Microbial and abiotic interactions driven higher microbial anabolism on organic carbon accumulation during 2000 years of paddy soil development in the Yangtze River Delta, China

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- Paddy soils in China may have a positive effect on the terrestrial carbon sink over the last two decades. (current C sequestration rate: 0.13–2.2 t C ha^{-1} yr^{-1})
- Soil microorganisms are central to the conversion of organic matter into SOC.

High input of organic materials

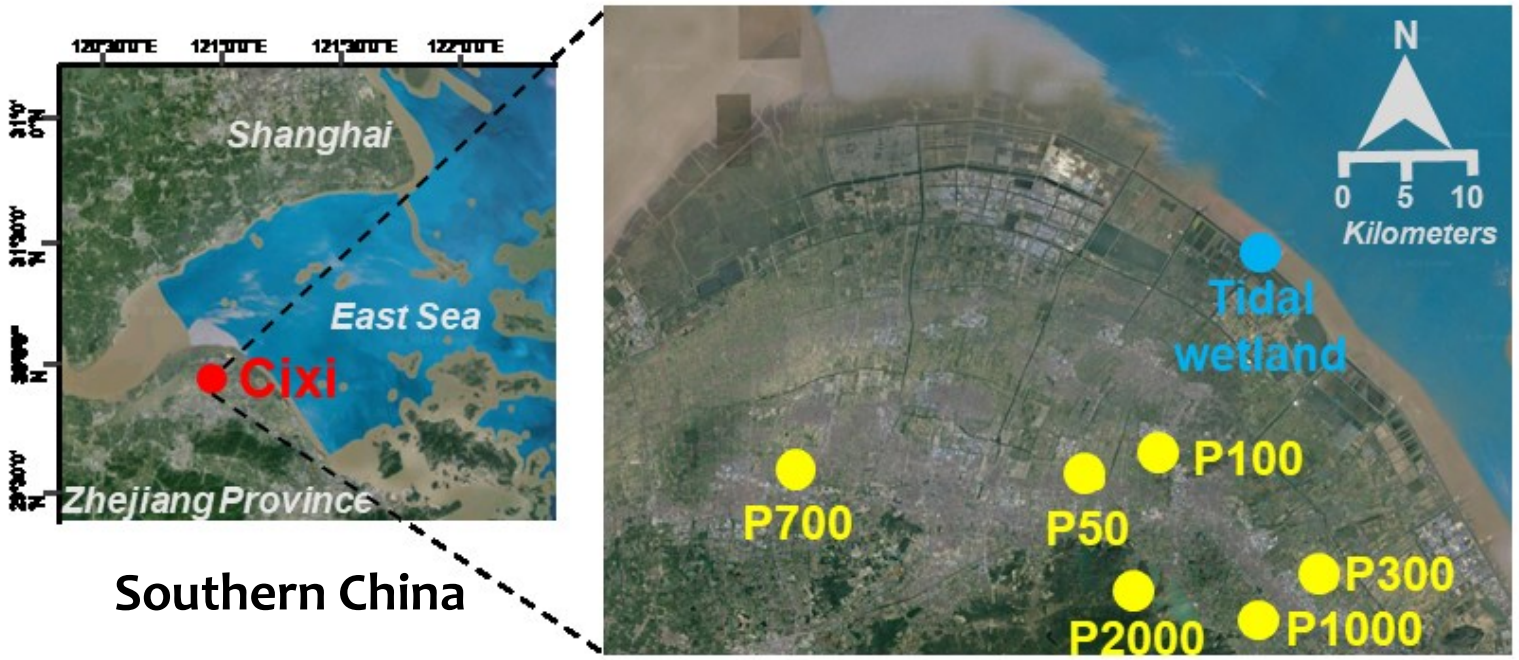
anaerobic

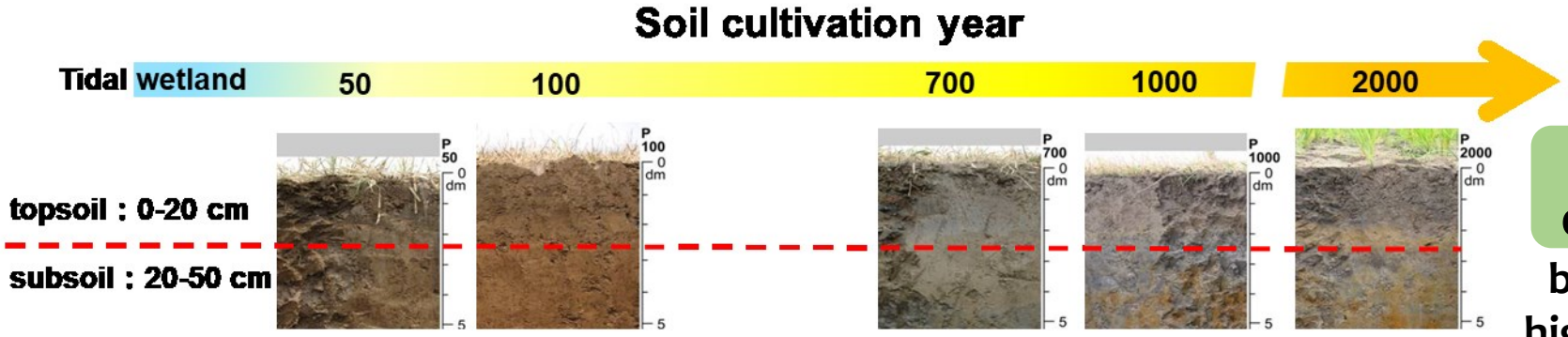
Low decomposition rate

How microbial community affects SOC sequestration in paddy soils across multiple time-scales ranging from decades to millennia?

Materials

Paddysoil chronosequence (0-50cm)





Methods

CUE NUE → **Process**

^{18}O-H_2O labelling DNA growth

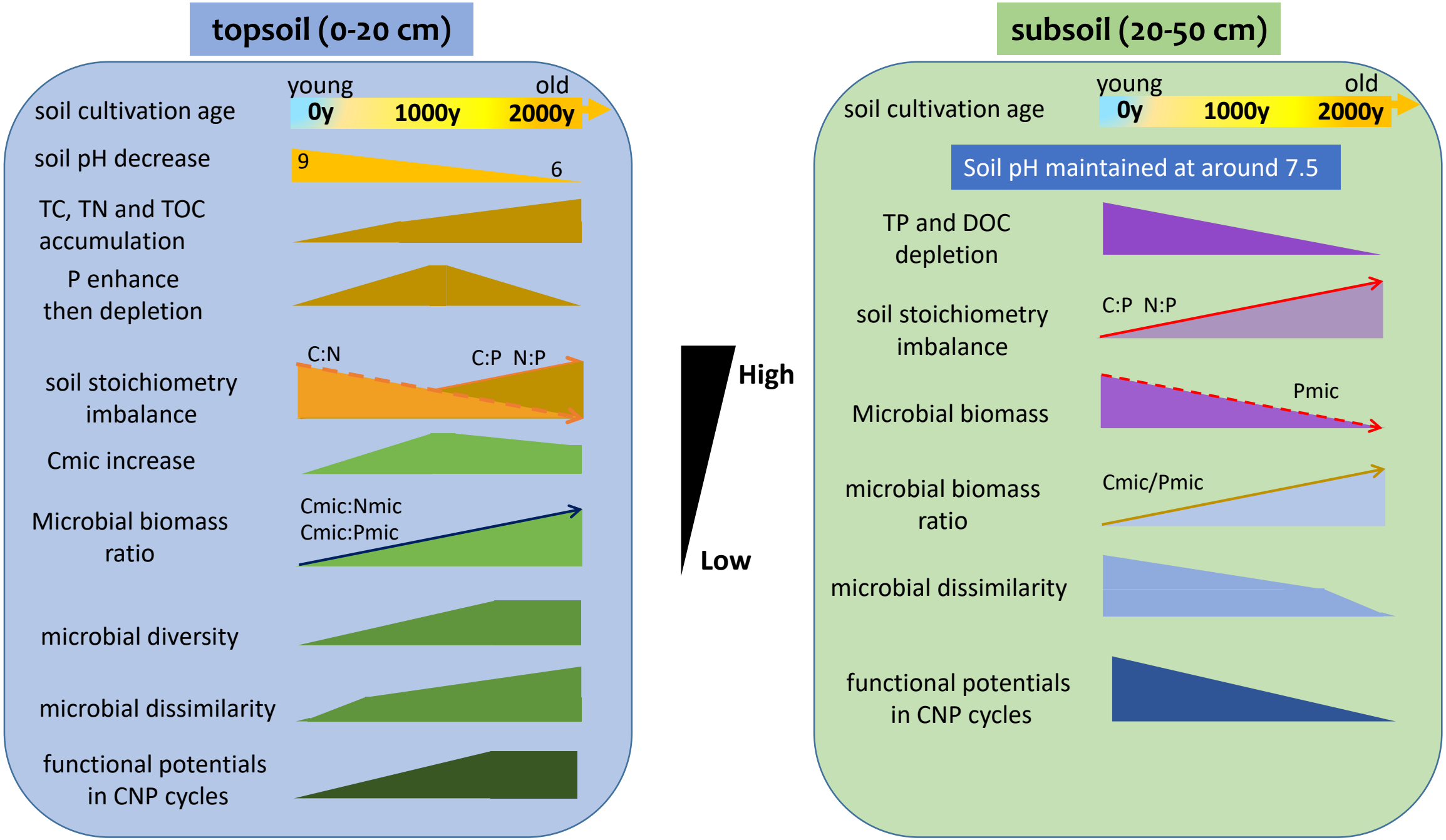
Genes → **Function**

QMEC Chip HT-qPCR

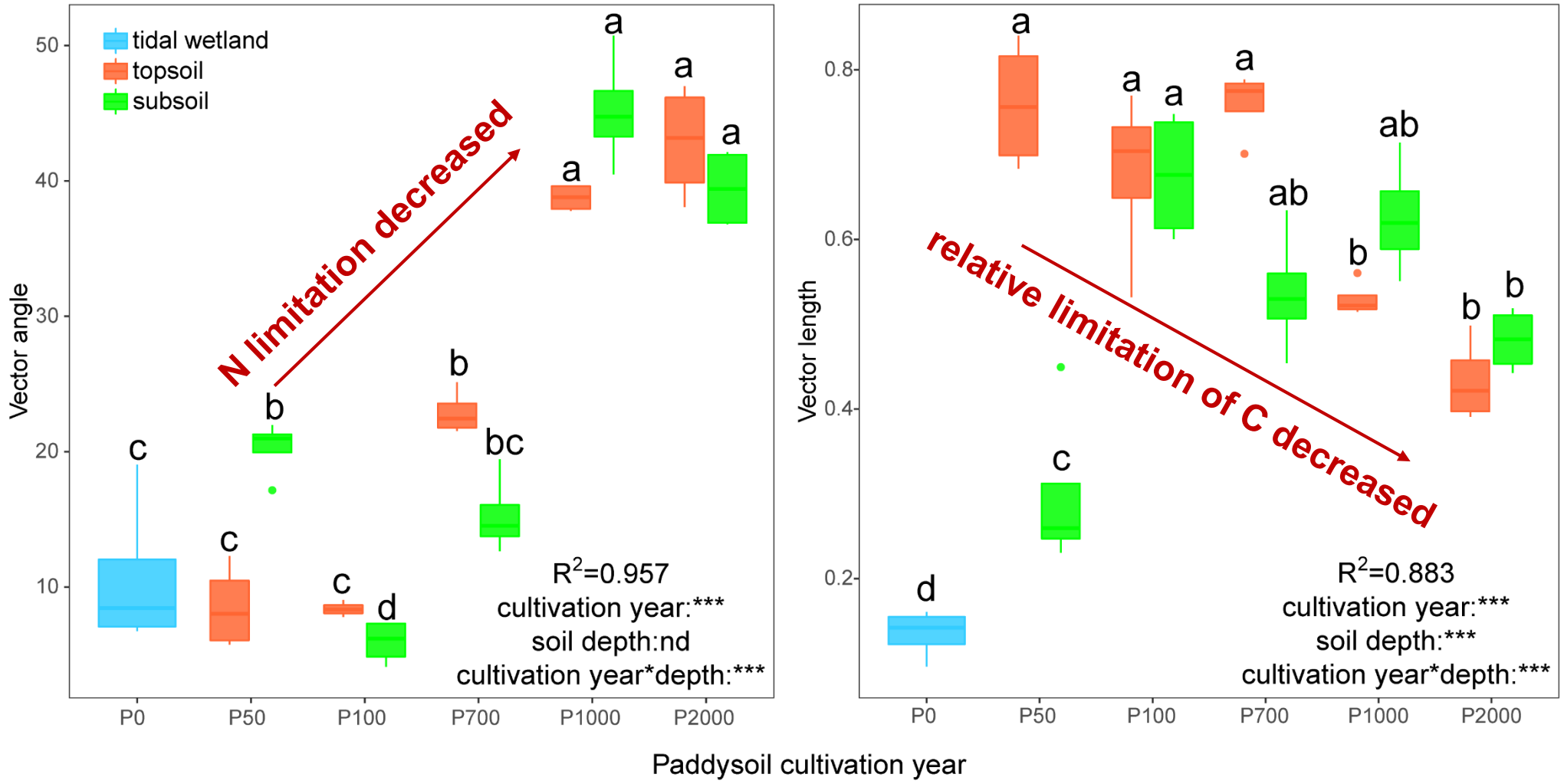
Microbial community → **Who**

bacteria/fungi high-throughput sequencing

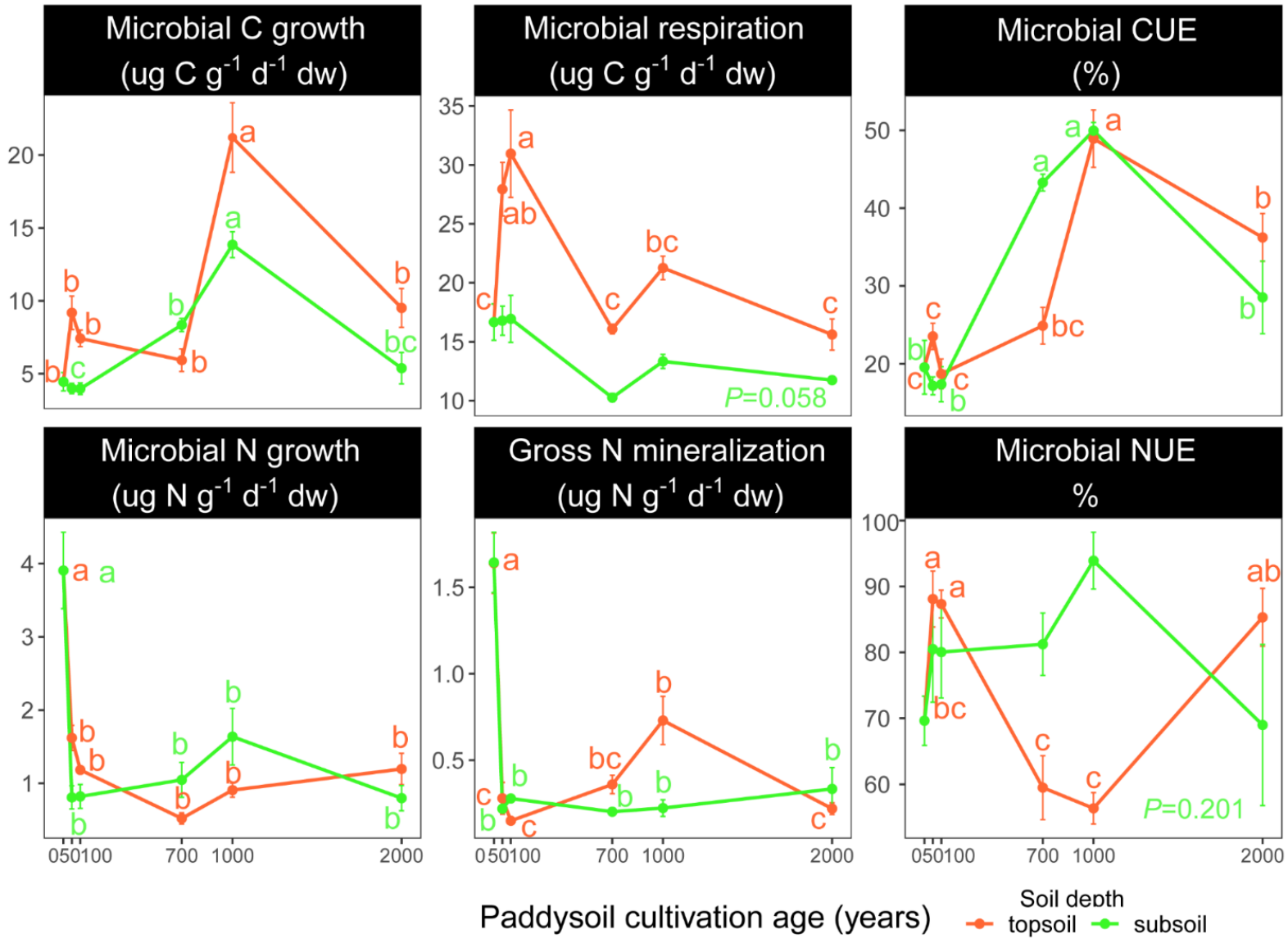
Correlations


topsoil (0-20 cm)
young
old
soil cultivation age
0y
1000y
2000y
soil pH decrease
9
6
TC, TN and TOC accumulation
P enhance then depletion
soil stoichiometry imbalance
C:N
C:P N:P
Cmic increase
Microbial biomass ratio
Cmic:Nmic
Cmic:Pmic
microbial diversity
microbial dissimilarity
functional potentials in CNP cycles
High
Low
subsoil (20-50 cm)
young
old
soil cultivation age
0y
1000y
2000y
Soil pH maintained at around 7.5
TP and DOC depletion
soil stoichiometry imbalance
C:P N:P
Microbial biomass
Pmic
microbial biomass ratio
Cmic/Pmic
microbial dissimilarity
functional potentials in CNP cycles

Vector analysis of soil enzyme stoichiometry indicated that both of top- and sub-soil were limited by carbon and nitrogen, but the limitations decreased after 1000 years.



How do microbial CUE and NUE response ?

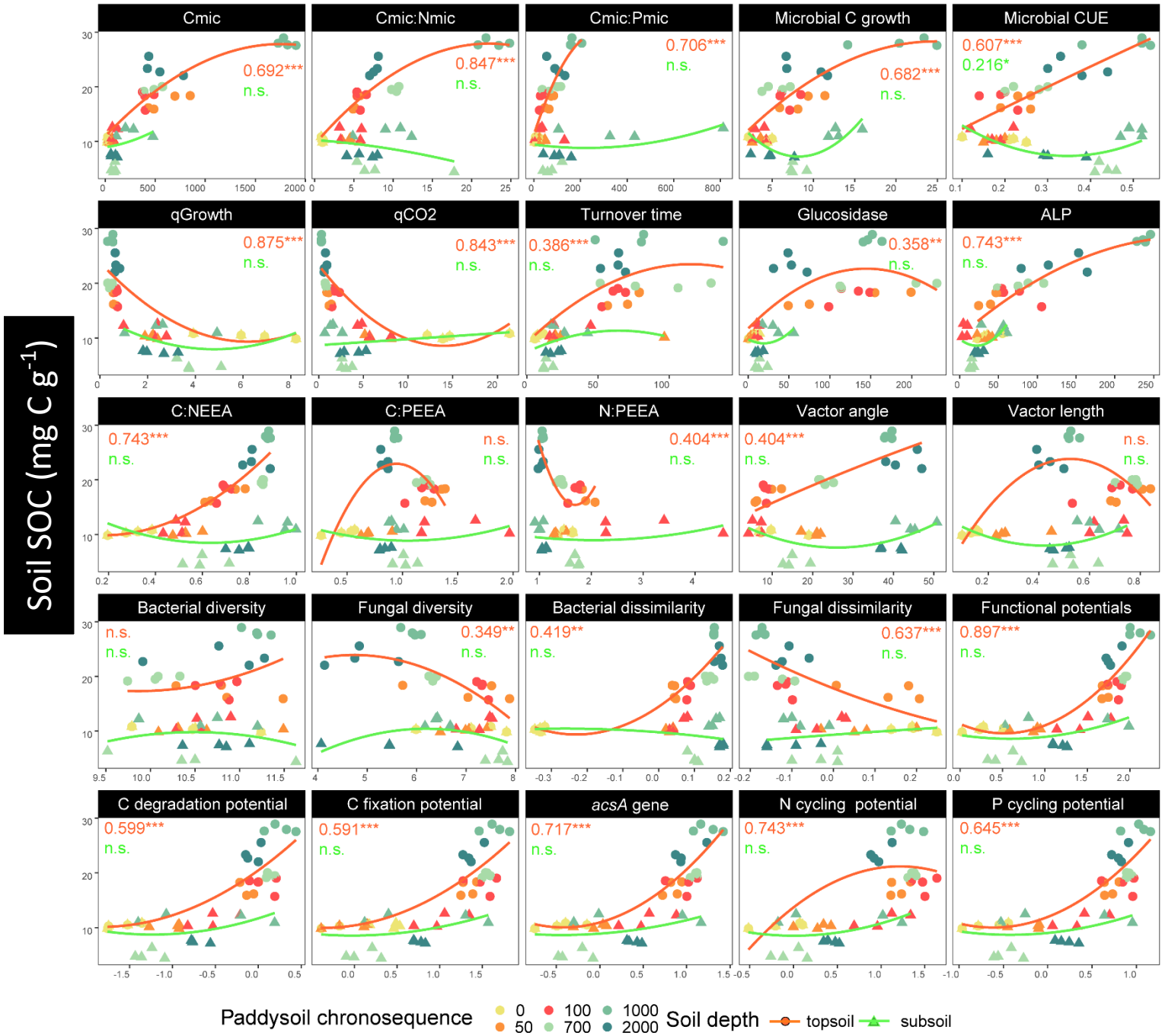


initial stage (100y)

- low CUE and Growth, high NUE: mainly constituted by slow-growing microorganisms, which was limited by C and N.

Long-term stage (1000y)

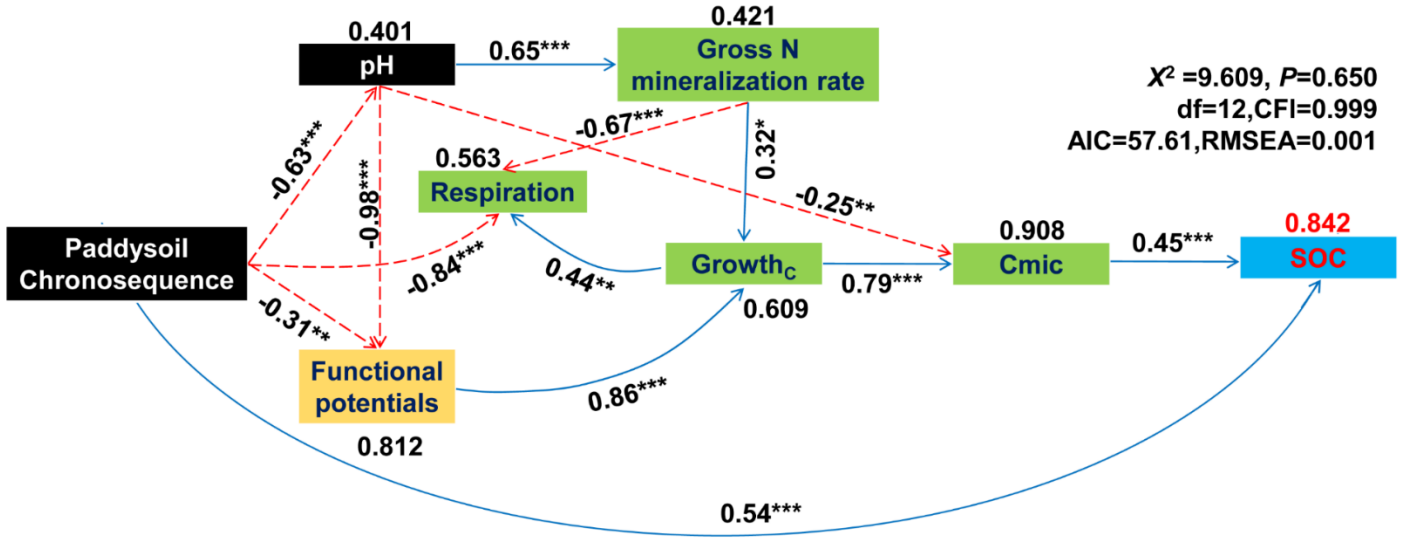
- high CUE and Growth, low NUE: increased microbial growth and decreased N limitation.

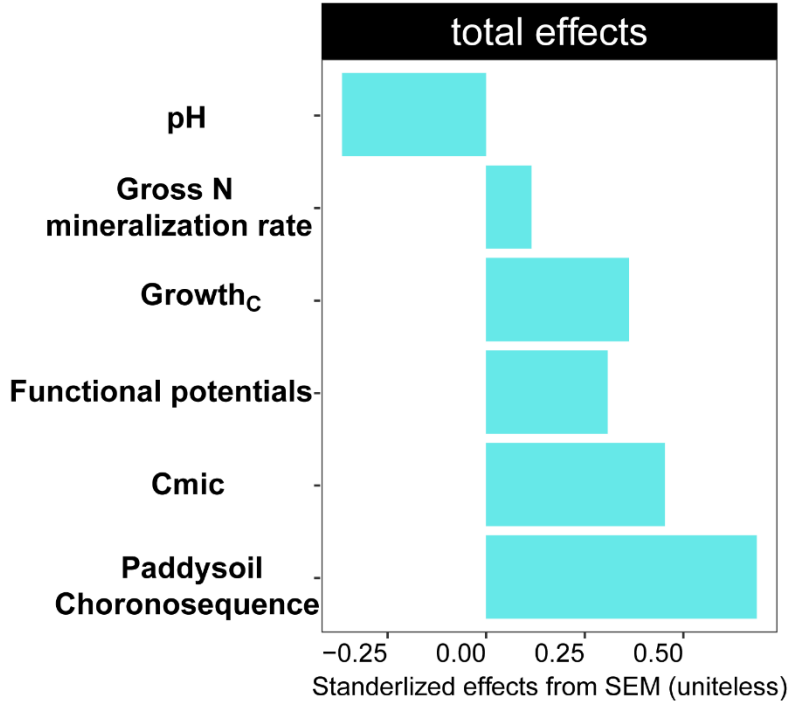


Linear regressions between soil SOC content and microbial parameters

- ✓ Cmic
- ✓ Growth
- ✓ CUE
- ✓ turnover time
- ✓ reduction of CN limitations
- ✓ microbial community homogenization
- ✓ functional potentials (C-degradation, C-fixation, NP cycling)

The accumulation of SOC in topsoil was significantly correlated with soil microbial community structure, functional potentials and metabolism.





with the continuous cultivation

- the decline in soil pH had positive effects on microbial functional potentials and microbial biomass carbon.
- N mineralization rate stimulated microbial growth.
- the enhanced microbial functional potentials directly positively affected microbial growth, and thereby on microbial biomass carbon.

Conclusion

- The continuous paddy cultivation at long time scales captures the cumulative microbial anabolism on SOC sequestration in the plough layer, with the shifts in abiotic and biotic conditions towards increased nutrient availability and homogenous microbial community with higher functional potentials.

Thank you!

China Soil Microbiome Initiative (CSMI)

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My research interests primarily focus on microbial ecology and soil biogeochemistry. In the period of my doctoral training, I have been working extensively on the topic of the effects of agricultural management scenarios on soil-microbes-plant interactions regulating carbon and nutrient cycles, and understanding the microbial mechanisms regulating these processes. I have learned state-of-the-art methods including implementing field and greenhouse experiments, isotope tracing, microbial molecular approaches, bioinformatic analysis and R program.

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