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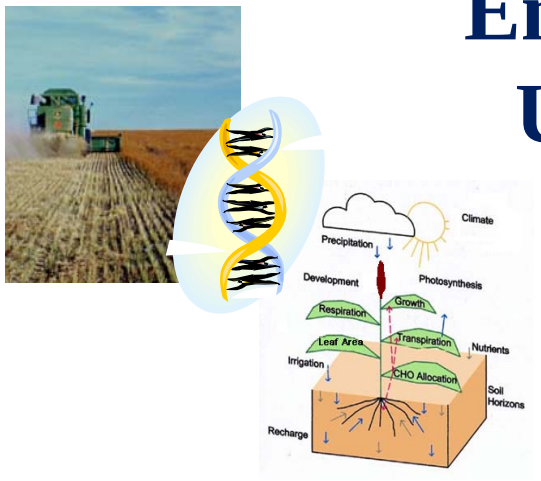


Environment Characterisation Using Simulation Modelling

Graeme Hammer [and many others]

Centre for Plant Science
Queensland Alliance for Agriculture and Food Innovation
The University of Queensland

Working together with the
Queensland Government

Queensland Government

Overview

- Background
  - The plant's view of environment
- Modelling dynamic of crop stress experience
- Relevance to explaining G*E in the TPE
- Application in TPE
  - Sorghum case study
  - E, M, and G effects
- Implications

Background

- Key question
  - can environments be classified from the plant's perspective to enhance selection efficiency when faced with G*E in the TPE?

1. What is G*E in the TPE?
   - the target population of environments (TPE) is the complete set of "types" of crop growth environments in the geographical area targeted by a breeding program (Comstock, 1977)
   - G*E is variable performance of genotypes in different environment types (e.g. change of ranking)

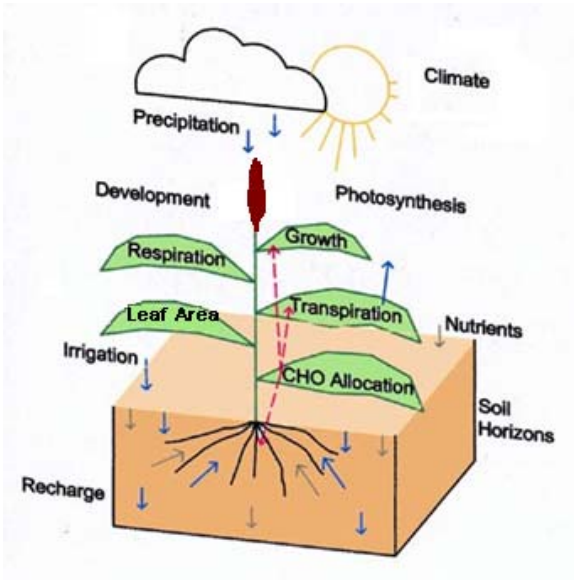
Background

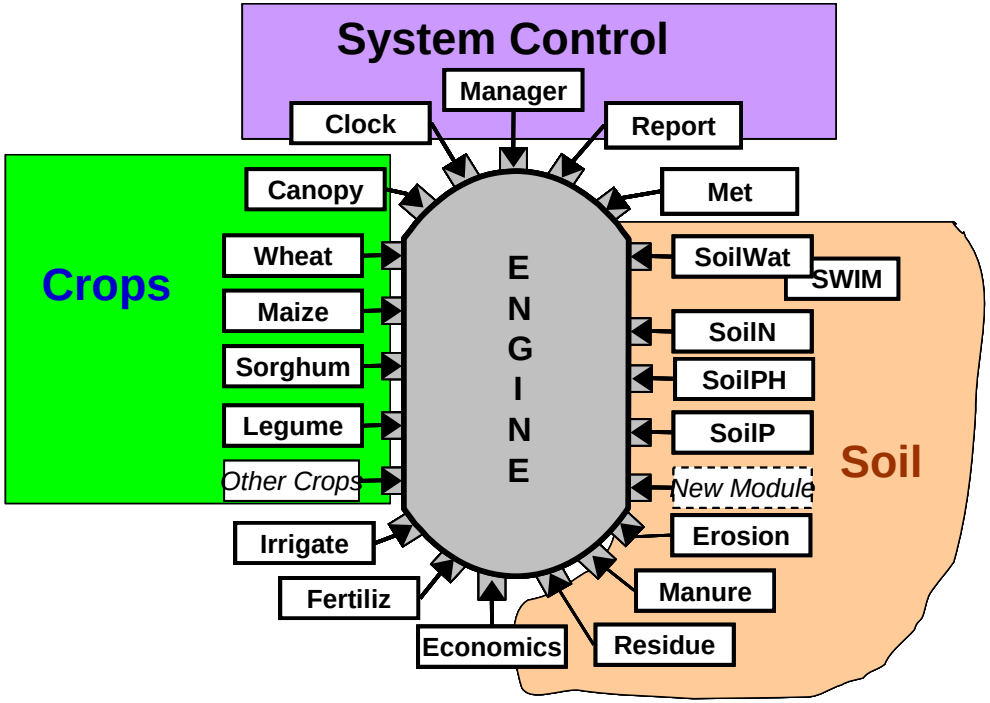
- Key question
  - can environments be classified from the plant's perspective to enhance selection efficiency when faced with G*E in the TPE?

2. What is the plant's perspective?
   - the nature and extent of challenges (biotic and abiotic) faced during crop growth and development
   - for water can quantify via trace of stress level through the crop cycle → crop modelling

Modelling Crop Stress Experience

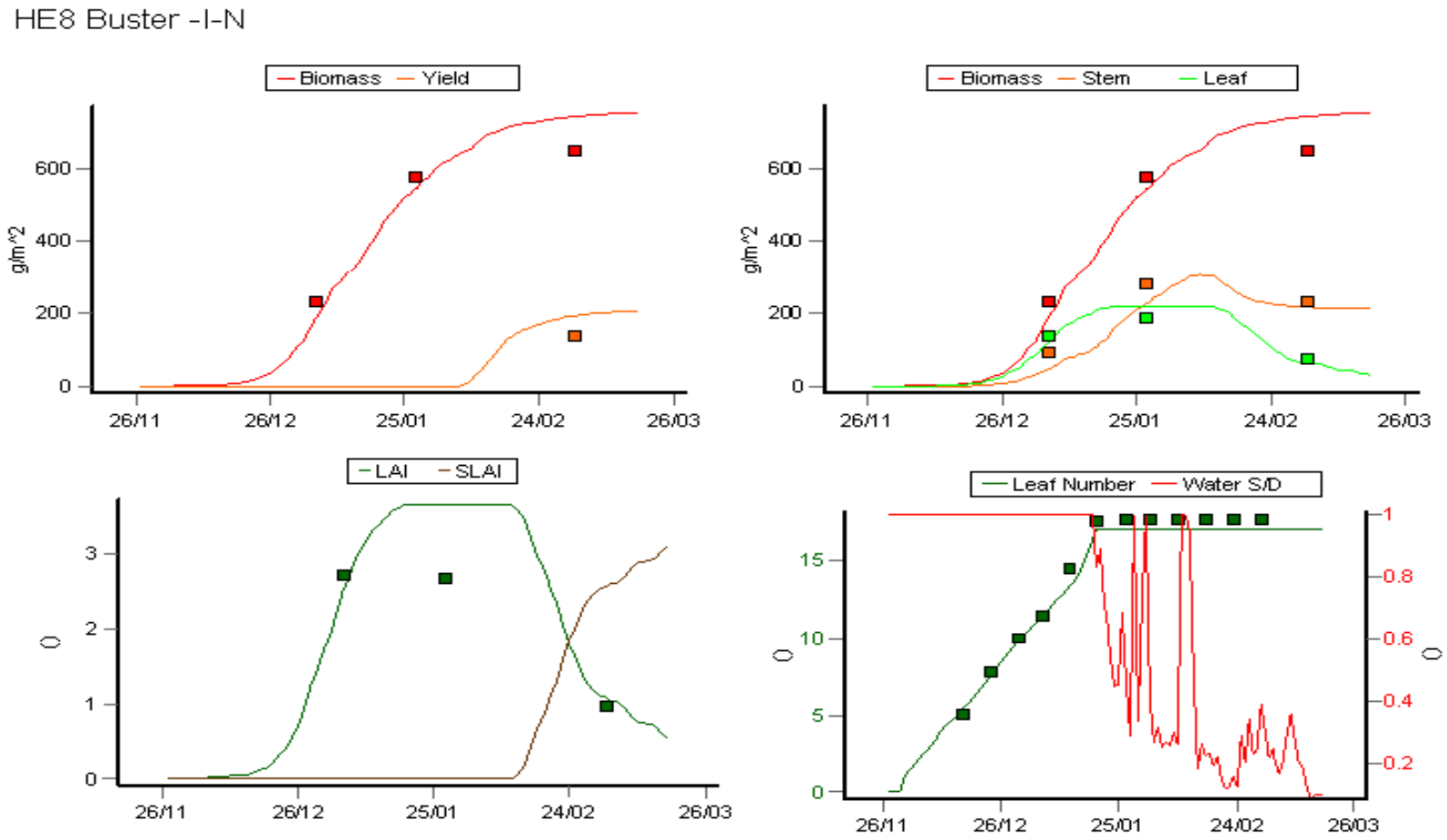
- Use model as virtual bioassay of stress dynamics through crop cycle to provide basis for environmental classification
  - Crop models in APSIM platform
  - Generate indicators (stress level, biomass, yield etc)





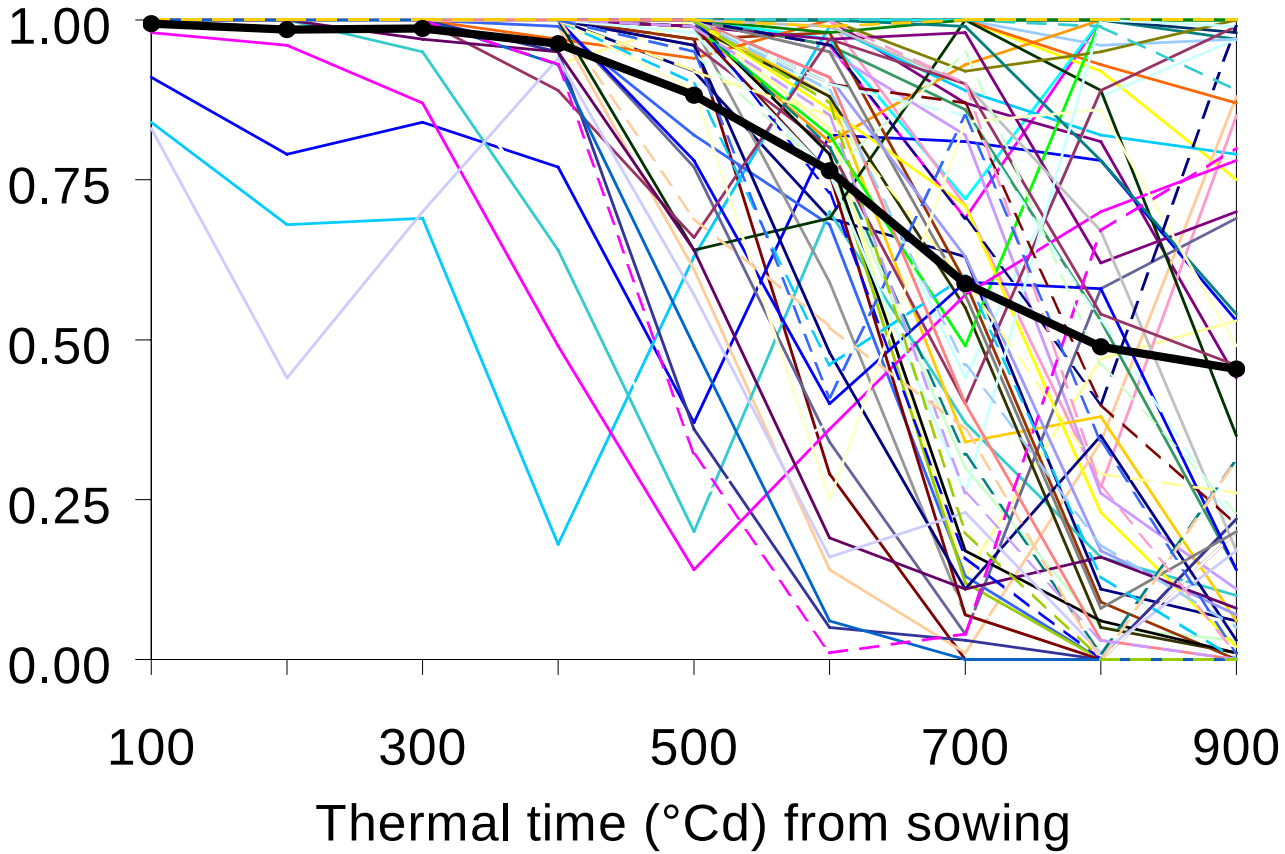
Modelling Crop Stress Experience

- Use model as virtual bioassay of stress dynamics



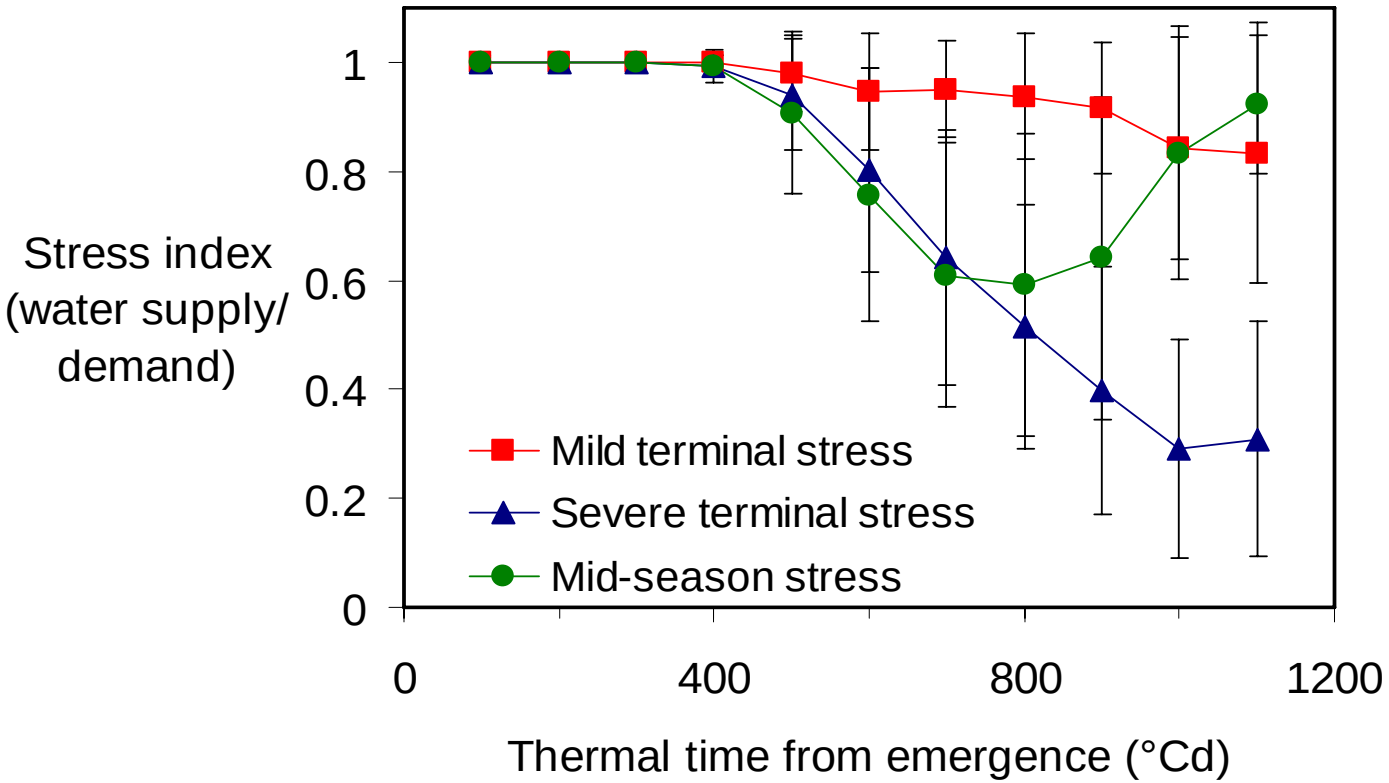
Modelling Crop Stress Experience

- Extend virtual bioassay to entire TPE and classify responses for individual instances



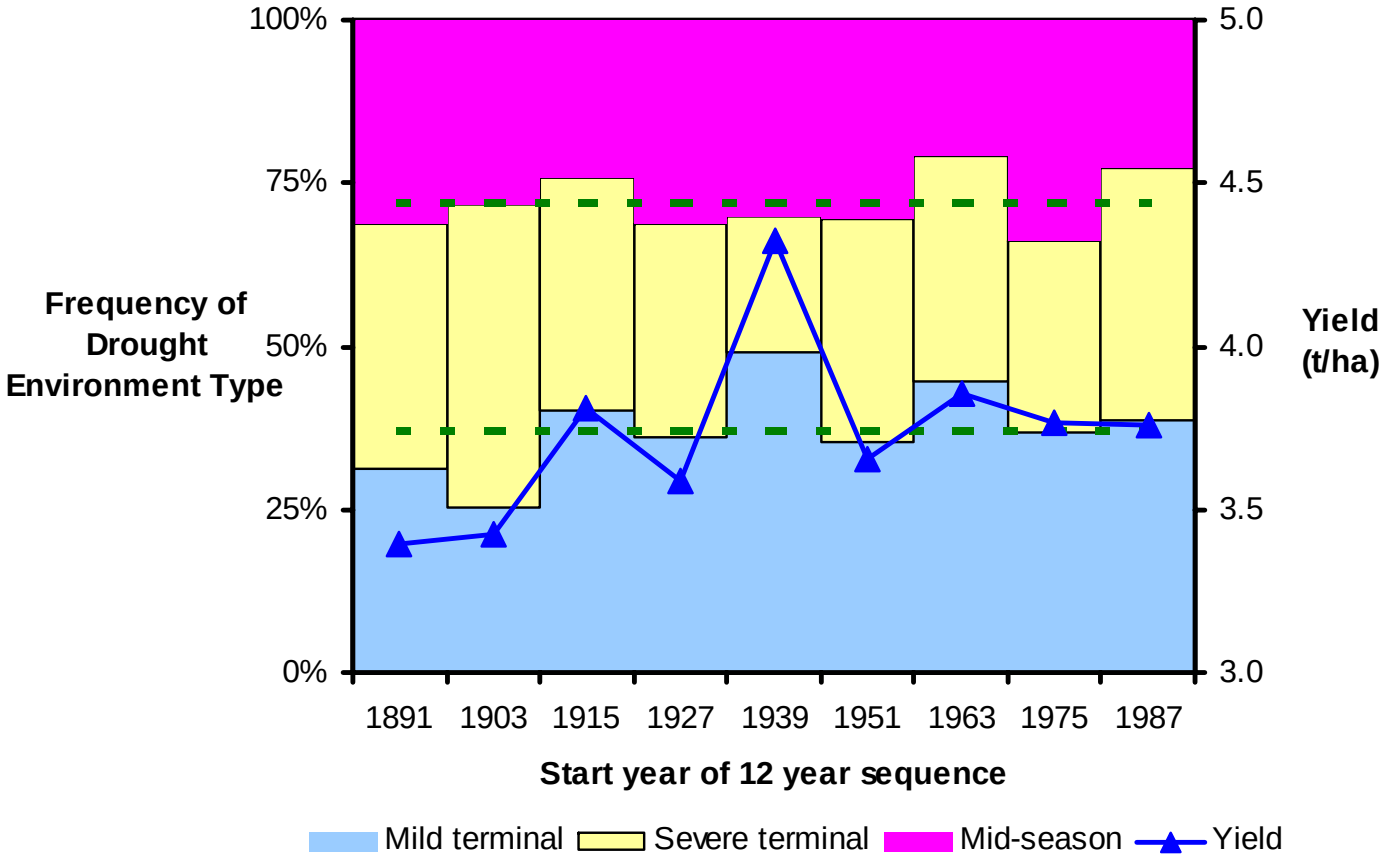
Modelling Crop Stress Experience

- Relative transpiration patterns through the season for initial sorghum study (Chapman et al, 2002, AJAR)



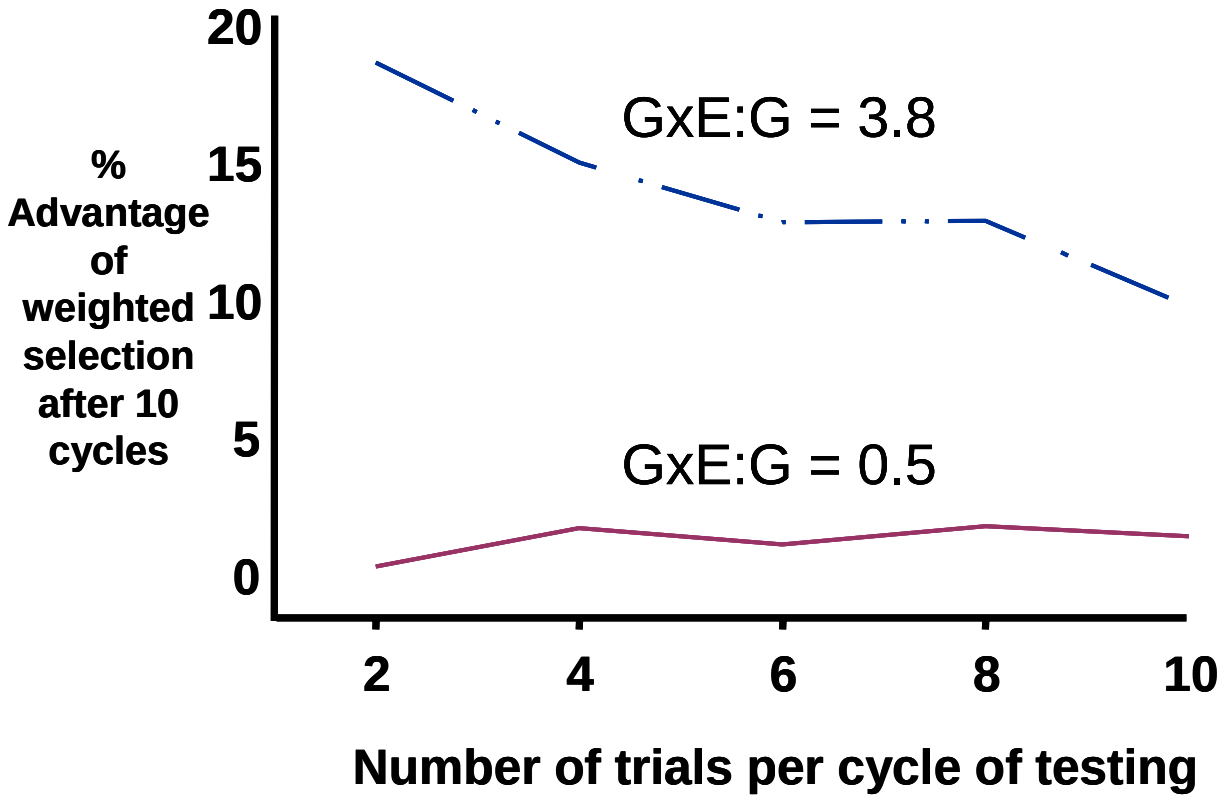
Relevance to G*E in the TPE

- Frequencies of environments change
- Changes in frequencies effect yield likelihood and cause g*e



Relevance to G*E in the TPE

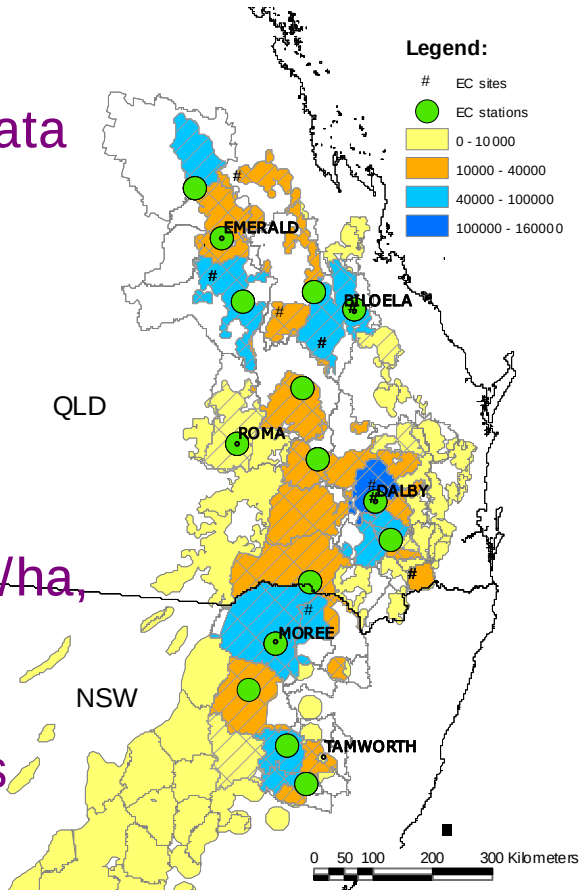
- Env Type important in weighting representativeness of selection environments
- Weighted selection increases rate of yield gain



Podlich et al. 1999, Plant Breeding

EC in sorghum TPE

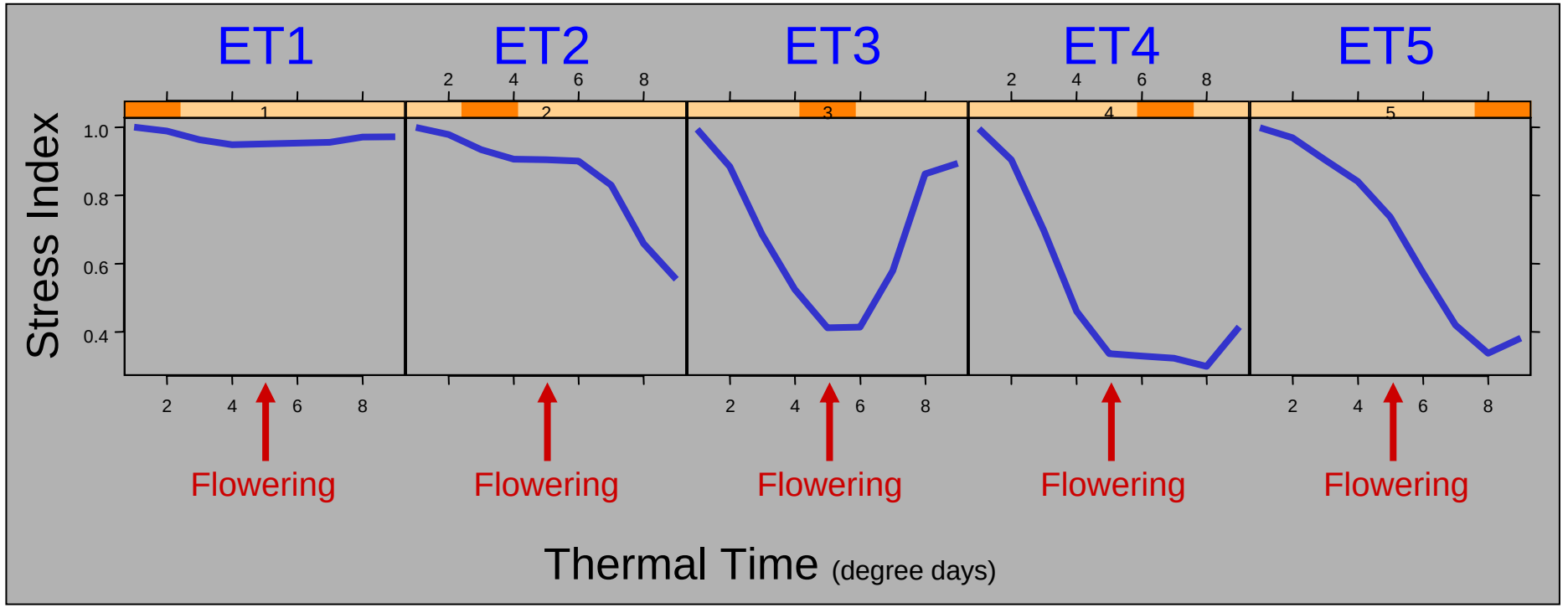
- 116 years of climatic data
- 5 Maturity types
  Q,MQ,M,MS S
- 3 types of agronomy
  1m 50K/ha,
  1m double skip 50K/ha,
  0.75 100K/ha
- 29,485 simulated crops



Location	Soil	Depth
Clermont	Black Earth	120
Clermont	Black Earth	80
Emerald	Black Earth	120
Emerald	Black Earth	80
Rolleston	Black Earth	120
Rolleston	Black Earth	80
Taroom	Gray Clay	150
Baralaba	Gray Clay	150
Biloela	Gray Clay	150
Dalby	Gray Clay	150
Dalby	Vertisol	180
Pittsworth	Gray Clay	150
Goondiwindi	Gray Clay	130
Goondiwindi	Red Clay	140
Miles	Gray Clay	150
Miles	Gray Clay	150
Roma	Black Earth	80
WeeWaa	Vertisol	150
Gunnedah	Vertisol	200
Moree	Vertisol	120
Quirindi	Vertisol	200

EC in sorghum TPE

- S/D ratio patterns classified to derive 5 ETs



EC in sorghum TPE

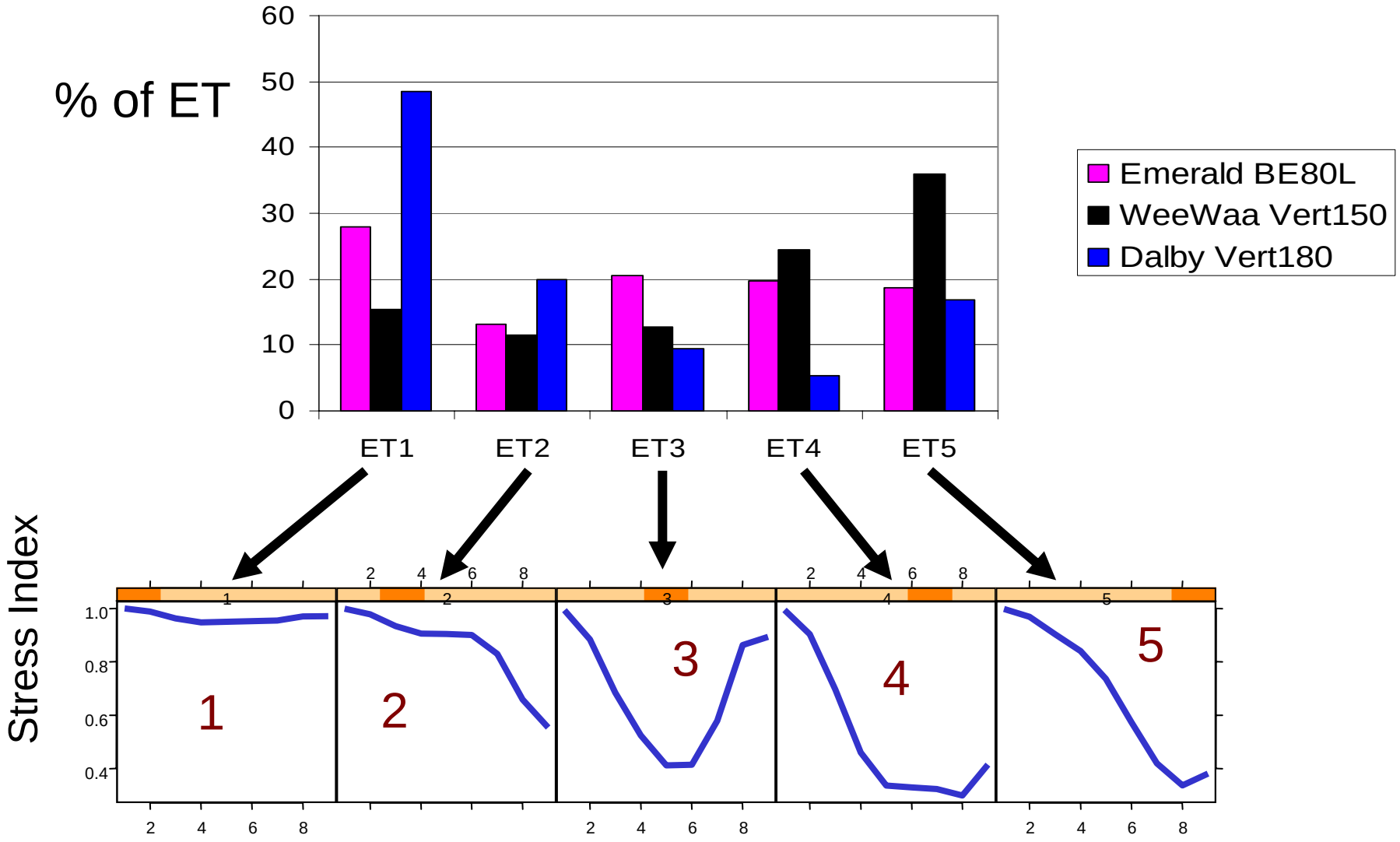
- ET mix changes with year → sampling issue

Season	Type1	Type2	Type3	Type4	Type5
1994	3	1	1	3	6
1995	12	2	2	3	1
1996	9	5			2
1997		2	1	5	13
1998	8	4			4
1999	5	8			5
2000		6	2	1	8
2001		2	1	2	10
2002	3		1	5	6
2003	3	4	2	2	10
2004	3	1		2	15

Plant breeding trials grown in a particular year may not sample all of the types of environment, different years may over or under sample particular environment types

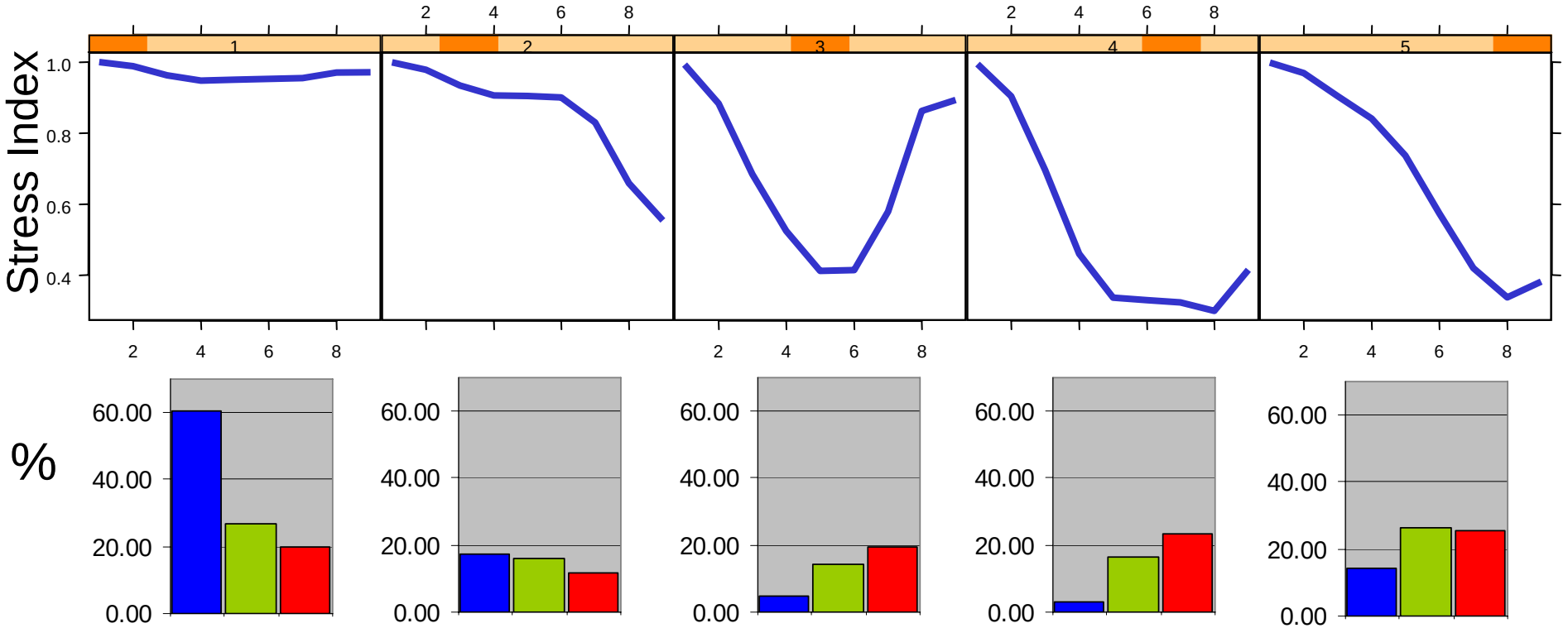
EC in sorghum TPE

- ET mix changes with location → sampling issue



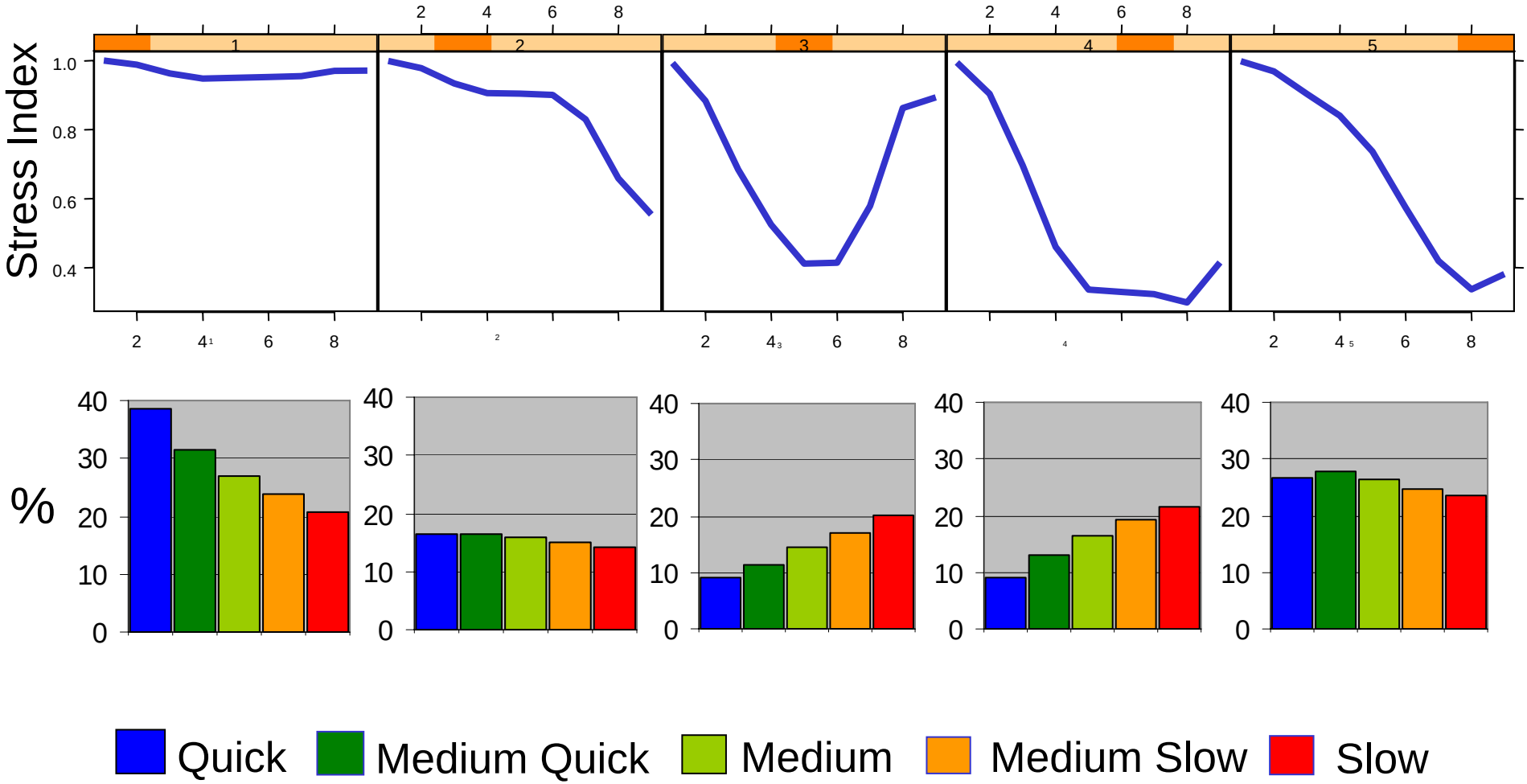
EC in sorghum TPE

- ET frequency changes with management



EC in sorghum TPE

- ET frequency changes with genotype (e.g. maturity)



Implications

- G*M*E affect ET frequency
- Can identify ET frequencies in TPE by modelling
- Do not need to restrict indicator to S/D ratio
- Can be used to weight results of breeding trials

- But how do you assign an ET to a breeding trial?

Overview

- The Breeding Questions
  - What environment type did this experiment experience?
  - Do entries within an experiment experience different environment types?

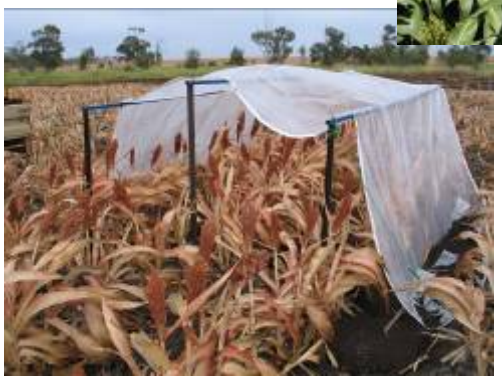
Quantifying environment type for an experiment

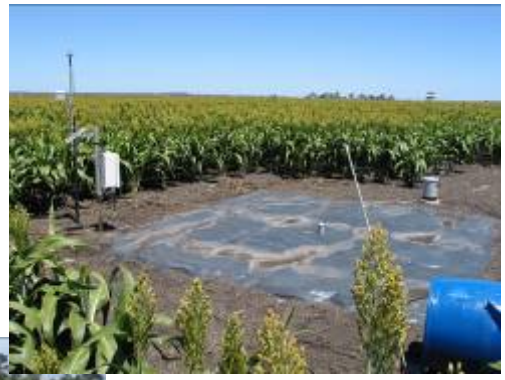
- Site Characterisation
- Sampling of check hybrids
- Simulation analysis

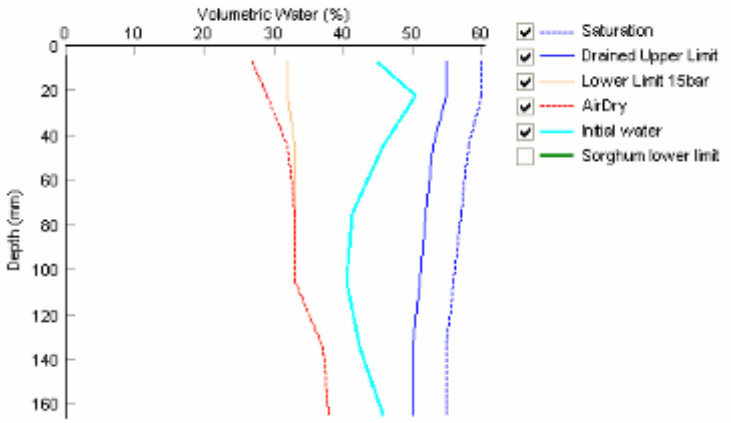
Quantifying environment type for an experiment

Site Characterisation

- Climate
- Soil





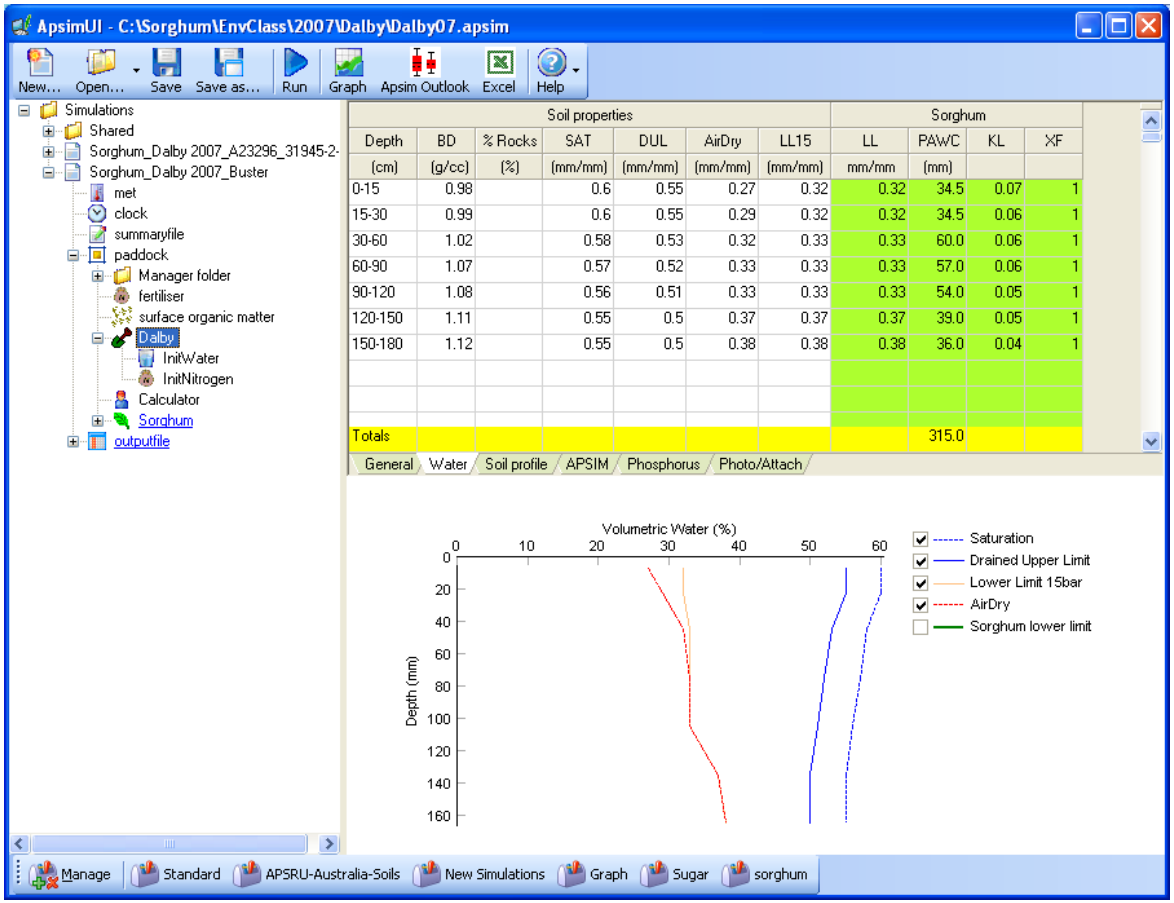


Quantifying environment type for an experiment

- Sampling of check hybrids
  - Quadrat harvests for leaf area, biomass, yield at flowering and maturity

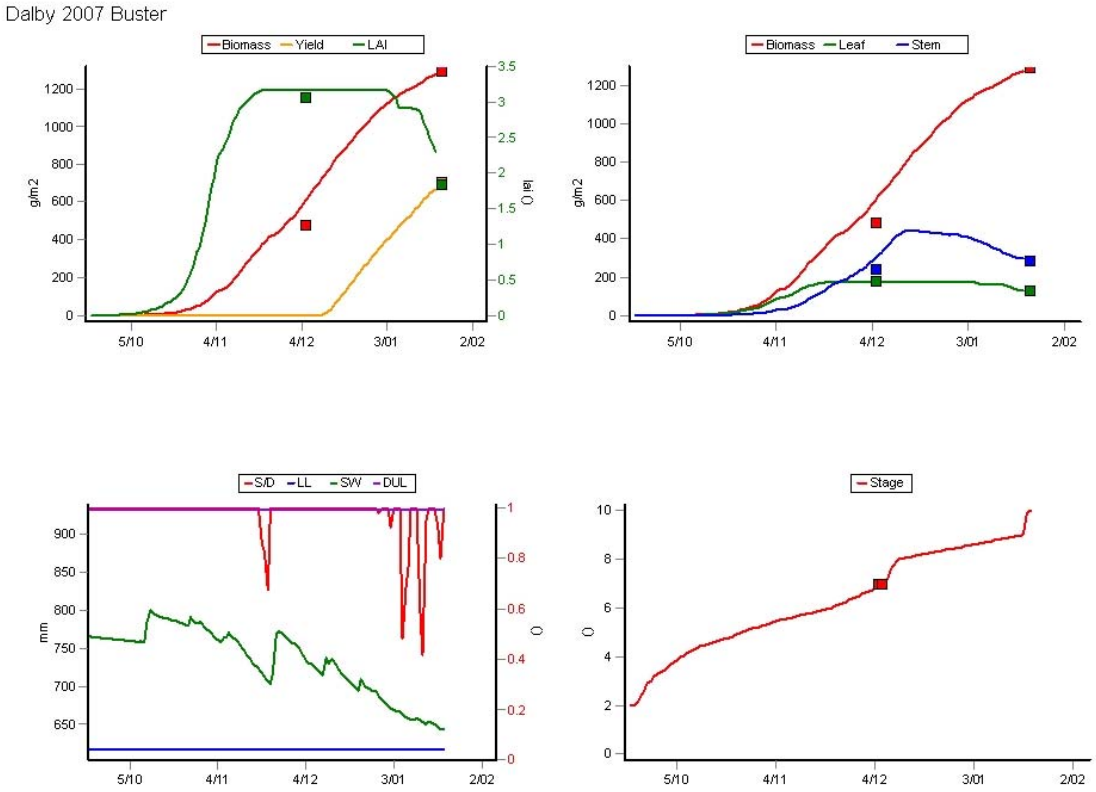
Quantifying environment type for an experiment

Simulation analysis - APSIM

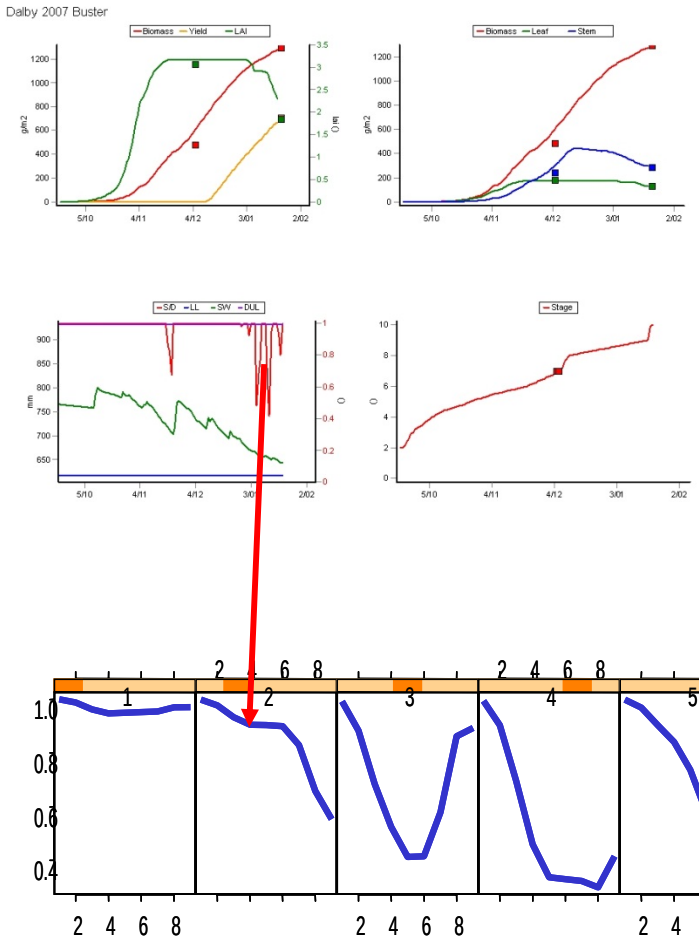


Quantifying environment type for an experiment

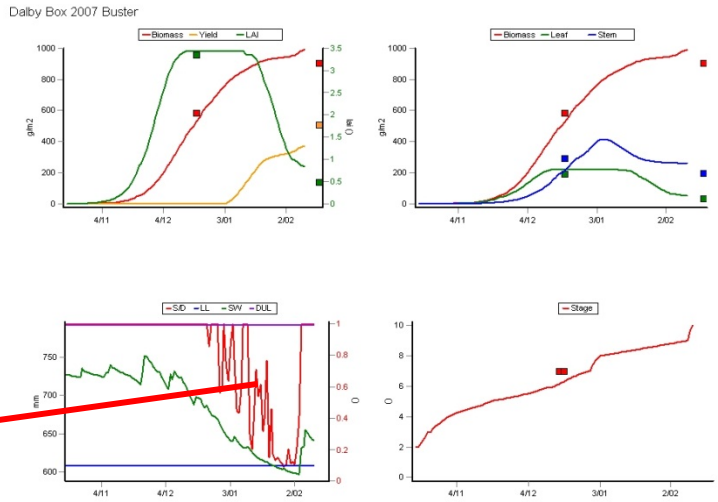
Simulation analysis - Results



Quantifying environment type for an experiment



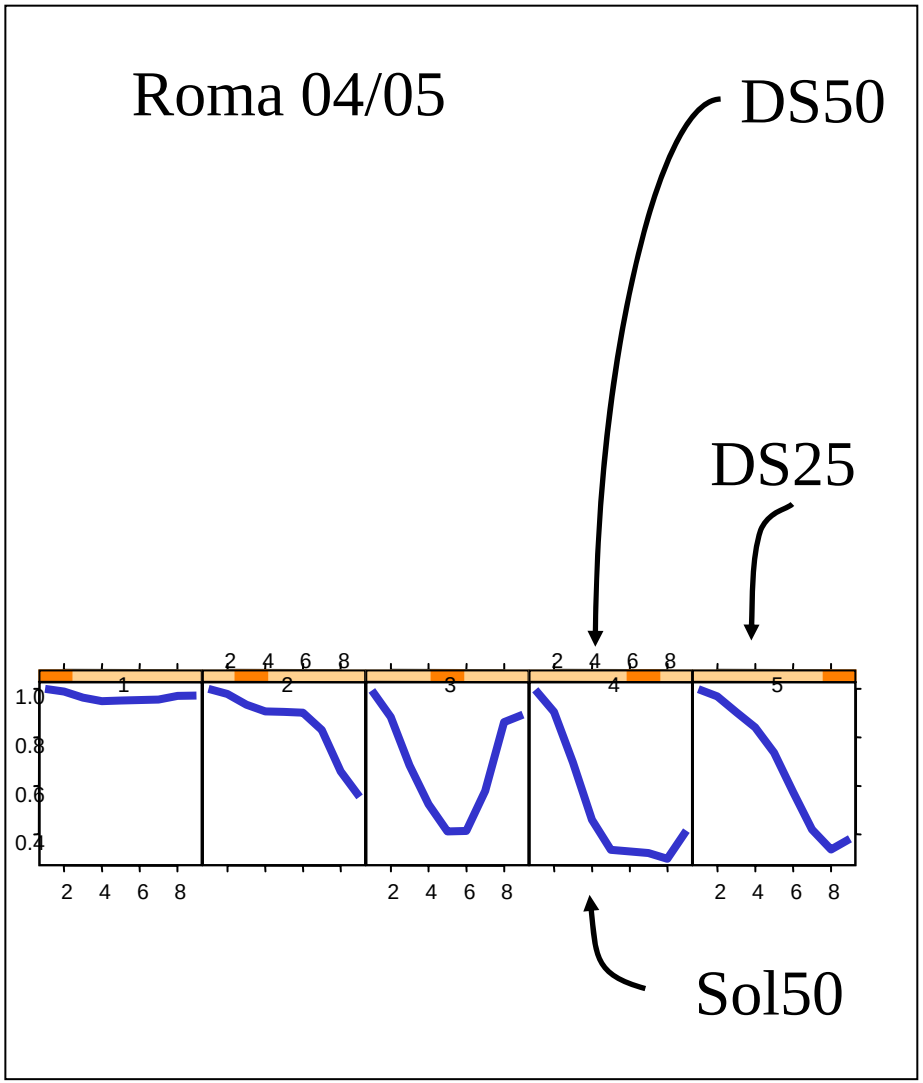
Map stress to ET

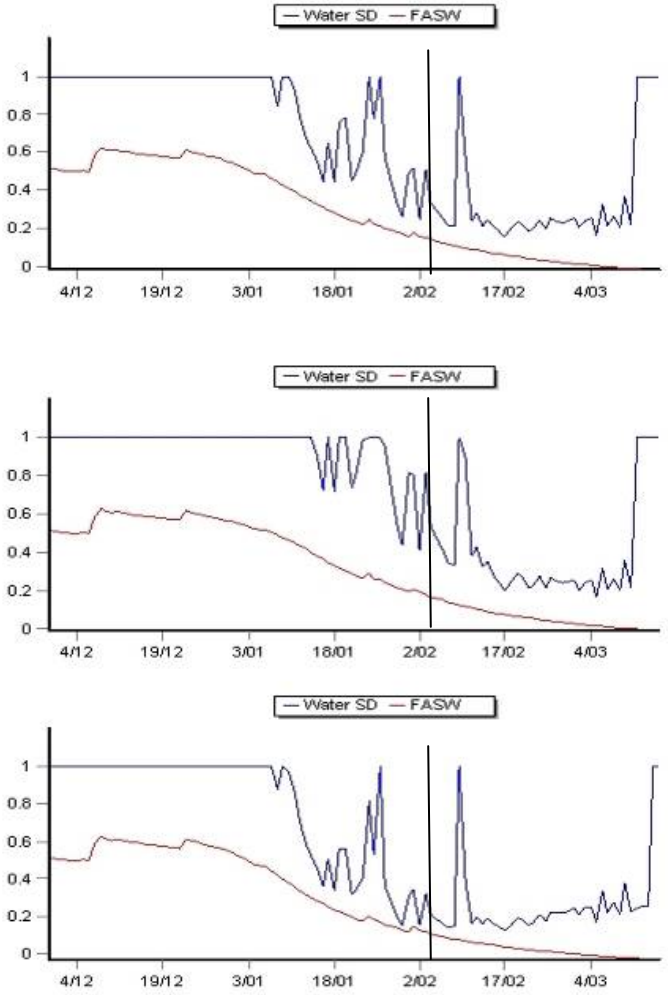


Quantifying environment type within an experiment

- Environment type can vary with G and M
  - Management – density, row configuration
  - Important genetic factors – those that affect canopy development (Maturity and tillering)

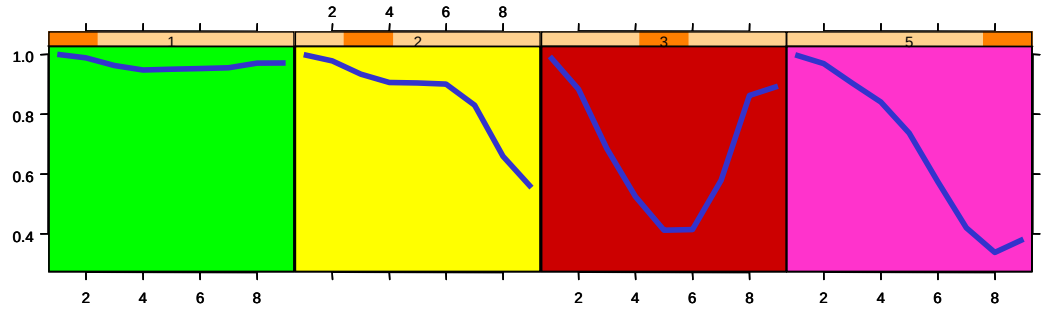
Quantifying environment type within an experiment





Quantifying environment type within an experiment

Environment	Quck	Medium Quick	Medium	Medium Slow	Slow
Biloela_GC150H_1903_Std	1	1	2	2	2
Biloela_GC150H_1904_Std	1	1	2	2	2
Biloela_GC150H_1916_Std	2	2	2	5	5
Biloela_GC150H_1924_Std	1	1	2	2	2
Biloela_GC150H_1925_Std	1	2	2	2	5
Biloela_GC150H_1929_Std	1	2	2	2	2
Biloela_GC150H_1932_Std	1	1	2	2	2
Biloela_GC150H_1934_Std	1	1	2	2	2
Biloela_GC150H_1937_Std	2	2	2	5	5
Biloela_GC150H_1943_Std	1	2	2	2	5
Biloela_GC150H_1944_Std	1	1	2	2	2
Biloela_GC150H_1949_Std	1	2	2	5	5
Biloela_GC150H_1951_Std	1	2	2	2	2
Biloela_GC150H_1952_Std	2	2	2	5	5
Biloela_GC150H_1954_Std	2	2	2	2	5
Biloela_GC150H_1962_Std	1	1	2	2	2
Biloela_GC150H_1963_Std	2	2	2	5	5
Biloela_GC150H_1966_Std	1	2	2	5	5
Biloela_GC150H_1976_Std	1	1	2	2	2
Biloela_GC150H_1978_Std	1	1	2	2	2
Biloela_GC150H_1979_Std	2	2	2	2	2
Biloela_GC150H_1985_Std	1	1	2	2	2
Biloela_GC150H_1986_Std	2	2	2	5	3
Biloela_GC150H_1988_Std	1	2	2	2	2
Biloela_GC150H_1999_Std	1	2	2	2	2



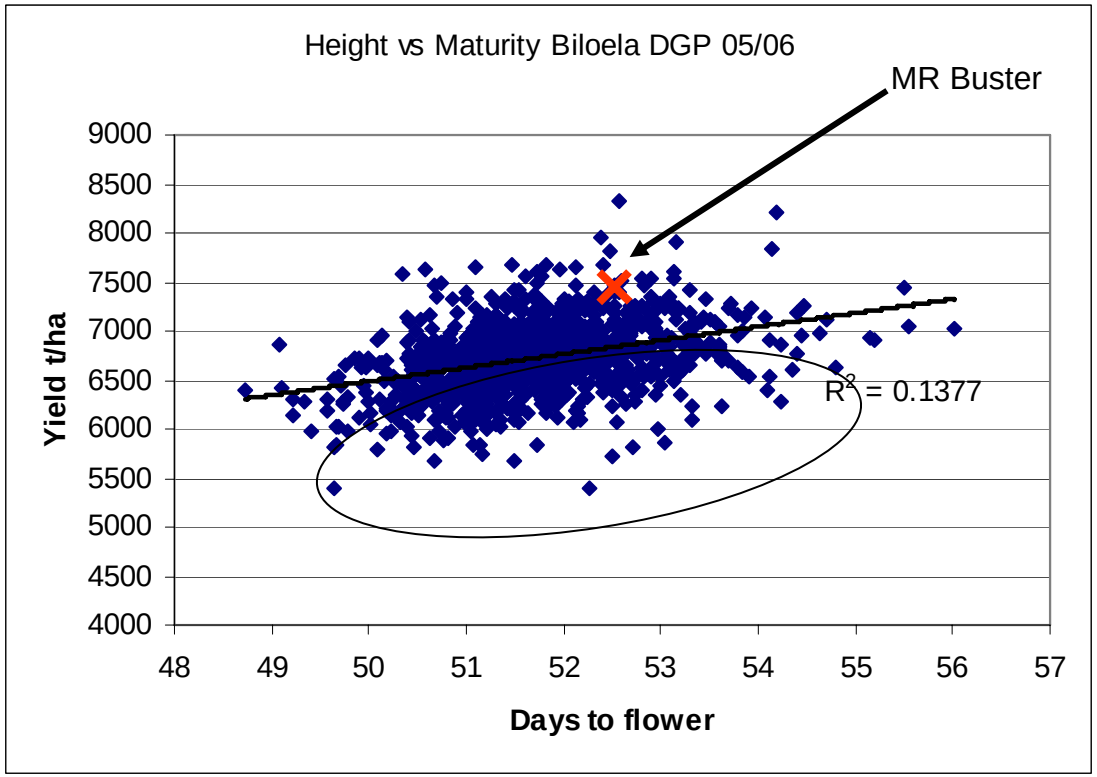
Environment types can vary within trials

- Maturity
- Tillering

Implications

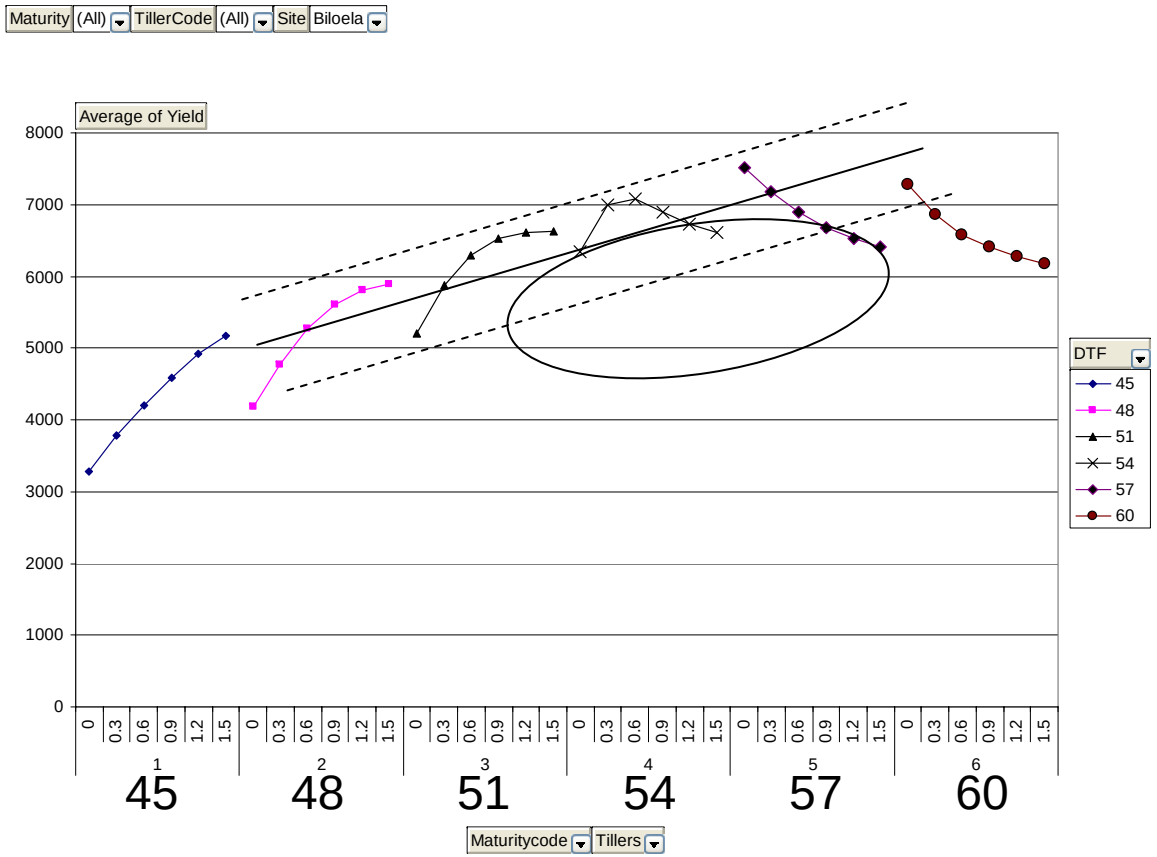
- Can classify environments for experiments and for entries within experiments
- Only useful if it can help explain G x E

Data for Biloela Sorghum DGP 2006



- Confounded by variation in maturity and tillering
- Consider simulated variation for this experiment?

Simulated Data for Biloela DGP 2006



- Explanatory of much G*E
- Opportunity to remove confounding by variation in maturity and tillering