Characteristics of environmental and genotypic variation for wheat in the National Variety Trial

Bangyou Zheng, Pengcheng Hu, Javier Fernandez, Scott Chapman

CSIRO Agriculture and Food, The University of Queensland

CSIRO Agriculture and Food
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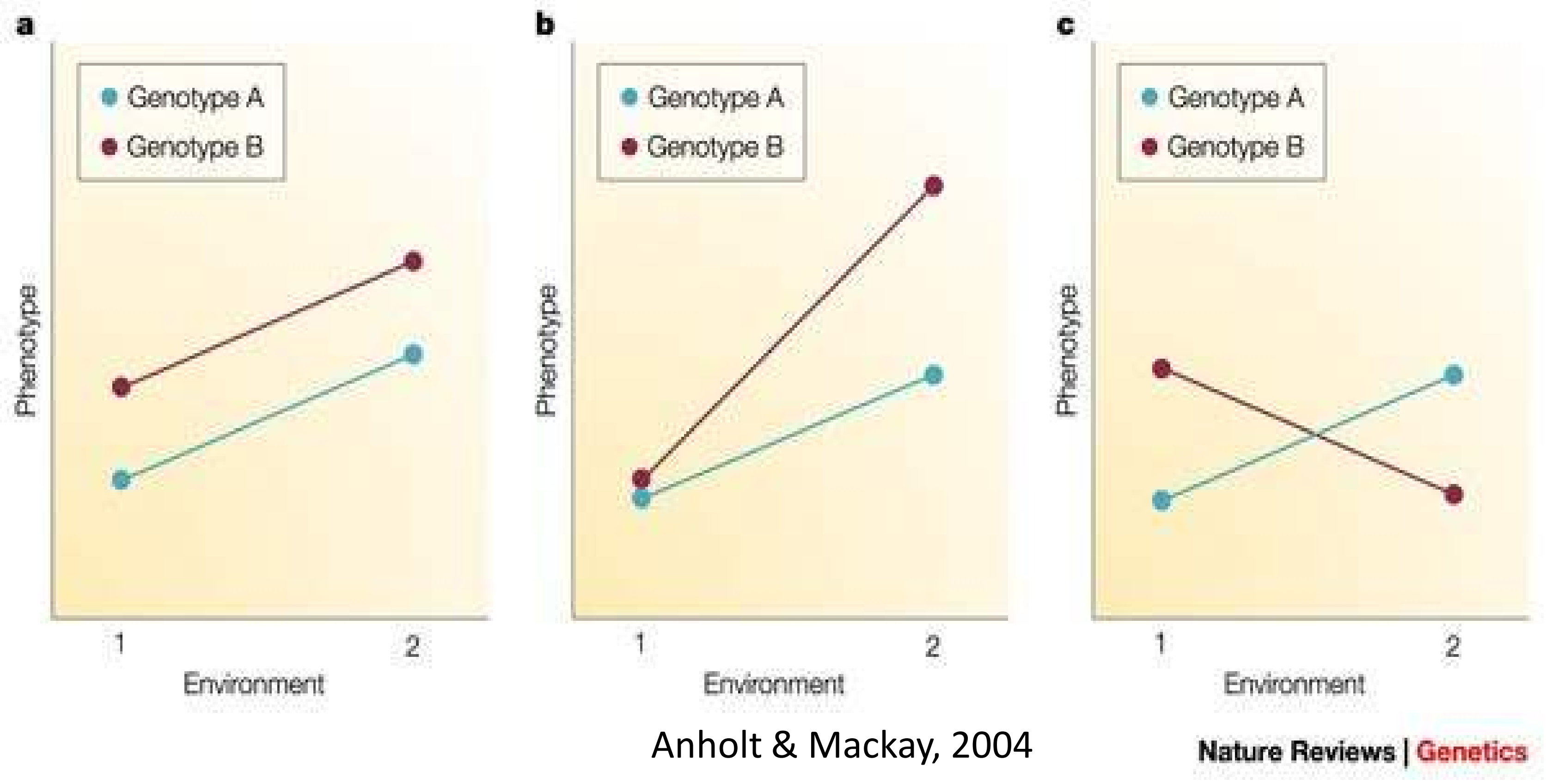
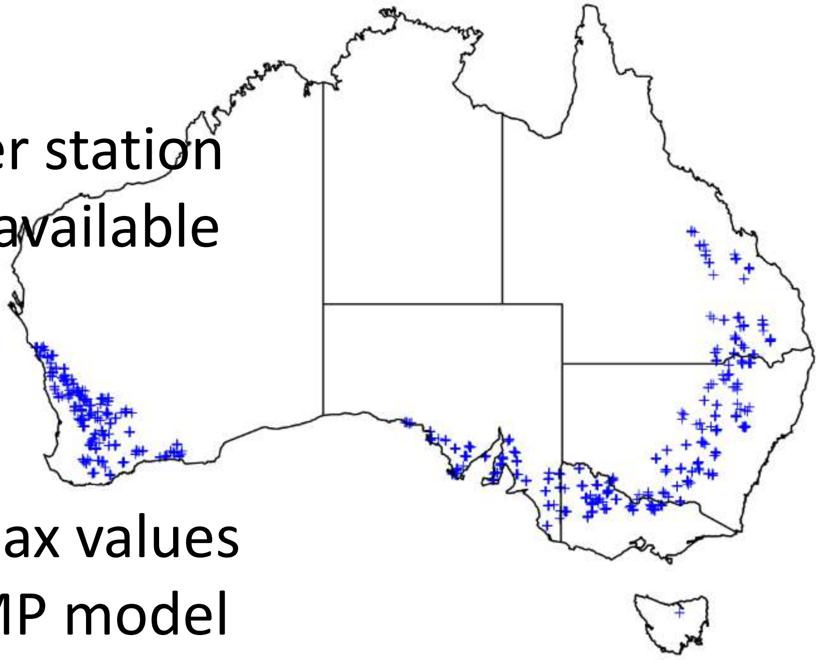
Interaction of GxE / GxExM



Anholt & Mackay, 2004

Phenotypic variation in relative performance of genotypes in different environments (and managements)

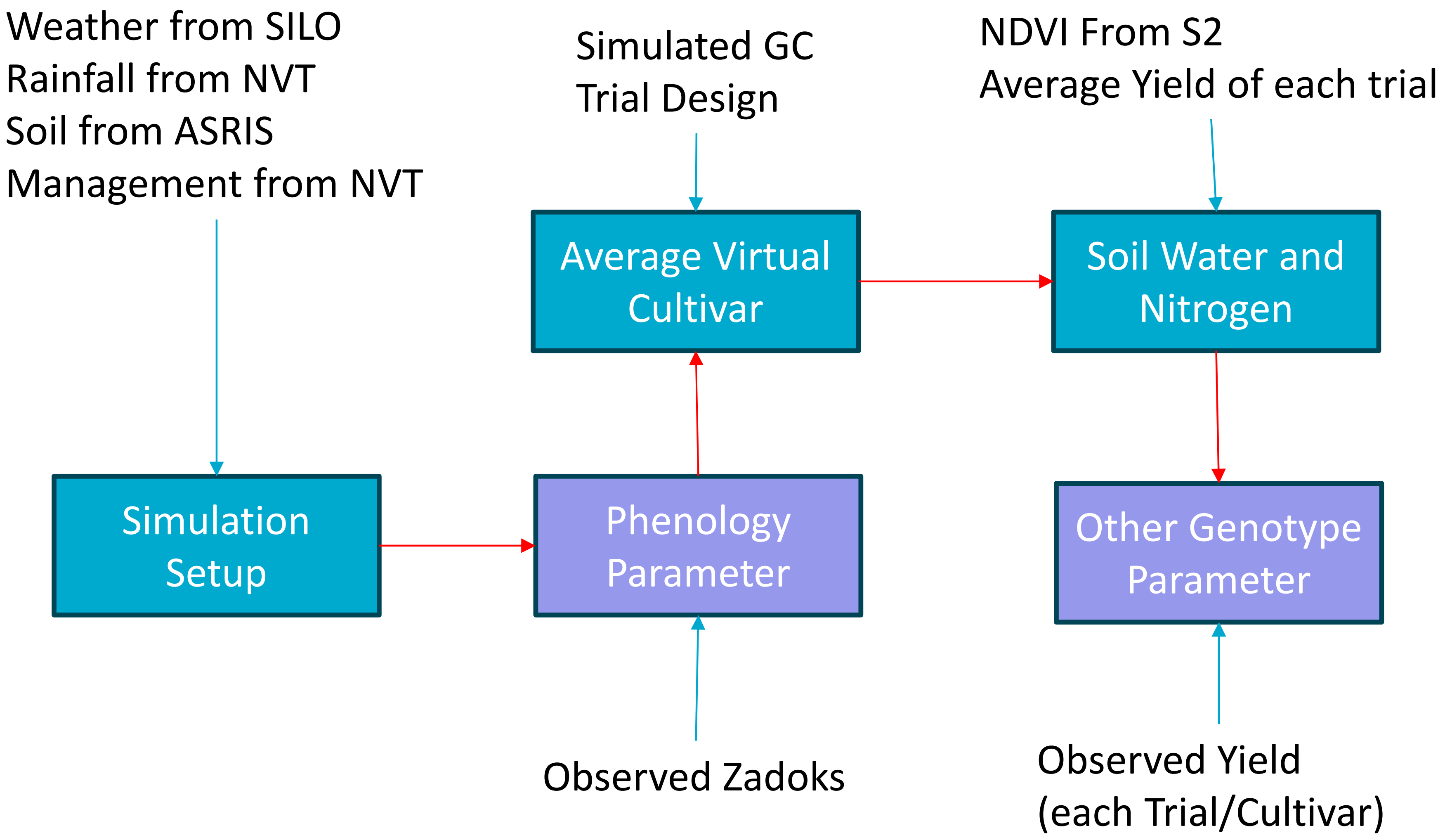
Multiple Environment Trials – National Variety Test



- from 2015 to 2021
- Managements (sowing, cultivars)
- Weather data obtained from SILO/weather station
- Monthly rainfall from onsite rain gauge if available
- Soil data obtained from ASRIS
- Observed Zadoks and yield (plot)
- NDVI from Sentinel 2 for NVT (trial)
  - normalised with long term min and max values
- APSIM Wheat Model in NG with new CAMP model

How do we use all collected information to characterise environment and genotype variations?

Workflow of data processing



Weather from SILO
Rainfall from NVT
Soil from ASRIS
Management from NVT

Simulation Setup

Simulated GC
Trial Design

Average Virtual Cultivar

Phenology Parameter

Observed Zadoks

NDVI From S2
Average Yield of each trial

Soil Water and Nitrogen

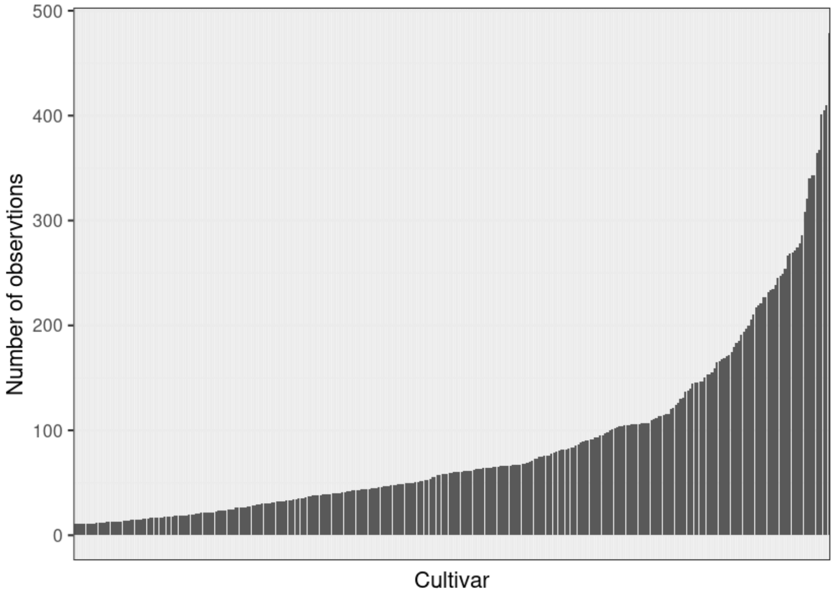
Other Genotype Parameter

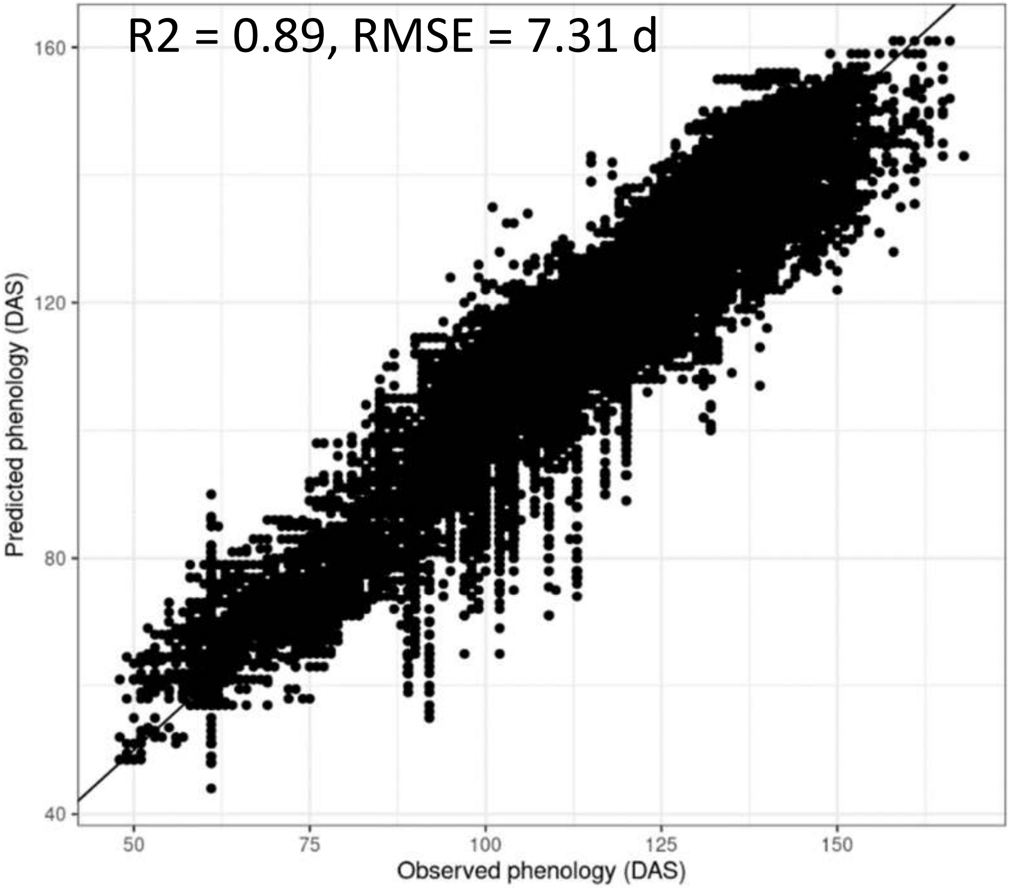
Observed Yield
(each Trial/Cultivar)

Whole Trial
Each Cultivar

Phenology Optimisation using Zadoks

- 311 Cultivars
- Zadoks 39 to 69
- 28, 068 observations

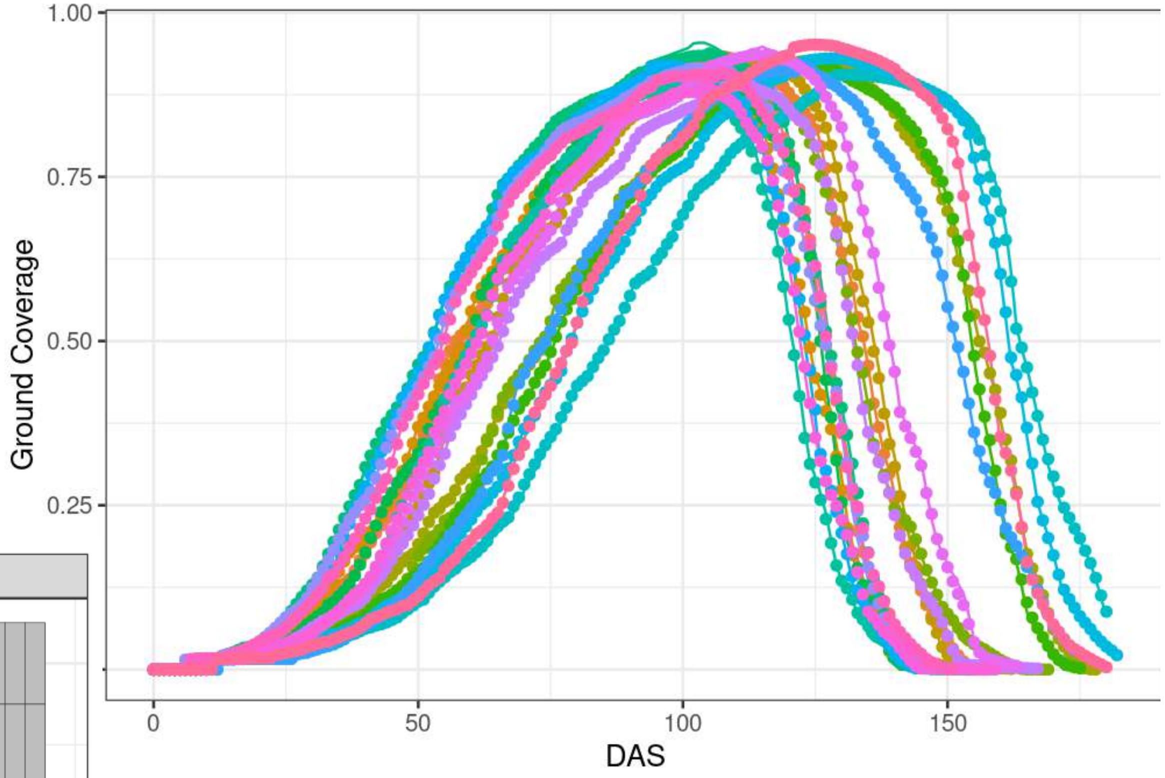


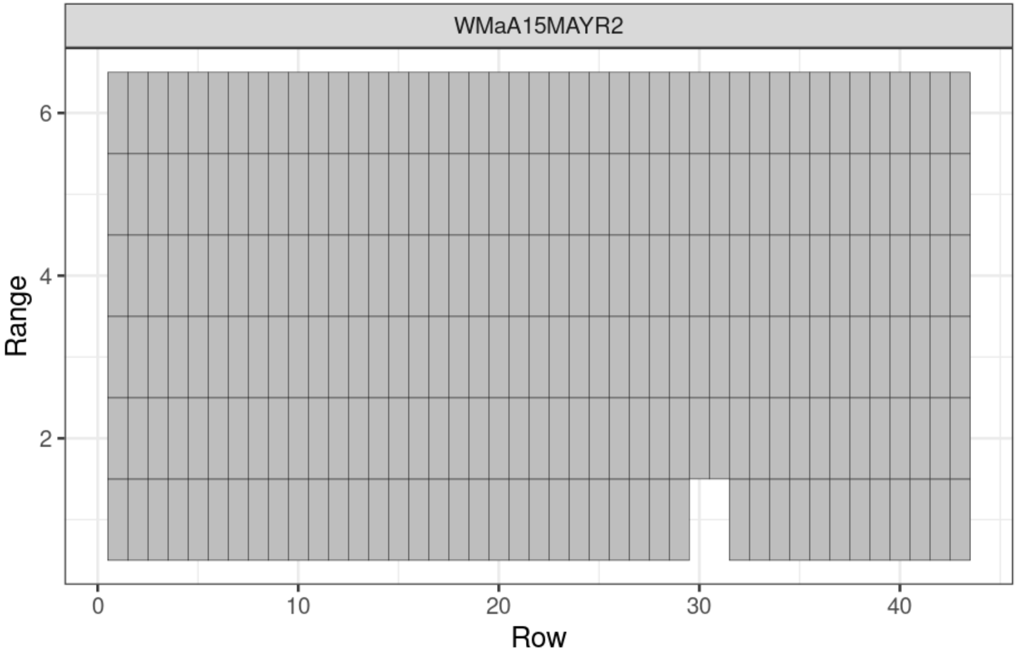


Flowering/Heading vs Zadoks stages?

Representative Cultivar for Trial Average

- Average daily predicted GC with experiment design
- Fit a virtual cultivar to represent average status of a trial
- Ignore plots with missing values or filler plots (< 10%)





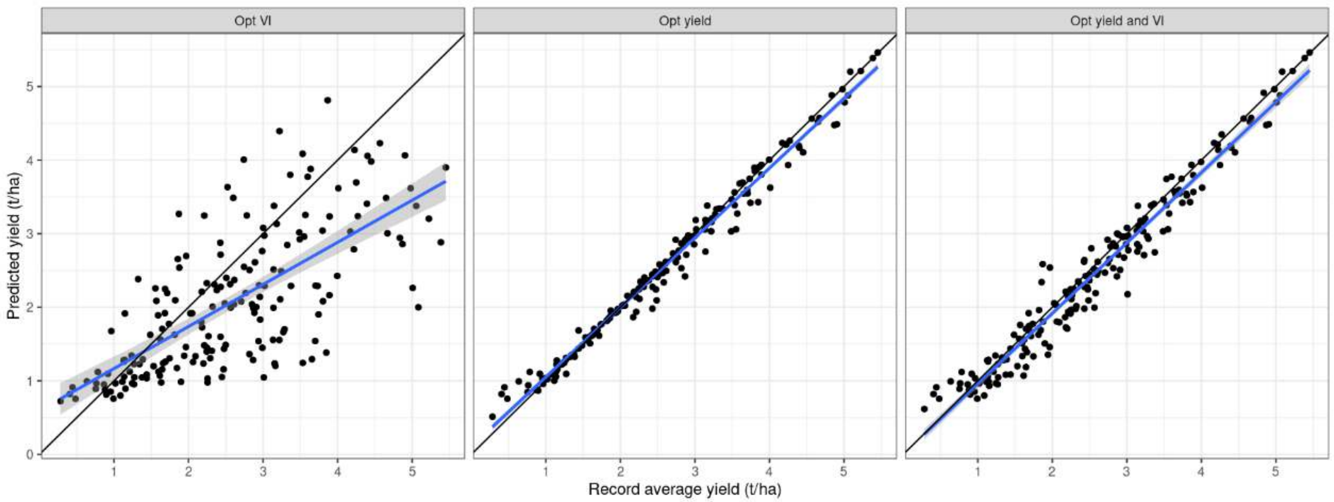
- No consideration of factors
    - environments
    - non-phenology genotypic
- Non-matching phenology at the end of season

Characterisation of Environments in Trial Level

- Initial Water and Nitrogen in a trial
  - No spatial variation
  - Optimisation with three strategies

- Optimisation targets
  - VI (NDVI) only
  - Average Yield in whole trial only
  - Yield and VI

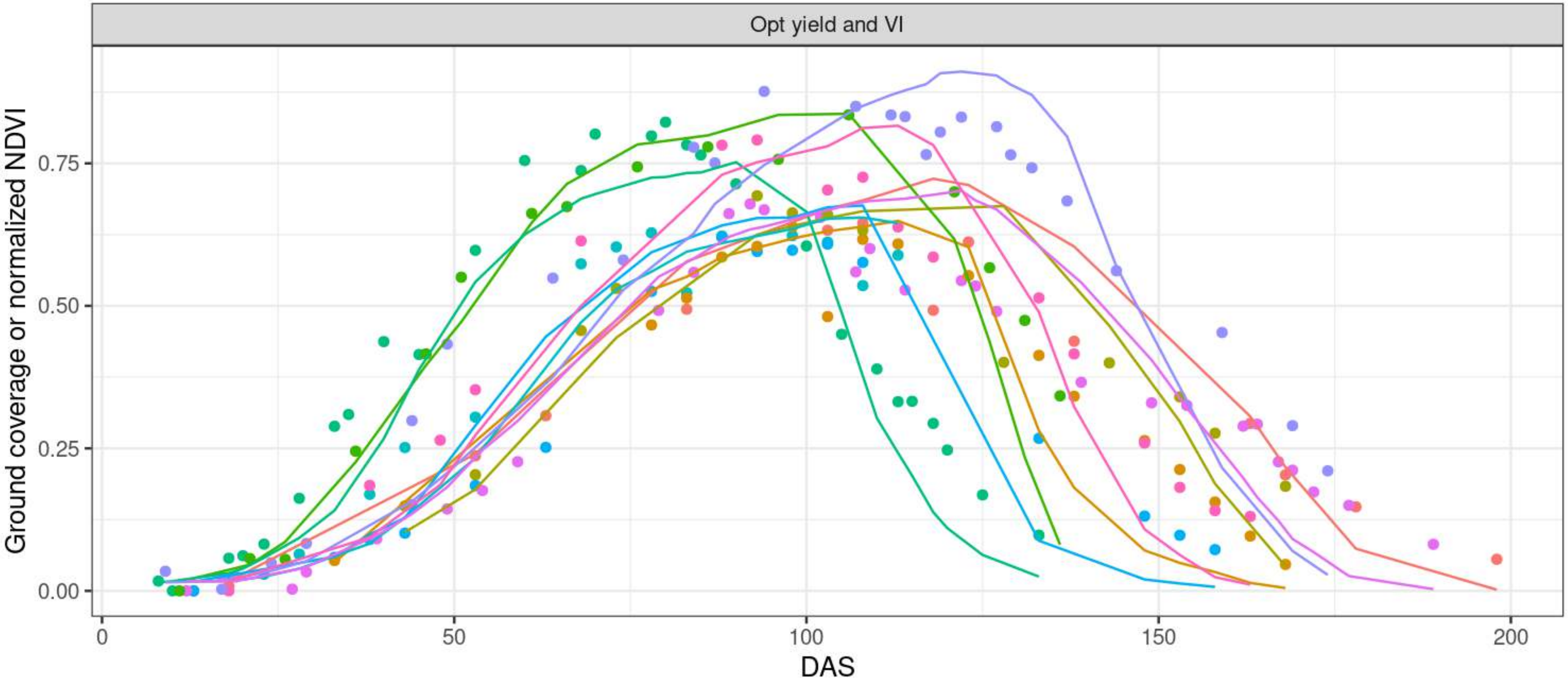
scenario	n	r	r2	bias	mse	rmse	nrmse	d
Opt VI	183	0.71	0.5	0.5	0.95	0.98	0.38	0.79
Opt yield	183	0.99	0.99	0.03	0.02	0.15	0.06	1
Opt yield and VI	183	0.97	0.95	0.12	0.09	0.29	0.11	0.98



- VIs only cannot capture the major effects for yield
- Overfitting for yield only
- Yield and VIs capture environment effects for yield and dynamic of VIs

Characterisation of Environments in Trial Level

Performance to match GC with normalized NDVI



- Yield average over whole trial
- Optimisation for yield and VI

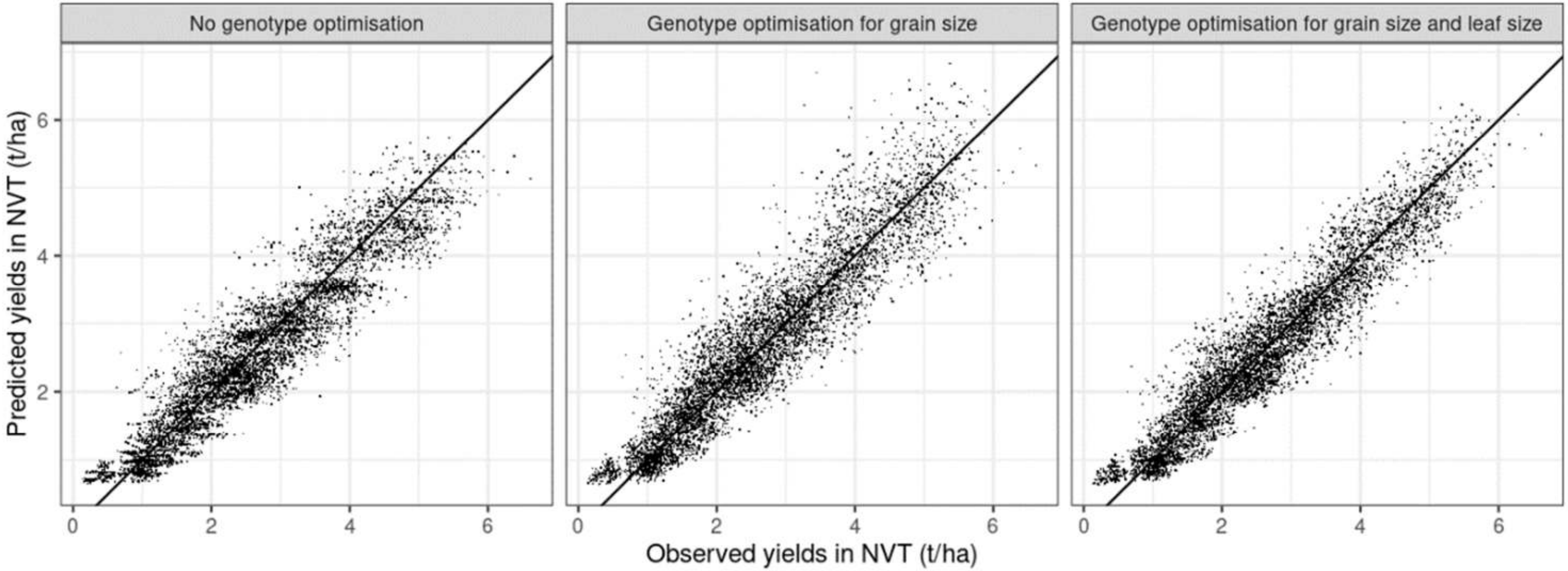
Characterisation of Genotypic Variation in the Trial

Fixed environment variables (i.e. initial water and nitrogen)

Optimisation each cultivar with three methods

- No genotypic optimisation (same parameter values except phenology)
- Optimisation for grain size (sink)
- Optimisation for grain size and leaf size (source and sink)

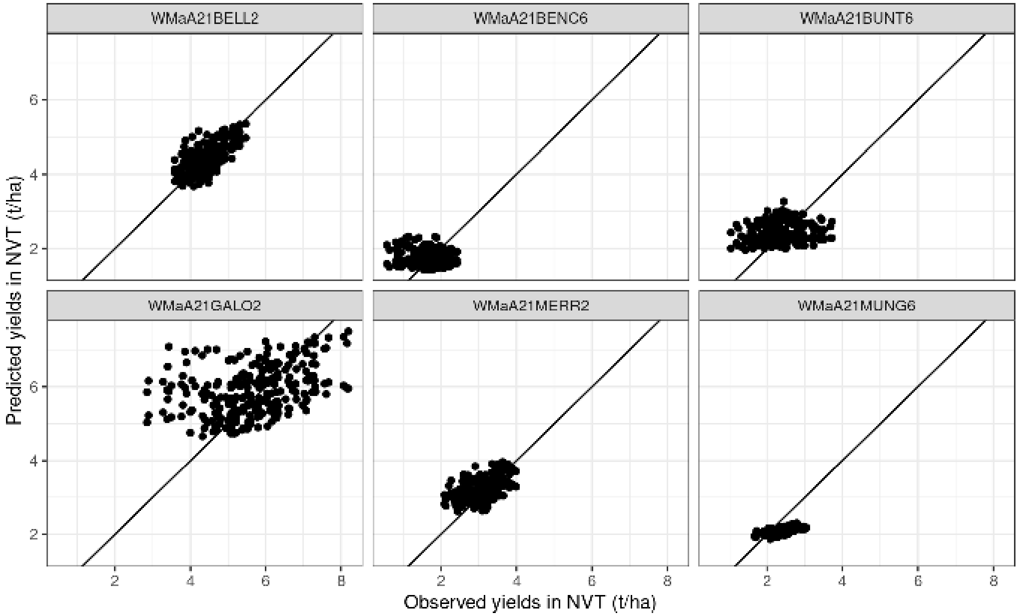
Characterisation of Genotypic Variation



method	n	r	r2	bias	mse	rmse	nrmse	d
No genotype optimisation	27298	0.91	0.83	0.21	0.32	0.57	0.2	0.95
Genotype optimisation for grain size	27298	0.92	0.85	0.08	0.27	0.52	0.18	0.96
Genotype optimisation for grain size and leaf size	27298	0.93	0.87	0.08	0.22	0.47	0.16	0.97

Characterisation of Genotypic Variation

An example of 6 trials in 2021



(Plot yield – genotype average) / genotype average

Low correlation might be caused by spatial variation of environment

Take Home Message and Future works

- Crop growth model can be utilised to check data consistence in the multiple environment trials

- Datasets from plot-based observations, remote sensing of satellite can be used to characterize environmental variation in the trial level

- Genotypic variations in the plot level depends on spatial variation in the trial

- Combine geospatial model with crop growth model to capture spatial variation in the experiment
- Environmental characteristics for paddock spatial variation

Acknowledgements

This research is funded by GRDC INVITA UOQ2003-011RTX

Scott Chapman, Pengcheng Hu, Carla Gho Brito, Qiaomin Chen, Daniel Smith, Zhi Chen, Javier Fernandez and many others

Thank you

Bangyou Zheng
Digital Agronomist
Agriculture CSIRO
Phone: 07 3214 2620
Email: Bangyou.Zheng@csiro.au
Profile: https://www.bangyou.me