ModelLowN: Innovative modelling of nitrogen use-efficiency in winter oilseed rape

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Giessen Plant Breeding

Model Low N

# High-throughput phenotyping and genetic analysis to promote breeding for enhanced nitrogen use efficiency in winter oilseed rape

*Katharina Tyson, Rod Snowdon, Andreas Stahl*

Department of Plant Breeding, International Research Center for Biosystems, Land use and Nutrition, Justus-Liebig-University, Heinrich-Buff-Ring 26-32, 35392 Giessen, Germany

## Objectives

- Development of a high-throughput multispectral sensor-based method for determining nitrogen use efficiency of new winter oilseed rape genotypes in the field
- Compilation of a phenotypic database for analyzing growth dynamics under low nitrogen fertilization
- Improve genetic models to predict genotypic performance and leverage selection models

## High-throughput phenotyping to capture crop dynamics

PARROT BLUEGRASS™ quadcopter for agricultural analyses; Integrated PARROT SEQUOIA™ multispectral sensors

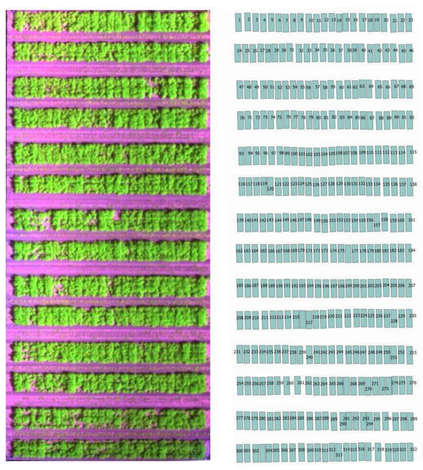
Multispectral sensor records sunlight reflection at the crop canopy.

The GPS-controlled drone periodically captures multispectral images to precisely monitor the development of each genotype.

Vegetation indices (VI) provide information on canopy biomass, leaf area, and nitrogen status.

## Translating sensor information into plant nitrogen status

In a calibration trial of different varieties under a range of nitrogen fertilization treatments, multispectral data and plant samples were collected across developmental stages. Samples were analyzed for nitrogen content and dry mass in the laboratory. VI were calculated from the multispectral data and correlated with nitrogen content data.



*A multispectral orthomosaic (left) provides localized information on reflectance at multiple wavelengths. The reflectance data are extracted with a plot raster (right) in QuantumGIS.*

*Statistical models fitted on calibration data predict crop parameters from VI:*

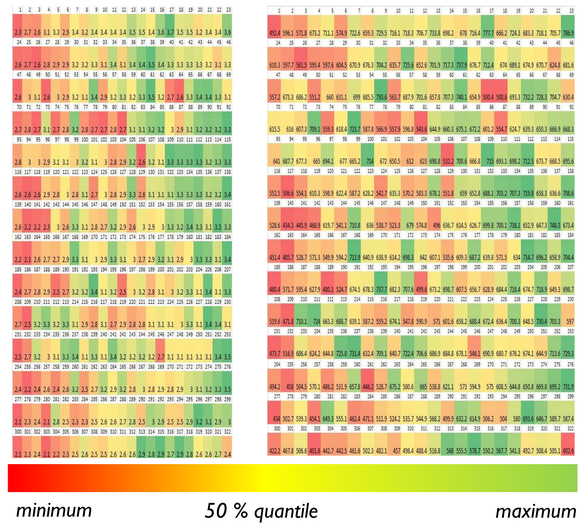
$$Y(c_{Nitrogen}) \sim BBCH\ stage + VI_1 + VI_2 + VI_3$$

$$(R^2_{adj} = 0.92;\ p < 0.001)$$

$$Y(Dry\ mass) \sim BBCH\ stage + VI_1 + VI_2 + VI_3$$

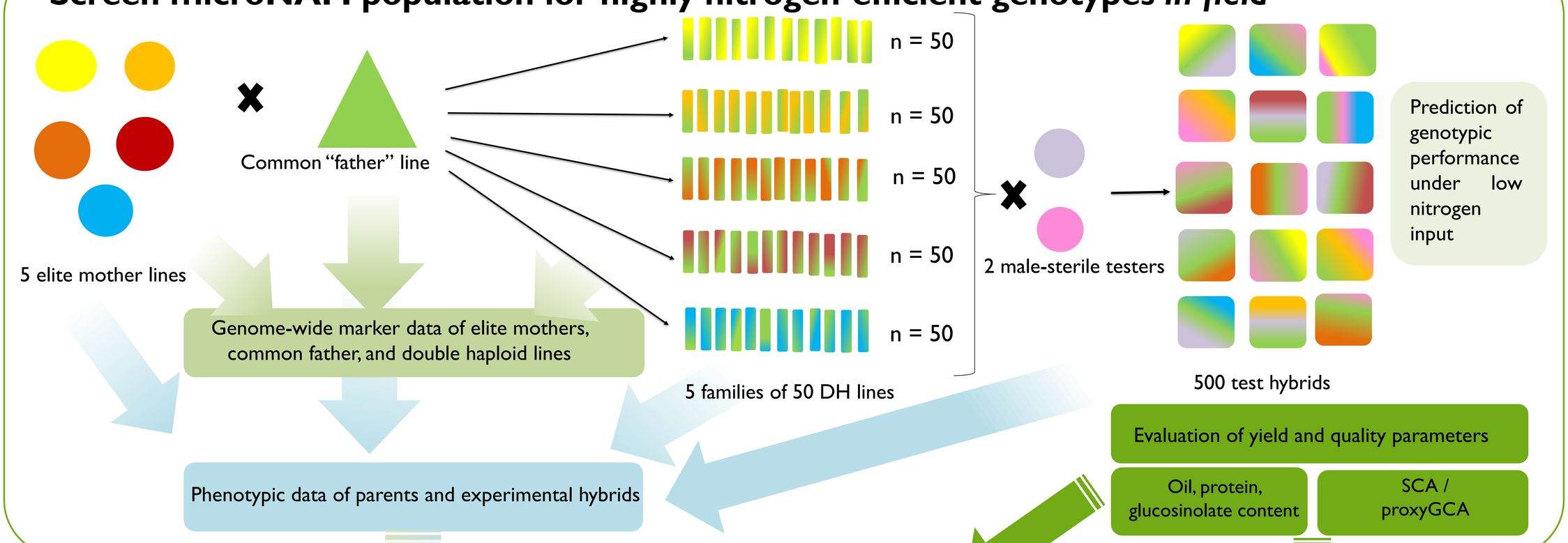
$$(R^2_{adj} = 0.82;\ p < 0.001)$$

$$Nitrogen\ uptake = c_{Nitrogen} * Dry\ mass$$

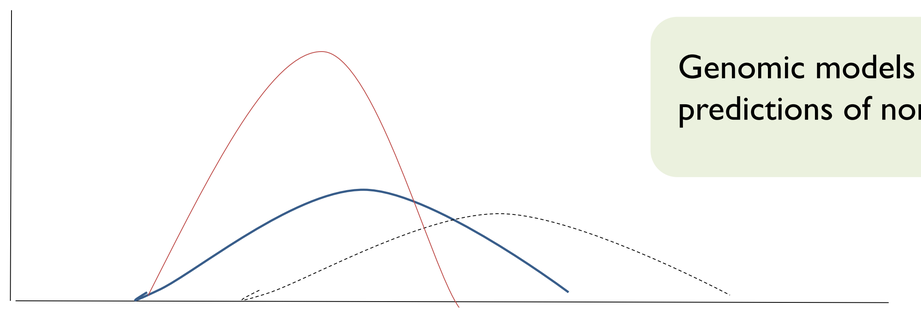



*Predicted nitrogen concentration [%] (left) and shoot dry mass [g/m²] (right) values for each plot. The color scale indicates genotypic differences and spatial trends.*

## Screen microNAM population for highly nitrogen-efficient genotypes *in field*




## Modelling genotypic performance under low N-fertilization



Genomic models should allow performance predictions of non-phenotyped hybrids

## Examining the genomic basis of heterosis

- Mapping of haplotypes associated with heterotic effects
- Genome-wide association studies
- Identification of nitrogen-use efficiency candidate QTL

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*Contact: Katharina.Tyson@agrar.uni-giessen.de*