NUTRIENT DISTRIBUTION ACROSS DEEP SOIL PROFILES UNDER DIFFERENT MANAGEMENT PRACTICES

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Background_P cycle

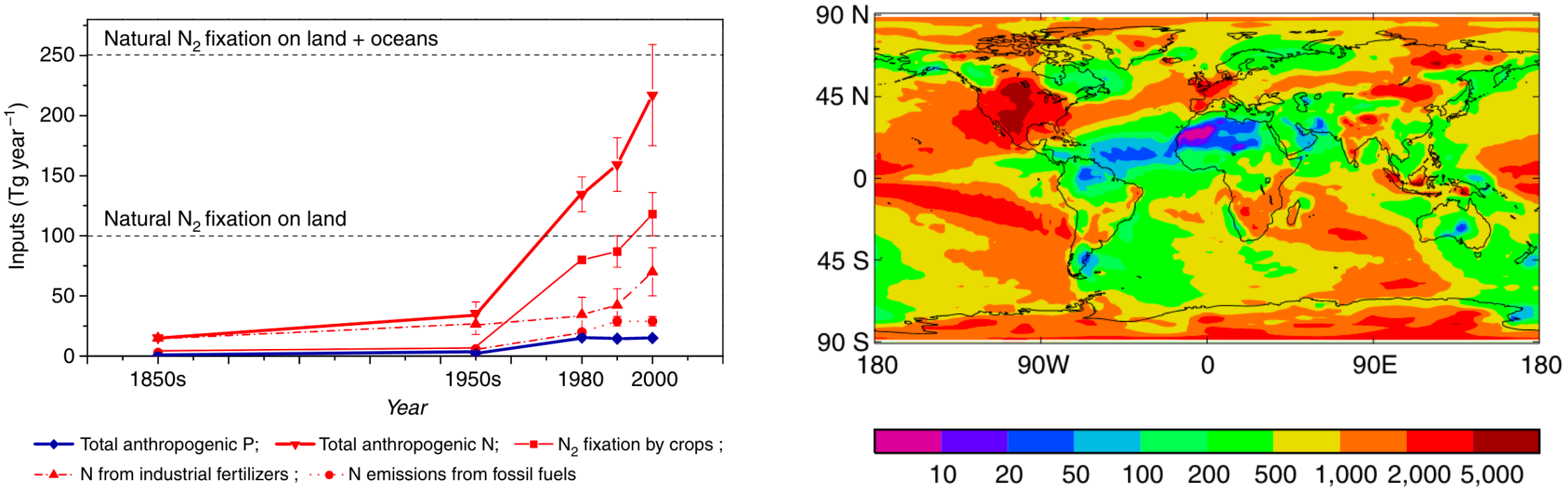
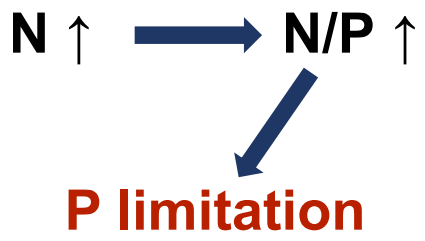


Fig1. Anthropogenic N and P inputs to the biosphere; N/P ratio 2010. [Josep Penˆuelas.et.al. 2013.]



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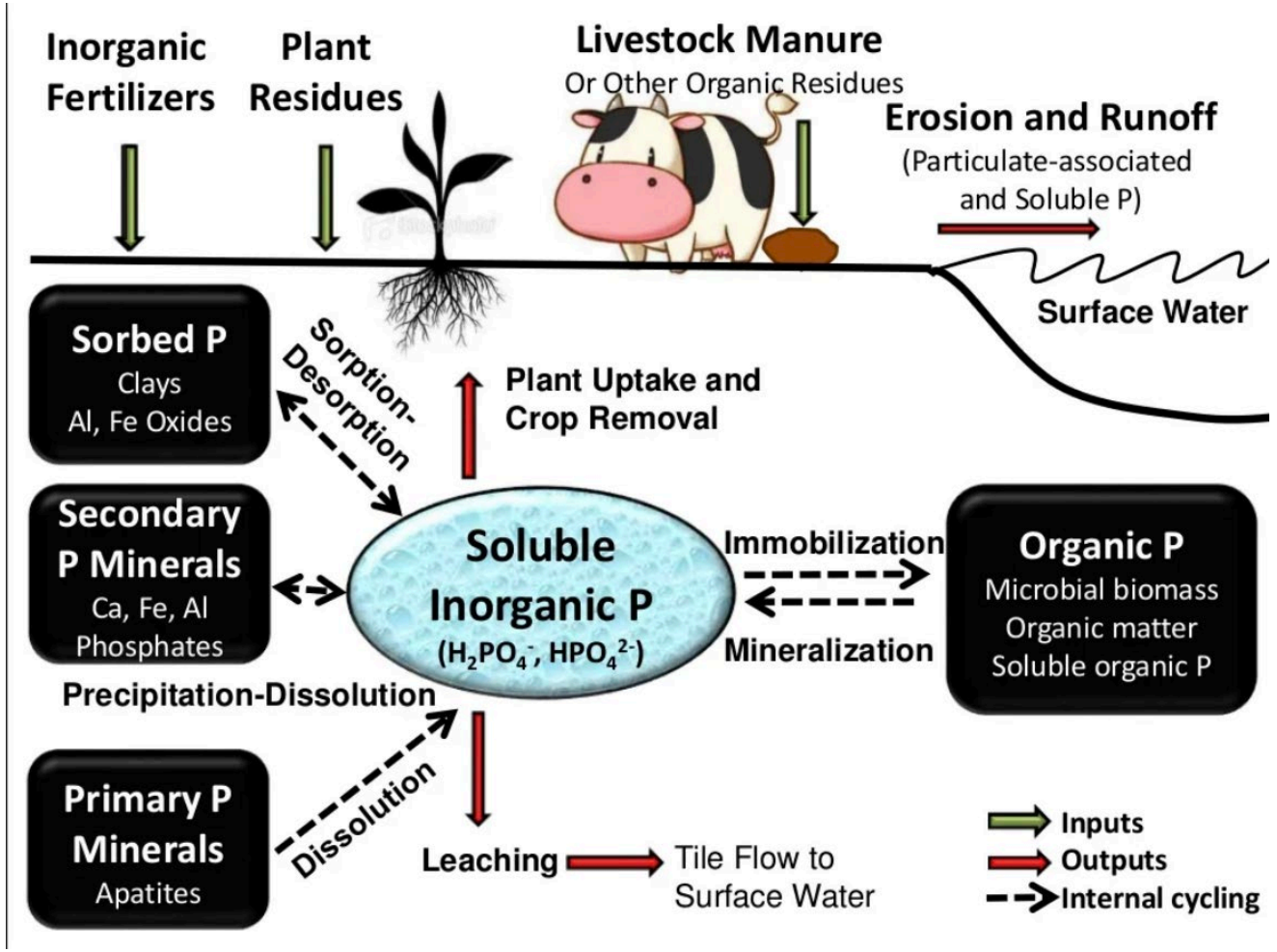


P-exhaustible

Legacy P

[https://www.slideshare.net/LPELC/legacy-phosphorus-in-calcareous-soils-effects-of-long-term-poultry-litter-application-on-phosphorus-distribution-in-texas-blackland-vertisol]

Vertical and lateral transport of P through soil profiles has been recognized as a critical pathway for P movement to waterbodies

Research Objectives

Mediate P loss **Enhance P use efficiency**

Addressing the current imbalanced P situation in agroecosystems

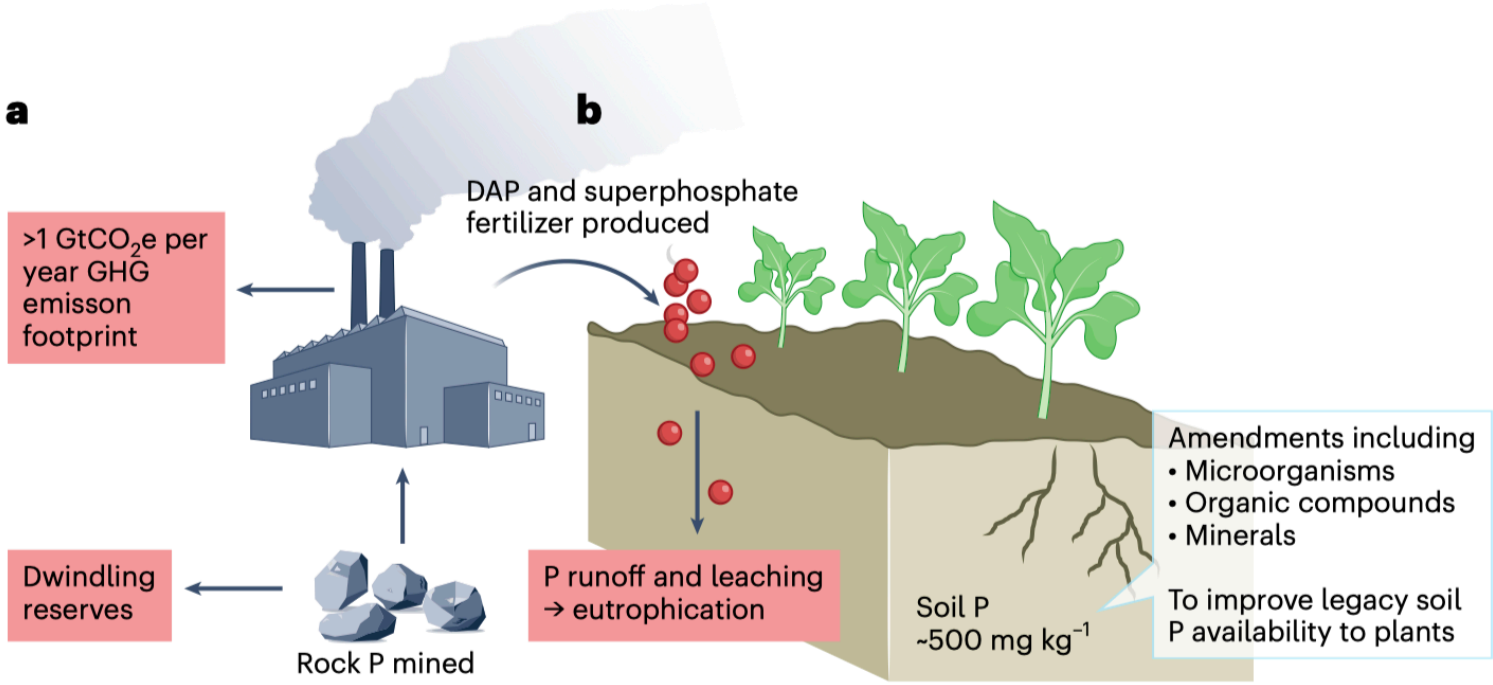
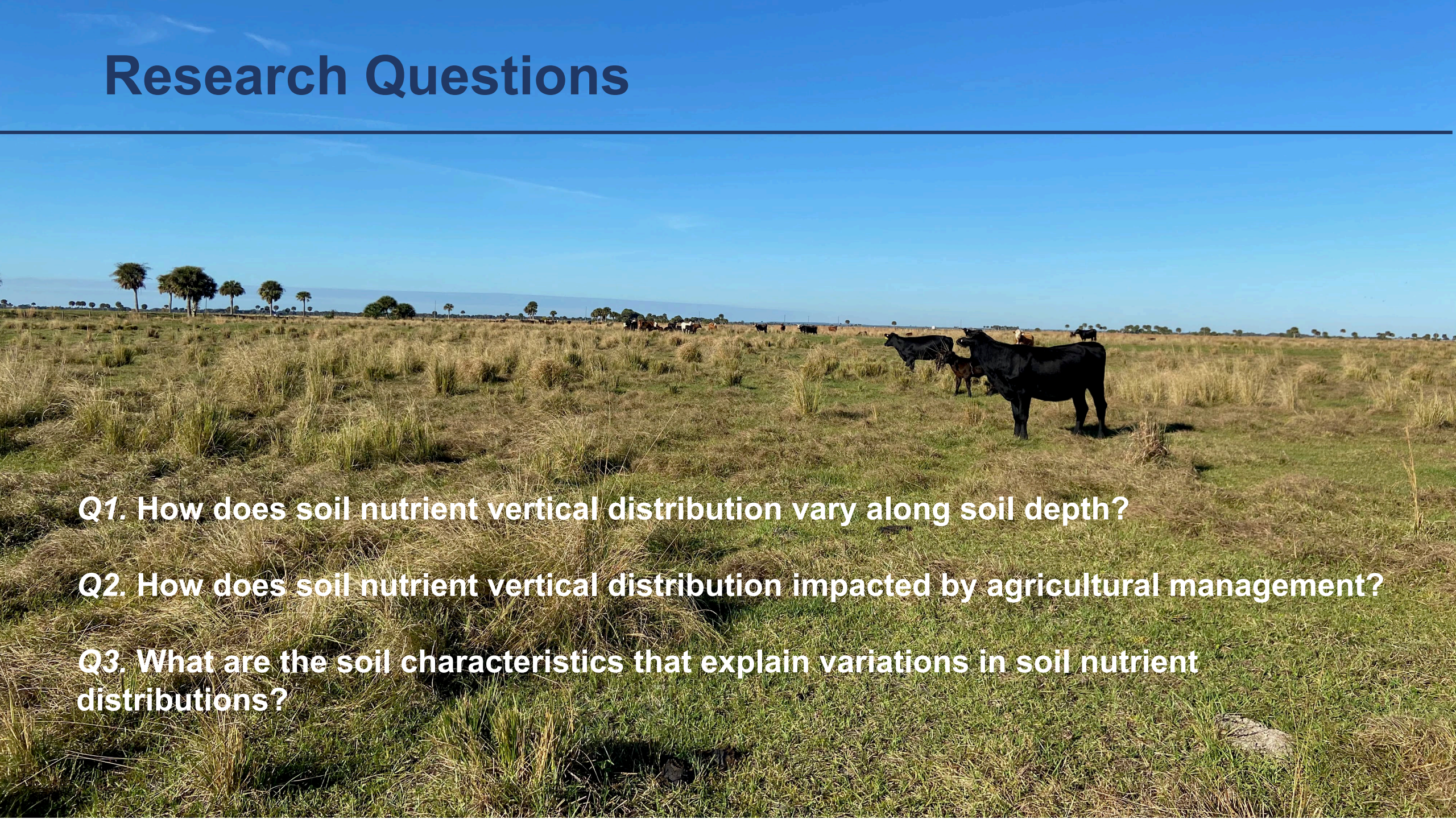


Fig. 1 | Approaches to phosphorus fertilization. Current (**a**) and proposed new (**b**) approach to phosphorus fertilization. A shift to the proposed new approach could help alleviate the environmental and resource constraints associated with conventional production practices. DAP, diammonium phosphate; $GtCO_2e$, gigatonnes of CO_2 equivalent. [Christopher Pratt & Ali El Hanandeh, 2023.]

Research Questions

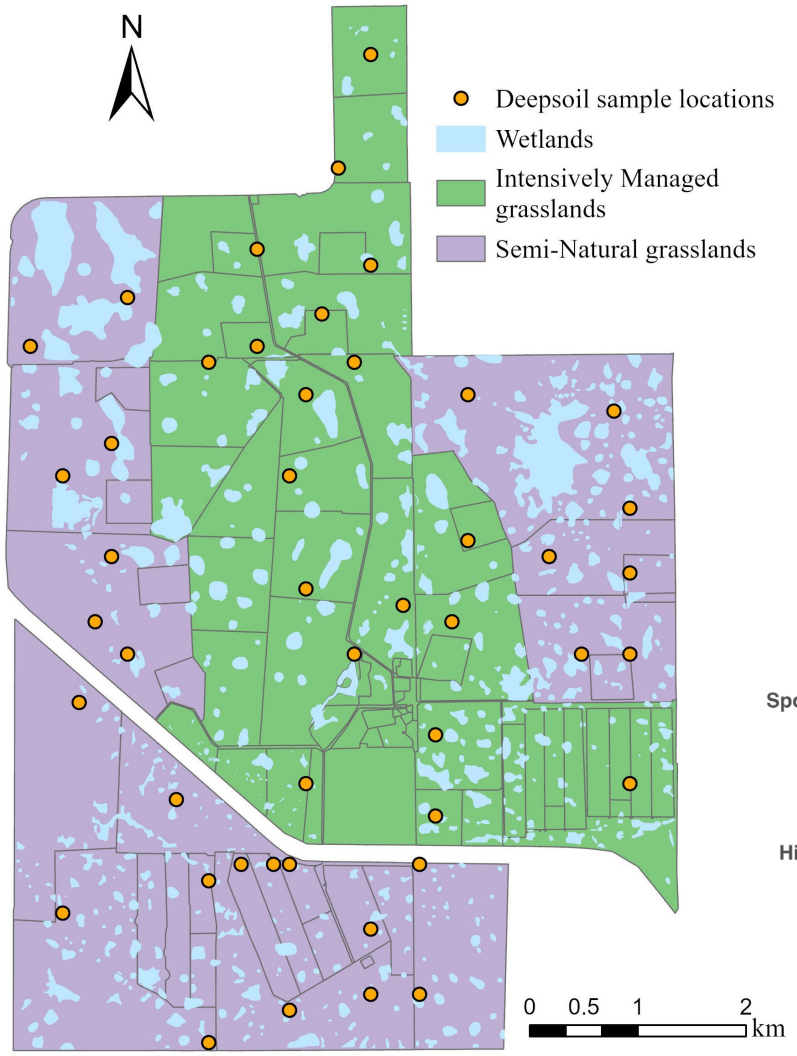


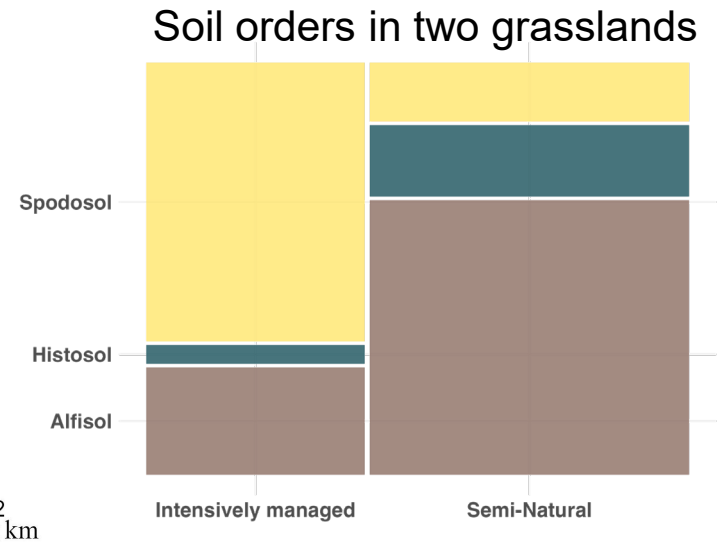
Q1. How does soil nutrient vertical distribution vary along soil depth?

Q2. How does soil nutrient vertical distribution impacted by agricultural management?

Q3. What are the soil characteristics that explain variations in soil nutrient distributions?

Methods



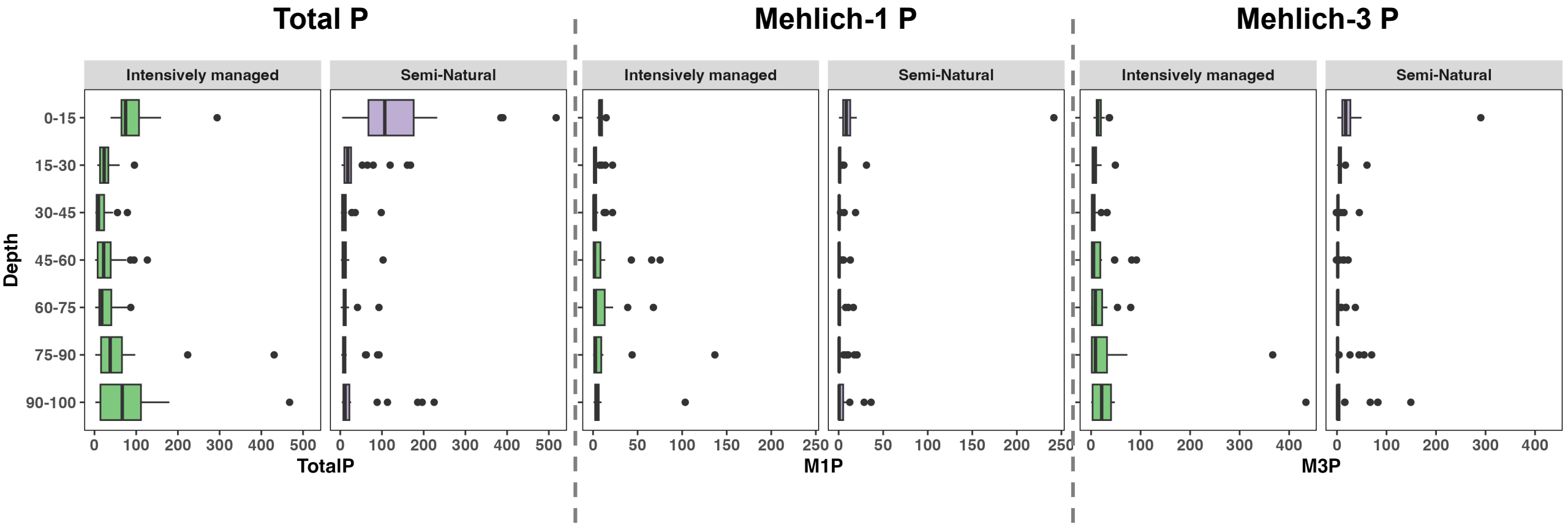


Soil Sampling and Measurement

- 47 soil samples were collected from 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-100 cm depths, respectively.
- Soil total P, Mehlich-1 P (M1P), Mehlich-3 P (M3P), total Nitrogen, total carbon, Alumni (Al), iron (Fe), pH, and organic matter were measured by soil core samples.
- Soil P storage capacity (SPSC) for each soil sample was calculated based as equation:

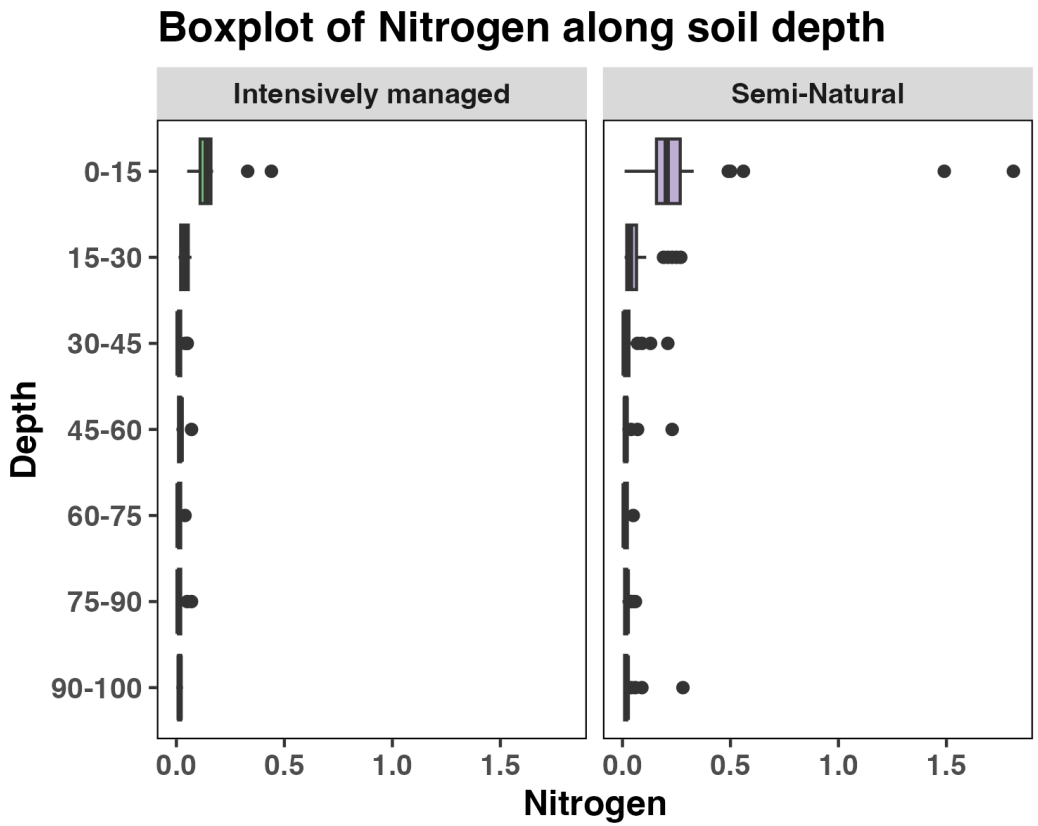
$$SPSC = (Threshold\ PSR_{M1} - PSR_{M1}) \times \left[\left(\frac{Fe}{56}\right) + \left(\frac{Al}{27}\right)\right] \times 31 \times X$$ [Dari et al., 2017; Nair et al., 2004]

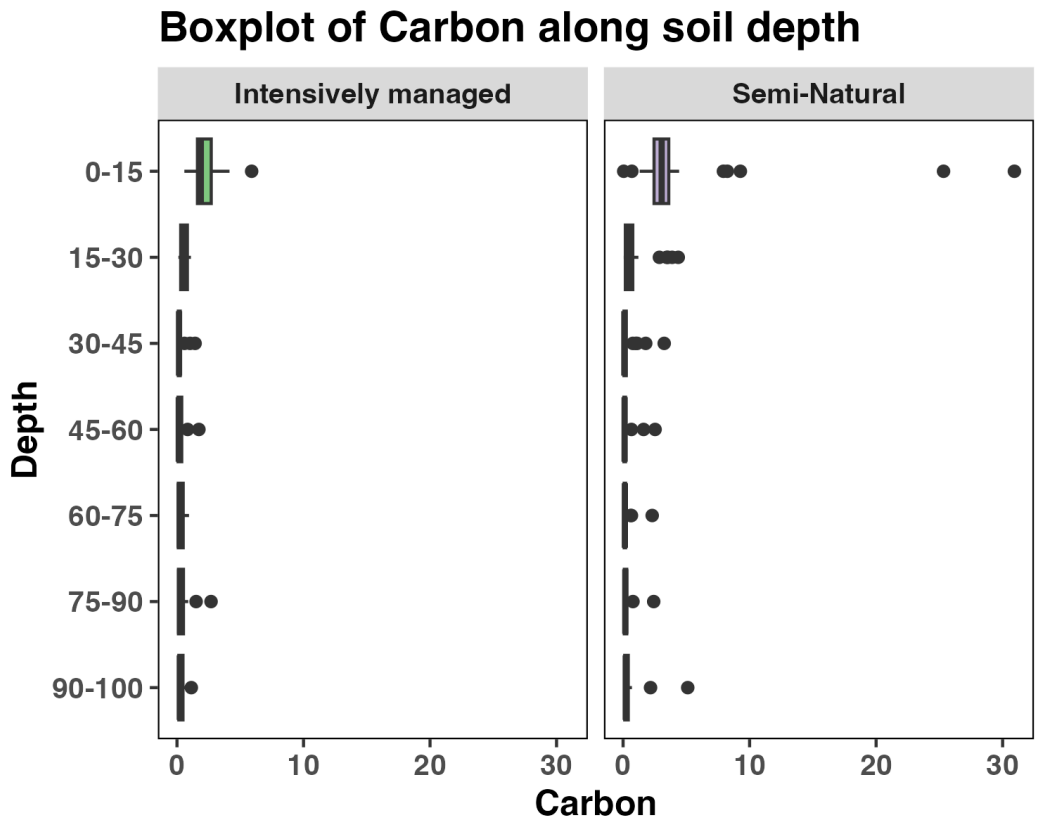
Results – *Soil P vertical distribution*



- High total P at topsoil and bottom soil layers for intensively managed grasslands while high total P at topsoil for semi-natural grasslands.
- M1P and M3P exhibited similar trends under the two managed practices.

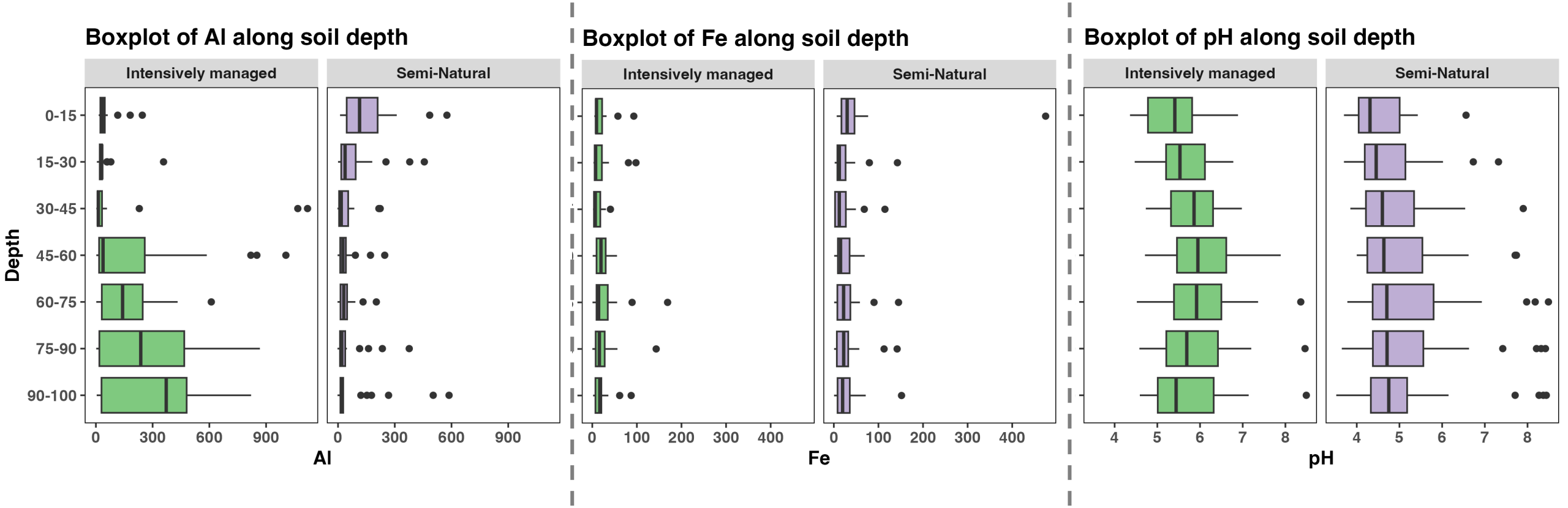
Results – *Soil N & C vertical distribution*





- Higher total nitrogen and total carbon percentage at topsoil, decreasing with soil depth, for both management practices.

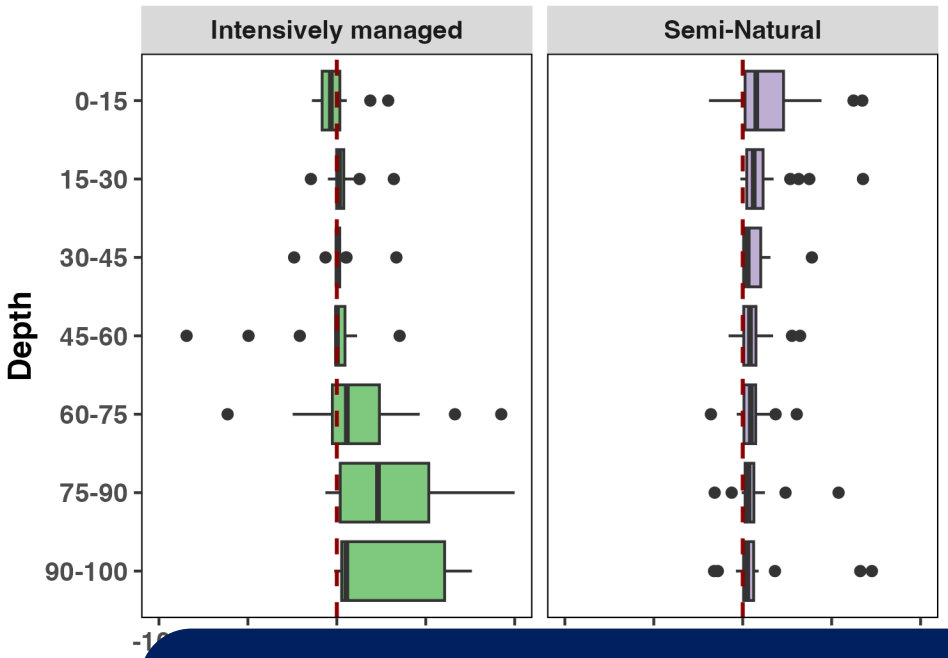
Results – *Soil Al, Fe, pH vertical distribution*

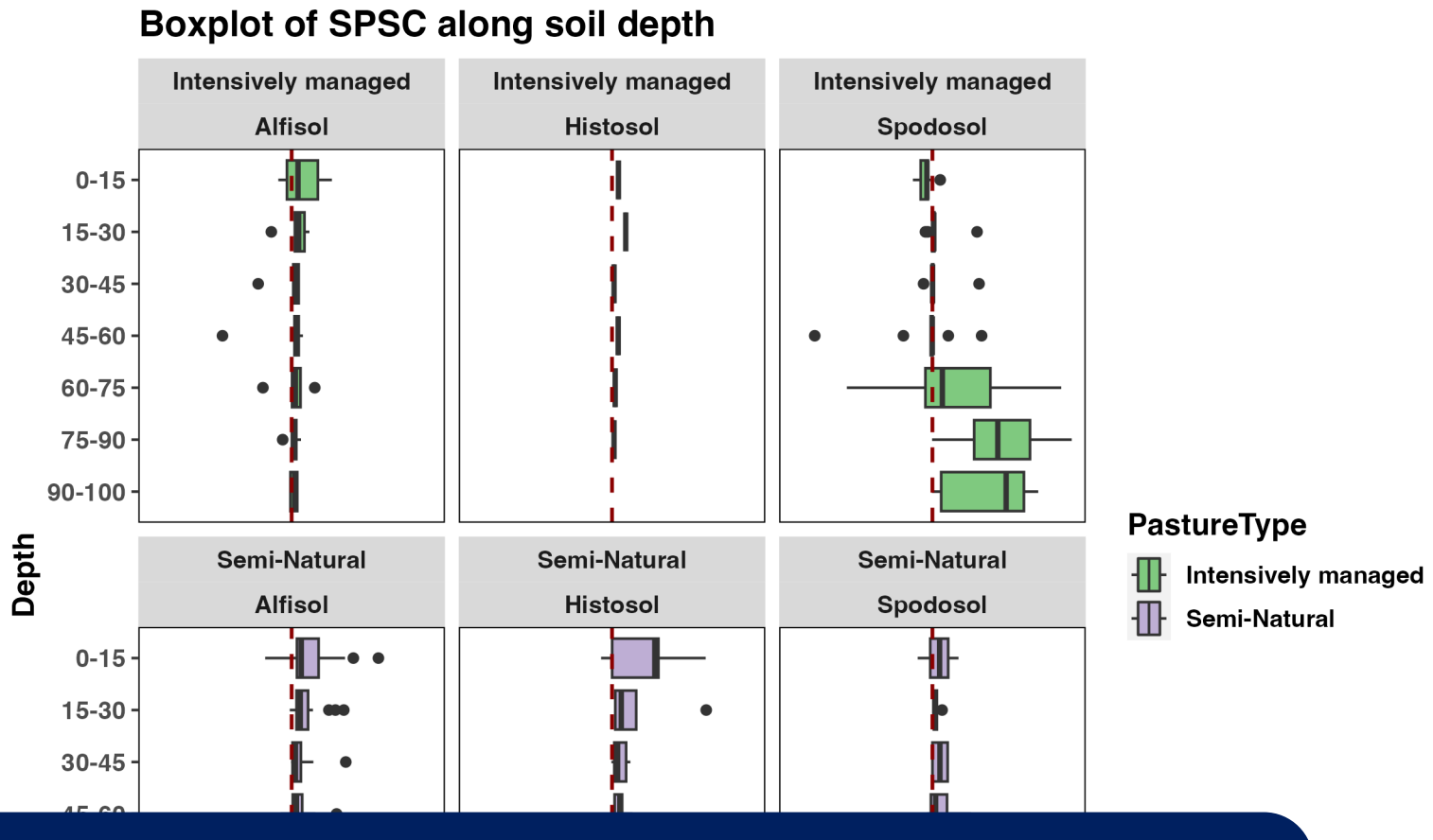


- Opposite Al concentration distribution in two managed grasslands.
- Fe and pH distribution doesn't change much along soil depth.

Results – *SPSC vertical distribution*

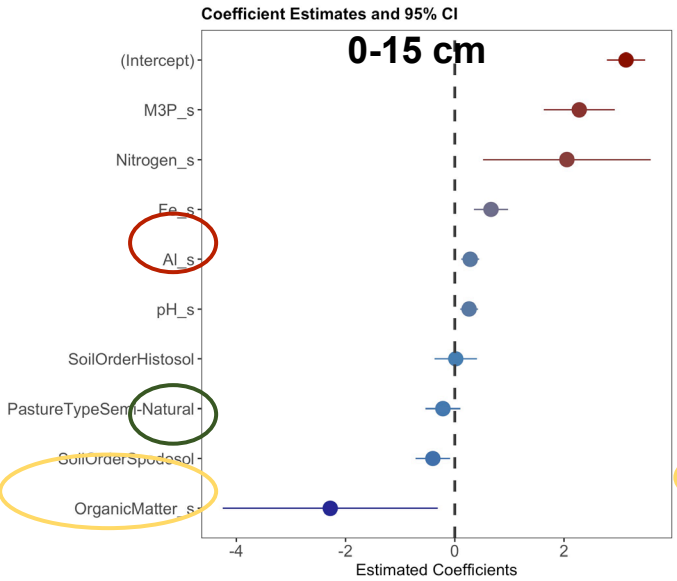
SPSC>0: P Sink
SPSC<0: P Source

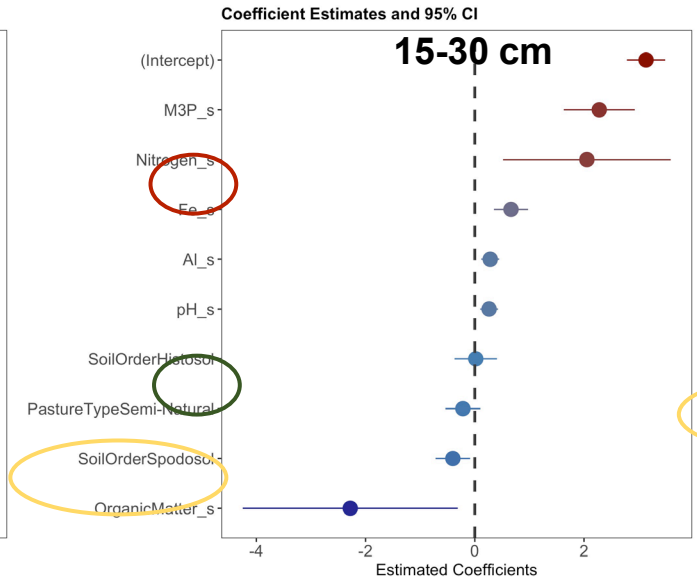


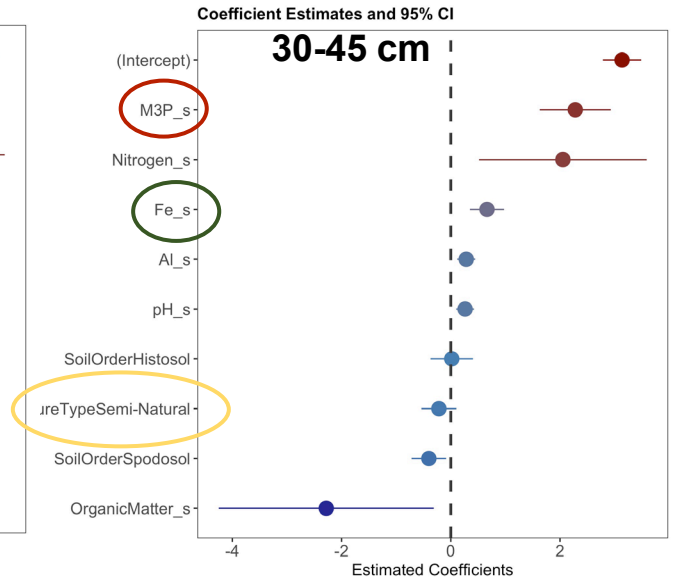


- SPSC increase along soil depth in intensively managed grasslands; SPSC decrease along soil depth in semi-natural grasslands.
- Soil orders determine the distribution of SPSC.
- Soil Al and Fe concentrations determine the distribution of SPSC.

Results – *Drivers for Total P (Linear regression)*



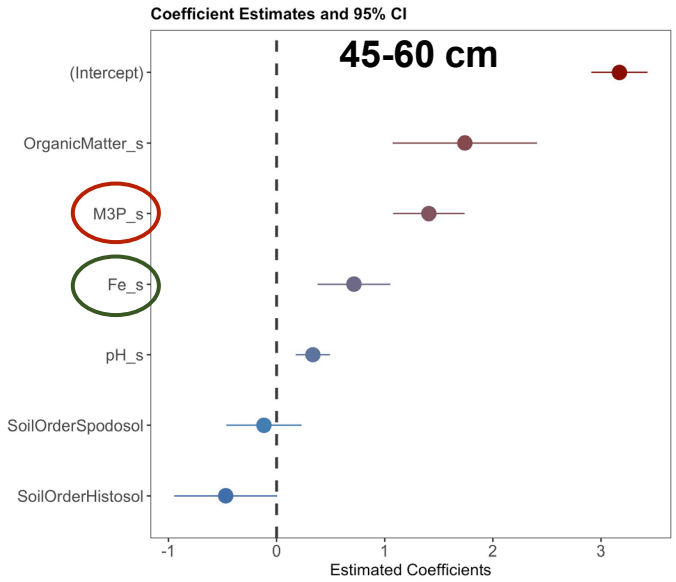


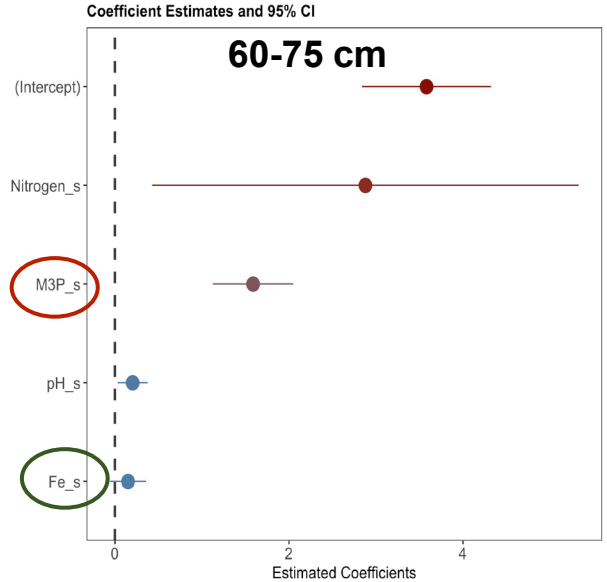


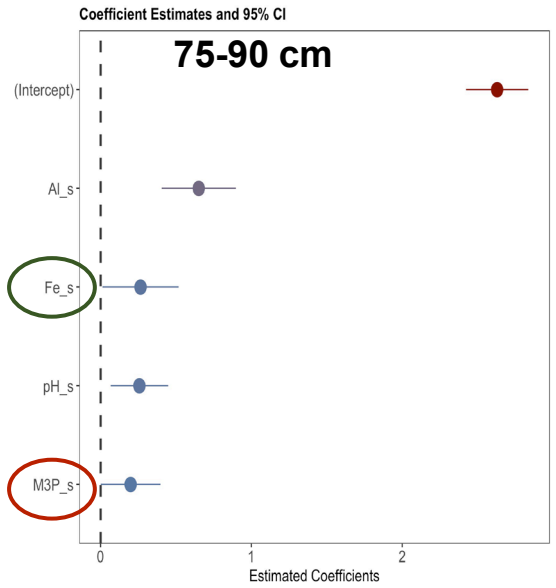
M3-P

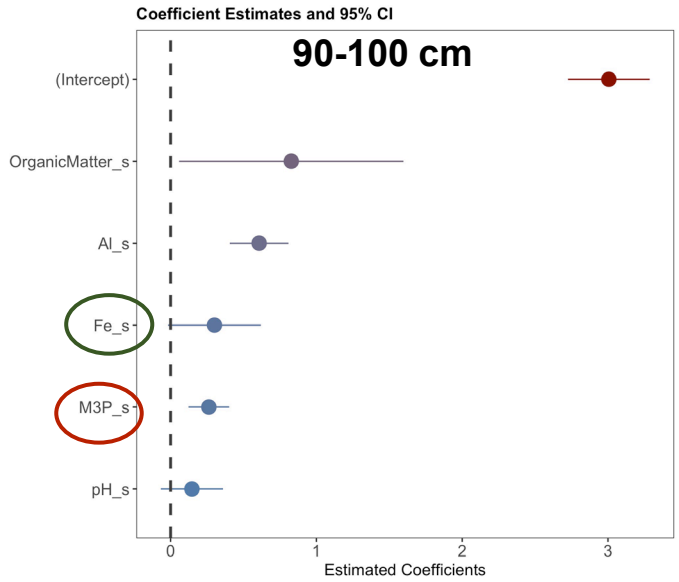
Fe

Pasture management









Conclusion

1. Agricultural management practices impact the distribution of total phosphorus (P) along soil depth but have little effect on the distribution of plant-available phosphorus.

2. Soil carbon and nitrogen display similar trends along soil depth in both grasslands..

3. Management intensity significantly impacts the distribution of aluminum (Al) and iron (Fe), thereby regulating the soil phosphorus storage capacity (SPSC).

4. Mehlich-3 P and Fe are important drivers for soil total P at every depth.

Thank you!

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