Wheat Traits, Genes and Germplasm for Adaptation to Water-Limited Environments in the Northern Region

Adapted Germplasm and pre-breeding ↔ **Physiology of Phenotypic Response**

Genetics and Genomics

A Pre-breeding Research Project

GRDC Grains Research & Development Corporation

Approaches & Outputs
for northern environments

Research approaches:

- **Identify elite germplasm and its basis**
- **Investigate traits and their interactions**
- **Identify genetic basis of adaptive traits**

GRDC agreed project outputs:

- **Higher yielding germplasm**
- **Knowledge of traits, their interactions, and selection methods**
- **Markers and candidate genes**

GRDC Grains Research & Development Corporation

CIMMYT Germplasm evaluated 2003 - 2008

- Derived synthetic (Syn) wheats, 495 lines
- Spring wheats (SW), >1000 lines, 600 yield tested
- IAT (SW), 30 lines
- SERI/BABAX (SB) population, 192 RILs

SERI/BABAX lines

- *Elite SB lines 9-13% higher yield **and** 13-24% higher grain weight than commercials*
- High yield attained via different combinations of traits
- SB Population bifurcated based on grain weight and grain number
- Examined trait combinations in these subsets

SERI/BABAX lines

- Proposed ***ideotype*** for attaining high grain yield ***combined*** with high grain weight:
  - Earlier to anthesis
  - High harvest index
  - High WSC (content and %)
  - Fewer and heavier culms/plant
  - Greater % of viable culms
  - Higher number of grains spiklet^{-1}

Elite CIMMYT Germplasm identified

Group	Yield (g m^{-2})	Grain weight	WSCc	Spike m^{-2}	Grains $spike^{-1}$	DW $spike^{-1}$
Check (12)	280 c	28.1 b	94 b	306 a	37.6 b	2.8 b
SB (35)	300 a	31.1 a	105 a	265 b	42.5 a	3.4 a
SW (36)	293 ab	31.4 a	104 a	263 b	40.9 a	3.5 a
Syn (21)	287 bc	31.1 a	103 ab	274 b	39.9 ab	3.3 a

Group means with different letters are significantly different at $p = 0.05$

CIMMYT parents in elite germplasm

- Many elite lines were related
  - Yield- Seri, Babax, Pastor, Kauz, and Opata
  - Grain weight- Seri, Babax, Pastor
- Is proposed ideotype pedigree independent?
- Proposing research to examine generality of proposed ideotype in other CIMMYT germplasm and pre-breeding pops across environments

Northern Wheat Adaptation Research Areas of Focus

Adapted Germplasm and pre-breeding

Physiology of Phenotypic Response

Genetics and Genomics

- non-invasive phenotyping
- carbon partitioning
  - WSC trait dissection
  - tillering
- water use traits

- candidate genes for drought traits
- genetic complexity of traits
- regulation of drought traits
- genetic analysis of derived synthetics

- **DNA markers**
- **genetic and genic understanding**
- **transgenes**

- **selection tools**
- **traits and trait combinations**
- **physiological understanding**

Large projects require large multidisciplinary teams

Scientists

Allan Rattey
Ray Shorter
Scott Chapman
Fernanda Dreccer
Anthony van Herwaarden
Lynne McIntyre
Gang Ping Xue
Ky Mathews
Heather Way

Linkages with Canberra PI

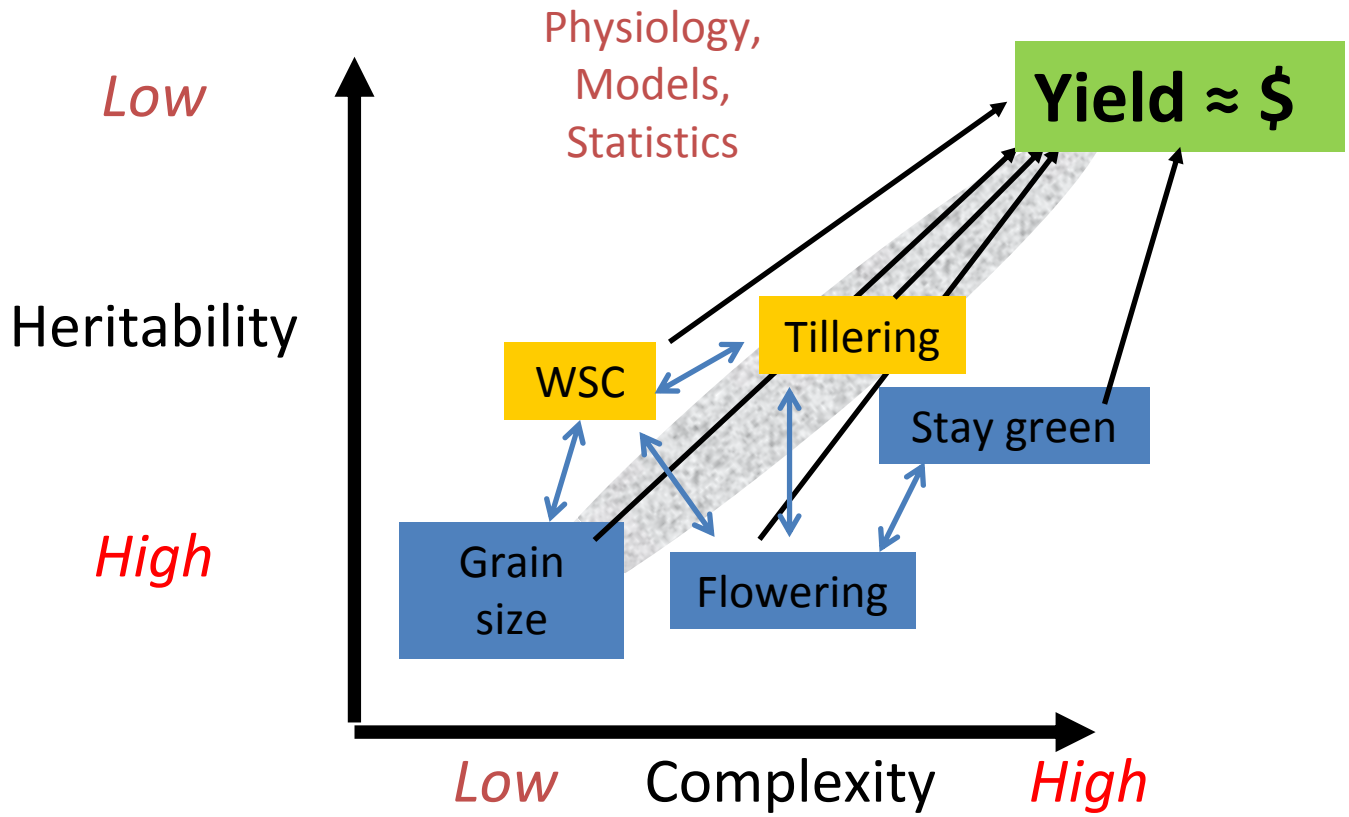
Technical

Phil van Drie
Janneke Drenth
Terry Collins
Greg Roberts
Kevin Niemeyer
Neil Wiltshire
Laura Barnes
Kathryn Lambkin
Peter Harland

Students

Jason Kam
Jaquie Mitchell
Suzuky Pinto (CIMMYT Obregon)
Lindsay Shaw

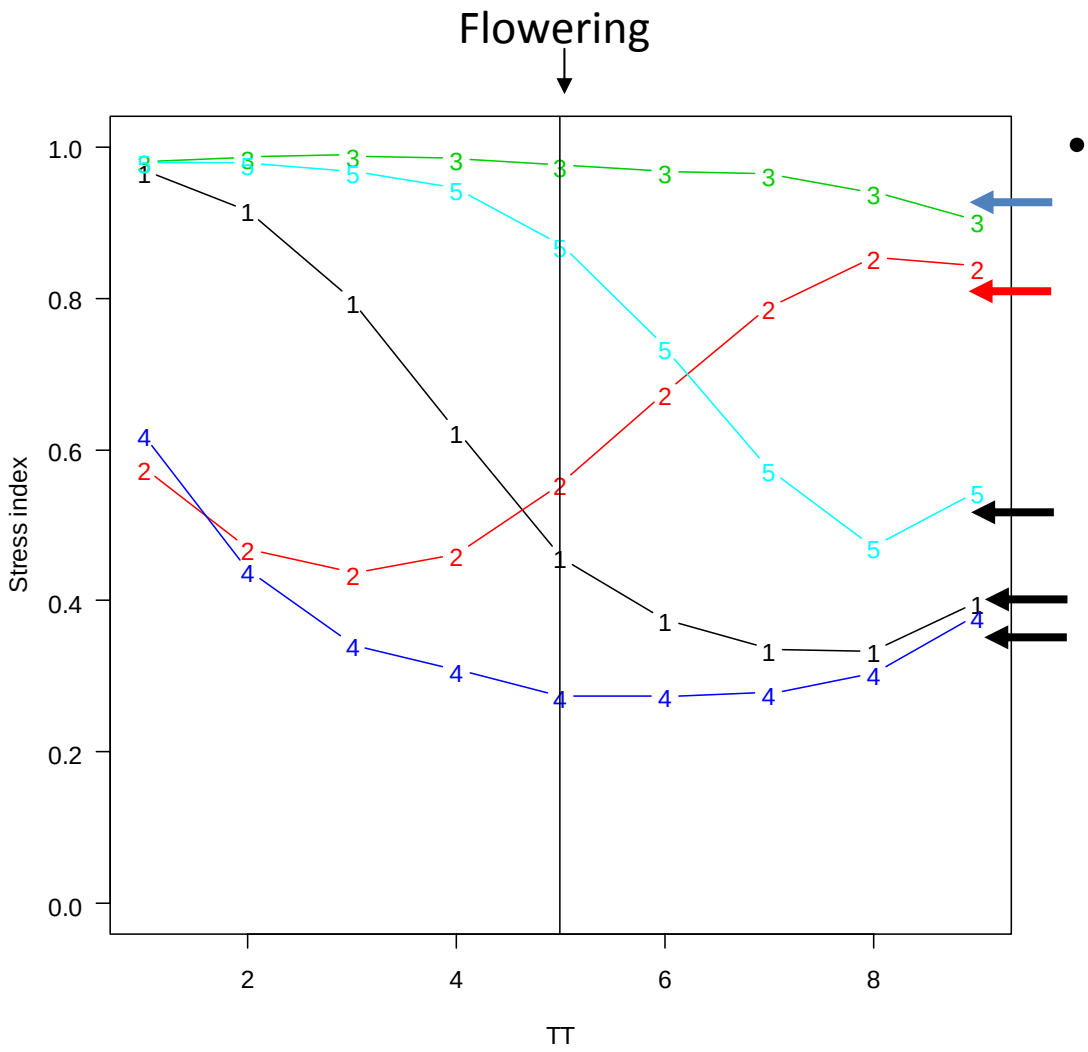
Why work with traits?
Physiologically speaking…



…. to account for 'unexplained variance' and increase efficiency of selection using highly heritable traits

$$\frac{CR_{x,y}}{R_x} = \frac{i_y}{i_x} \times \frac{r_g \times h_y}{h_x}$$

Variable drought stress patterns



- 3 major types of stress
  - mild/no stress (22%)
  - pre-flowering (25%)
  - Terminal (53%) beginning
    - flowering (29%)
    - boot (10%)
    - pre-boot (14%)