Healthy Soils, Healthy Crops

What we have learned from both sides of the equation…

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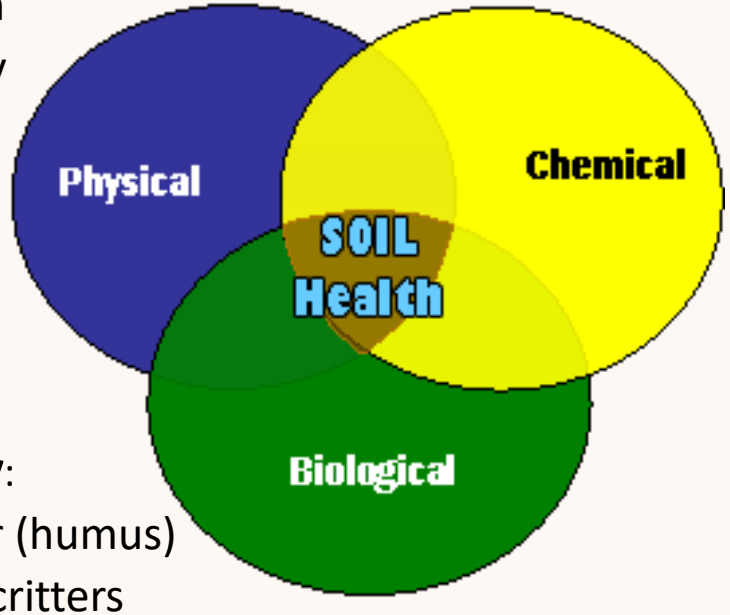
Soil Fertility (What is it?)

Physical fertility:

- Soil texture
- Aggregation
- Bulk density
- Infiltration

Chemical fertility:

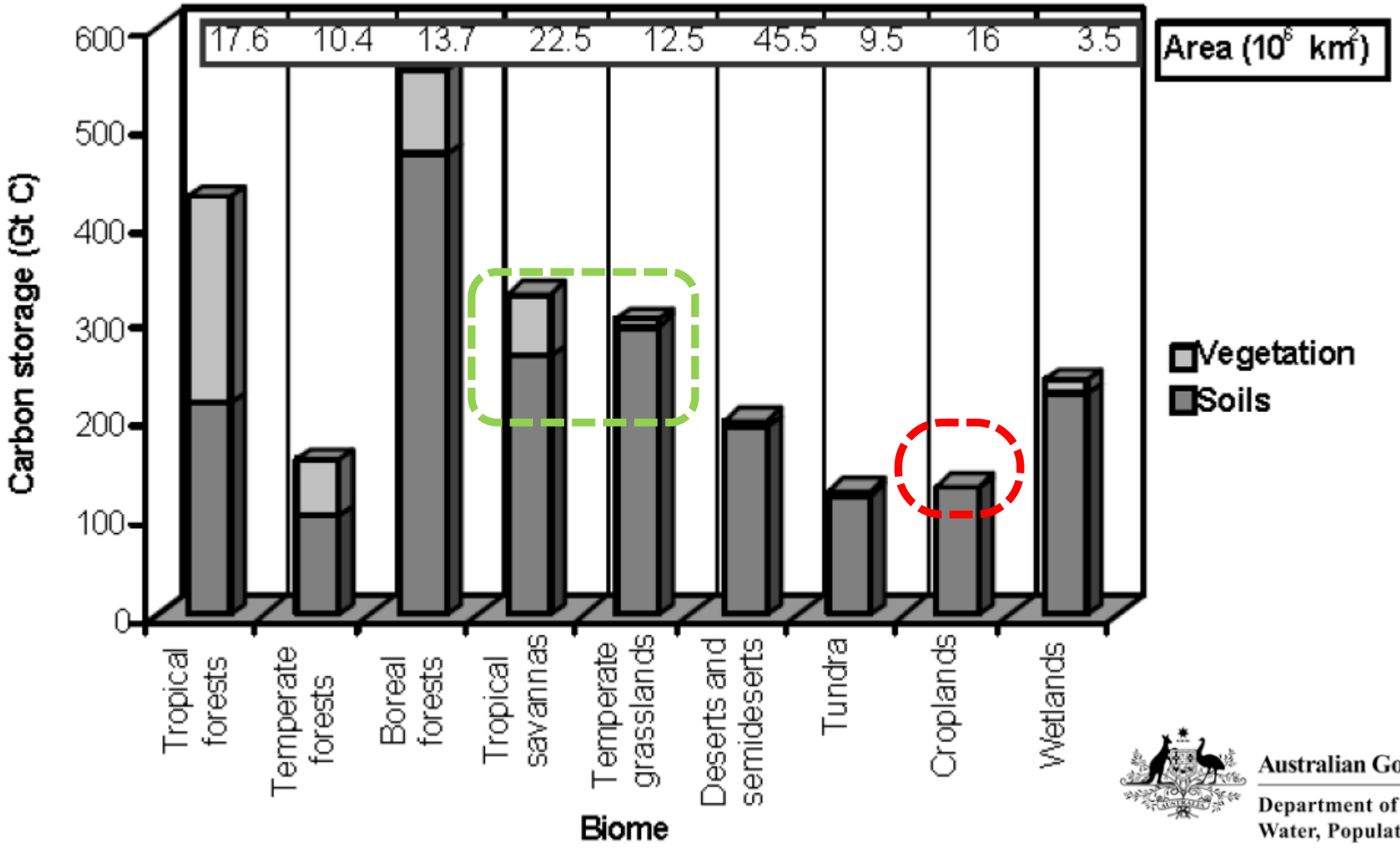
- pH
- Salinity
- Mineralogy
- Fertilizer
- Reactive carbon



Biological fertility:

- Organic matter (humus)
- Worms/other critters
- Microorganisms (fungi and bacteria)
- Enzymes

Global carbon stocks



Australian Government

Department of Sustainability, Environment, Water, Population and Communities

Cover crops help microbes build soil carbon and benefit cash crops

Cover crop

C Respiration

More C stored in aggregates

Legacy Effect

Cash crop

Retain beneficial microbes; Increase C source from microbial biomass

More SOM being processed to release nutrients for plants; Better water infiltration

Increase crop-available nutrients; Create pathogen unfriendly environments

Outcomes

Short/mid-Term

Promote crop growth, productivity; Reduce disease incidence; Increase soil biota diversity; Facilitate soil biota interaction; Increase soil quality (soil health)

Long- Term

Improve ecosystem services & sustainability

The residue from cover crop

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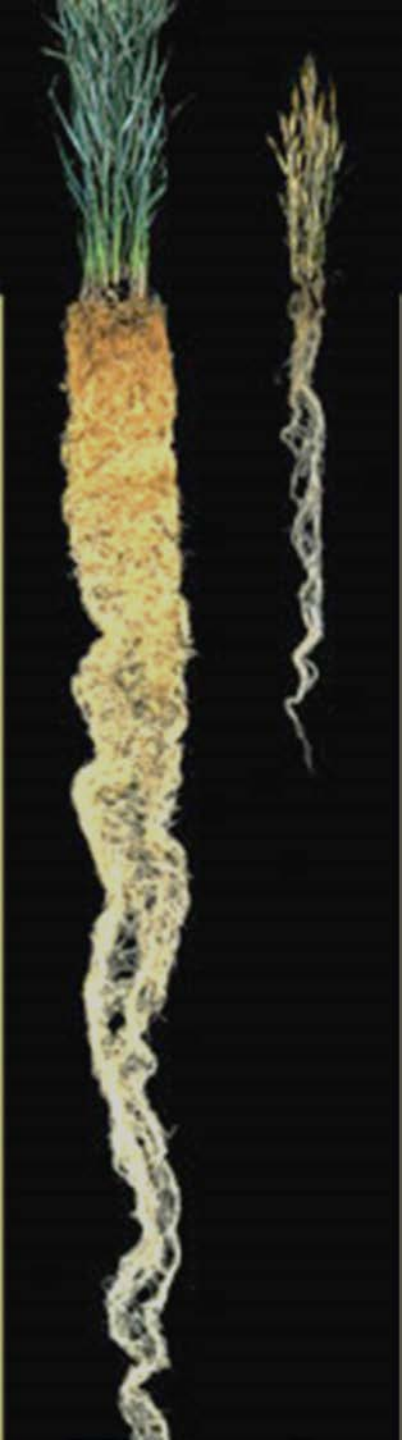
Annual cover crop impacts vary by species, variety, and planting date



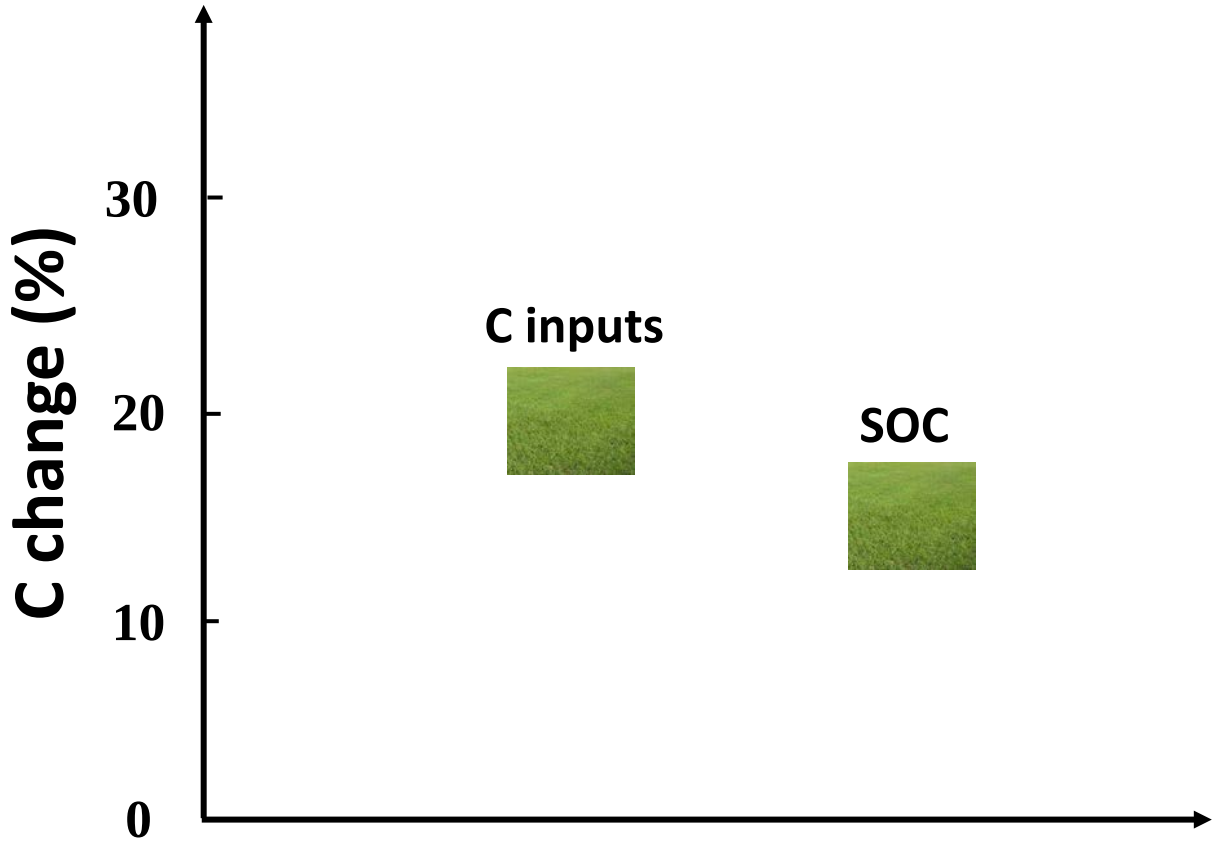
Perennial vs Annual Crops

- Greater access to resources via a deeper rooting zone
- More efficient use of soil nutrients
- Reduced soil erosion (especially during spring/fall transitions)
- Additional carbon inputs (greater root mass)

Glover et al., 2010; Culman et al., 2013

Percent change in C inputs and SOC

Compared to grain-only systems, crop rotations with perennials increase C inputs and SOC



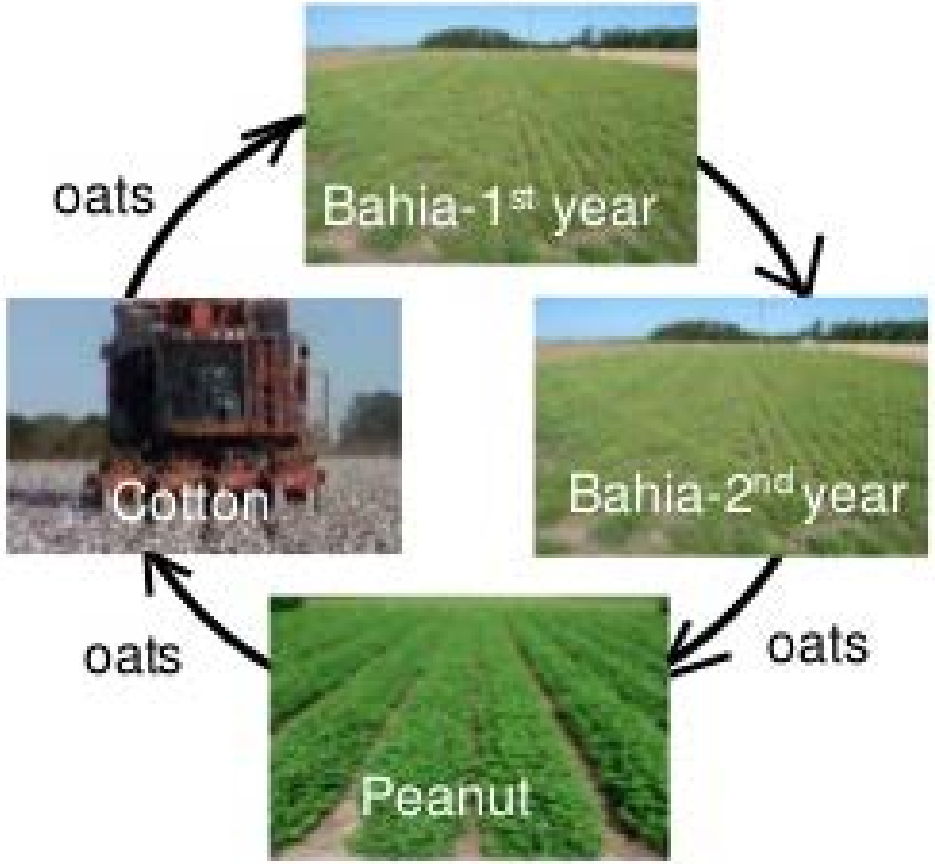
(King and Blesh 2018)

Plants require good chemical fertility!

Overview of rotation systems

SBR

Sod- based rotation



CR

Conventional rotation

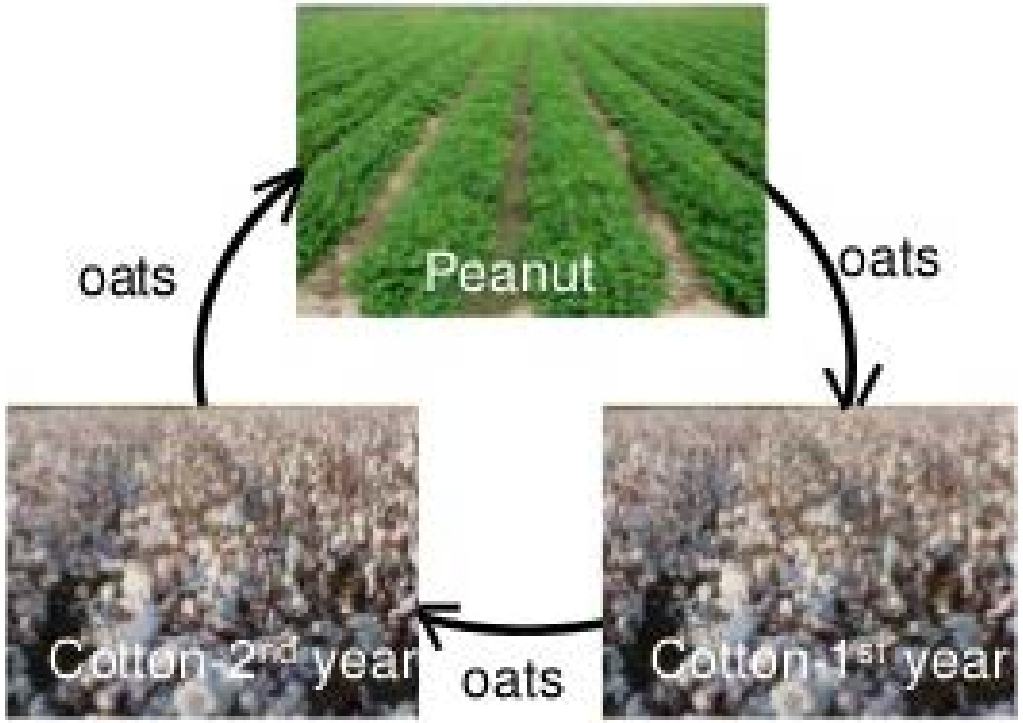
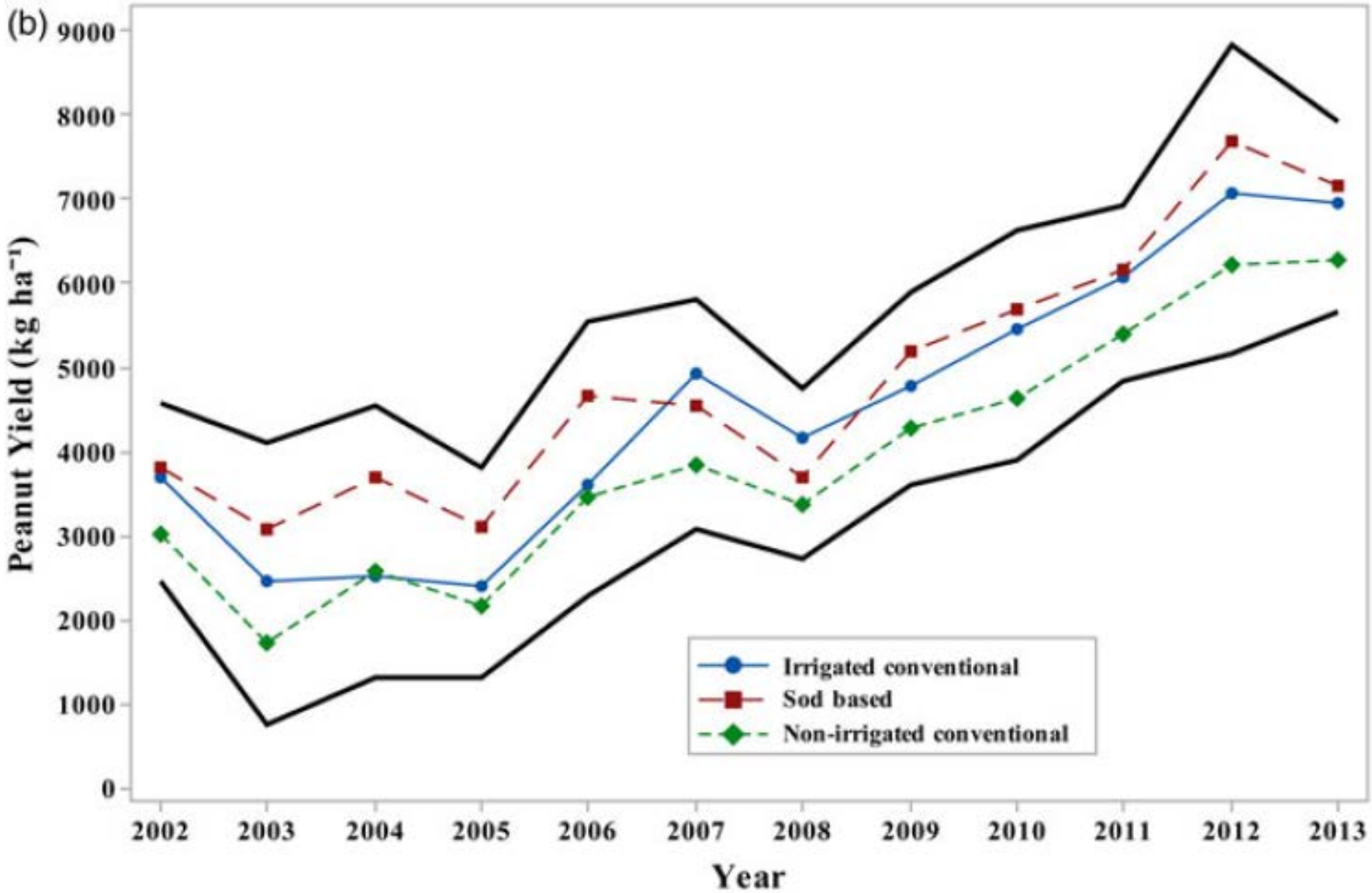
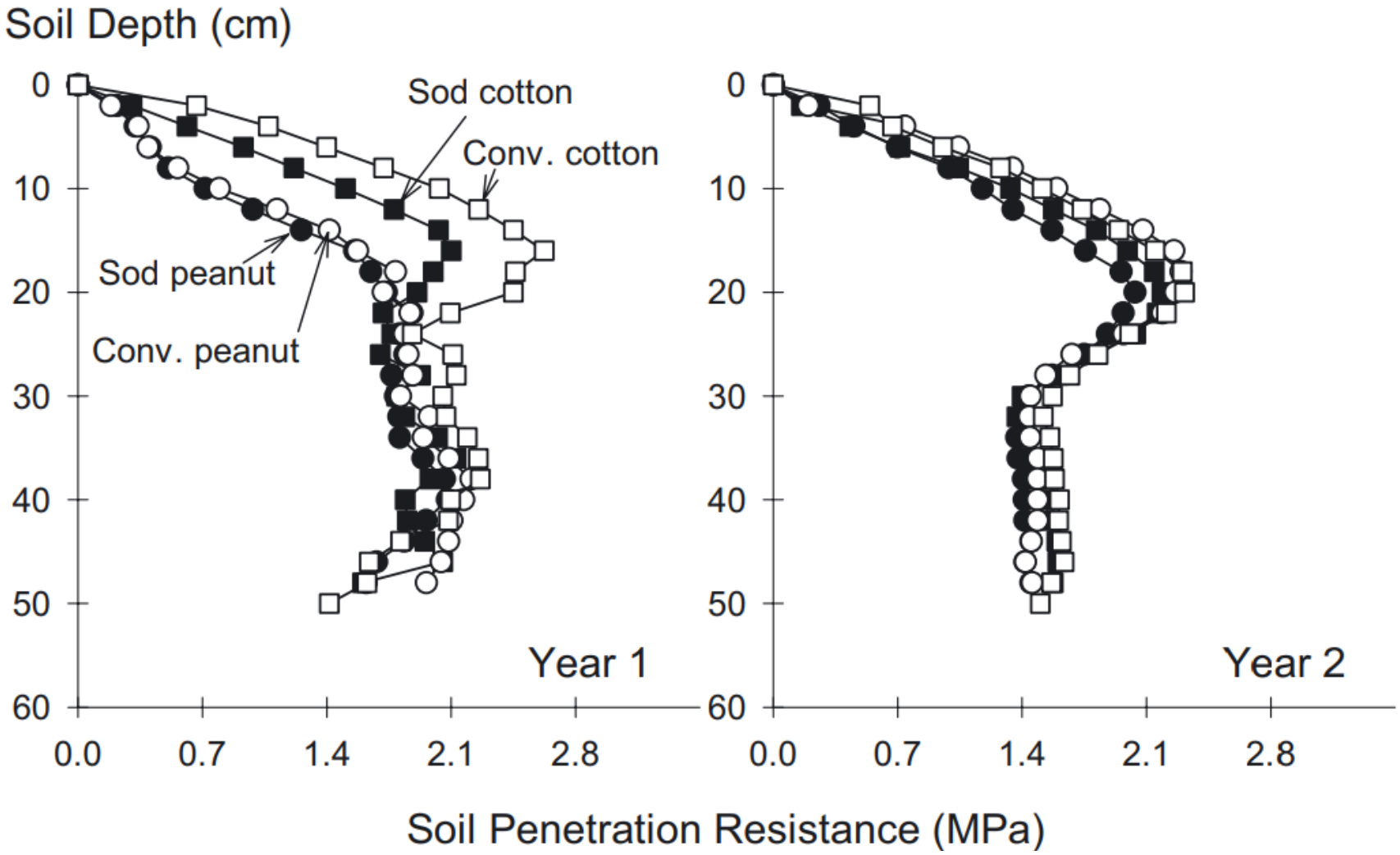


Photo Source: Sheeja George et al.

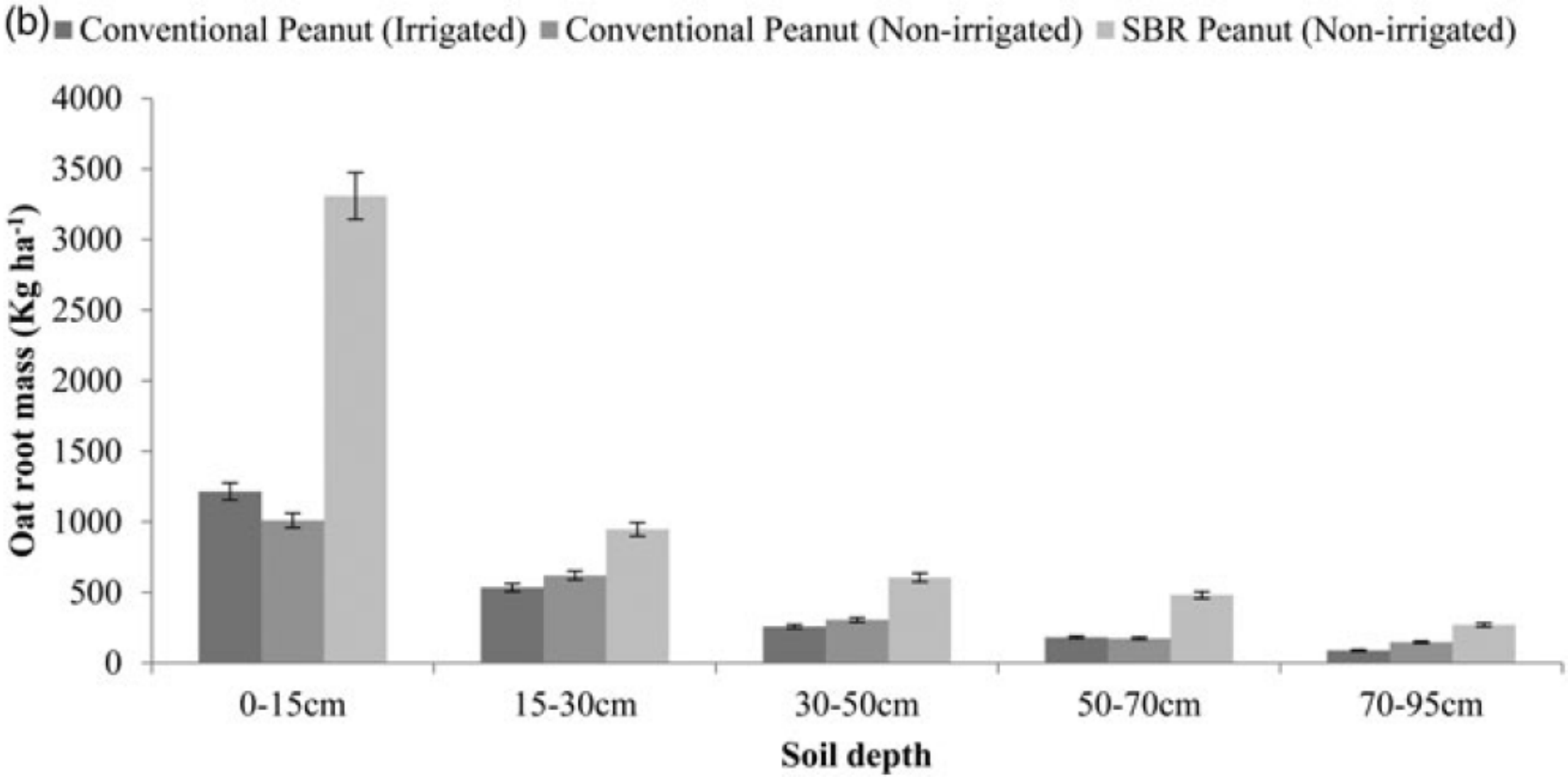


Dourte et al., 2015. Renew. Ag Food Syst.

Crop and management has carryover impact (under oat cover crop)



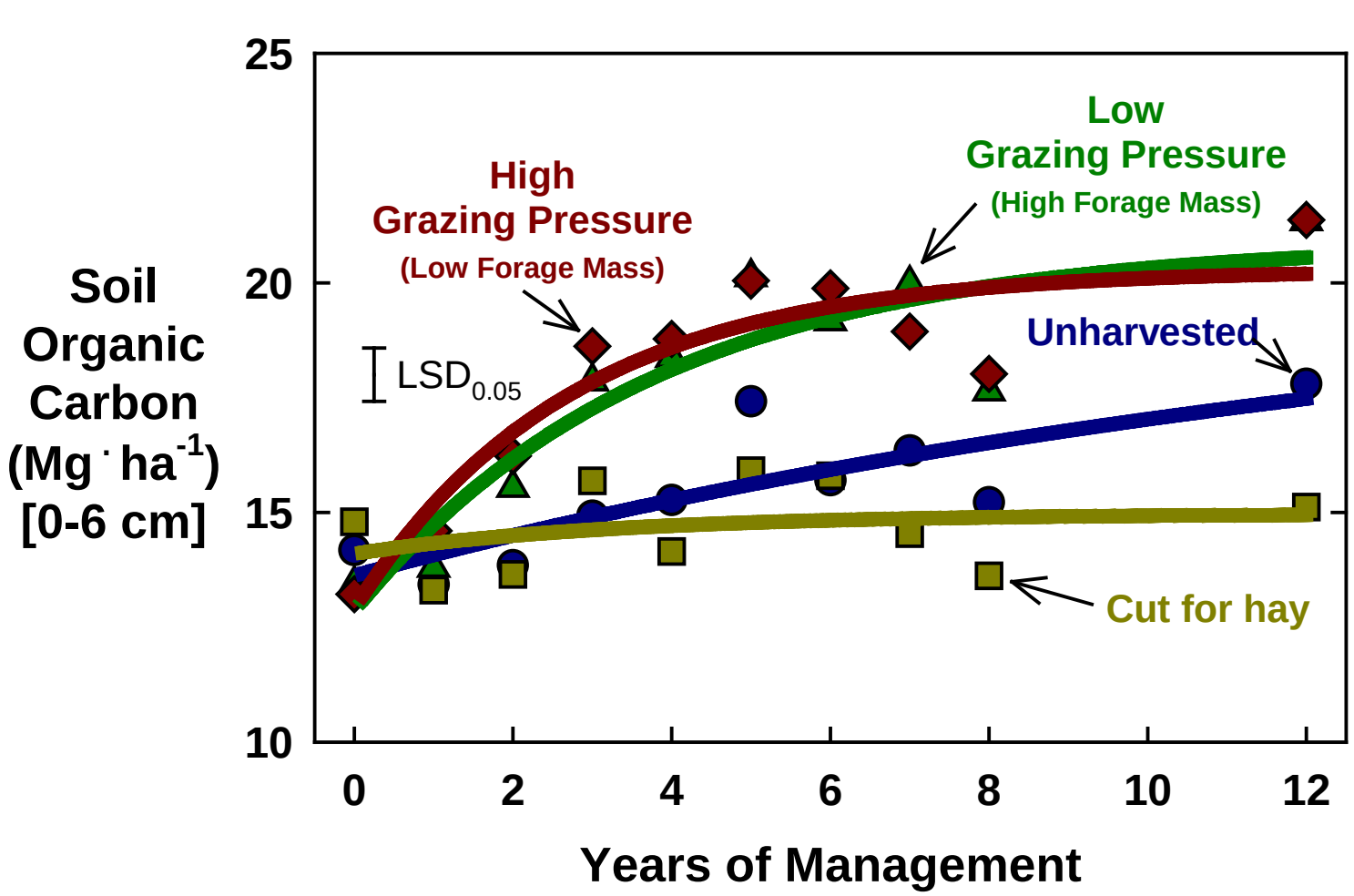
Zhao et al., 2010. Agron. Sustain. Dev.



Dourte et al., 2015. Renew. Ag Food Syst.

Soil Organic Carbon

Surface soil (~1-inch depth, GA)



Yearly Accumulation Rate (Mg ha^{-1} yr^{-1})

0.62 (554 lbs/acre, 0.17% OM)

0.59 (527 lbs/acre, 0.16% OM

0.32 (286 lbs/acre, 0.09% OM)

0.07 (63 lbs/acre, 0.02% OM)

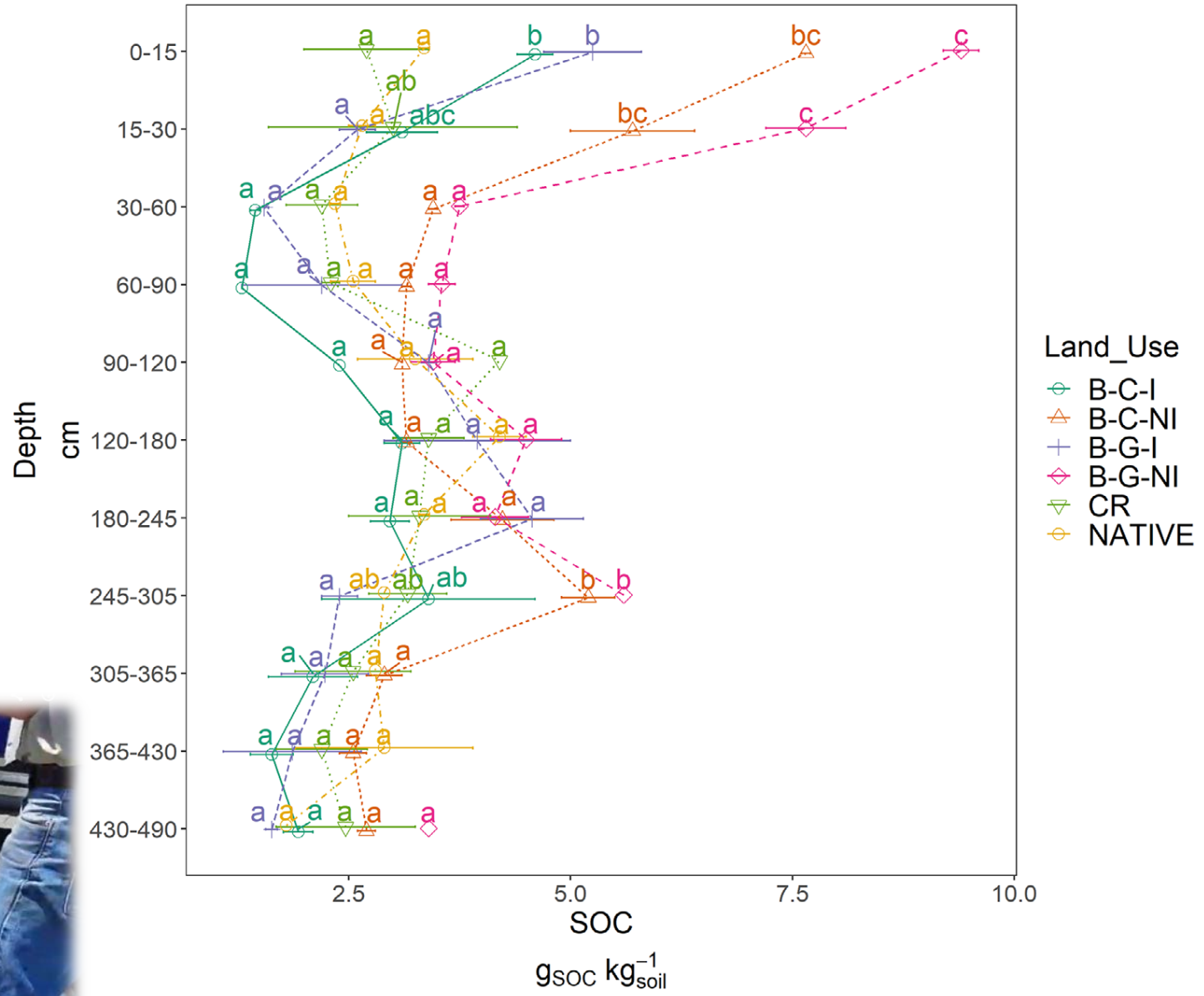
Franzluebbers and Stuedemann. 2010. Soil Sci. Soc. Am. J.

Livestock Inclusion (ICLS):

Sod-based rotation

Treatment effects on Soil organic C

- Irrigation and no grazing led to less SOC.
- Land management greatest impact in upper 30 cm.



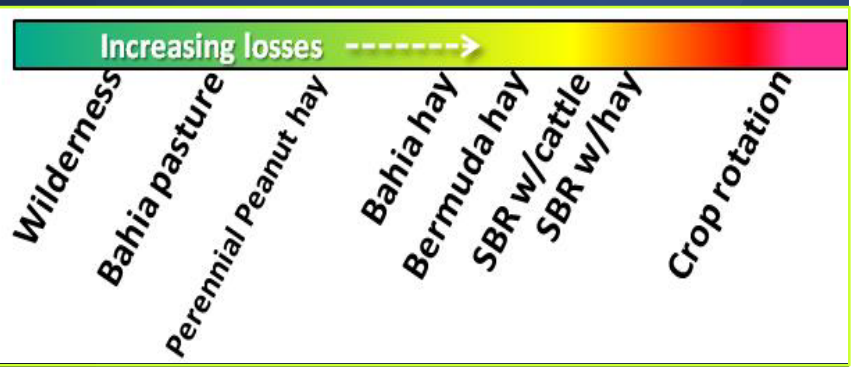
Rolando et al. 2021. Agrosyst Geosci Environ.

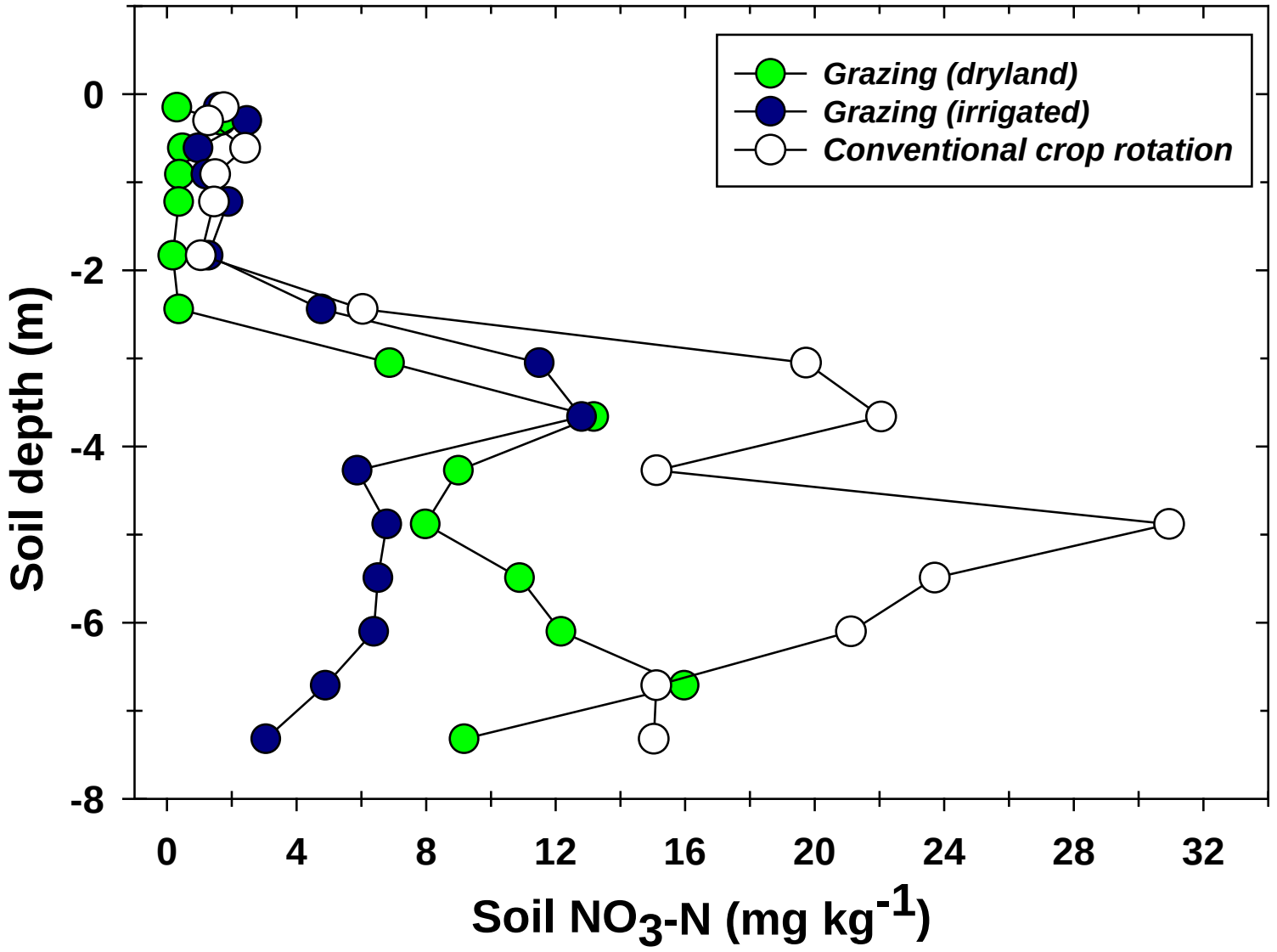
Soil C distribution in a North Florida Ultisol

Soil profile	SOC	Bulk density	SOC stock	Percentage of total SOC stock
cm	g C kg^{-1} soil	g cm^{-3}	Mg C ha^{-1}	%
0–30	4.8 ± 0.6	1.9 ± 0.1	28.4 ± 4.0	10.4
0–90	3.6 ± 0.4	1.9 ± 0.1	60.0 ± 6.4	21.9
0–500	3.0 ± 0.2	1.8 ± 0.1	273.9 ± 23.3	100.0

Rolando et al. 2021. Agrosyst Geosci Environ.

Deep soil cores for tracking nutrients in SBR

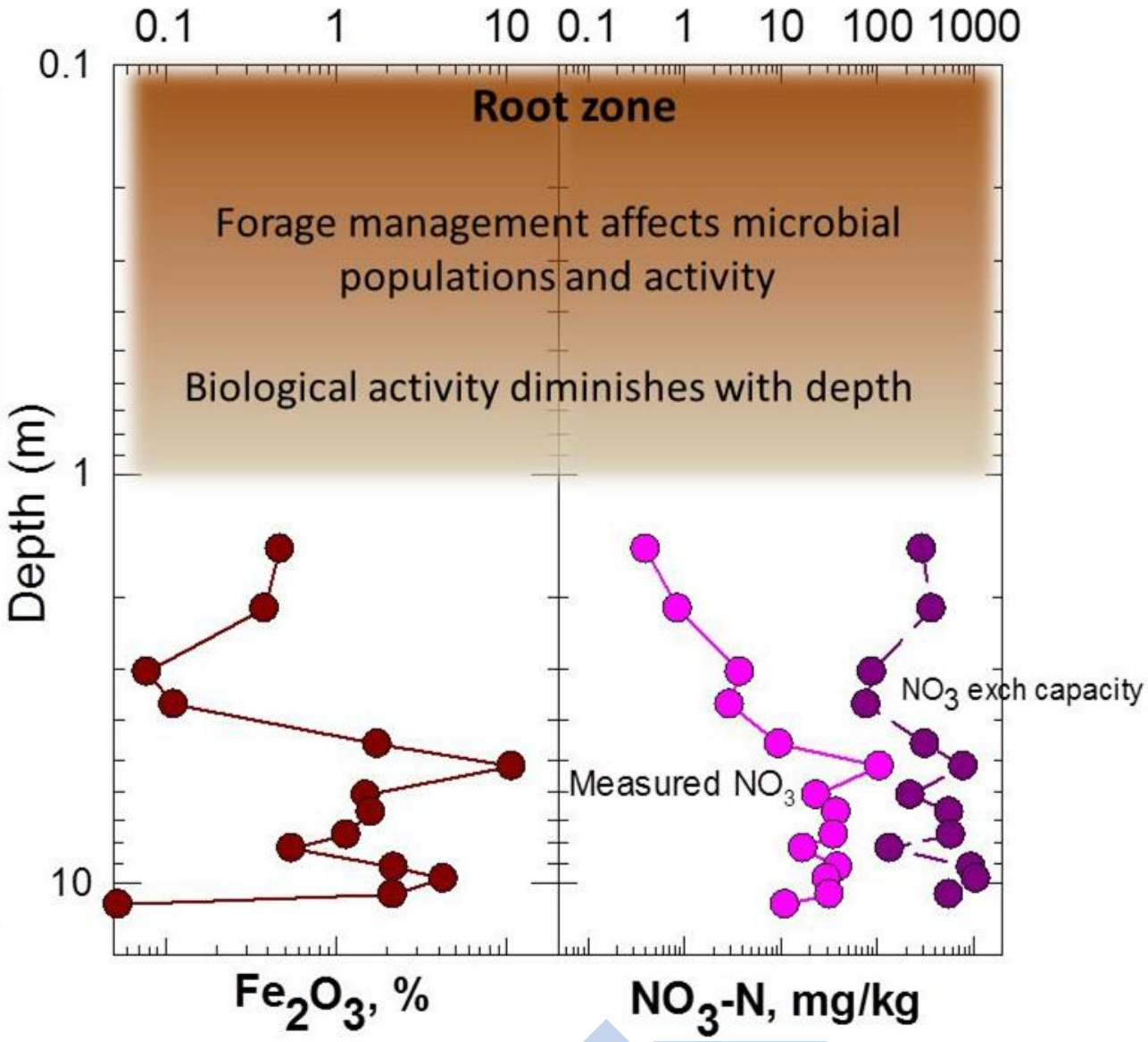




Is the nitrate entering groundwater?

Principal focus: Effects of forage management systems on source, leach rate, distribution, age, attenuation, and fate of subsurface N forms under karst.

Deep subsoils: Surface factors (land management) influences N migration to subsoils. Subsoil composition and physical environment further affect nitrate mobility and longevity in a karst landscape.

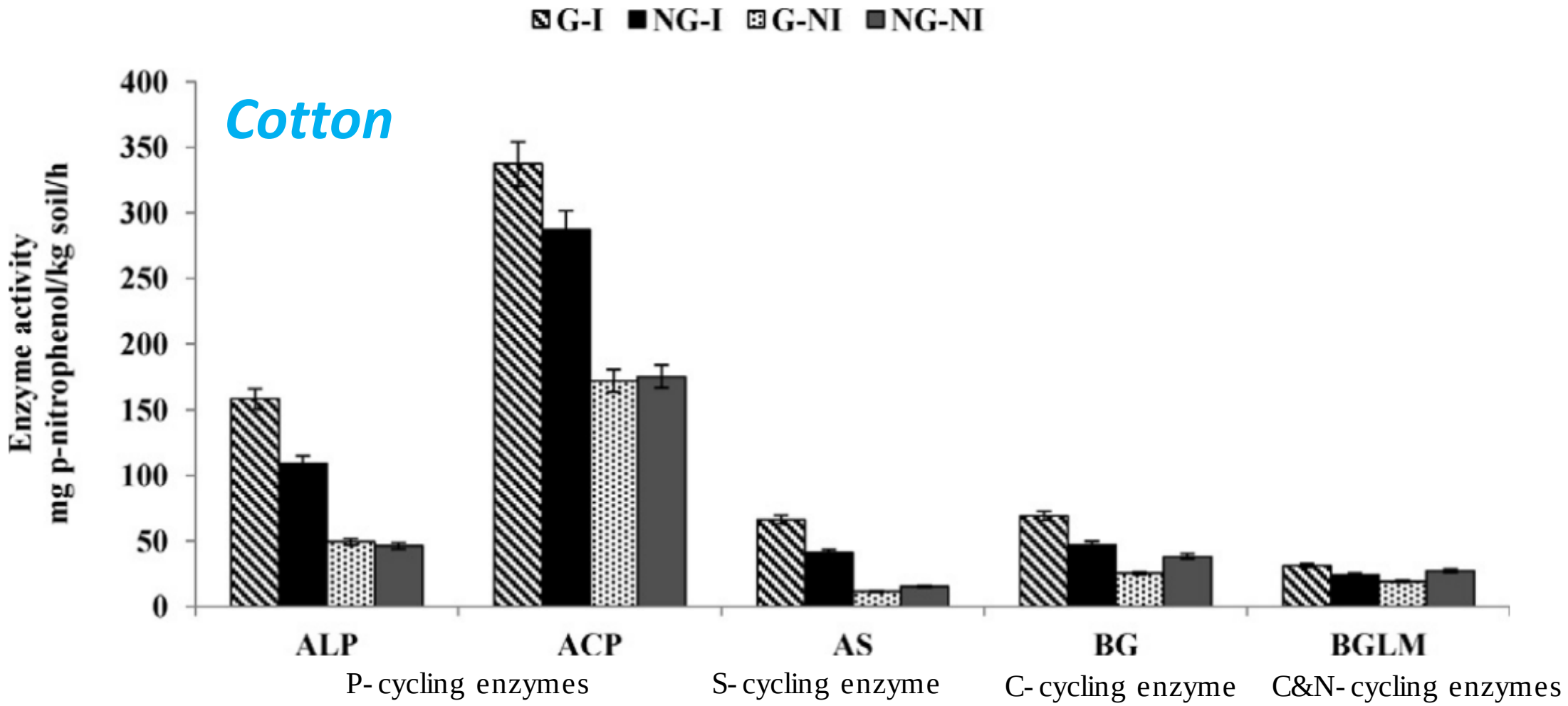


Cotton and peanut yield during 2007–2010 in a sod based rotation (bahiagrass–bahiagrass–peanut–cotton) integrating cattle grazing during summer (bahiagrass) and winter (oats/rye).

Year	Cotton yield (kg ha^{-1})				Peanut yield (kg ha^{-1})			
	G-I	NG-I	G-NI	NG-NI	G-I	NG-I	G-NI	NG-NI
2007	1675	1697	1661	1479	–	–	–	–
2008	2206	1919	2004	1510	5473	5856	4164	4558
2009	1292	1317	1119	988	5238	4967	3922	4587
2010	1924	1869	1669	1529	5236	6001	4823	4249

George et al. 2013. Soil and Tillage

Increased enzyme activity: (soil moisture and grazing impacts)



George et al. 2013. Soil and Tillage

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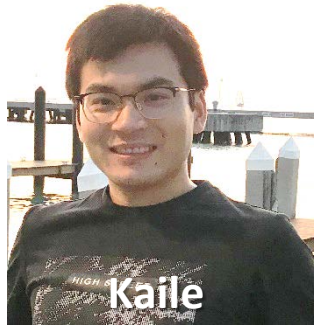
DEPARTMENT OF SOIL, WATER, AND ECOSYSTEM SCIENCES

Impacts of sod-based rotation on soil health

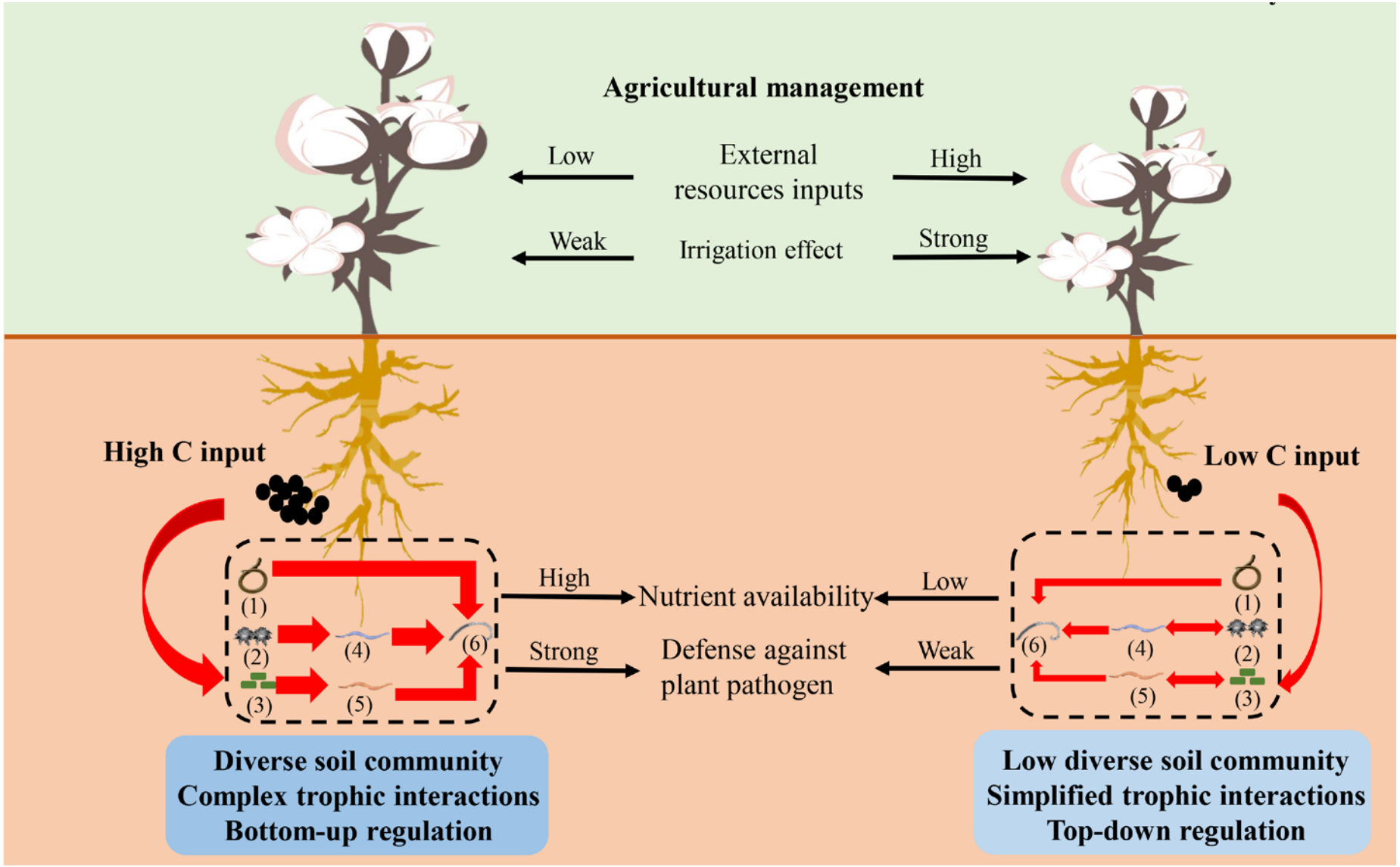
Kaile Zhang (Post-doc)
Sunny Liao (Assistant Professor)
Gabriel Maltais-Landry (Assistant Professor)



Sunny

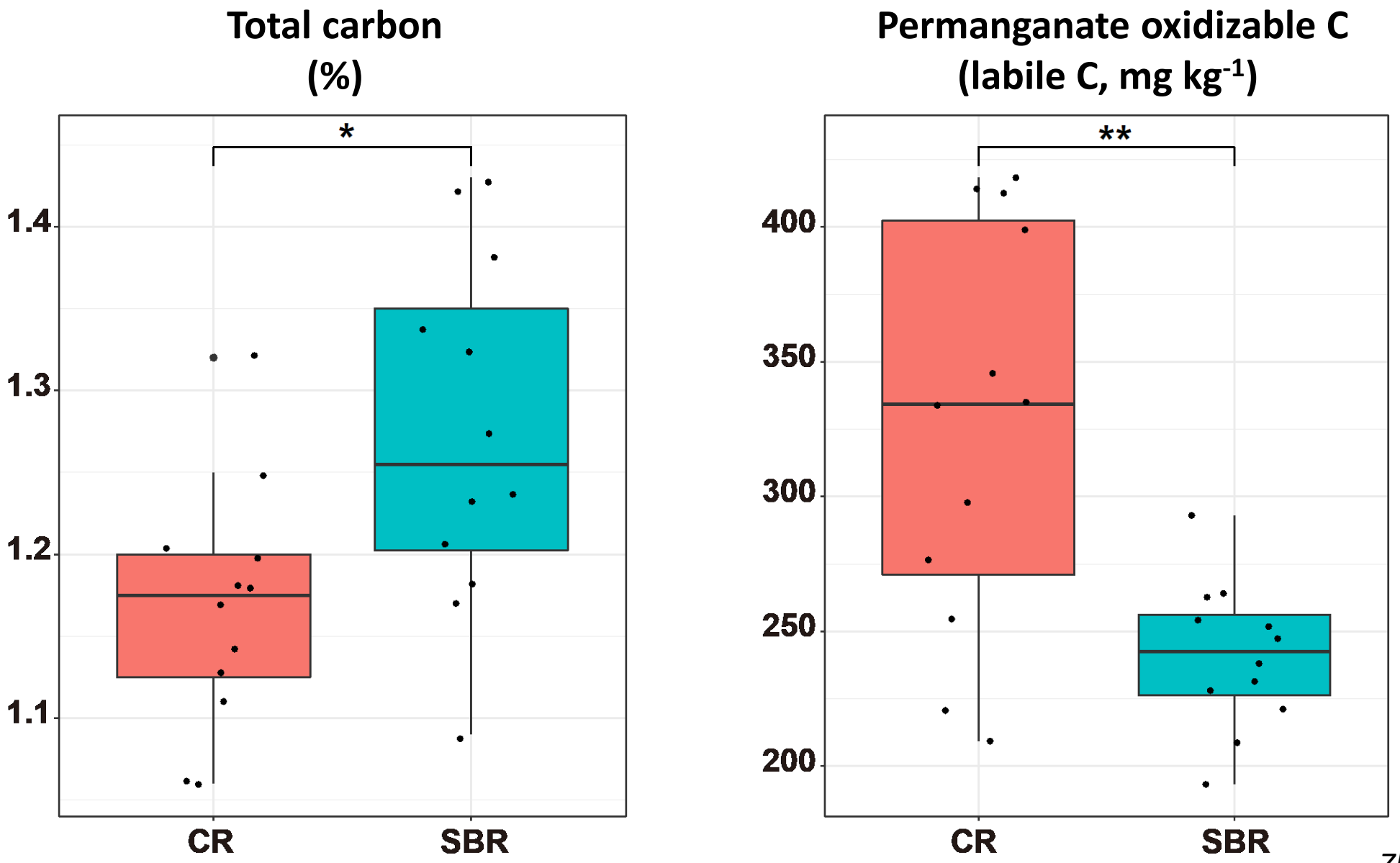
Links between Ag management and agroecosystem processes

SBR (high rotational diversity) **CR (low rotational diversity)**



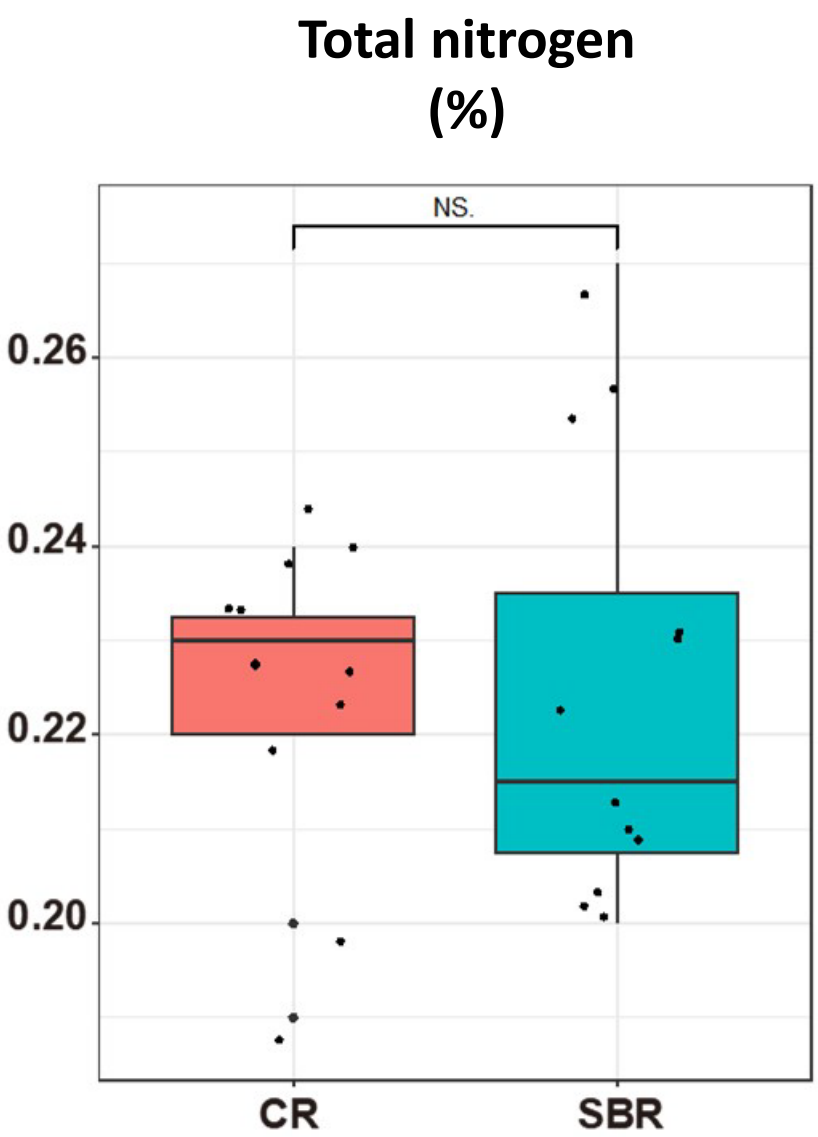
Zhang et al. 2022 *ASE*

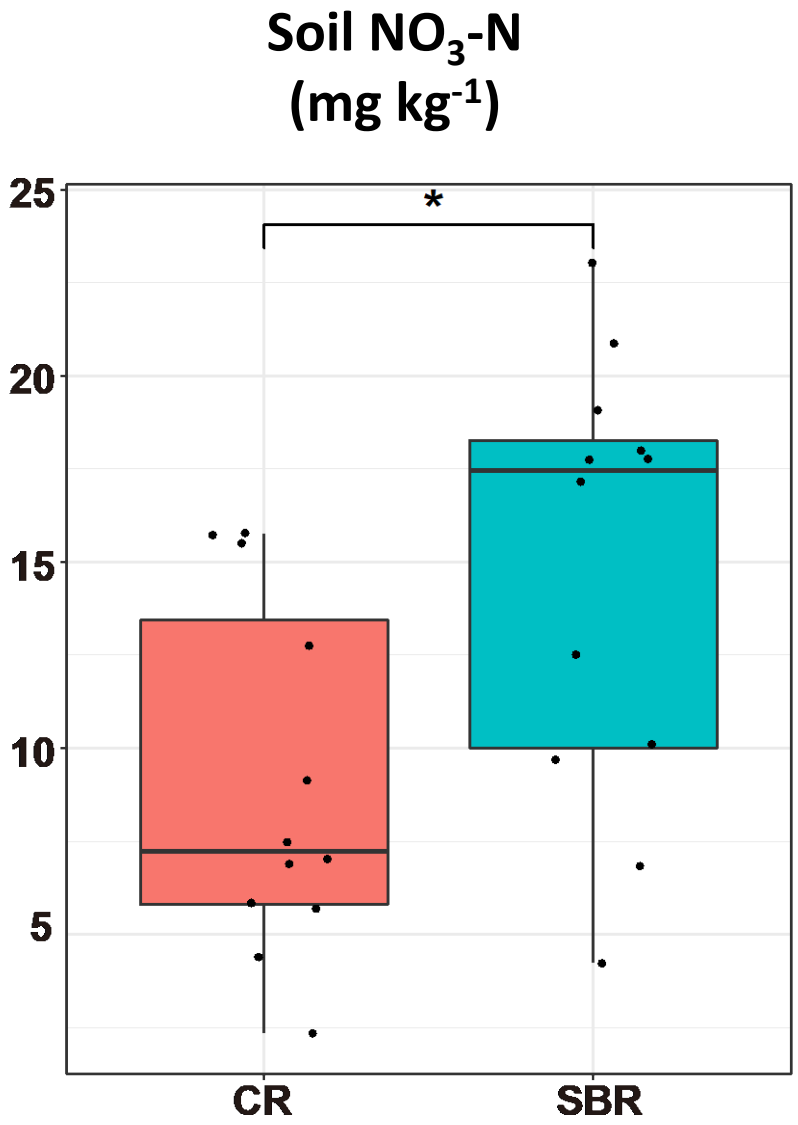
Greater total carbon but lower labile C in SBR vs. CR in peanut plots

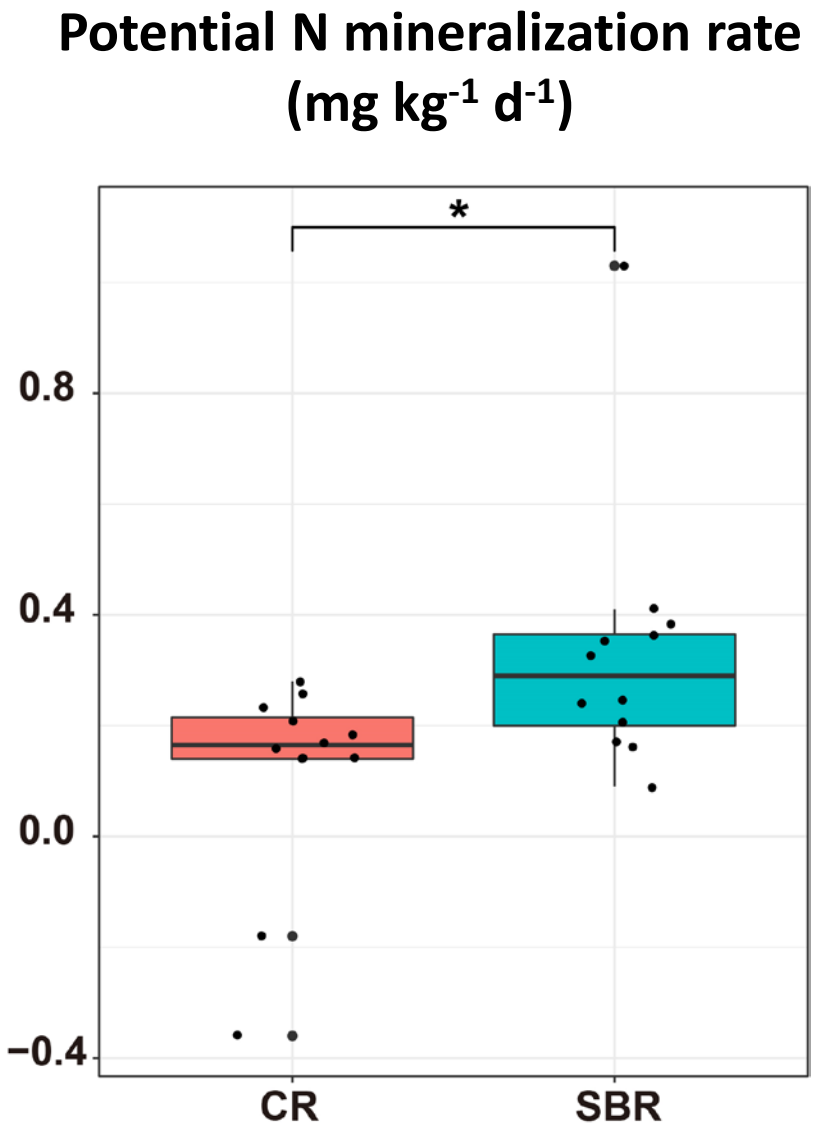


Zhang et al., 2022 BFS

Higher soil nitrate and N mineralization in SBR vs. CR in peanut plots

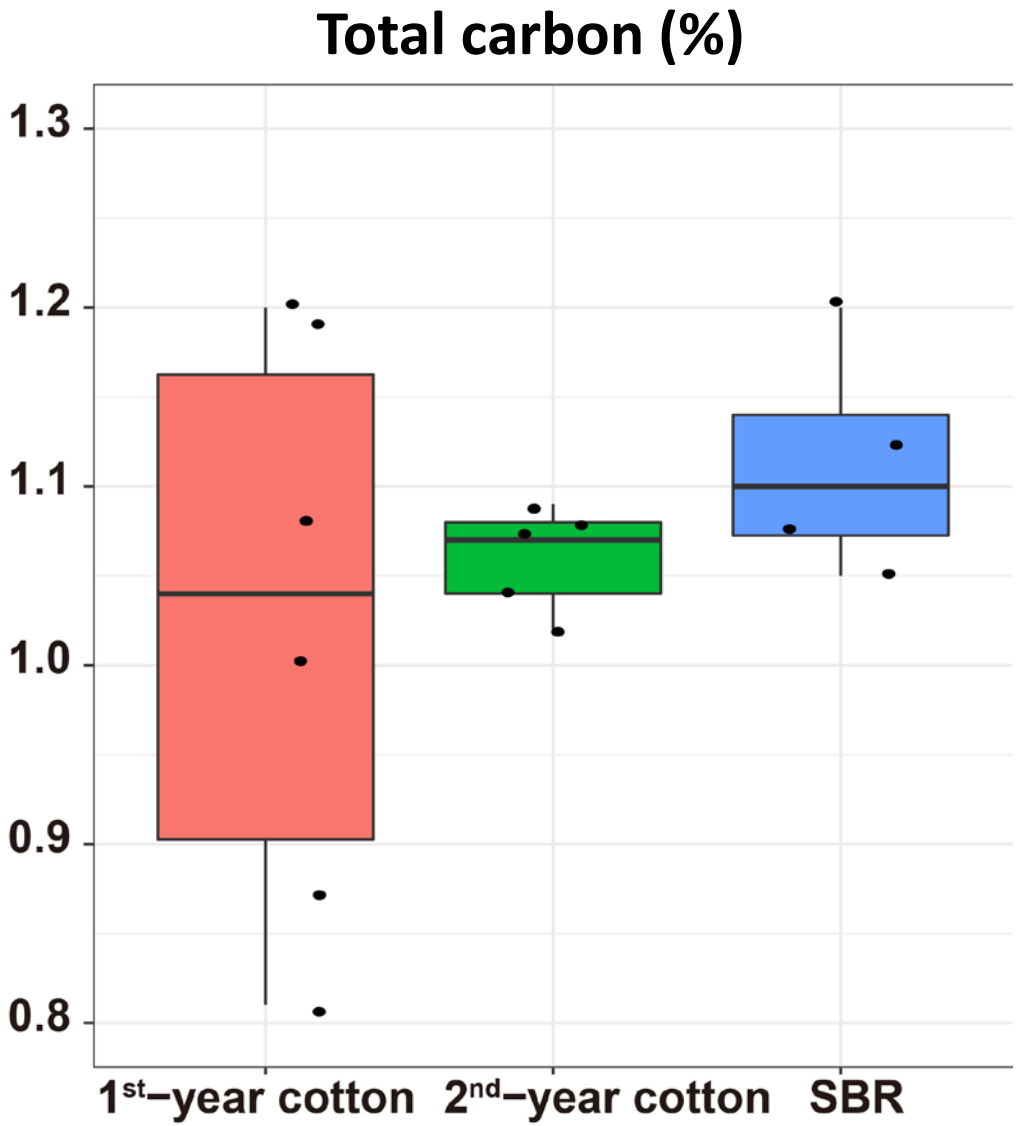


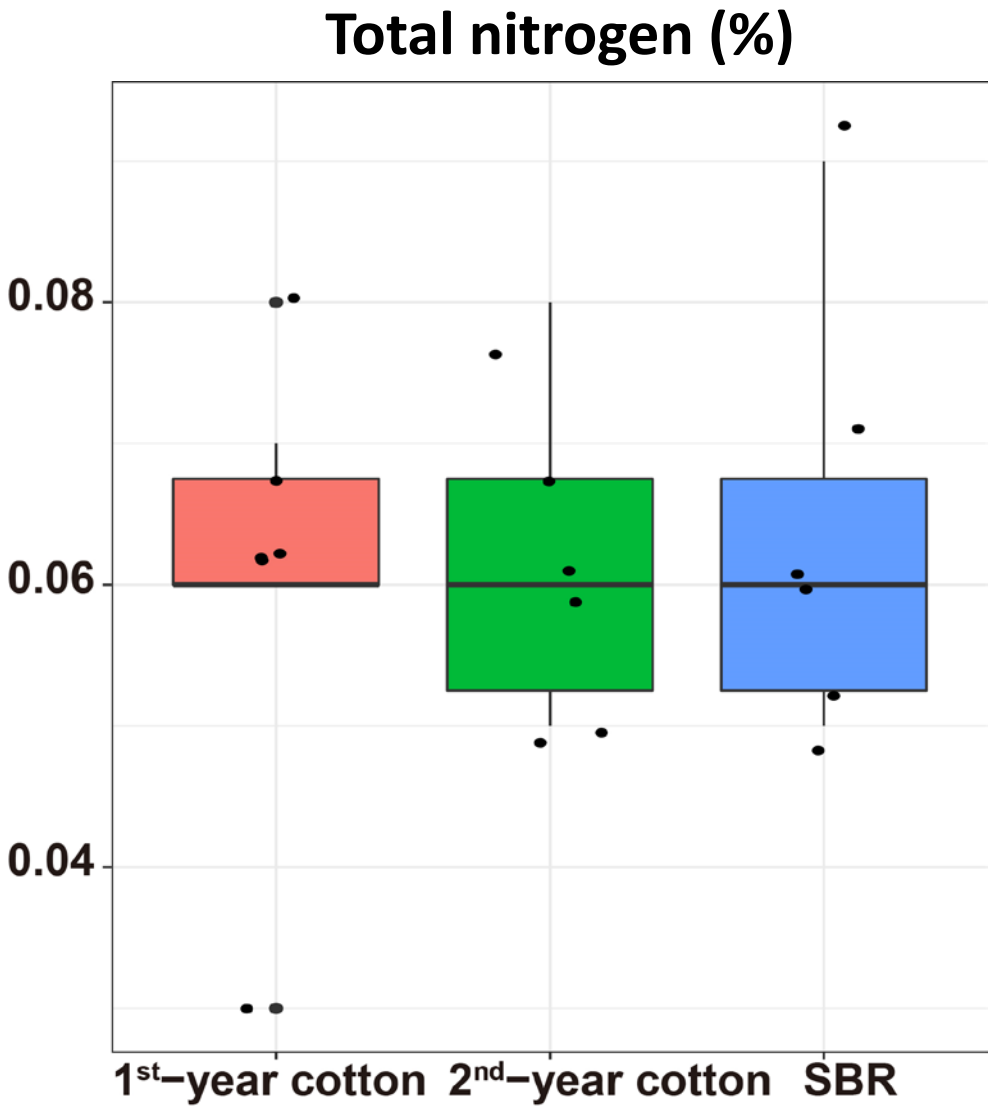




Zhang et al., 2022 BFS

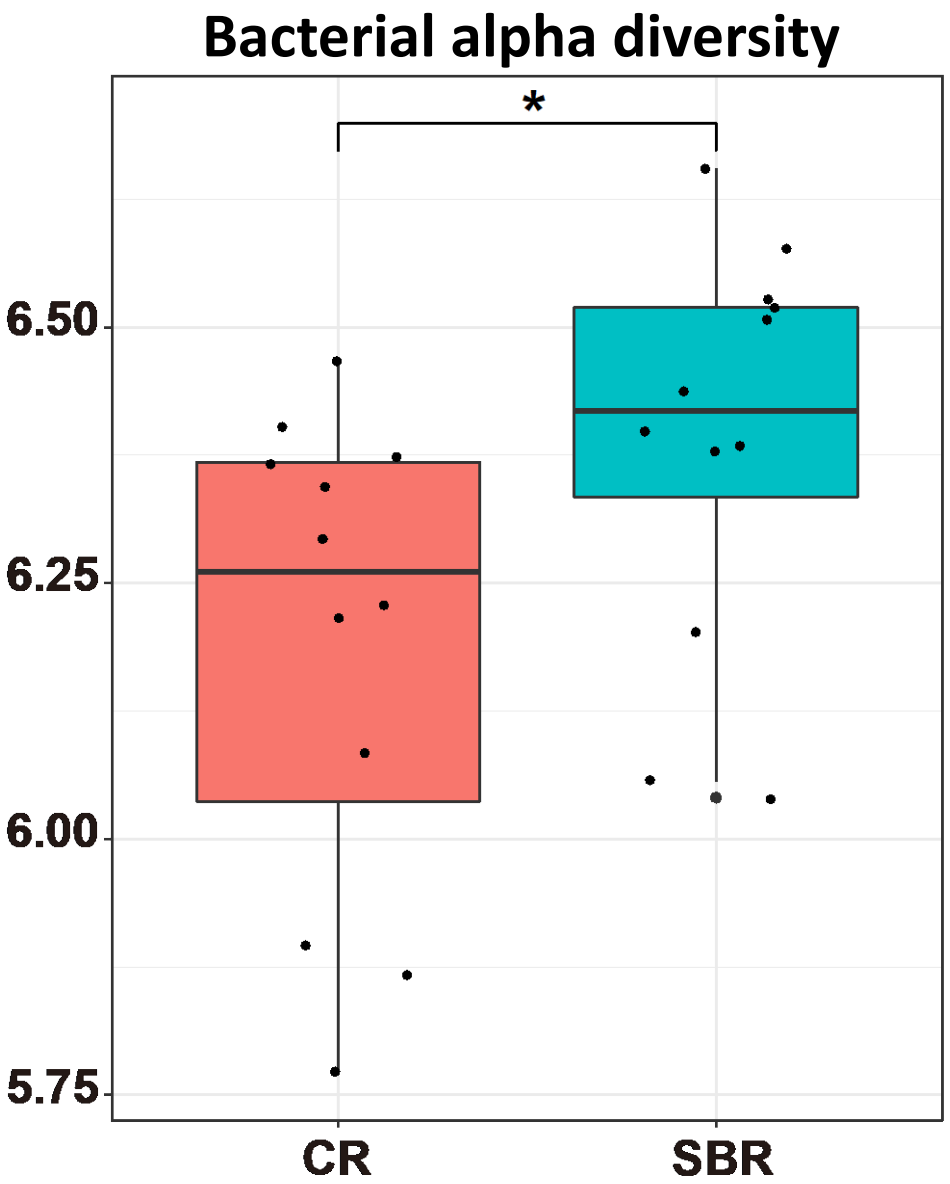
SBR did not differ from CR for soil total C and N in cotton plots

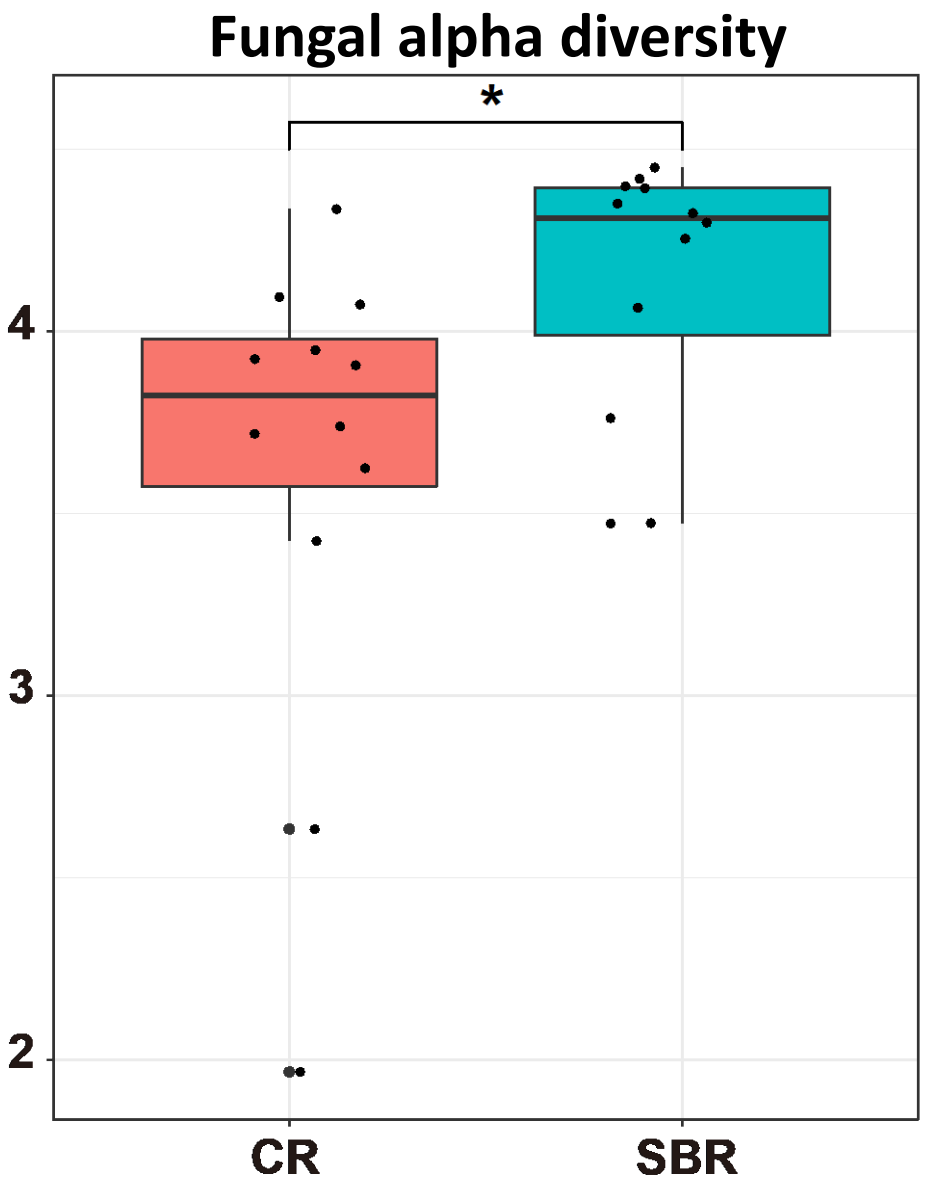




Zhang et al. 2022 ASE

Higher microbial diversity with SBR vs. CR in peanut plots



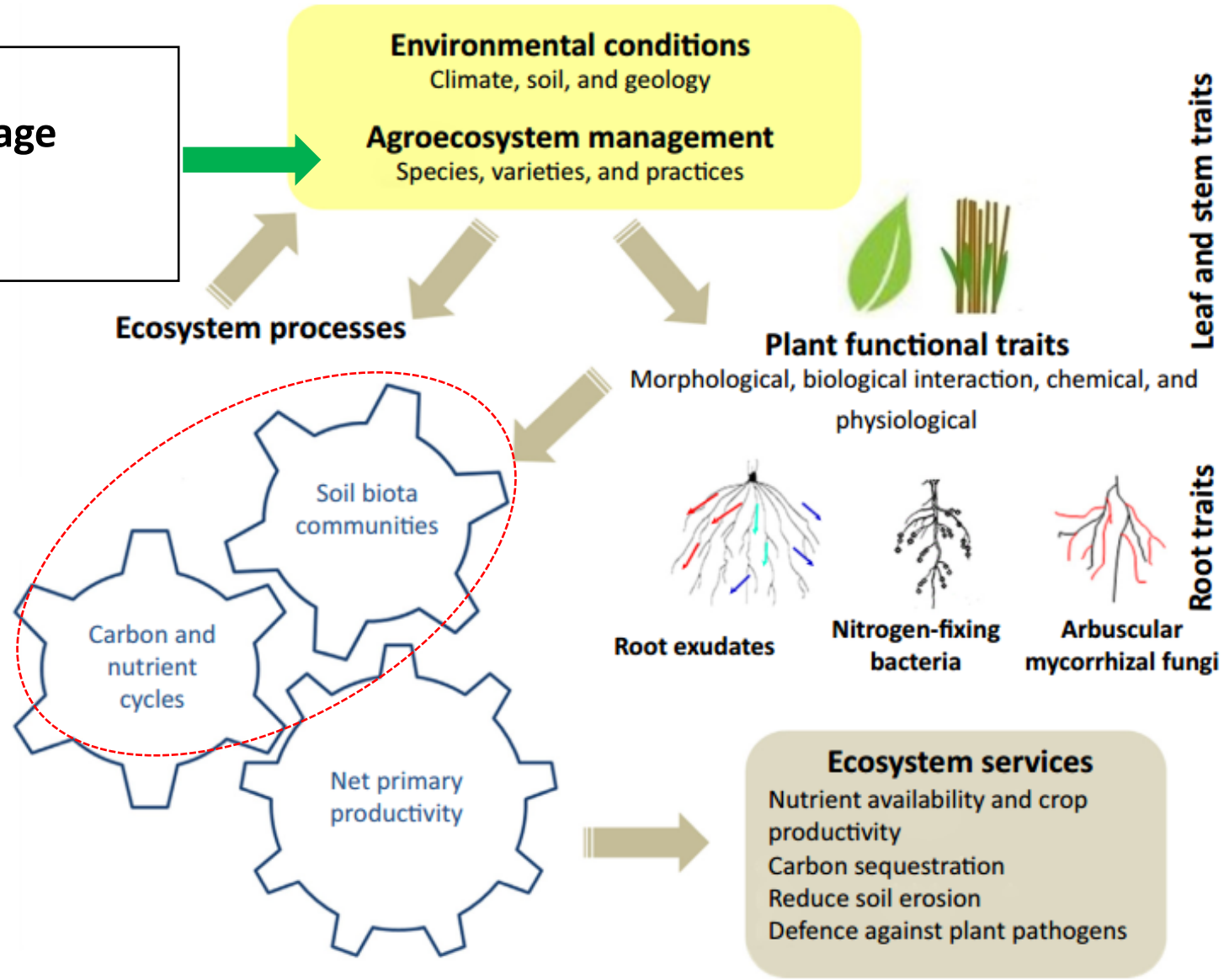


Zhang et al. 2022 BFS

Impacts of conservation practices on above- and below-ground processes

Practices

- Crop rotation
- Conservation tillage
- Sod inclusion
- Livestock grazing



Faucon et al., 2017

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