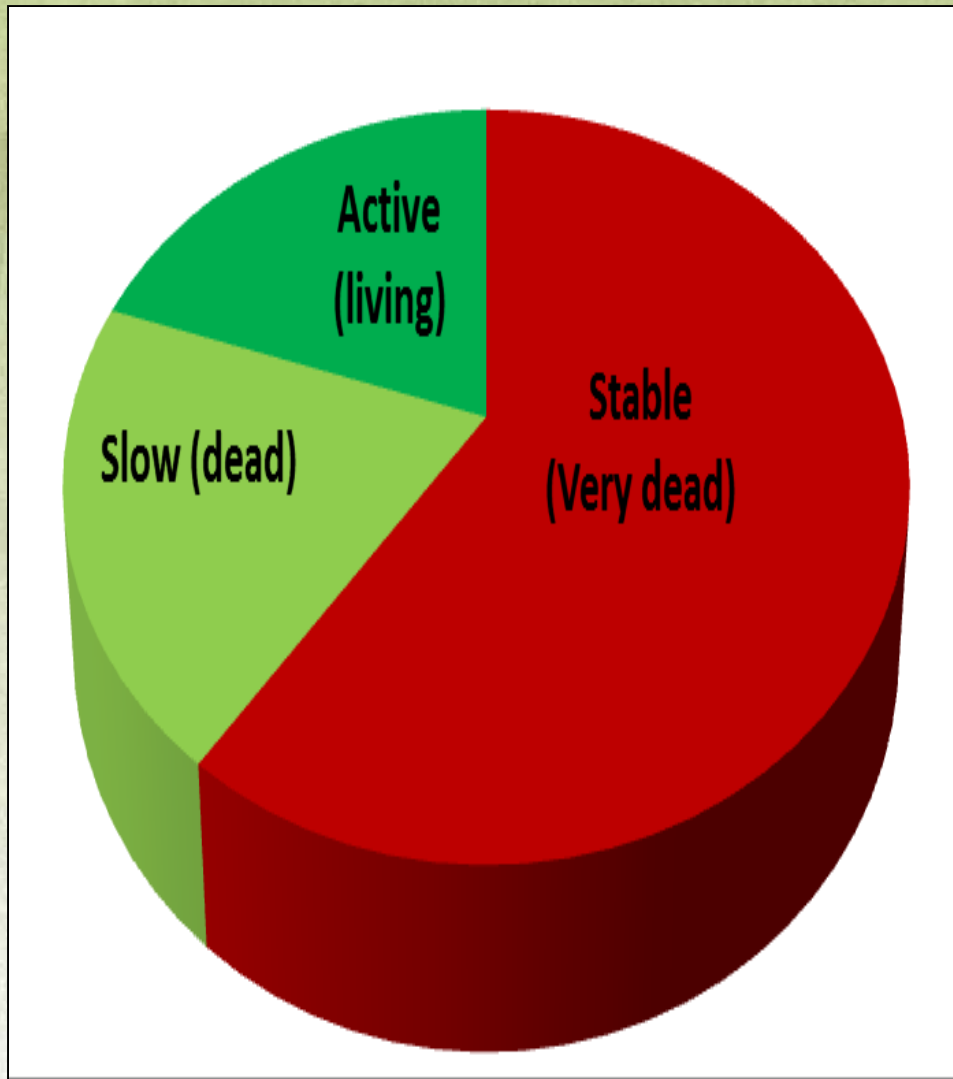
2. Enhance Carbon inputs

(Add compost, cover crops, manure, crop residue & increase yields)

SOM Building

Depends on past use or abuse of soil.

Must transfer C from Active & Slow Pools into Humus



Building the Slow Pool

Add organic materials

1. Leave crop residue, roots & cover crops in place

2. Apply manure amendments

3. Roots critical to build slow & stable pool

Legume / Pasture hay roots

- Large taproots
- Slow to breakdown
- Good to increase SOM
- Improve infiltration

& reduce runoff

Legume & Pasture Roots Increase SOM

Kellogg Biological Station LT Research:

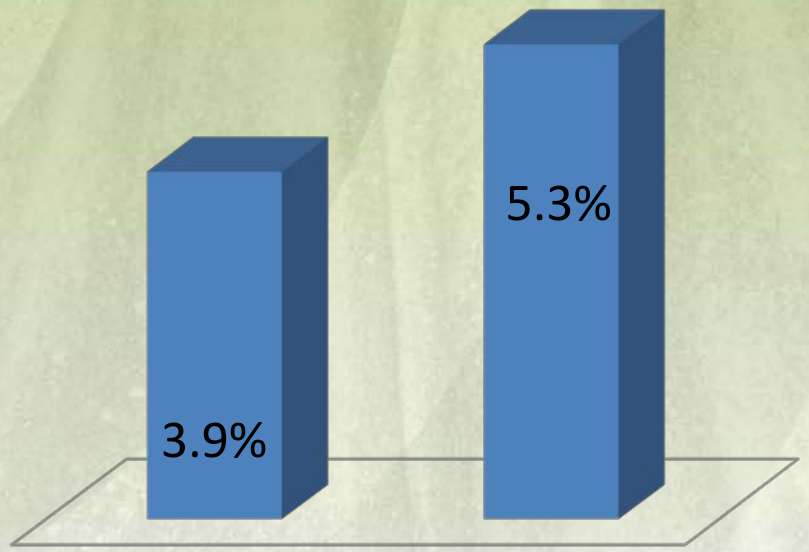
1. Crop Rotation w/ Alfalfa increased soil C (60%) vs CG/Soy/WW system

2. NO-till increased soil C (40%)

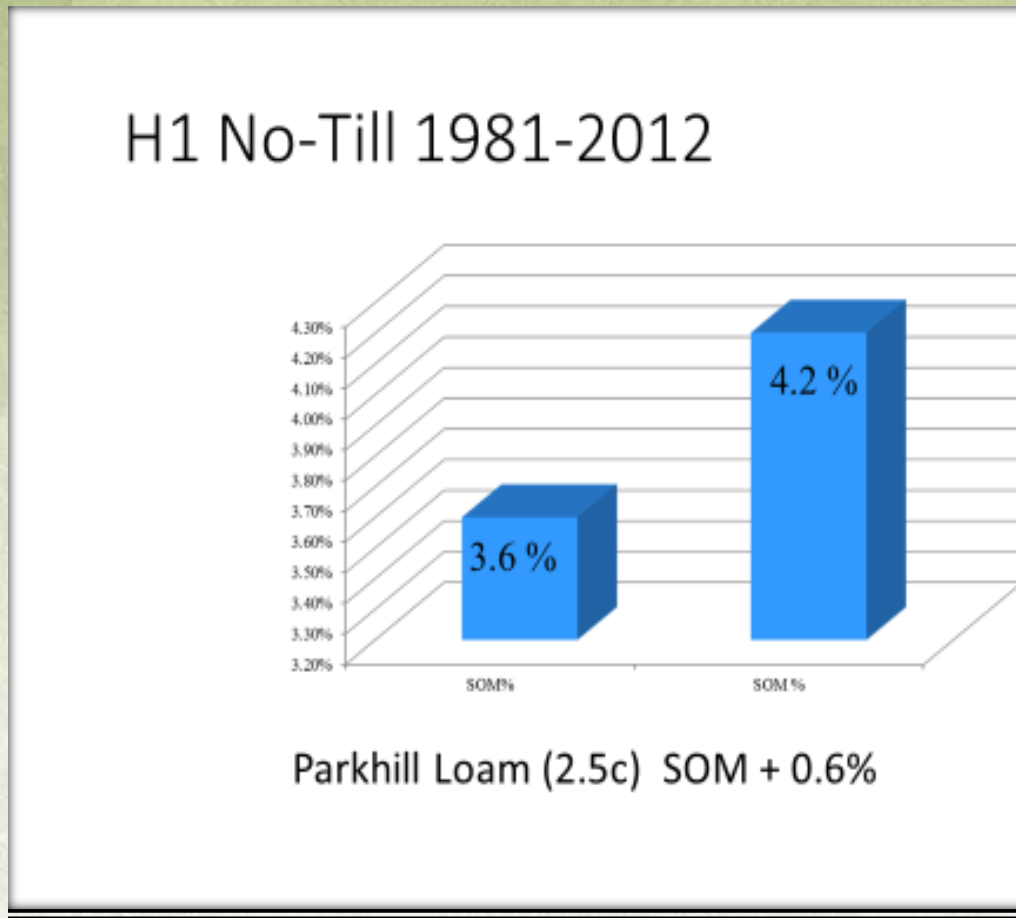
To Maximize Yield Potential:

Manage Hi and Low quality residue with fertilizer sources

SOM + 1.4 % in 30 yrs.



No-till w/ Alfalfa
7 of 30 yrs.



P300 - Fertilizer 2016

Corn ESN Starter Fertilizer

Strip Banded Twin Rows

Starter: lb/ac	550
ESN	200
AMS	21
Zn	
Total N	210
Total Organic N:	
OM 5%	100
Soy N credit	40

N Management 2015

High ESN Starter
32 yrs. No Till

Urea
Broadcast tilled

N Management 2015

Urea Broadcast Tilled

High N Starter No Till

Nitrogen Oxide

1. De-Nitrification in wet soils
2. Increased loss using N fertilizer on crops
3. Ag adds 12% GHG- 58% N_2O
4. Global warming potential 310 x CO_2

NRCS 590 Goals: 64 Million Ac

Reduce N_2O Emissions

Slow Release N fertilizers

- Agrium ESN- Environmentally Smart N

ICL

- Agrocote Max 1-2M
- Agrocote Max 2-3M
- Agrocote Max 4-5M

Reduce N loss wet years

- -Max Release Technology™ is a reacted polymer coating for use on macronutrients and micronutrients to improve nutrient efficiency and plant utilization. The release of nutrition is based upon moisture and temperature, offering predictable longevities, even under the warmest conditions.

SOM Enrichment Plans

1. Diversity of crops
2. Add Compost or manure
3. Crop residues with different C:N ratios
4. Eliminate tillage
5. Add Cover Crops
6. Slow release

Nutrient sources

Crop Residue as a Food Source

Decomposition of SOM

1. Tillage accelerates
2. Smaller residue pieces
3. Residues break down faster
4. Increases food (C)
5. Adds (O_2)
6. Fuels biology fire (bacteria)
7. Releases $C0_2$

Downward Spiral of Soil Degradation

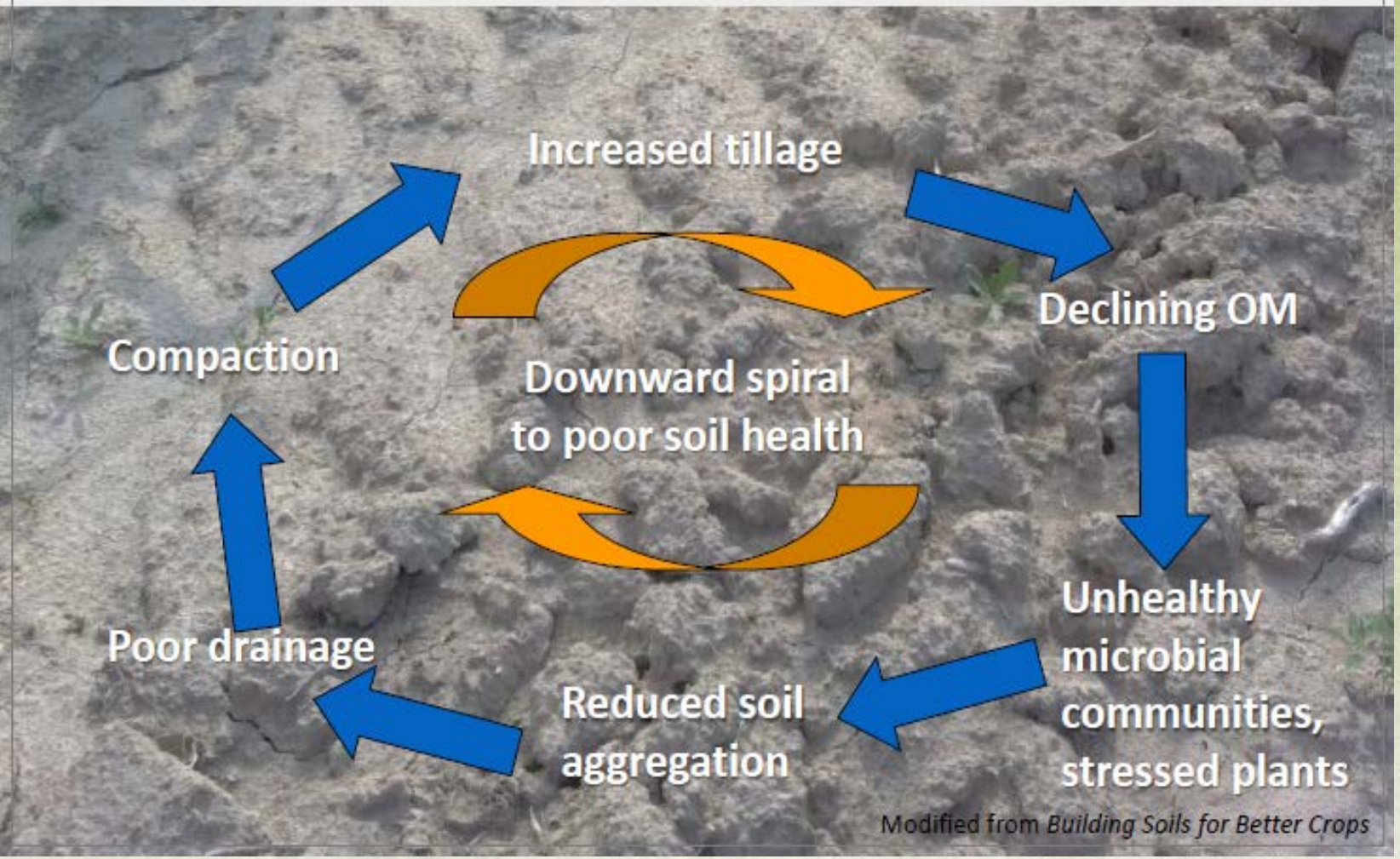
1. Intensive tillage, insufficient added residues, low diversity, no surface cover
2. Soil organic matter decreases, erosion, subsoil compacted
3. Aggregates break down
4. Surface becomes compacted, crust forms
5. Infiltration decreases
   Erosion by wind and water increases
6. More soil organic matter, nutrients, and top soil lost
7. MORE ponding & persistent wetness, but LESS soil water storage; less rooting; lower nutrient access by plants; less diversity of soil organisms, more disease
8. Crop yields decline
9. Hunger and malnutrition, especially if little access to inputs

Modified from *Building Soils for Better Crops*

Cornell PPT Bianci 2015

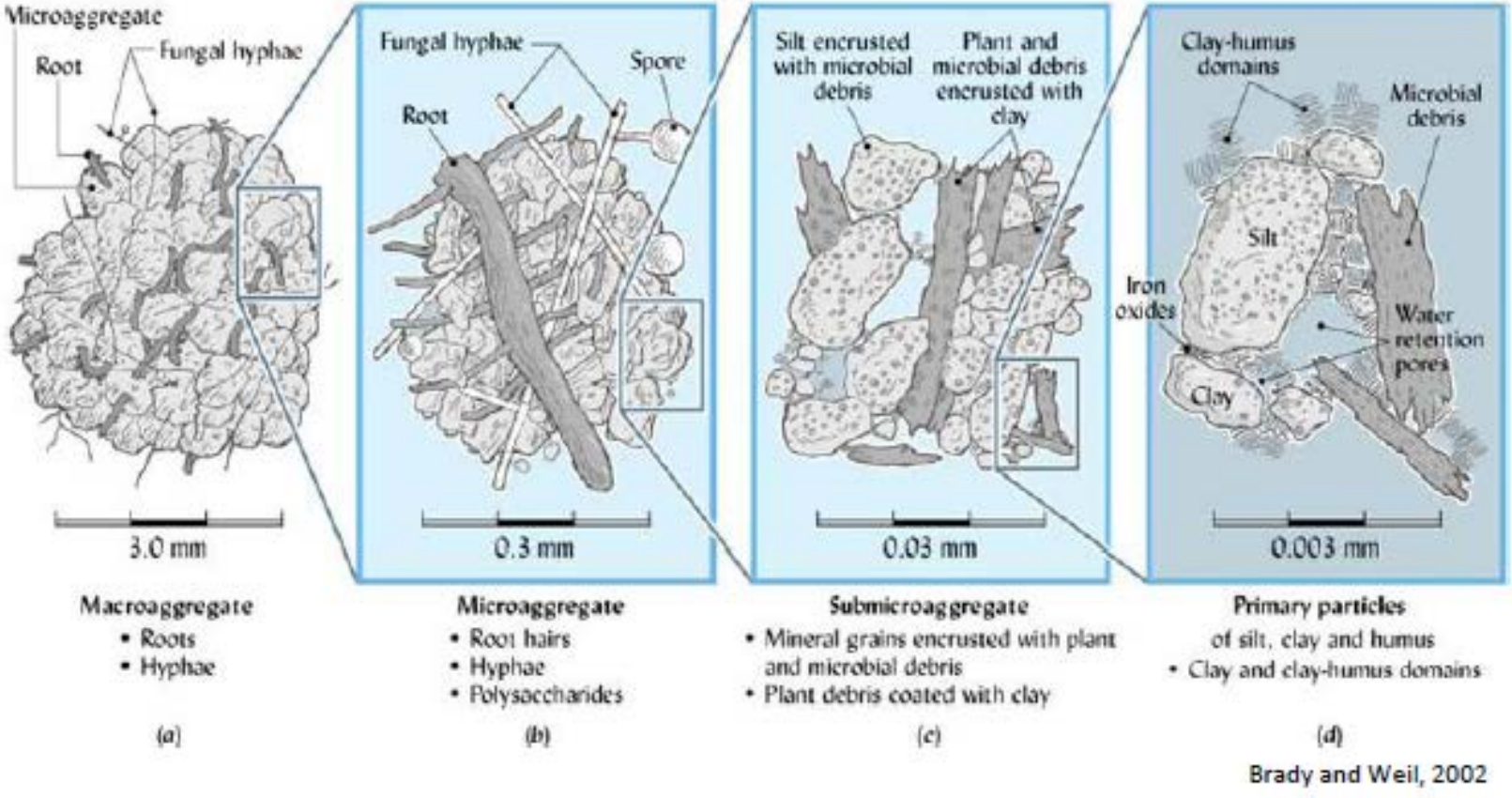
Note: soils also degrade without tillage, through overgrazing, compaction, etc

Tillage Addiction: Downward Spiral in Soil Health



Cornell PPT Bianci 2015

Building Aggregates means improving biological functioning through physical and biological methods



Brady and Weil, 2002

Reduce tillage, increase fresh organic matter availability to decomposers, improve environment for plants and soil organisms

Managing for C instead of T

1. Soil Erosion when T = 0 that is TOLERABLE!

2. Efforts to build Active, Slow and Stable SOM pools must be practiced!

KBS SOM Changes

Manure + Compost can build (old) SOM with complete Corn Stover removal

Manure + rye cover crop provides: maximum SOM benefit & erosion control

Source: MSUE Bulletin E3137: Advanced Soil Organic Management

KBS SOM Changes

10 years Dairy compost at 2 ton/ac/yr

- Increased SOM 50%!

Continuous No-till

- Increased SOM 40%

Source: MSUE Bulletin E3137: Advanced Soil Organic Management!

Manage for C instead of T

Result:

- Improved Ecological Services
- Increased soil productivity
- Better environmental quality

NO Erosion, including gully erosion, should be TOLERABLE!

Manage for C instead of T

ASA Quote:

Only Through Direct Engagement with the Real World can Science free itself to Rediscover the Path Toward Truth.

Vegetative Barriers

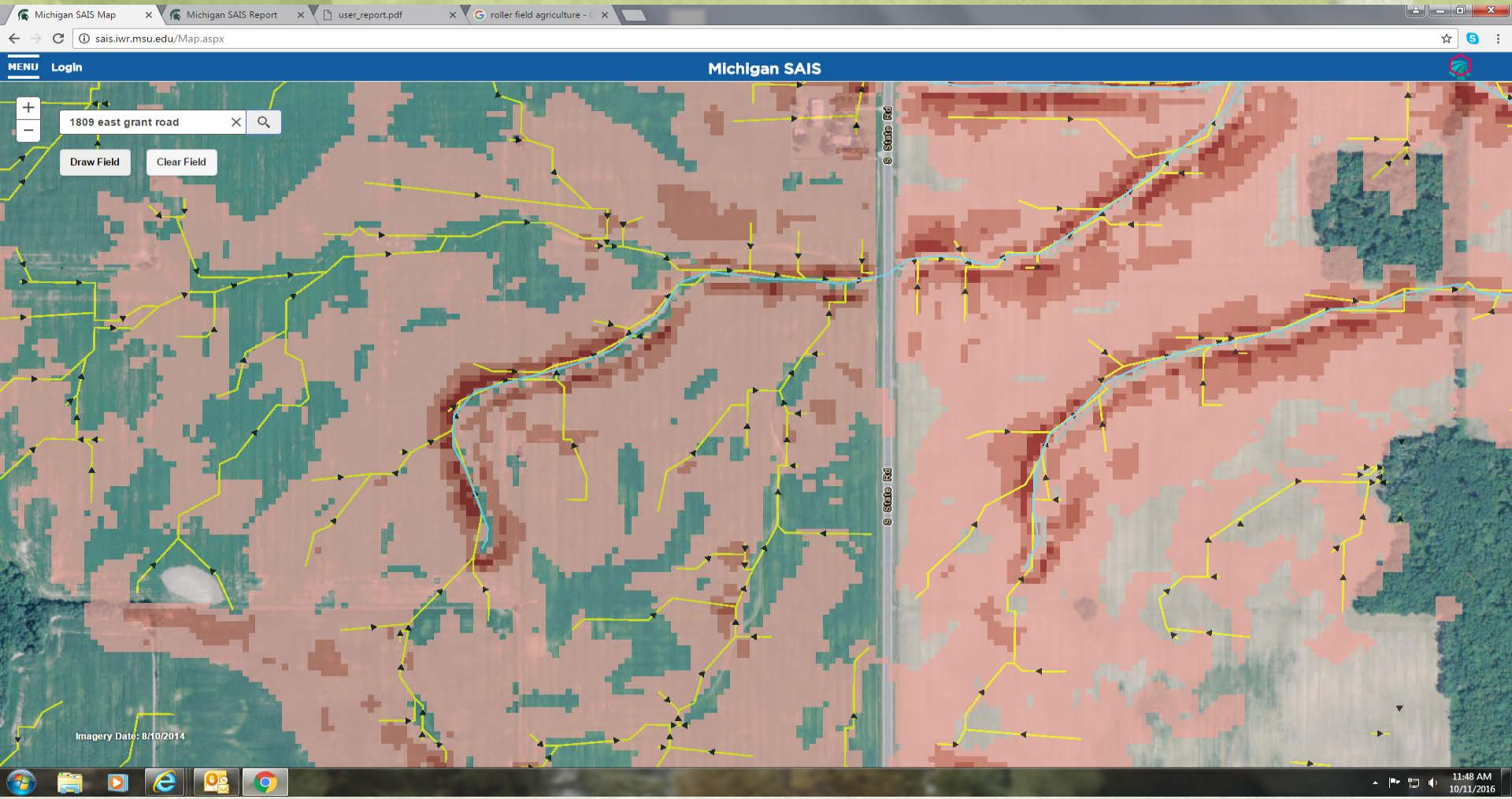
Ephemeral gully control

Traps Sediment & heals gully

KBS Vegetative Barrier System.

Vegetative Barriers KBS 2014

Locating Gullies w/ SAIS



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