Sustainable winter rapeseed production by breeding for NUE and by optimizing its cultivation system

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GCIRC, Cambridge, 09.04.2025

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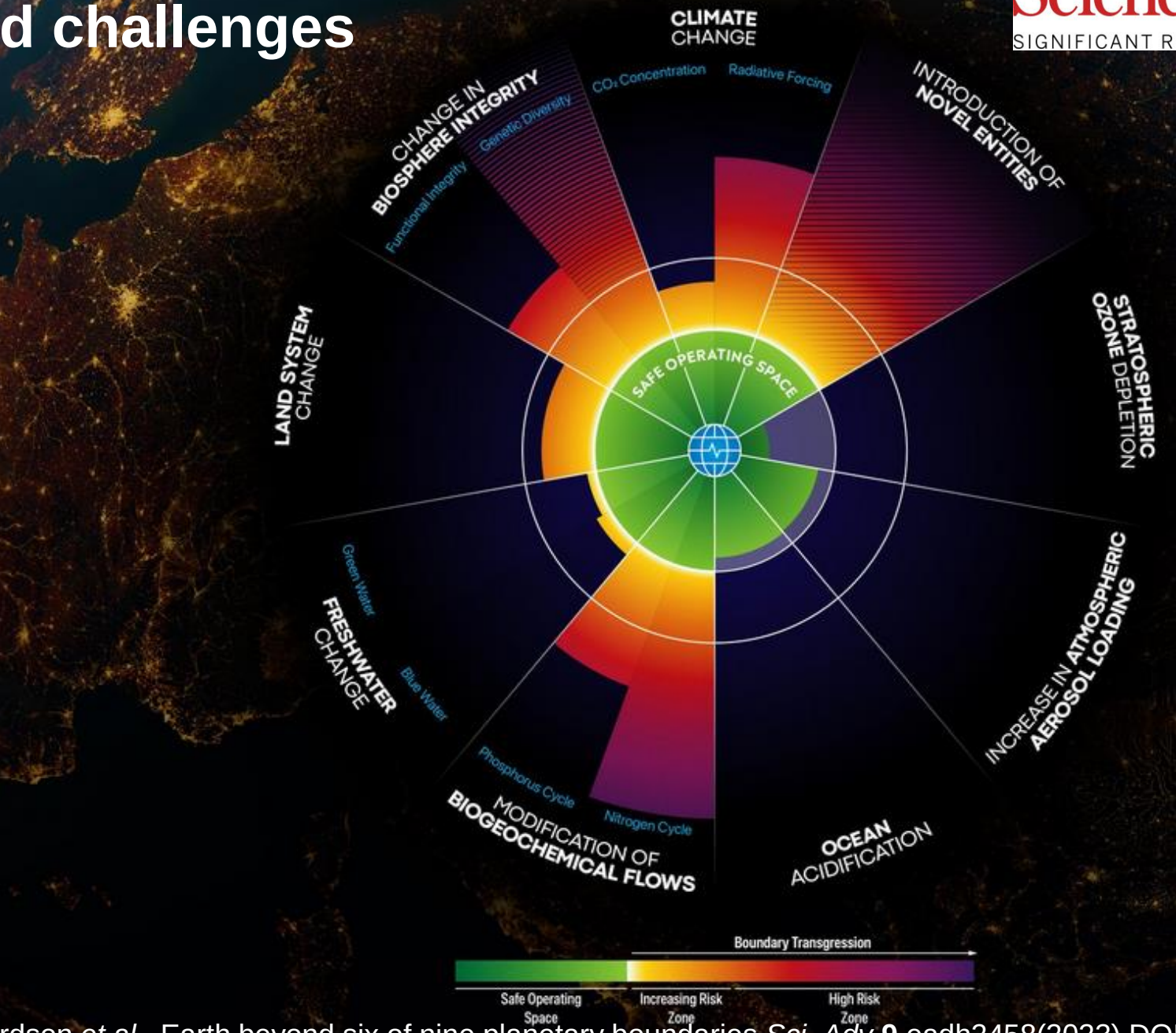
Federal Research Centre for Cultivated Plants


Photo: Daniel Valle Torres

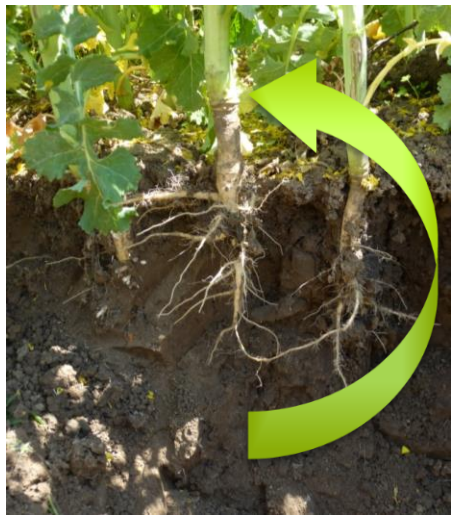
Our grand challenges

Science Advances
SIGNIFICANT RESEARCH. GLOBAL IMPACT
AAAS



Katherine Richardson *et al.*, Earth beyond six of nine planetary boundaries.*Sci. Adv.***9**,eadh2458(2023).DOI:10.1126/sciadv.adh2458

What is NUE?



N-Uptake

$$\frac{\textit{N in Biomass [kg]}}{\textit{N fertilized [kg]}}$$

×

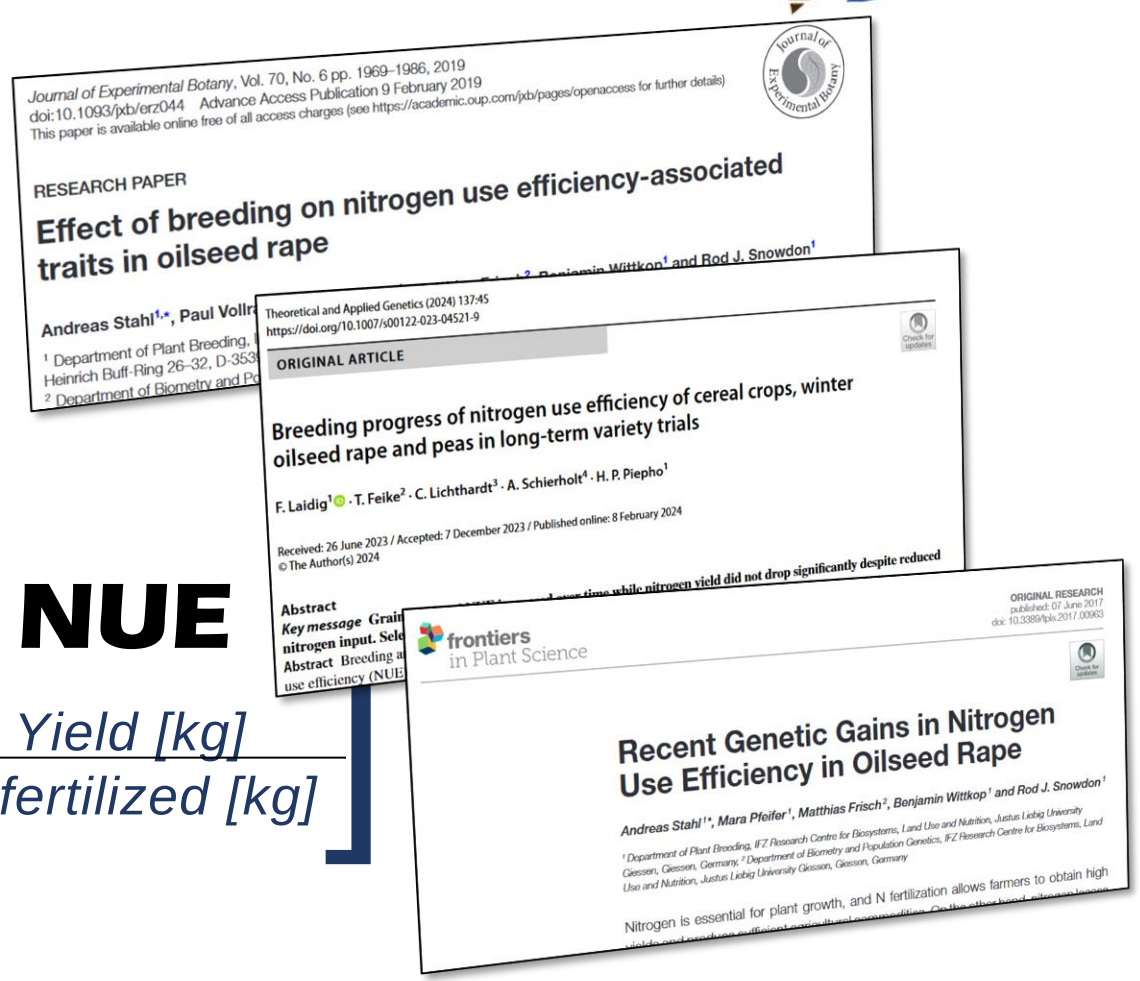
N-Utilization

$$\frac{\textit{Yield [kg]}}{\textit{N in Biomass [kg]}}$$

=

NUE

$$\left[\frac{\textit{Yield [kg]}}{\textit{N fertilized [kg]}}\right]$$



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RESEARCH PAPER

Effect of breeding on nitrogen use efficiency-associated traits in oilseed rape

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ORIGINAL ARTICLE

Breeding progress of nitrogen use efficiency of cereal crops, winter oilseed rape and peas in long-term variety trials

F. Laidig[1] · T. Feike[2] · C. Lichthardt[3] · A. Schierholt[4] · H. P. Piepho[1]

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Abstract
Key message Grain… nitrogen input. Sele…
Abstract Breeding a… use efficiency (NUE…

…time while nitrogen yield did not drop significantly despite reduced

frontiers in Plant Science

ORIGINAL RESEARCH
published: 07 June 2017
doi: 10.3389/fpls.2017.00963

Recent Genetic Gains in Nitrogen Use Efficiency in Oilseed Rape

Andreas Stahl[1], Mara Pfeifer[1], Matthias Frisch[2], Benjamin Wittkop[1] and Rod J. Snowdon[1]*

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Nitrogen is essential for plant growth, and N fertilization allows farmers to obtain high …

Diagram: Andreas Stahl

But NUE interacts strongly with E & M

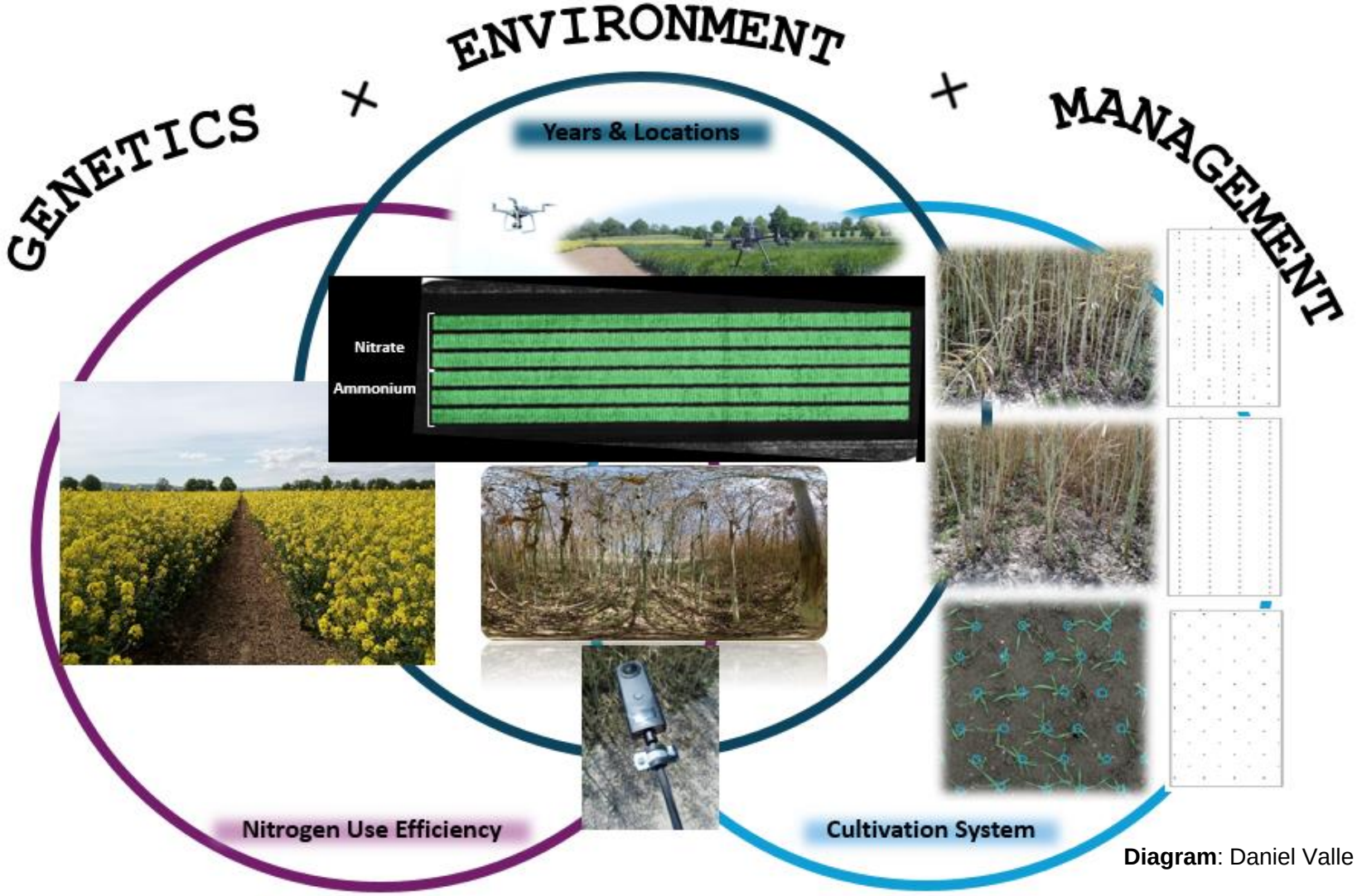


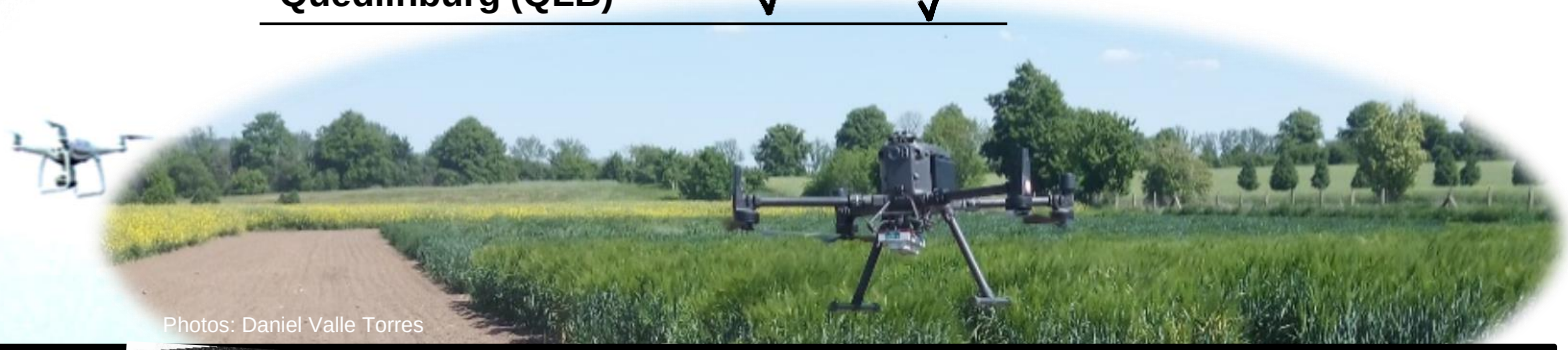
Diagram: Daniel Valle Torres

Consequence: assess, understand and predict G×E×M Interaction is desired!

Materials and experimental setup

Multi-environment trials
300 winter oilseed rape F1-testhybrids

Location	NO_3^-	NH_4^+
Hohenlieth (HOH)	✓	✓
Brunswick (BS)	✓	✓
Quedlinburg (QLB)	✓	✓



Fertilizer	Description
PIAGRAN® Pro	**Nitrate-based** = Urease inhibitor
ALZON® neo-N	**Ammonium-based** = Urease inhibitor + nitrification inhibitor

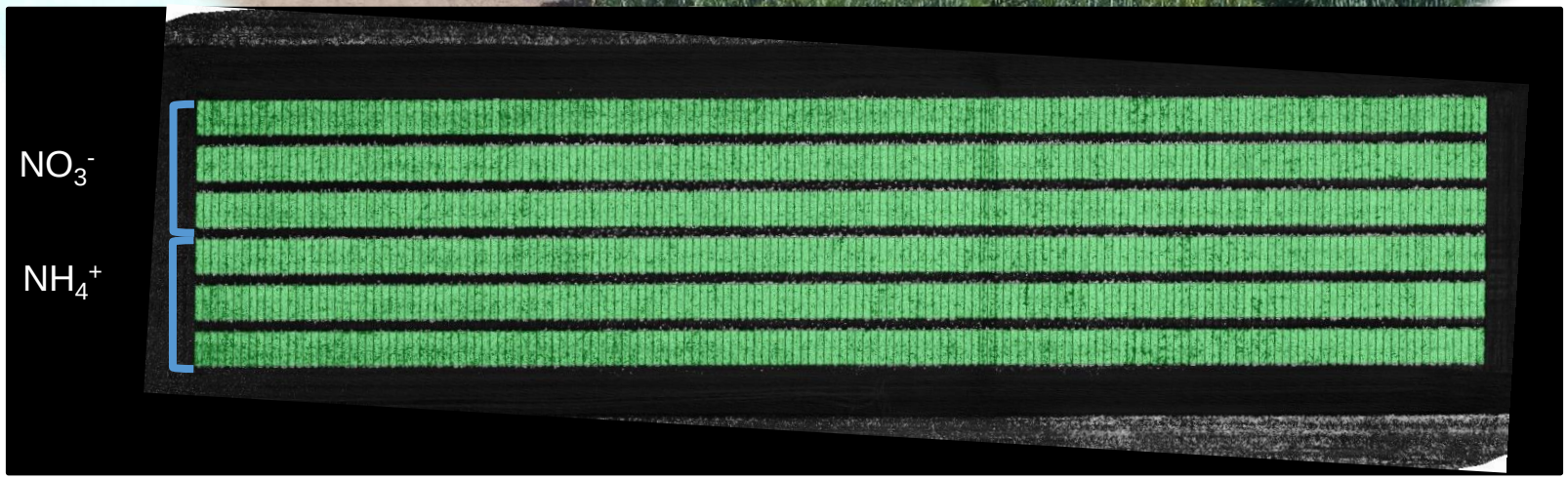


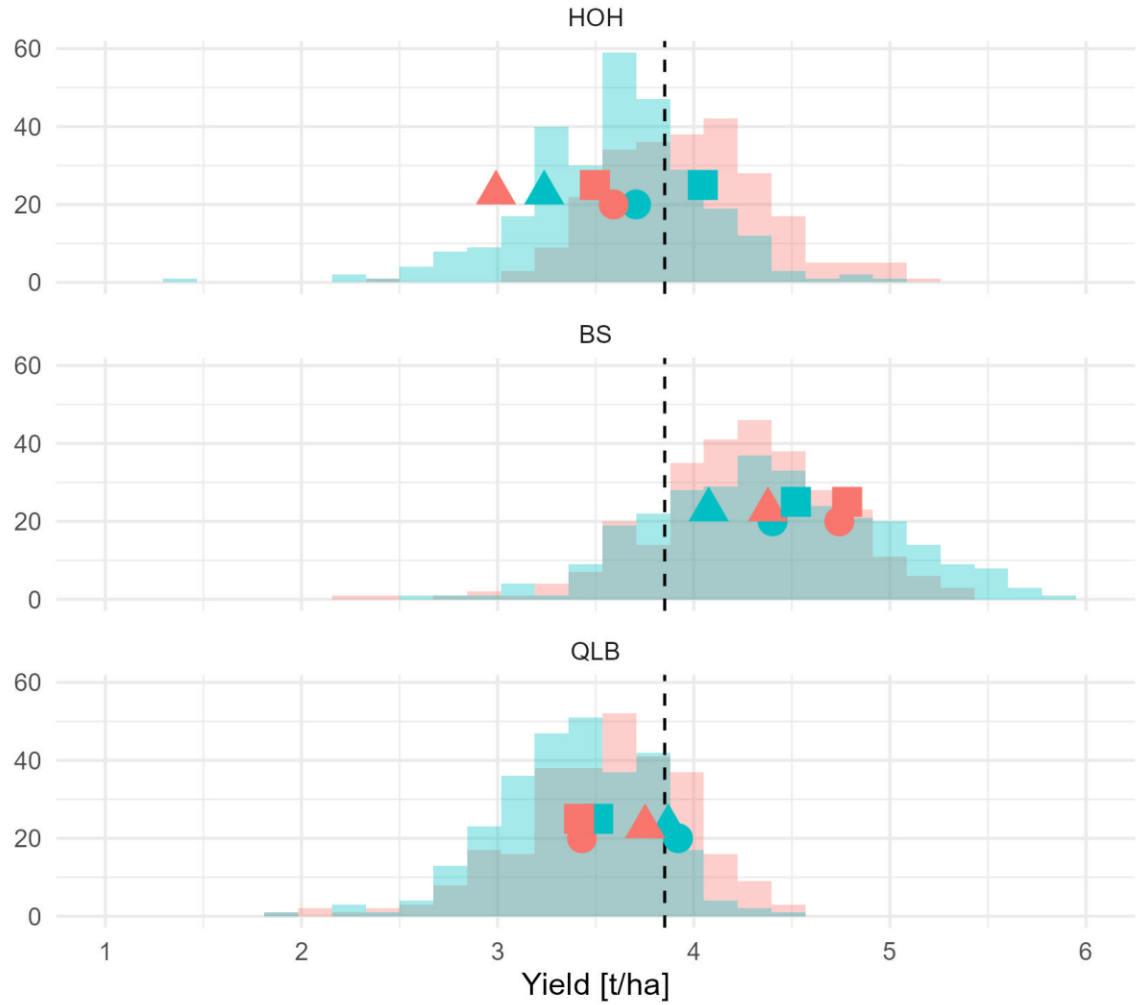
Photo: Sebastian Warnemünde, - JKI

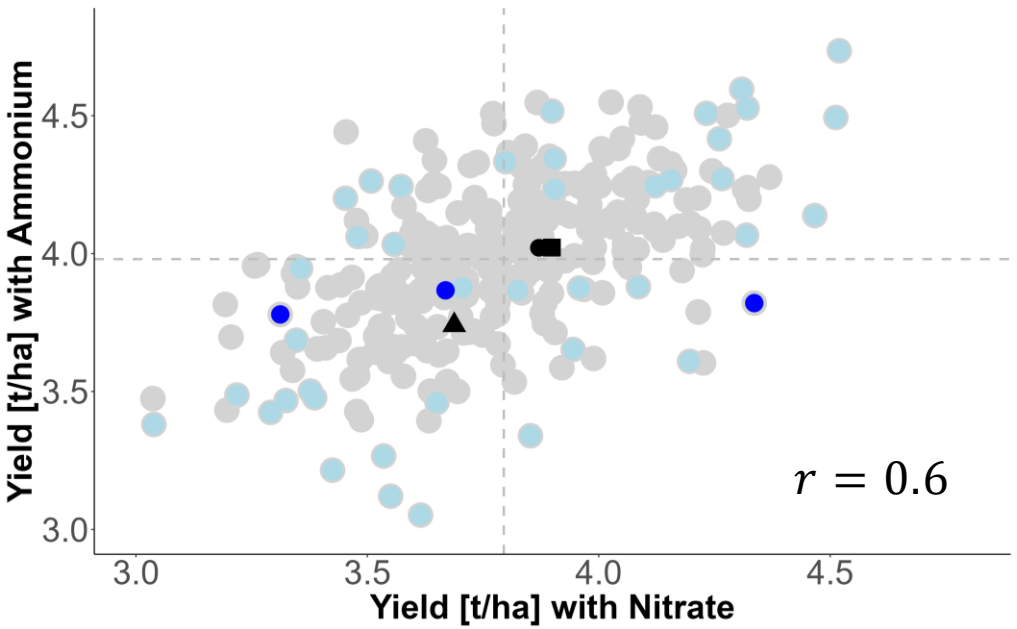
Yield adjusted means across locations 2023-2024

140 kg N/ha

100 kg N/ha

100 kg N/ha





Spatial distribution of plants and NUE

- Sowing techniques
- Sowing densities: 50 *vs* 25 seed/m²


Photo: Daniel Valle Torres

Direct drill


Photo: Daniel Valle Torres

Single seed

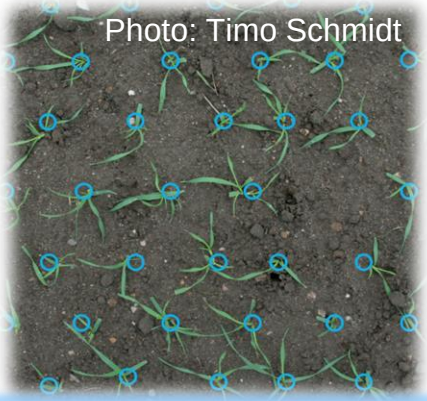
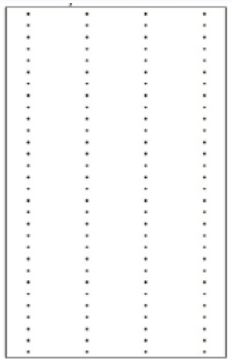
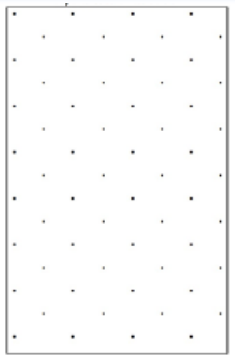


Photo: Timo Schmidt

Equidistant





Diagrams: Daniel Herrmann

Kottmann et al. 2019


Flight: Martin Kock

Multiple data sources

Genome wide marker data:
15k SNP chip

Agronomical traits:
Yield, flowering time, plant height, etc.

Reflectance measurements:
Multispectral (MS) camera
360° RGB images

Near-infrared spectroscopy (NIRS):
Protein, oil, quality parameters, etc.

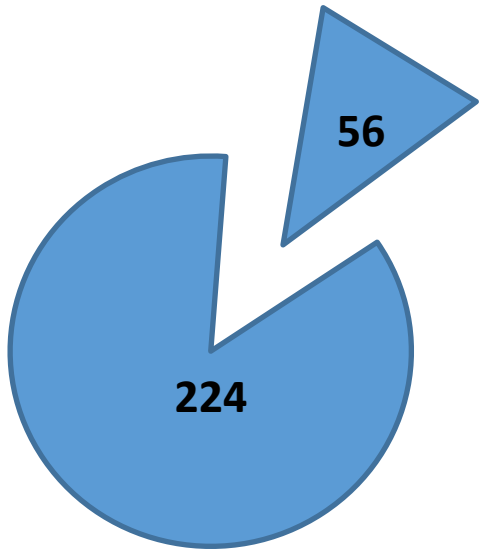
Photos: Daniel Valle Torres

PHENO-INSPECT

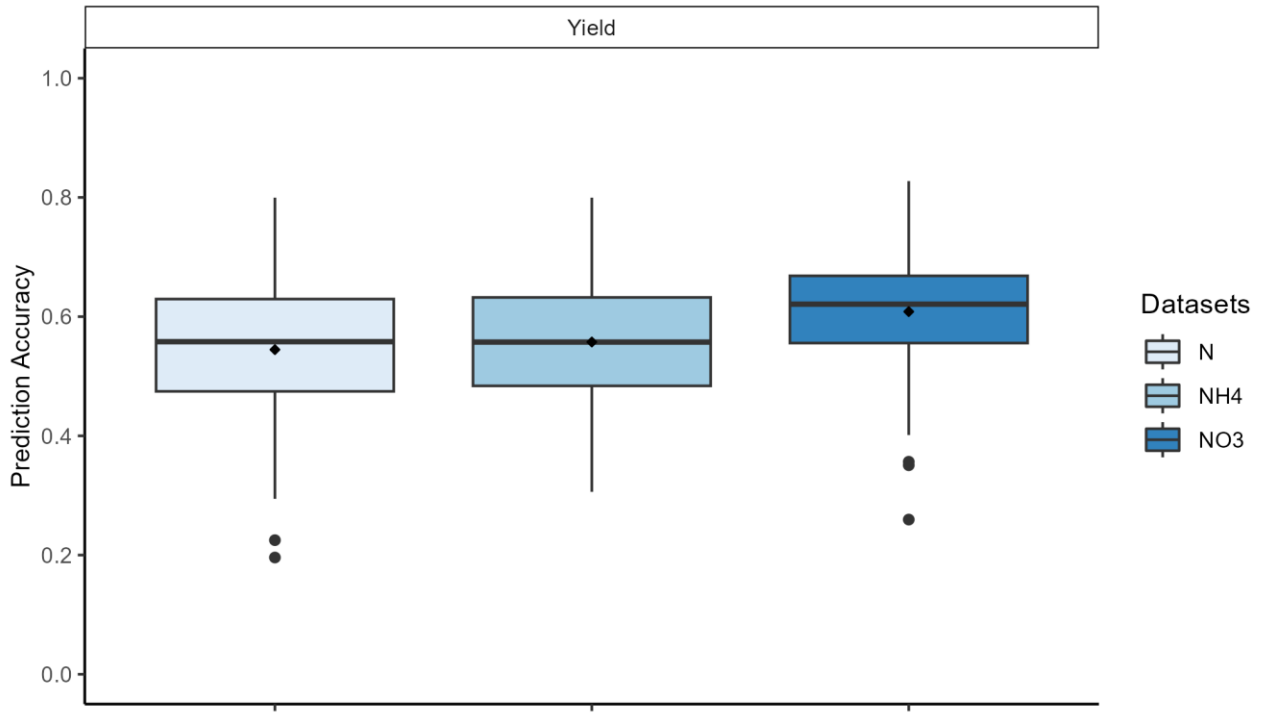
Predictive breeding

- Evaluate multi-layer genomic and phenomic prediction

- 280 individuals with genotypic data
- GBLUP model (kinship matrix)
- 5-fold cross validation
- 10 repetitions



Genome wide marker data: 15k SNP chip

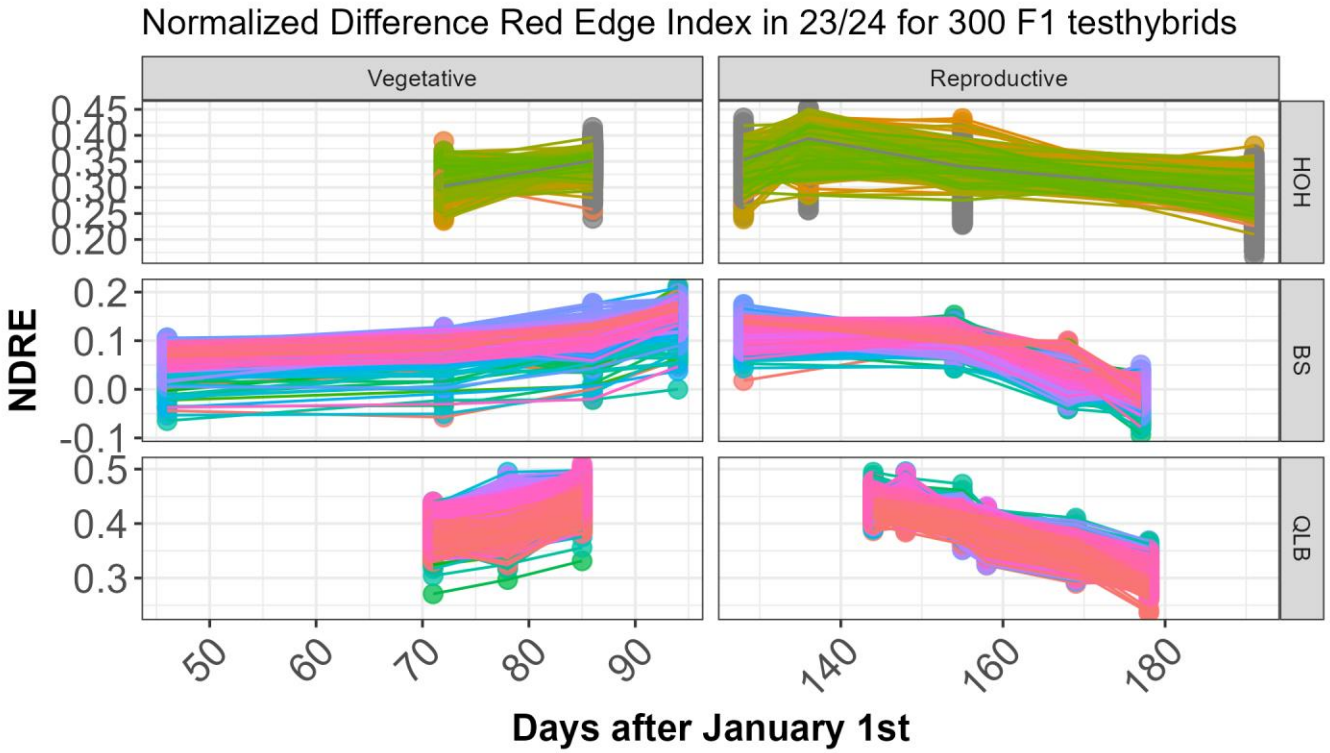


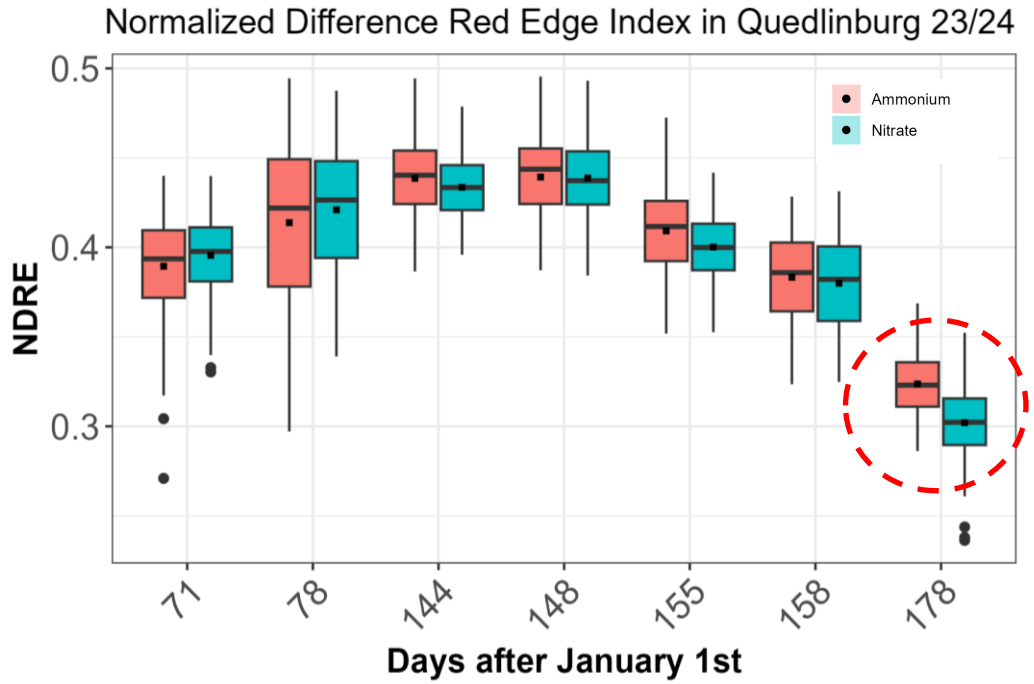
$$PA = cor(estimated\ values, observed\ phenotypes)$$

Preliminary data for one year. Work in progress

MS reflectance measurements

Sebastian Warnemünde-JKI





G × N fertilizer interaction for stay green?

Preliminary data from one year. Work in progress

Outlook

- Diverse genetic and physiological response observed in first year results

- Combining genomic and phenomic prediction is promising to reduce the gap in phenotype-to-genotype link and increase prediction accuracy for NUE-related traits

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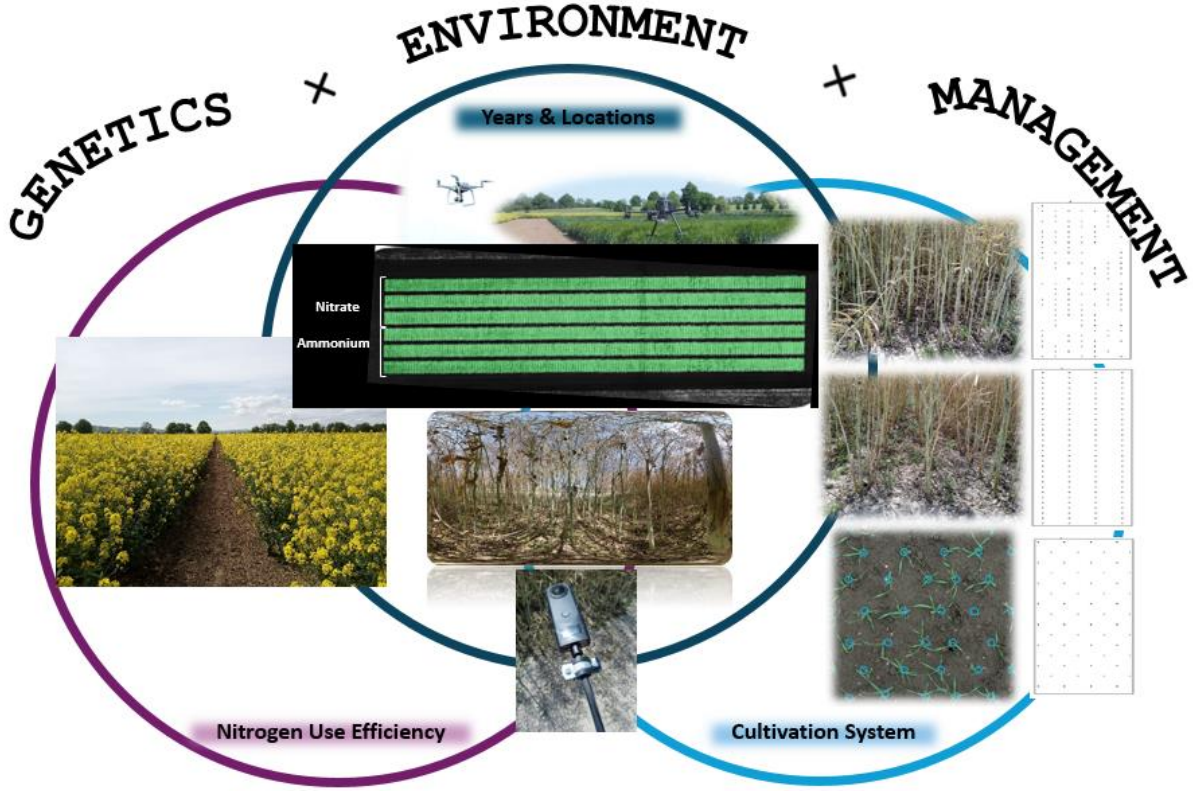

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