The indigenous nitrogen supply of flooded rice paddy soils is determined partially by soil organic carbon content

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Outline

- Why study this?
- Objectives
- How we investigated?
- What did we find?
- Conclusions

Why study this?

Increased interest to grow rice in the Sacramento San-Joaquin Delta, to reduce subsidence, but:

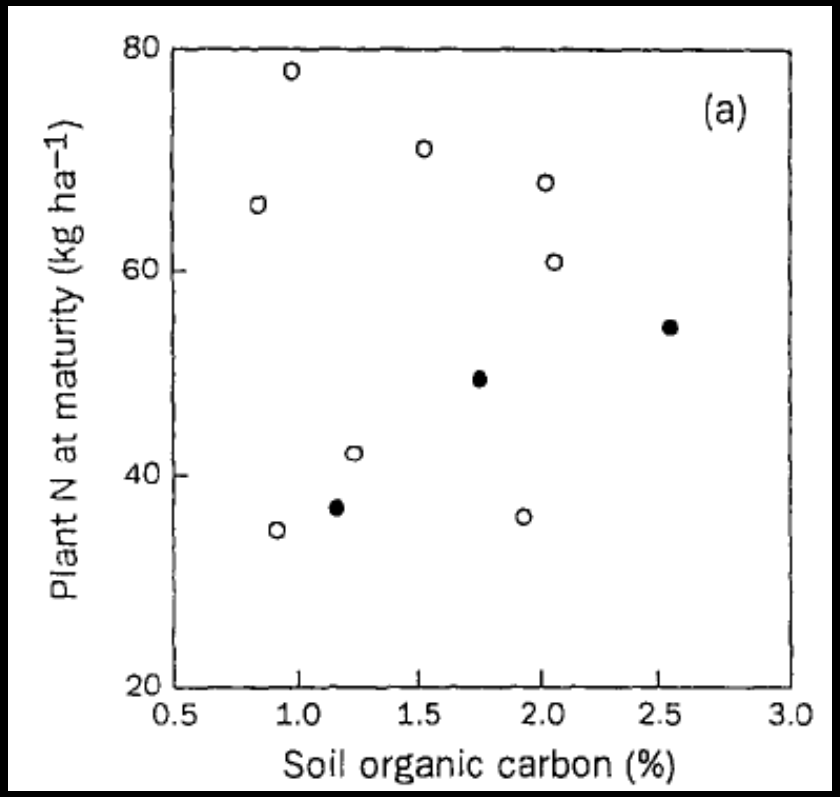
- Nitrogen (N) is typically the most important yield limiting nutrient in rice.
- N is released by soil organic matter (SOM) as it decomposes.
- Over-application of N has negative environmental and economic costs.

Why study this?

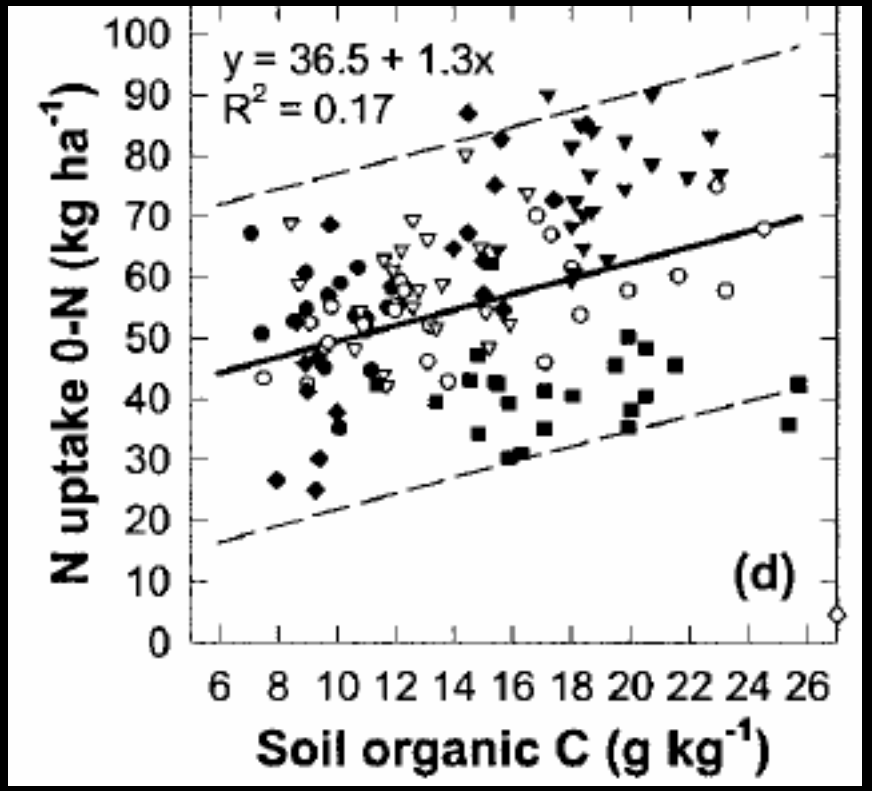
- SOM decomposition (mineralization) provides nitrogen to rice
  - A component of the indigenous supply
  - Previous study suggested large contribution of N to rice crop from peat soils (Kirk et al., in review)

- More SOM should result in more nitrogen to rice…

Previous studies:



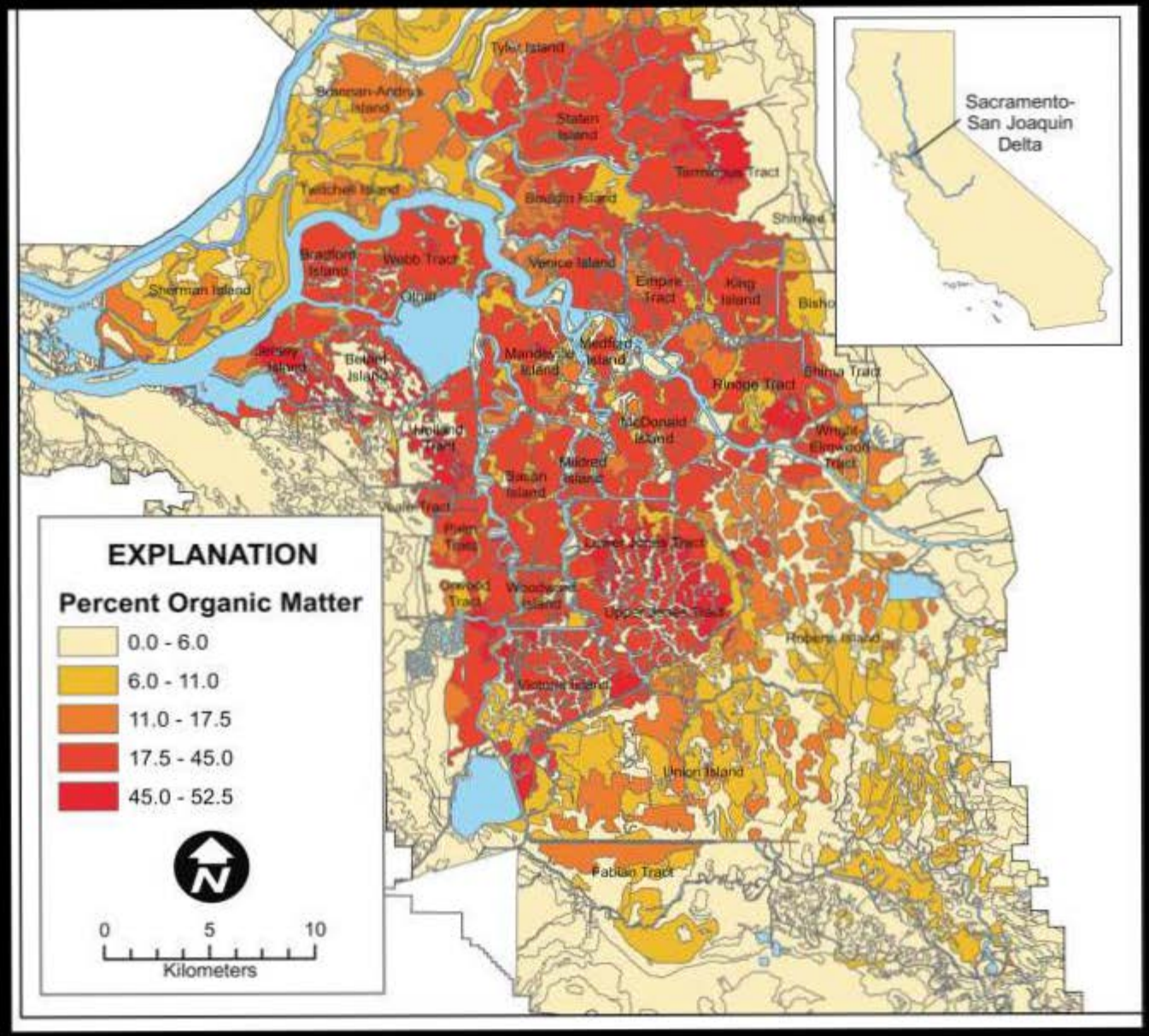
Cassman et al, 1996



Dobermann et al, 2006

Aside: Soil organic carbon units

- SOC measured multiple ways
  - % by mass
  - g carbon per kg soil (g kg^{-1})
- g kg^{-1} / 10 = % by mass
- SOM ≈ 2x SOC



Deverel and Leighton, 2010

Objectives

- How much nitrogen is provided from these soils?
- What fertilizer requirements will these soils have?

Hypothesis:

- The amount of nitrogen mineralized is proportional to the amount of soil carbon in a soil.
  - Soils low in soil carbon will show a strong positive yield response to added nitrogen.
  - Soils high in soil carbon will not show a yield response to added nitrogen.

How we investigated

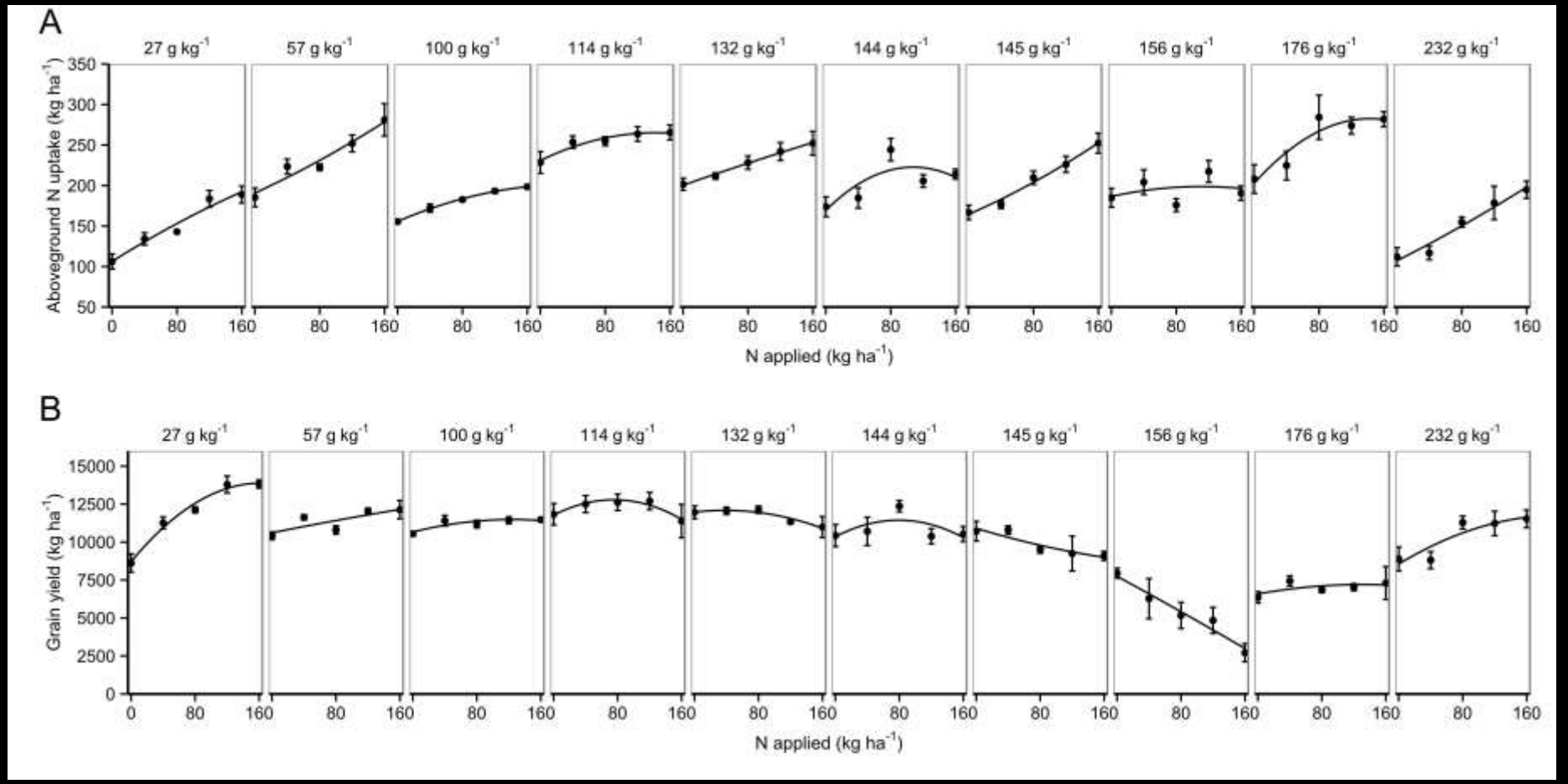
- Ten nitrogen rate trials (2011-2013)
  - Nine at Twitchell Island
  - One outside of Stockton, CA
  - Represented soils: 27 g kg^{-1} C to 232g kg^{-1} C
  - Treatments: 0, 40, 80, 120, 160 kg N/ha
- 20+ nitrogen omission plots (2013)
  - Tarped to prevent granular fertilizer application
  - Represented soils: 6 g kg^{-1} C to 270g kg^{-1} C
- 100kg K_20 and 50kg P_2O_5 applied to all plots

What did we find?

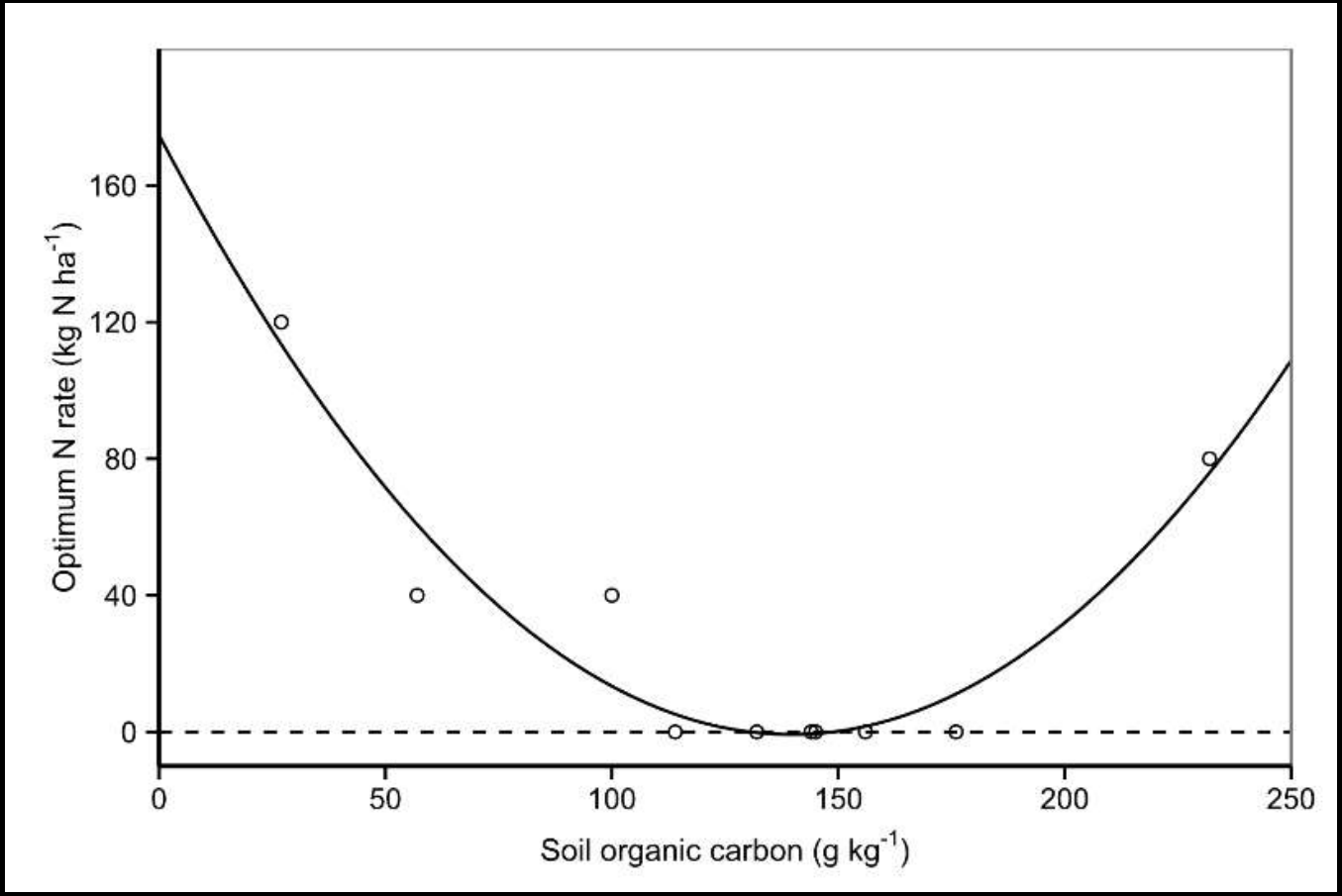
- Clear nitrogen response at ends of the soil carbon spectrum (25 g kg^{-1} and 250 g kg^{-1} C)

- Small to no response in middle (100 – 150 g kg^{-1})

Yield and N Uptake by SOC

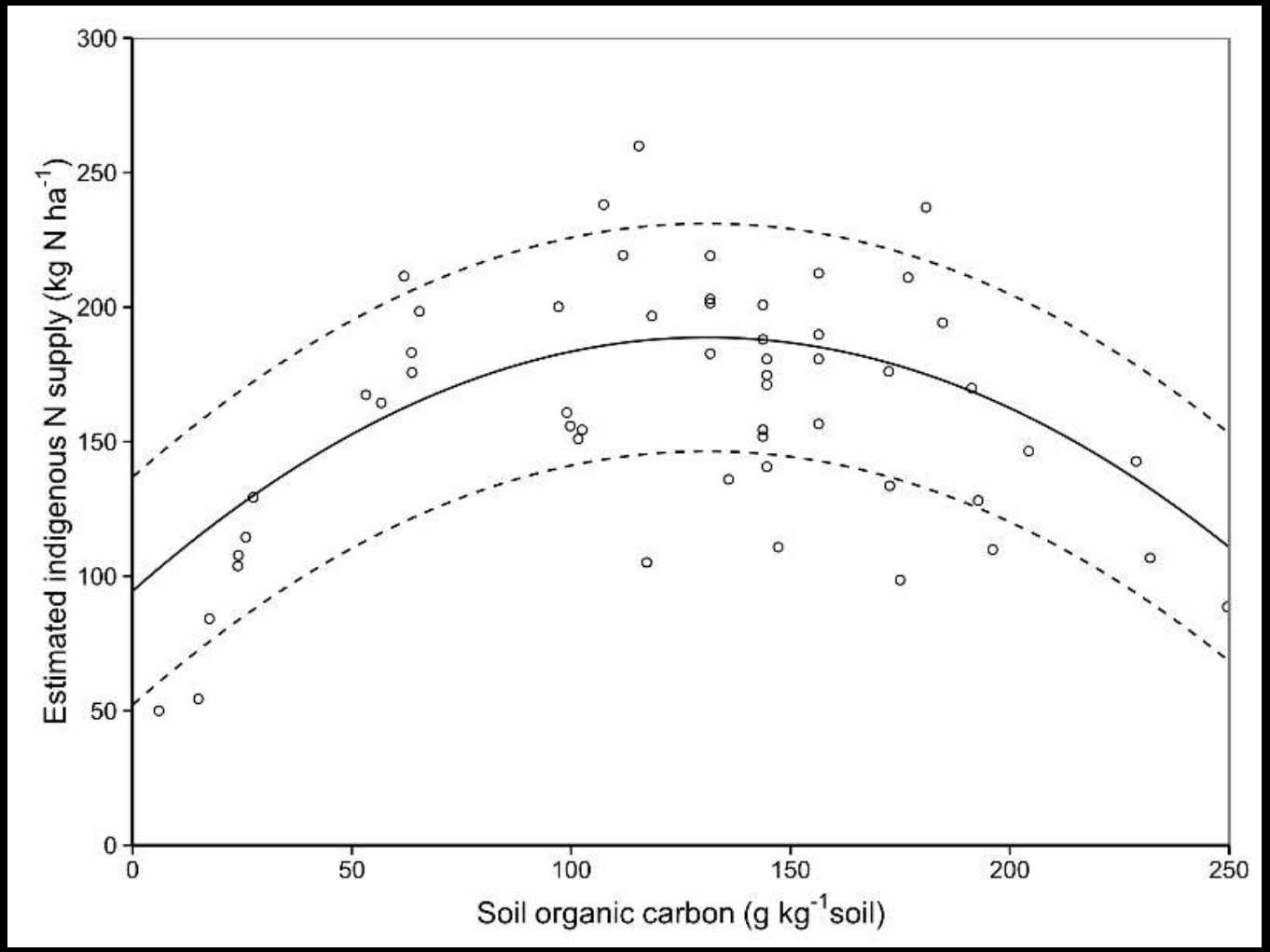


N response by SOC



Espe et al., *in review*.

Aboveground N uptake by SOC



Espe et al., *in review*.

Conclusions

- “Sweet spot” for N mineralization between 100 – 150 g kg^{-1} SOC

- Fertilizer N likely needed for both low and high carbon soils

Acknowledgements

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Questions?