TEXAS A&M AGRILIFE RESEARCH

Improving Life through Science and Technology

Restoring Soil Carbon on Farms

Harvard Forest, Petersham, MA
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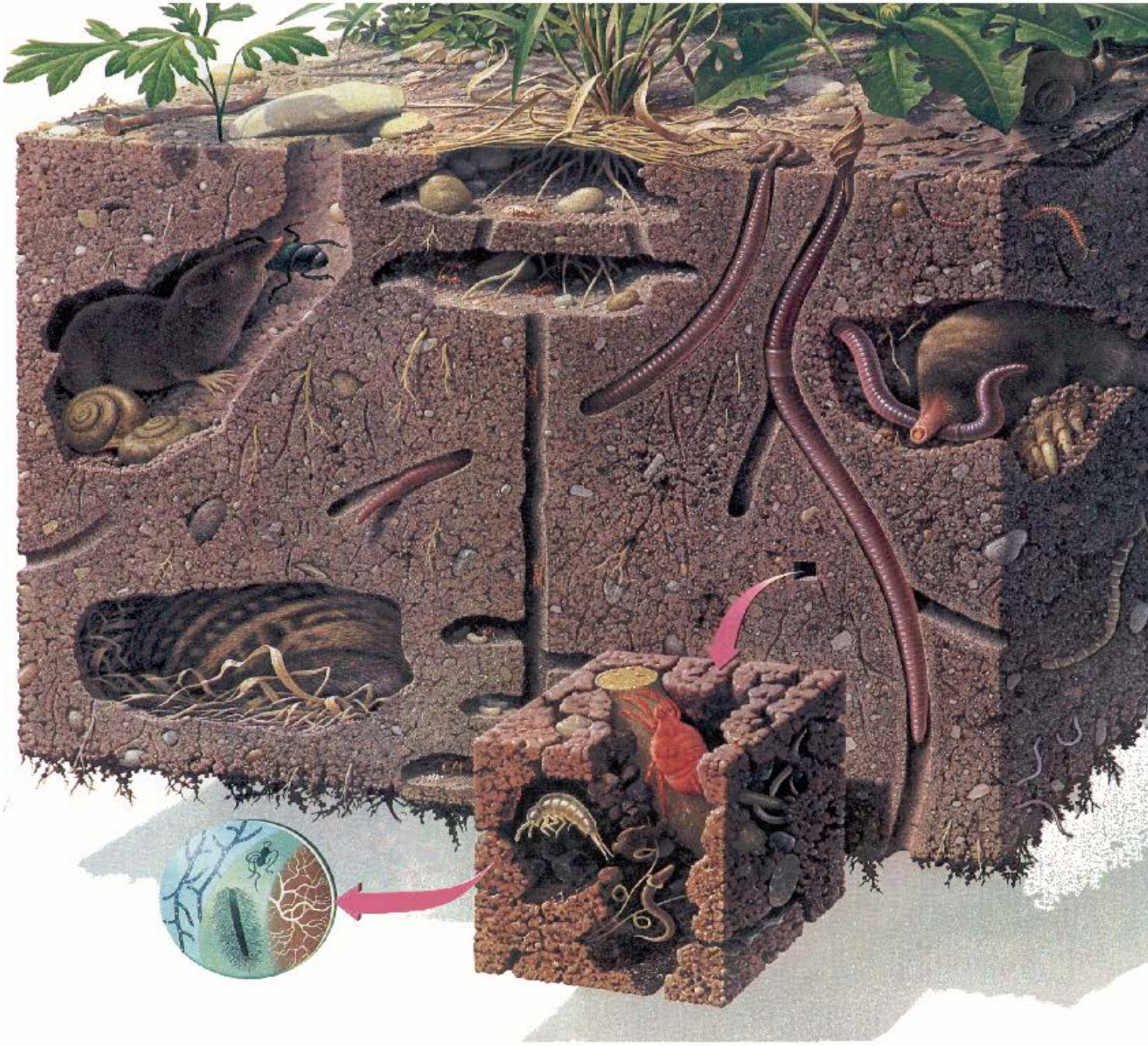
90% of Soil function is mediated by microbes

Microbes depend on plants

So how we manage plants is critical



The Four Ecosystem Processes

1. **Energy flow** – Maximize the flow of solar energy through plants and soil.

2. **Water cycle** – Maximize capture and cycling of water through plants and soil. Reduce export and import.

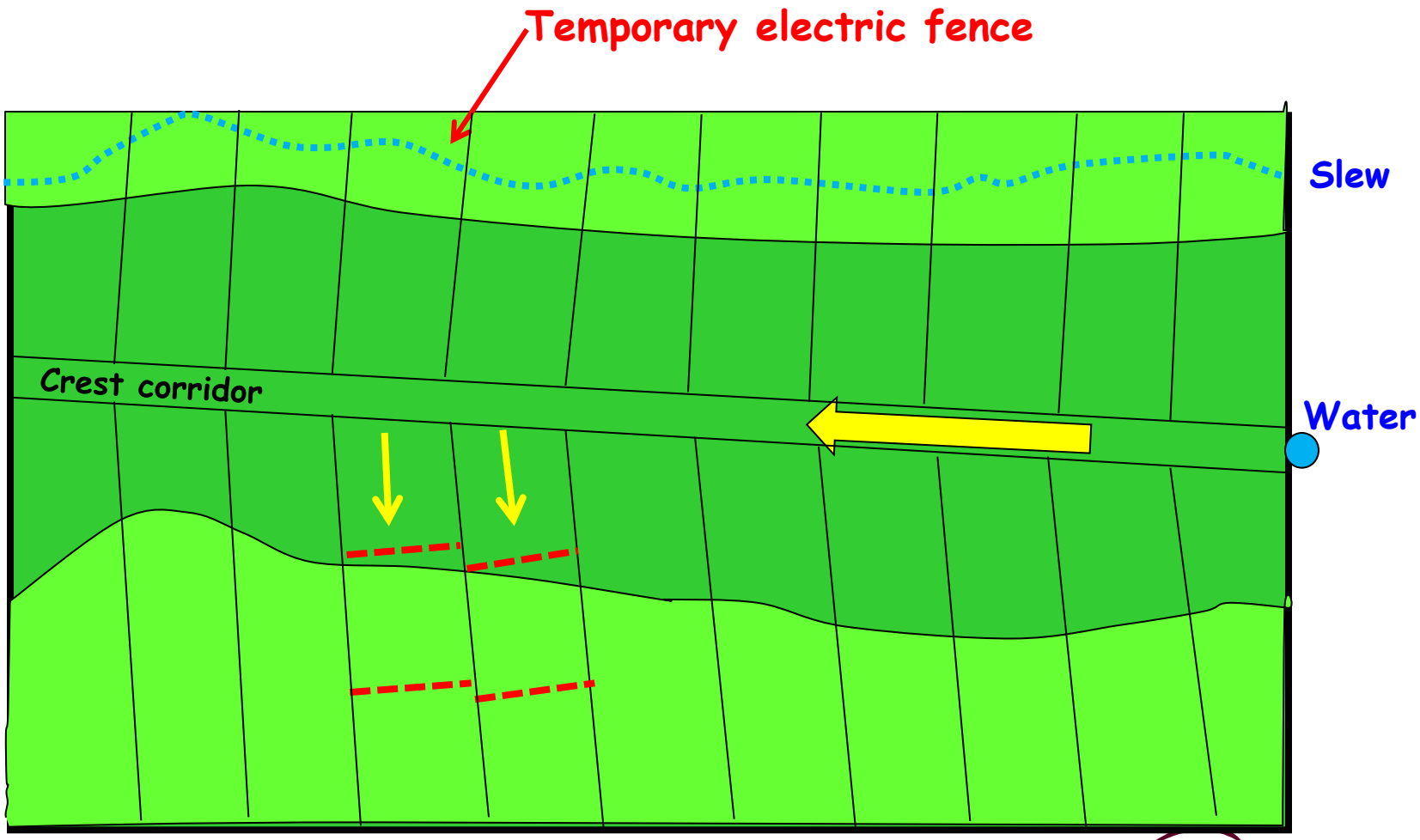
3. **Mineral cycle** – Maximize cycling of nutrients through plants and soil.

4. **Community dynamics** – High ecosystem biodiversity with more complex mixtures and combinations of desirable plant species leads to increased stability and productivity

Soil Microbes

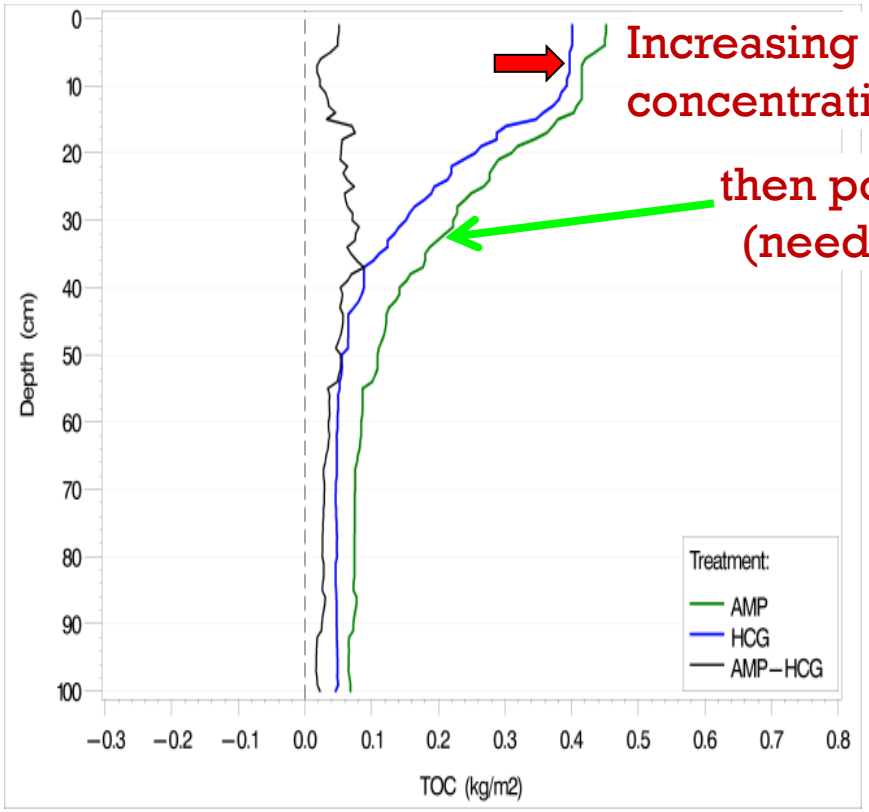
Parameter	Grazing Management			
	Heavy continuous	Light continuous	Multi-paddock	Grazing exclosure
Total bacteria (g m^{-2})	82a	74a	78a	98a
Total fungi (g m^{-2})	97b	98b	174a	105ab
Fungi to Bacteria ratio	1.2b	1.1b	3.1a	0.7b

Flexible management

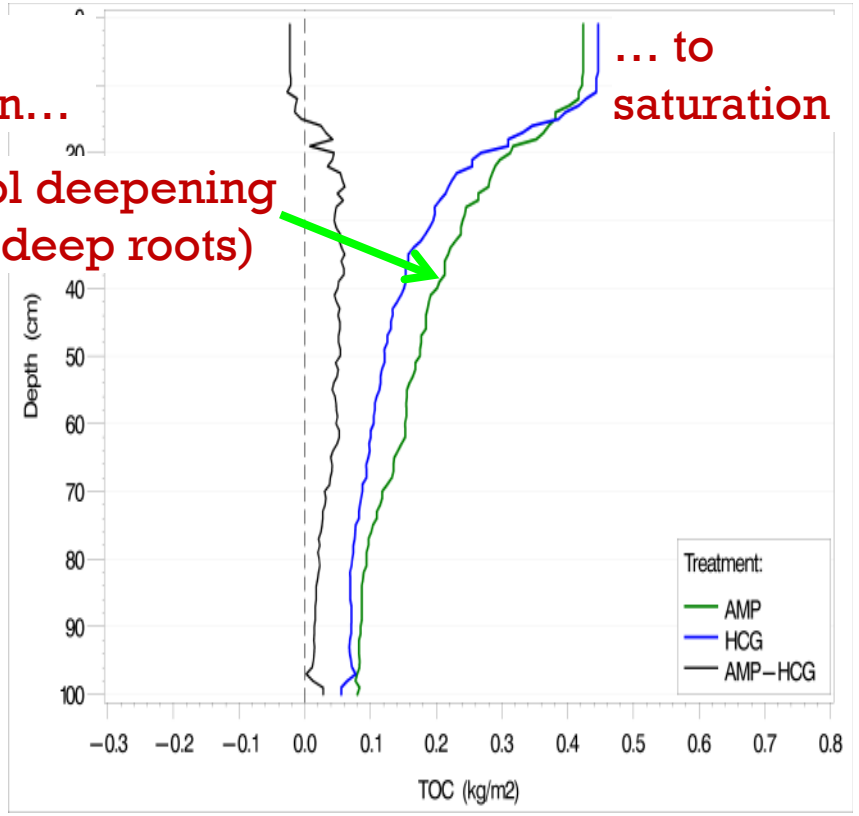


2 Dimensions Drive Total Carbon Pool

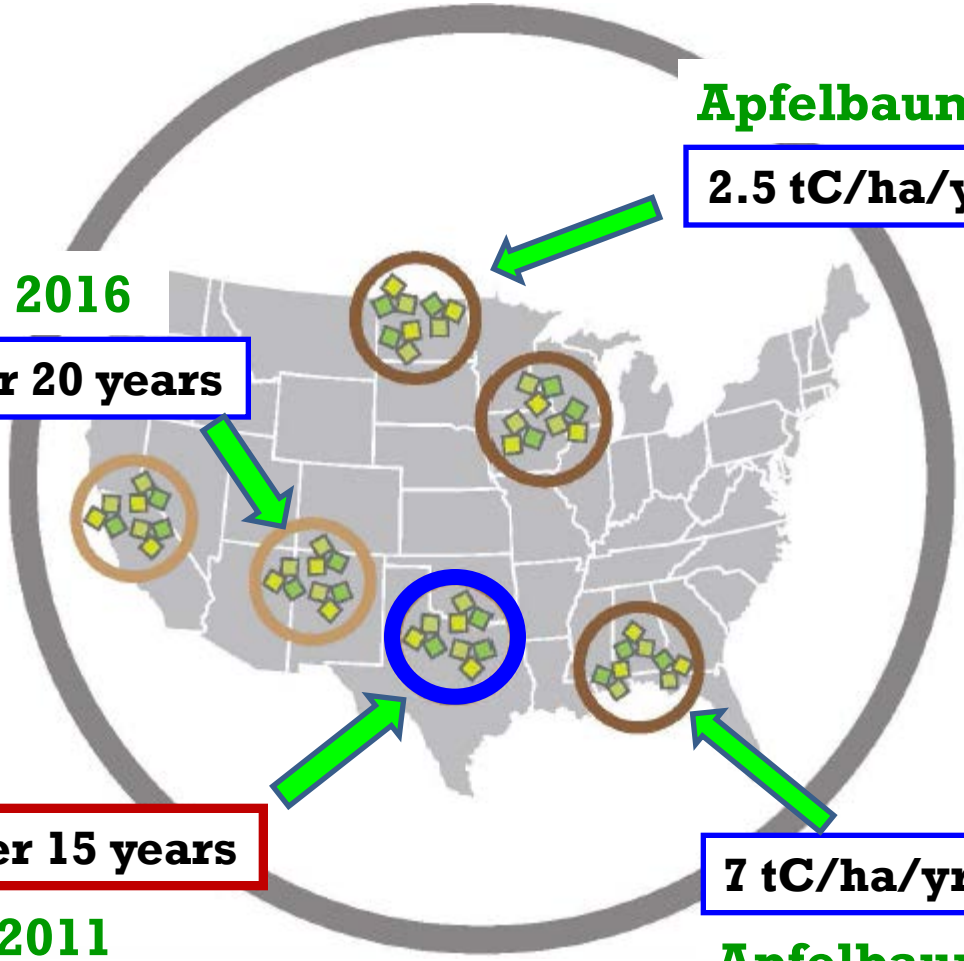
Towers – planted pastures



Cross – native grasses



Published & Reconnaissance Sampling



Apfelbaum et al 2016

2.5 tC/ha/yr over 20 years

Apfelbaum et al 2016

< 0.5 tC/ha/yr over 20 years

3 tC/ha/yr over 15 years

Teague et al. 2011

7 tC/ha/yr over 5 years

Apfelbaum et al 2015

To improve pasture soil health

Improve soil microbe population by:

- Perennial plants rather than annuals
- Manage for most productive plants
- Leave adequate plant residue
- Use diverse species mixes and cover crops
- Eliminate tillage
- Cover the soil
- Use organic soil amendments
- Reduce N-fertilizer use
- Grow plants for maximum days each year

Delgado et al 2011; Rodale 2014; Jones, 2014

Keys to Healthy Cropping Soils

- Minimize mechanical disturbance
- Cover the soil surface
- Use high plant diversity
- Grow plants as many days as possible
- Integrate livestock on cropland

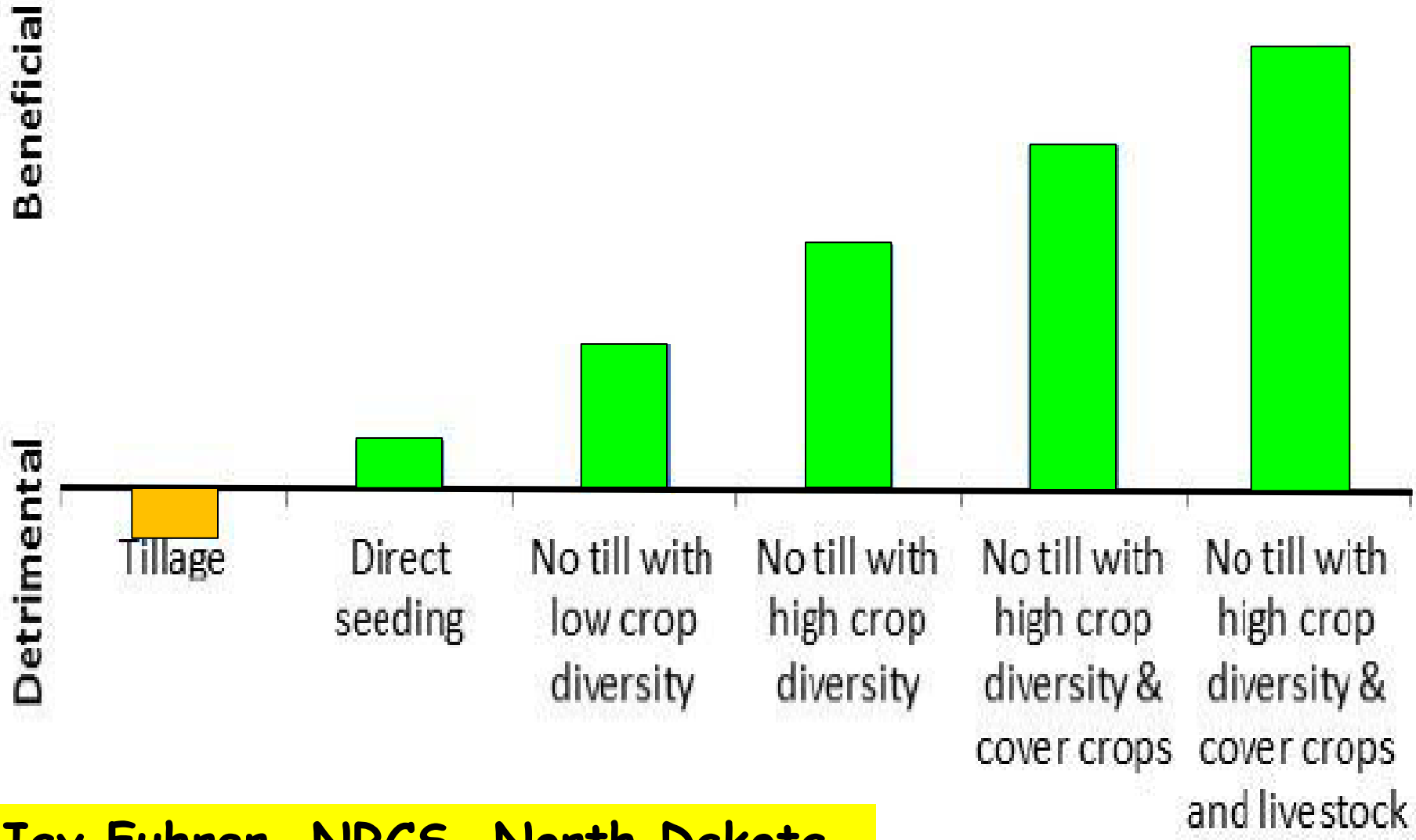
Delgado et al 2011; Rodale 2014; Jones, 2014

Cover Crops: a key to improving soil health

- Cover soil
- Build organic matter
- Build soil aggregates
- Improve water cycle
- Enhance nutrient cycling
- Enhance fertility
- Improve C/N ratio
- Provide crop diversity
- Enhance pollinators
- Wildlife habitat
- Livestock integration

Cropland Soil Health Timeline

How different cropping practices affect soil health



Jay Fuhrer, NRCS, North Dakota


END

Importance of Microbes and Fungi

- Improve soil structure
- Produce and cycle nutrients plants need
- Access and transport nutrients to plants
- Promote efficient photosynthesis
- Extend root volume and depth
- Produce exudates to enhance soil C
- Increase water and nutrient retention
- Increase drought resistance
- Fend off pests and pathogens
- Plant growth increases with increasing fungal to bacterial ratio

Lehman et al. 2015; Montgomery & Biklé 2015