High Throughput Phenotyping as a Future Plant Breeding Tool at Graminor AS

NPPN Virtual Field Day 2020

Jon Arne Dieseth

Graminor AS

- Only plant breeding company in Norway
- Should supply the Norwegian farmer with the best possible adapted varieties of important agricultural crops
- Breeding programs:
  - Cereals (Spring barely, Oat and Spring wheat)
  - Forage crops
  - Potato
  - Fruits and Berries
- Representing foreign plant breeders in Norway:
  - Testing foreign material

13 crops in 6 breeding programs

Graminor
Njøs

Graminor
Bjørke

Graminor
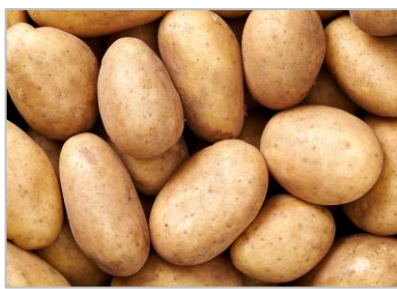
Present Phenotyping

- Yield trails
- Field notes
  - Earliness
  - Diseases
  - Lodging
  - Appearance
- Visual selection in early
  generations
- Laboratory quality testing

- Time and resource demanding
- Costly
- Capacity and accuracy depend on weather
- Different events occur simultaneously
  - Not possible to do all registrations

New phenotyping tools are wanted

- Higher capacity for data collection

- Lower costs

- Higher precision

- Observation of not viable traits

The breeders equation for genetic gain

selection intensity   selection accuracy

genetic gain over time   genetic variance

$$R_t = \frac{ir\sigma_A}{y} \leftarrow \text{years per cycle}$$
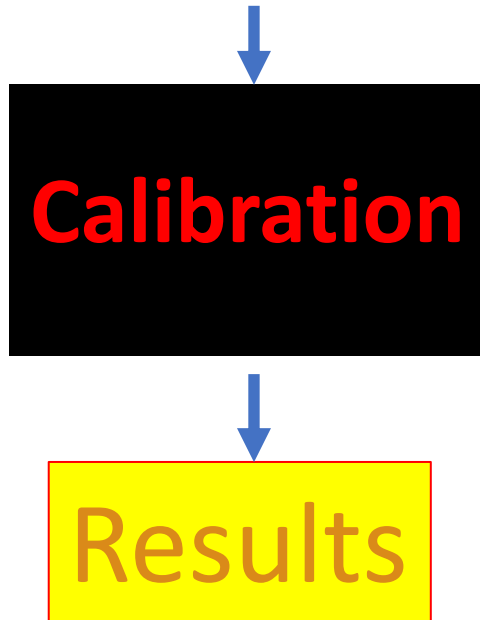
Graminor

Implementation of high throughput phenotyping in Graminor AS

NIR/NIT analices of whole grains

• Measurements of reflectance/transmittance in 100 wave lengths

Measurements by Infratec

↓

Calibration

↓

Results

Implementation of high throughput phenotyping in Graminor AS

Drone mounted RGB camera

• Measurements of reflection of red, green and blue light

Measurements by RGB camera

↓

Calculation of indices
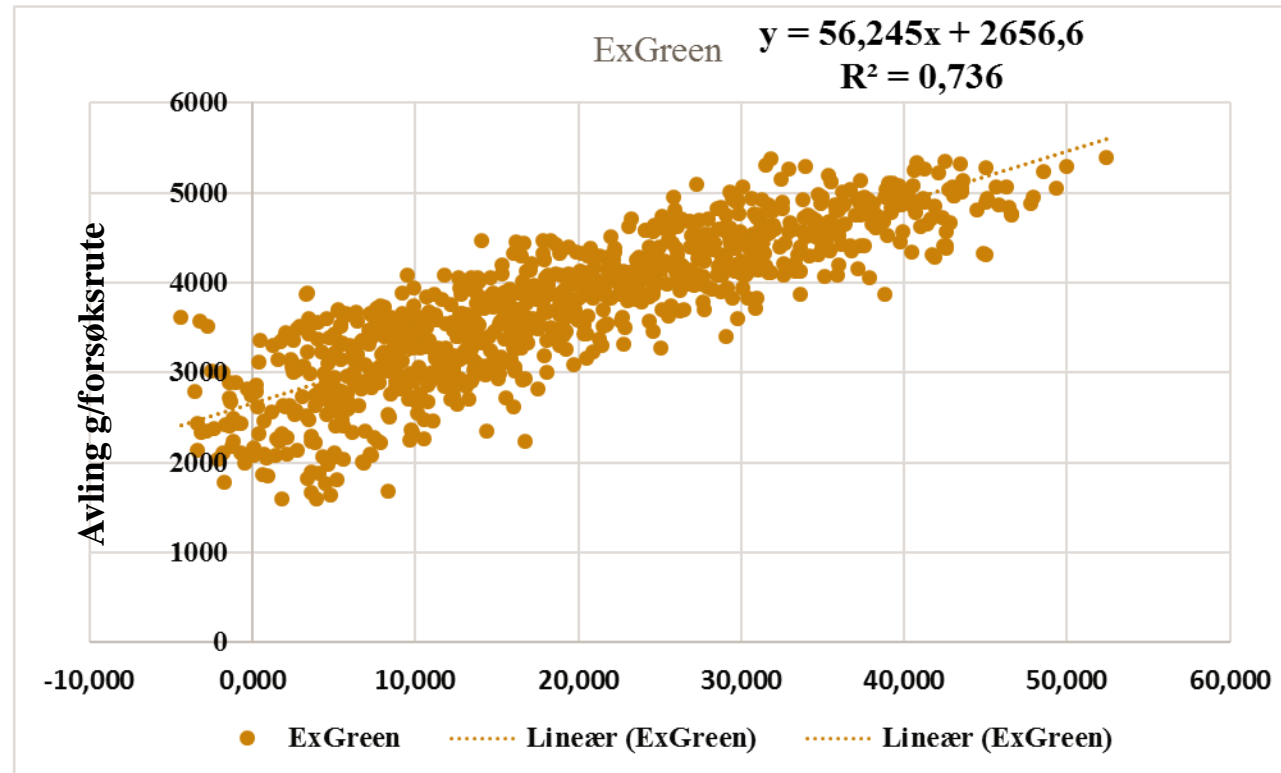
↓

Indices correlated to biomass

Experience with the use of drone for HTP

- Some interesting results that indicate the potential for the method
  - Highly positive correlation between Excess Green Indices and grain yield in wheat
  - Highly negative correlation between nExG and late blight in potato

Graminor

# Correlation between Excess Green Indices and grain yield in wheat

Gihle 30.07.2018

Excess Green Index = 2G - R - B

Experience with the use of drone for HTP

- Some interesting results that indicate the potential for the method
  - Highly positive correlation between Excess Green Indices and grain yield in wheat
  - Highly negative correlation between nExG and late blight in potato
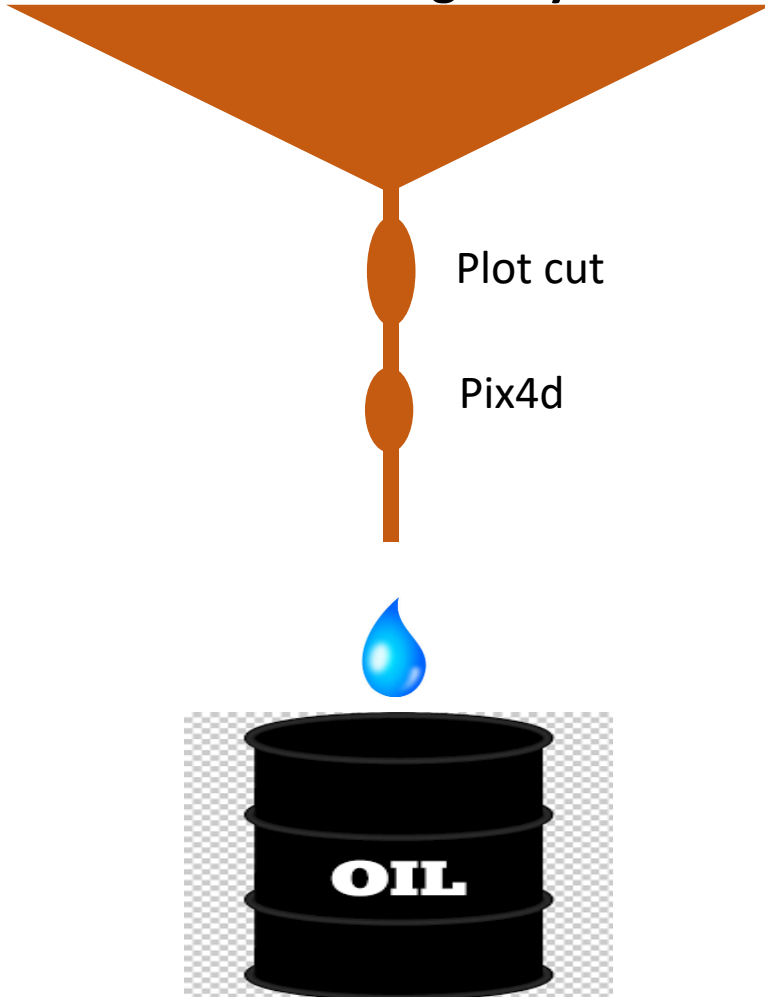
Graminor

Phenomics: Late blight
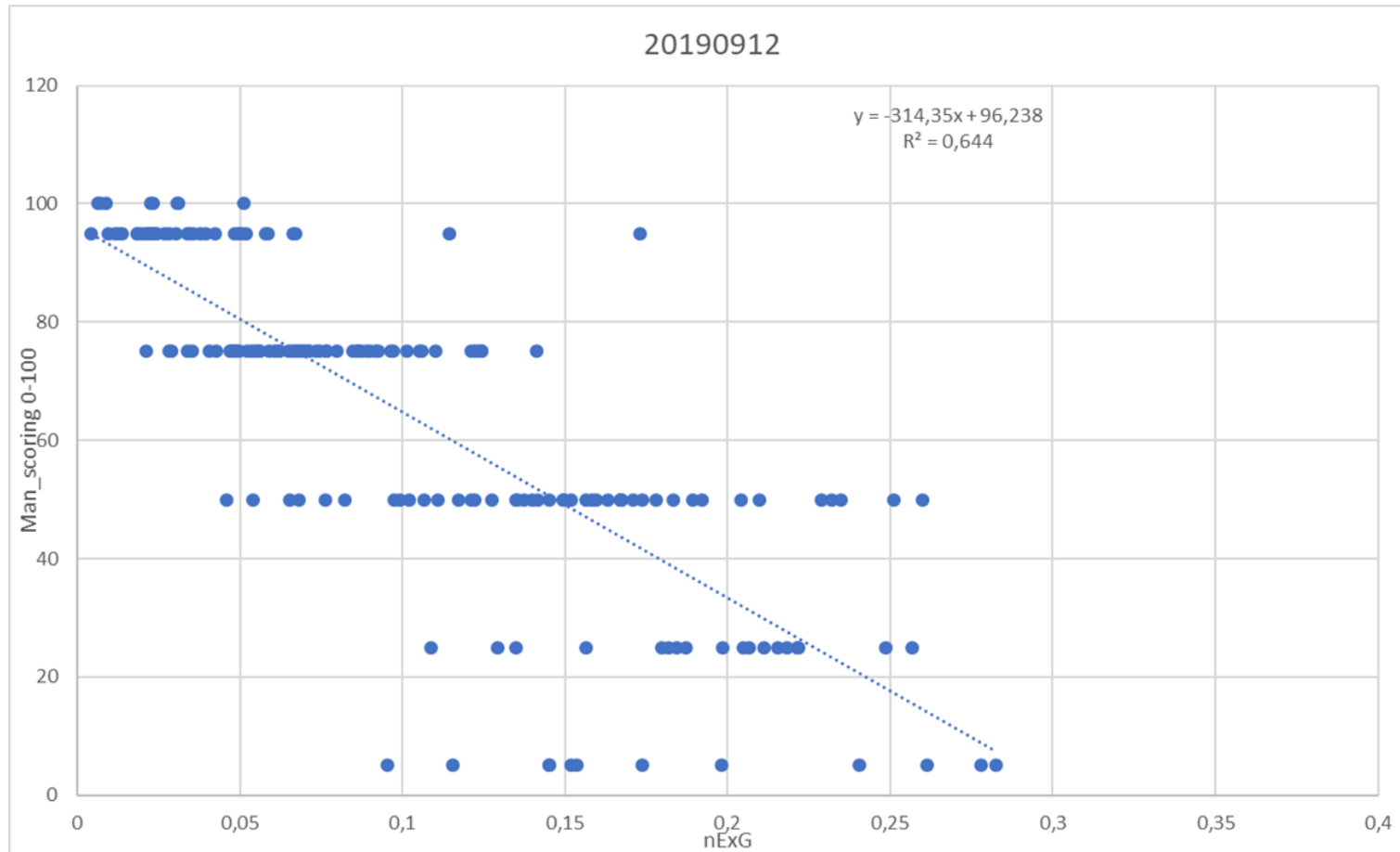
Experience with the use of drone for HTP

- Training of people for routine flights are quite easy, but manpower for the data extraction is more difficult

- Variable sun/clouds a big concern for the quality of the images

- Easily very much data that is time and resource consuming to handle, store and process

- Present statistical breeding software not fitted to utilize large amounts of data from HTP

Graminor

Data pipeline from HTP with drone

**Collection of images by drone**

Plot cut

Pix4d

OIL

- Collection of «big data»

- Time consuming adjustments of images

- Large computer capacity needed

- Outcoming data difficult to integrate with other results

Graminor

Future use of HTP in Graminor

- Working to overcome the logistic problems connected to extraction and analyzes of HTP data
  - An automated data pipeline is needed
- Use HTP data (indexes) as a covariates to improve the quality of field data and decrease the importance of experimental error in variable experimental fields
- Will collect experience in use of calculated indexes as supportive tools for selection in advanced yield trails
- If successful, expect to use HTP data as a main tool in selection in earlier generations, first in wheat

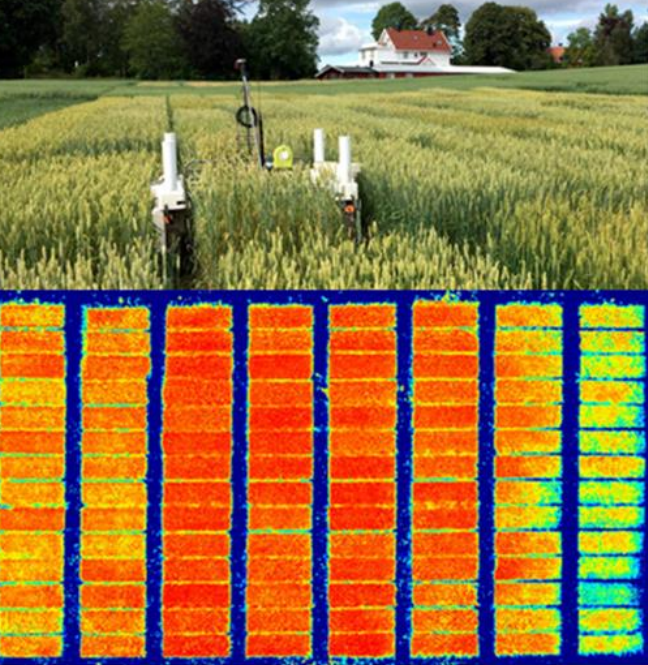Grain yield prediction accuracies within and across years
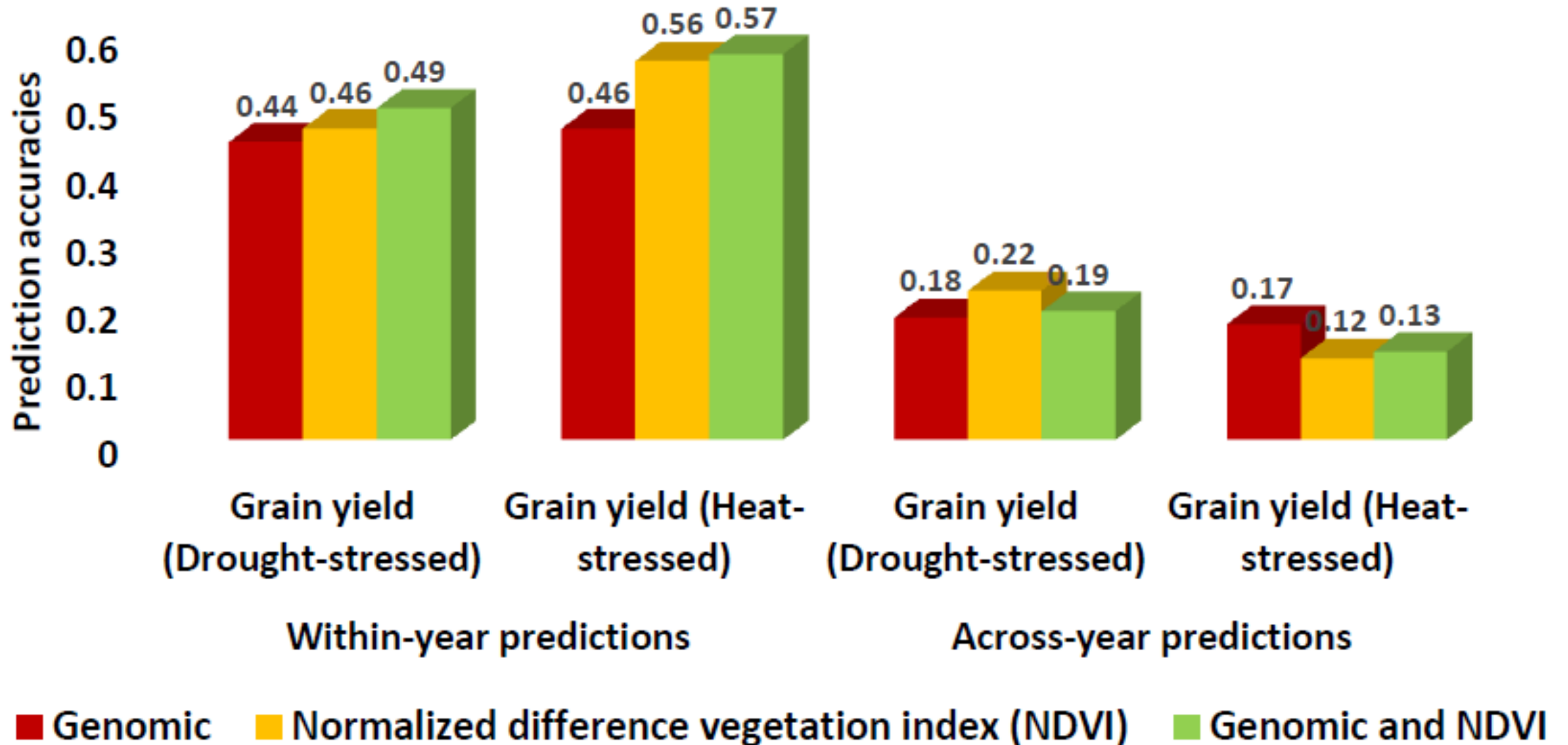
(Data from CIMMYT)

Additional phenotypic trait that should be possible to measured with drone mounted sensors

- Winter survival
- Plant height
- Heading and maturity
- Growth curve
- Number of heads
- Disease severity and identification

Phenomics

1. Reliable platforms for high-throughput data capture
2. Building 3D models of field trials and modelling pixel to phenotype relationship
3. Adapting and integrating tools and methods into user-friendly systems

HTP

The Research Council of Norway

Forskningsmidlene for jordbruk og matindustri

Nordic Co-operation

REGIONALE FORSKNINGSFOND

Innovation Norway

skattefunn

NMBU

Graminor

MAKING VIEW

BOSTON UNIVERSITY

CIMMYT International Maize and Wheat Improvement Center

Forskningsmidlene for jordbruk og matindust

Thank you for your attention!