Considering nitrogen responsiveness as a trait underlying sustainable cereal production

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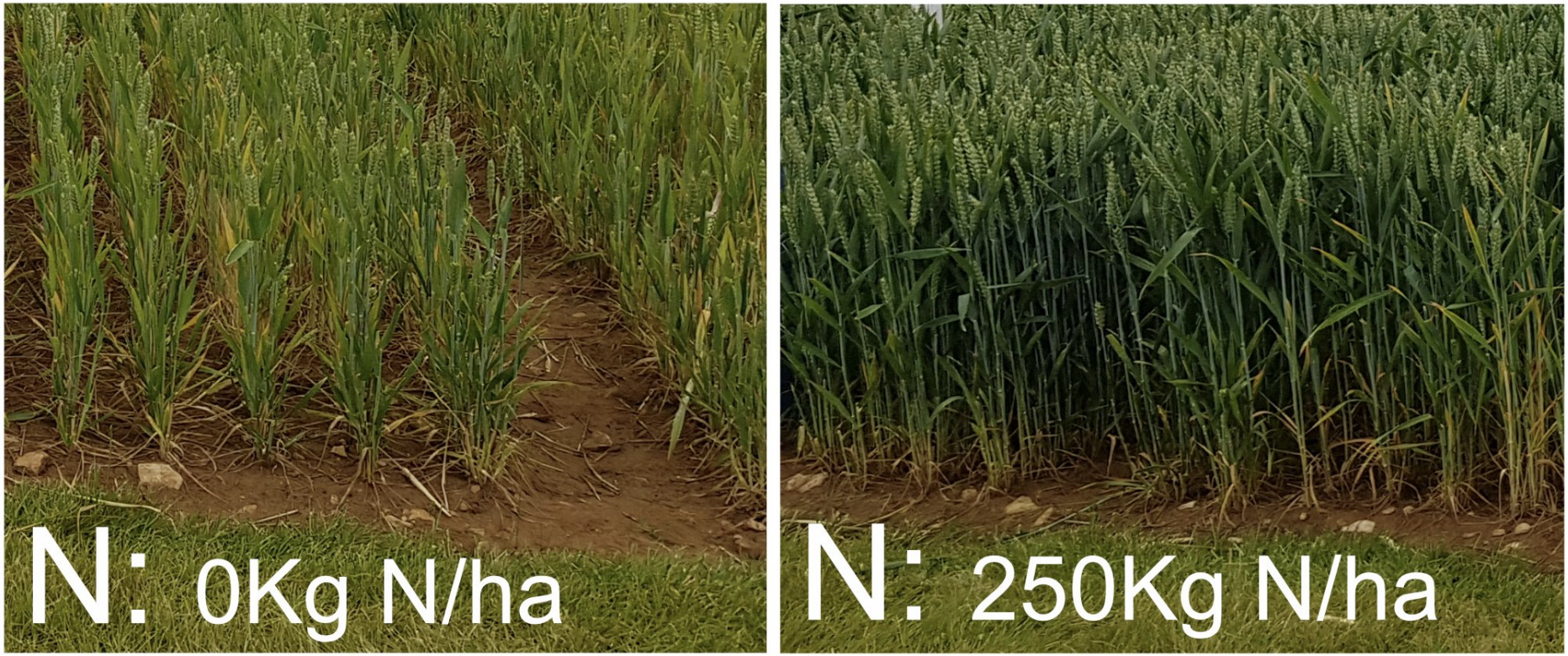
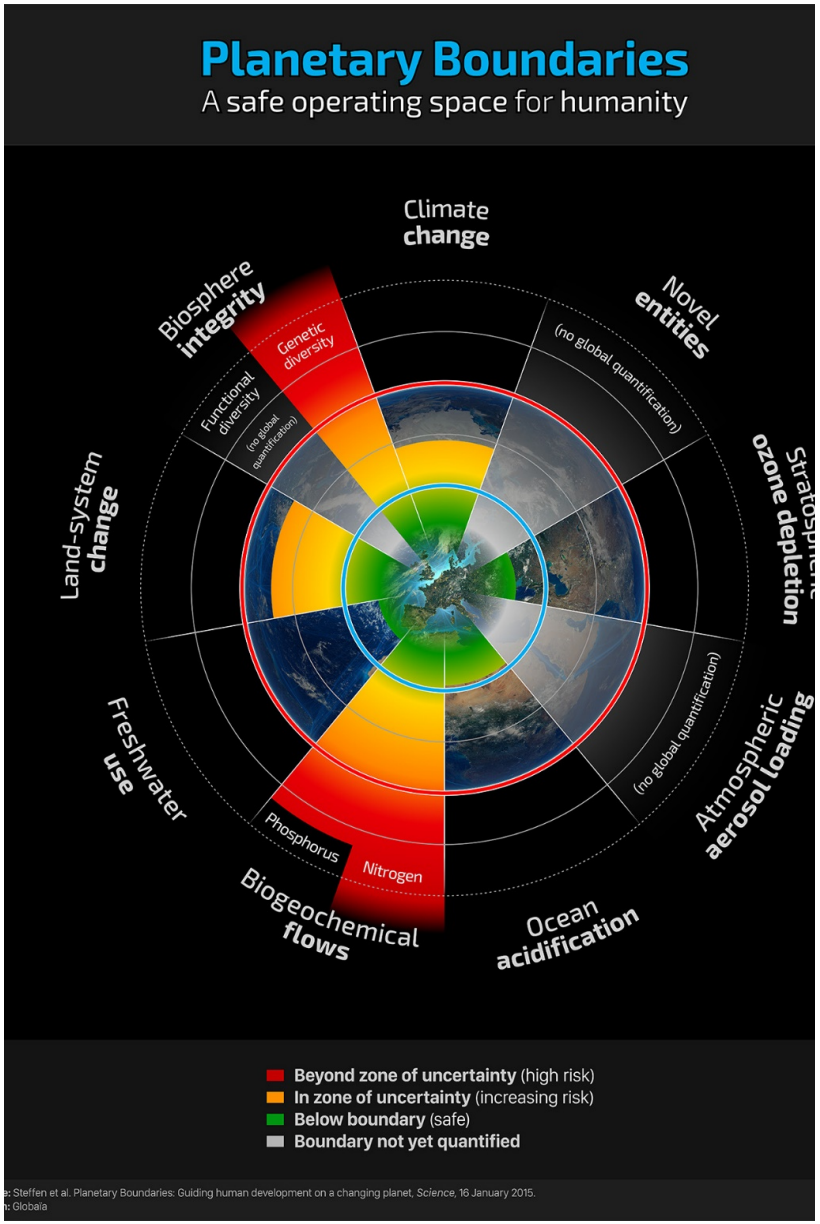
Nitrogen is often a limiting macronutrient

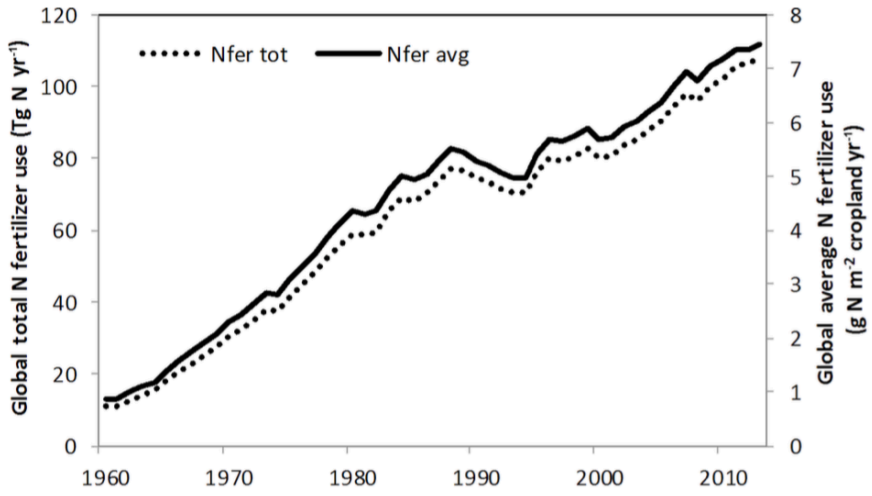


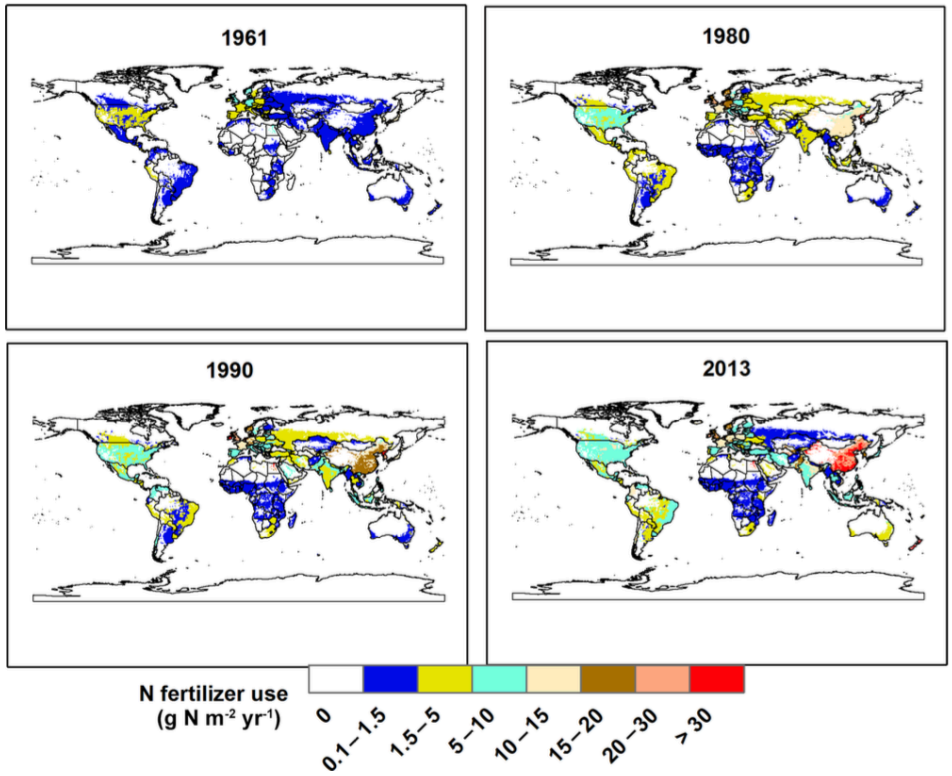


Placing the nitrogen cycle in a global context

- Rockström et al. 2009 *Nature*; Steffen et al. 2015 *Science*

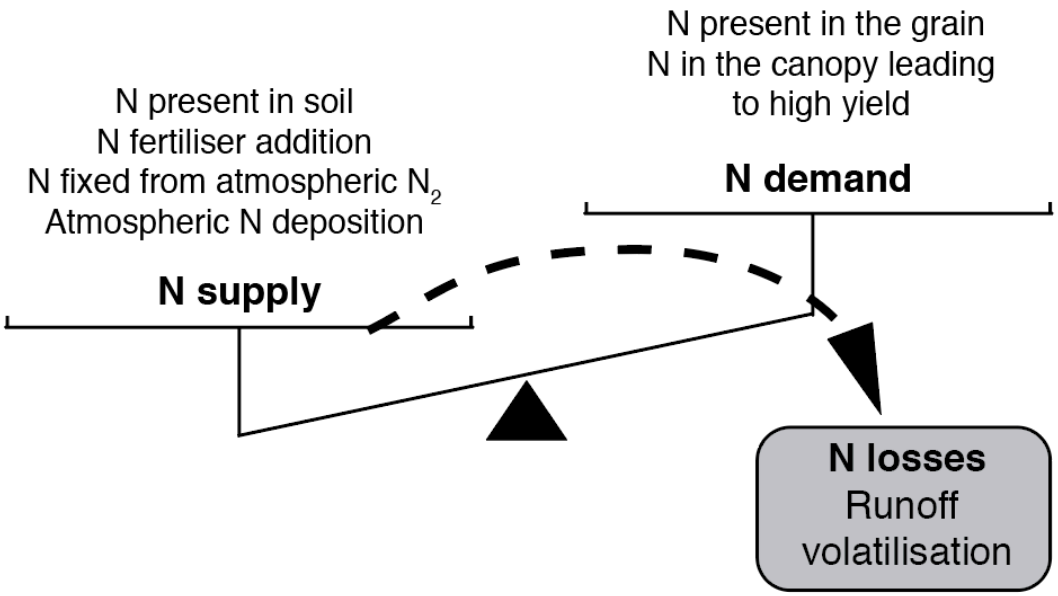
Global increase in N fertiliser use



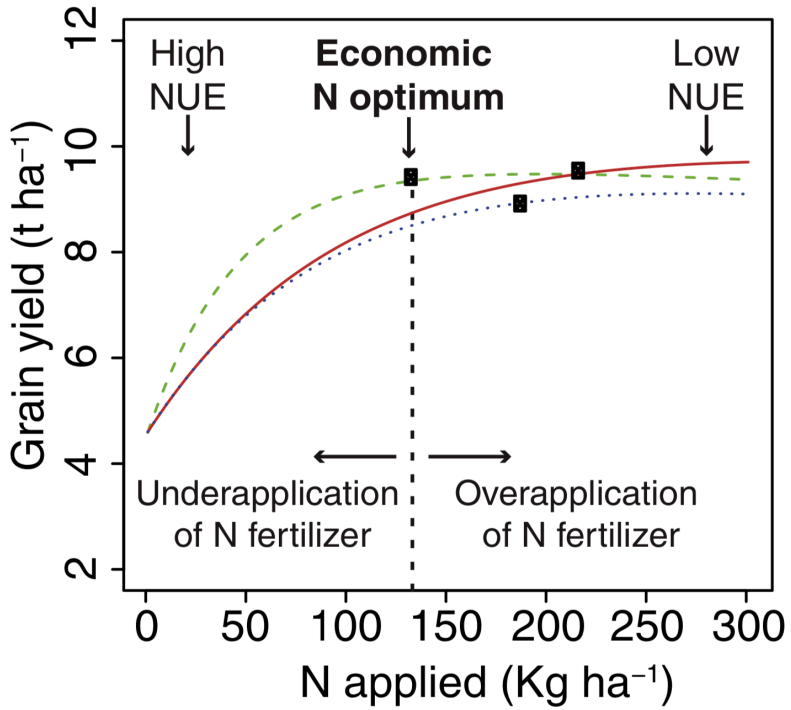


Lu and Tian (2017, Earth Syst Sci Data)

The challenge is to find the balance between N supply and demand



Defining N responsiveness



N responsiveness, defined as the capacity of plants to induce morphological and physiological changes according to external N availability, is a trait that can be selected for to enable the development of low N requirement cereal crop.

Swarbreck et al. (TiPS, 2019)

Exploring N responsiveness in the WGIN Diversity trial dataset

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Release of compiled yield and NUE data for WGIN Diversity trial, 2004-2019

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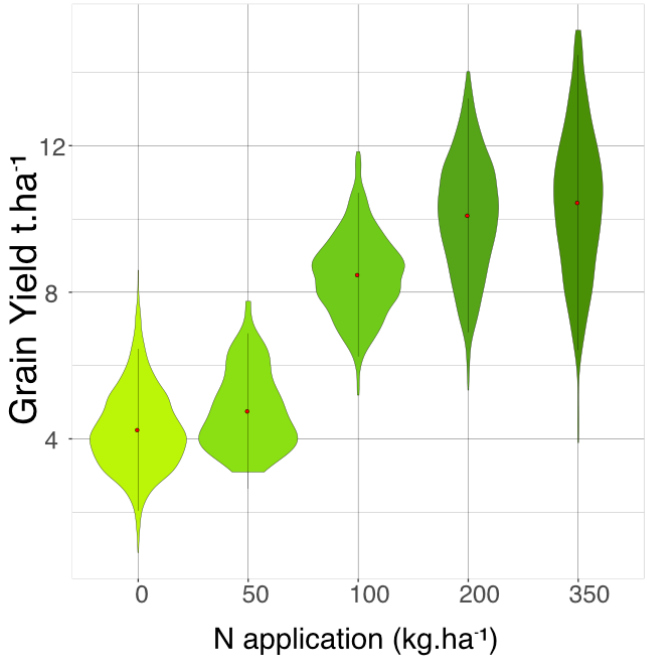
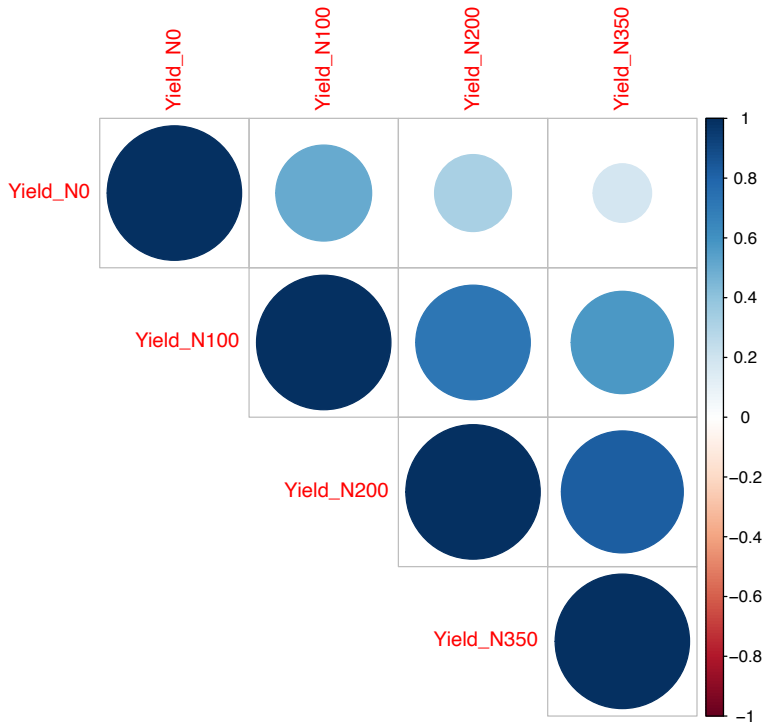
The Wheat Genetic Improvement Network (WGIN) germplasm diversity trial is an example of a multi-variety, multi-N treatment series of trials conducted over multiple years. Data from the initial years (2004-2008) of these trials reported variation in yield and N-responses and contributing physiological processes (Barraclough et al. 2010; 2014). The trials have continued to the present date and have involved a large panel of modern commercial hexaploid wheats (varieties introduced between 1964 and 2016) and **data has been compiled for trials from 2004-2019** and is available on this website. In most years there were four N rates, from zero to 350 kg N/ha/yr, which represents no input through to excess applied N. All trials were conducted following local commercial agronomic practice, at the Rothamsted Farm in Hertfordshire in the UK. Whilst more than 60 varieties were examined in total, a smaller subset of 15 core varieties have been grown for most years.

All data can be accessed by following this link.



- A total of 45 wheat varieties/lines
- tested under 4 N rates (0, 100, 200 and 350 N kg.ha^{-1}, with 50 N kg. ha^{-1} was tested in 2004),
- from 2004-2019

Positive correlations amongst yield decreases as difference in N supply increases



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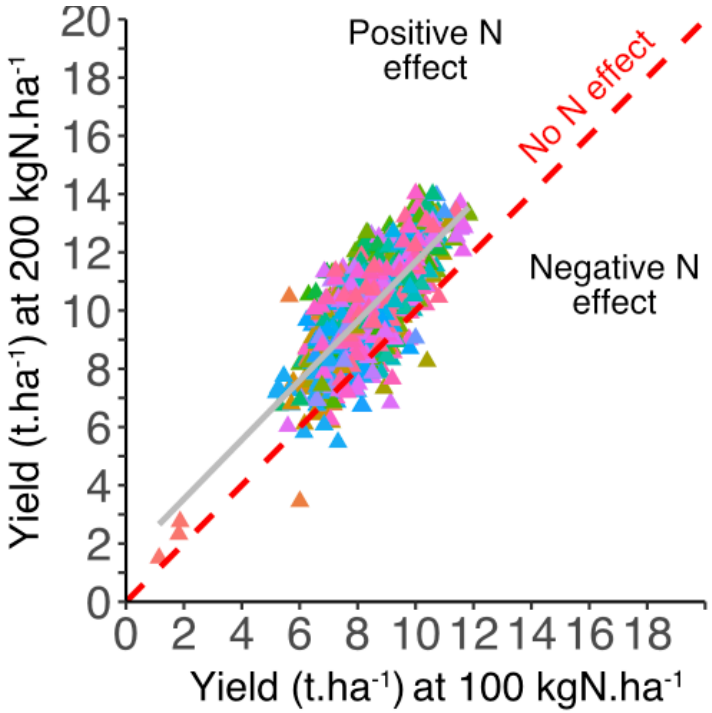
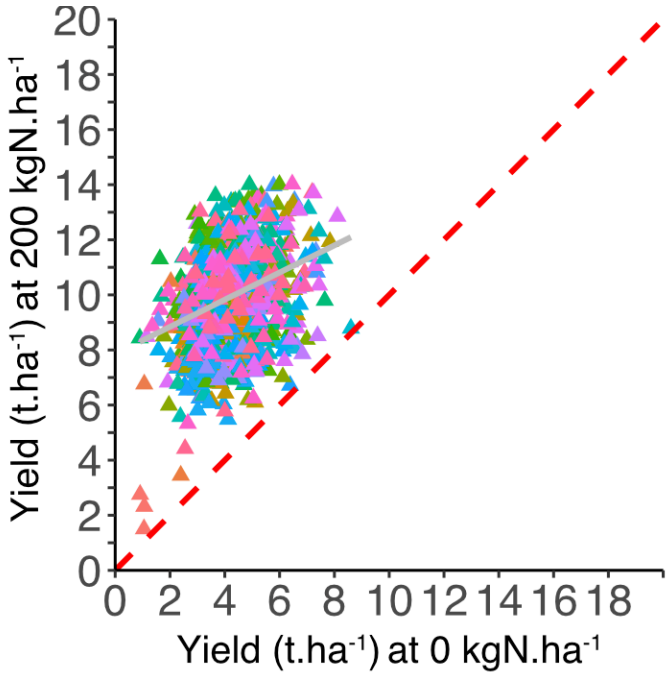
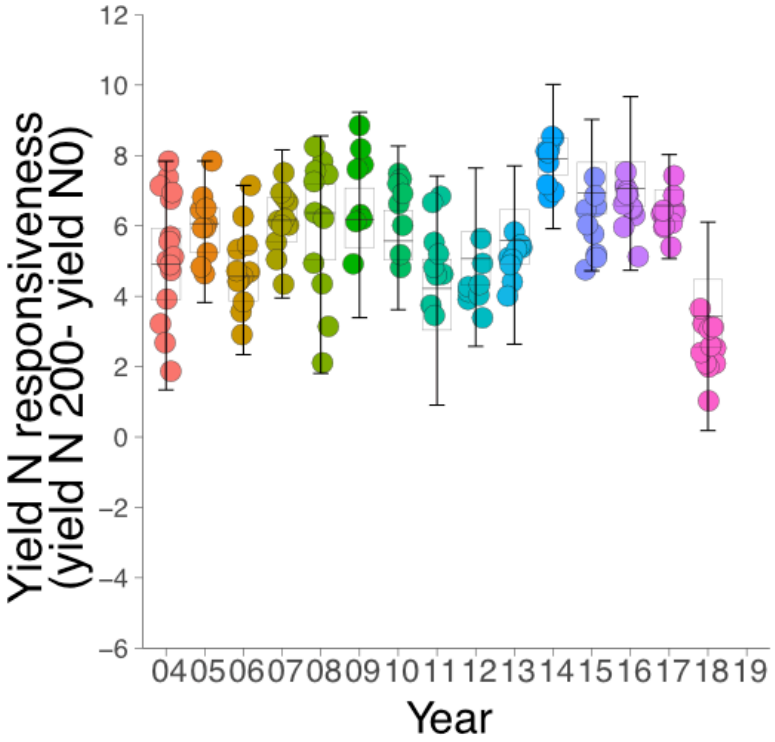


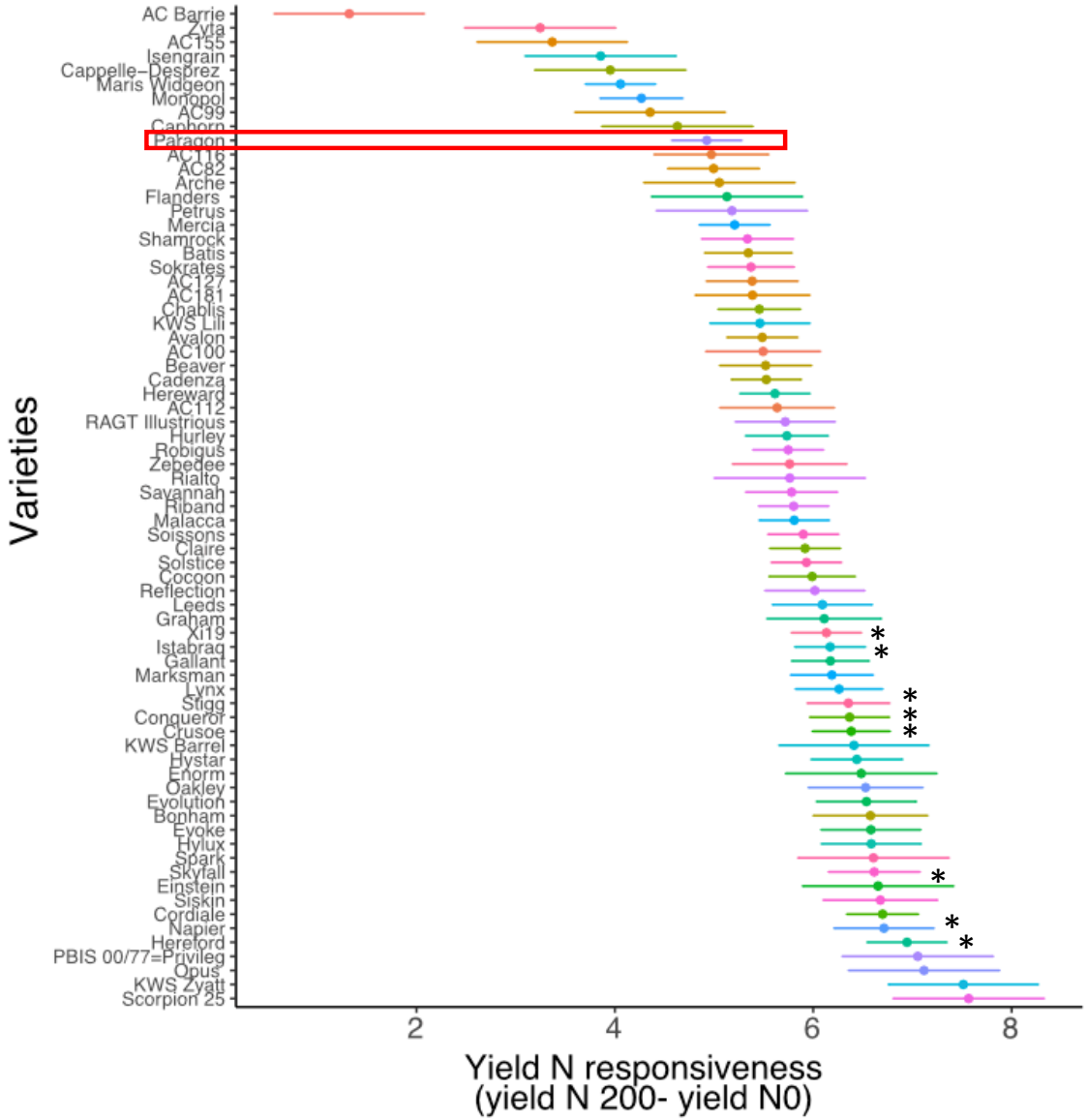


Year to year variation in N responsiveness

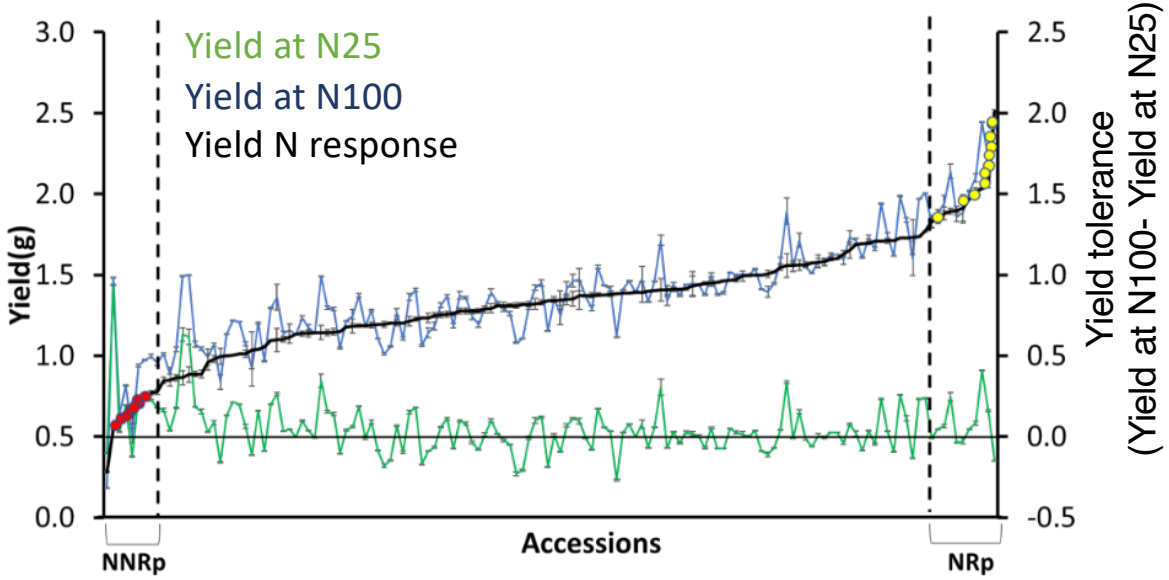


Varietal differences in N responsiveness

- Heritability H^2c= 0.74
- No strong pattern related to year of registration
- No strong pattern related to NABIM group

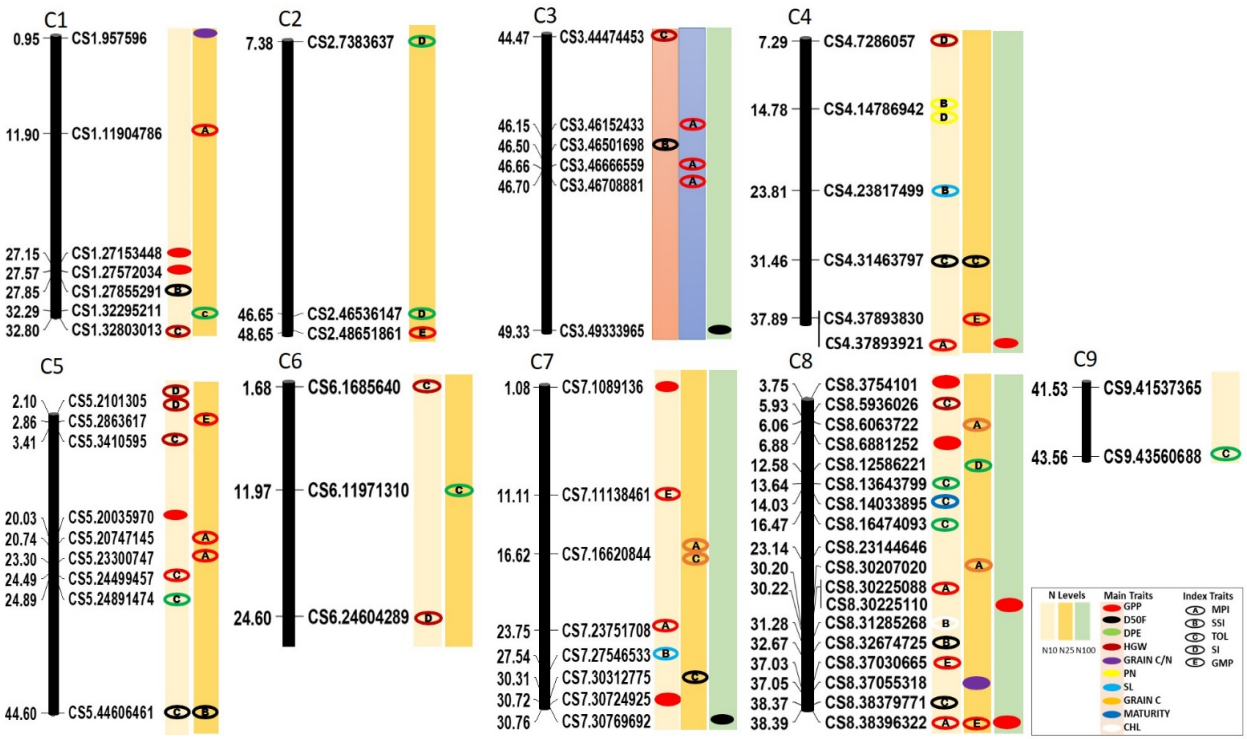


Defining N responsive (NRp) and N non-responsive (NNRp) accessions in *Setaria italica* (L.)



Bandyopadhyay et al. JoR 2022

Genetic markers for N responsiveness in *S. italica*



- 68 non-redundant significant marker traits associations (MTAs)
  - 13 associated with main traits
  - 55 associated with index traits

- 22 non-redundant MTAs associated with grain number per plants

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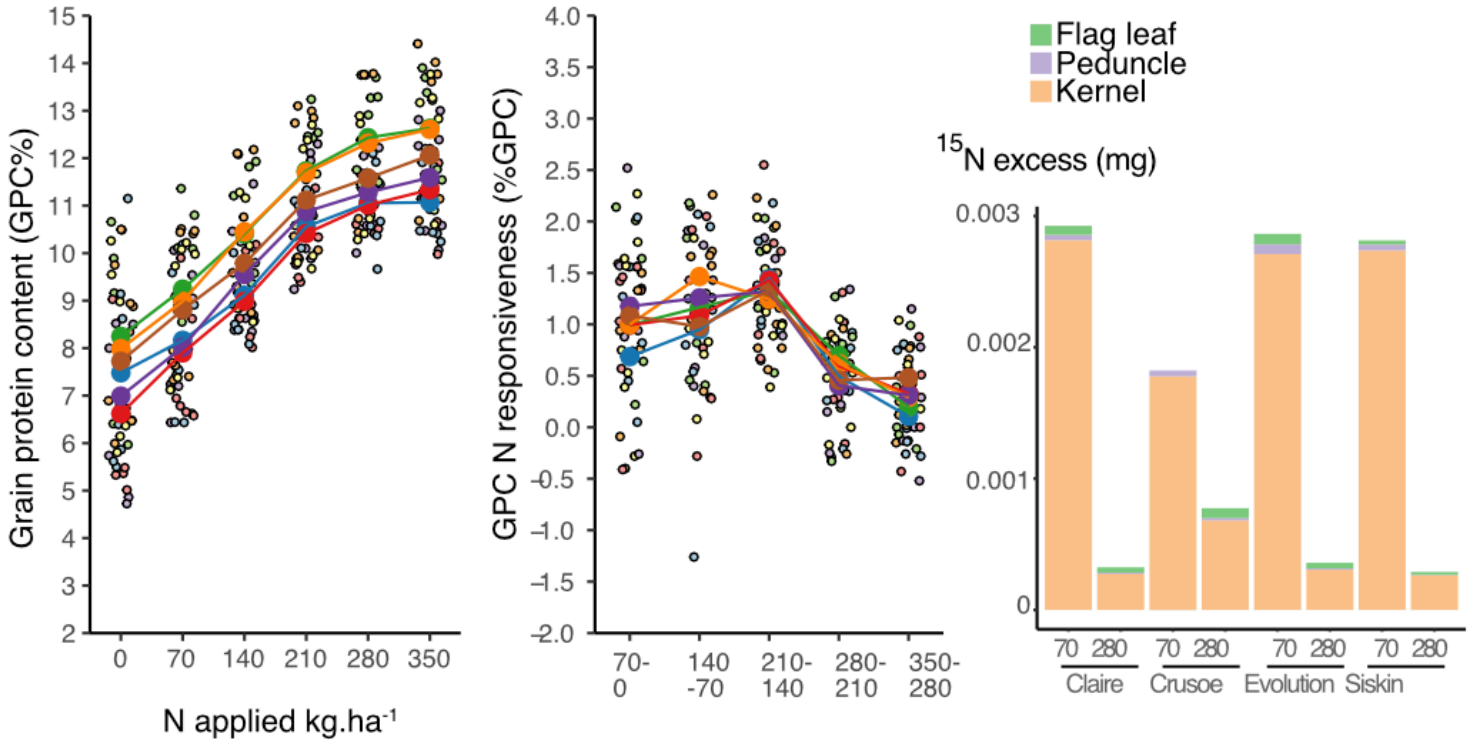
N responsiveness decreases with increasing N availability



Summary

- Lowering N requirement while maintaining yield and grain quality is necessary to achieve sustainable wheat production
- Considering N responsiveness and its genetic underpinning can provide a way of selecting varieties with lower N requirement
- The use of derived indices highlighted new areas of genomes potentially relevant to selecting high N responsive varieties.
- N responsiveness provides a framework for producing low N requirement crops, which enables the translation of fundamental work into crop.

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