Impact of Soil Health on Crop Production

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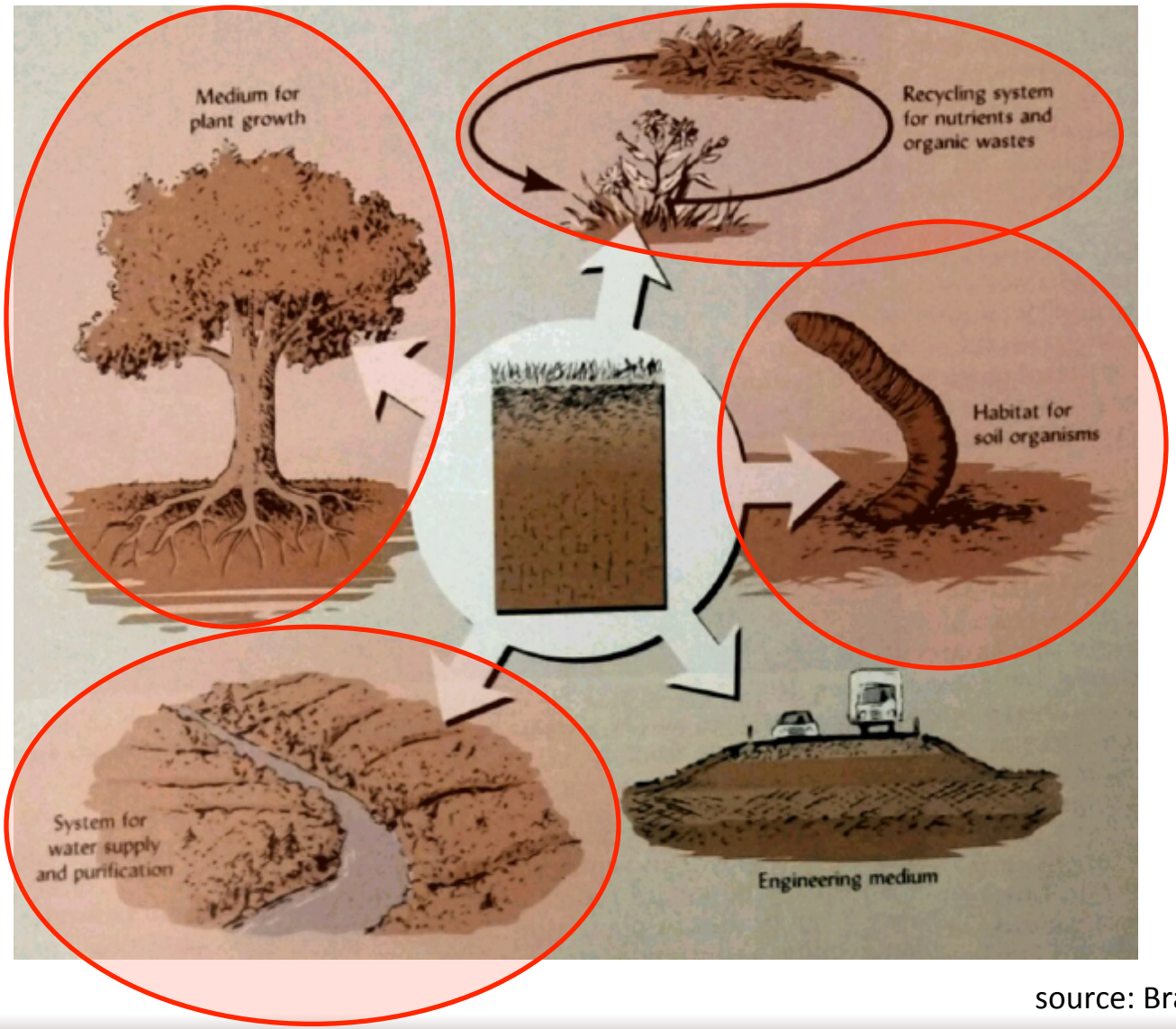
What is Soil Health?

- "the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation."

(Karlen et al., 1997)

Functions of Soil



source: Brady & Weil, 1996

Soil Functions

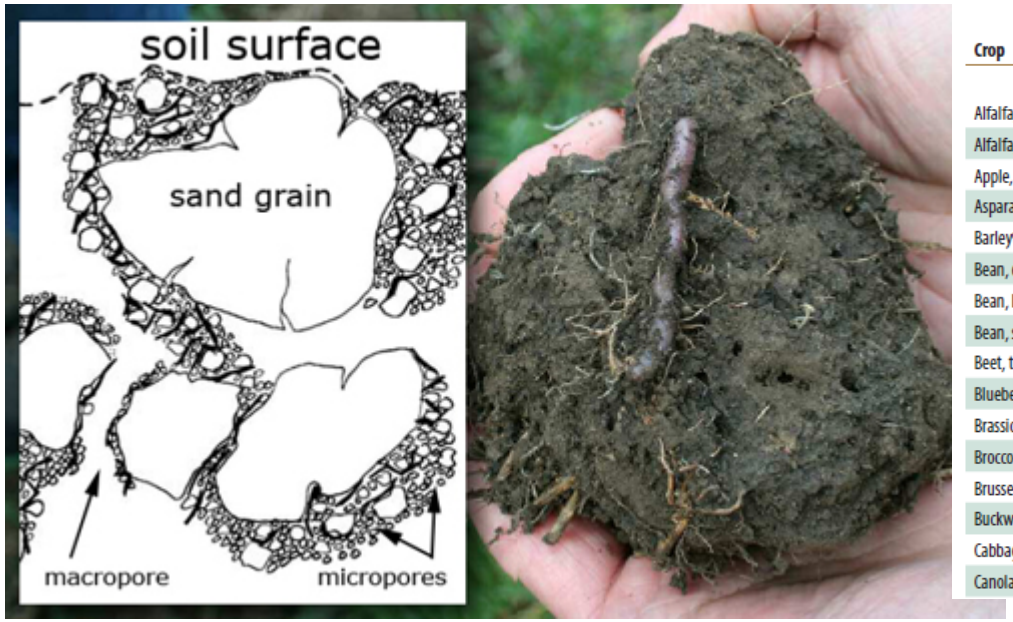
- Medium for plant growth
- Recycle/store nutrients & organic materials
- Habitat for soil organisms
- Water storage & purification

Indicators

- Texture
- Structure
- Infiltration & bulk density
- Water holding capacity
- Aggregate stability
- Soil organic matter
- pH
- Extractable N,P, & K
- Microbial biomass C & N
- Potentially mineralizable N
- Soil respiration

Soil Properties Affected by SOM

- Physical
  - infiltration
  - water retention
  - hydraulic conductivity
  - bulk density
- Chemical
  - CEC
  - nutrient availability
  - buffering capacity



source: soilquality.org

Crop	Yield range per acre	Soil organic matter content (%)			
		< 2.0	2.0–9.9	10.0–20.0	> 20.0
		lb N/a to apply[a]			
Alfalfa, seeding	1.0–2.5 ton	30	0	0	0
Alfalfa, established	2.6–9.5 ton	0	0	0	0
Apple, establishment[b]	—	2	2	2	2
Asparagus	2,000–4,000 lb	80	60	40	20
Barley[c]	25–100 bu	70	50	30	15
Bean, dry (kidney, navy)	10–40 cwt	40	30	20	10
Bean, lima	2,000–5,000 lb	60	40	20	10
Bean, snap	1.5–6.5 ton	60	40	20	0
Beet, table	5–20 ton	120	100	80	30
Blueberry, establishment[d]	—	30	30	30	30
Brassica, forage	2–3 ton	120	100	80	40
Broccoli	4–6 ton	100	80	60	25
Brussels sprouts	4–6 ton	100	80	60	25
Buckwheat	1,200–2,000 lb	50	30	20	0
Cabbage	8–30 ton	180	140	100	40
Canola	30–50 bu	80	60	40	20

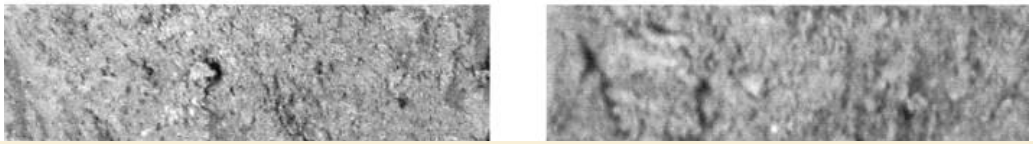
A2809 Table 6.3

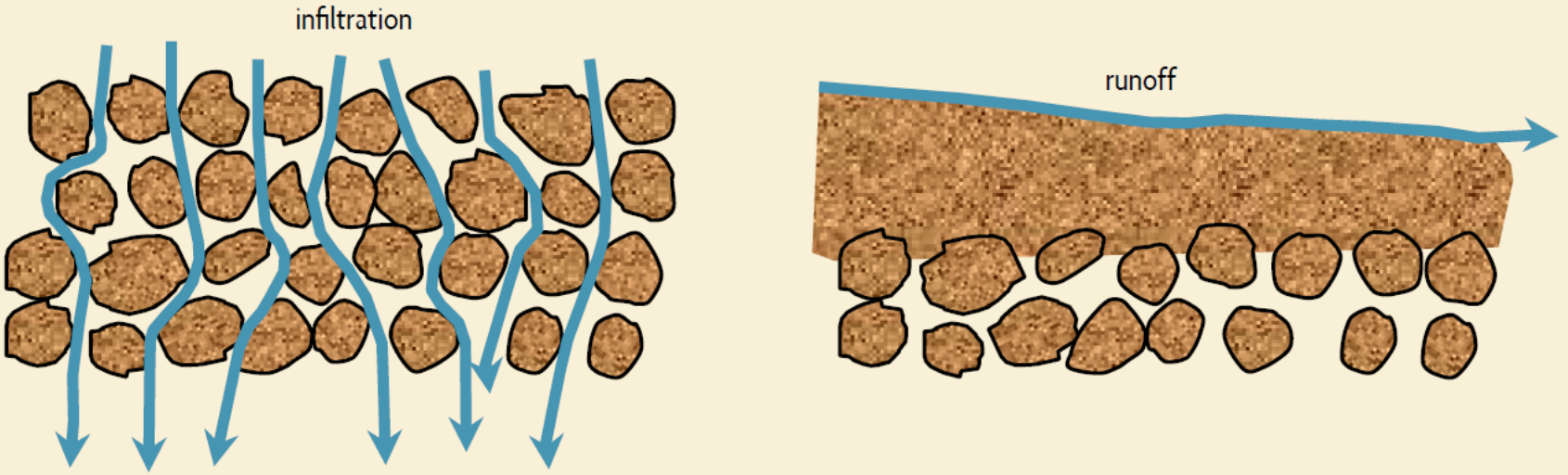
Low Organic Matter soil

High Organic Matter soil

Aggregate size

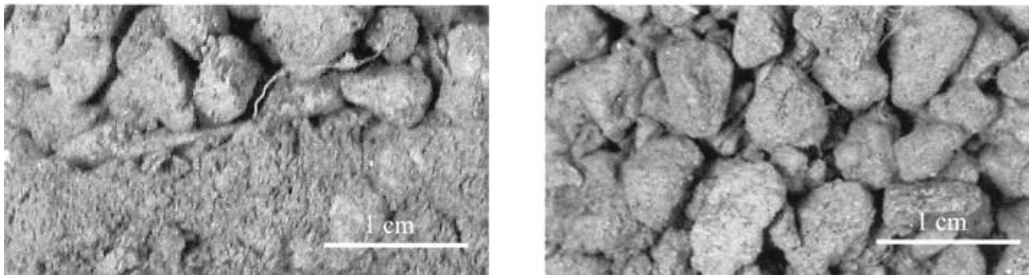
<2 mm





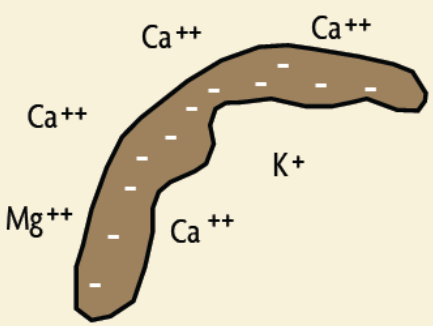
Source: Magdoff and van Es, 2009

4-6 mm

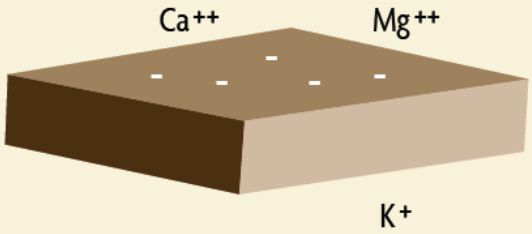


(Lado, Paz and Ben-Hur, 2004)

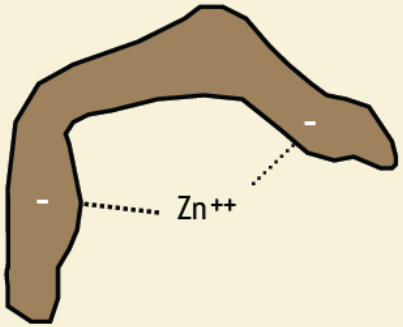
Nutrient Retention



a) cations held on humus



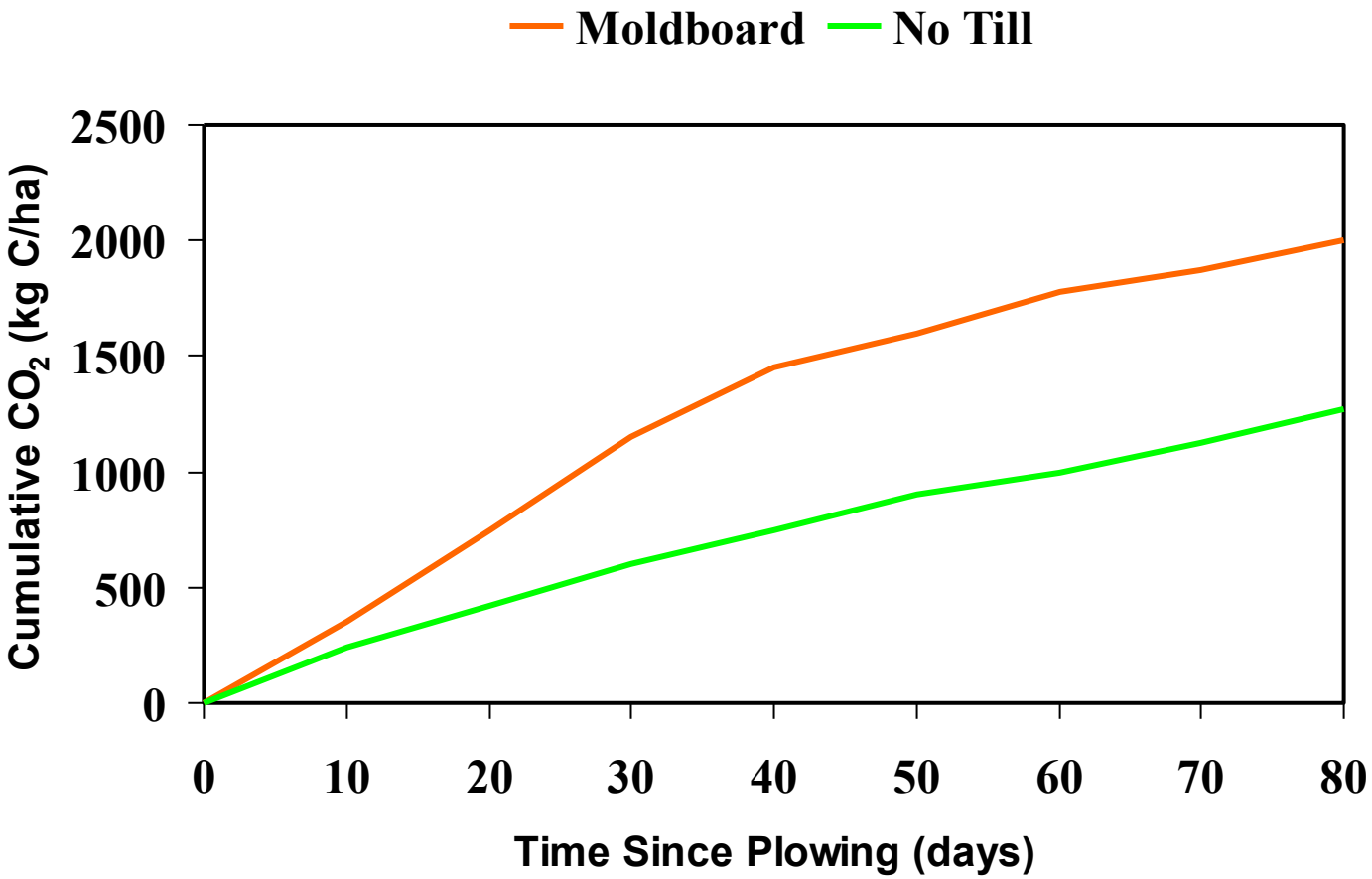
b) cations held on clay particle



c) cations held by organic chelate

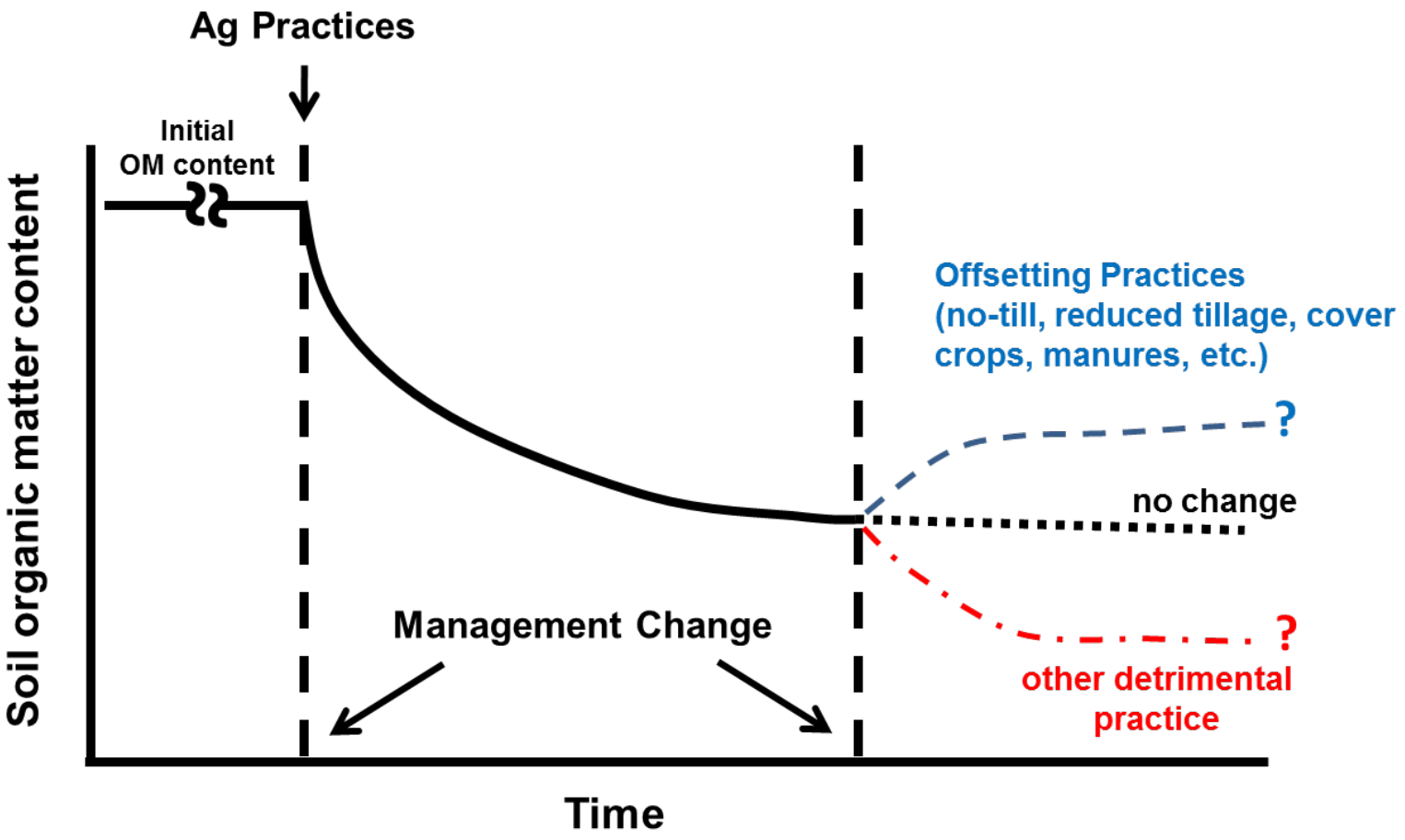
Source: Magdoff and van Es, 2009

How is Soil Organic Matter Lost?



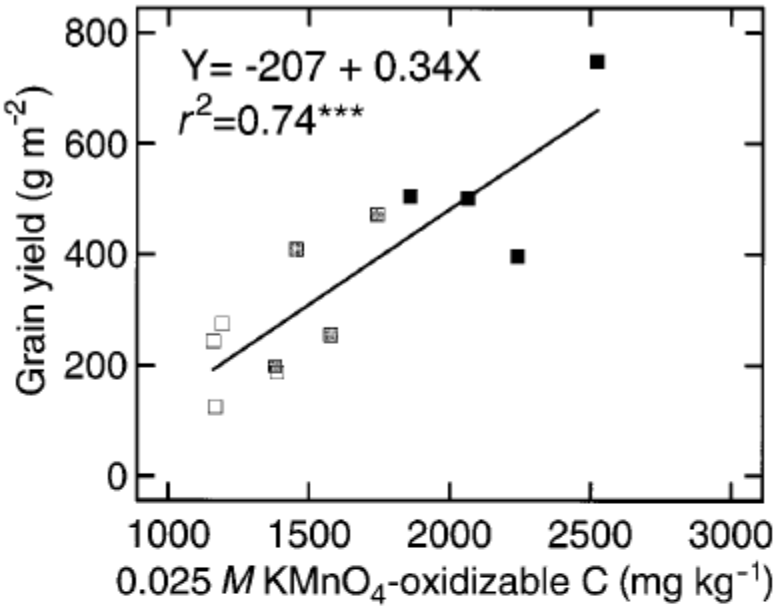
(Rochette and Angers, 1999)

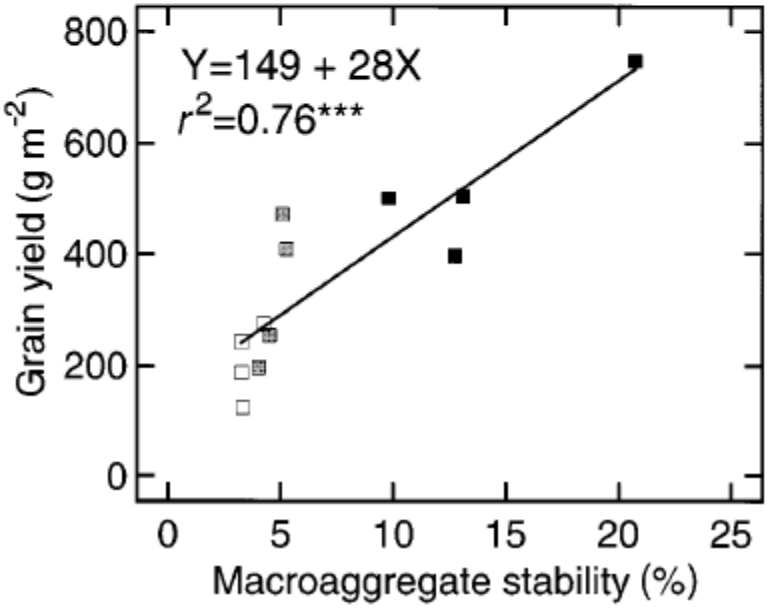
Farming for Soil Organic Matter



(adapted from National Academy of Sciences, 2009)

Corn Yield





Tillage:
- conventional
- reduced
- no-till

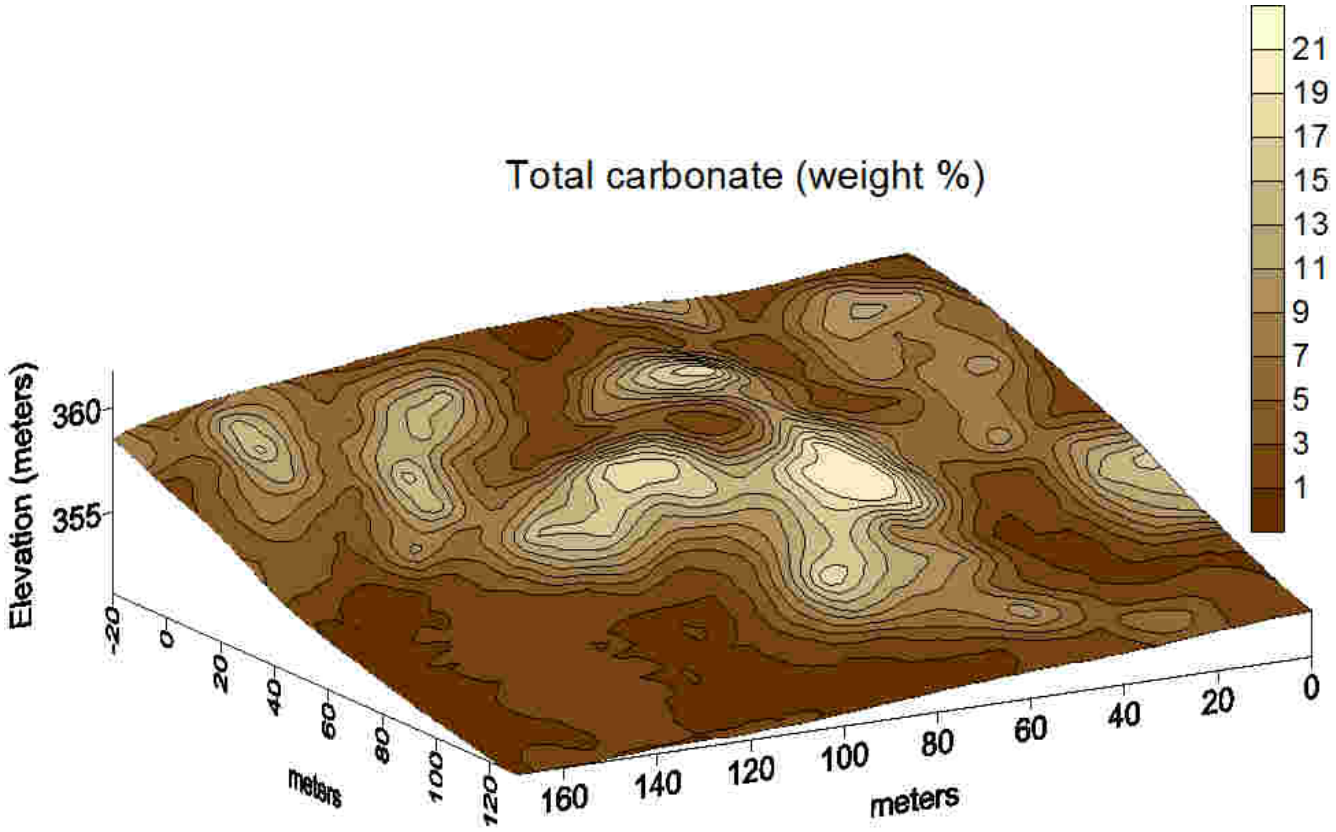
(Stine & Weil, 2002)

Why Does Soil Health Matters?

- Eroded field example:

source: S. Papiernik, 2013

Why Does Soil Health Matters?



source: S. Papiernik, 2013

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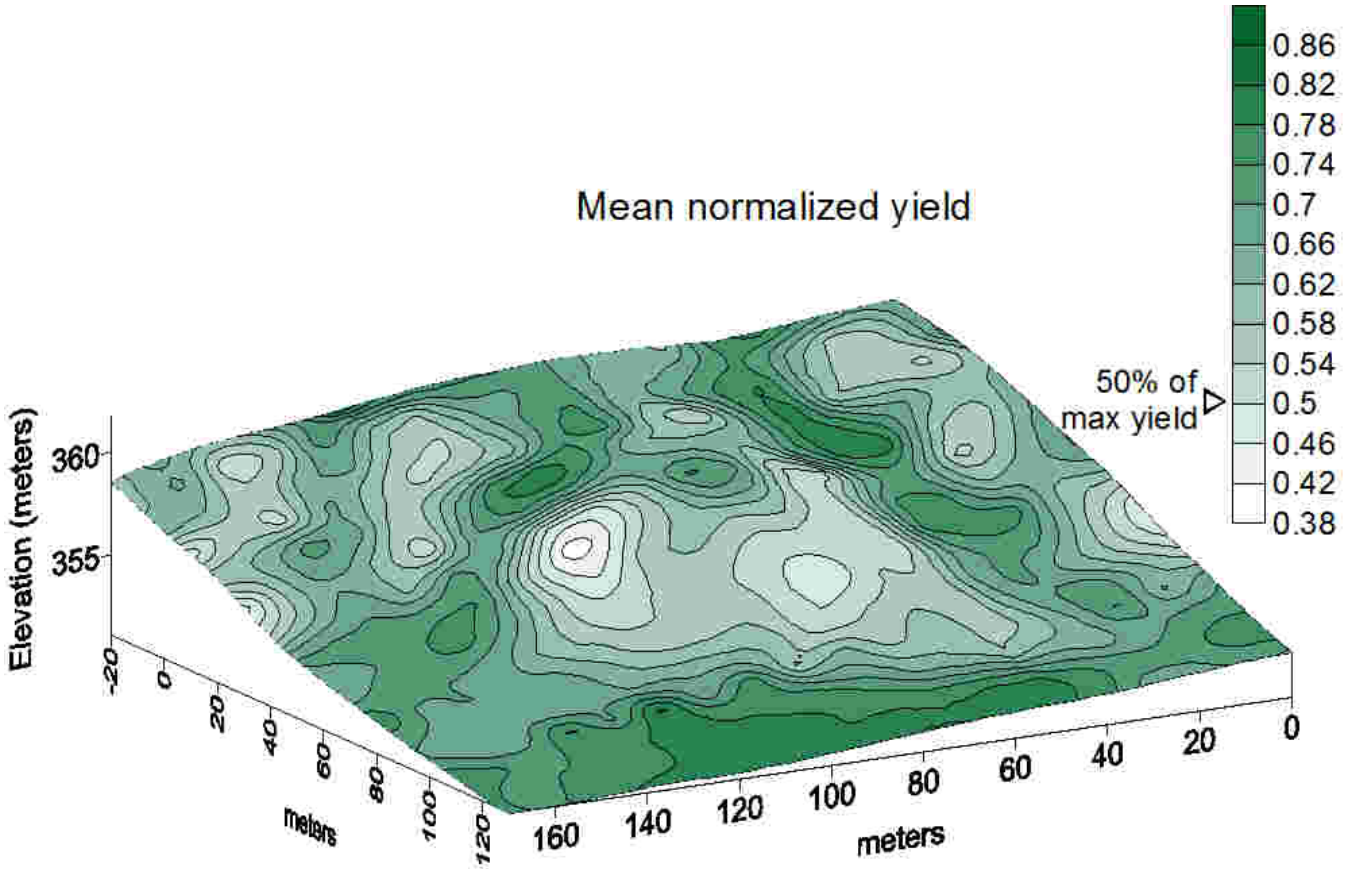

source: S. Papiernik, 2013

How Can the Health of a Soil be Improved?

Measurement	Process Affected
Organic matter	Nutrient cycling, pesticide and water retention, soil structure
Infiltration	Runoff and leaching potential, plant water use efficiency, erosion potential
Aggregation	Soil structure, erosion resistance, crop emergence, infiltration
pH	Nutrient availability, pesticide absorption and mobility
Microbial biomass	Biological activity, nutrient cycling, capacity to degrade pesticides
Forms of N	Availability to plants, leaching potential, mineralization and immobilization rates
Bulk density	Root penetration, water/air filled pores, biological activity
Topsoil depth	Rooting volume, water and nutrient availability
Available nutrients	Capacity to support plant growth, environmental hazard

(adapted from Karlen et al. SSSAJ , 1997)

It is About Management!

Source: Case Quick Start Guide


Licht & Al-Kaisi, 2004

Final Thoughts

Soil health is about managing SOM and aggregates…

Old woods

Kewaunee B horizon

Hay (2009-12); Corn (2013)

Corn silage-2 years

Corn silage-2 years