IMPROVING TRANSPIRATION EFFICIENCY IN SUGARCANE

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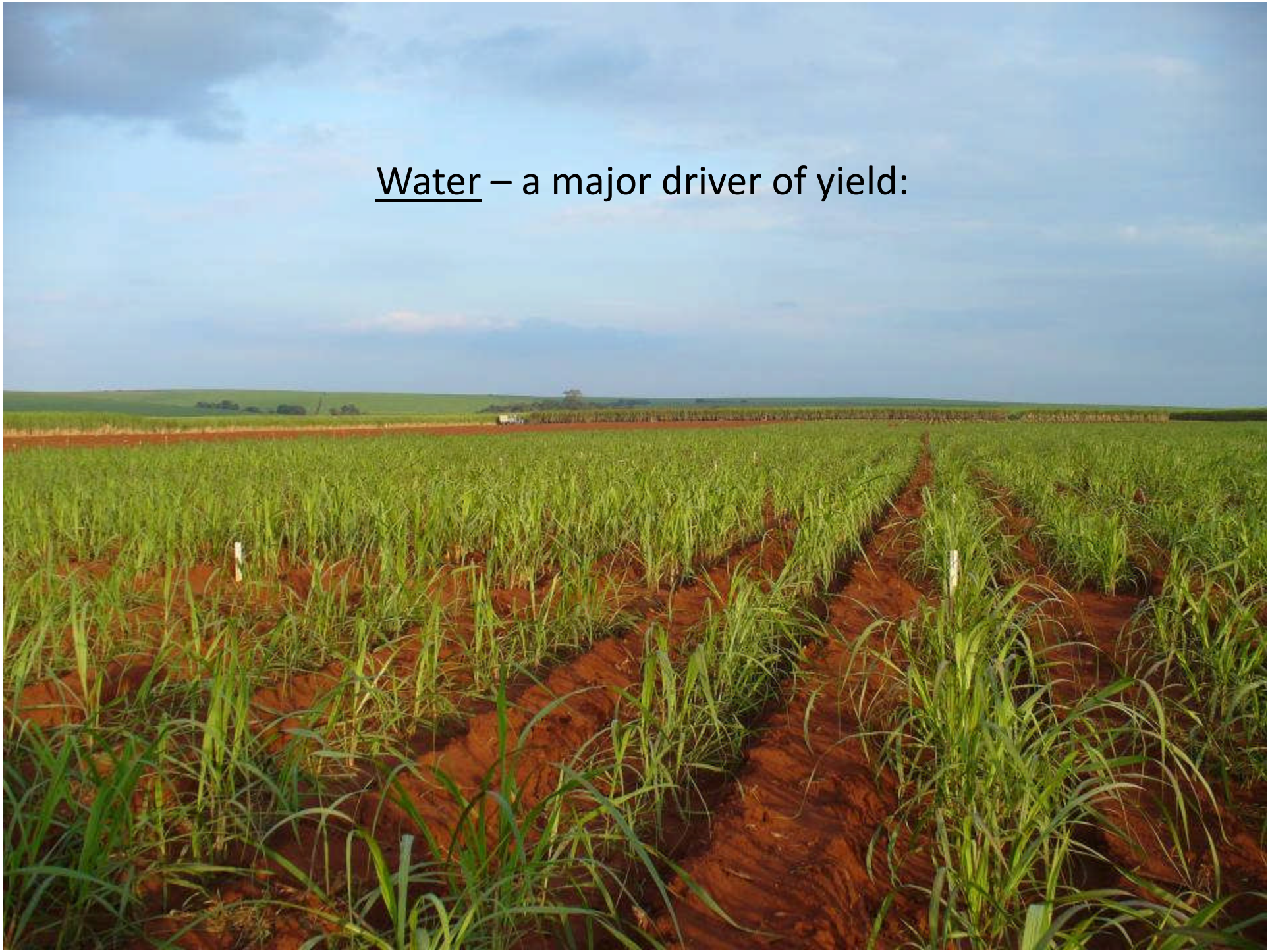
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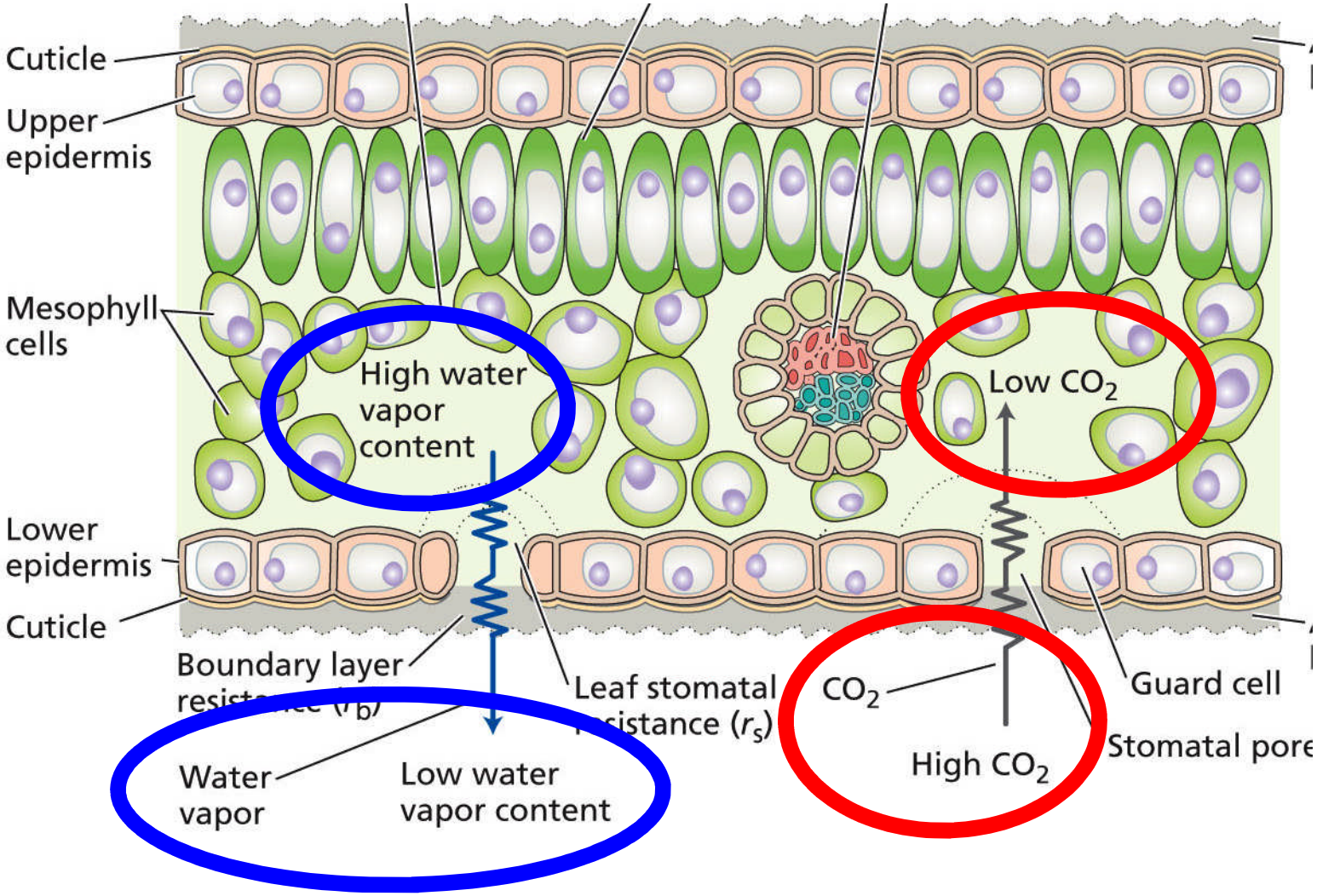
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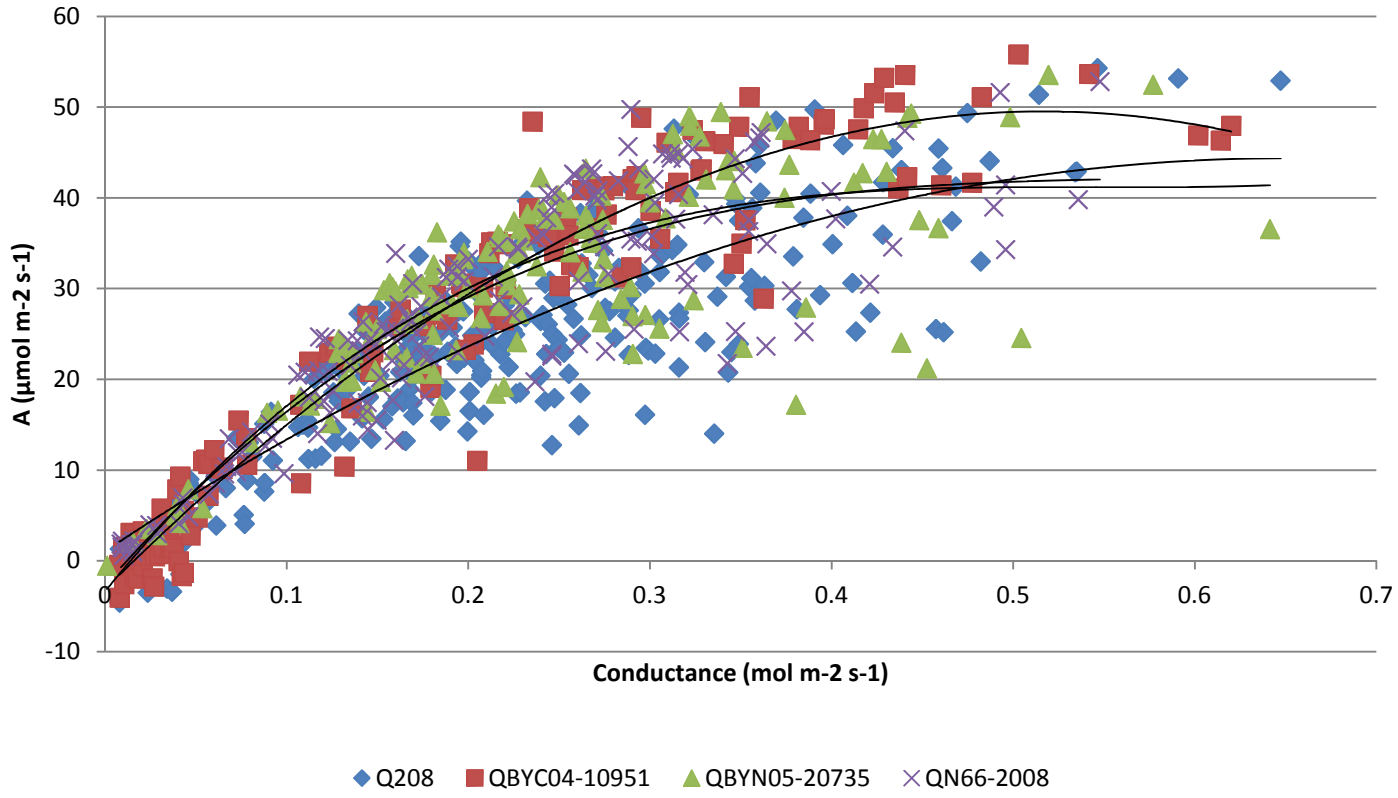
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Water – a major driver of yield:

A plant needs to draw in CO_2 for photosynthesis, but cannot help but lose water at the same time…



Photosynthesis rate closely related to conductance



Definitions

Water use efficiency : Biomass produced per water used

Water used by crop = transpiration + soil evaporation + drainage

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Water used by crop = transpiration + soil evaporation + drainage

Transpiration efficiency: biomass produced per water transpired

Yield (t/ha) = Transpiration efficiency (t/ML) x Transpiration (ML/ha)

Transpiration efficiency (TE)

Yield (t/ha) = Transpiration efficiency (t/ML) x Transpiration (ML/ha)

Yield maximised by increasing transpiration OR increasing TE

No breeding up to now for high TE – breeding to date may be selecting against high TE due to competition effects in early growth (later)

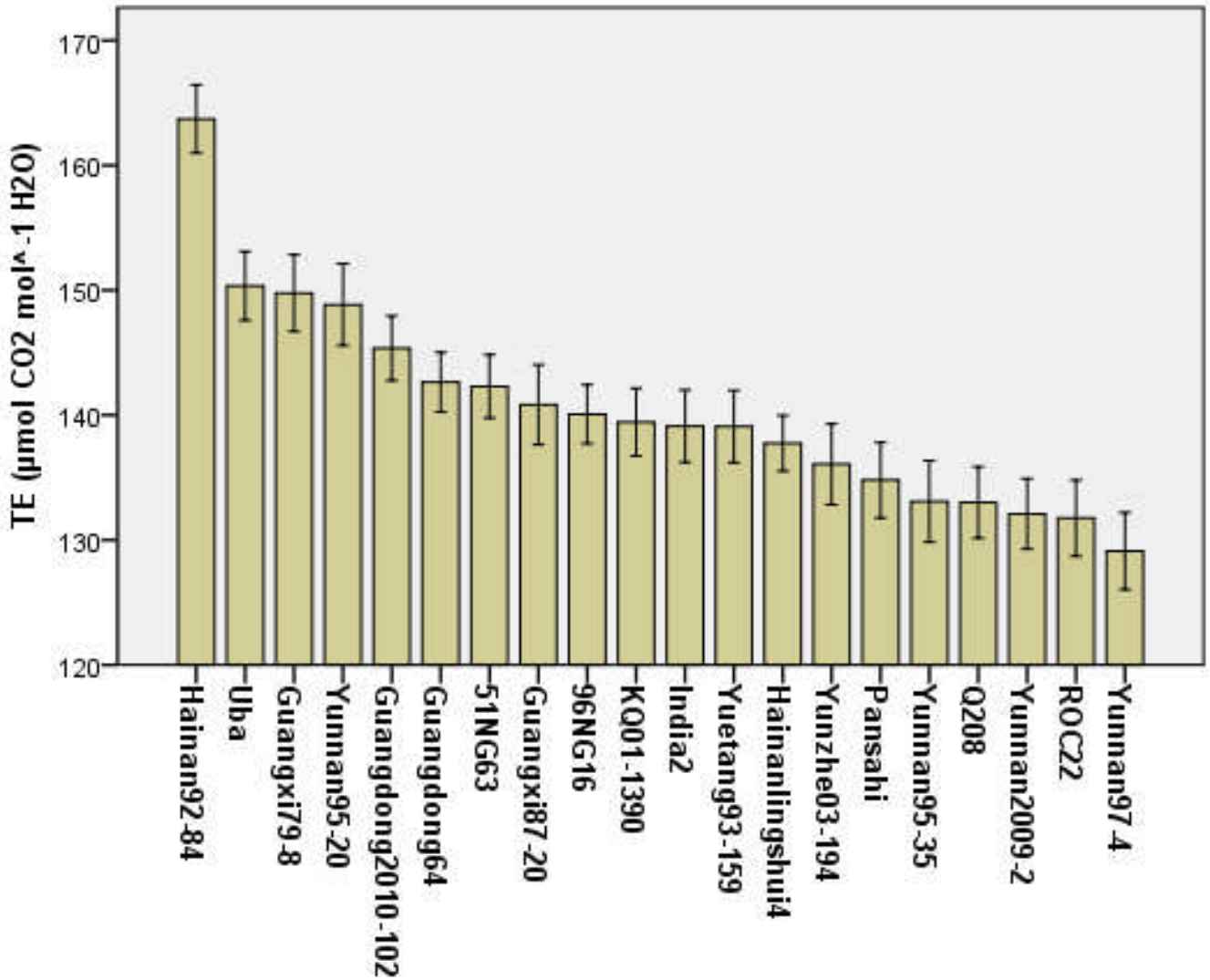
Economic impact of improving TE is a complex question but may be very large:

- Depends on extent of genetic variation
- Depends on environment, and timing of stress for rainfed environments
- Depends on water costs and limitations in irrigated systems

There is important genetic variation for TE in sugarcane even in commercial types - eg:

Clone	TE (g/L)
QN66-2008	8.28
Q183	6.67
Q200	7.22
Q208	7.47
KQ228	5.95
LSD(P<0.05)	*1.46*

…and variation may be even bigger in wild germplasm…



How important is this variation?

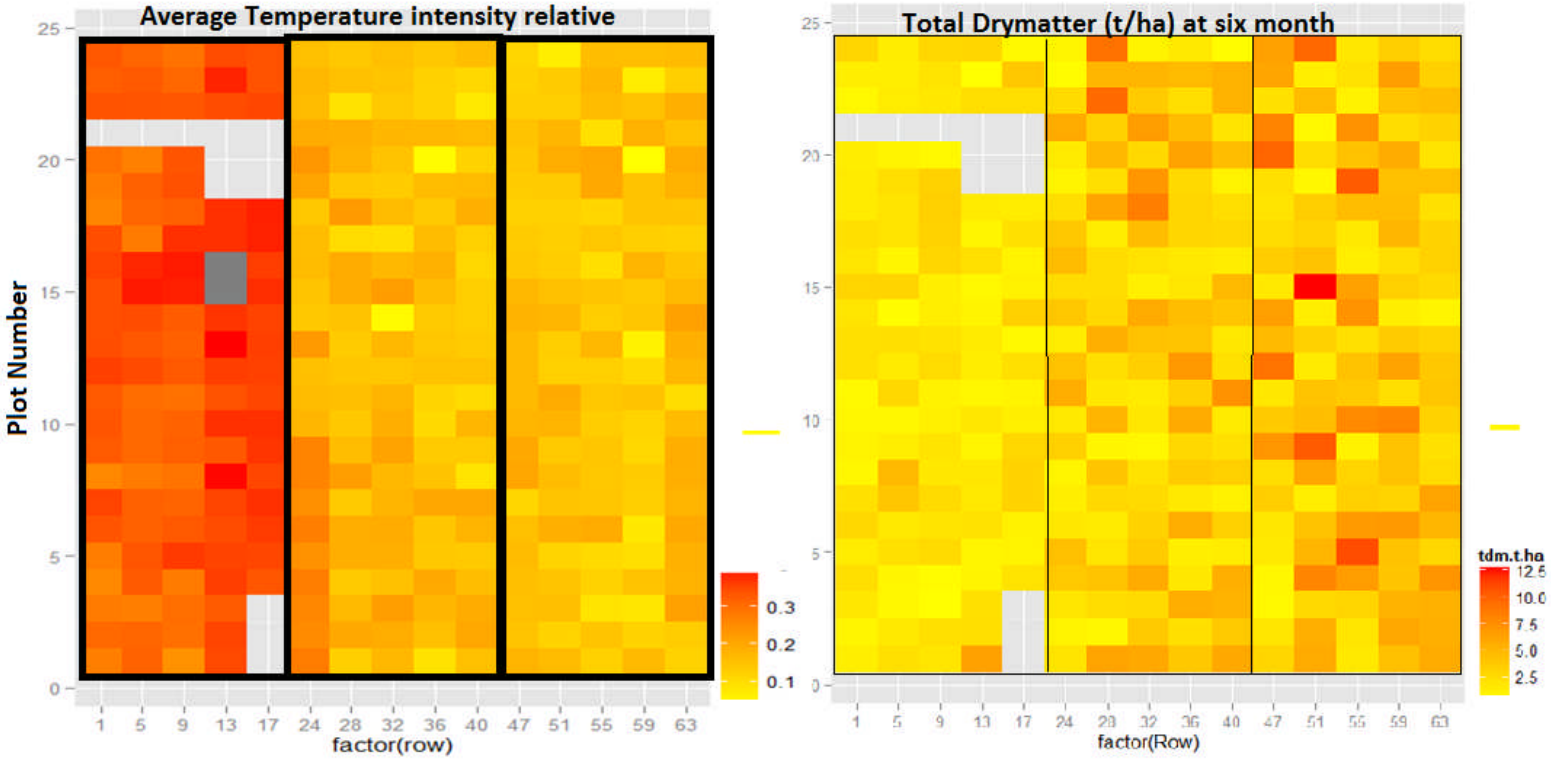
- In environments where available soil moisture has “run out” – increased yield will be proportional to TE
  - Eg. 40% increase in TE = 40% increase in yield



Targeting two applications in breeding:

1. Introgression and parental development
   - Seeking extreme responses in parental material for subsequent breeding
2. Routine selection in commercial breeding

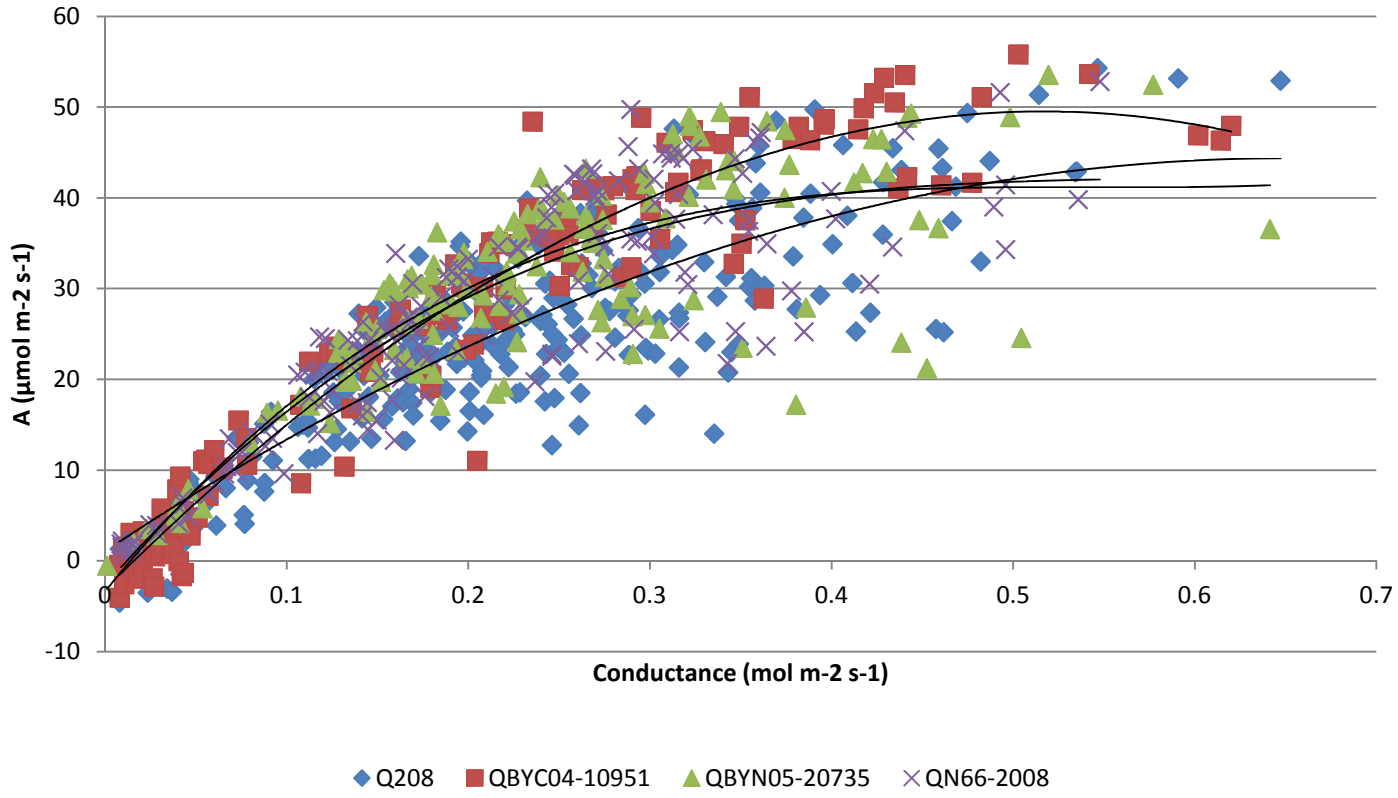
Canopy temperature – new ways to cheaply measure large scale trials; & correlated with transpiration rate



TE ~ Yield/(1/temperature)

One complication - TE may be negatively genetically correlated with rate of transpiration.

Need to simultaneously measure conductance, or yield, for optimal selection



Hypothesis - optimal selection index

- Yield + canopy temp measured several times at single site
  - Yield + TE a better predictor of yield in water limited environments
  - Theoretical predictions suggest this will improve gains from selection, but yet to be tested in practice through measuring realised gains

Summary

- Transpiration efficiency a key trait, but improvement probably hasn't occurred in normal breeding because of components negatively related to yield and competitiveness
- High genetic variation in TE exists
- Ways to use this trait in breeding being explored
  - Introgression of extreme expression
  - Use in selection indices together with yield

Acknowledgements

- Funding - Sugar Research Australia, Department of Agriculture, Australia; Yunnan Academy of Agricultural Sciences, CSIRO
- Technical staff in SRA, CSIRO, YSRI

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