Defining agro-ecological regions for field crops in variable target production environments: a case study for mungbean

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Toward Tomorrow's Queensland

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Crop improvement requires

- Crosses of parents with desirable traits and selection of progenies for target production environments
- Evaluation of progenies in different environments
- Release of superior lines

Fair bit of modelling goes on in breeders' mind to learn

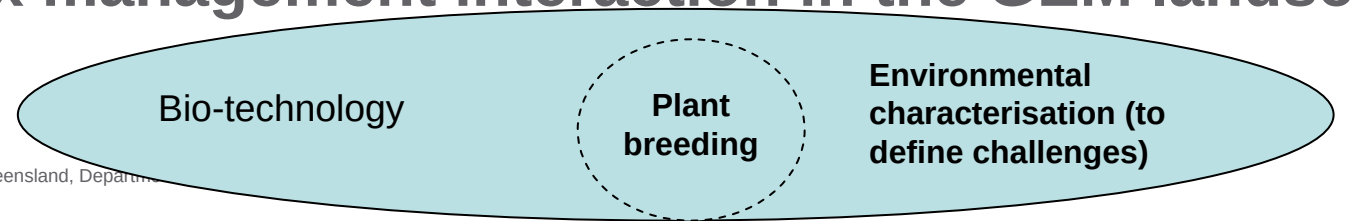
- What traits should be considered for selecting parents in a crossing program?
- What environments will be suitable to test their lines?
- Which environments will their lines be better adapted to?
- Crop improvement becomes complicated for variable environments due to high g x e x m interactions

Lack of understanding about contributing factors can lead to

- **Undefined environmental challenges**
- **Under exploitation of the environmental potential – the yield gap**
- **Seasonal fluctuations in yield will remain large**
- **Slows progress in breeding**
- **Farmers profitability and interest in the crop will decline**

Biological characterisation of physical environment using crop models

- Helps identify factors that determine the yield potential and influence genotypic performance
- Characterise target population of environments (TEP) experienced by the crop in a region
- Assist in evaluating the role of different traits in conferring adaptation to different TEPs
- Define agro-ecologies based on above considerations
- Identify the most productive genotype x environment x management interaction in the GEM landscape



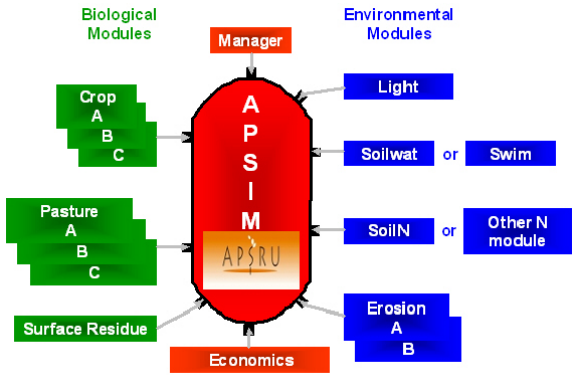
Defining agro-environments: a case study with mungbean

- Used mungbean as a case study to characterise its environments in the Northern Grains Region
- The industry has evolved well over the last 10 years
- Yields have remain low and variable
- The breeding focus has been on quality and disease resistance
- Adaptation to climatic variability equally important?

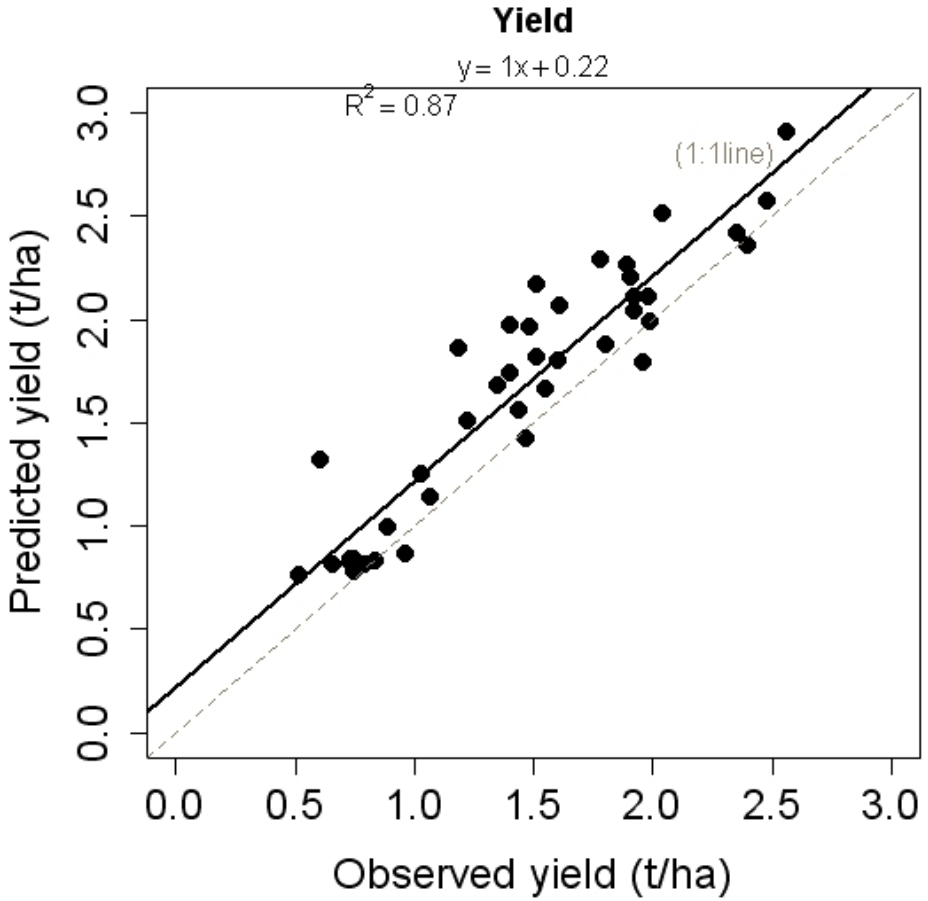
Characterising environments

- What type of production environments mungbean experiences in the region?
- Do these affect yield and by how much?
- Based on this info can breeders choose better test sites?
- Do we have environments which are similar (iso-environments)
- Traits that will confer better adaptation to these iso-environments

Characterisation of mungbean environments: model validation

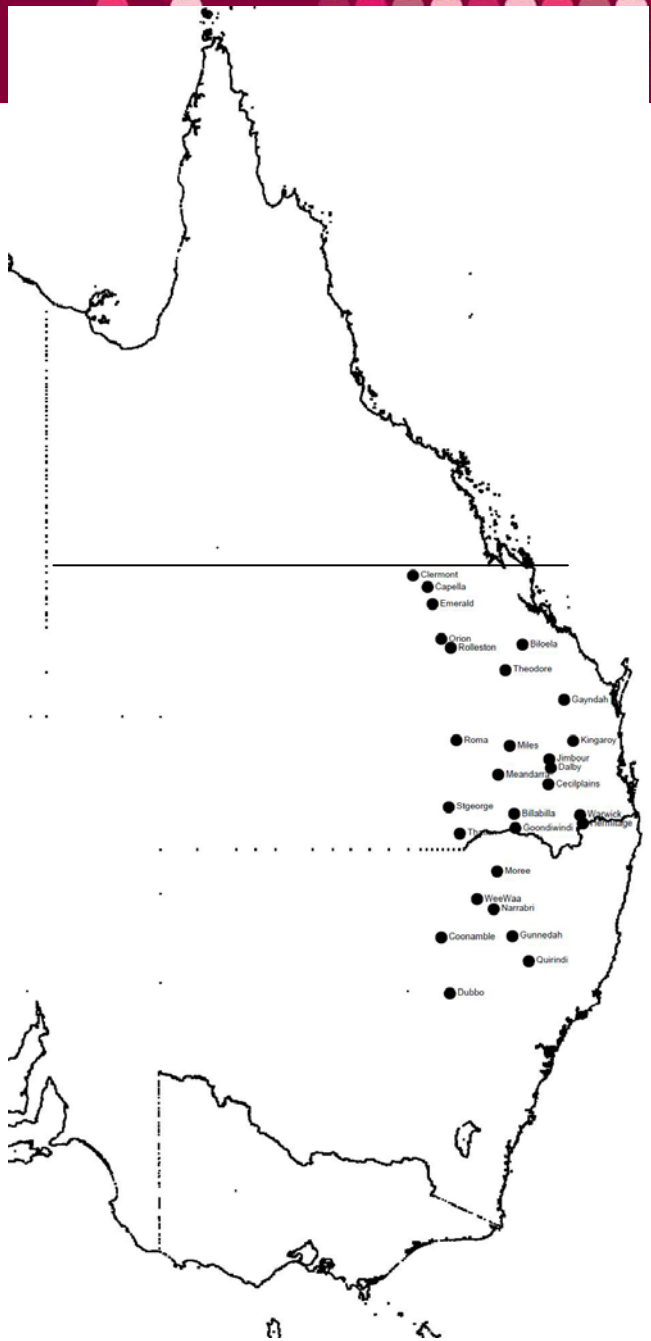


The APSIM Model



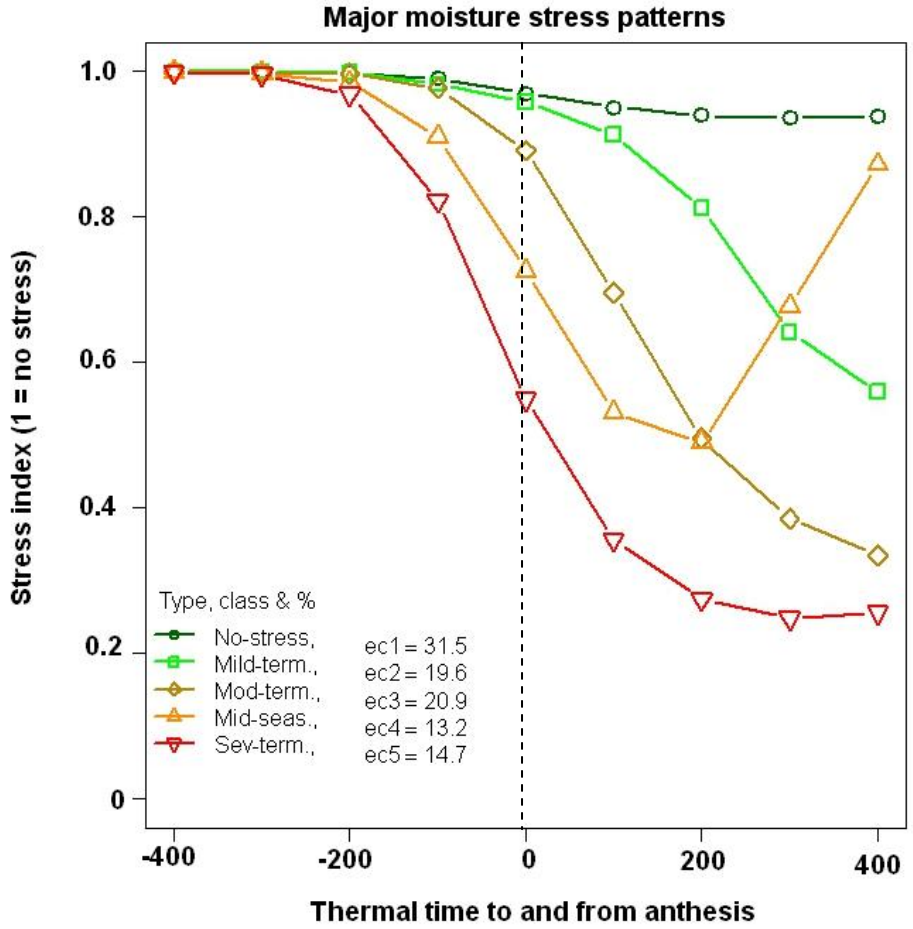
Validation with observed data on Crystal

Sites used in the study



Mungbean experiences five dominant moisture patterns in 28 locations of NGR

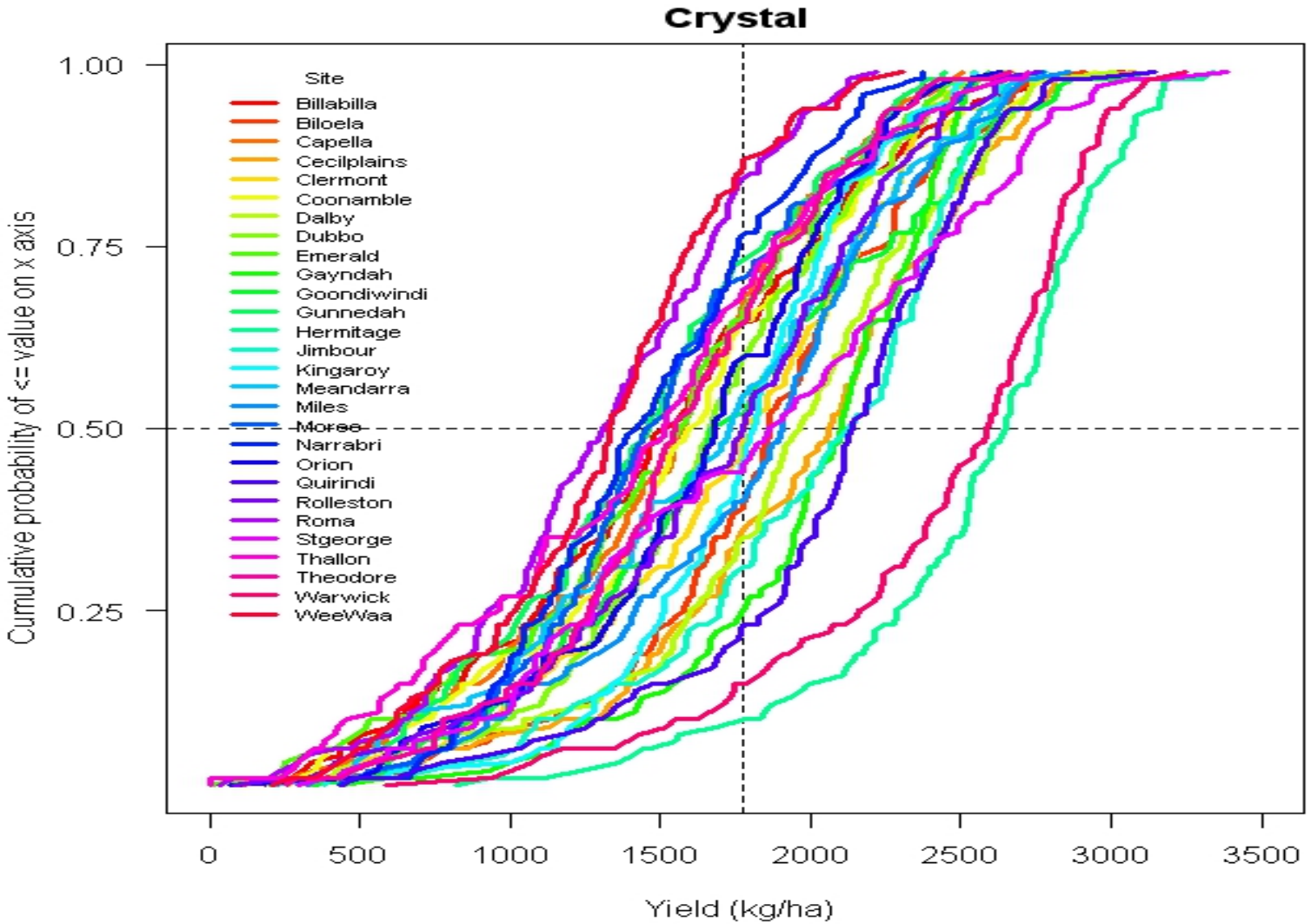
No stress



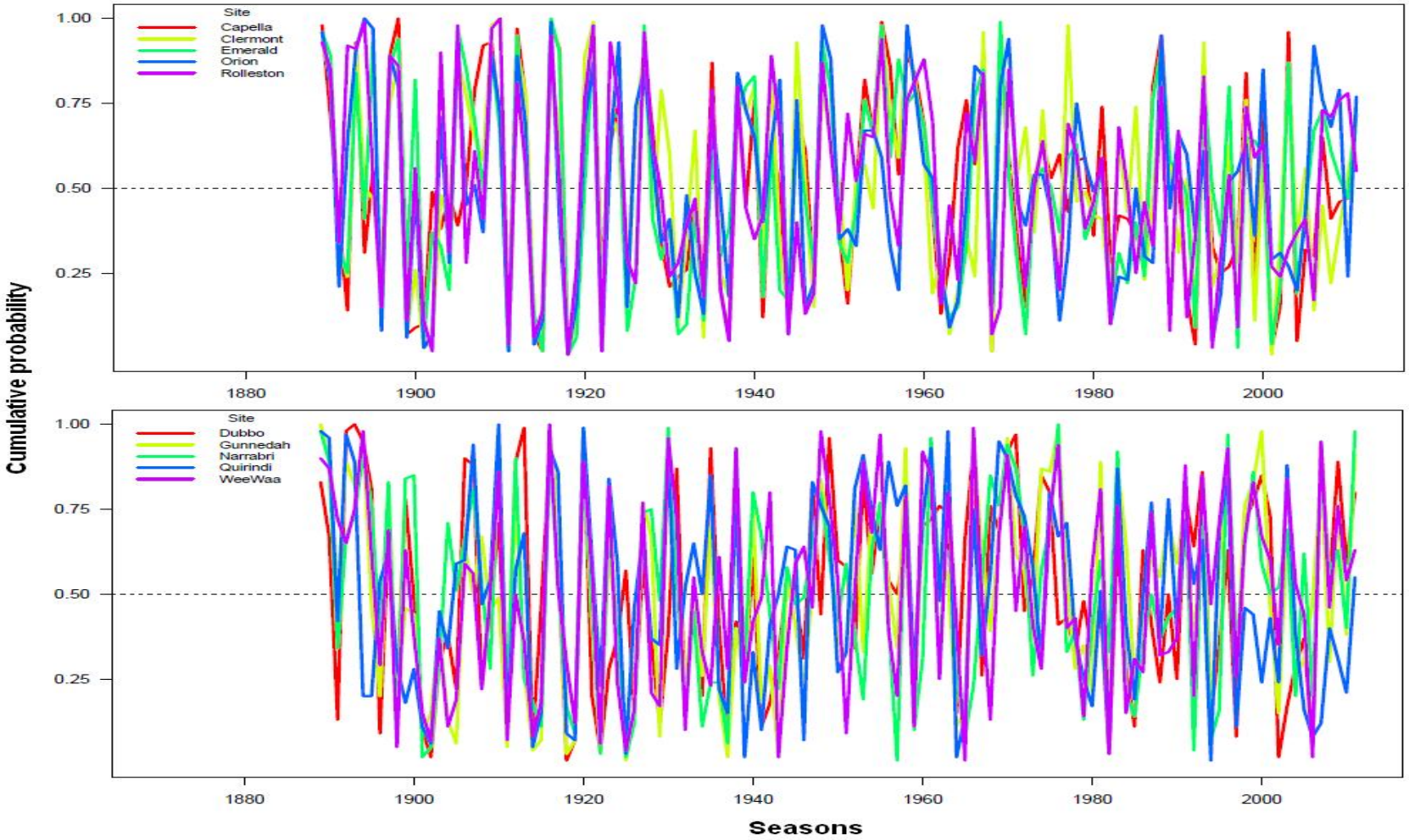
Stress

Drought adversely impacts mungbean in >2/3rd of the years

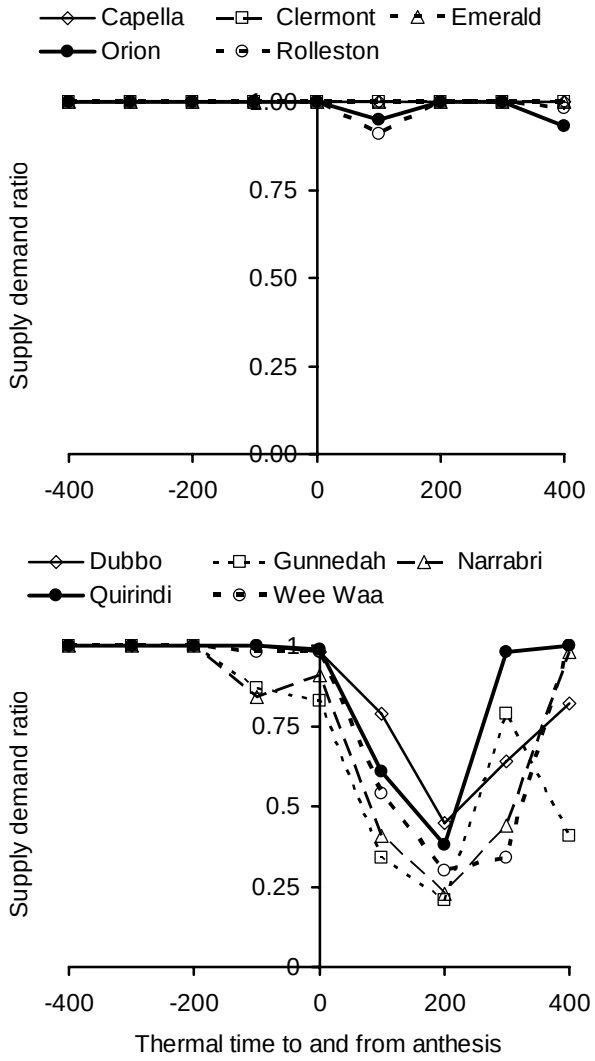
Extent of variability in yield



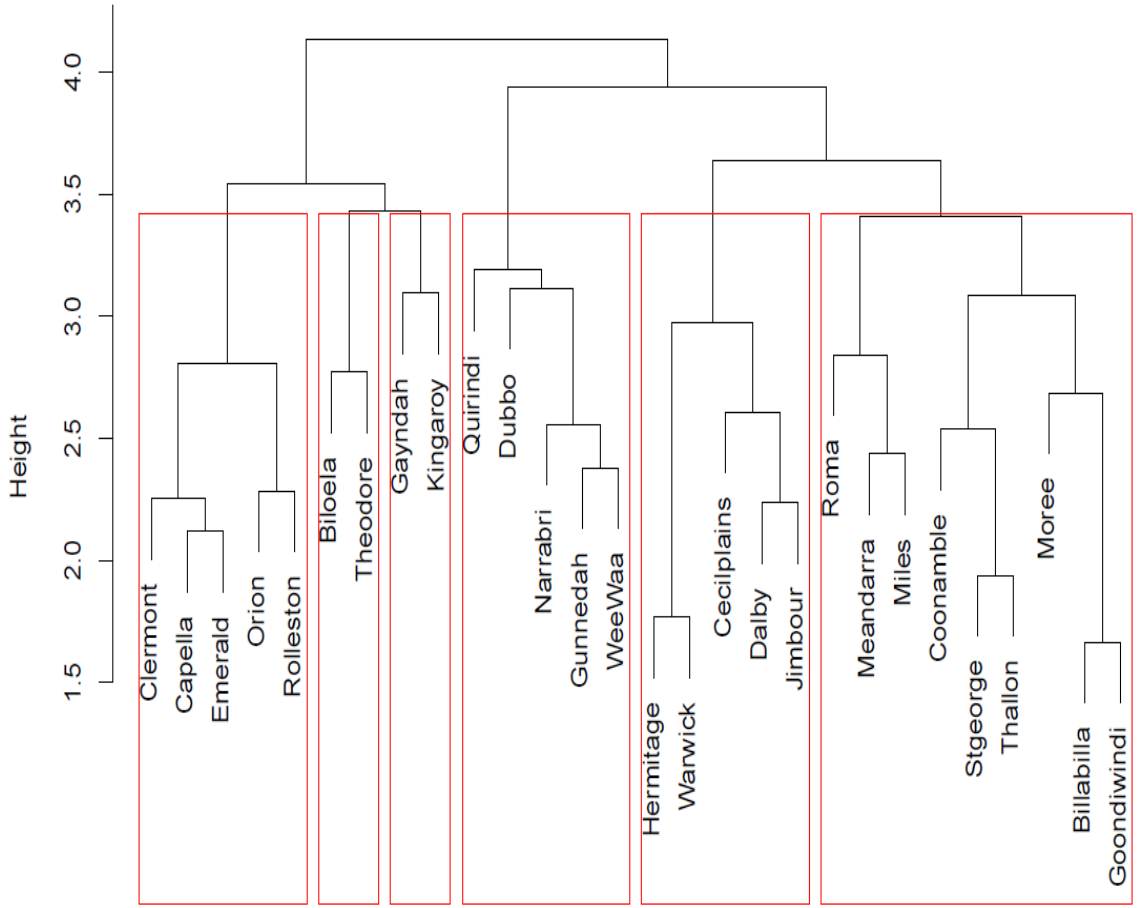
Cumulative probability distribution acorss seasons among a few sites

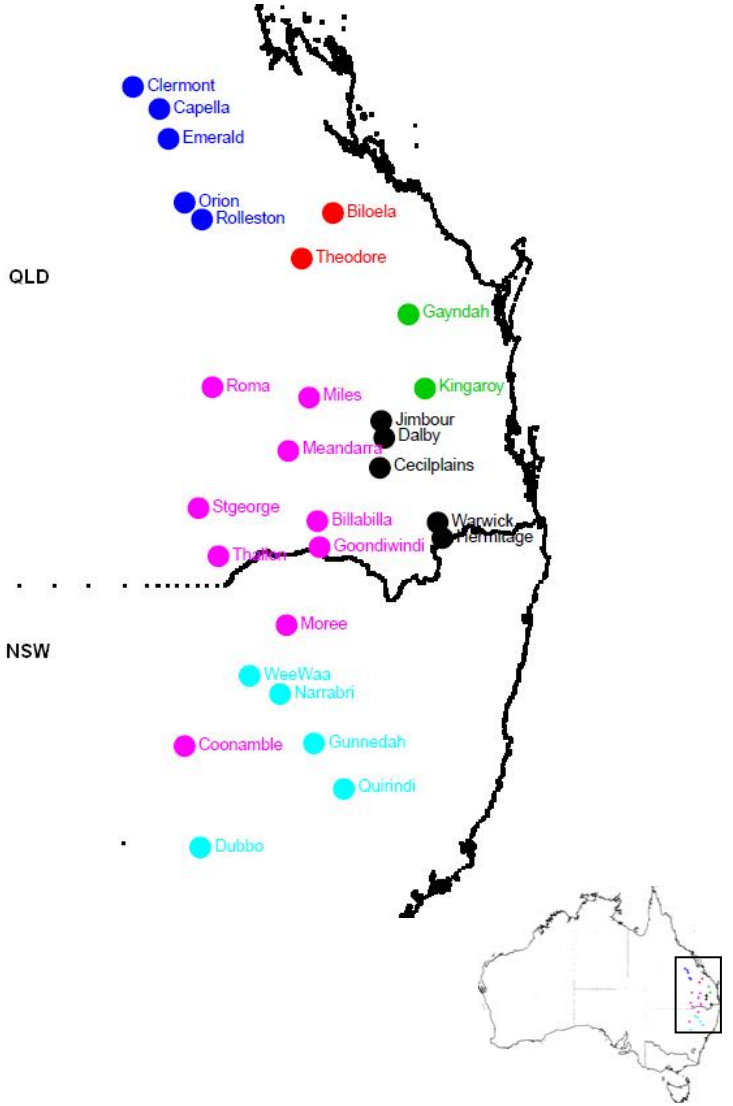


Stress patterns in the sites of two different clusters

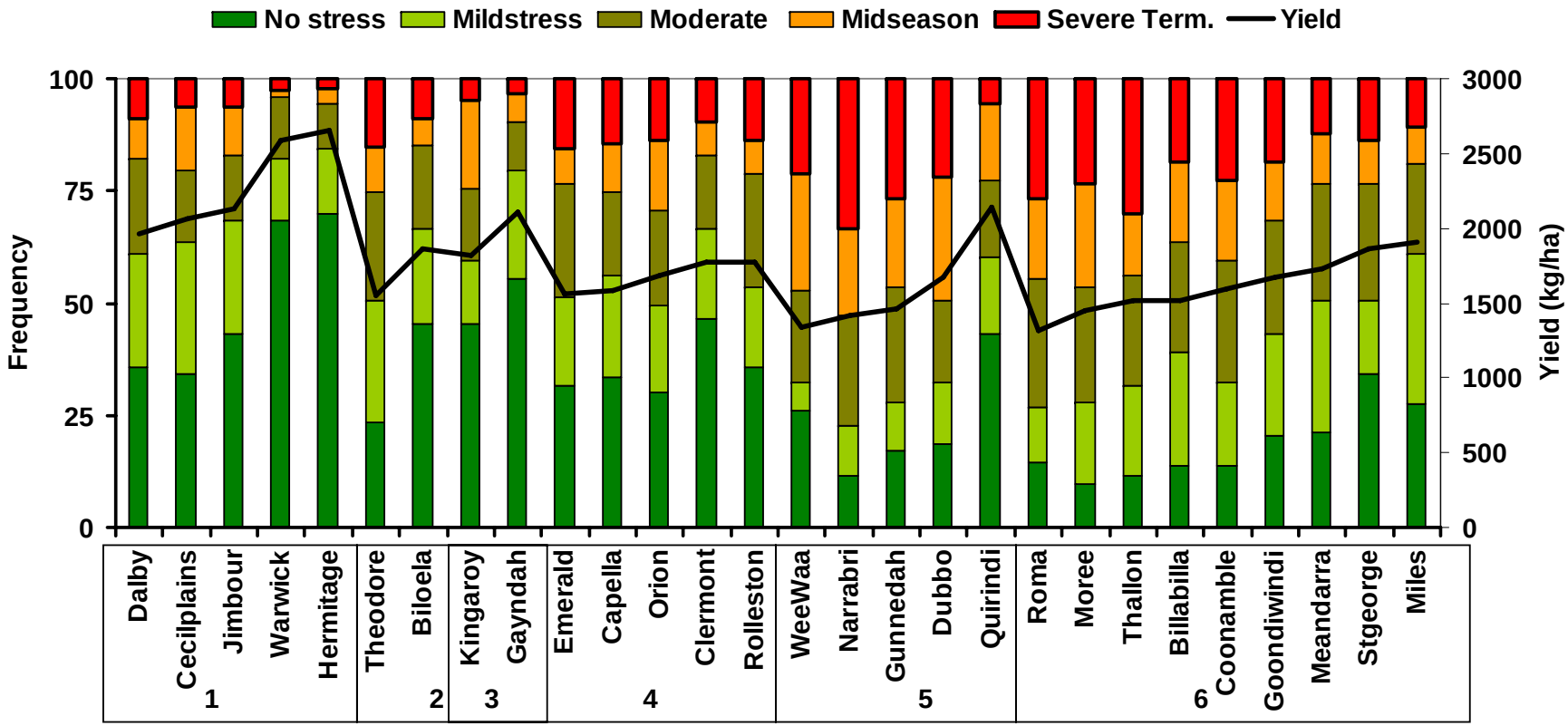


Defining agro-ecoregions based on seasonal risk to production

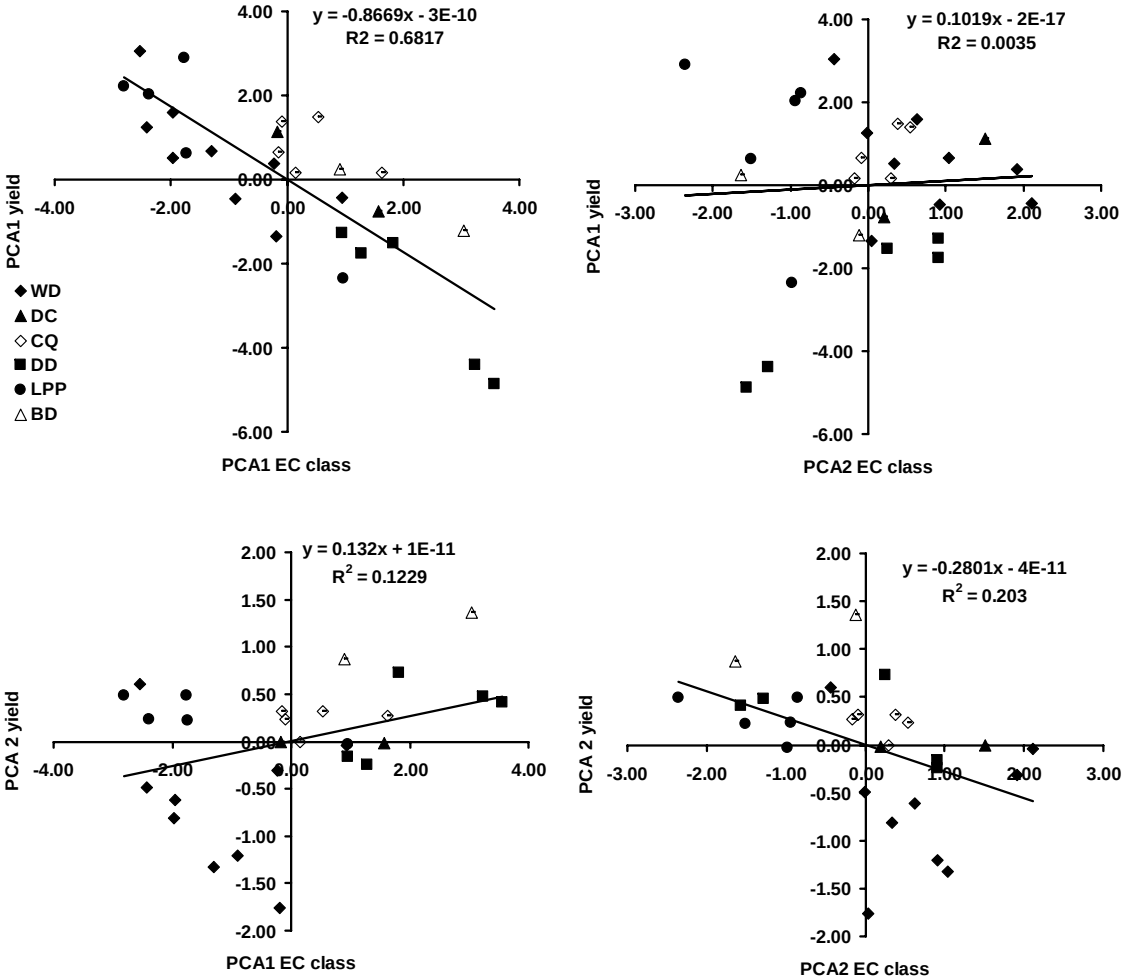




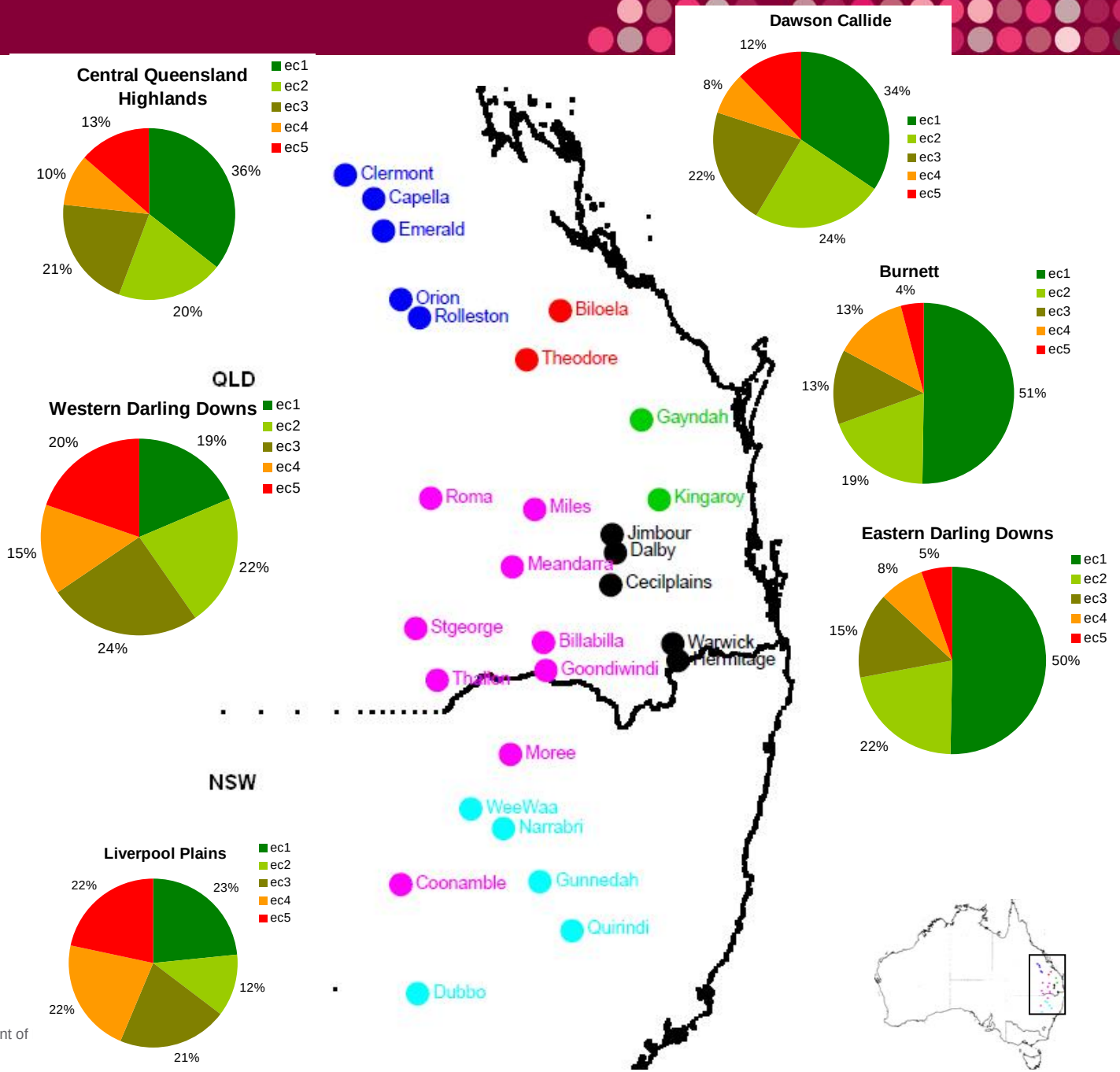
Frequency of stresses at individual sites in the NGR



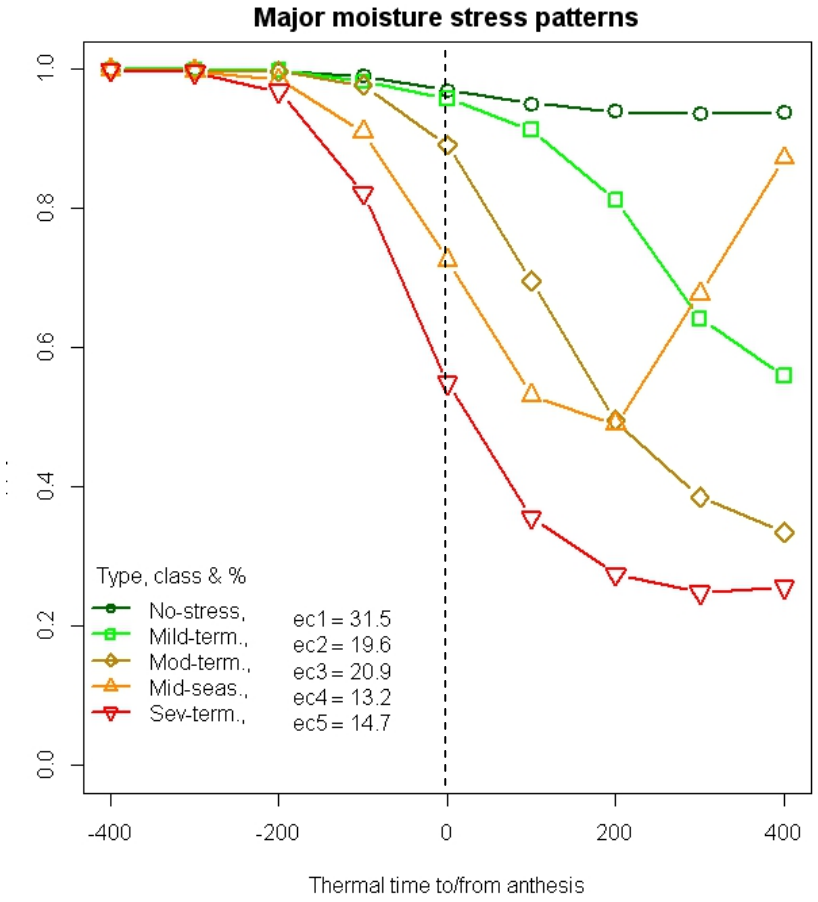
Principal component analysis of yield and drought frequencies



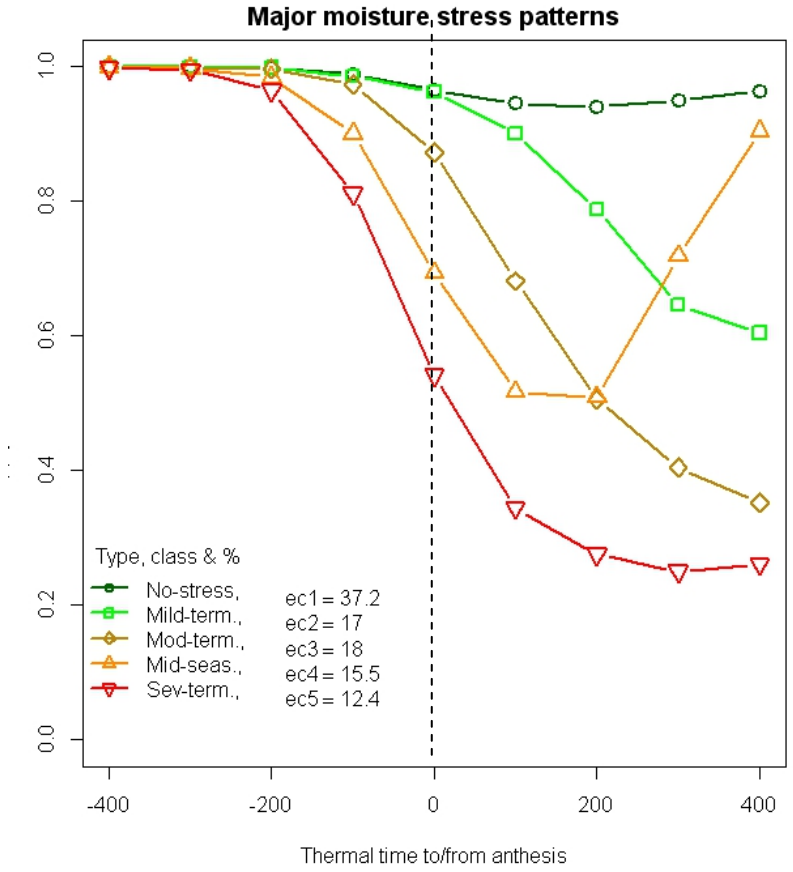
Defining agro-eco regions and frequencies of moisture patterns



Do traits affect drought frequencies?



Crystal



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Summary

- A novel method to define mungbean agro-ecoregions using APSIM has been developed which helps identify drought challenges in different regions.
- This new method can greatly increase the geographical relevance of crop modelling work.
- The types and frequencies of drought patterns mungbean experiences in Queensland have been characterised
- Overall drought reduces yield of mungbean in about 2/3rd of the years (when diseases and insects are under control)
- A paper that discusses implications of this work for breeding and agronomy is being submitted to Agriculture and Forest Meteorology