The Mechanisms of Soil Organic Carbon Accumulation in Saline Soil

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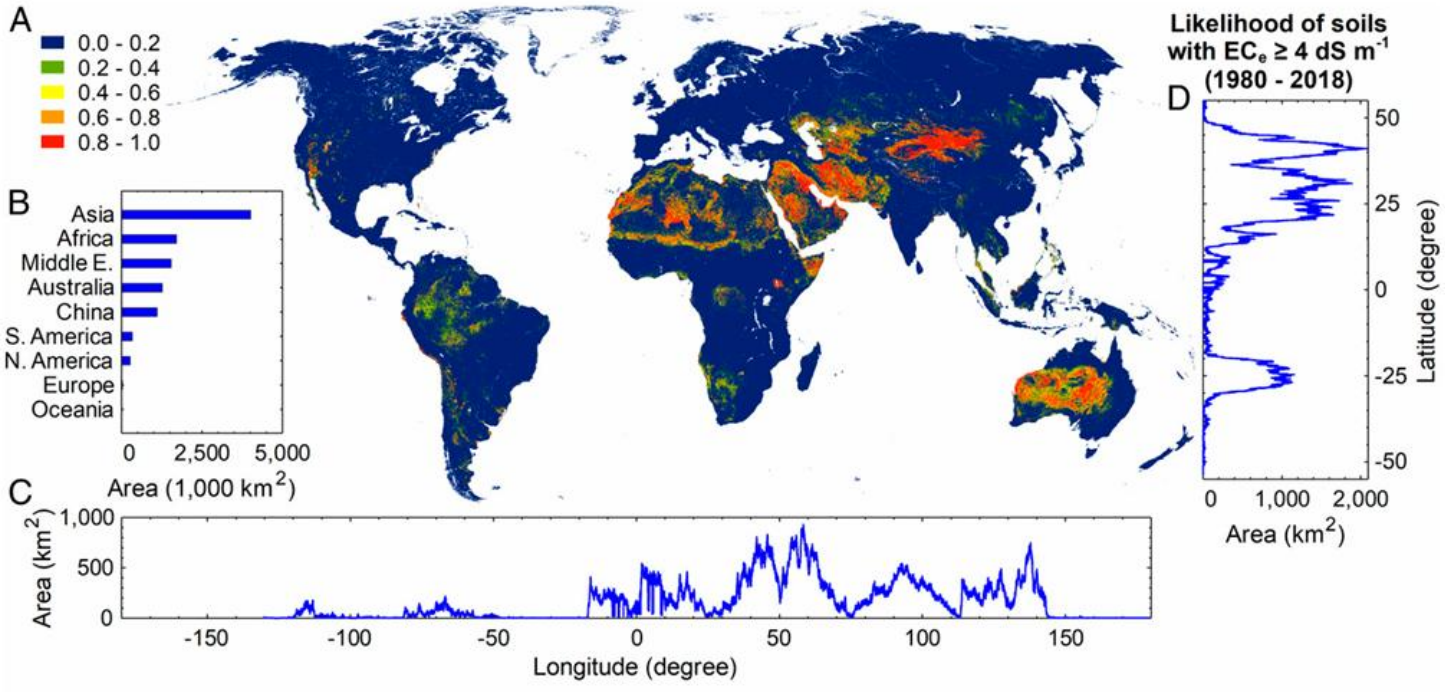
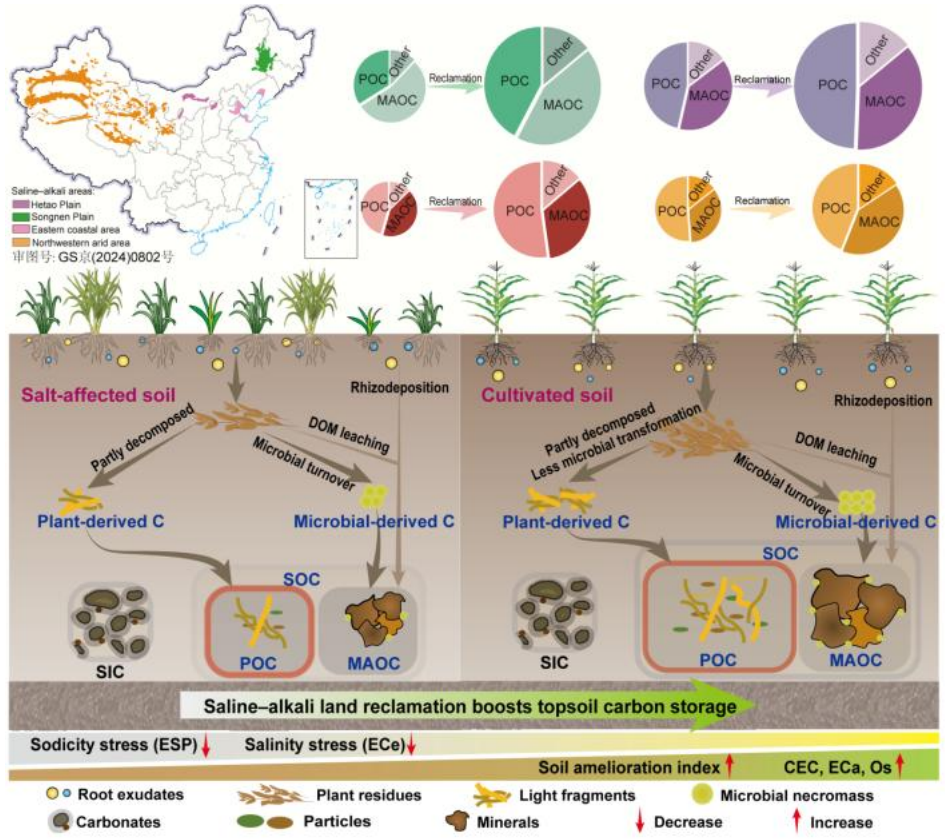
Soil Organic Carbon (SOC) in Saline Soil

- The global area of saline soils exceeds 1.38 billion hectares, accounting for 10.7% of the Earth's land surface
- High salinity and low C storage are not conducive to SOC accumulation



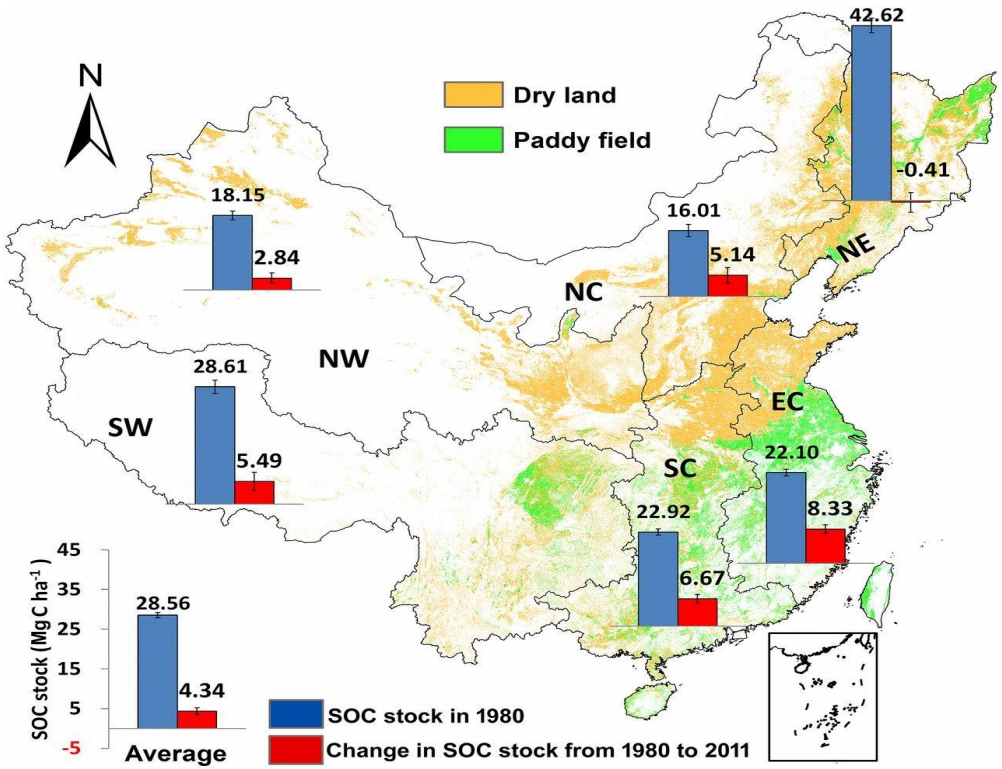
Hassani et al., PNAS, 2020



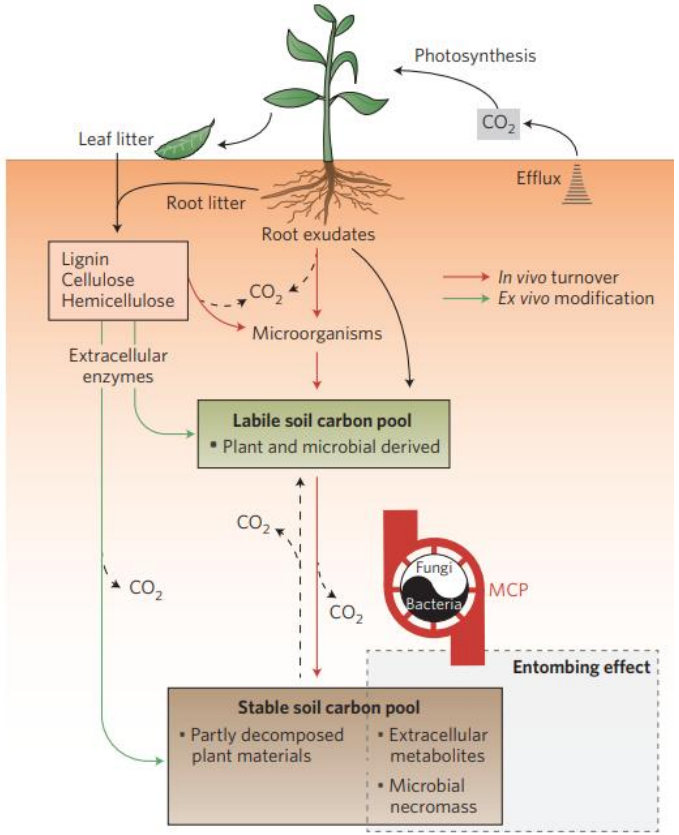
Chen et al., Science Bulletin, 2024

SOC Input and Accumulation

- SOC accumulation driven farmland productivity and soil quality enhancement
- Organic carbon input and microbial assimilation are key steps in promoting SOC accumulation



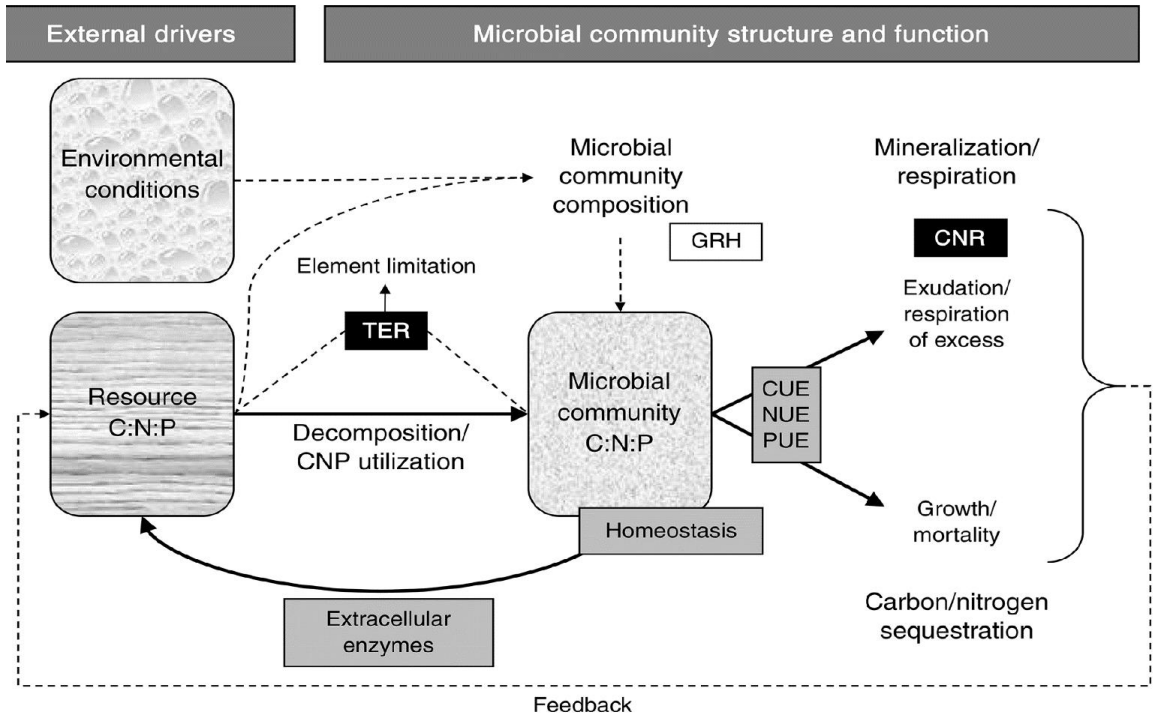
Zhao et al., PNAS, 2018



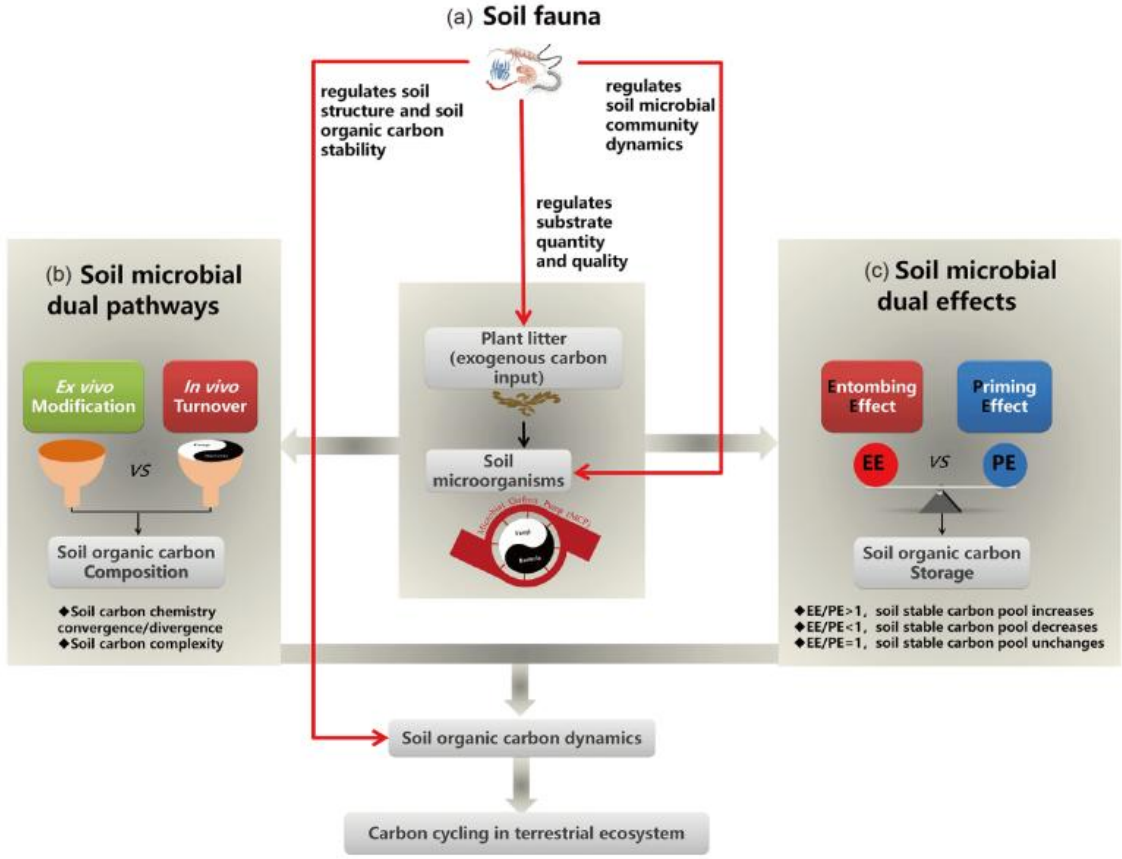
Liang et al., Nature Microbiol 2017
Liang et al., Soil Biol Biochem 2022

Elemental Stoichiometry and Mcirobial Metabolism

- SOC accumulation is regulated by carbon quality and nutrient stoichiometry
- Microbial community structure and composition influence SOC accumulation by affecting the formation of microbial necromass



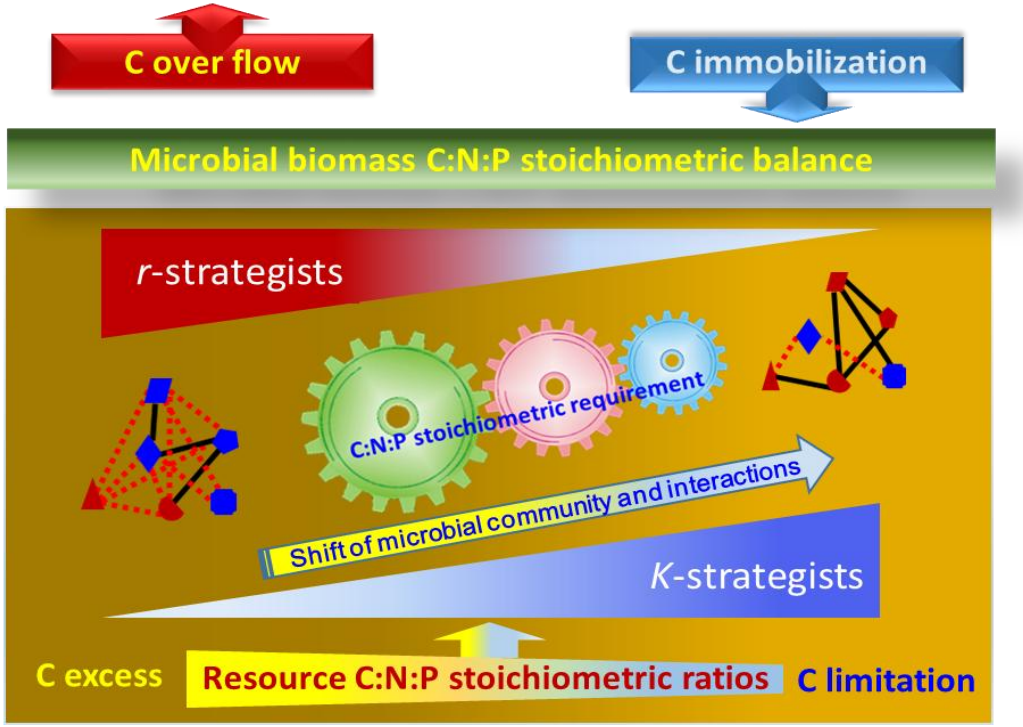
Zechmeister-Boltenstern, et al, 2015



Liang et al., Sci China Earth Sci, 2021

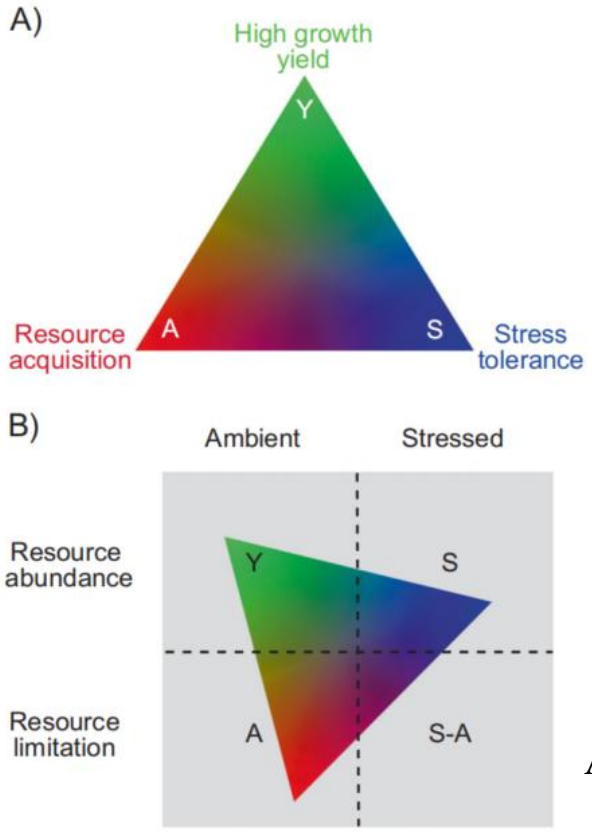
The Mechanisms of SOC Accumulation in Saline Soils ?

- **Microbial life strategies reveal how resource allocation trade-offs are shaped by environmental stress and nutrient competition**



Wei et al., Biol. Fertil. Soils, 2022

***r*- vs. *K* strategies**



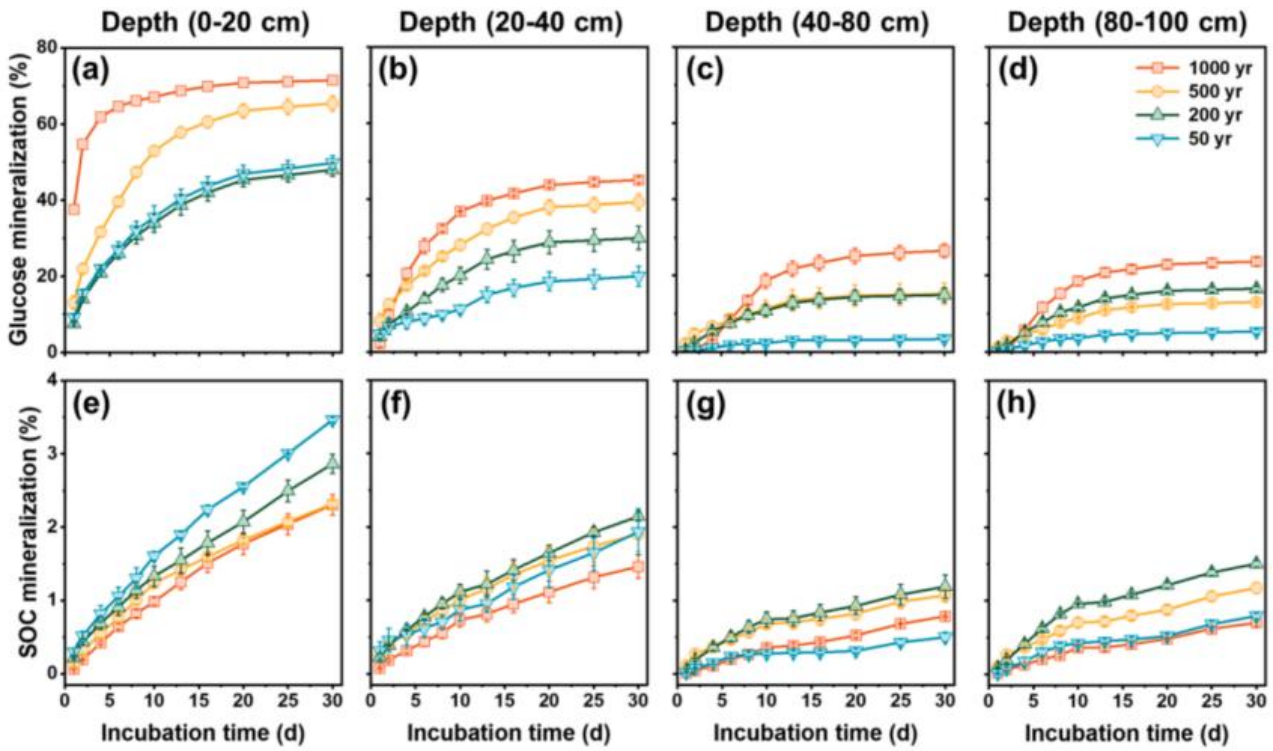
Ashish et al., ISME, 2020

Y, A, S strategies

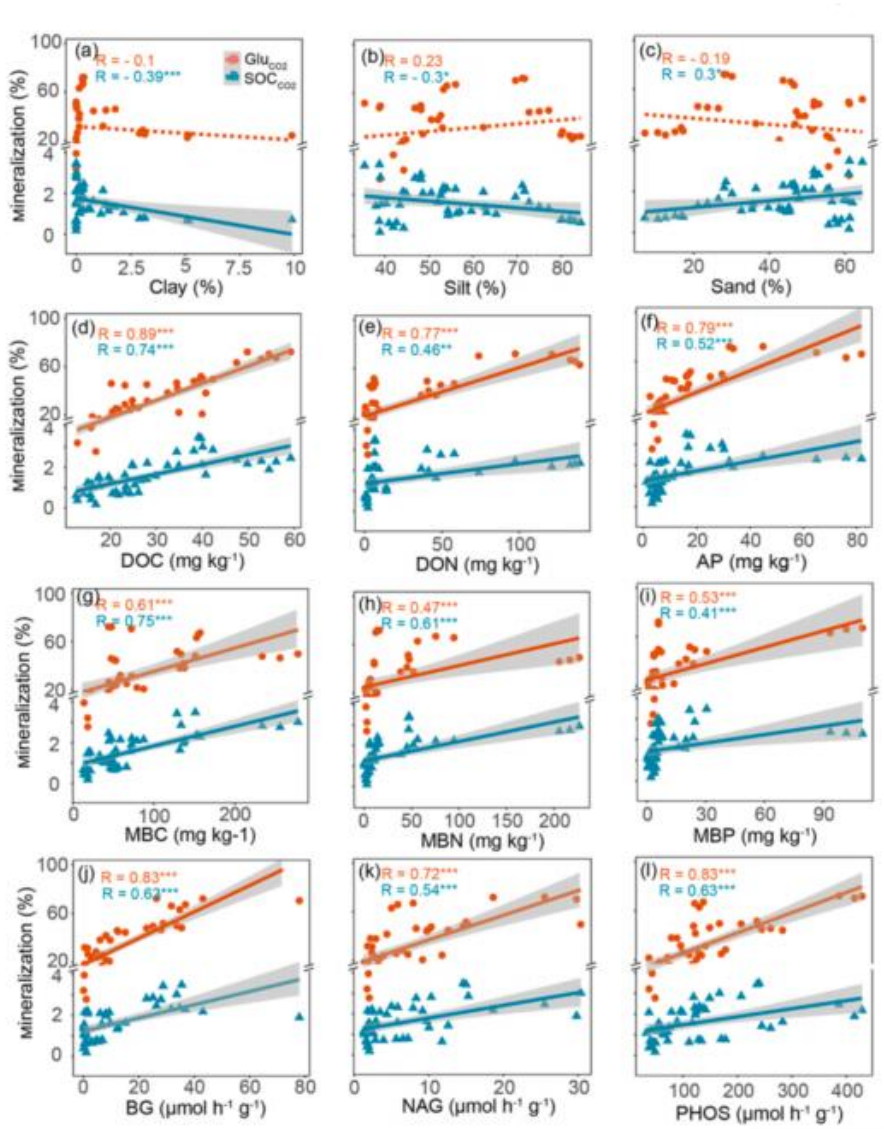
The Mechanisms of Soil Organic Carbon Accumulation in Saline Soil ?

1. Microbial Mechanisms Affect Carbon Mineralization

- **Surface soils showed higher mineralization rates for both glucose and SOC than deep soils**
- **Higher nutrients, microbial biomass, and enzyme activity enhanced OC mineralization**



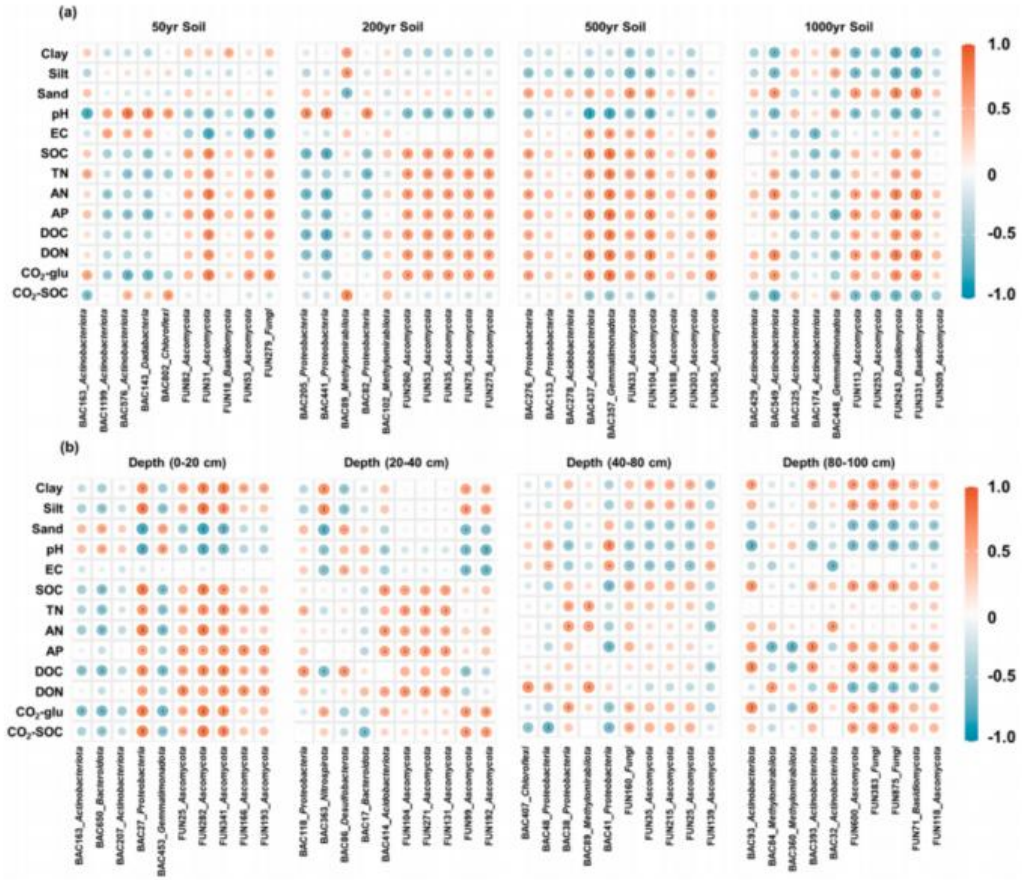
Studied SOC dynamics and microbial responses in saline paddy soils across a millennium (50, 200, 500, and 1000 years) and four depths (0–20, 20–40, 40–80, and 80–100 cm). Using ^{13}C-labeled glucose (2 % of SOC) as a tracer, we evaluated exogenous labile C and SOC mineralization in saline soils sampled

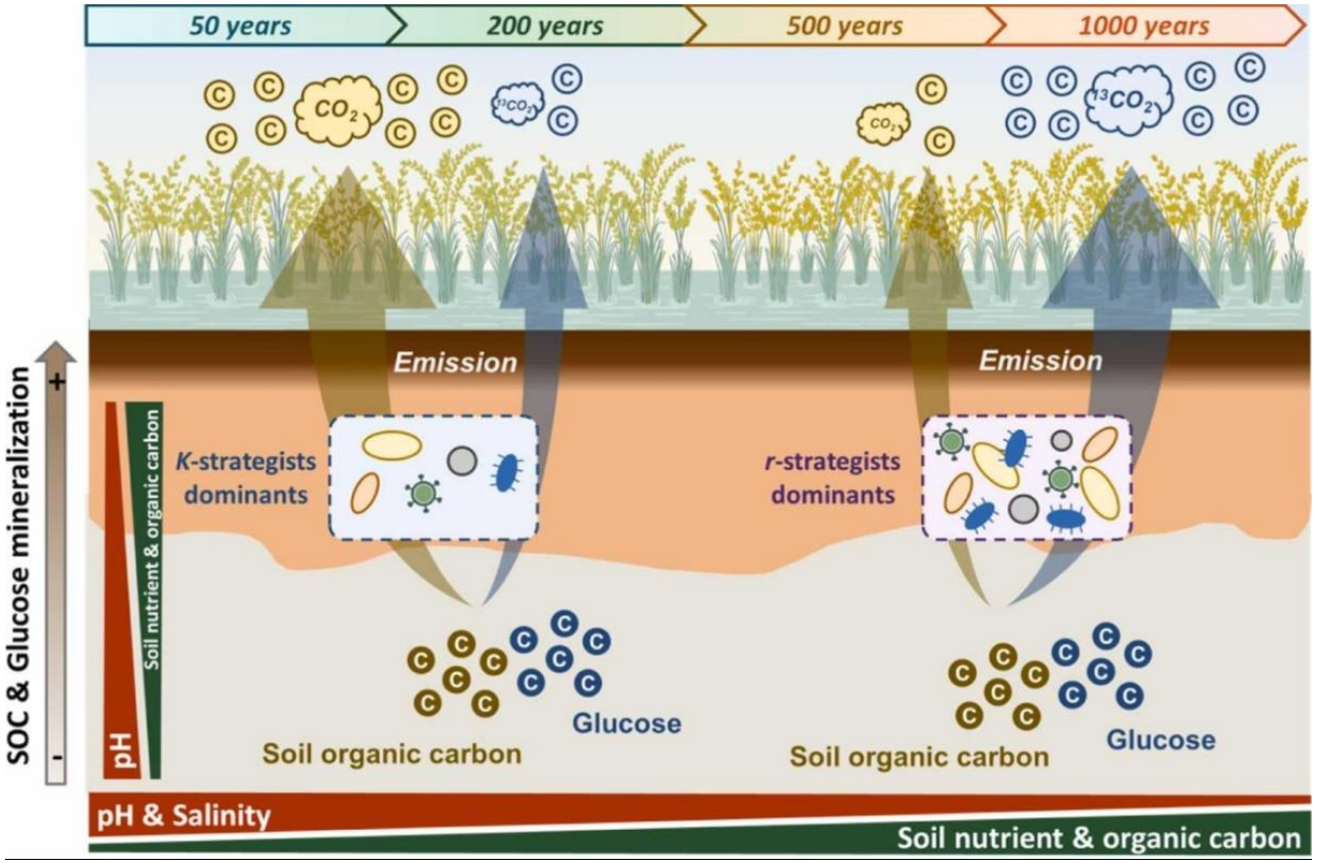


Ying et al., Soil & Tillage Research, 2026

1. Microbial Mechanisms Affect Carbon Mineralization

- **Microbial community was strongly linked to glucose mineralization**
- **Initial glucose mineralization was driven by *r*-strategists, long-term cultivation shifted toward *K*-strategists, further accelerating SOC mineralization**

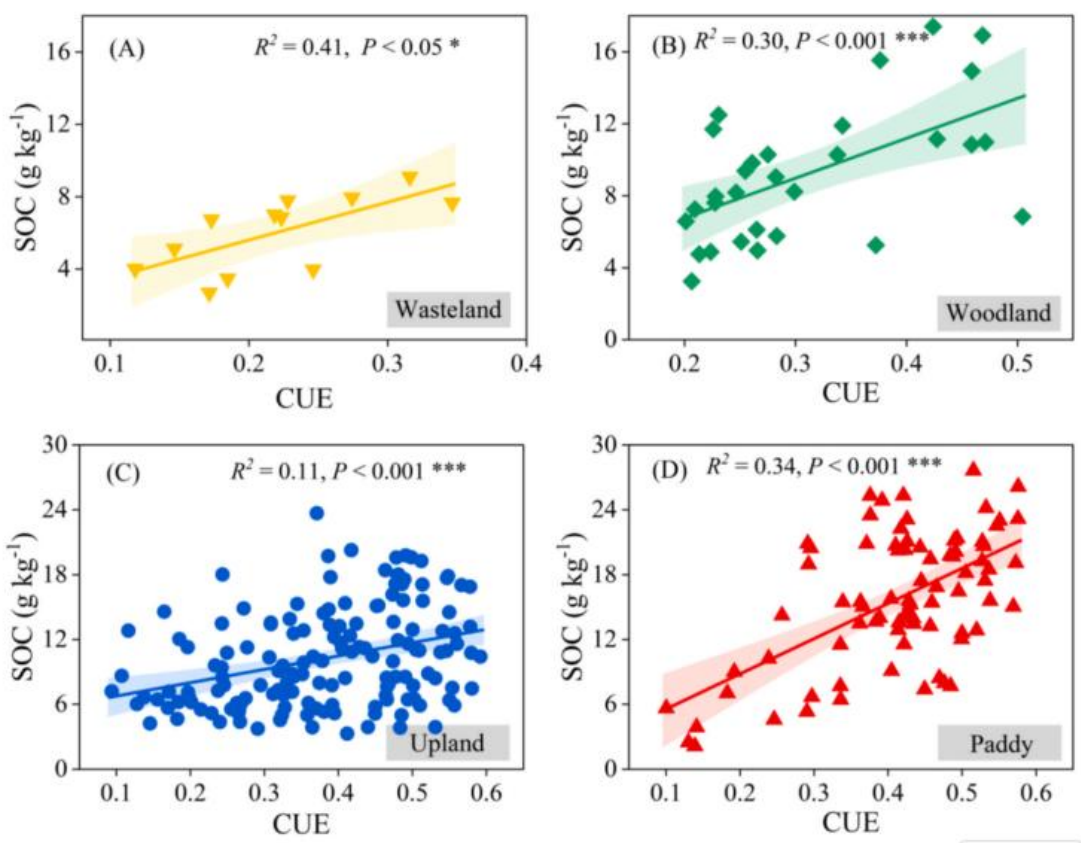


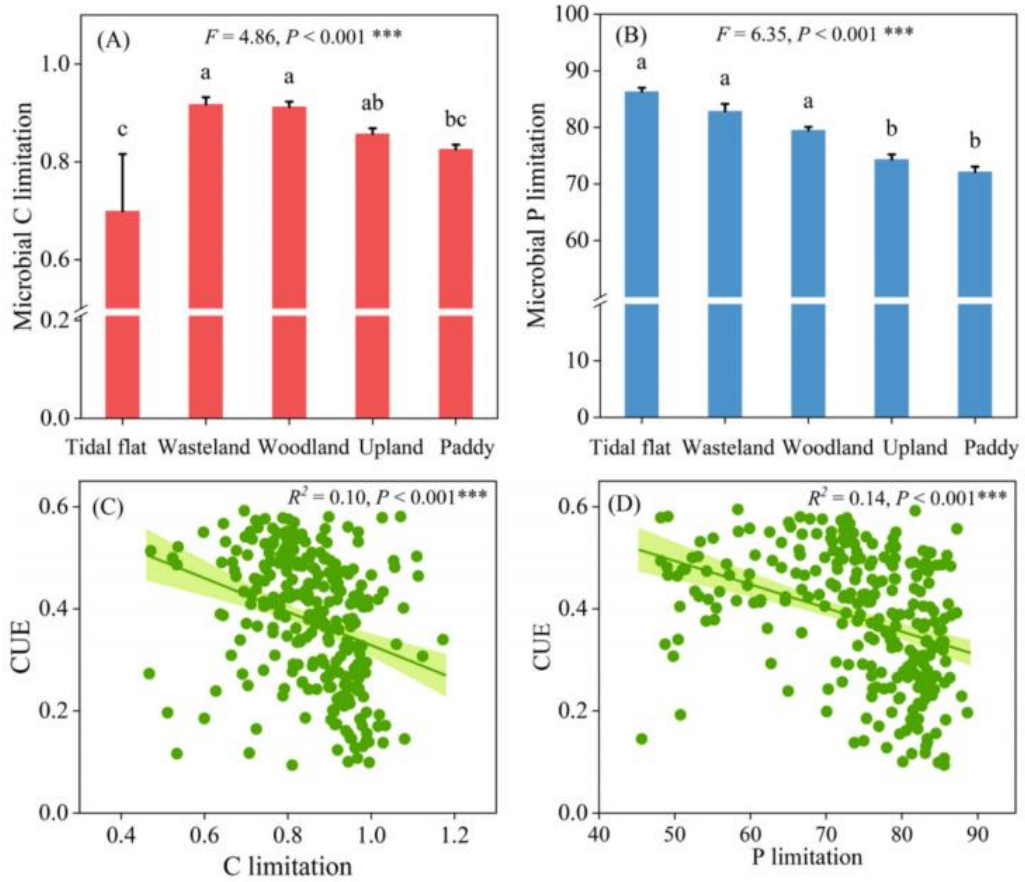


Ying et al., Soil & Tillage Research, 2026

2. Elemental Stoichiometry Regulates SOC Accumulation

- **Microbial carbon use efficiency (CUE) is positively coupled with SOC accumulation**
- **CUE has a significant negative correlation with microbial nutrient limitation**



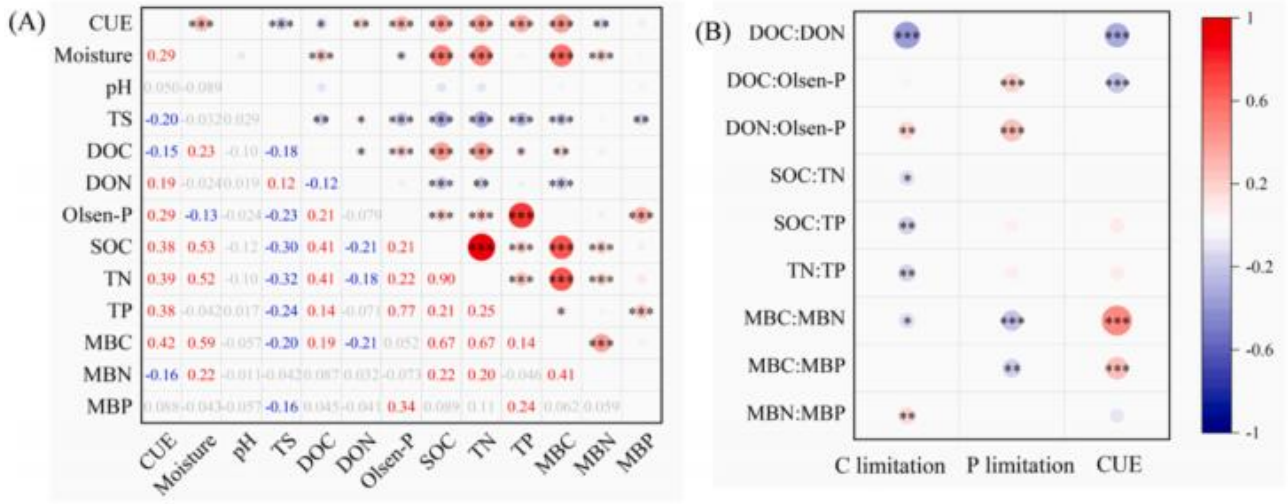


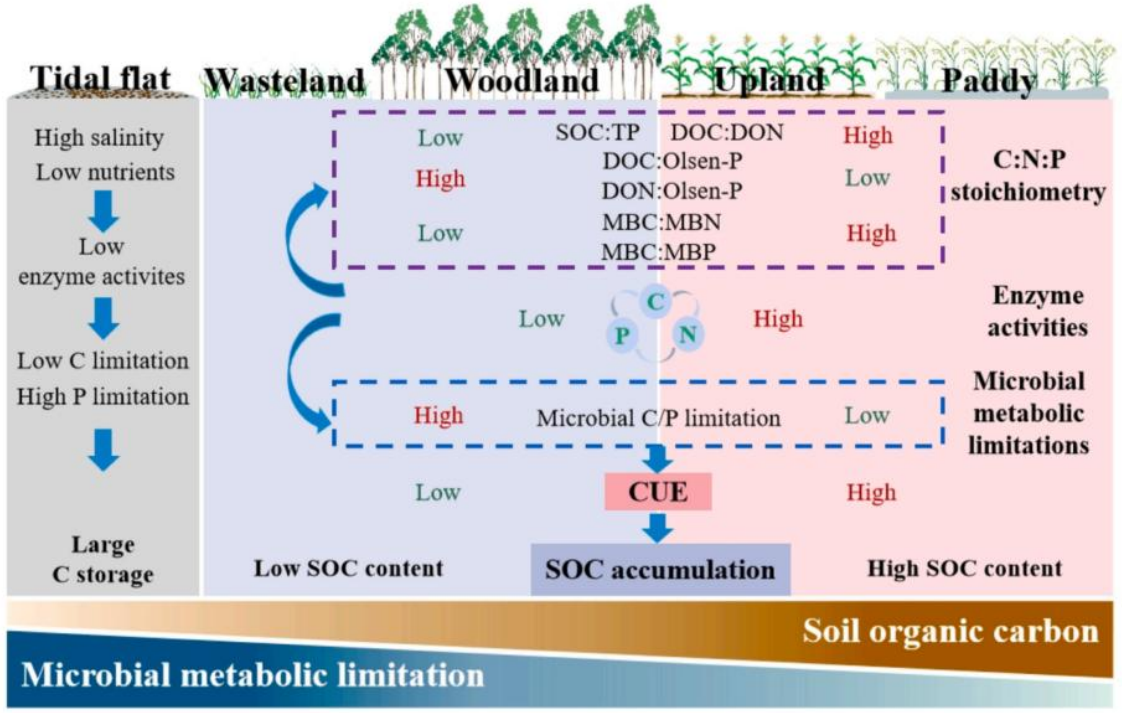
This study aimed to investigate the impact of soil and microbial biomass (MB) C:N:P stoichiometry and microbial metabolic limitation on SOC accumulation in agricultural and natural soils.

Wang et al., Soil & Tillage Research, 2024

2. Elemental Stoichiometry Regulates SOC Accumulation

- **High stoichiometric ratios (SOC:TP, DOC:DON, MBC:MBN/P) in agricultural soils increased nutrient supply, alleviating microbial nutrient limitations**
- **Microbial nutrient limitation regulated by C:N:P elemental stoichiometry promotes SOC accumulation**

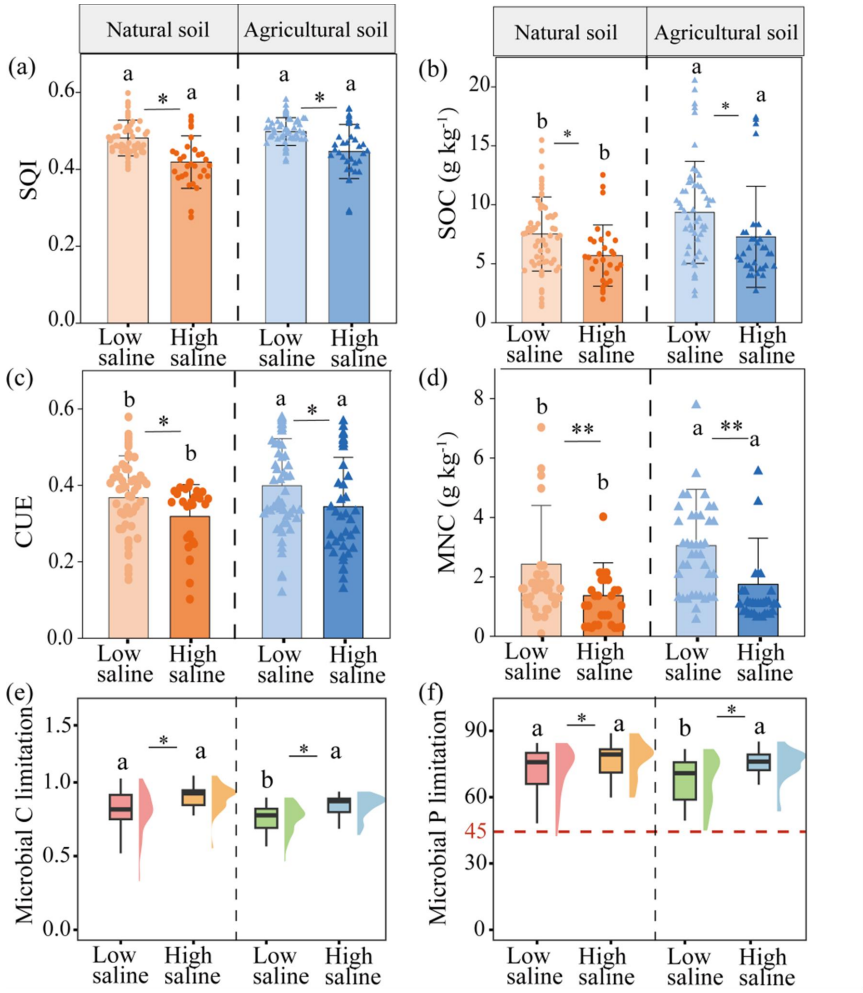


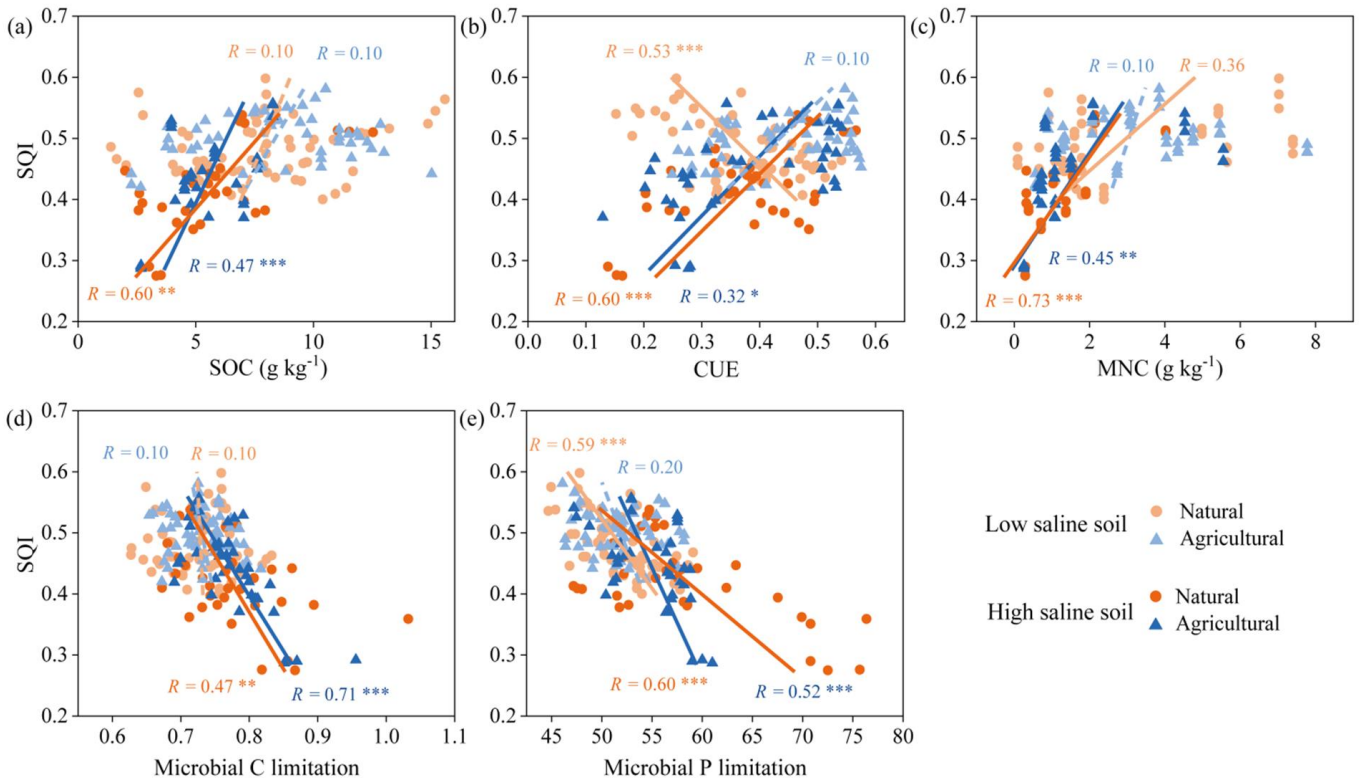


Wang et al., Soil & Tillage Research, 2024

3. Microbial Network Drives SOC Accumulation

- **Salinity decreased soil quality, SOC content, microbial carbon use efficiency (CUE), and microbial necromass carbon (MNC)**



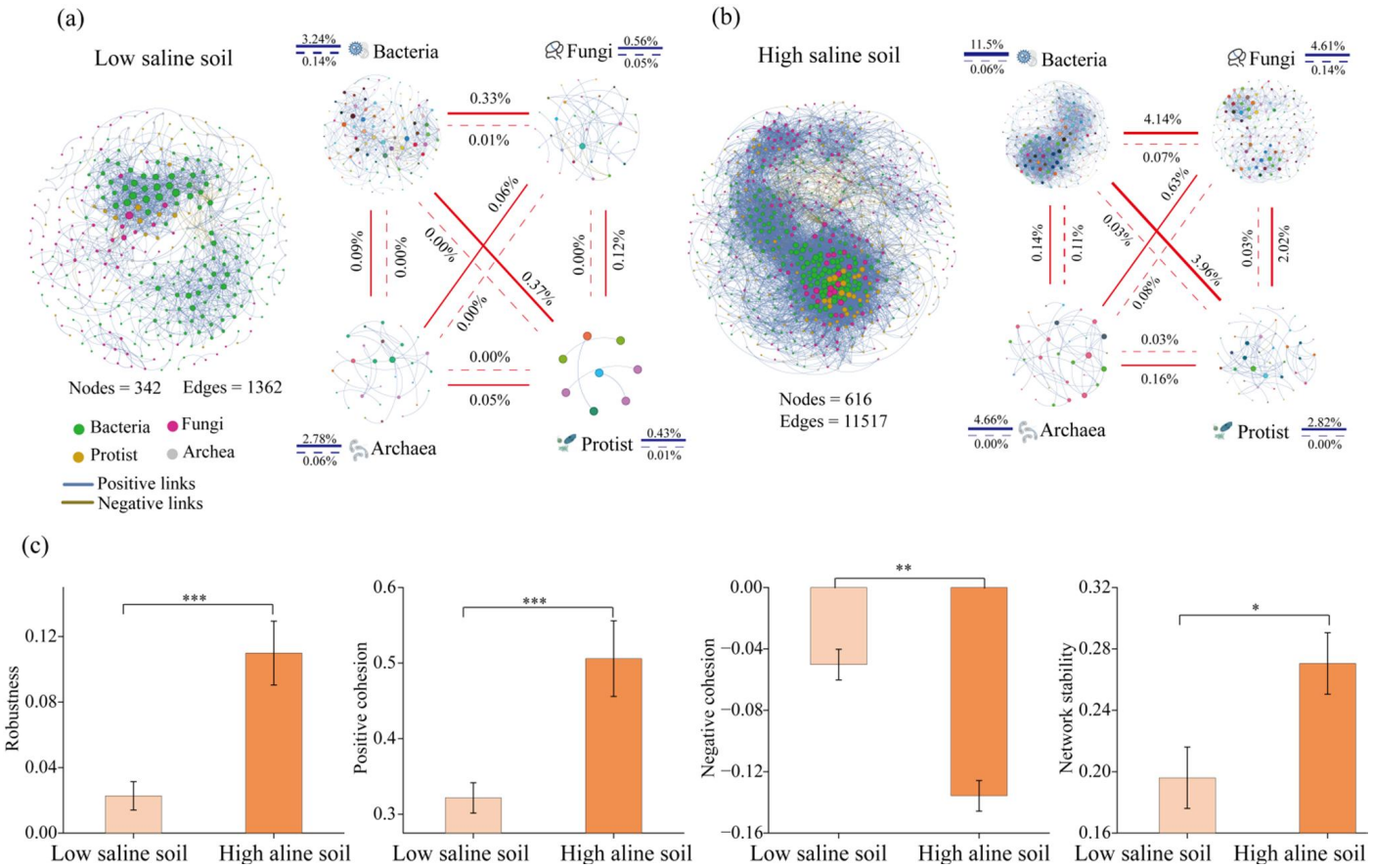


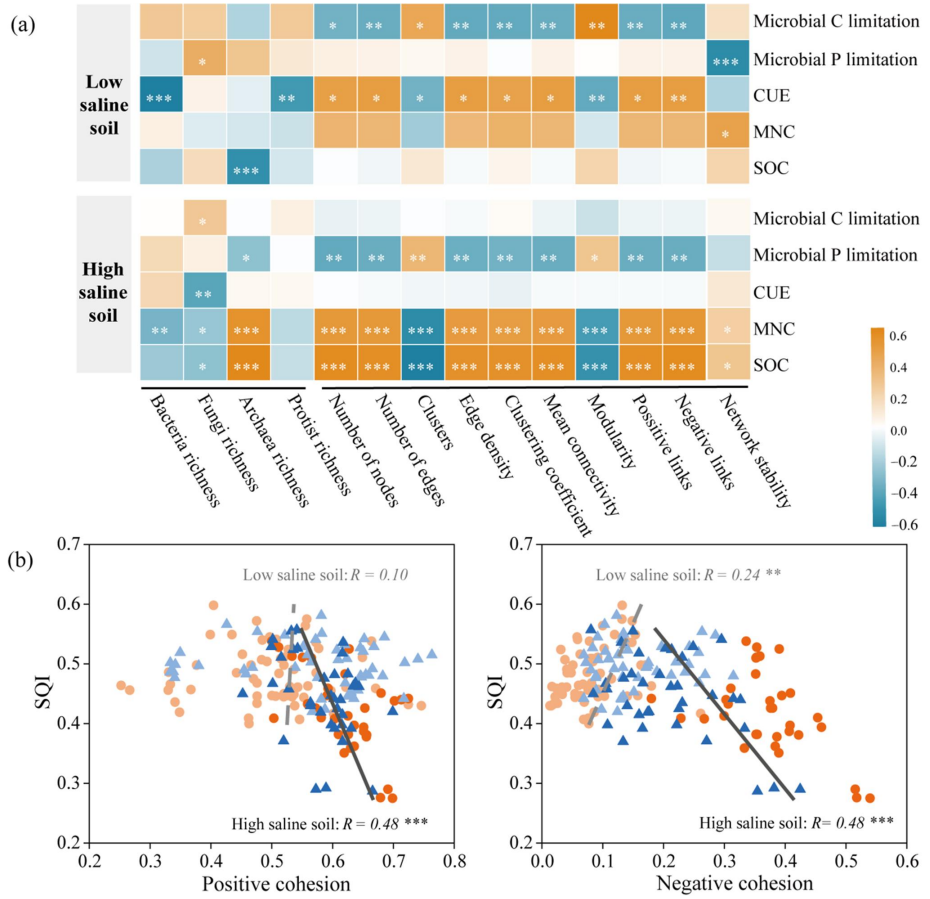
We analyzed 31 paired natural and agricultural sites of low- and high-salinity soils in coastal China according to SOC, soil quality index (SQI), microbial carbon use efficiency (CUE), microbial necromass carbon (MNC), enzyme activities, and microbial community composition

Wang et al., unpublished data

3. Microbial Network Drives SOC Accumulation

- **High salinity enhances the microbial network complexity and positive cohesion, reflecting close cooperation that boosted resource competition**

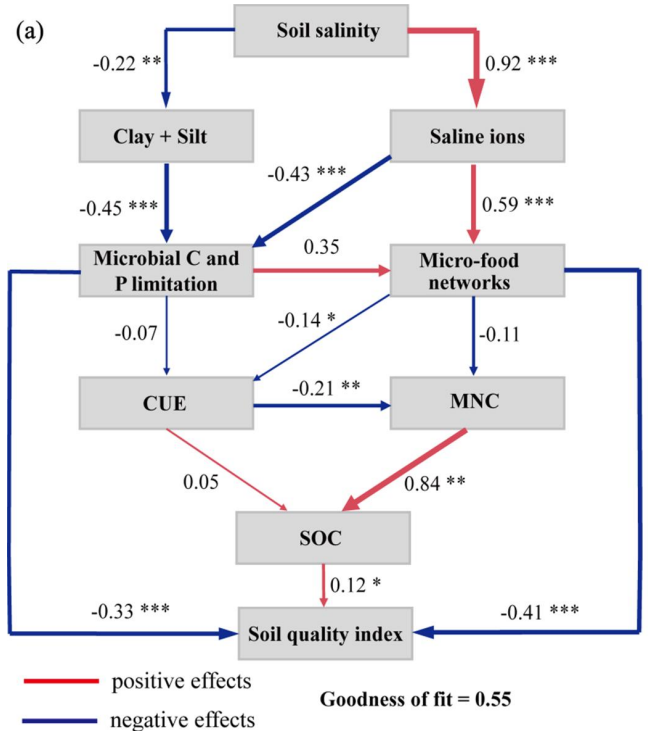


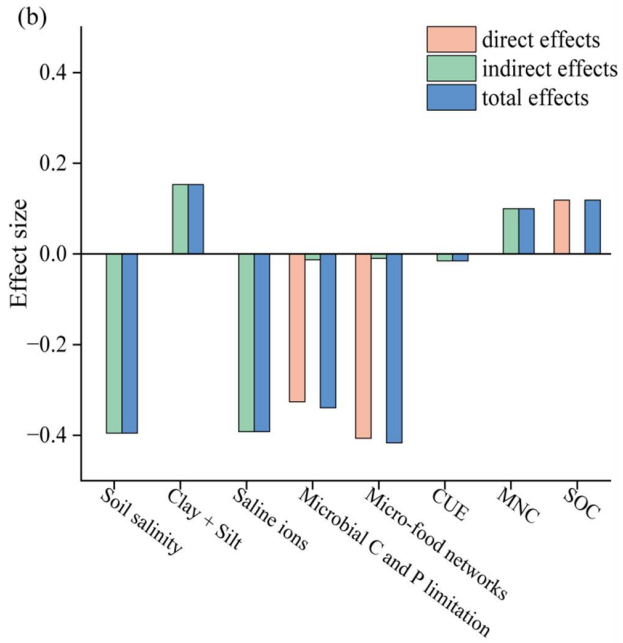


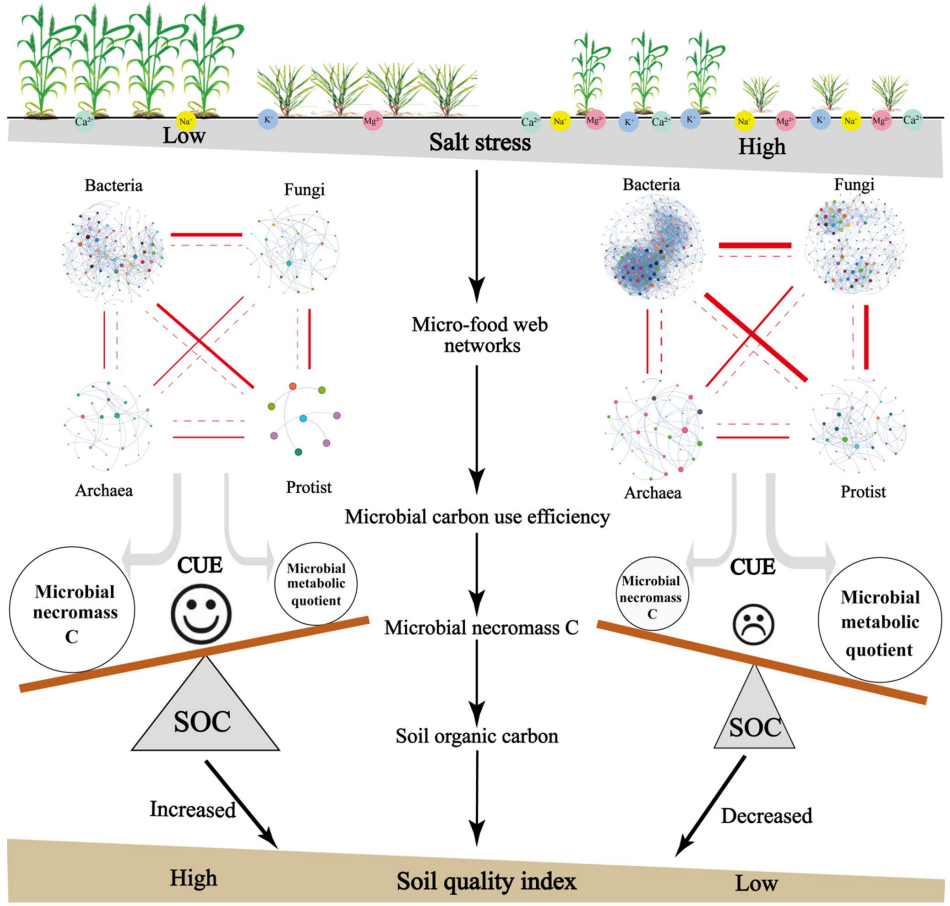
Wang et al., unpublished data

3. Microbial Network Drives SOC Accumulation

- **Salinity disrupted soil aggregation and nutrient balance, which increased microbial network complexity and reduced microbial carbon use efficiency and microbial necromass carbon, driving SOC decline**



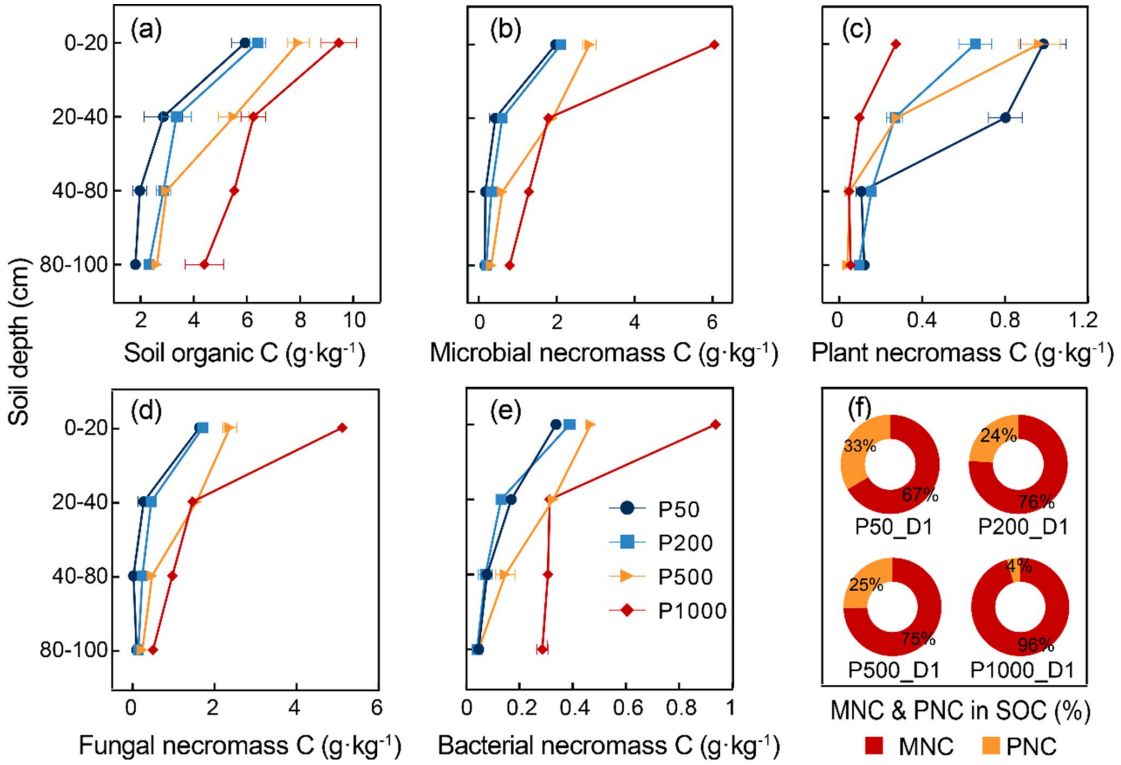


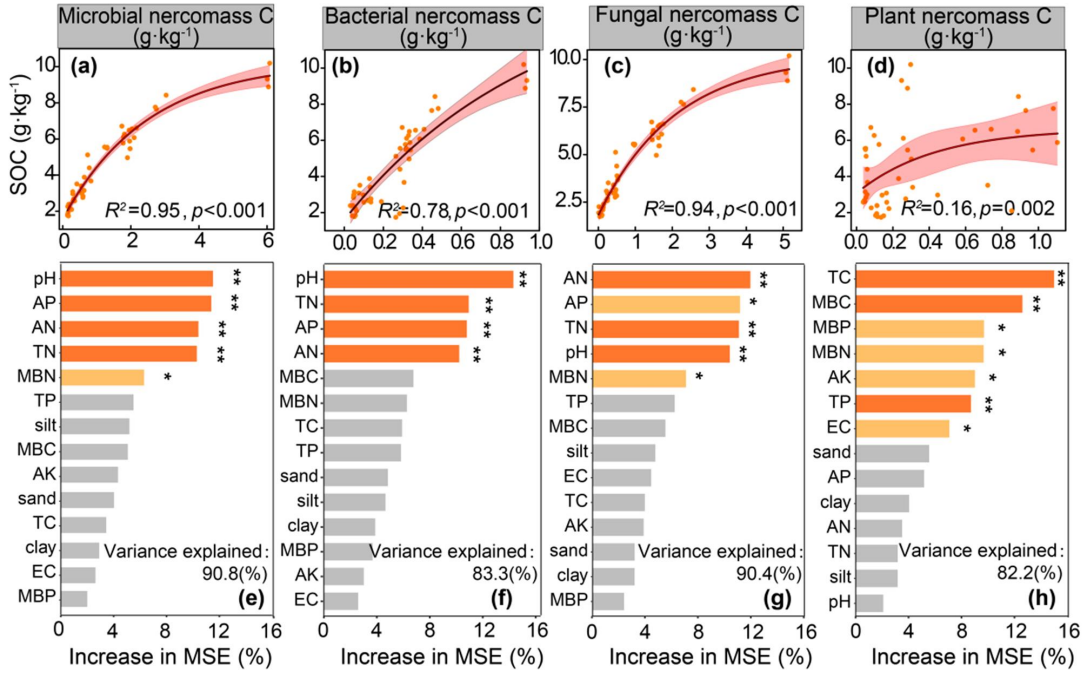


Wang et al., unpublished data

4. Microbial Life Strategies Driving SOC Accumulation

- **A significant increase in SOC with cultivation duration, pH and salt decreased during cultivation time**
- **Microbial necromass carbon acts as the primary driver of SOC accumulation**



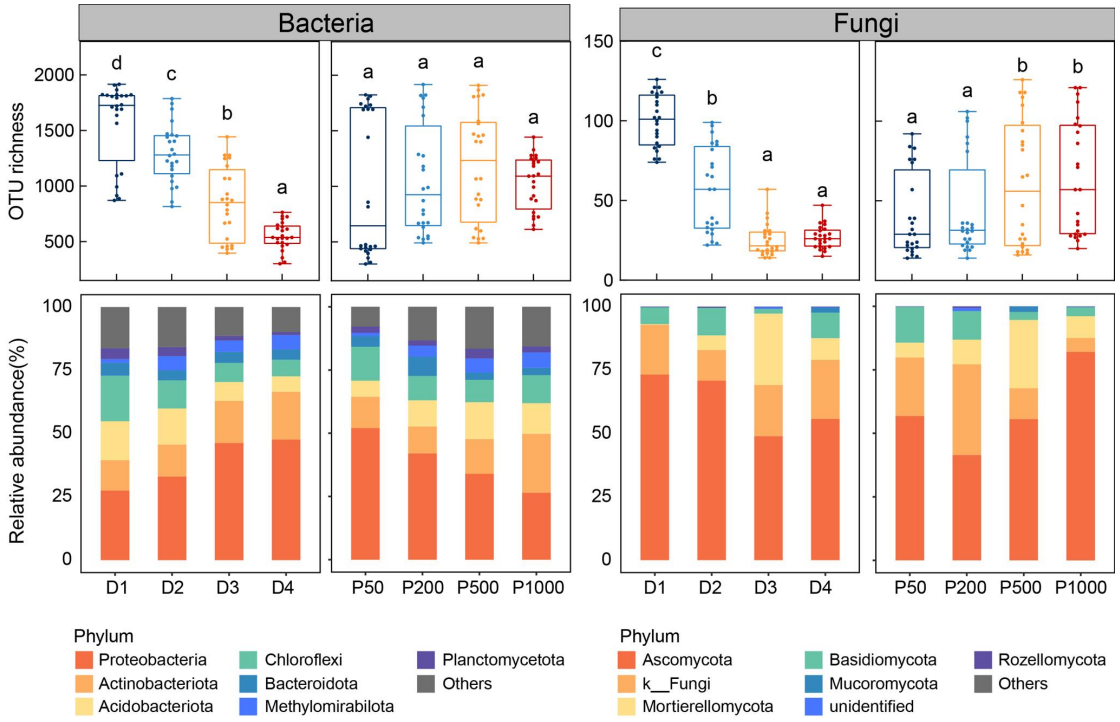


How microbial life strategies—high growth yield (Y), resource acquisition (A), and stress tolerance (S)—affect microbial necromass carbon (MNC) and soil organic carbon (SOC) accumulation in paddy saline soils over a millennium. (50, 200, 500, 1000 years)

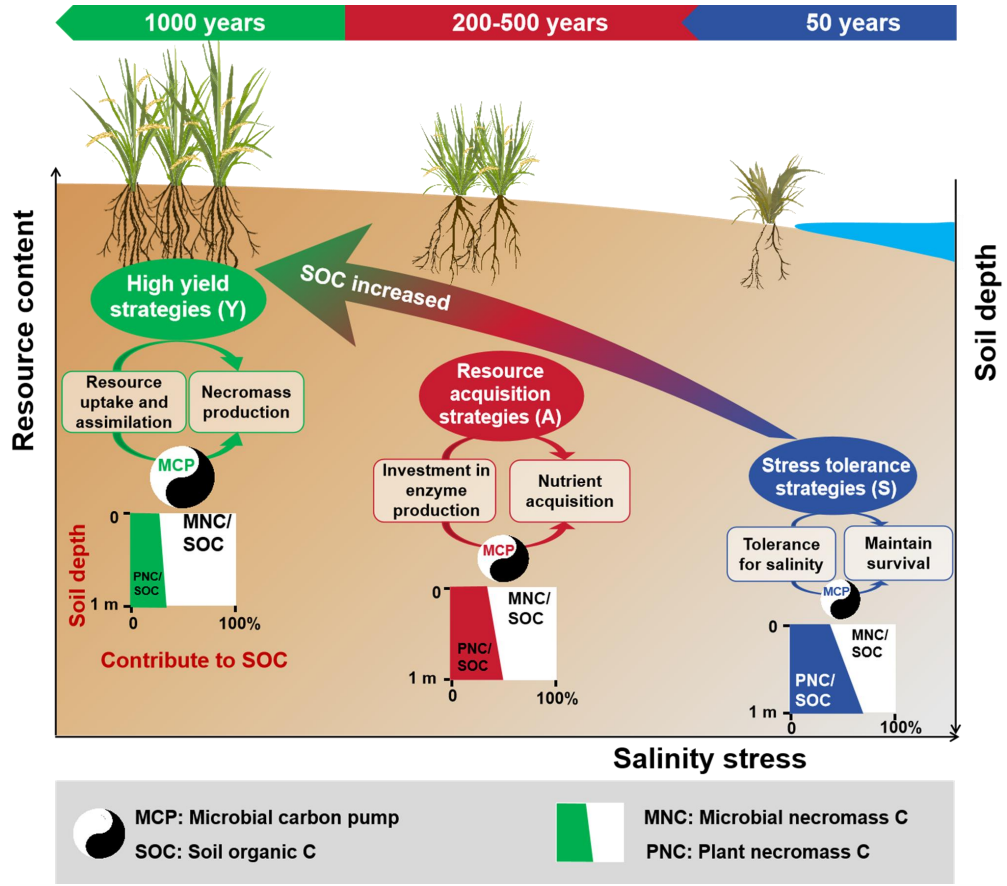
Wang et al., Catena, 2024

4. Microbial Life Strategies Driving SOC Accumulation

- Salinity significantly decreased the bacterial and fungal diversity
- Cultivation shifted microbial strategies from S (stress tolerance) and A strategies (resource acquisition) to Y strategies (high growth yield) via desalination and nutrient enrichment, increasing necromass accumulation and SOC sequestration



Wang et al., Catena, 2024



Summary

- **Microbial community, soil texture, nutrient availability, serves as direct regulators of carbon emissions**
- **Salinity decreased SOC accumulation by elemental stoichiometry (C:N:P) and microbial nutrient limitation**
- **Salinity-induced the decrease of SOC accumulation controlled by microbial networks complexity**
- **Microbial necromass carbon promoted SOC accumulation by a shift of microbial life strategies from A and S strategies to Y strategies**

Thanks for your attention!

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