

# Leaf nitrogen responses to soil nitrogen

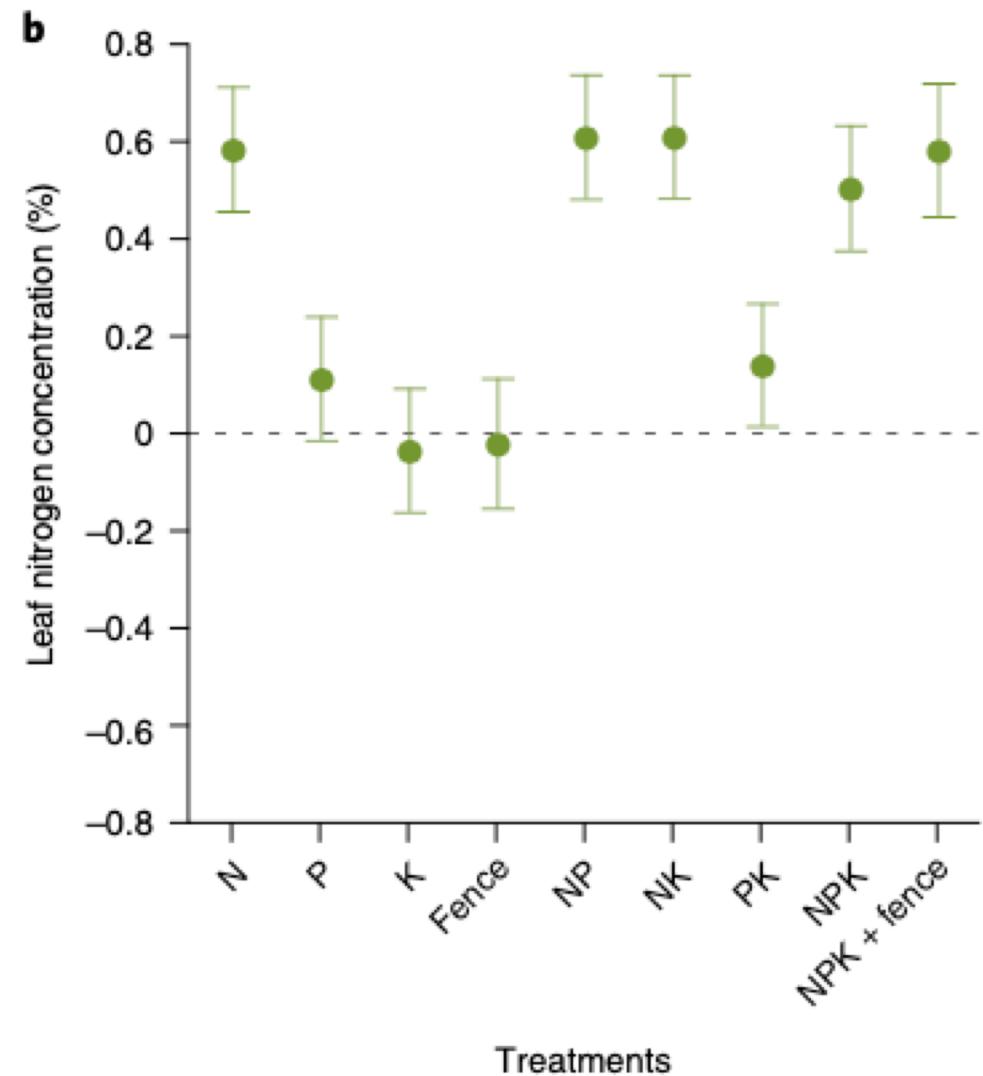
Nick, Lizz, et multi alia

# Rationale

- Leaf  $N_{area}$  is an important variable for ecosystem carbon and N fluxes
  - Used to predict photosynthesis in ESMs, including downregulation from N limitation
- Not clear how or why leaf  $N_{area}$  responds to soil N availability

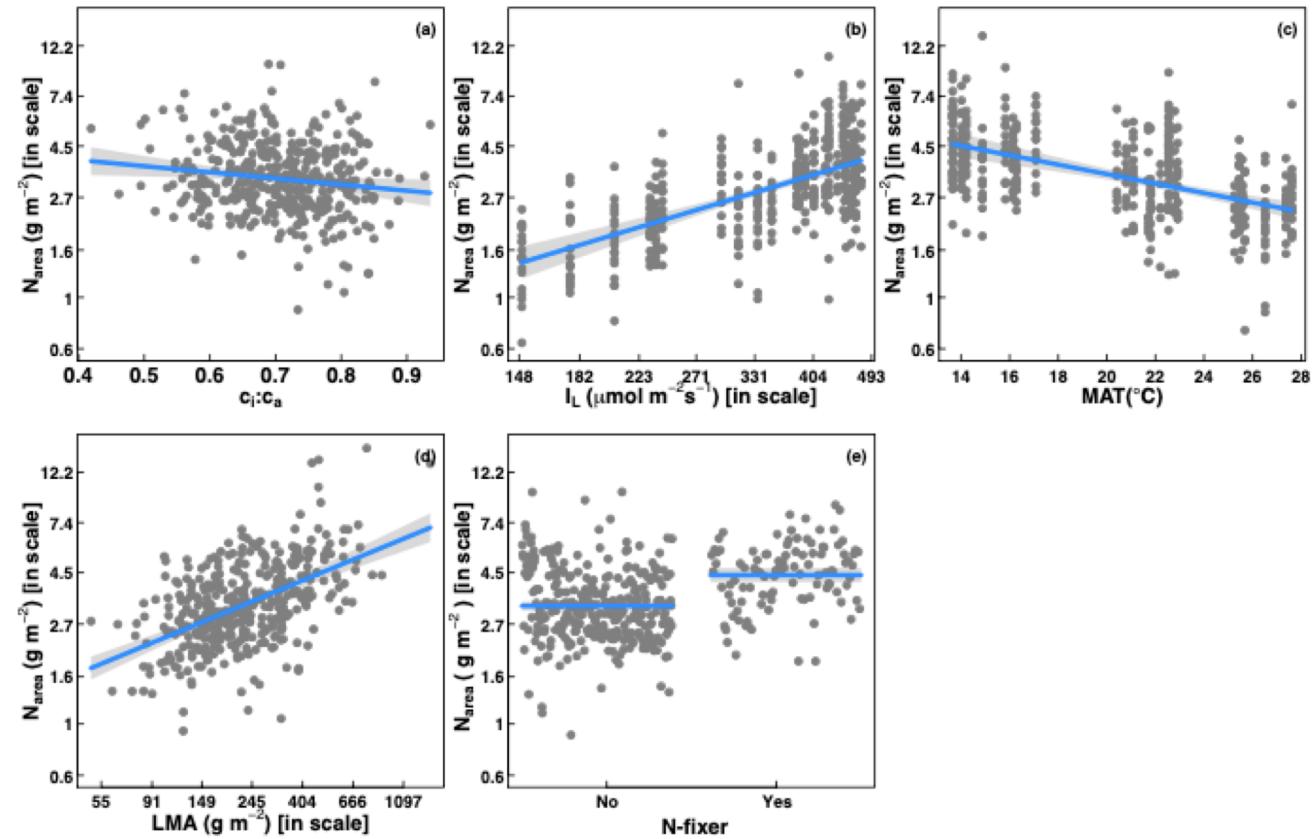
# Rationale CTD

- Firn et al. (2019): strong link b/w soil N and leaf N%



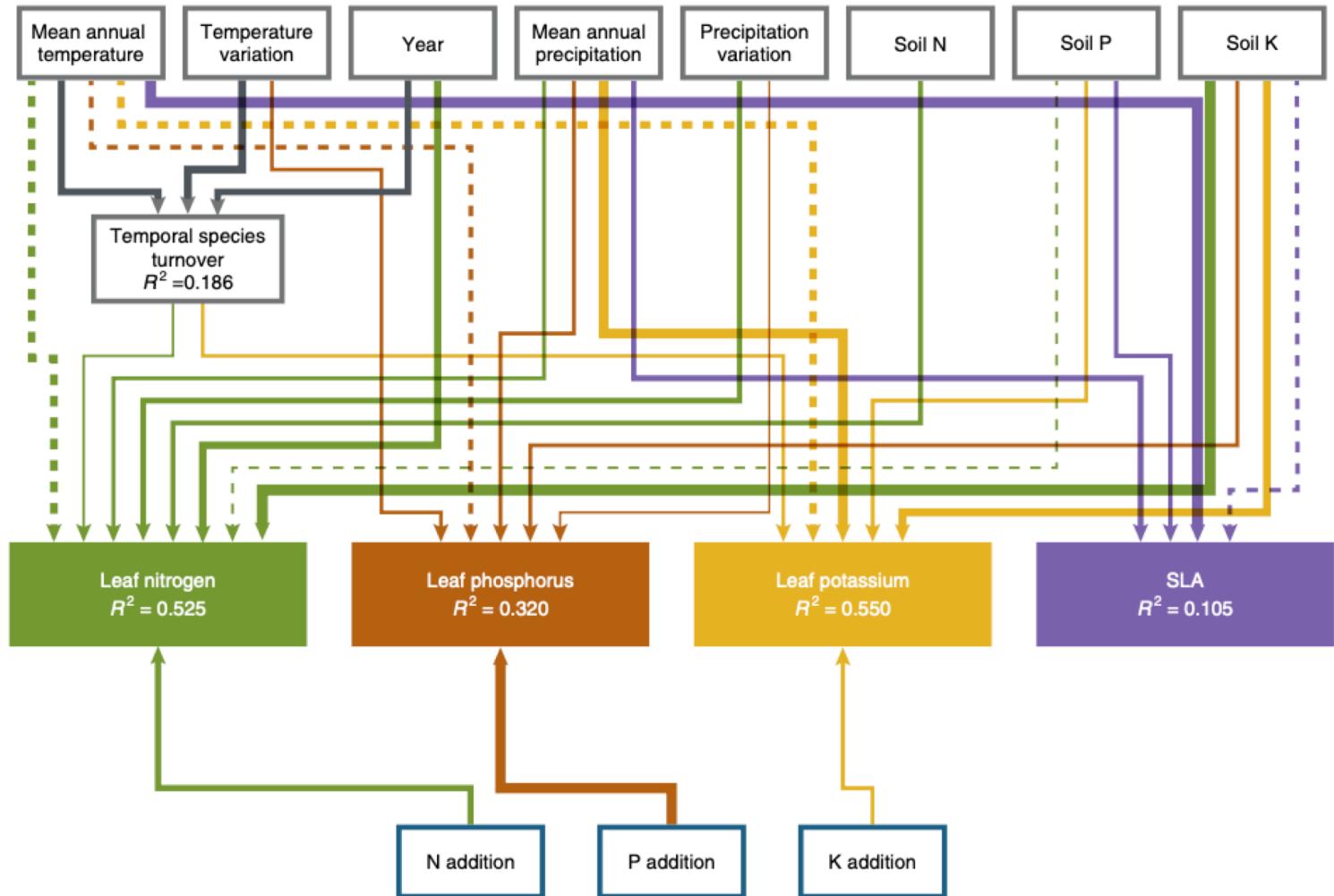
# Rationale CTD

- Dong et al. (2017): it's mainly climate and adaptation (LMA, Nfixer)



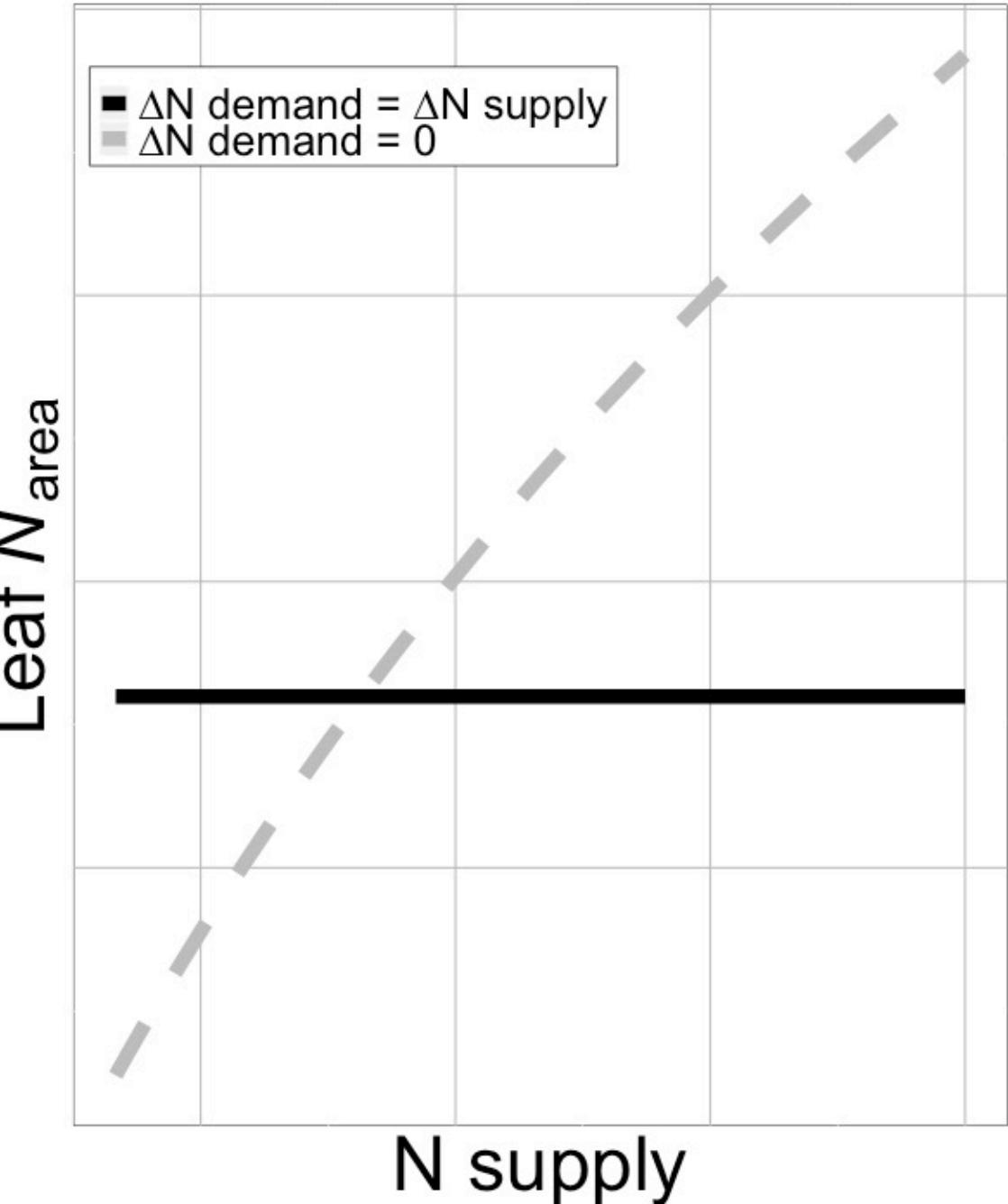
# Rationale CTD

- Firn et al. (2019) kinda showed that too!



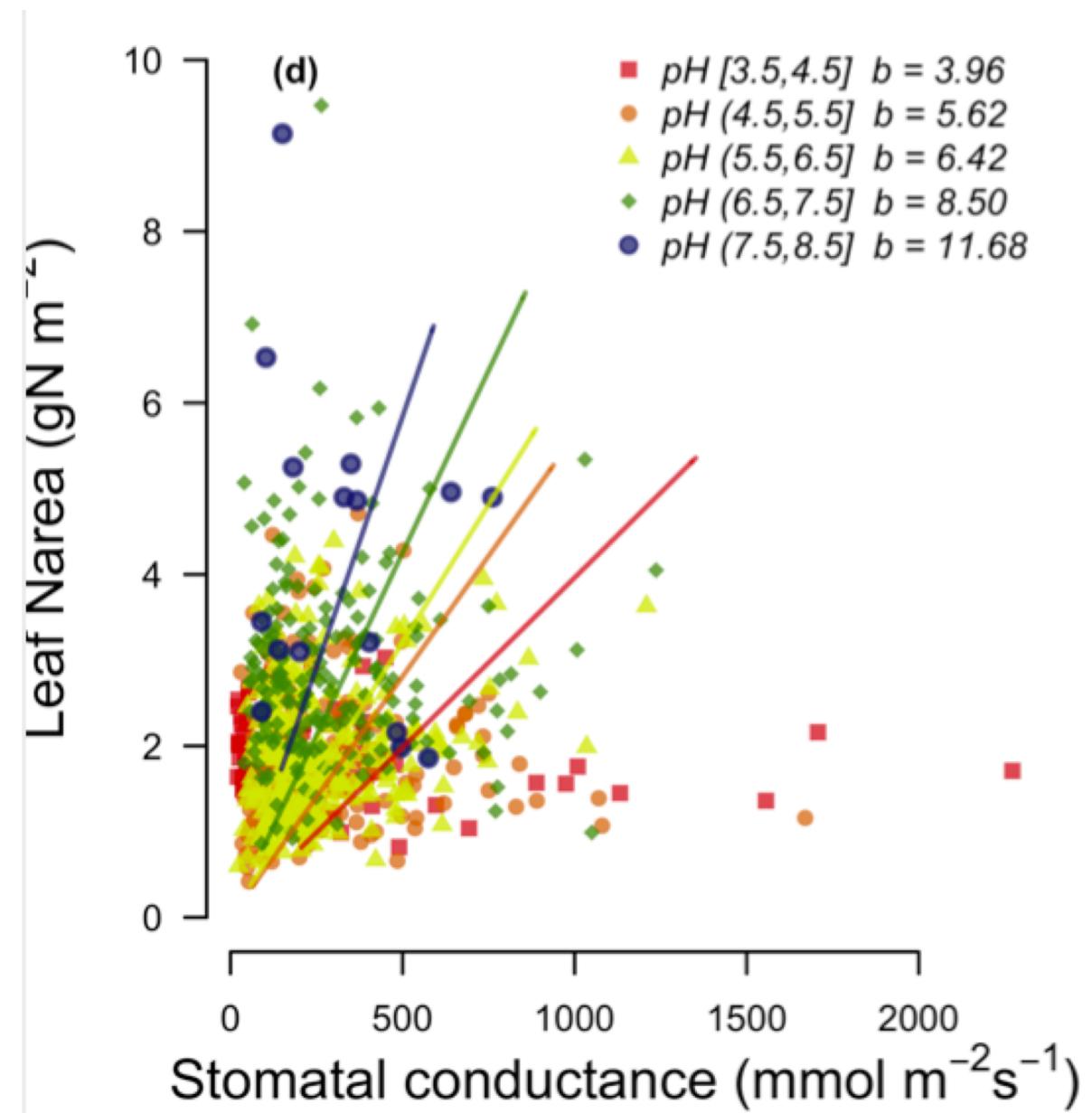
# Rationale CTD

- Recent analyses suggest that soil N may modify the nutrient economy of leaves (Paillassa et al., 2020)
  - This depends on the ratio of soil N demand and soil N availability



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# Specific aims

1. Quantify the impact of soil N on leaf N<sub>area</sub>
2. Separate soil N drivers from climate drivers
3. Separate the impacts of N demand and N availability on leaf N<sub>area</sub>

# Primary questions

- Does soil N impact leaf Narea?
- How does the impact of soil N on leaf Narea compare to other drivers, such as climate and LMA?
- How does the leaf Narea response to soil N compare to the LAI response to soil N?
- Does the impact of soil N on leaf Narea vary with leaf N demand, as indexed through the LAI response?

# Nutrient Network (NutNet)

- Globally distributed soil nutrient manipulation experiment
- Fully factorial soil N x P x K addition experiment (10 g m<sup>-2</sup> yr<sup>-1</sup>)
  - At least 3 blocks per site

# Datasets

- NutNet leaf trait data
  - n = 2048, 195 species, 22 sites
  - N<sub>area</sub>
  - LMA
  - d13C (converted to  $\chi$ )
  - Growing season climate conditions (CRU)
- NutNet plot data
  - n = 487, 15 sites
  - LAI

# Analyses

\*\*Analyses generally follow Dong et al. (2017)\*\*

- Drivers of leaf N<sub>area</sub> (mixed model)
  - Dependent variable: leaf N<sub>area</sub>
  - Fixed effects: soil N \* soil P \* soil K +  $\chi$  + temperature + PAR + LMA +Nfixer + photosynthetic pathway
  - Random terms: species + species:site + species:site:block

# Analyses

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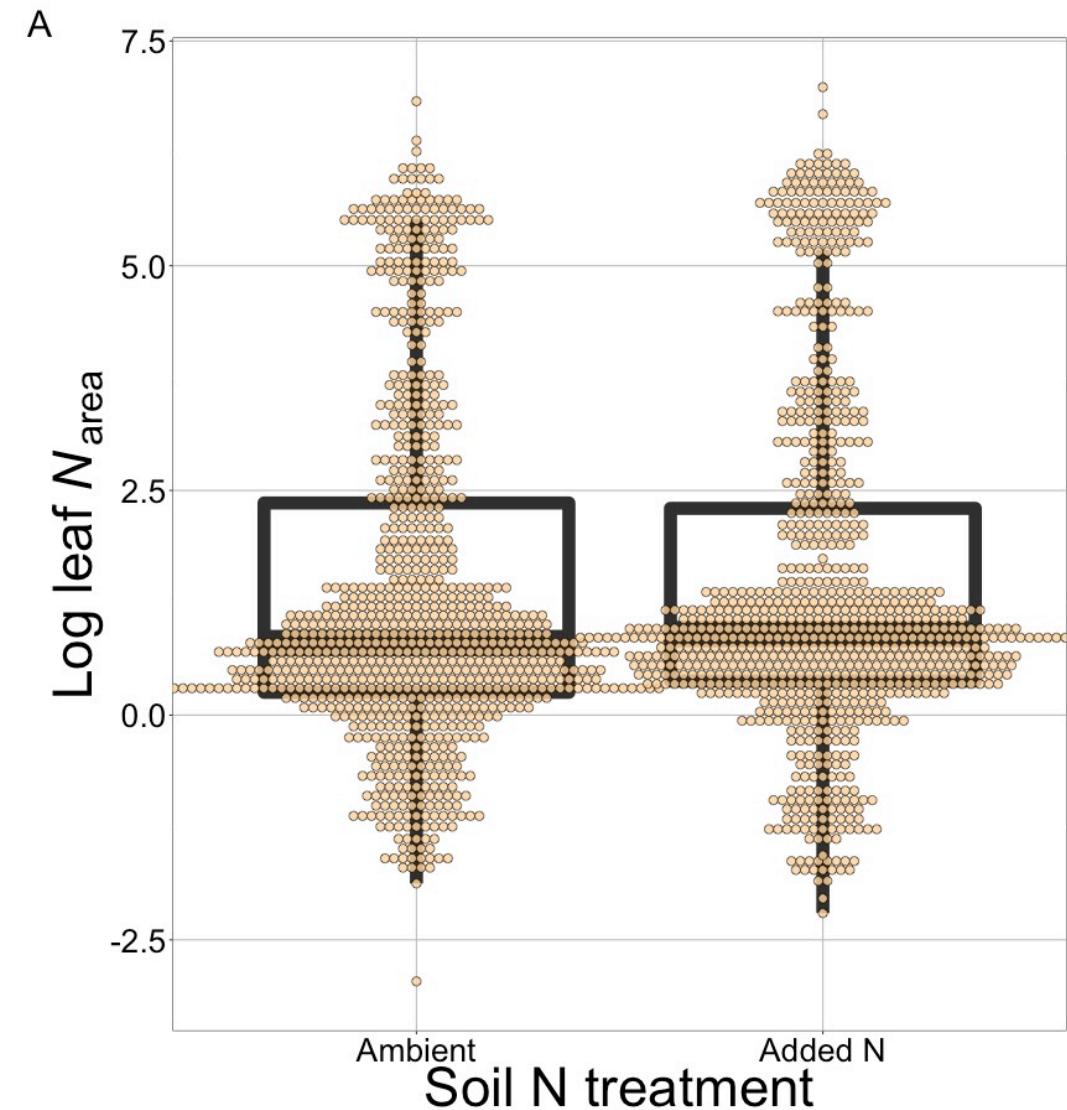
- Predictability of leaf N<sub>area</sub> (mixed model)
  - Dependent variable: leaf N<sub>area</sub>
  - Fixed effects: soil N \* soil P \* soil K + predicted Nphoto + predicted Nstructure + Nfixer + photosynthetic pathway
  - Random terms: species + species:site + species:site:block

# Analyses CTD

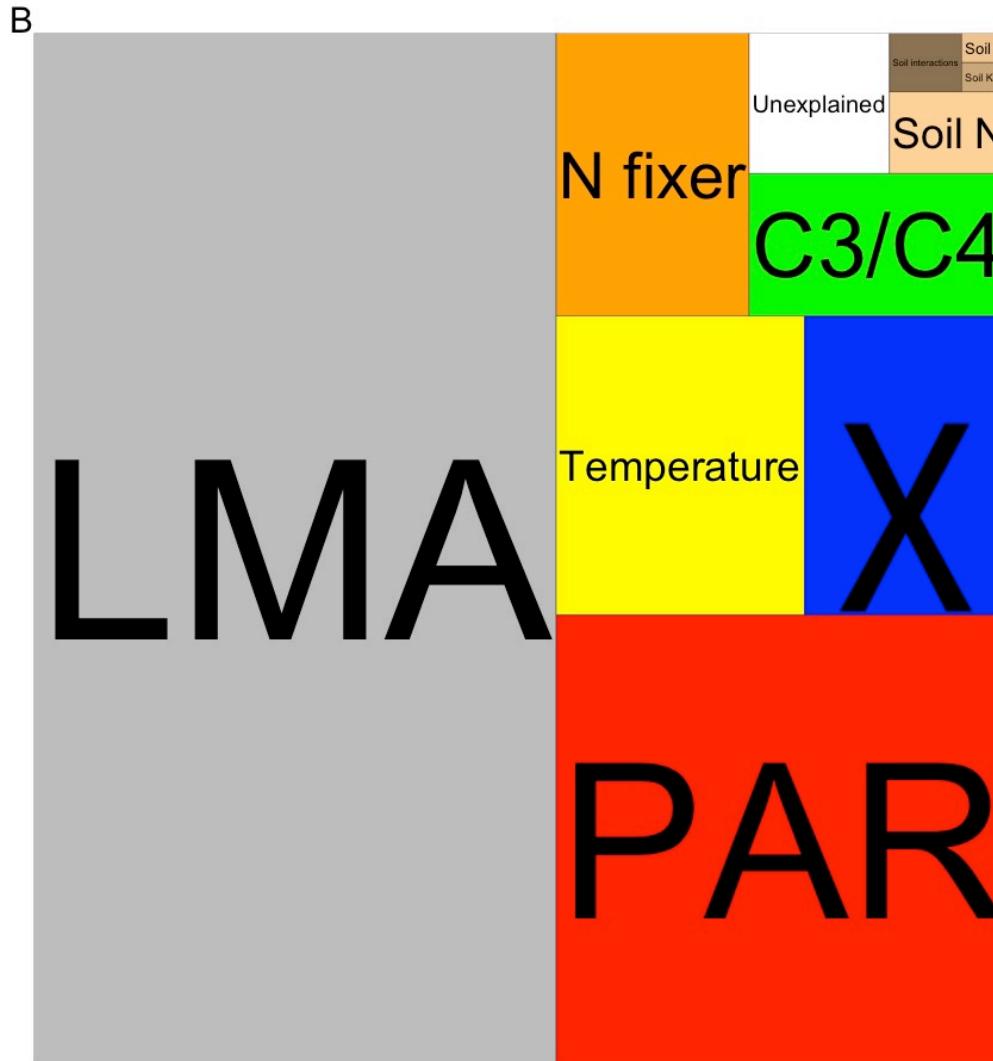
- LAI response to soil N
  - Dependent variable: plot LAI
  - Fixed effects: soil N \* soil P \* soil K
  - Random terms: site + site:block
- Supply/demand effects on leaf N<sub>area</sub> (linear model)
  - Dependent variable: change in plot averaged leaf N<sub>area</sub> in N addition plots
  - Fixed effects: change in plot LAI in N addition plots

# Results: Does soil N impact leaf N<sub>area</sub>?

- 19% increase in leaf N<sub>area</sub> with soil N ( $p < 0.01$ )

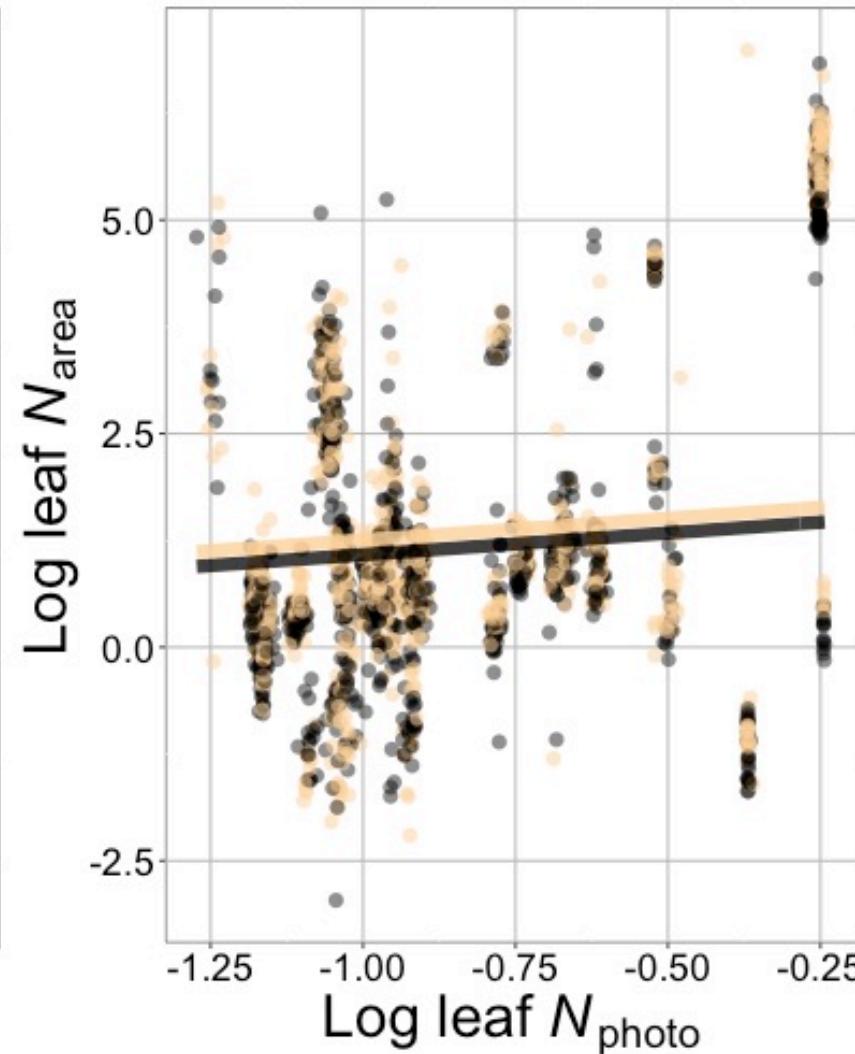
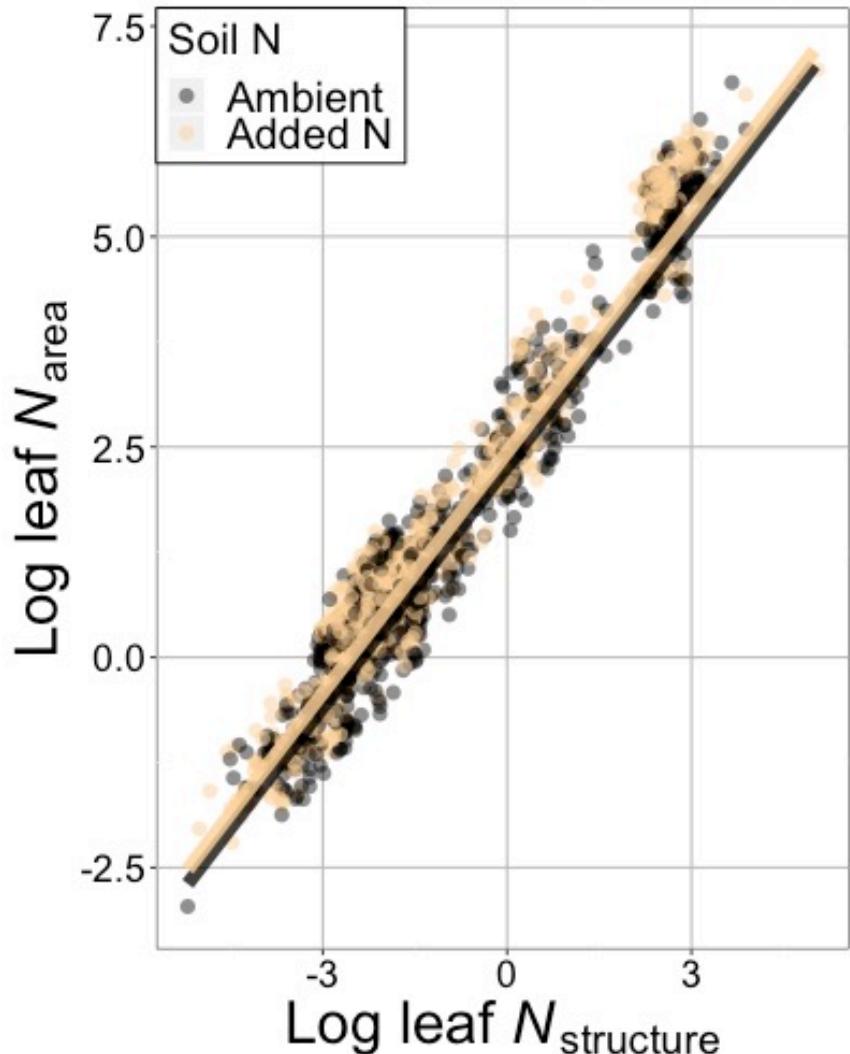


# Results: What about other variables?



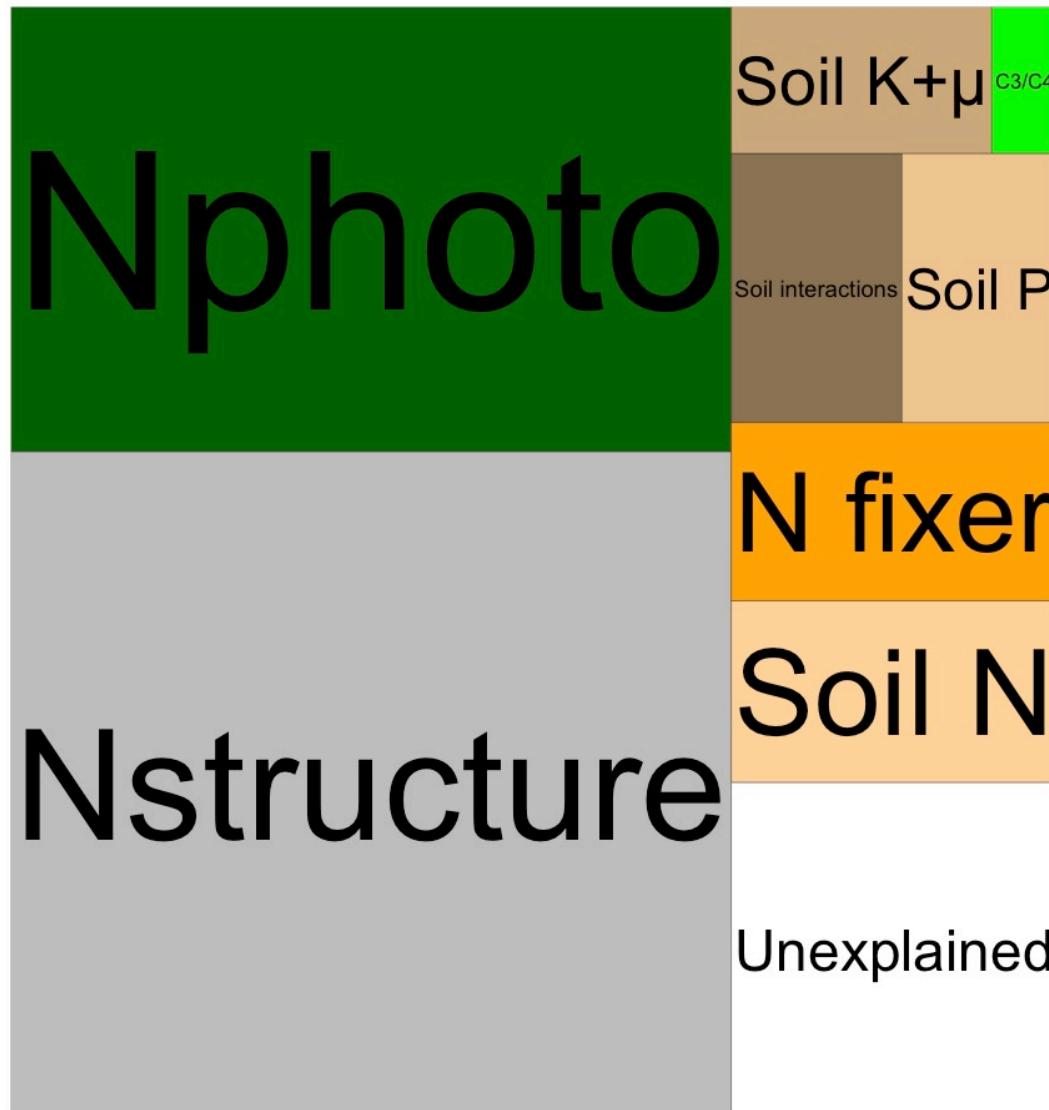
Soil (brown) is  
not that  
important (<2%  
combined)

# Results: Can we predict $N_{\text{area}}$ ?



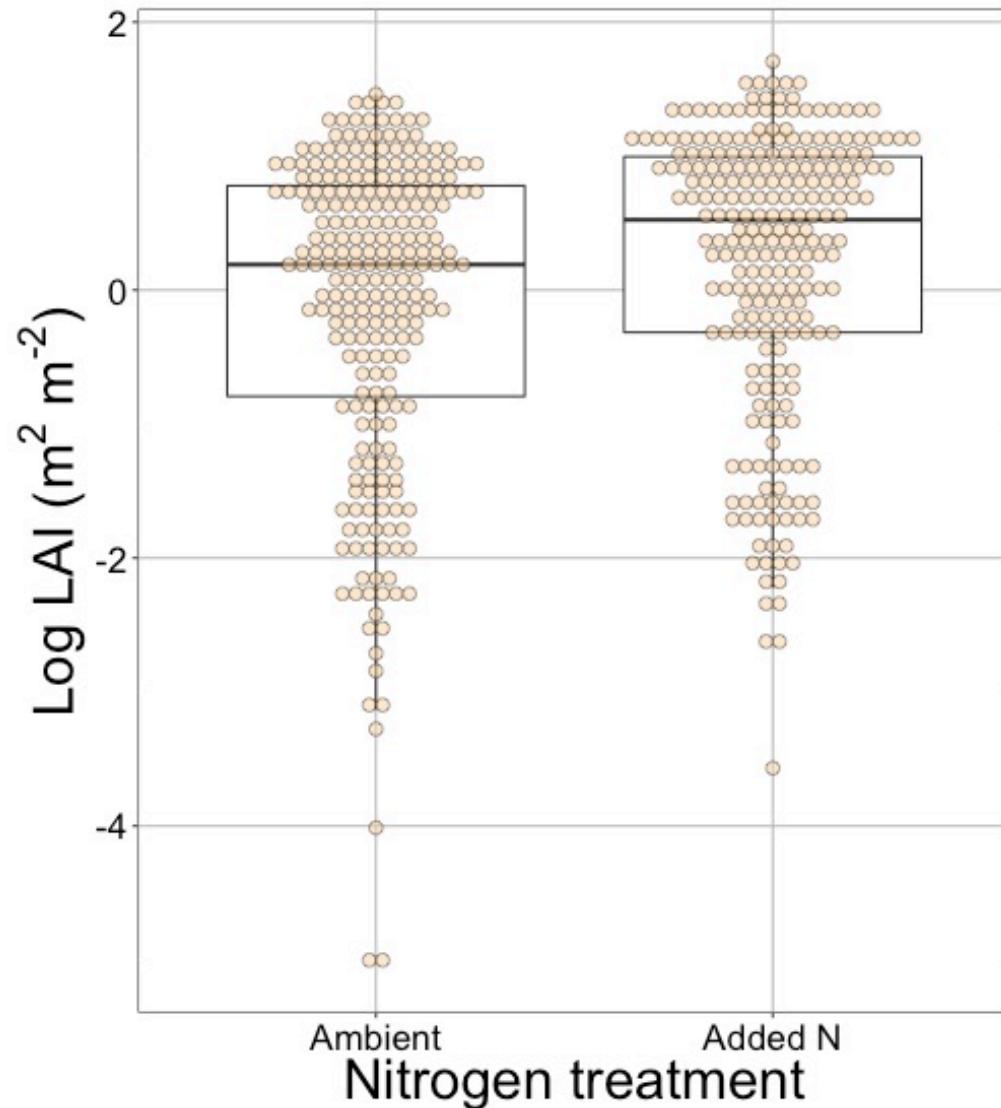
Soil N ( $P < 0.01$ )  
 $N_{\text{structure}}$  ( $P < 0.01$ )  
 $N_{\text{photo}}$  ( $P < 0.01$ )

# Results: Can we predict $N_{area}$ ?



Structural and photosynthetic N combined explain 69% of the variation in leaf  $N_{area}$

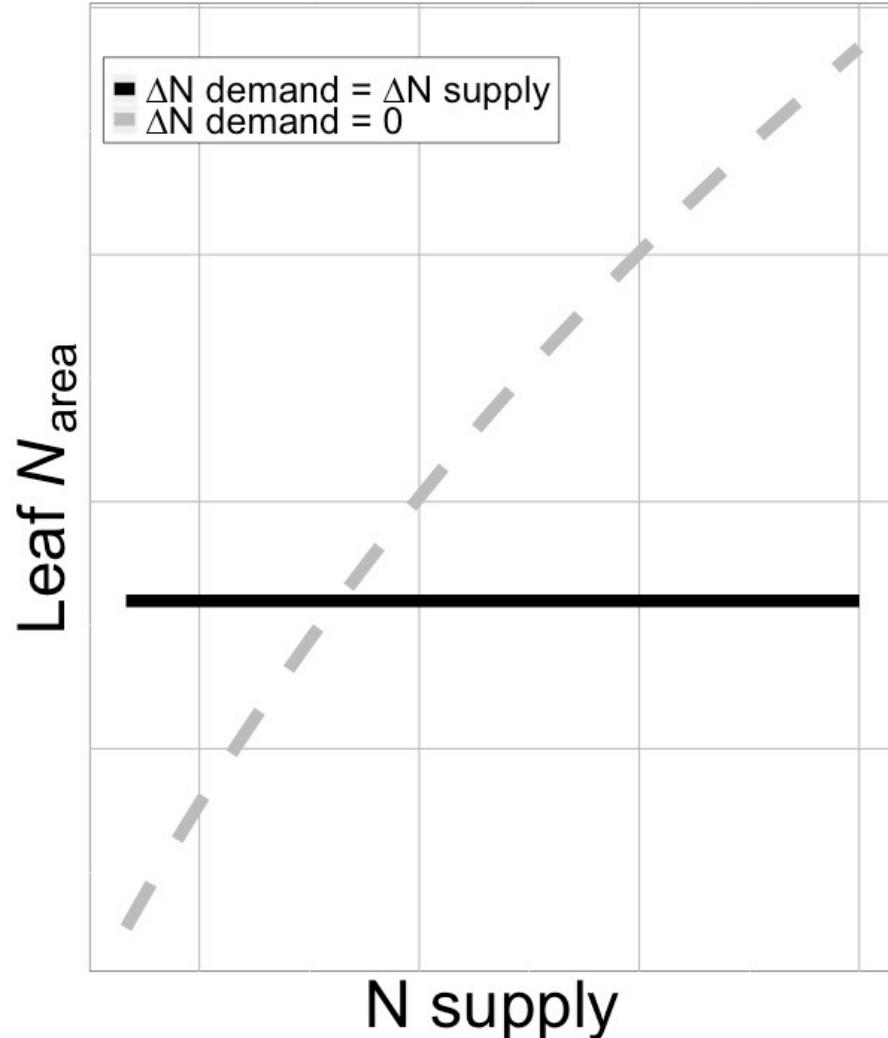
# Results: What is the LAI response to soil N?



43% increase in LAI ( $P < 0.01$ )

More N going to leaf quantity  
than quality

# Results: Does the impact of soil N on leaf N<sub>area</sub> vary with leaf N demand?

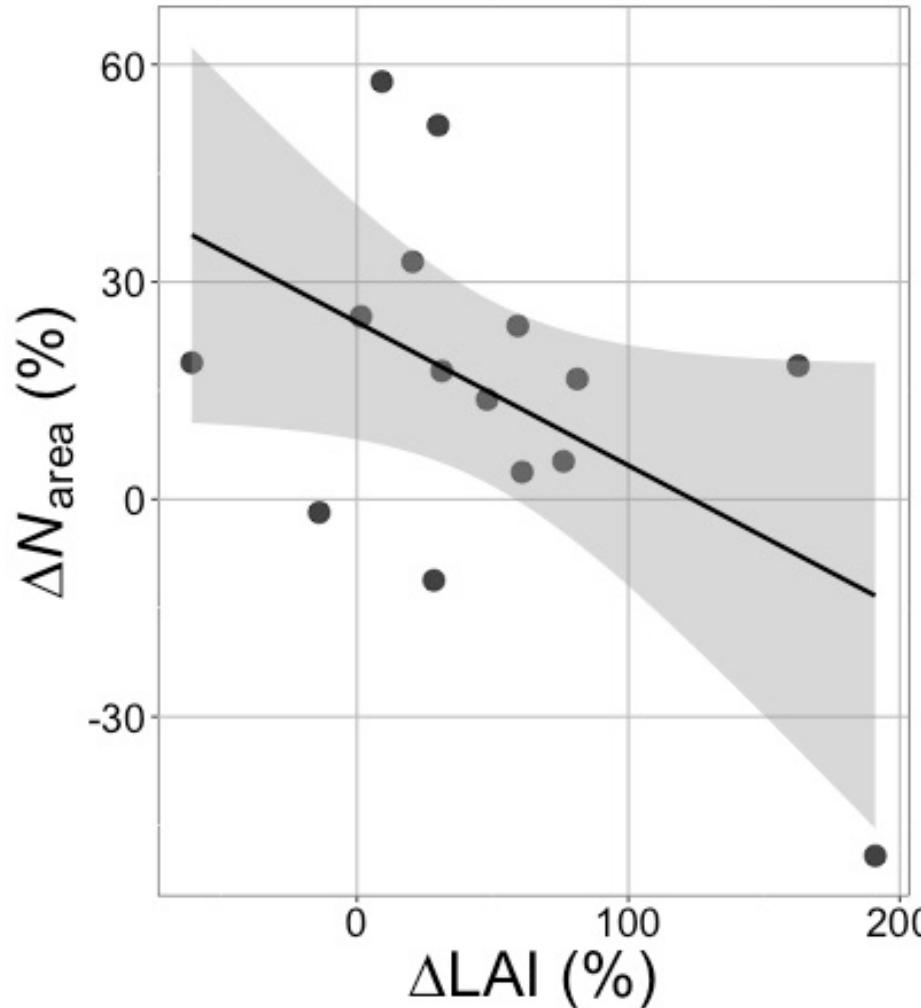


The change in leaf N<sub>area</sub> should be greater in places where the LAI (or plant N demand) doesn't change much

Results: Does the impact of soil N on leaf N<sub>area</sub> vary with leaf N demand?

If plants use added N to build new leaves, you would expect less stimulation of leaf N<sub>area</sub>

Results: Does the impact of soil N on leaf N<sub>area</sub> vary with leaf N demand?



P = 0.059

