

Unravelling spatial heterogeneity of soil legacy phosphorus in subtropical grasslands

Dr. Jiangxiao Qiu

**School of Forest, Fisheries, and Geomatics Sciences
Fort Lauderdale Research and Education Center
University of Florida**

**UF Water Institute Symposium
*20 February 2024***

Acknowledgements

Coauthors and collaborators

*Ran Zhi, Elizabeth Boughton, Haoyu Li, Charlotte, Henderson,
Daniel Petticord, Amartya Saha, Jed Sparks, Ramesh Reddy*

Funding supports

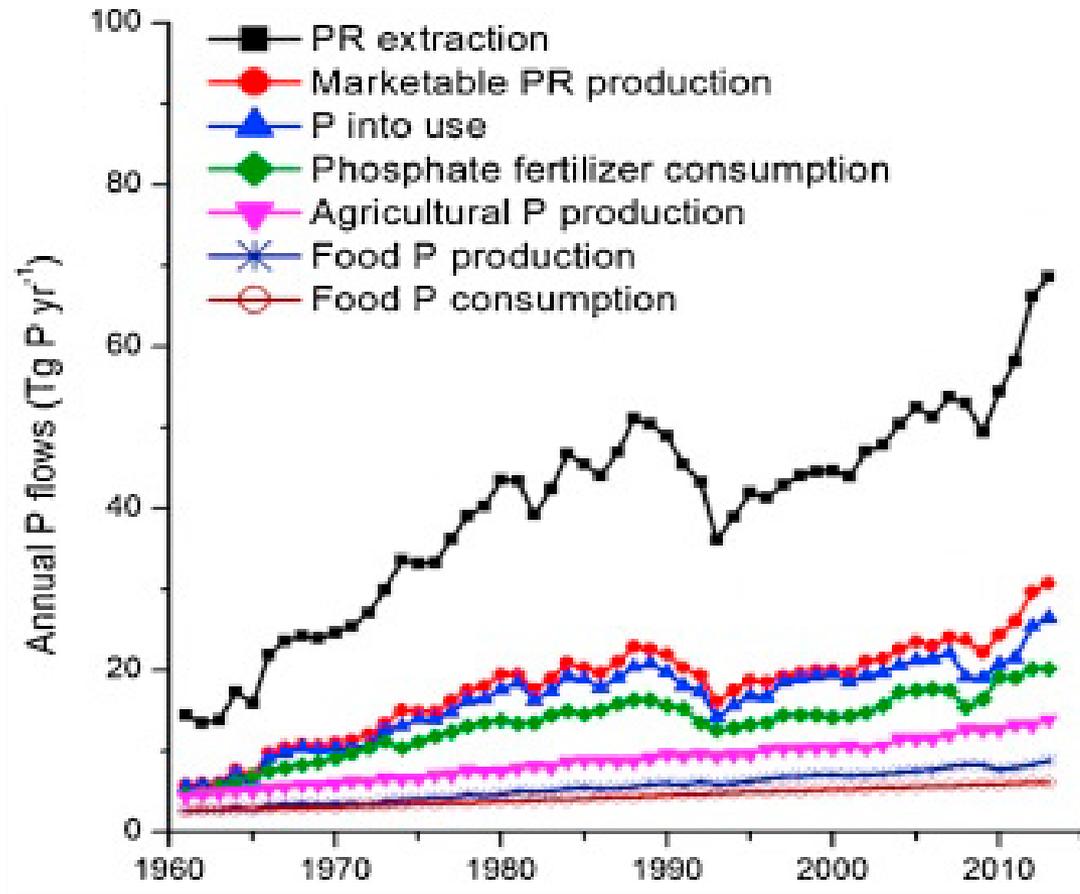


United States Department of Agriculture
National Institute of Food and Agriculture

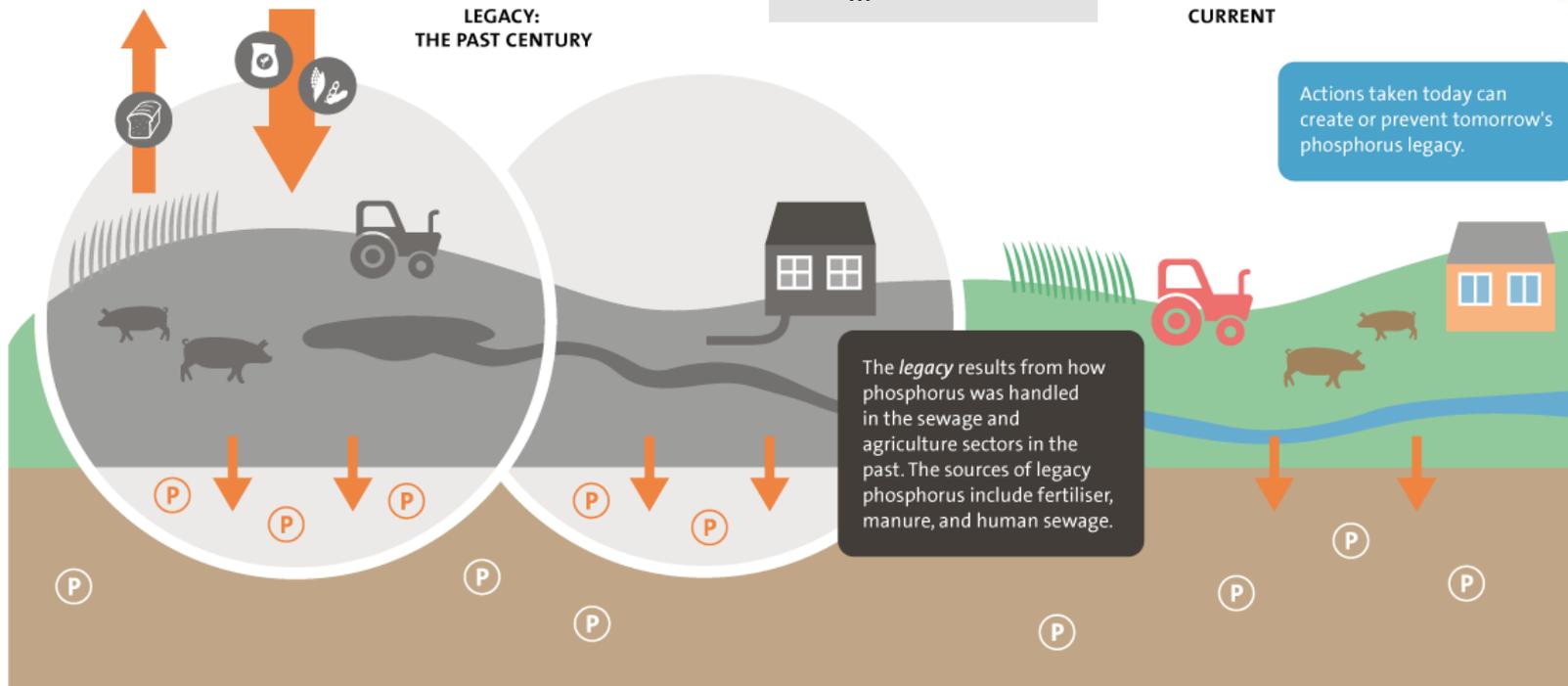
Phosphorus (P) is critical to global food security



Human modification of regional and global P cycle



Causes of 'soil legacy P'



(Image source: Baltic Eye; McCrackin et al. 2018)

Persistent and long-term consequences of legacy P



Current knowledge gaps

- Fine-scale spatial heterogeneity of legacy P and underlying environmental factors not well understood
 - Spatially target hotspots for interventions
 - Improve agroecosystem management
 - Less in low-latitudes grasslands
- Patterns of variance across spatial scales less investigated
 - *Within* pastures
 - *Among* pastures
 - *Between* pasture types

Research questions

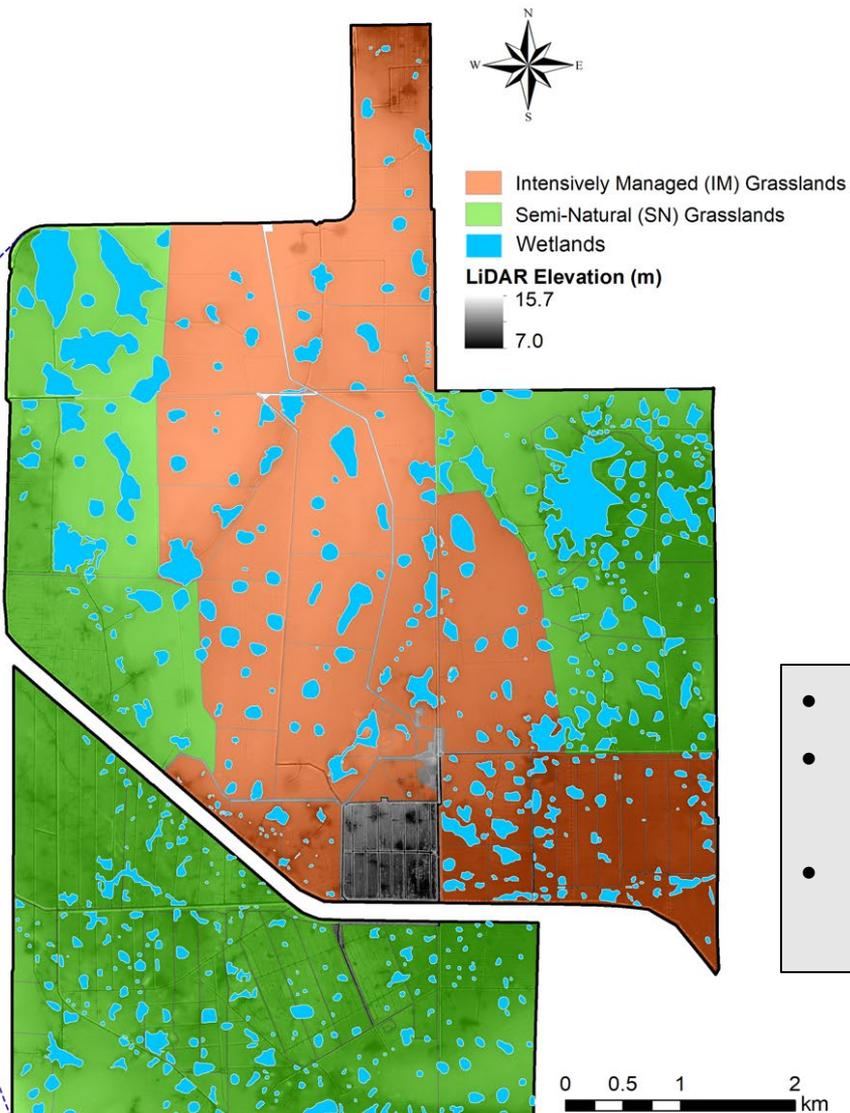
Q1: What is the spatial variability and hotspots of soil legacy P?

Q2: Does soil legacy P vary primarily within pastures, among pastures, or between pasture types?

Q3: How does soil legacy P relate to land management and soil characteristics?

Q4: What is the relationship between soil legacy P and aboveground plant tissue P concentration?

Study area: *Buck Island Ranch*



- Subtropical grasslands
- Managed for cattle production
- Two management intensities: high vs. low

Study area: *Buck Island Ranch*



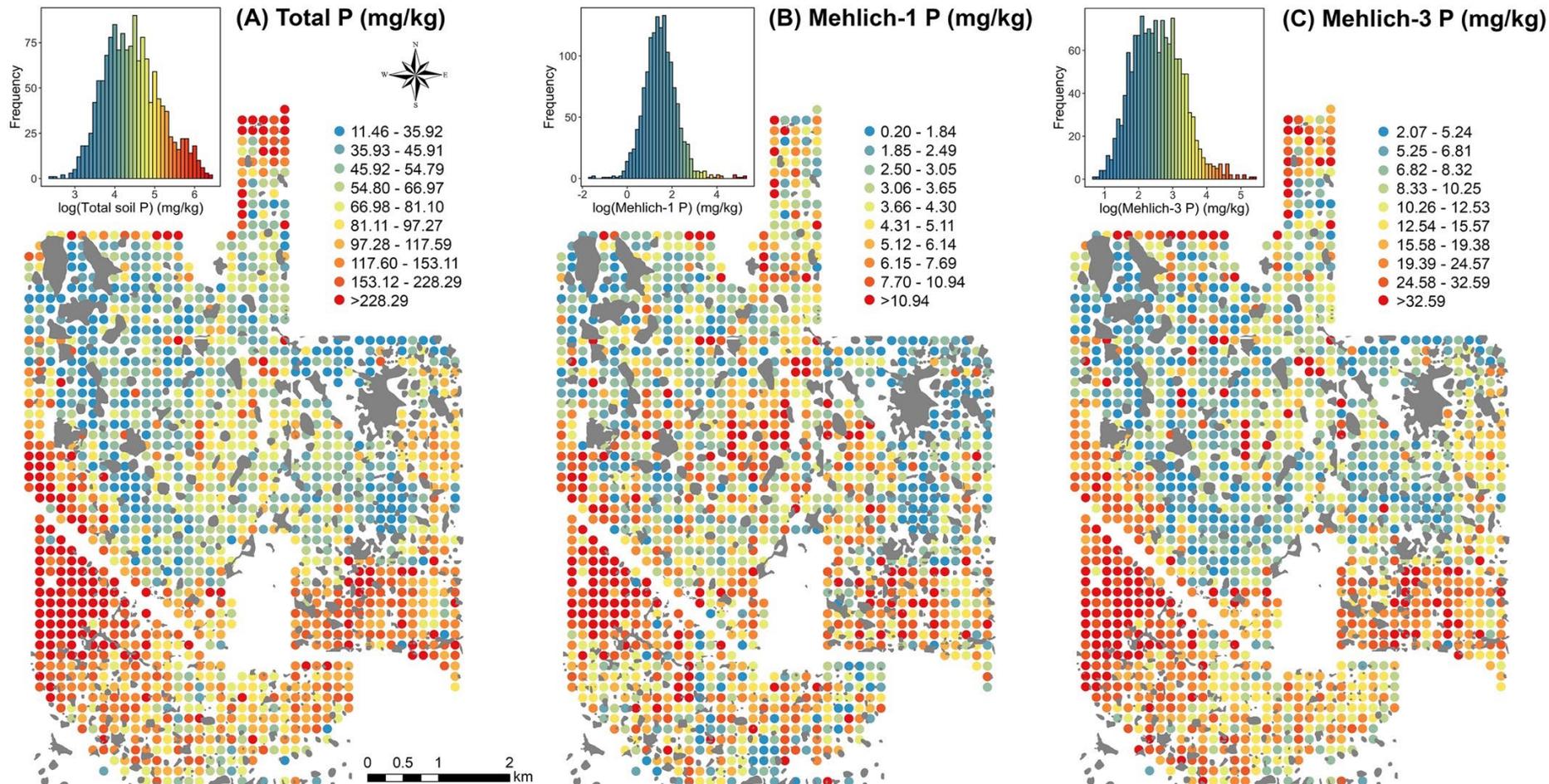
Intensively-managed (i.e., high-intensity)	Semi-natural (i.e., low-intensity or <i>control</i>)
N, P, K (P and K were up <i>until 1987</i>) fertilizations received	No fertilization received
Forage grasses (e.g., Bahiagrass) introduced	No forage grass introduced
Lime applied	No lime applied
Extensive drainage ditch constructed	Less extensive drainage ditch constructed
Water retention infrastructure (e.g., riser board)	No water retention infrastructure
Heavy grazing activity mainly in wet seasons	Light grazing activity mainly in dry seasons

Approach

- Gridded sampling at 150-m interval (i.e., ~1,400 samples)
- Lab analysis of Mehlich-1, Mehlich-3 and total P, along with other soil covariates (e.g., pH, organic matter, C, N, Fe, Al, etc.)
- Geospatial analysis to identify hotspots
- Variance partitioning
- Spatial regression models

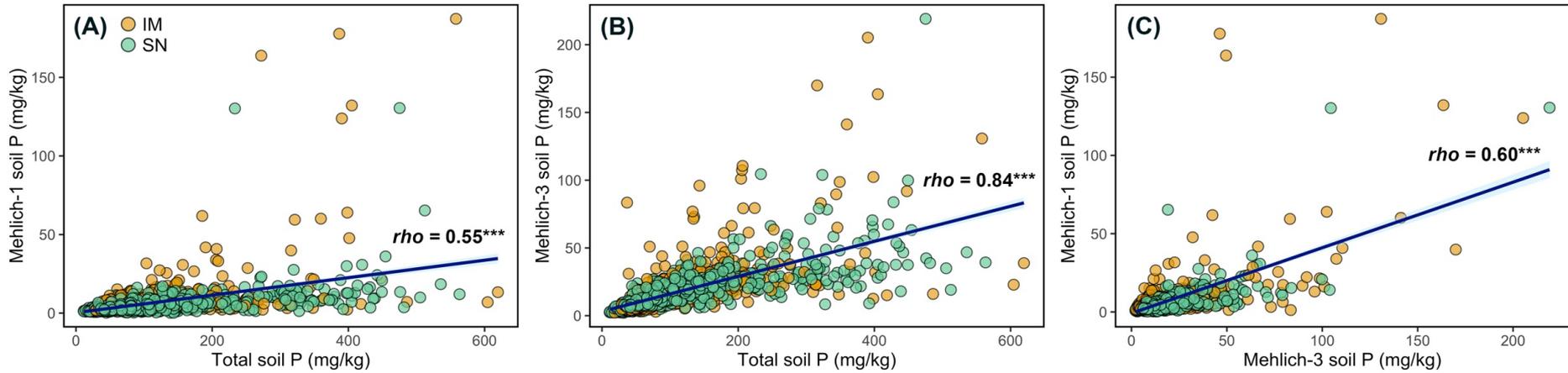
Result

Q1: Substantial spatial variability in soil legacy P



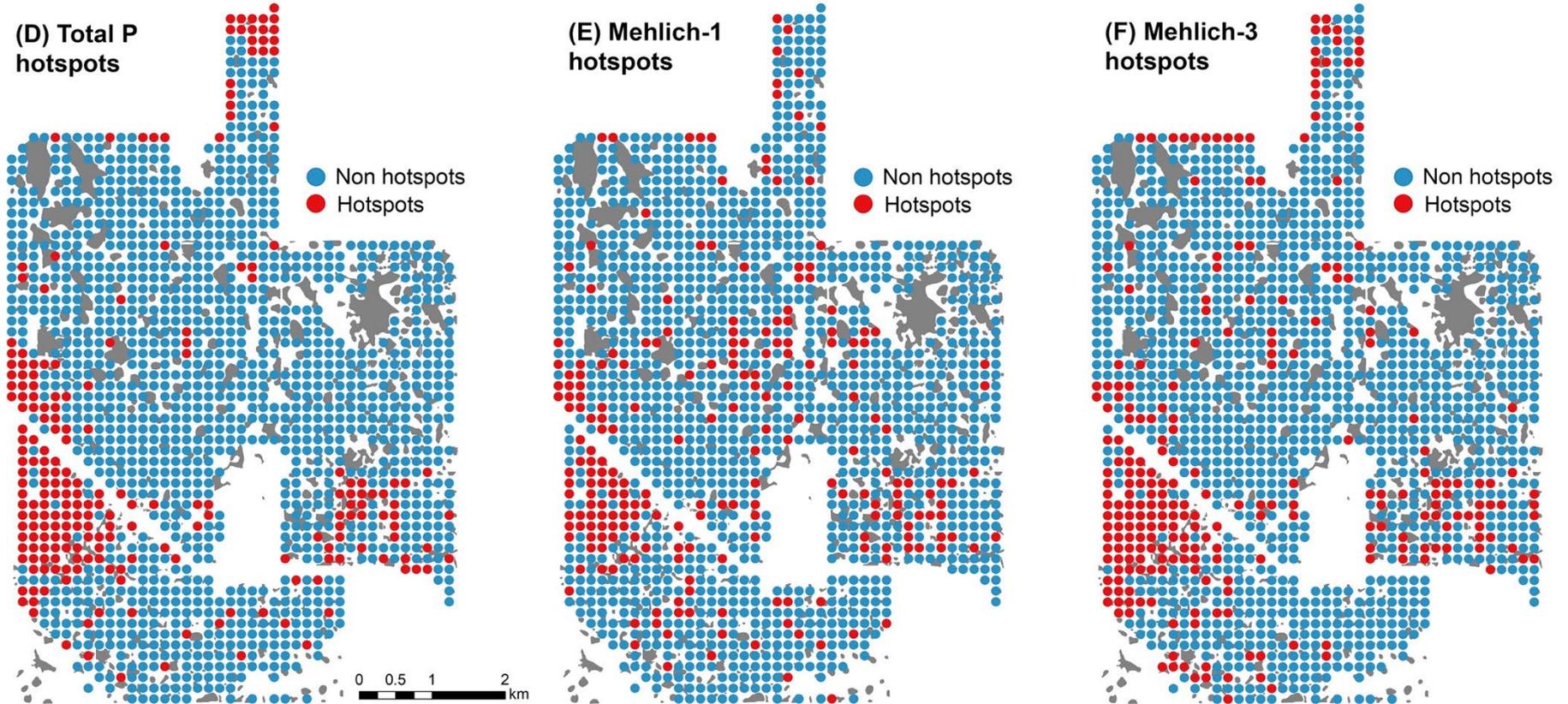
Result

Q1: Relationships among different forms of soil legacy P



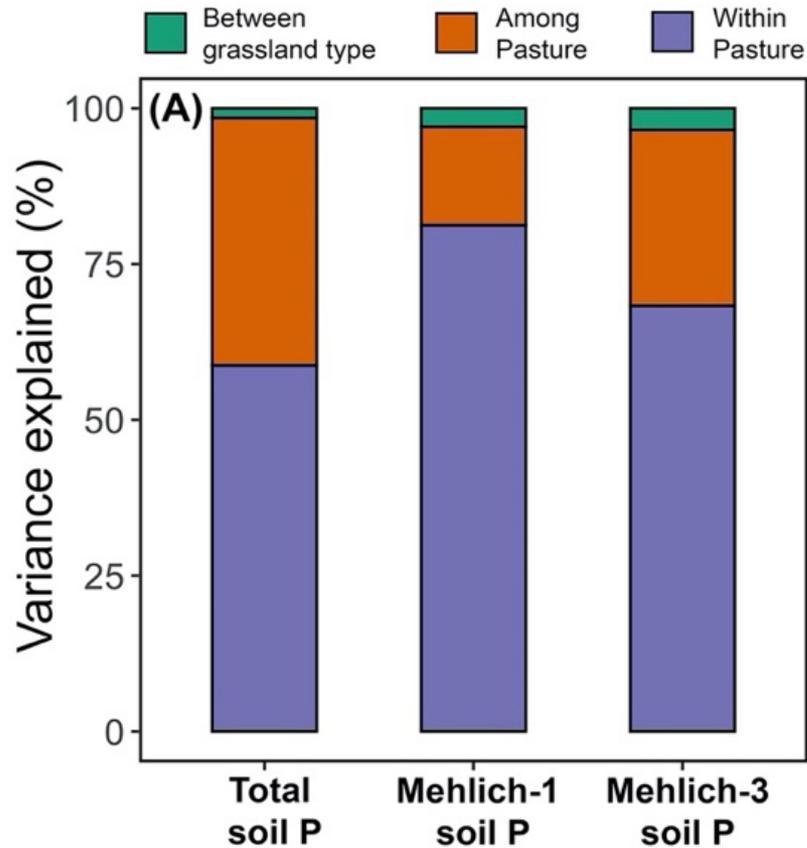
Result

Q1: Hotspots of soil legacy P



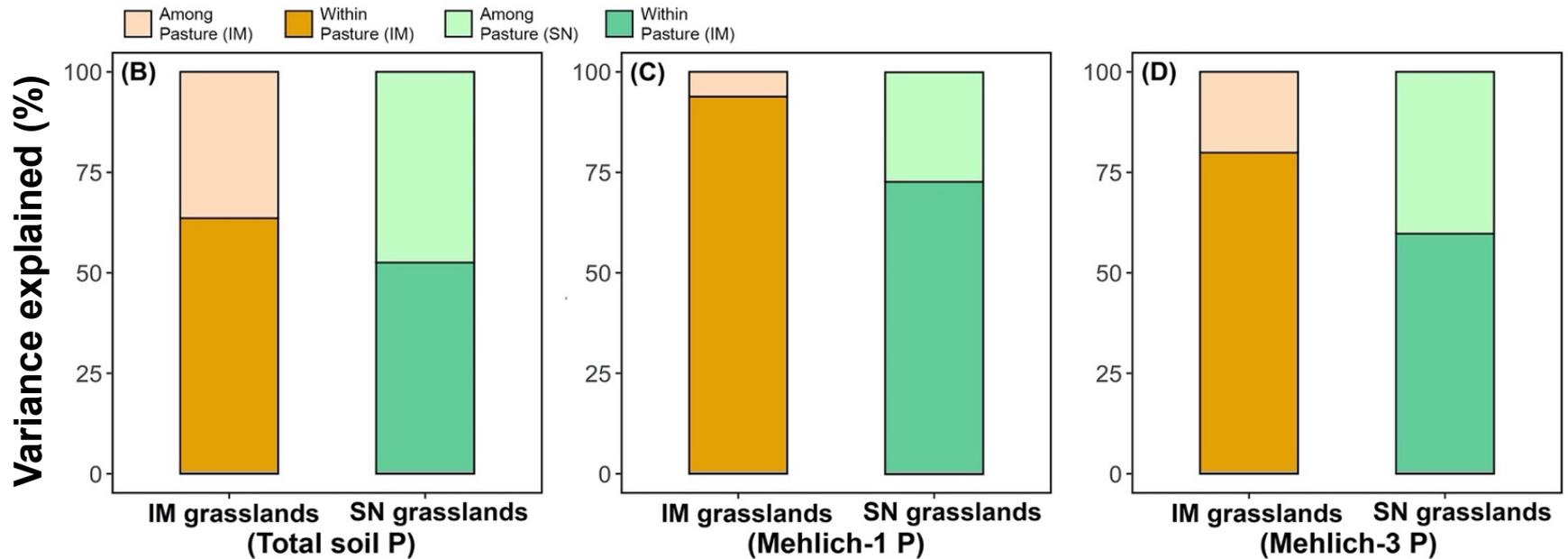
Result

Q2: Scales of variation in soil legacy P



Result

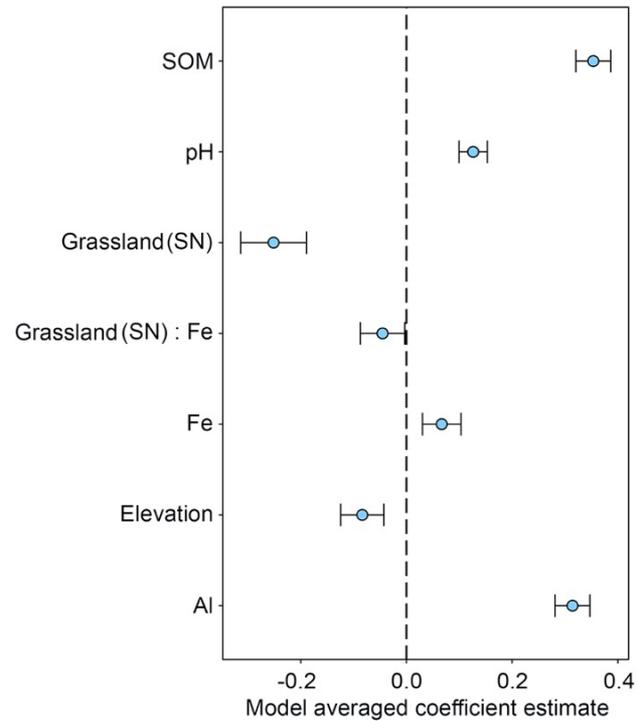
Q2: Scales of variation in soil legacy P



Result

Q3: Effects of land management and soil characteristics on soil legacy P

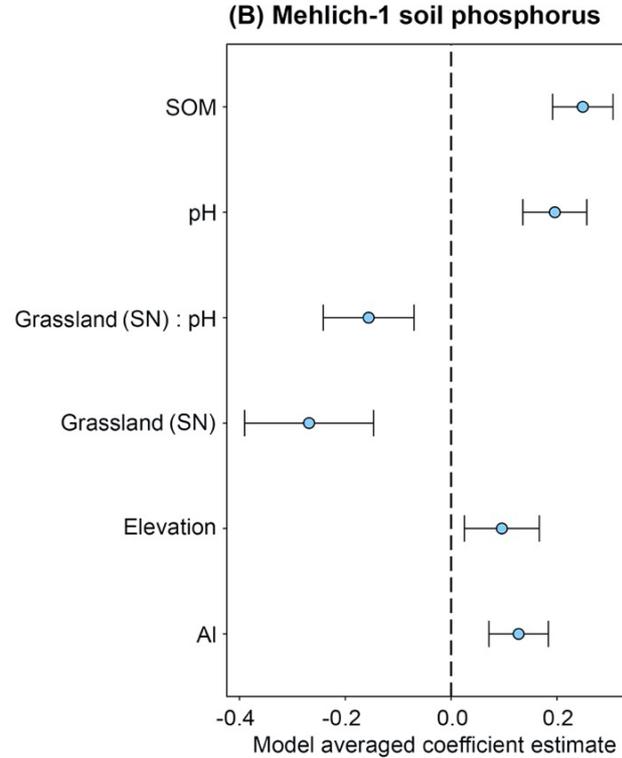
(A) Total soil phosphorus



68.9% variation

Result

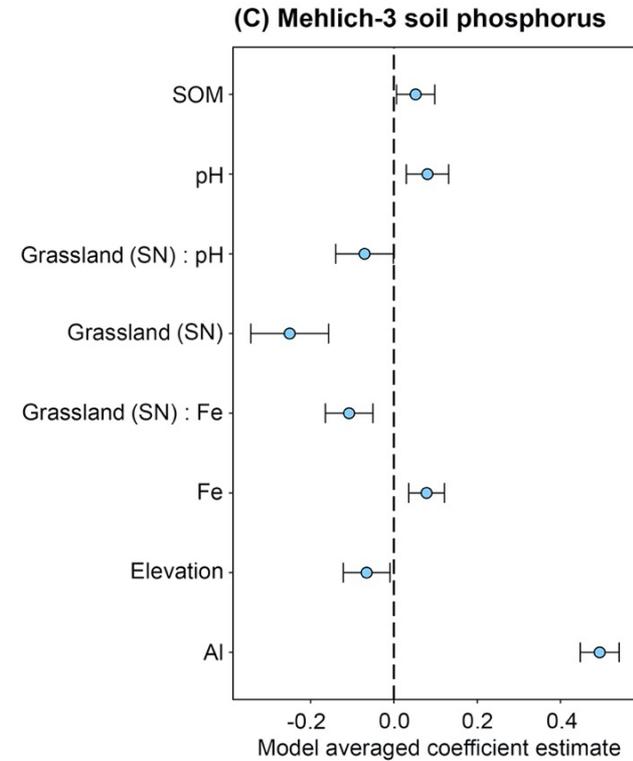
Q3: Effects of land management and soil characteristics on soil legacy P



23.2% variation

Result

Q3: Effects of land management and soil characteristics on soil legacy P

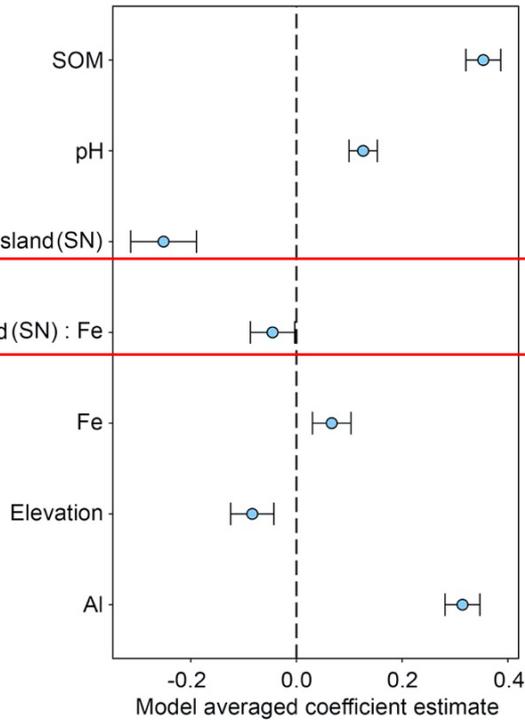


48.1% variation

Result

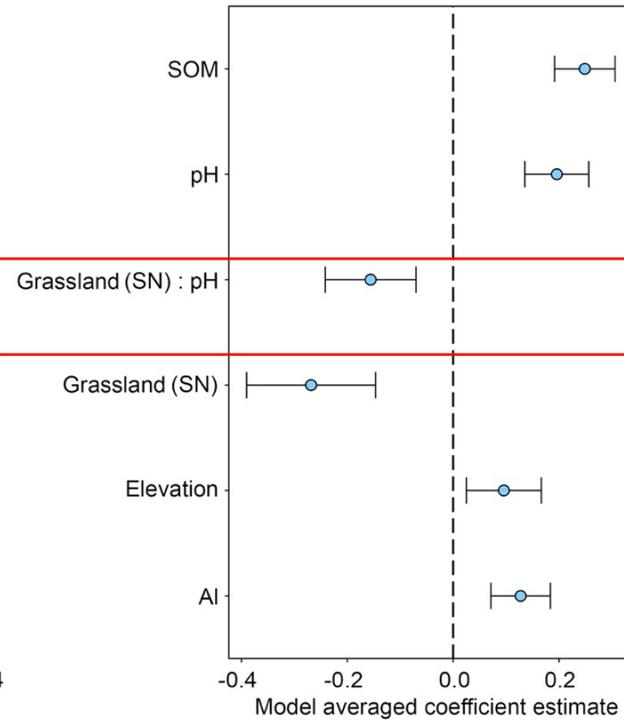
Q3: Effects of land management and soil characteristics on soil legacy P

(A) Total soil phosphorus



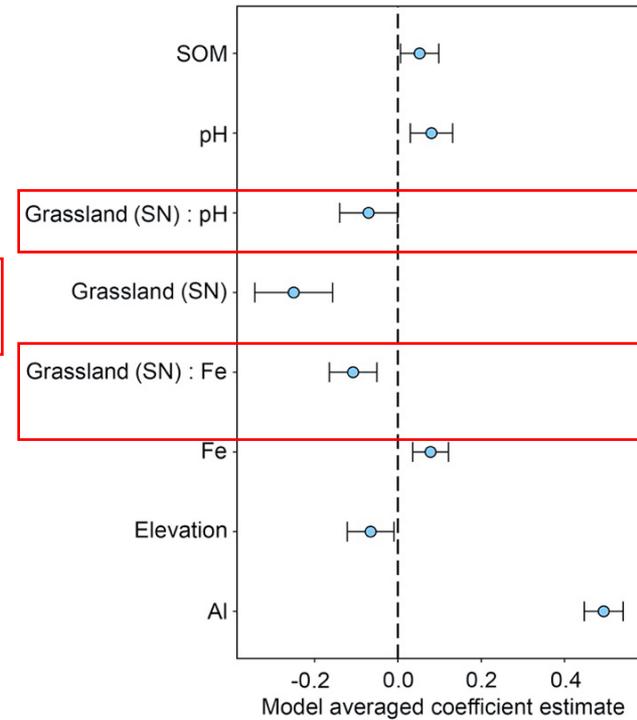
68.9% variation

(B) Mehlich-1 soil phosphorus



23.2% variation

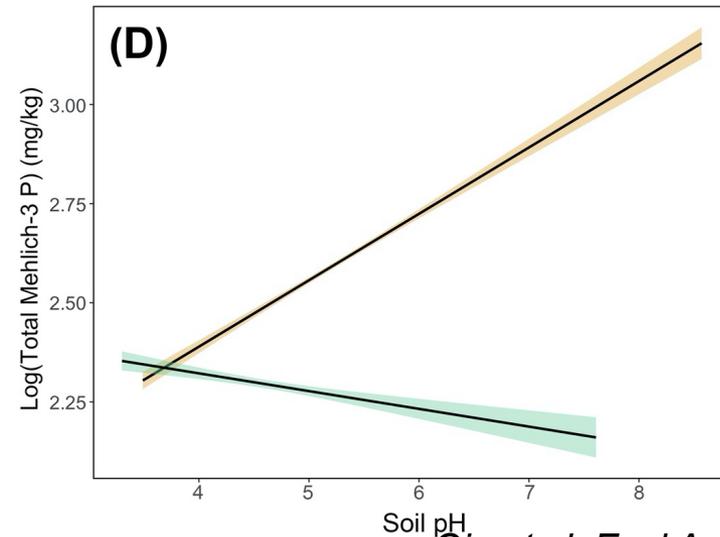
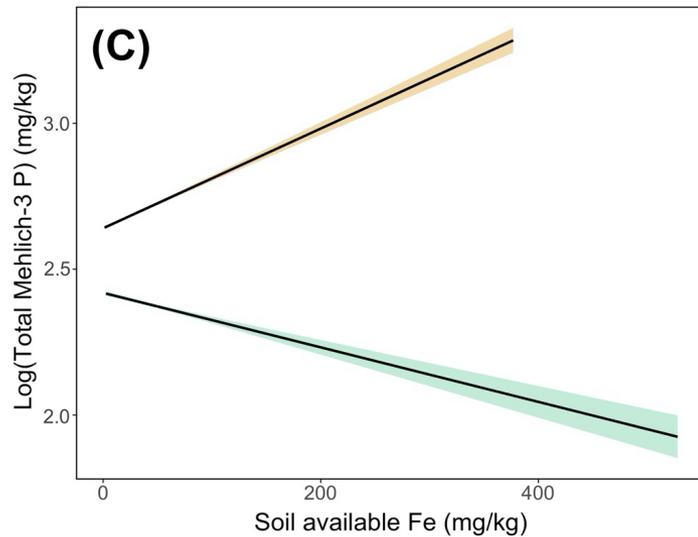
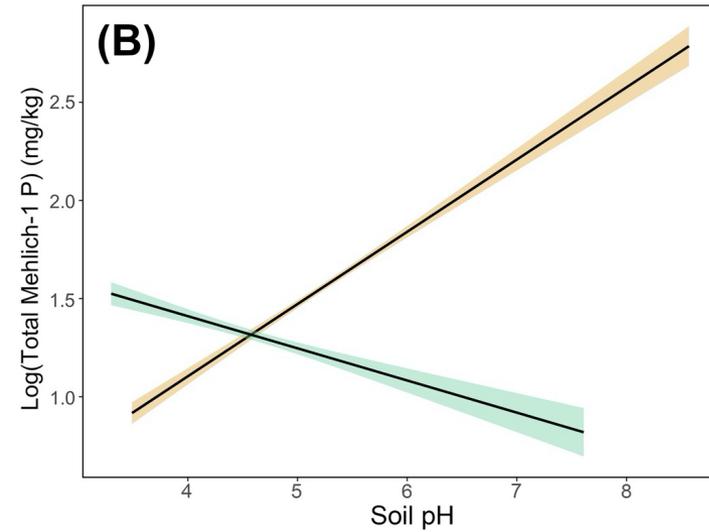
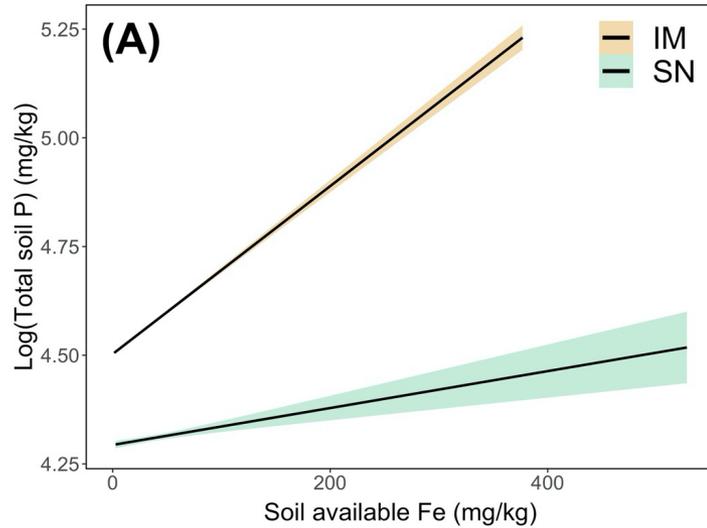
(C) Mehlich-3 soil phosphorus



48.1% variation

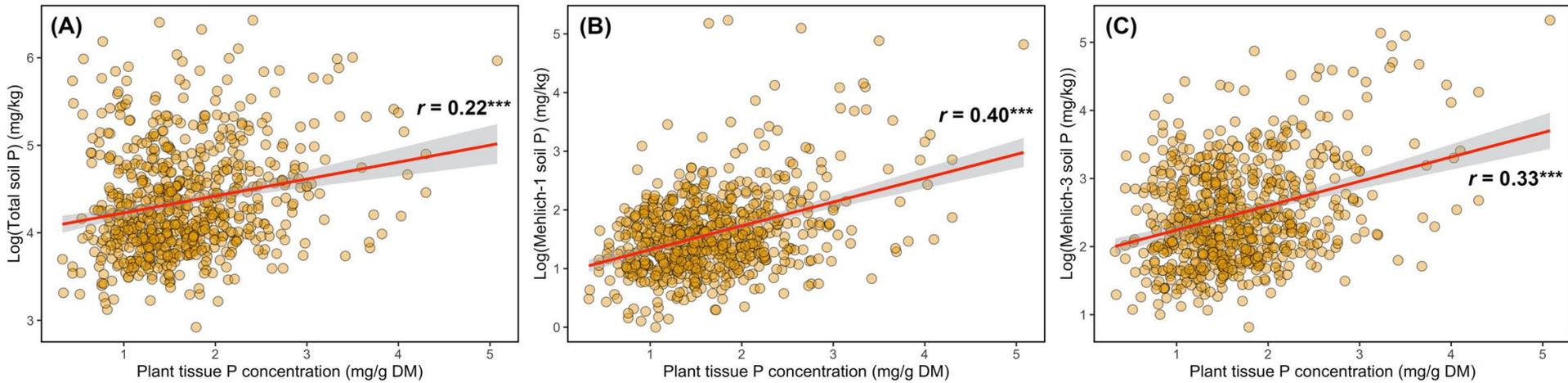
Result

Q3: Effects of land management and soil characteristics on soil legacy P



Result

Q4: Relationships between legacy soil P and plant tissue P



Take-home messages

- Substantial spatial variations in legacy soil P
- SOM, pH, available Fe and Al, elevation, and grassland management are crucial predictors for soil P
 - *More predicative for total P than labile P*
- Intensification rescaled and increased variance in total soil P
- Pattern of variance greatest in small scales, suggesting that broad pasture- or farm-level BMPs may be limited and less efficient, especially for high-intensity grasslands
- Management to curtail legacy P should be implemented at fine scales and spatially target P 'hotspots.'

Thank you!

Questions?



Jiangxiao Qiu

qiuj@ufl.edu



@Jiangxiao_Qiu