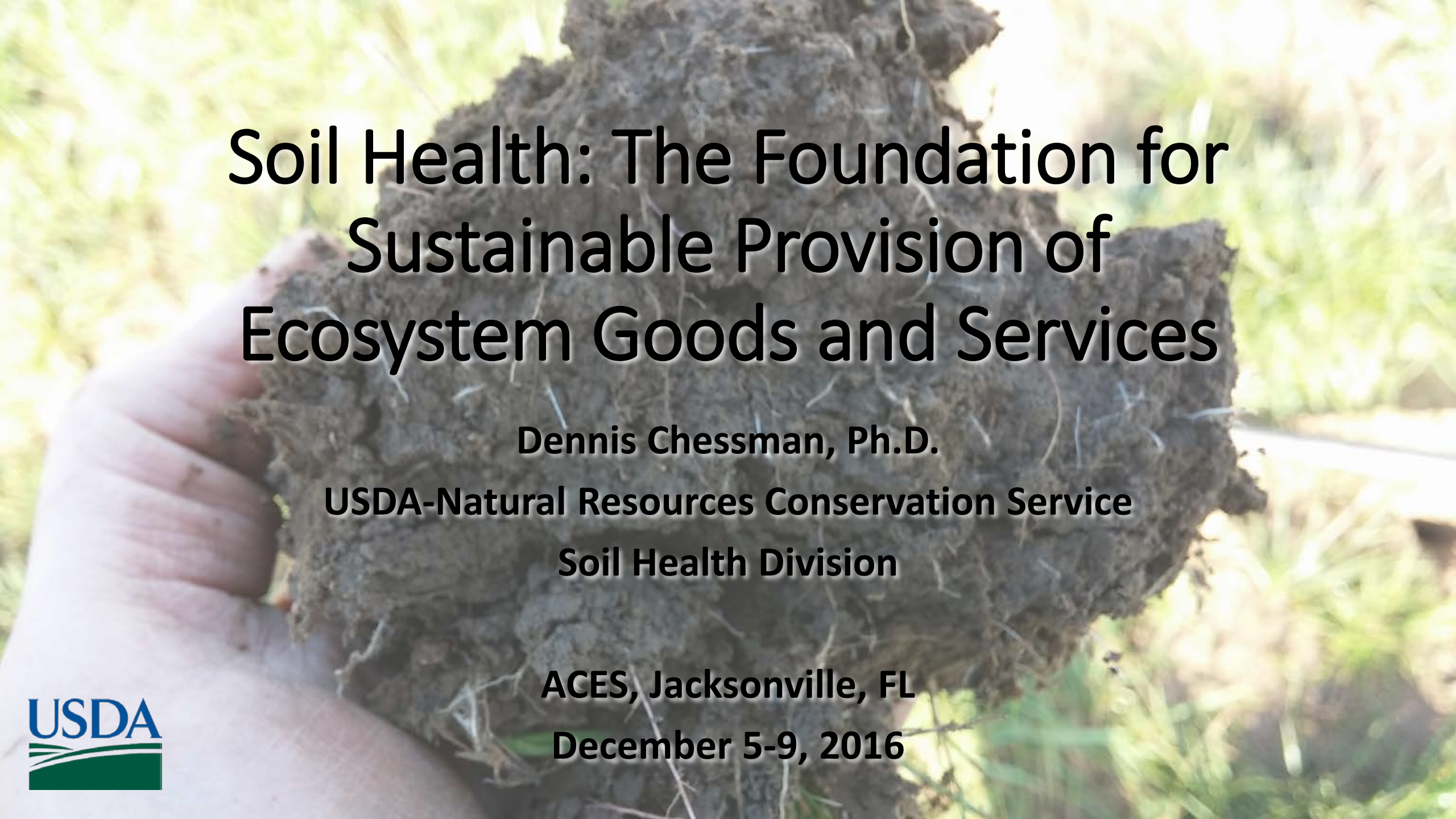

Soil Health: The Foundation for Sustainable Provision of Ecosystem Goods and Services

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USDA-Natural Resources Conservation Service

Soil Health Division

ACES, Jacksonville, FL

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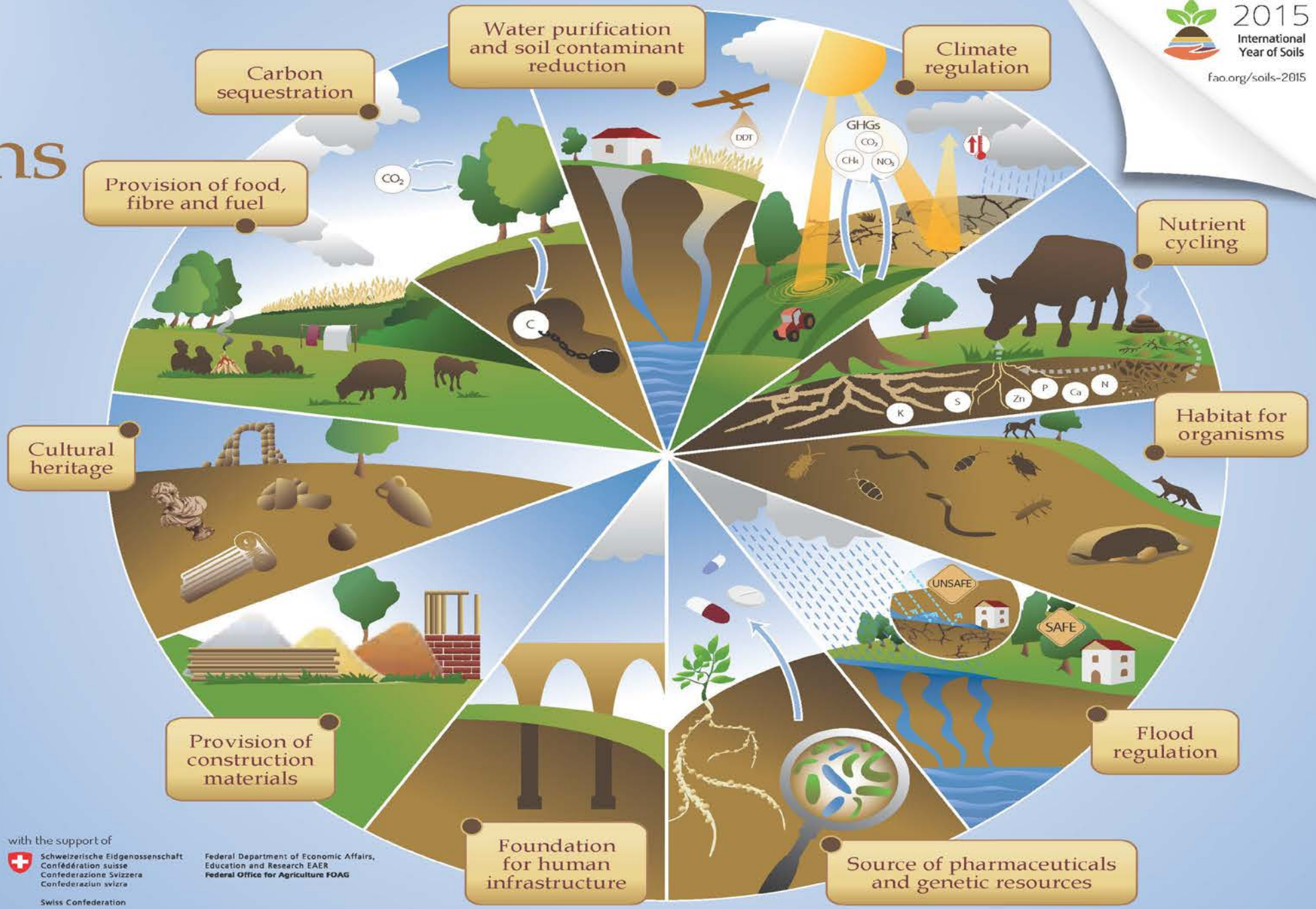
USDA

Soil functions

Soils deliver ecosystem services that enable life on Earth



2015 International Year of Soils

fao.org/soils-2015

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What is Soil Health?

According to NRCS and the Soil Health Institute

- The continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

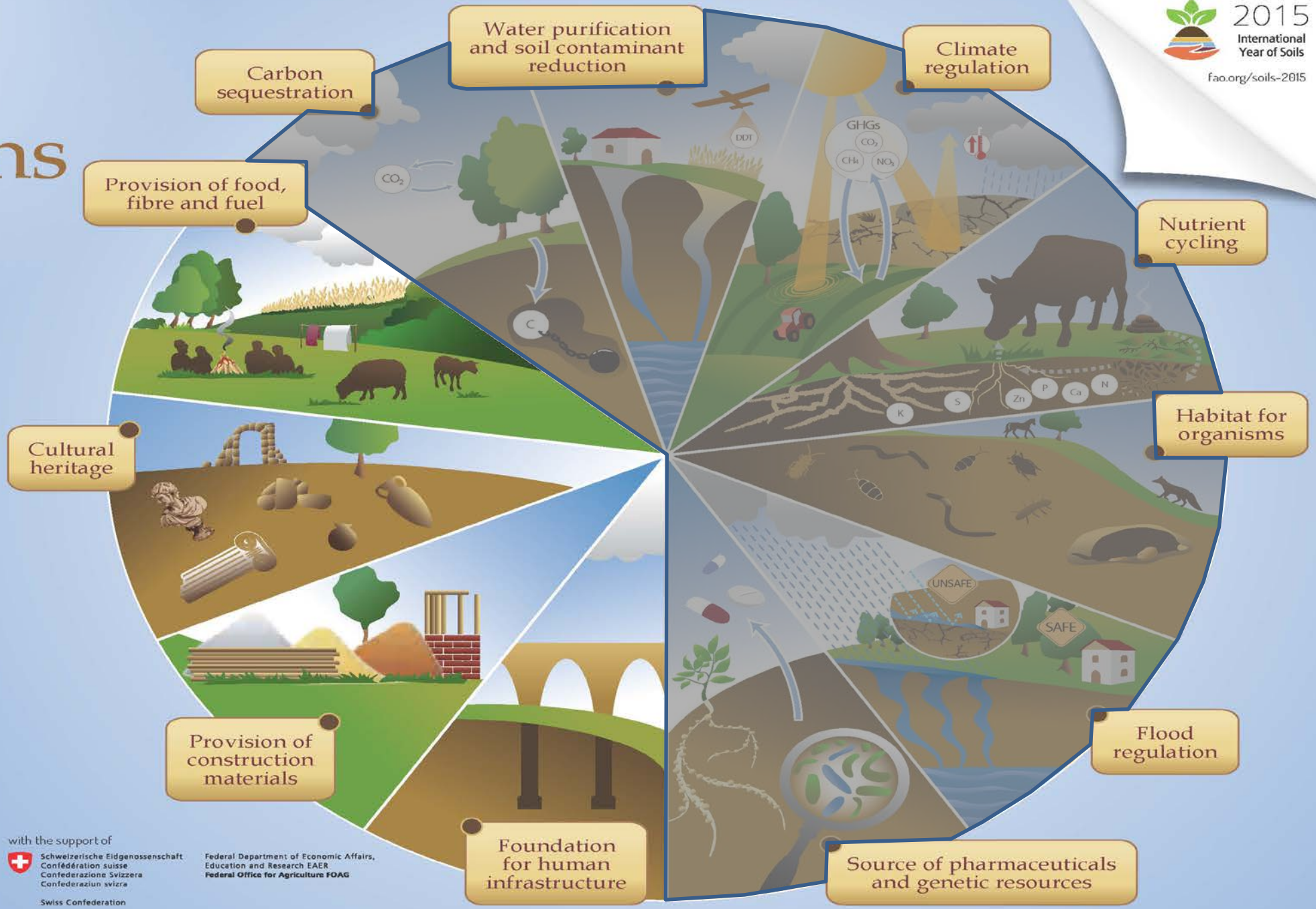
Natural systems typically differ from agricultural systems

When compared to their native counterpart, agricultural systems in general have:

- Decreased hydrologic function
- Less soil biological activity
- Inadequate nutrient cycle
- Less C sequestered
- Lower biological diversity
- Higher soil temperatures
- Less vigorous plants
- Lower system resistance and resilience

Soil functions

Soils deliver ecosystem services that enable life on Earth



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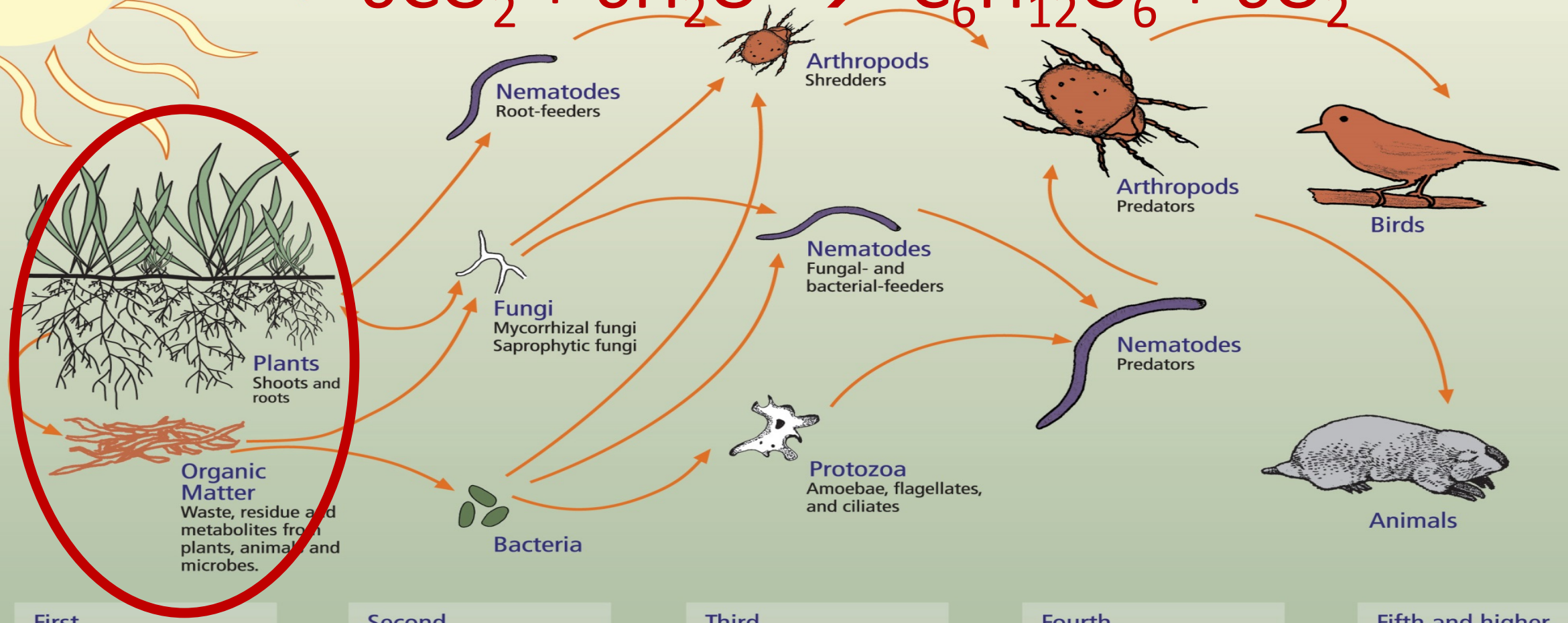
The Soil Food Web

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$



First trophic level:
Photosynthesizers

Second trophic level:
Decomposers
Mutualists
Pathogens, Parasites
Root-feeders

Third trophic level:
Shredders
Predators
Grazers

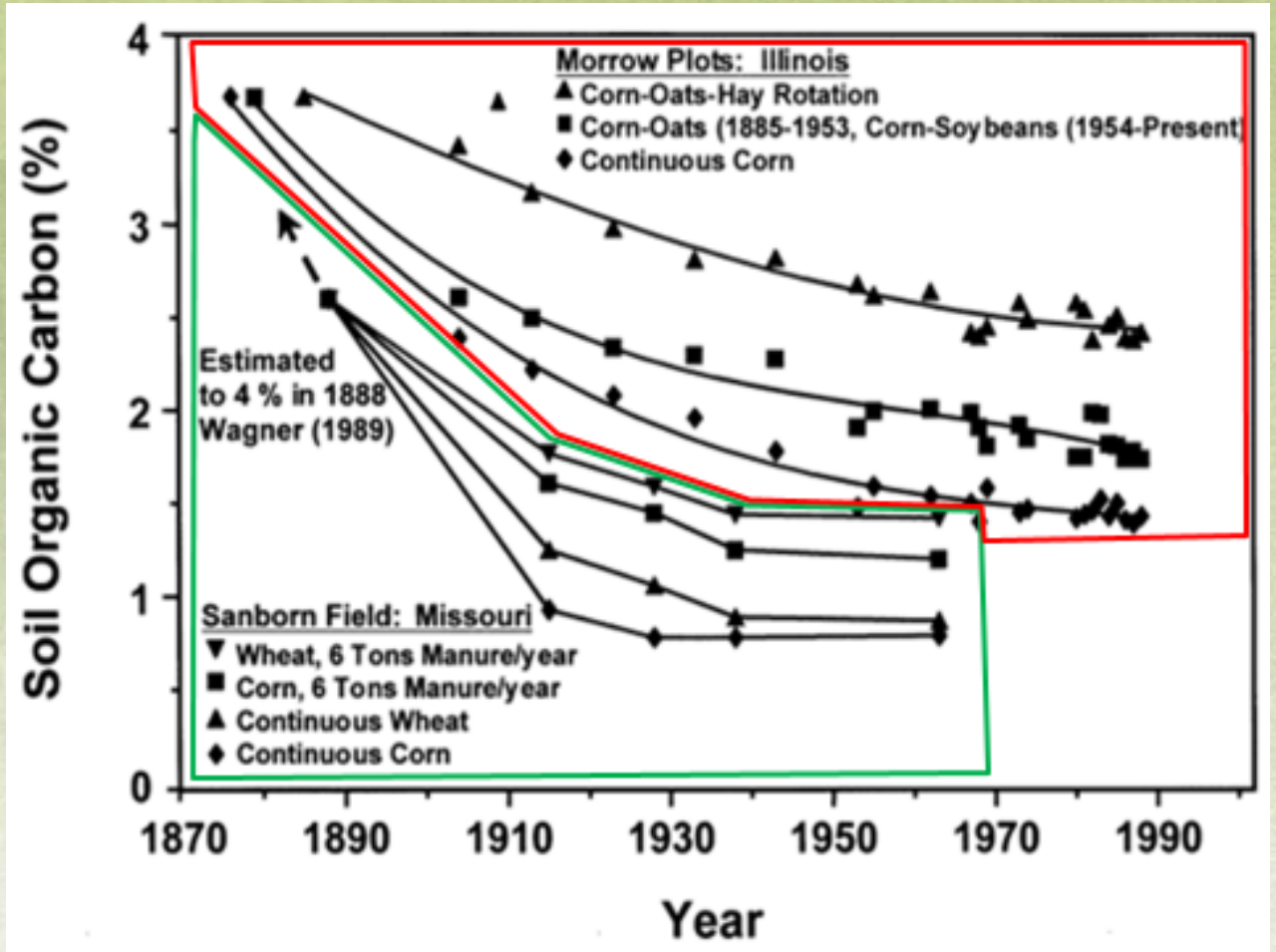
Fourth trophic level:
Higher level predators

Fifth and higher trophic levels:
Higher level predators

Organic carbon provides the energy that drives the food web and therefore the health of the soil ecosystem

Factors affecting SOC levels

- Temperature and precipitation
- Soil texture
- Drainage
- Vegetation (influenced by climate)
- Management



Agricultural goods	Soil-based delivery processes
Food and fibre	Nutrient capture and cycling
	OM input decomposition
	SOM dynamics
	Soil structure maintenance
	Biological population regulation

Non-agricultural services	Soil-based delivery processes
Water quality and supply	Soil structure maintenance
	Nutrient cycling
Erosion control	Soil structure maintenance
Atmospheric composition and climate regulation	SOM dynamics
Pollutant attenuation and degradation	Decomposition
	Nutrient cycling
Non-agricultural pest and disease control	Biological population regulation
Biodiversity conservation	Habitat provision
	Biological population regulation

Aggregate Ecosystem functions	Functional Assemblages
1. C transformations	Decomposers • fungi • bacteria • microbivores • detritivores
2. Nutrient cycling	Nutrient transformers • decomposers • element transformers • N-fixers • mycorrhizae
3. Soil structure maintenance	Ecosystem engineers • megafauna • macrofauna • fungi • bacteria
4. Biological population regulation	Biocontrollers • predators • microbivores • hyperparasites

Kibblewhite et al., 2008

How soil life contributes to ecosystem function

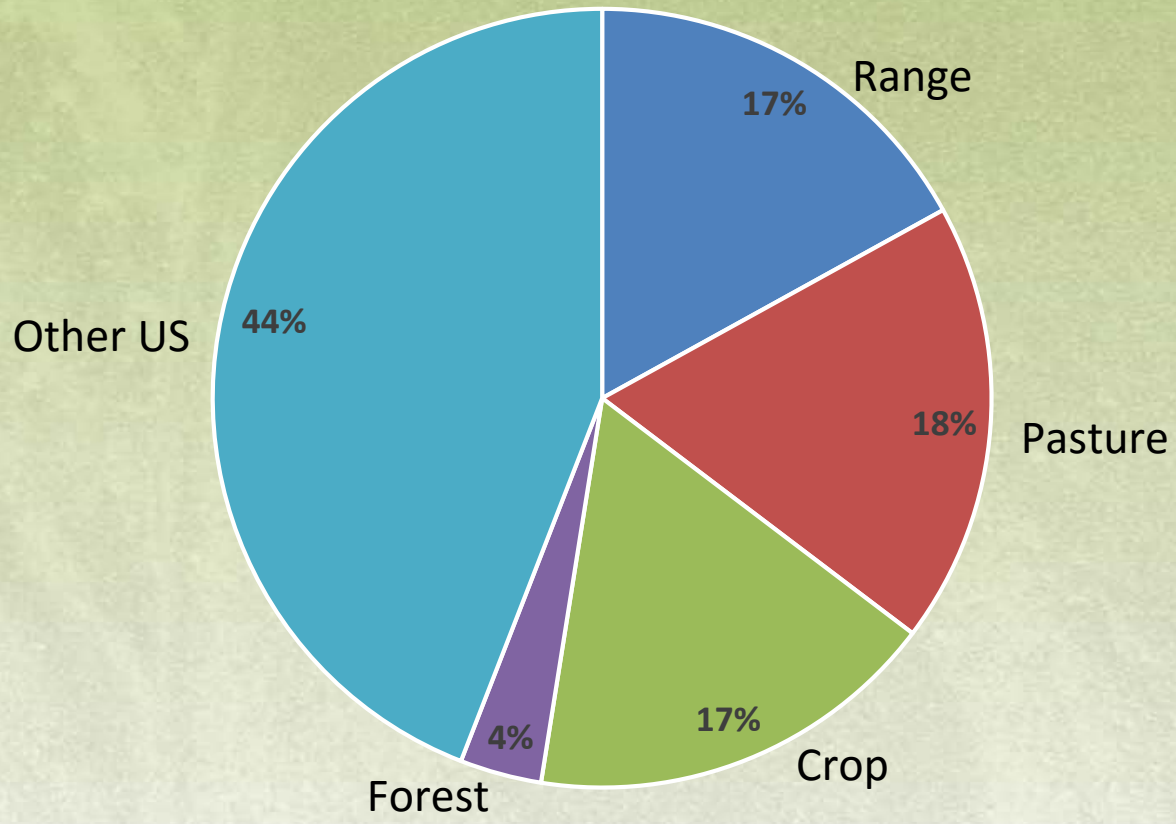
- Plant roots and biomass are the primary source of SOC
- Root exudates, bacteria and fungi provide organic glues for aggregation
- Earthworms and other burrowing macro-fauna improve water infiltration
- Organisms contribute to nutrient cycling by consuming, decomposing, mineralizing and retaining nutrients in their biomass
- Bioremediation of metals and contaminants by micro-fauna
- Pest suppression through antagonism, competition, or plant root-microbe communication

Managing agricultural lands to improve soil health – copying natural systems

- Optimize disturbance
- Keep the soil covered
- Increase system biodiversity
- Maintain roots in the soil

Potential benefit from changing management on private agricultural land is significant

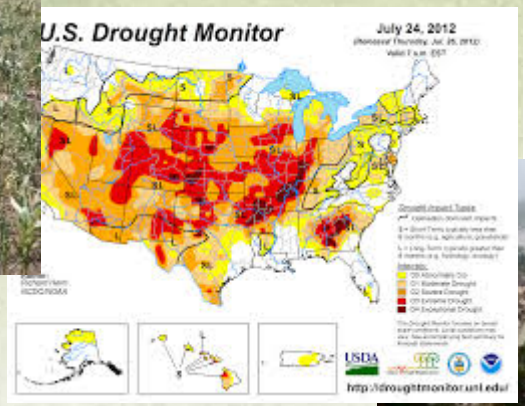
- ~2.3 billion total land acres in the U.S.
- 56%, or 1.3 billion acres occur on private farms and ranches
- Increasing SOC in the top 6” of 1.3 billion acres by an average of 0.5% would capture about 6 billion tons of carbon (60% of annual global emissions)



Private working lands as proportion of total US land area

Census of Agriculture, Sept. 2014; USFS, 2013

Our delicate relationship with water

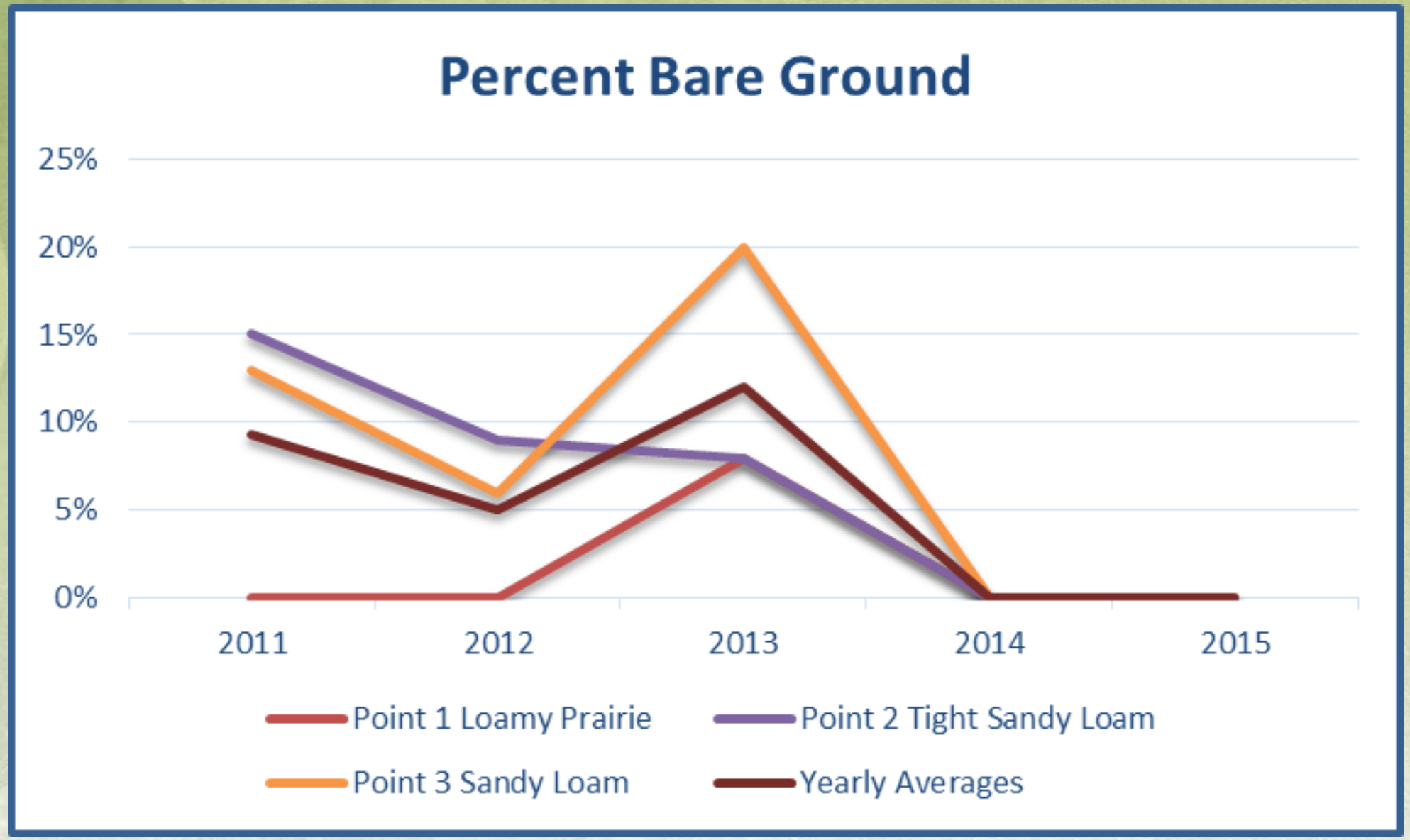


Hydrologic implications of functioning soils

Healthy Soils' Vegetation Production Effects

Transect – Ecological Site	Expected Ecological Site Production (lbs/acre)	2011 Production (lbs/acre)	2012 Production (lbs/acre)	2013 Production (lbs/acre)	2014 Production (lbs/acre)	2015 Production (lbs/acre)
Point 1 Loamy Prairie	4800	5943	1671	4580	4545	649
Point 2 Tight Sandy Loam	3000	2808	1178	4148	6593	795
Point 3 Sandy Loam	4400	4144	3000	3449	6209	557
Yearly Averages (lbs/acre)	**4,067**	**4,298**	**1,950**	**4,059**	**5782**	**667**

Total growing season production as pounds per acre on the JA Ranch in Bowie, TX, before, during and after the 2011 drought (Stanley and Derzapf 2015); figure from Maczko et al. 2016, NCBA Directions .



Percent bare ground on the JA Ranch in Bowie, TX for monitoring points visited annually from 2011-2015. Data provided by Stanley and Derzapf (2015); figure from Maczko et al. 2016, NCBA Directions.

Conclusions

- Healthy soils serve as the foundation for provision of natural and agricultural goods and services across ecosystems
- Soil health encompasses ecosystem processes with organisms both affecting and being affected by the environment
- Climate and precipitation influence soil health, however healthy soils can mitigate extreme weather event effects
- Soil systems are carbon-dependent; optimal disturbance, continuous plant cover, roots in the soil, and plant diversity support soil health


Thoughts?
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