How Erosion Impacts Farm Productivity and What to do About It

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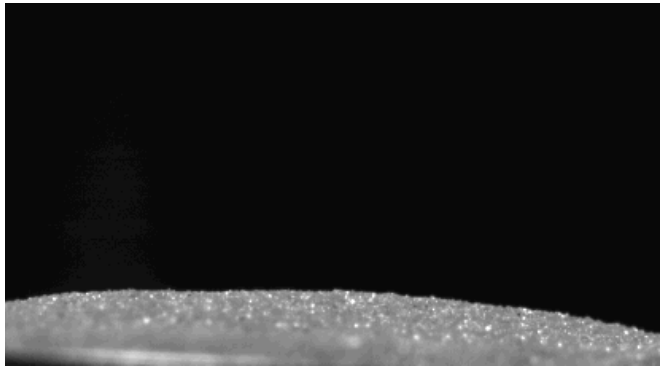
Wisconsin Crop Management Conference
January 13, 2016

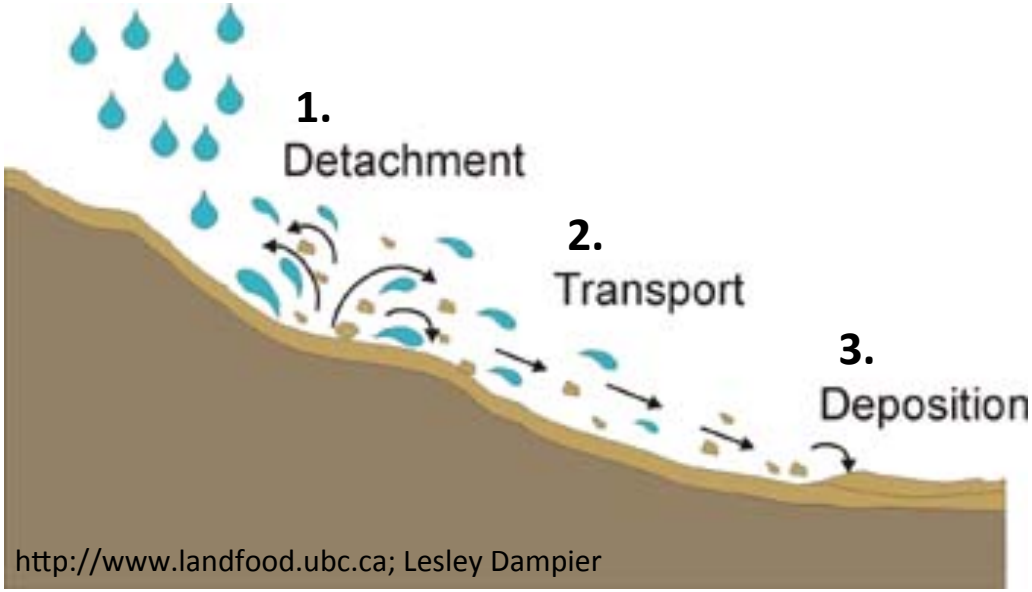
What is Soil Erosion?

- Soil erosion is the washing/blowing away of surface soil (topsoil). It is typically caused by water or wind. Although soil erosion is a natural process, human activities have increased erosion rates well beyond natural ones.

How Does Soil Erosion Occurs?
--is a three step process



http://www.cms.fu-berlin.de/; GeoLearning



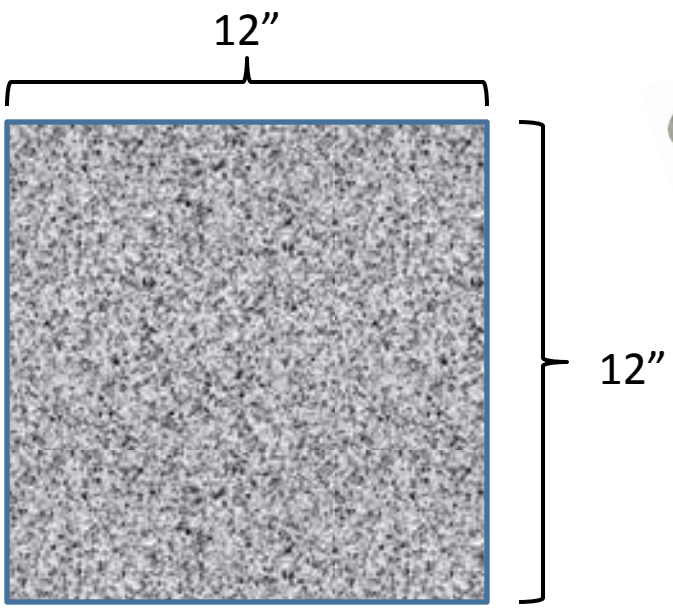
http://www.landfood.ubc.ca; Lesley Dampier

Impact of Erosion on Crop Production

- Loss of nutrients and soil organic matter
- Can reduce water infiltration and water recharge of the soil profile due to the formation of surface crusts or seals
- Reduces the thickness of the soil

Soil Erosion: Loss of Plant Nutrients

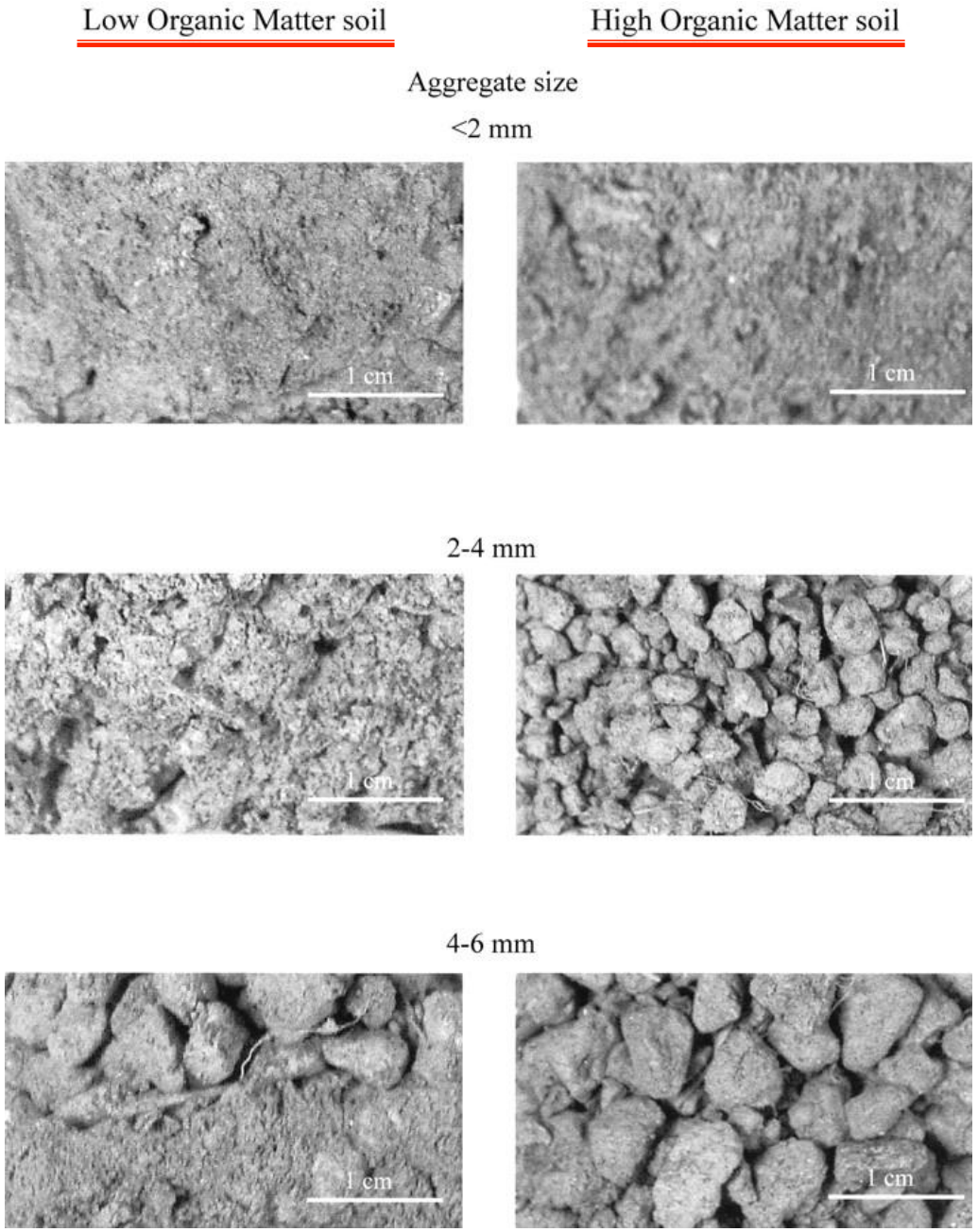
- What does a "T" value of 5 tons/ac/yr looks like?
  - 5 tons soil/acre = 3.7 ounces soil/ft^2



One teaspoon

- One ton of soil in the optimum nutrient range has about (10 ppm N, 20 ppm P, and 130 ppm K):
  - 2.0 lb Nitrogen
  - 9.0 lb P_2O_5
  - 31 lb K_2O

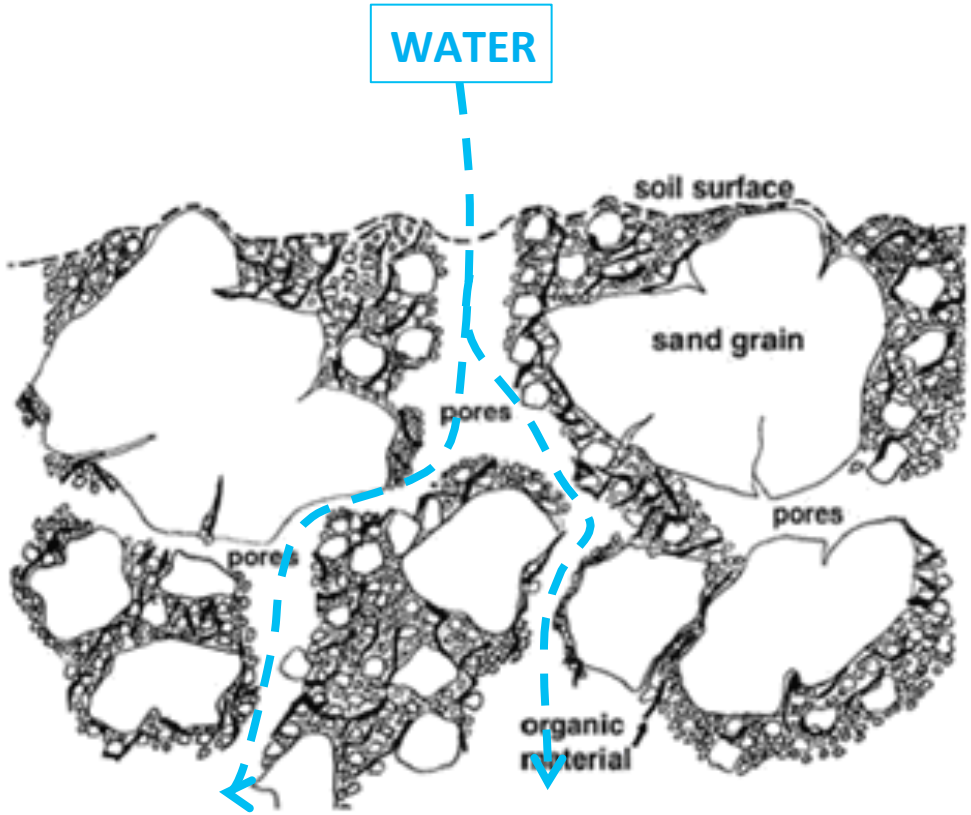
Soil Erosion: Loss of Organic Matter



(Lado, Paz and Ben-Hur, 2004)

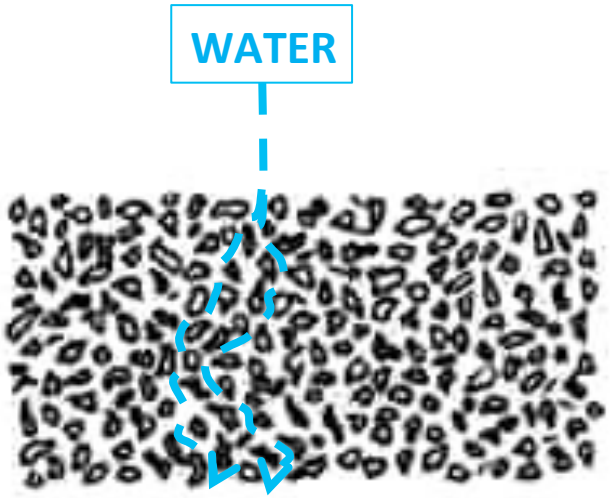
Soil Erosion: Organic Matter, Aggregation and Water Infiltration

Good aggregation



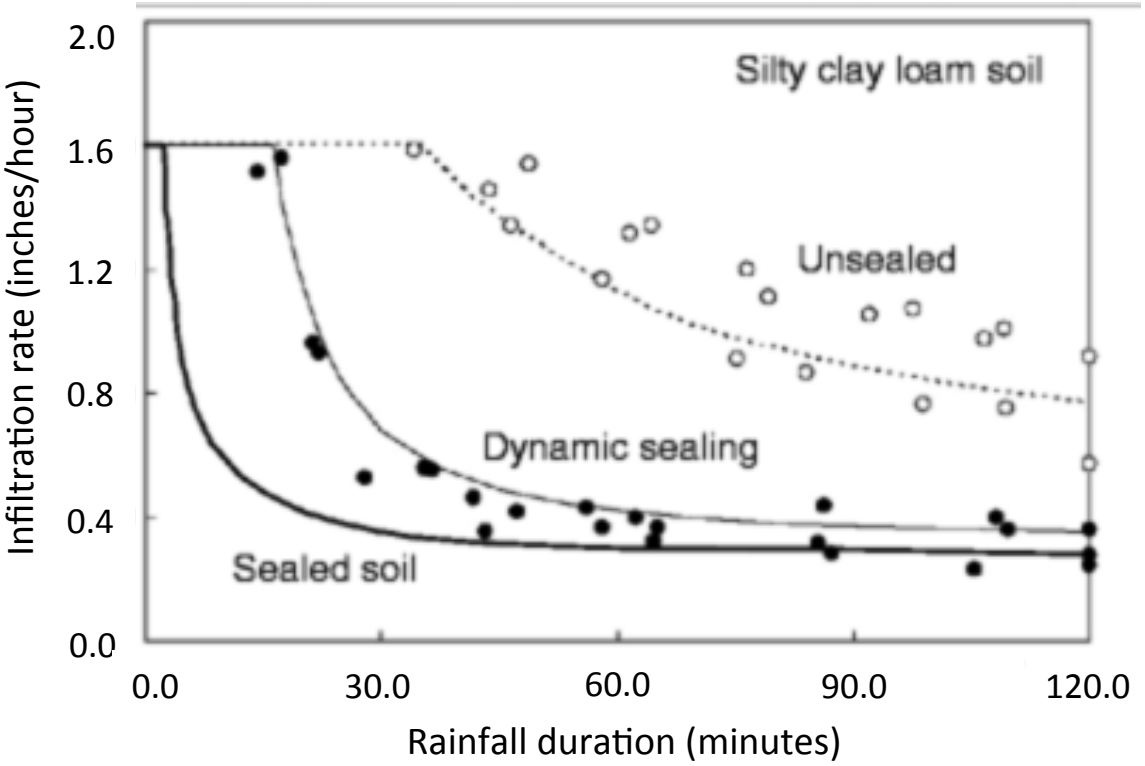
Adapted from http://vro.depi.vic.gov.au/

Poor or no aggregation



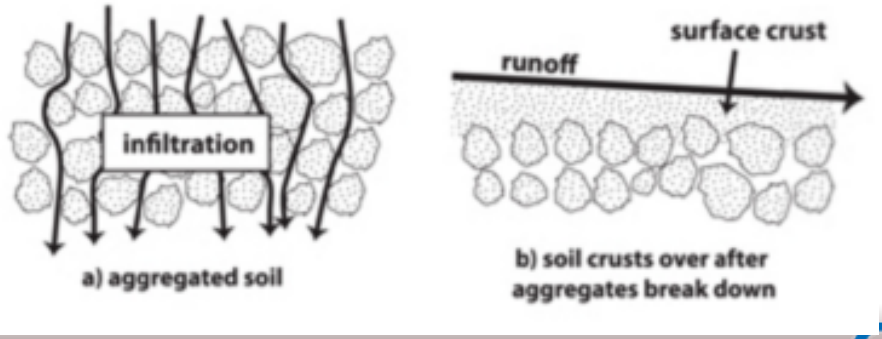
Adapted from http://cnrit.tamu.edu/

Surface Seals and Infiltration Rate

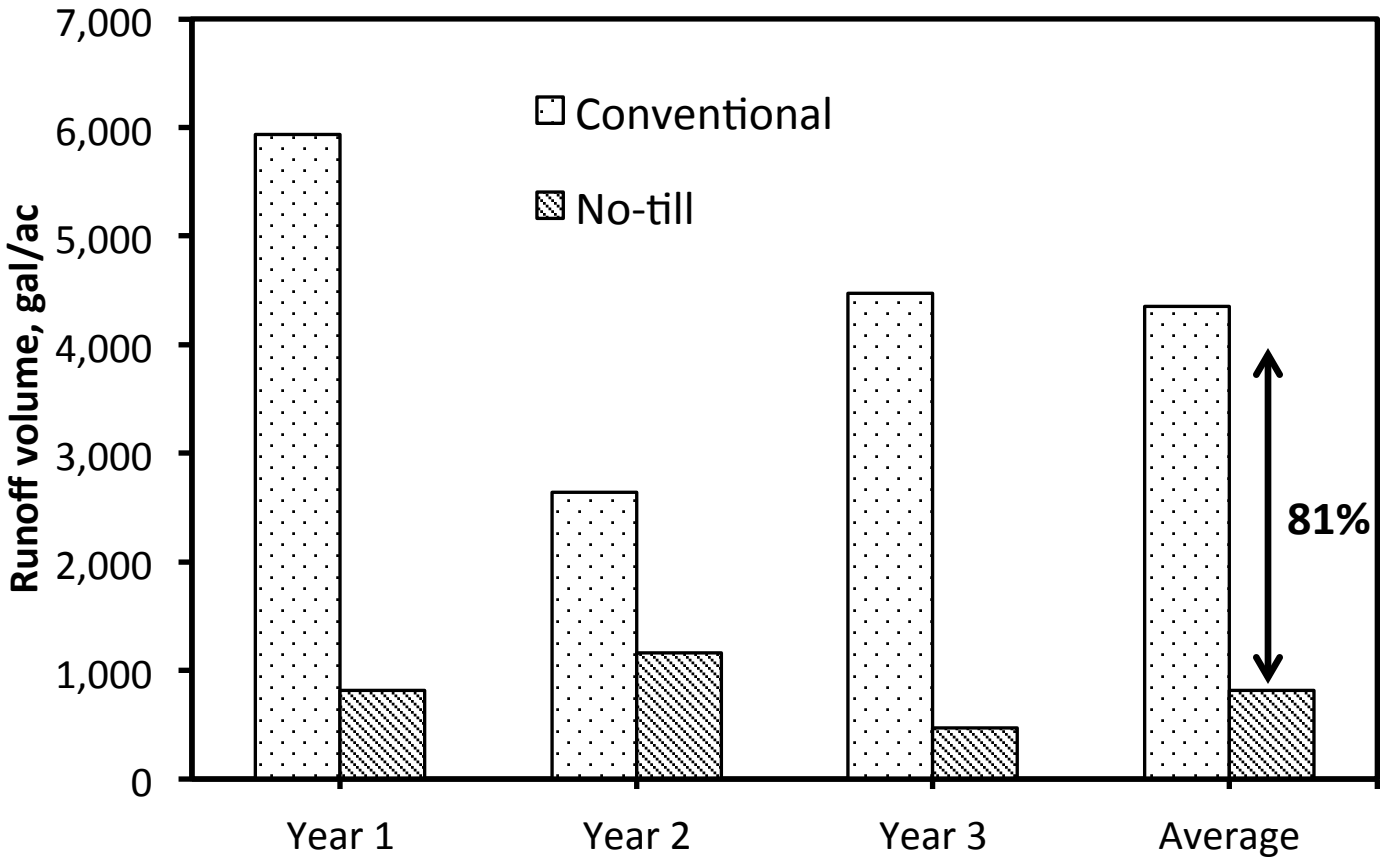


(Assouline, 2014)

Changes in water flow due to soil crusting/compaction.



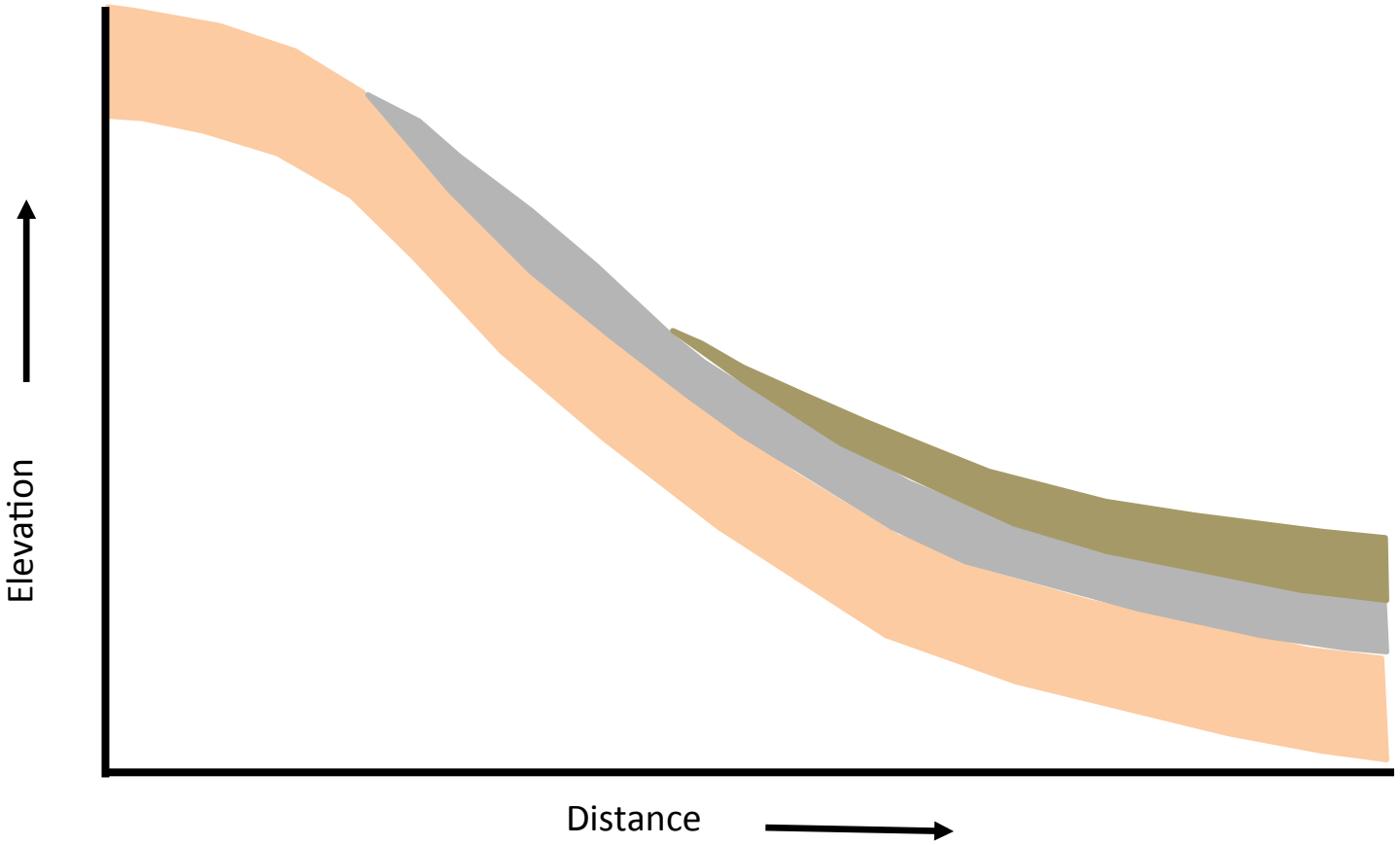
More Runoff = Less Soil Water Recharge



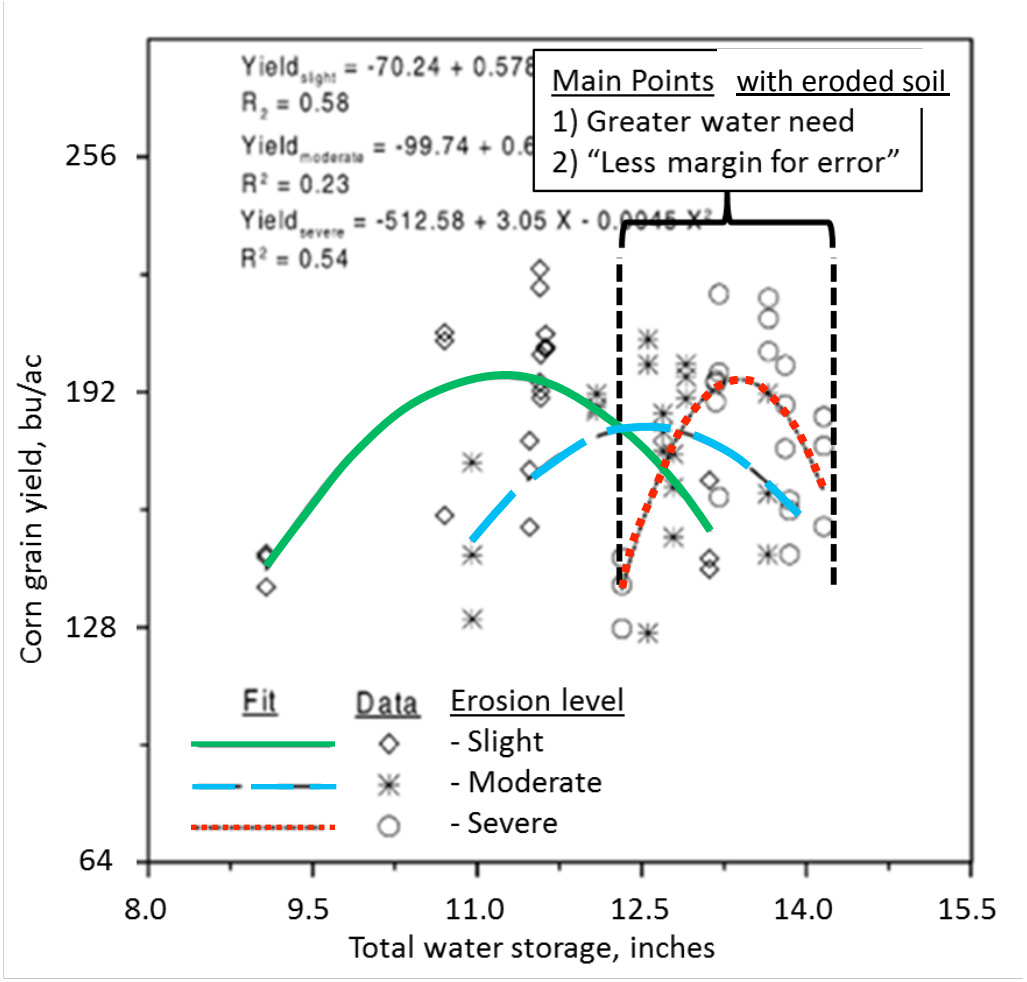
Suspended sediment followed a similar trend and there was 87% reduction with no-tillage

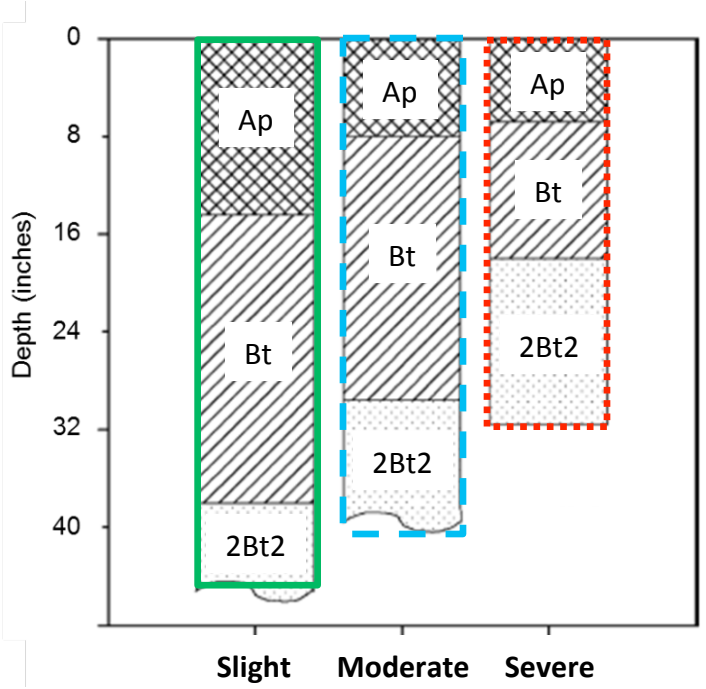
(Angle et al., 1984)

Soil Erosion Reduces Soil Thickness



Eroded Soil has Lower Water Storage Capacity





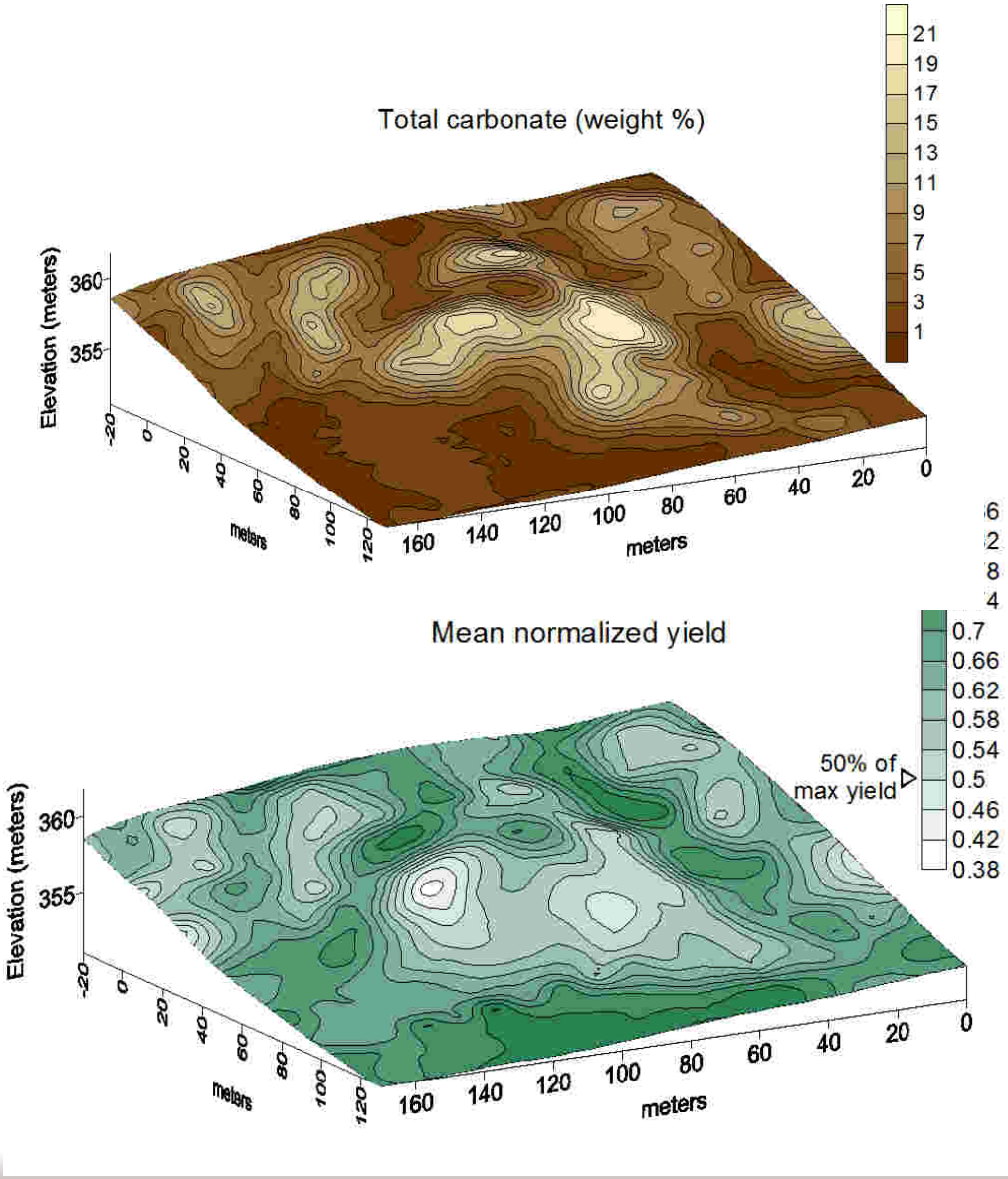
Source: Arriaga and Lowery, 2003

Why Does Soil Loss Matters?

- Eroded field example:

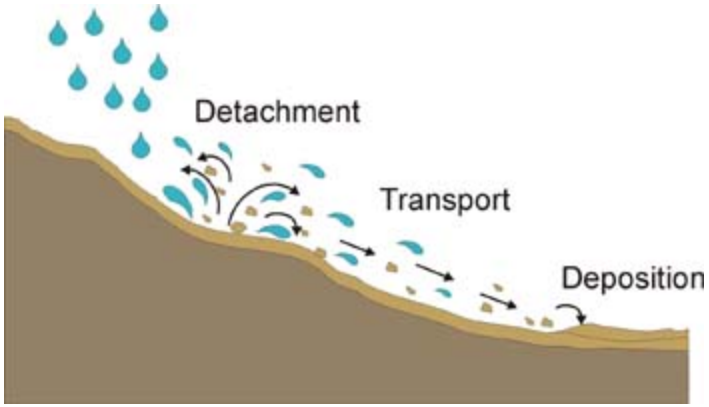
source: S. Papiernik, 2013

Why Does Soil Loss Matters?
It is Detrimental to Soil Properties and Yields



source: S. Papiernik, 2013

Universal Soil Loss Equation (USLE)
Now RUSLE2



http://www.landfood.ubc.ca; Lesley Dampier

Universal Soil Loss Equation (USLE)

Soil loss (ton/acre) = **R** x **K** x **LS** x **C** x **P**

Factors:

R = erosive force of rainfall and runoff (amount & intensity)

K = soil erodibility

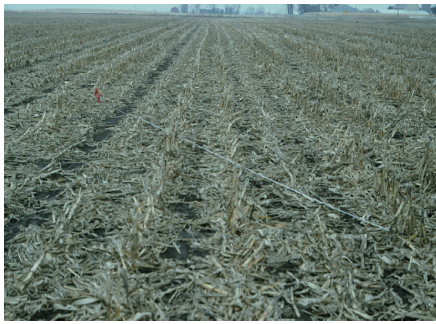
LS = slope length & steepness

C = vegetative cover & management

P = Erosion control practices (supporting practices)

What goes into C-factor?

- Canopy cover *(vegetation that intercepts raindrops)*
- Ground cover (*reduces waterdrop impact and runoff*)
- Surface roughness *(increasing infiltration, deposition, slows runoff)*
- Ridge height *(ridges parallel to flow lead erosion, cross flow increase deposition)*
- Soil biomass *(live and dead roots, buried residue)*
- Soil consolidation *(soil becomes less erodible over time after disturbance)*



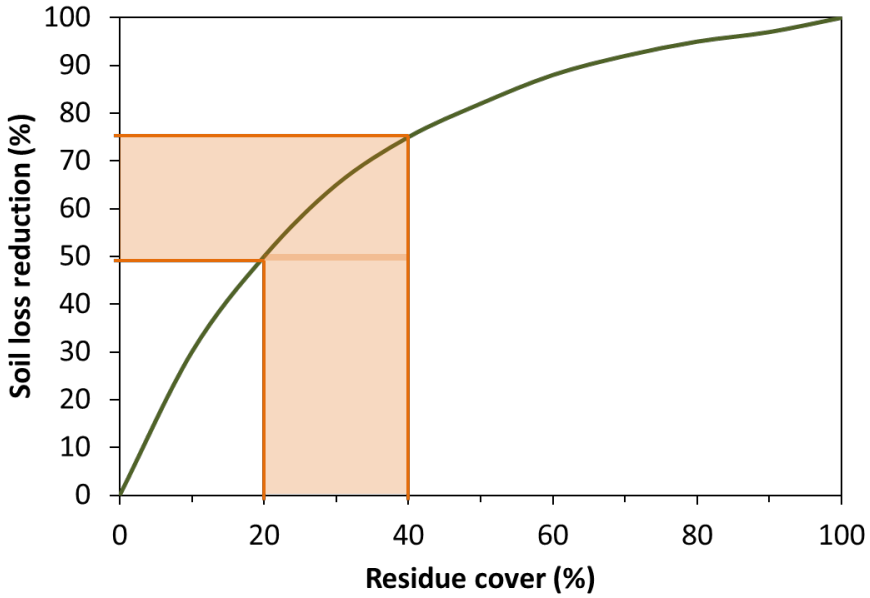
source: Ward-Good, 2014

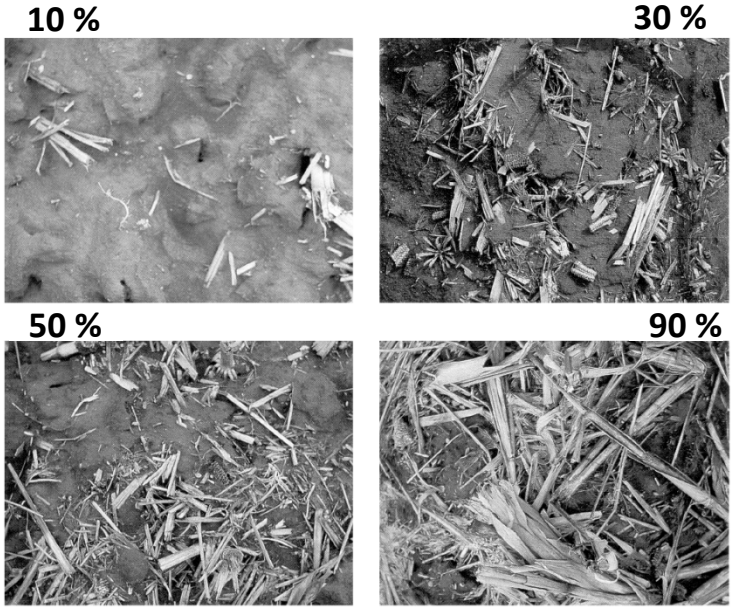
Management Choices that Affects the C-factor

- Crop type
- Crop growth and yield
- Primary and secondary tillage
- Harvest (how much residue is left)

source: Ward-Good, 2014

The C-factor: Crop Residue on Soil Surface & Erosion





Source: Purdue University AT-269-W

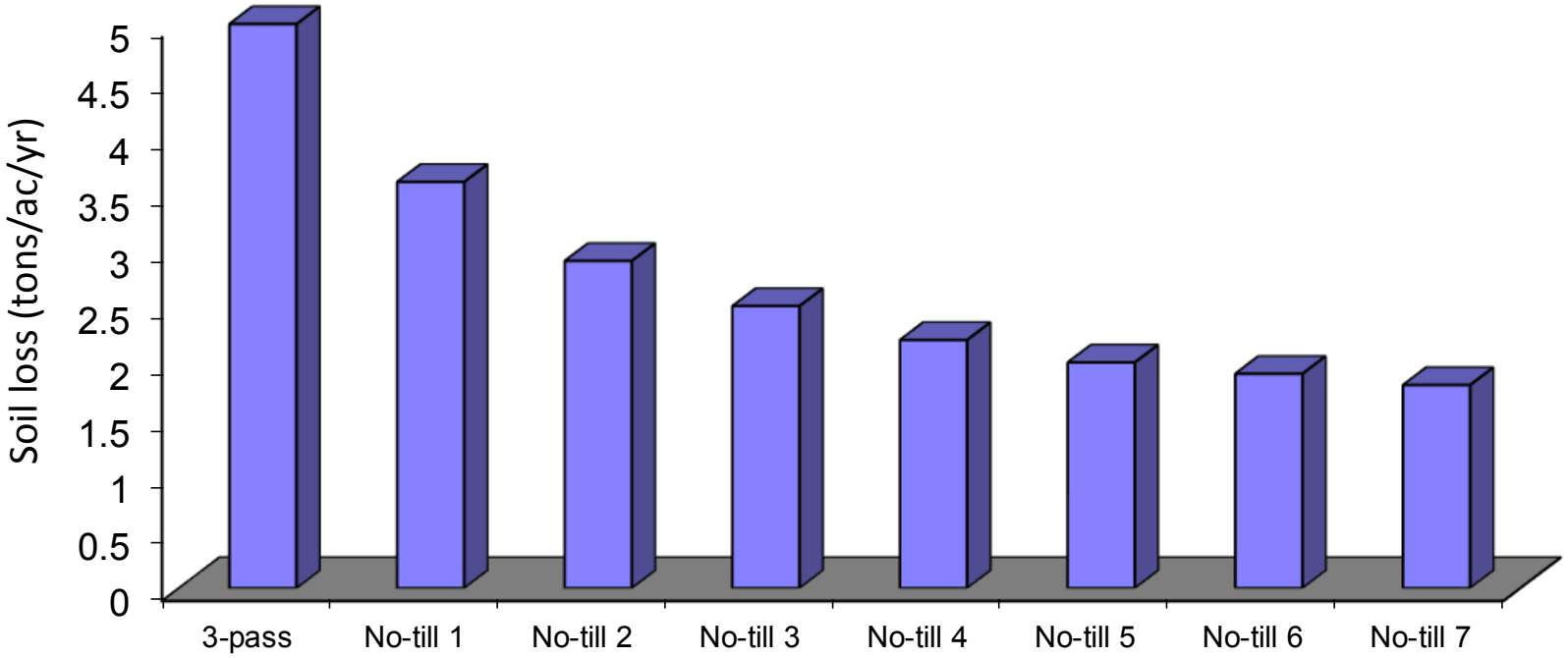
The C-factor: Less Erosion with Lower Tillage Frequency and Intensity

Crop: Continuous corn silage

source: Ward-Good, 2014

The C-factor: Erosion Decreases Over Time with Soil Aggregate Formation

Continuous corn silage with one year of tillage followed by 7 years of no-till



source: Ward-Good, 2014

The C-factor: Cover Crops Reduce Erosion

Crop: Continuous corn silage

Tillage: Spring chisel plowing, field cultivation prior to planting

	Erosion (Ton/ac/yr)
No cover crop	4.6
Disked rye cover crop	2.0
No-till rye cover	1.8

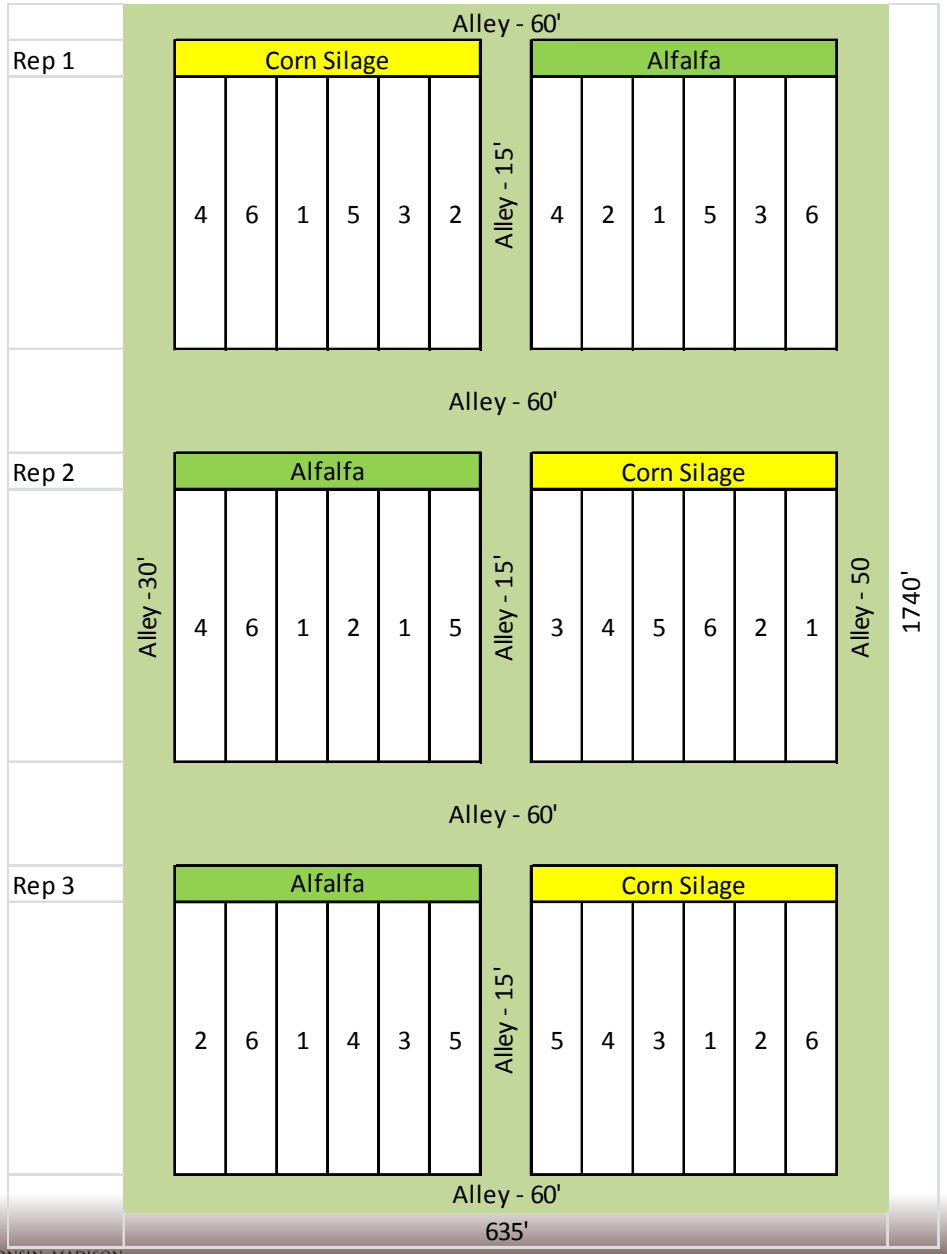
source: Ward-Good, 2014

The P-factor: Supporting Practices

	Erosion (T/a/yr)
Cont. corn silage - up and down slope	4.6
Cont. corn silage - on contour	3.1
Cont. corn silage - with in-field grass strips	2.2
Strips – rotation 3 yrs corn silage – 4 years alfalfa hay	1.4

source: Ward-Good, 2014

Corn Silage Management Example



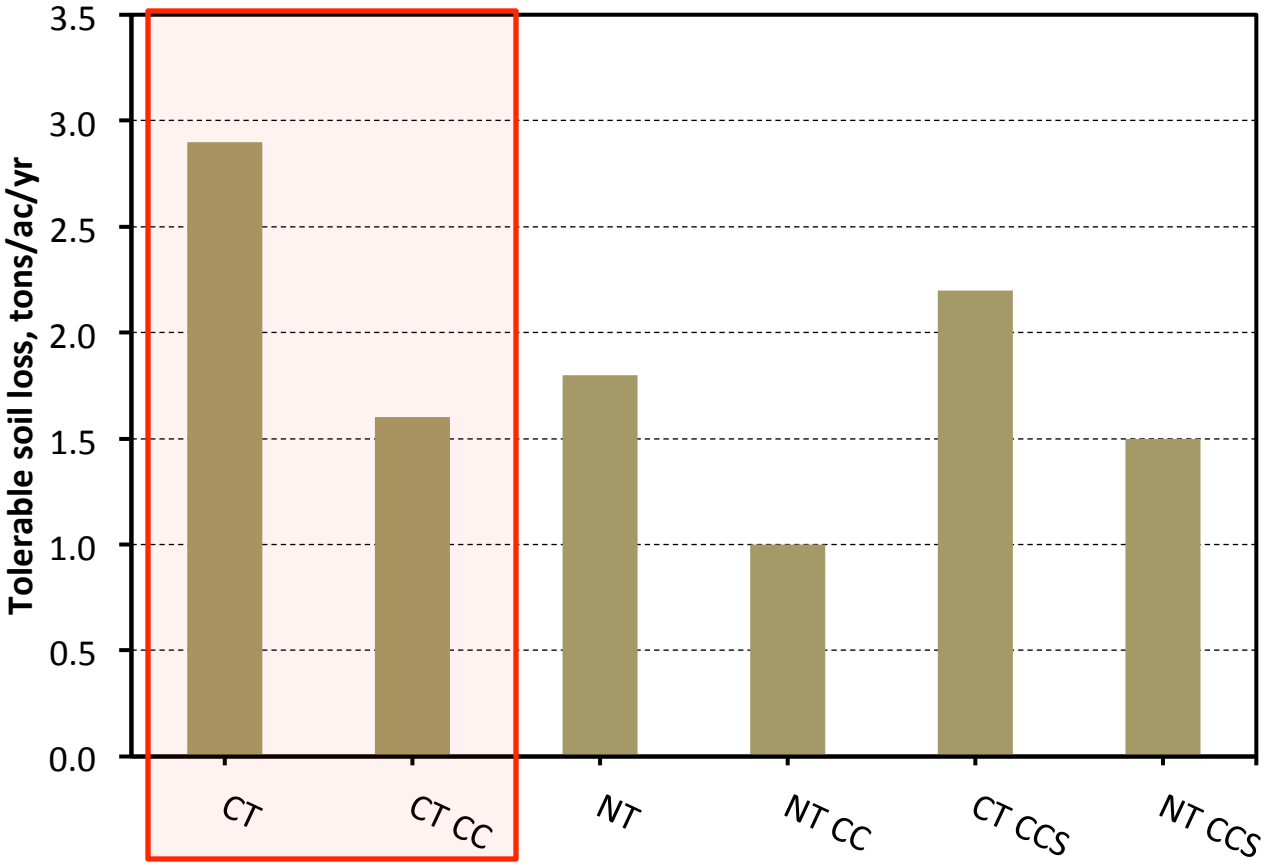
N

Treatments

1- NT Cover Crop
2- NT Cover Crop- harvest
3- NT No Cover Crop
4- CT Cover Crop
5- CT Cover Crop- harvest
6- CT No Cover Crop

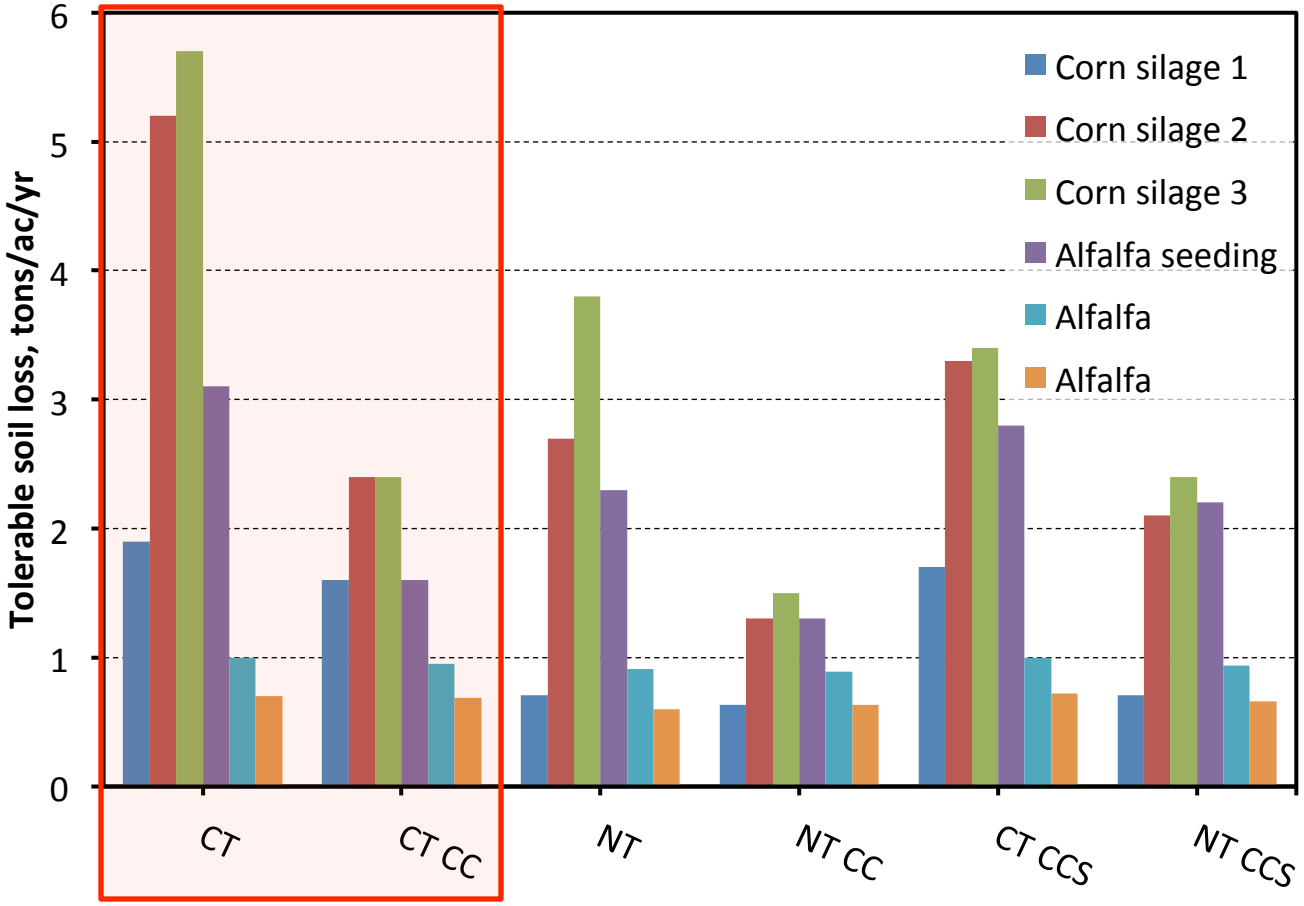
NT – No-tillage
CT – fall chiseling/spring finisher

Soil Loss Estimate – 6 Year Average for Rotation
(C-C-C-A-A-A)



RUSLE 2 runs by L. Ward-Good

Annual Soil Loss Estimates



RUSLE 2 runs by L. Ward-Good

Fertilizer Replacement Costs per Acre

Years	CT	CT CC	NT	NT CC	CT CCS	NT CCS
Corn silage 1	16.72	14.08	6.25	5.54	14.96	6.25
Corn silage 2	45.76	21.12	23.76	11.44	29.04	18.48
Corn silage 3	50.16	21.12	33.44	13.20	29.92	21.12
Alfalfa seeding	24.18	12.48	17.94	10.14	21.84	17.16
Alfalfa 2	7.80	7.41	7.10	6.94	7.80	7.33
Alfalfa 3	5.46	5.38	4.68	4.91	5.62	5.15
Total cost	$ 150.08	$ 81.59	$ 93.17	$ 52.18	$ 109.18	$ 75.49
Difference		$ 68.49		$ 40.99		$ 33.69

- These estimates are only for fertilizer replacement value of N, P and K. Reductions in SOM and soil profile depth due to erosion have long-term negative impacts on crop productivity.

Closing Remarks

- Soil erosion degrades soil productivity.
- Although some impacts of soil erosion can be "corrected" in the short-term, other impacts are not reversible and affect crop production permanently
- Management of crop residue/cover (C-factor) and supporting soil conservation practices (P-factor) can help reduce erosion significantly.

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