

# Restoring Soil Health and Ranch Livelihoods



Harvard Forest, Petersham, MA  
7<sup>th</sup> September, 2016

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90% of Soil  
function is  
mediated by  
microbes

Microbes  
depend on  
plants

So how we  
manage plants  
is critical

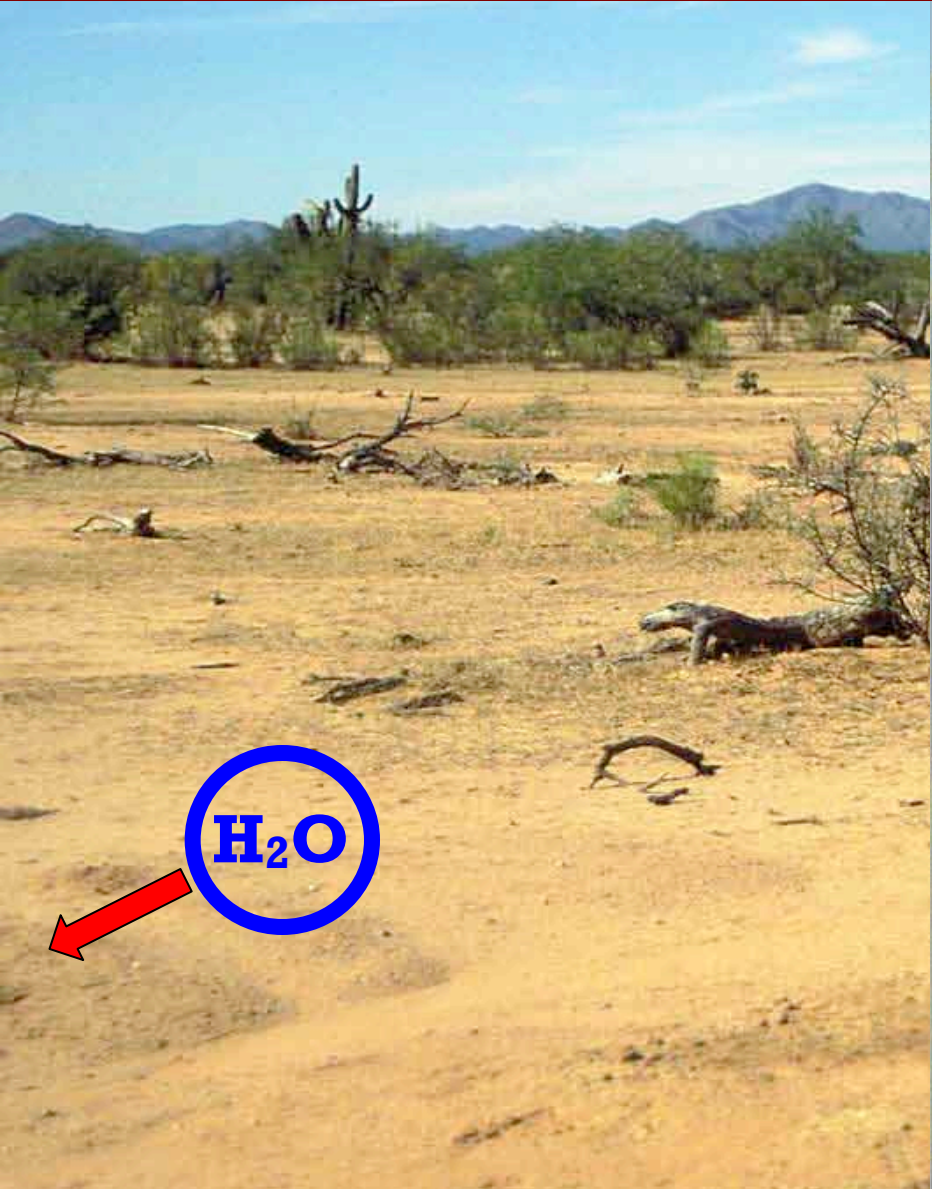






# Biggest limiting factor in Rangeland

## Water in the Soil



# The Four Ecosystem Processes

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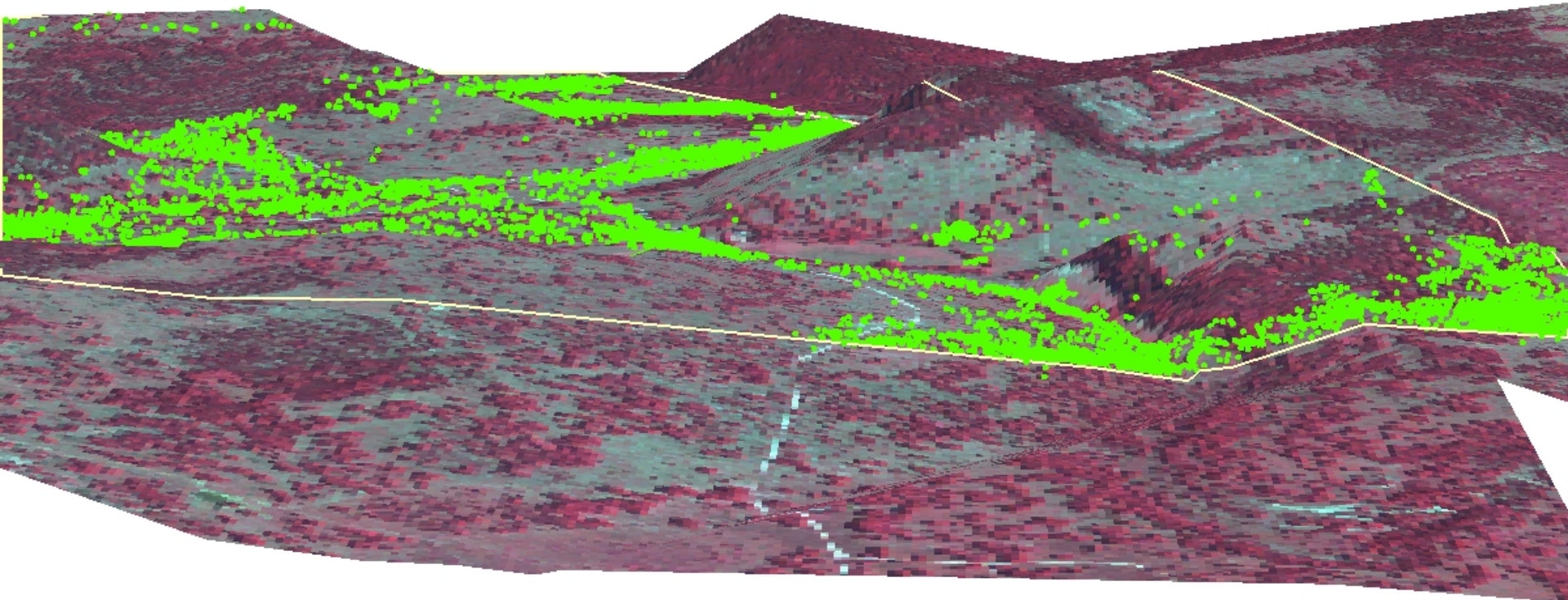
- 1. Energy flow** - Maximize the flow of solar energy through plants and soil.
- 2. Water cycle** - Maximize capture and cycling of water through plants and soil. Reduce export and import.
- 3. Mineral cycle** - Maximize cycling of nutrients through plants and soil.
- 4. Community dynamics** - High ecosystem biodiversity with more complex mixtures and combinations of desirable plant species leads to increased stability and productivity



# Landscape impact of continuous grazing

## Edwards Plateau Ranch 3-D View w/ GPS Locations

1. 39% area used
2. 41% GPS points on 9% area
3. SR: 21 ac/cow
4. Effective SR: 9 ac/cow



## **Light continuous grazing**

- patch selection
- no recovery



Many graziers use regenerative Multi Paddock grazing successfully

Most conservation winners use MP grazing



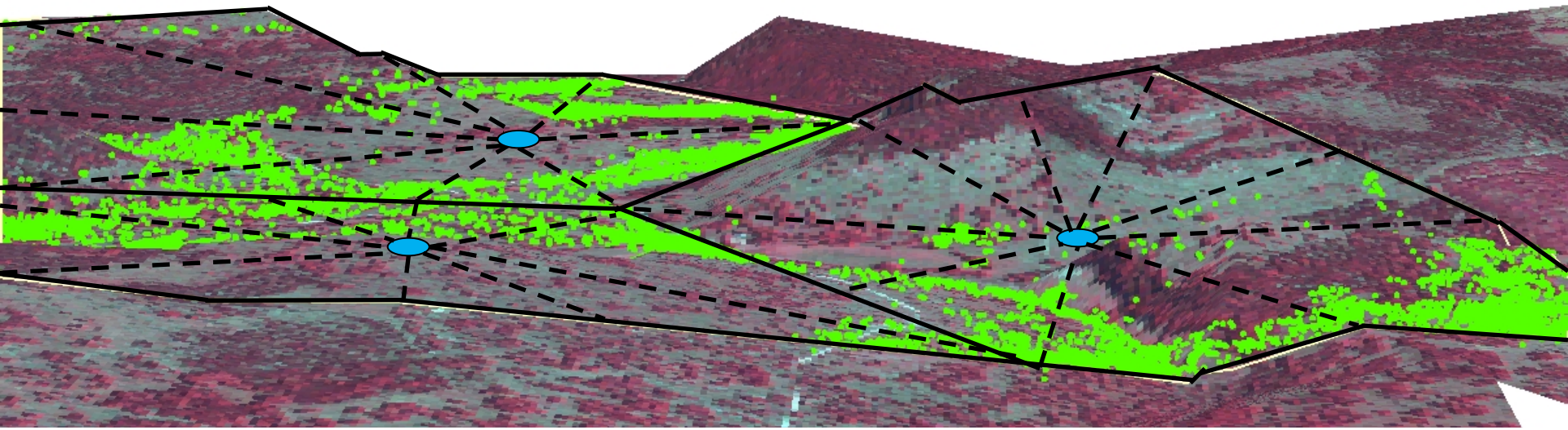
- Overgrazing has little to do with number of animals.
- But with the amount of time plants are exposed to animals.



# Regenerative multi-paddock grazing

## Manager can control:

- How much is grazed
- The period of grazing, and
- The length and time of recovery
- Use livestock to enhance wildlife habitat

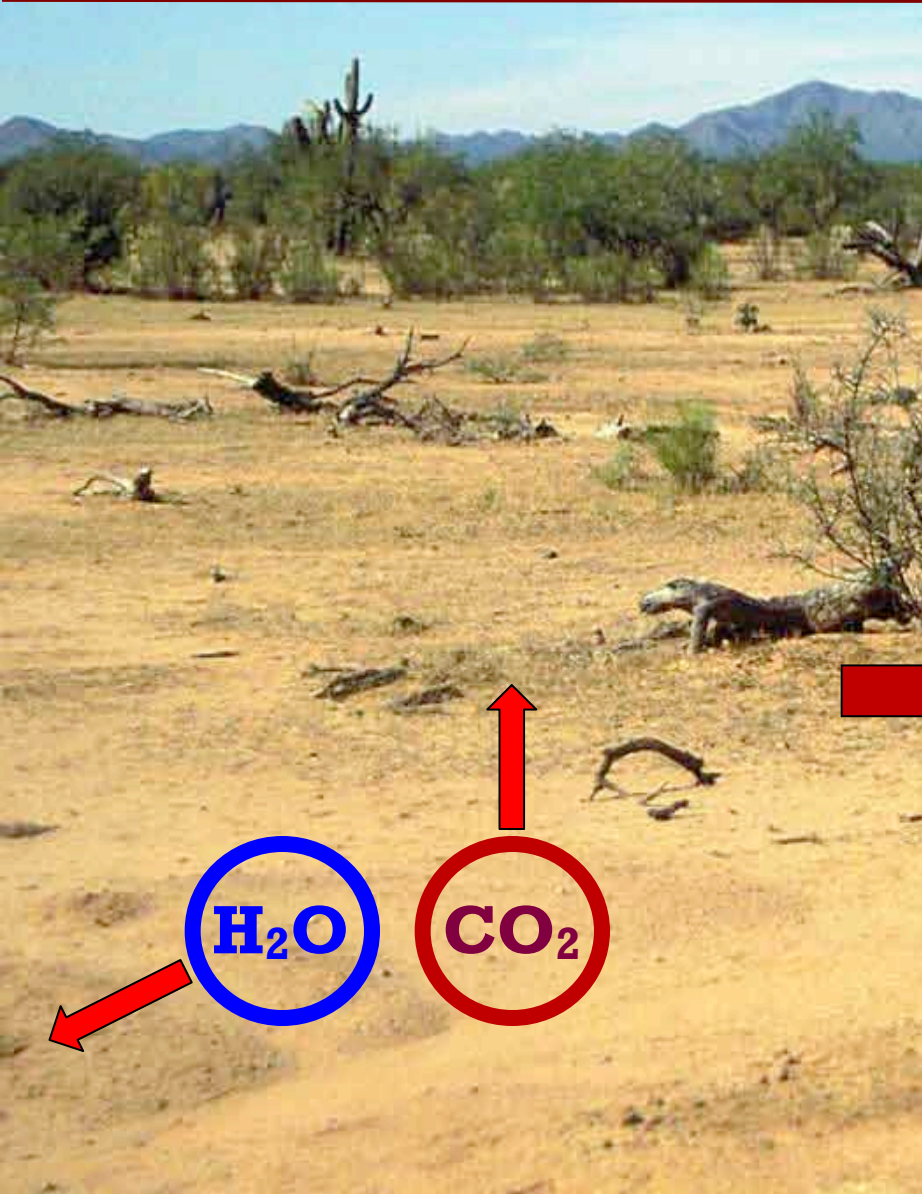


## Animals:

- Graze more of the whole landscape
- Select a wider variety of plant species

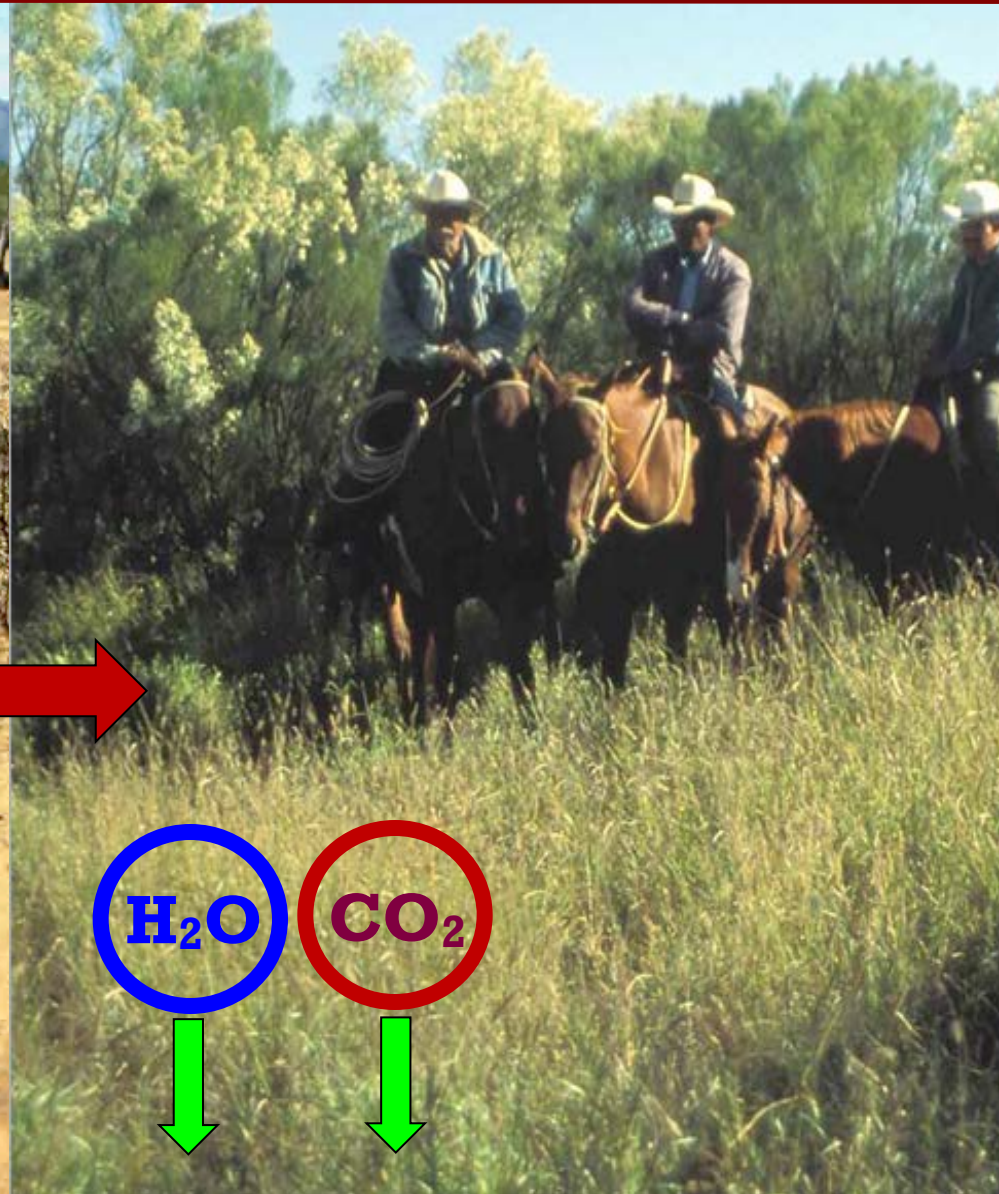


# North America - Semi-Arid Rangeland



$H_2O$   $CO_2$

**Continuous grazing**



$H_2O$   $CO_2$

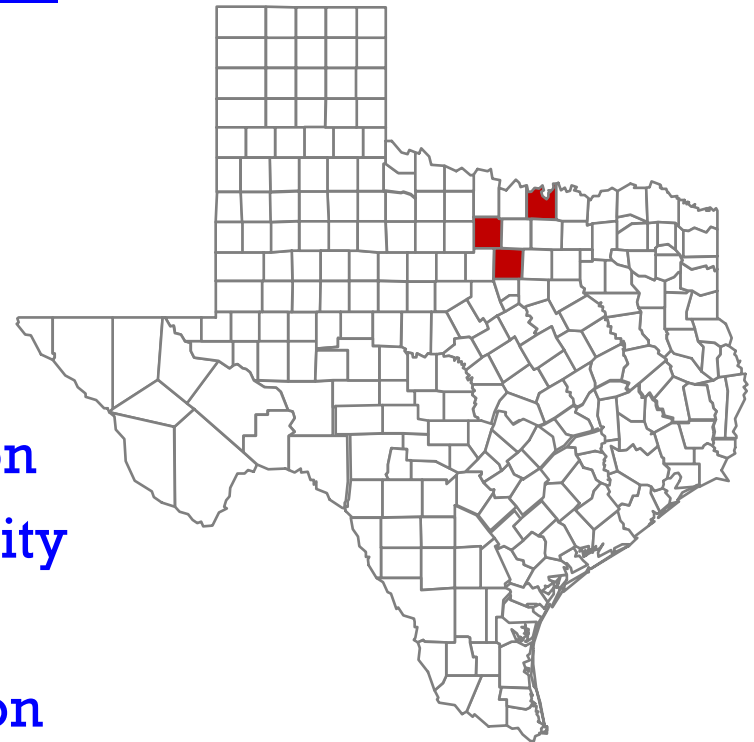
**Regenerative MP grazing**

# Texas Grazing Research

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Using AMP grazing 3 Texas ranchers :

- Added 3 tons Carbon /ha/year **more** than their 3 heavy continuous (HC) grazing neighbors
- Decreased bare ground
- Improved soil physical structure
- Bolstered soil fertility
- Enriched soil microbial composition
- Improved soil water holding capacity
- Enhanced plant productivity
- Improved plant species composition
- Increased livestock production





# Causal Mechanisms

## Multi-paddock grazing with

- Short graze
- Good recovery



## Light continuous grazing

- patch selection
- no recovery





**Low density  
continuous grazing**



**High density MP  
grazing**





# MP Grazing



# No-grazing





**Continuous grazing**



**Infiltration = 1 in/hr**

**Regenerative Grazing**



**Infiltration = 8-10 in/hr**





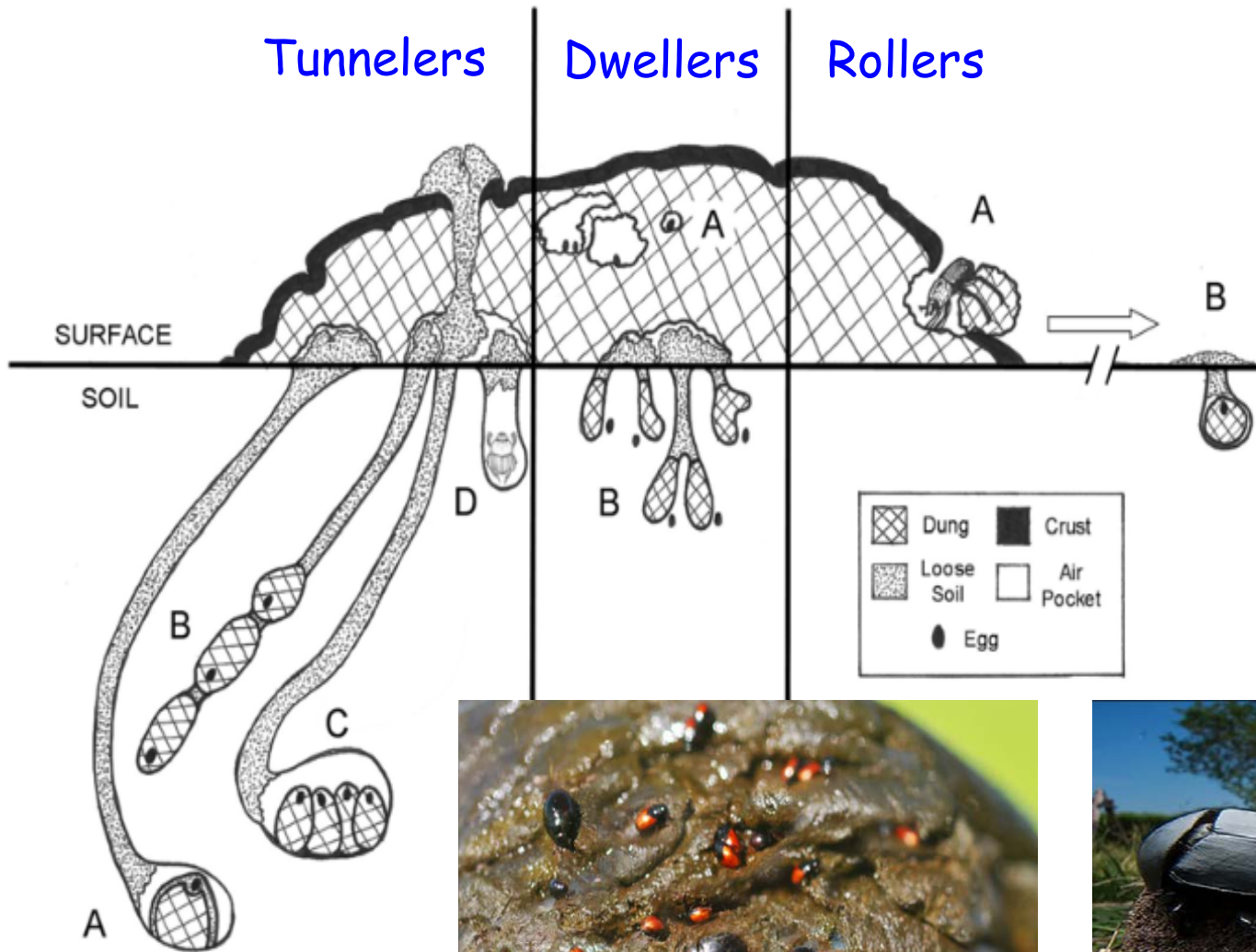
# Importance of Microbes and Fungi

- 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



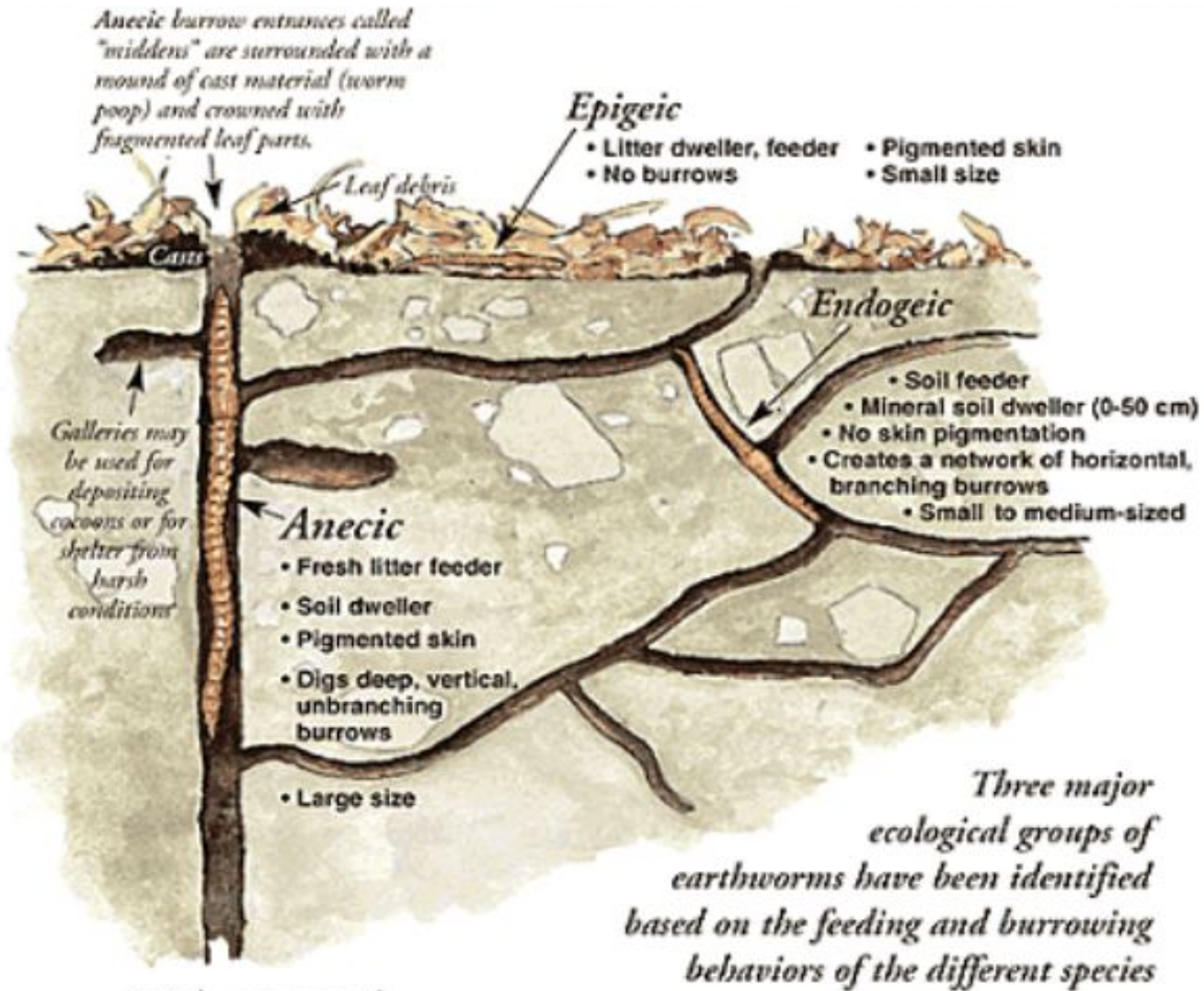
# Dung beetles in the Ecosystem



**Estimated value ± \$2 Billion per year**



# Earthworms in the ecosystem





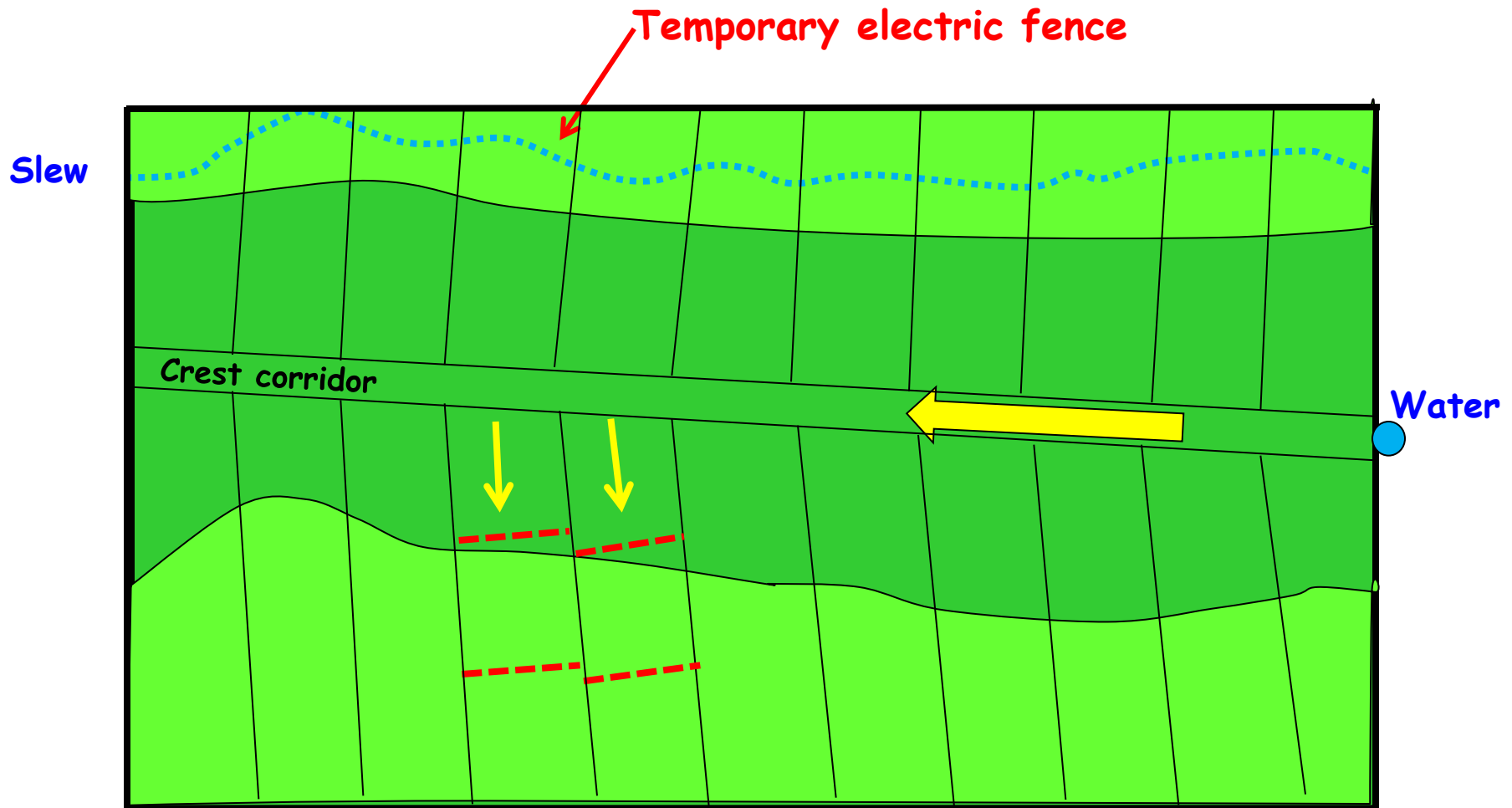
# High density Regenerative MP grazing



- 200 cows drop 25 tons of dung a week
- Increase infiltration ~ 130%



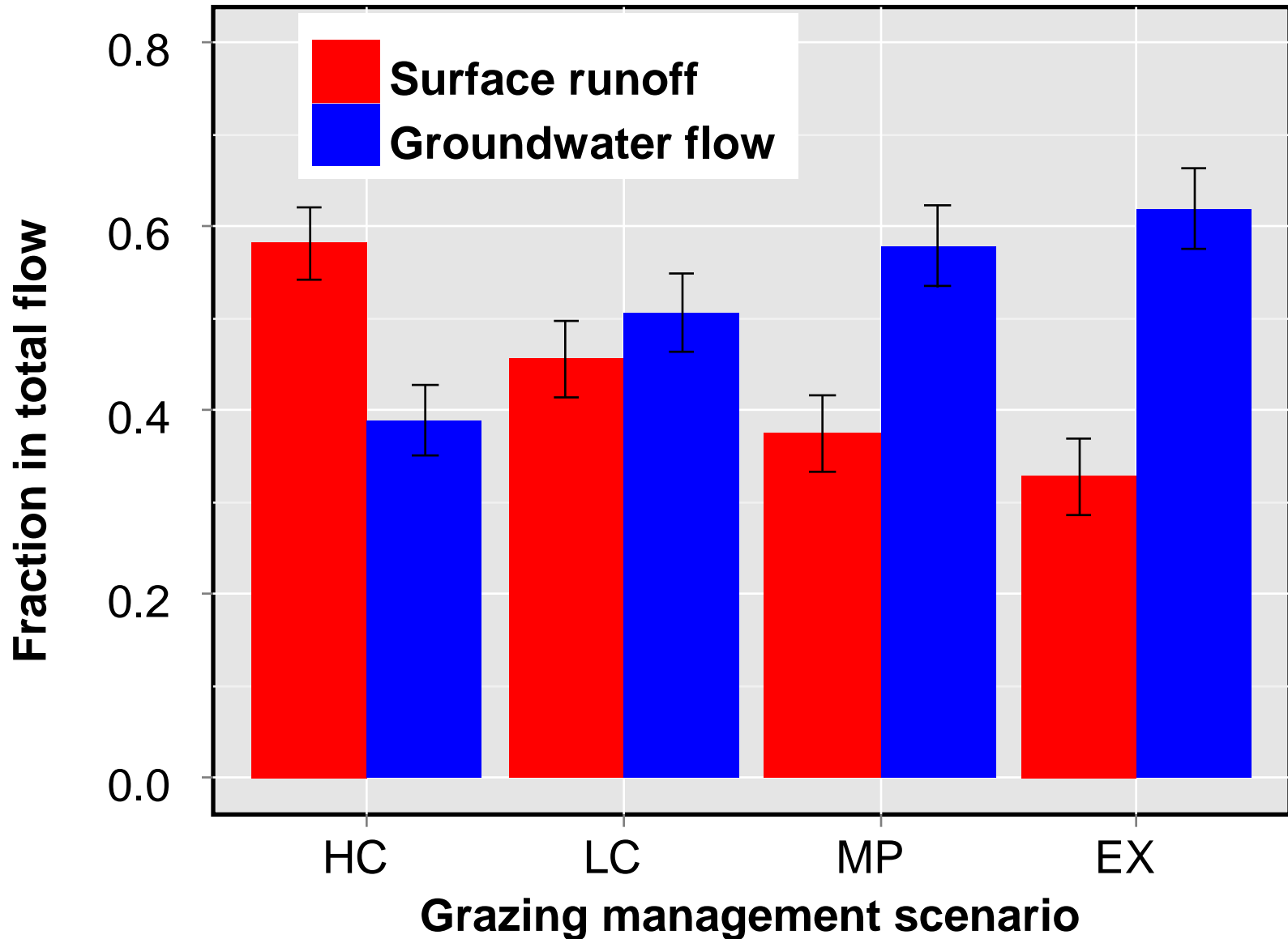
# Flexible management







# Clear Creek watershed, North Texas





# Published & Reconnaissance Sampling

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**Apfelbaum et al 2016**

**< 0.5 tC/ha/yr over 20 years**

**Apfelbaum et al 2016**

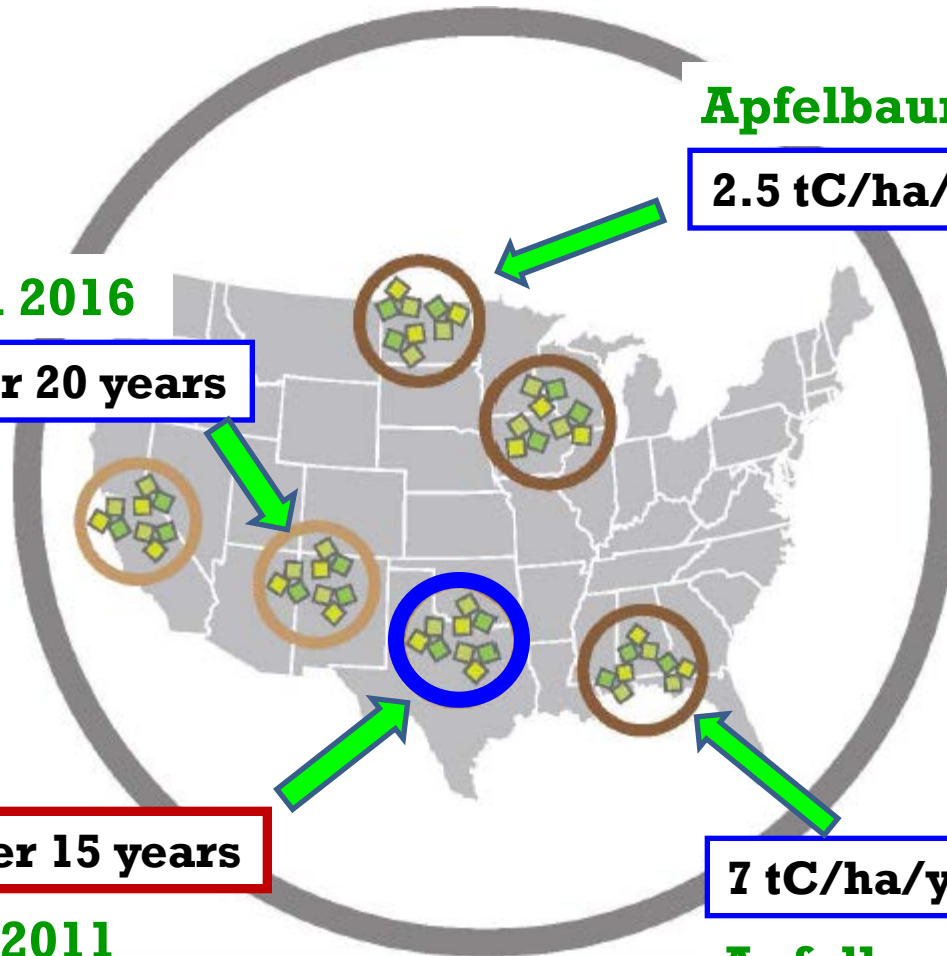
**2.5 tC/ha/yr over 20 years**

**3 tC/ha/yr over 15 years**

**Teague et al. 2011**

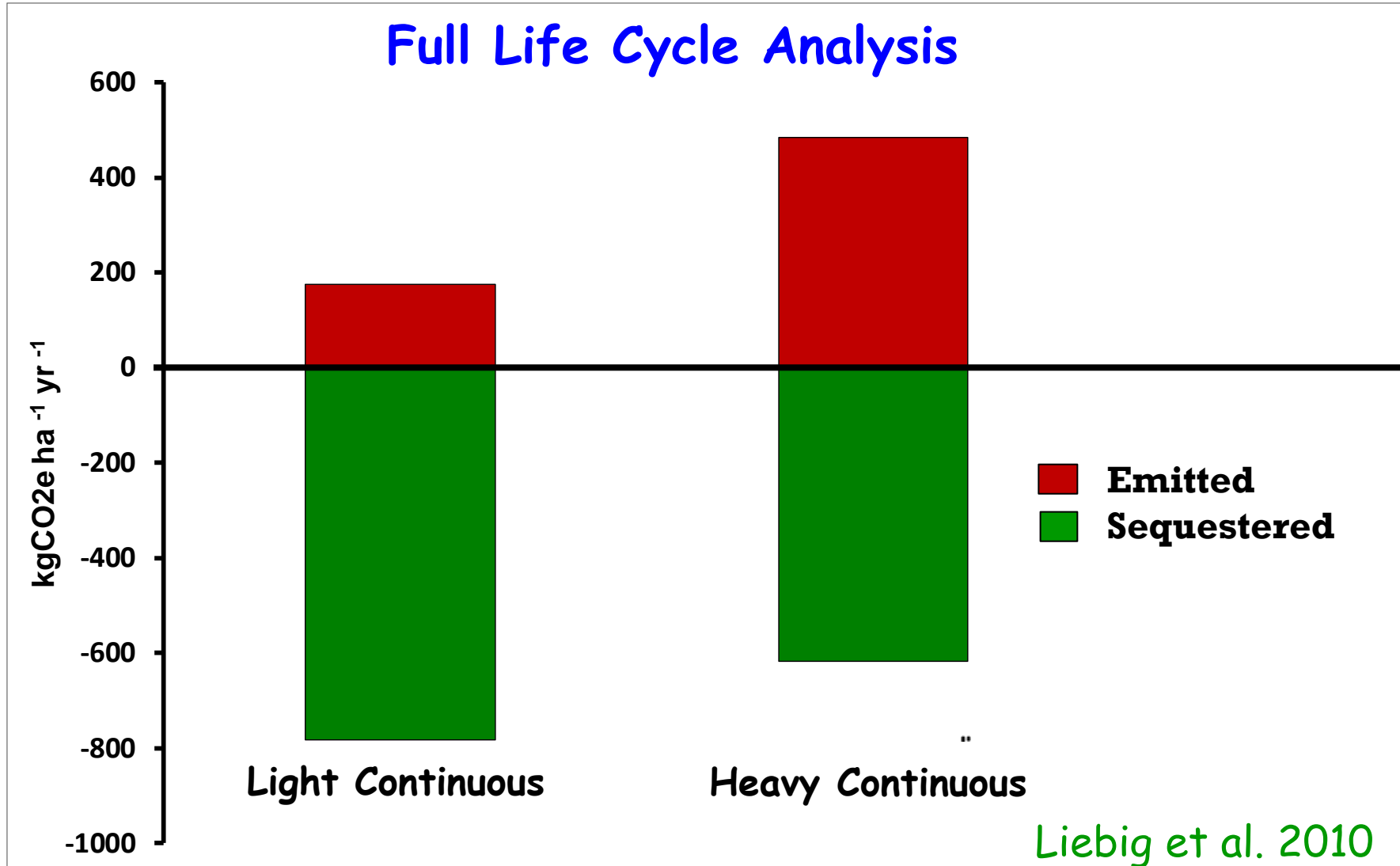
**7 tC/ha/yr over 5 years**

**Apfelbaum et al 2015**



# Carbon Sinks and Emissions:

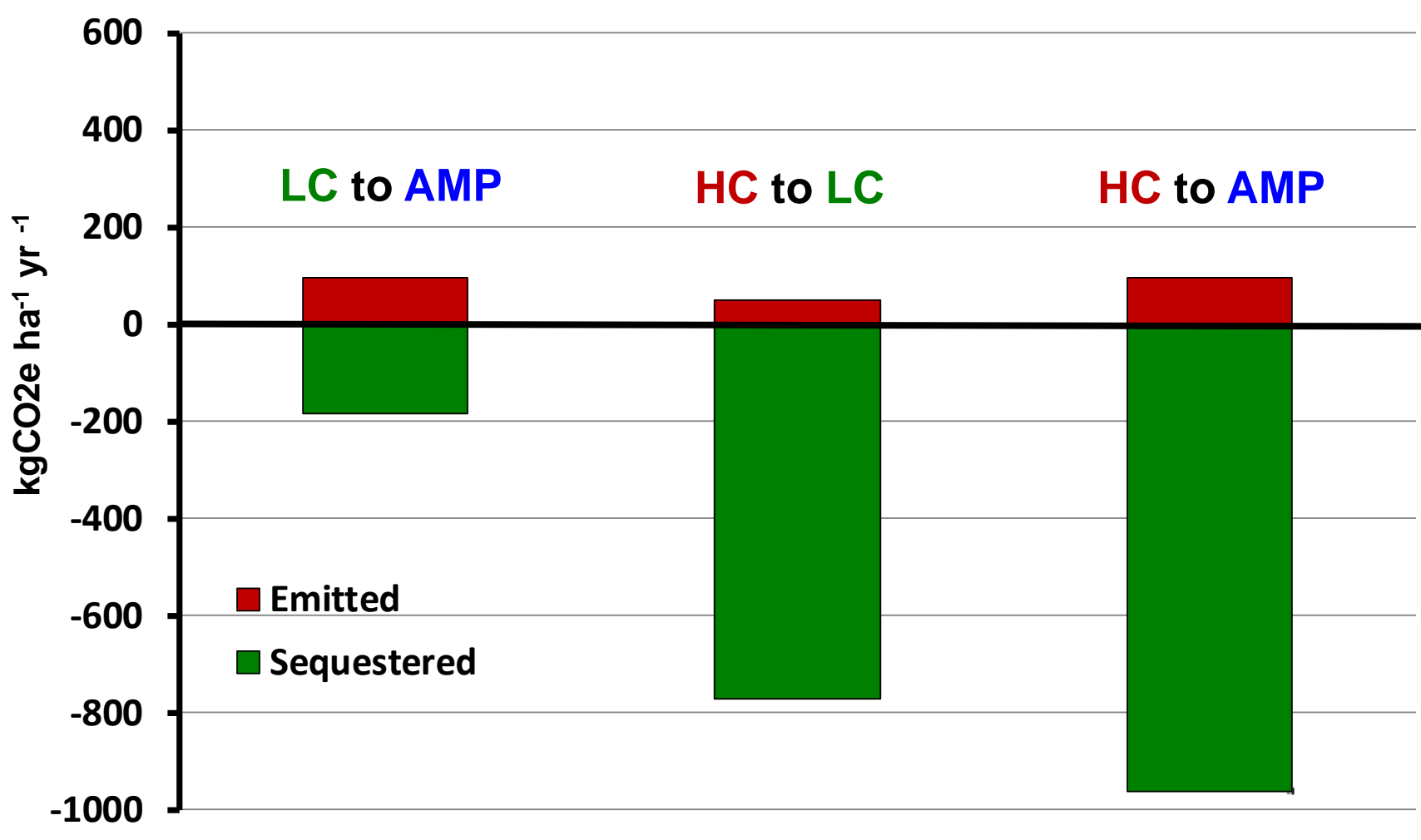
Northern Plains grazing only Cattle Operations





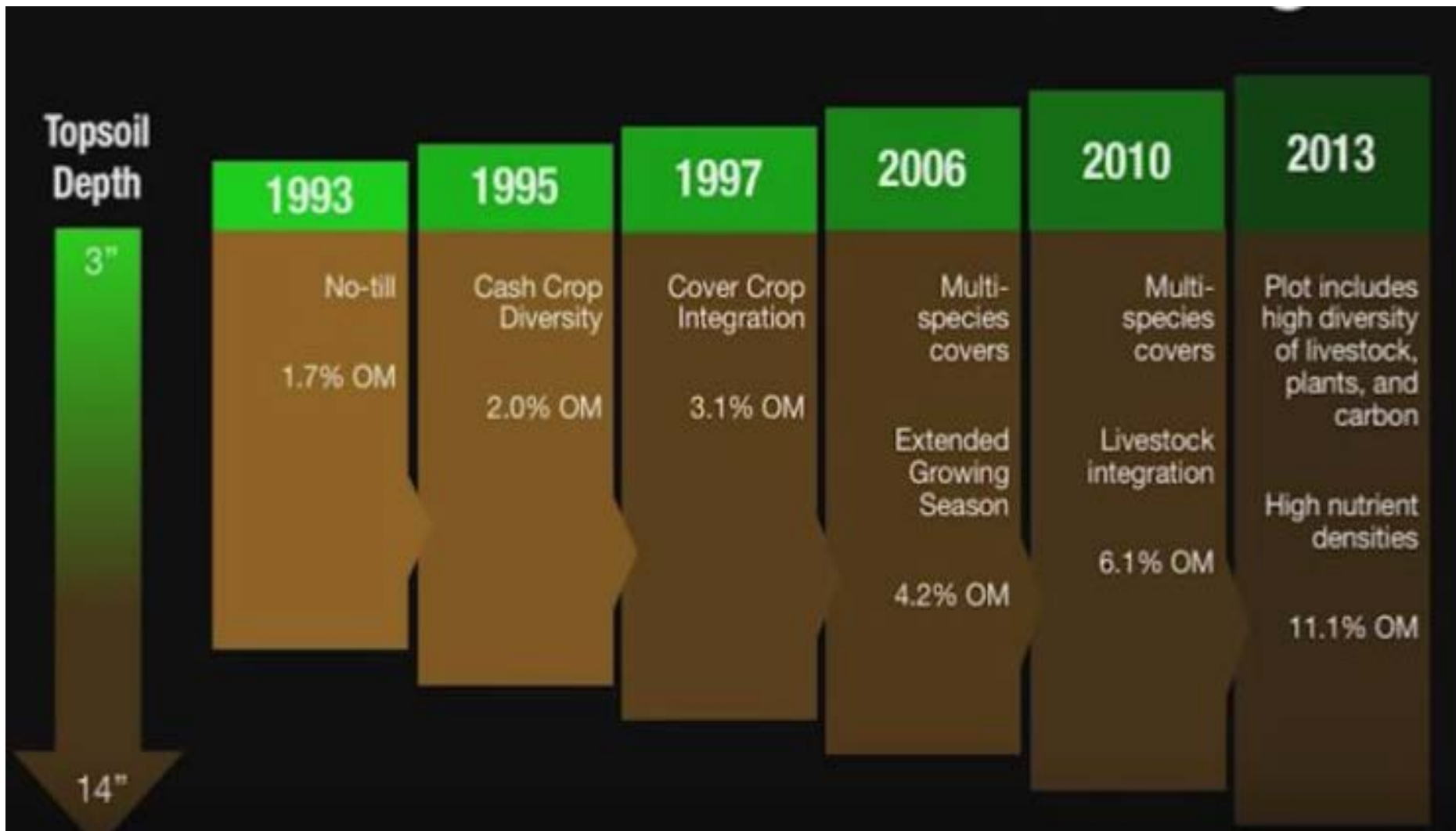
# Life Cycle Analysis of Change in Management

## Net C Emissions on grazing only Cow-calf Operations



# Cropland Soil Health

How different management practices influence soil health



Jay Fuhrer, NRCS, North Dakota





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Neil Dennis, Saskatchewan