Phenomics 2.0 Where to now?

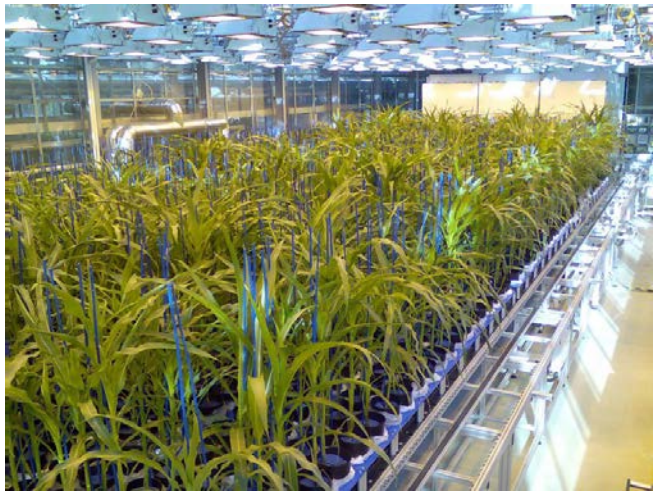
Bob Furbank
Director CoETP ANU

How big is YOUR platform?

In the beginning there was…..

BIG SCIENCE and Cool Kit

Platform envy:
“How many pots can you fit on YOUR belt?”
“I have a 10 Tesla magnet, how big is YOURS?”



Horses for Courses?

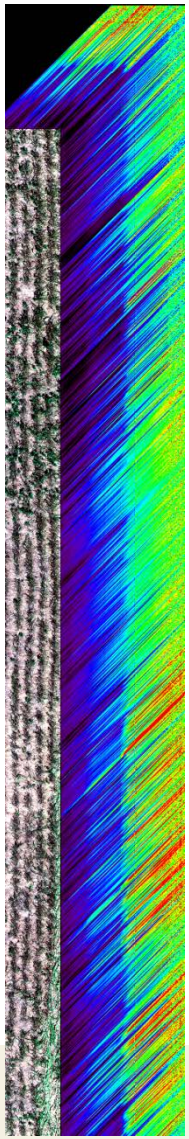
High Resolution
Research Grade
High Cost

Lower resolution
Fit for purpose
Low Cost

What is your science question?
Big monolithic platforms are NOT dead!

ARC CENTRE OF EXCELLENCE FOR translational photosynthesis

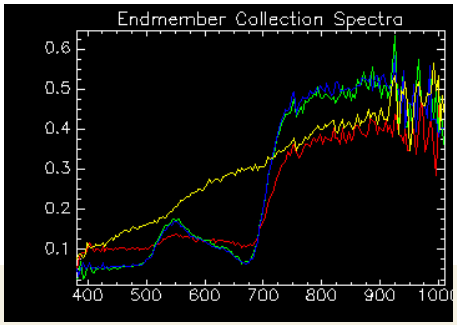
What is “new” about Phenomics Data?

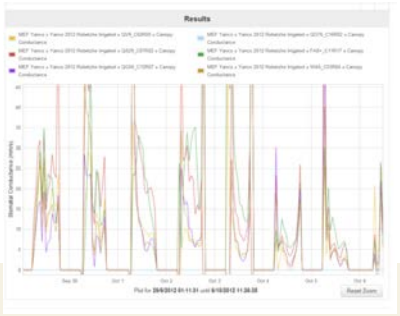


- **BIG data : High throughput, high resolution, time resolved.**
- **Multimodal / multidimensional 4D, 5D nD.**
- **Non-destructive: we can follow many individuals over time**

BUT

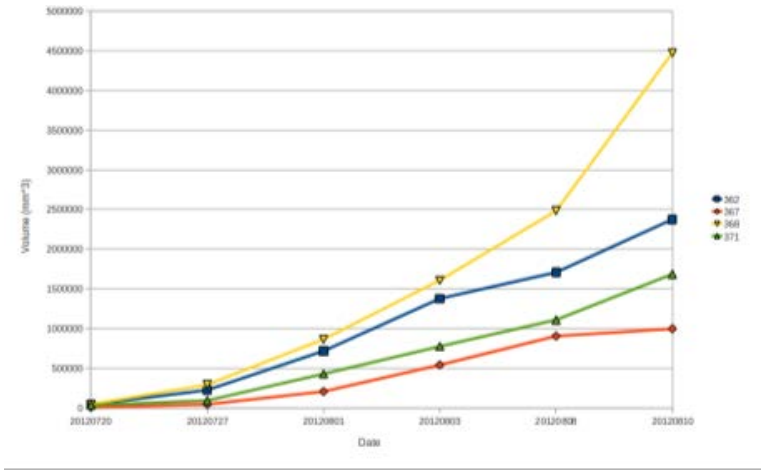
What is the best analytical platform to get the most from it?

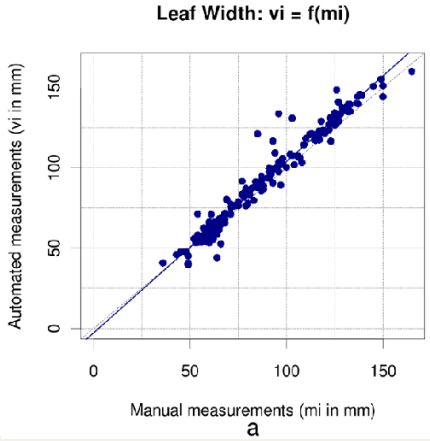


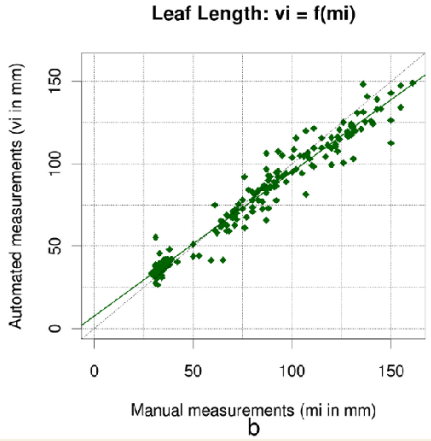


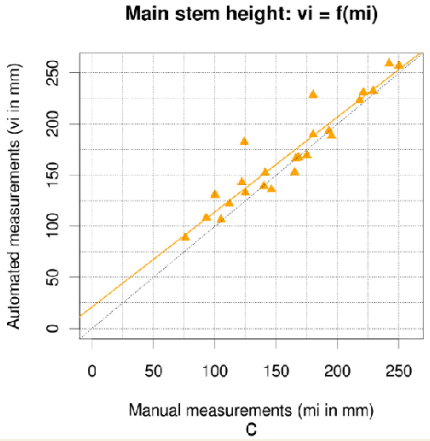
ARC CENTRE OF EXCELLENCE FOR translational photosynthesis

Time Series Data: What we do well



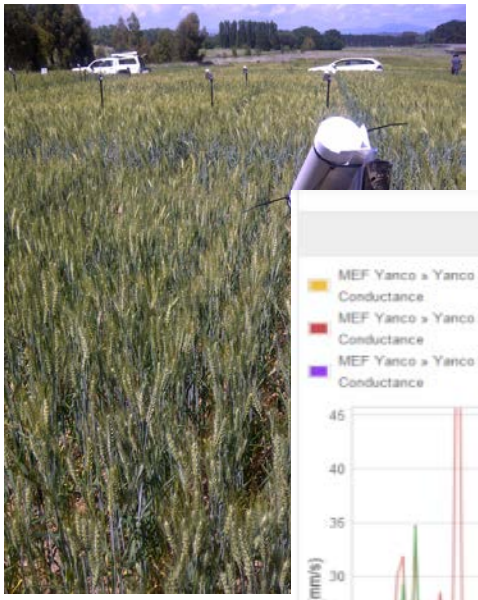


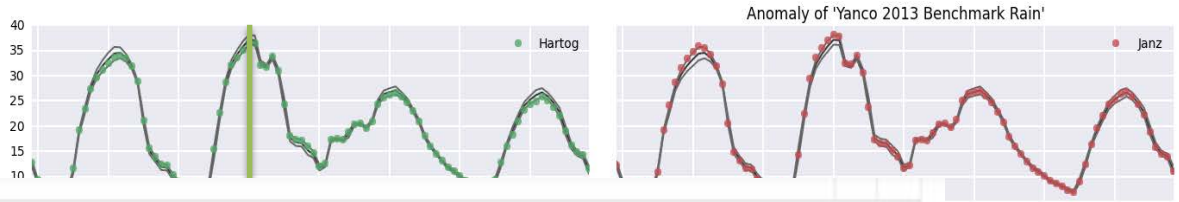


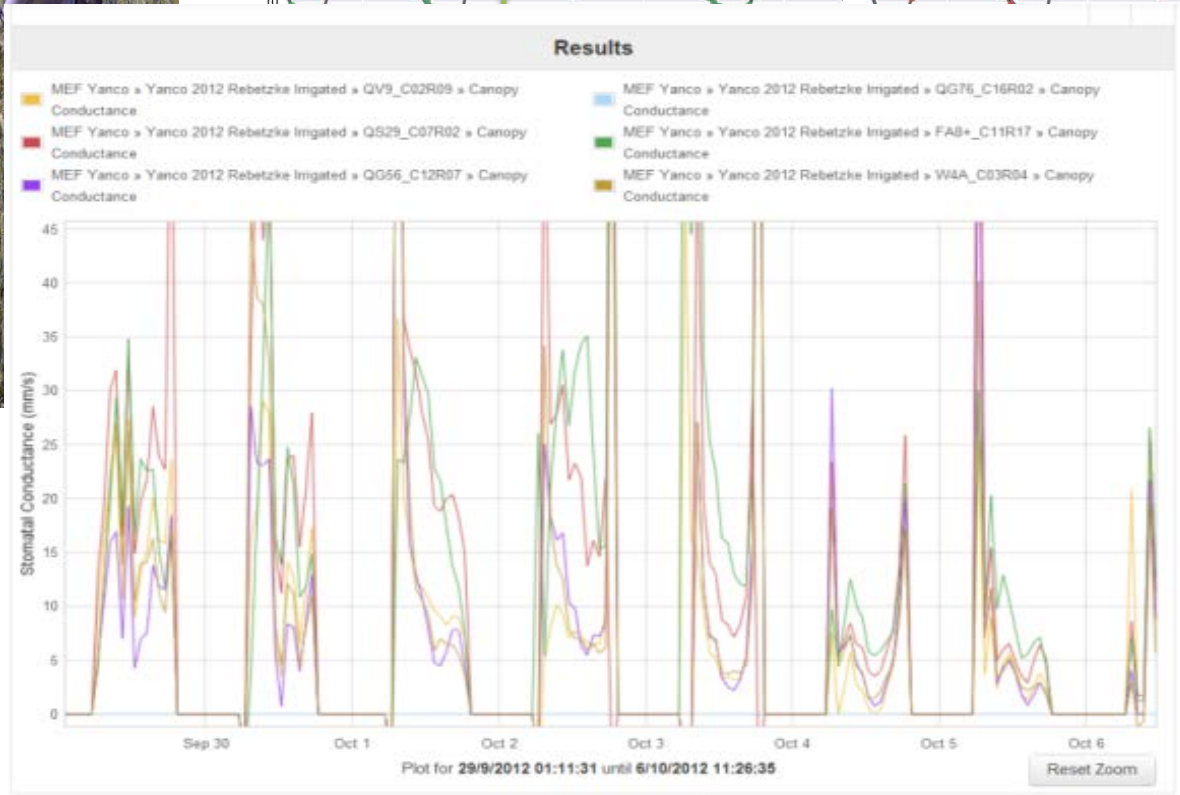


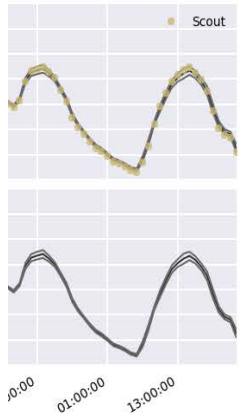
ARC CENTRE OF EXCELLENCE FOR translational photosynthesis

..and what we don't





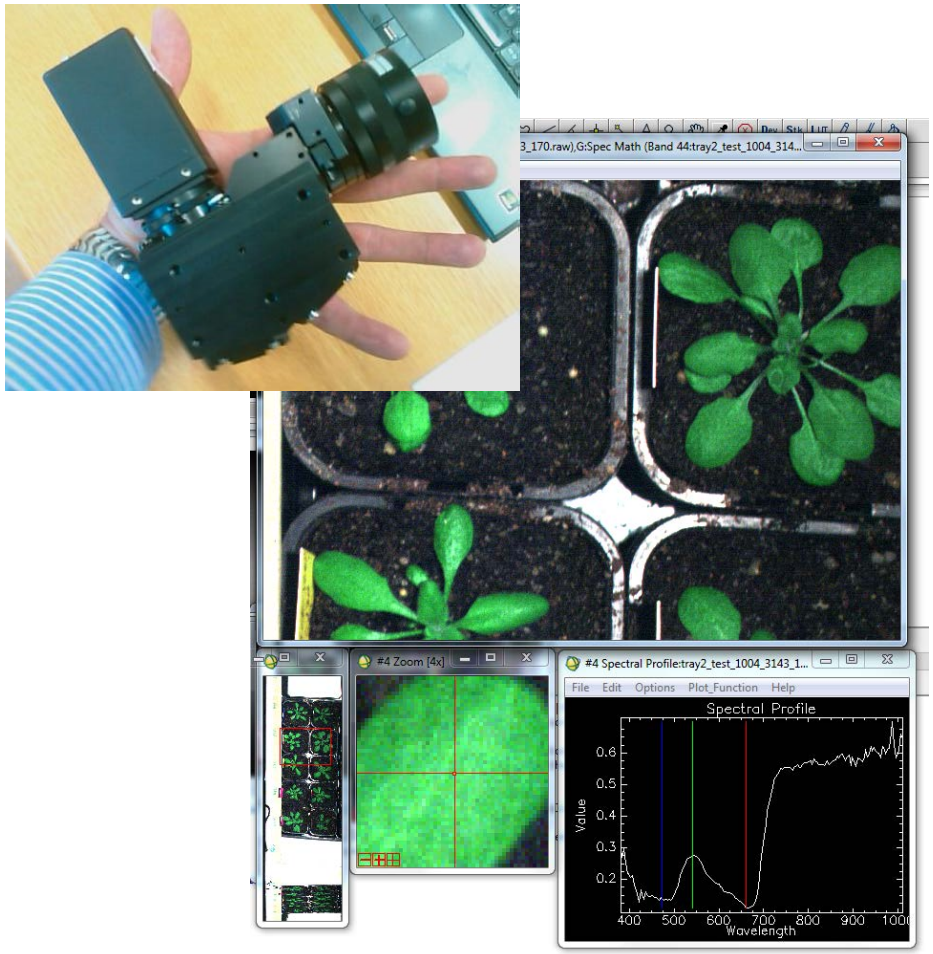


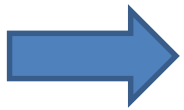


Need new statistical approaches for time series data and enable dynamic QTL mapping

ARC CENTRE OF EXCELLENCE FOR translational photosynthesis

Approaches to multidimensional data

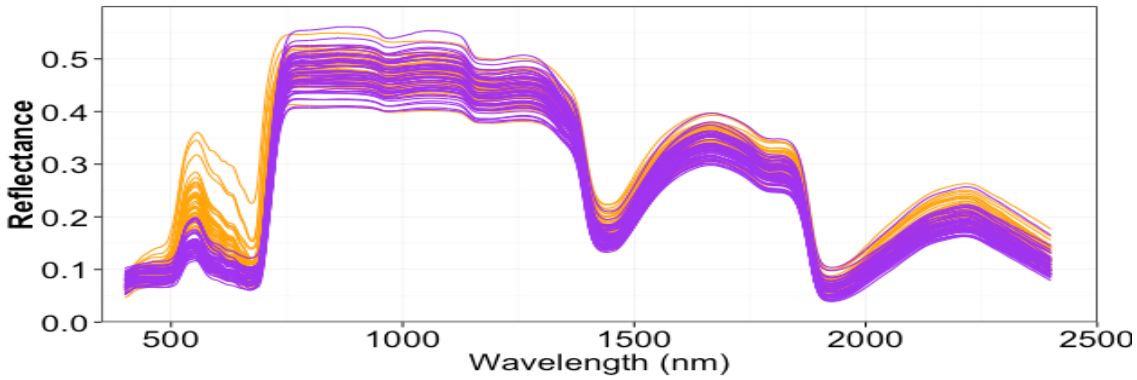


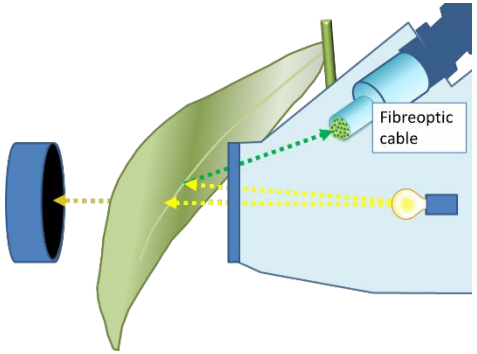


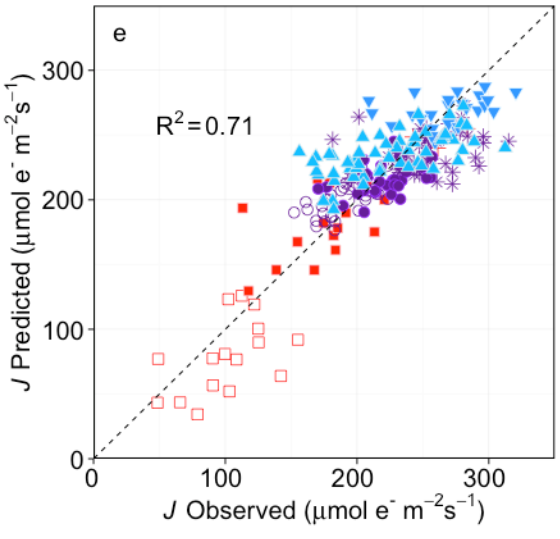
Visible Red Edge

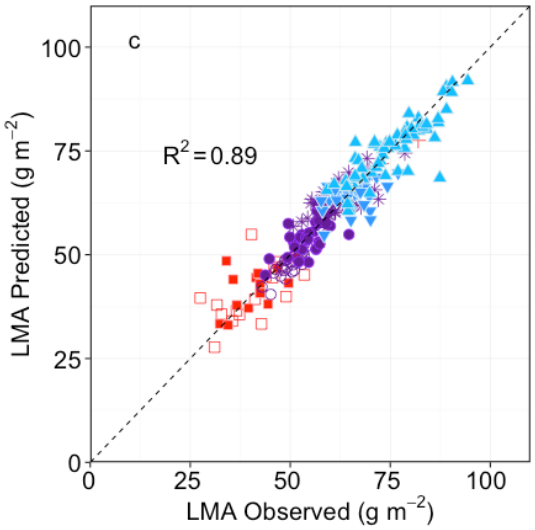
Red Edge: 680 – 780
PRI : 531 – 570
NDVI etc :
red (650) / NIR (900-1200)

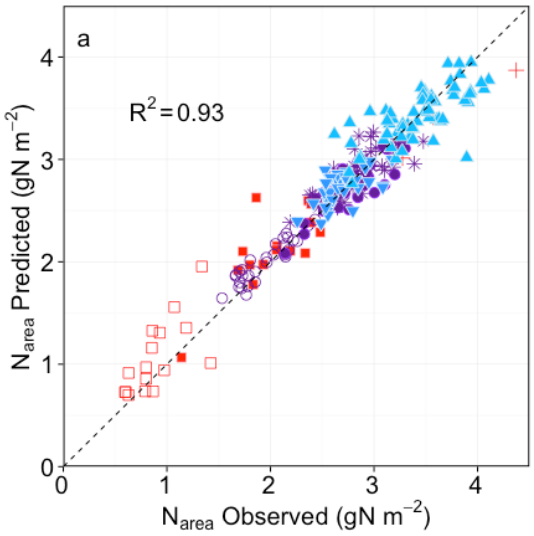
Machine Learning and Statistical Approaches : Trait Based Surrogates











Silva Perez 2016; also using in wheat, rice, sorghum

ARC CENTRE OF EXCELLENCE FOR translational photosynthesis

Spectral Models for Genetic Mapping

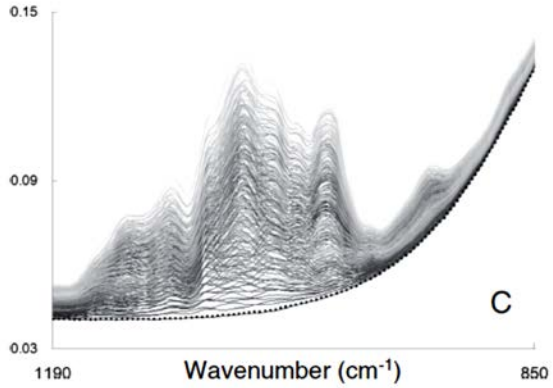
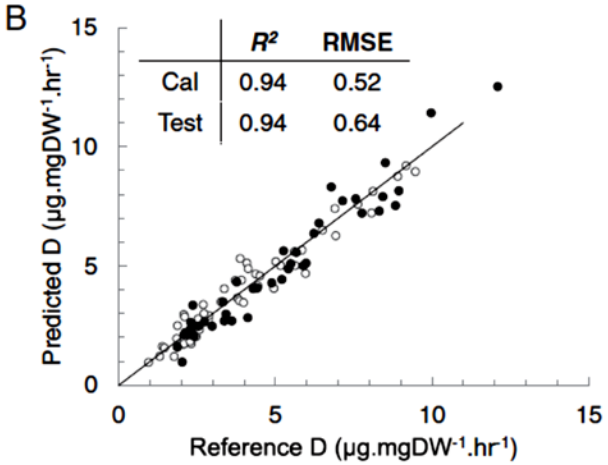
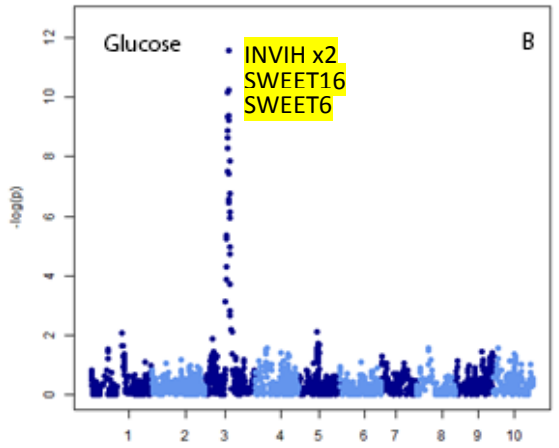
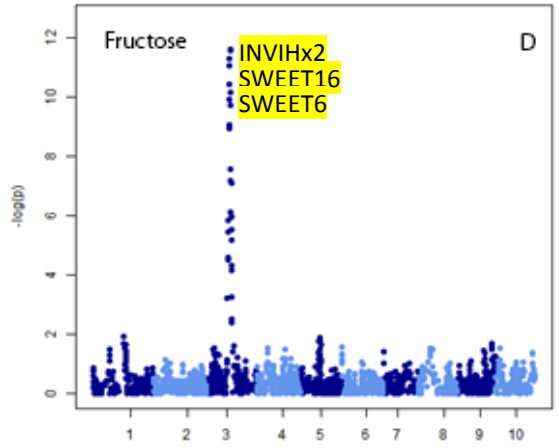


Figure 3 FTIR spectra of pure sugars, *S. bicolor* juice, and the PLS model calibration set. FTIR spectral fingerprint region



Sweet X Grain Sorghum RILS



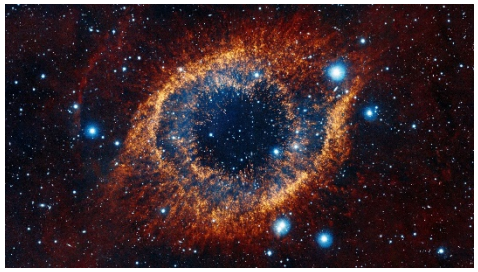


Martin et al 2013

Palmer et al (unpub)

ARC CENTRE OF EXCELLENCE FOR translational photosynthesis

Turning Data into Knowledge: A Truly 'Omics approach?



"We are like the early astronomers Bob……"

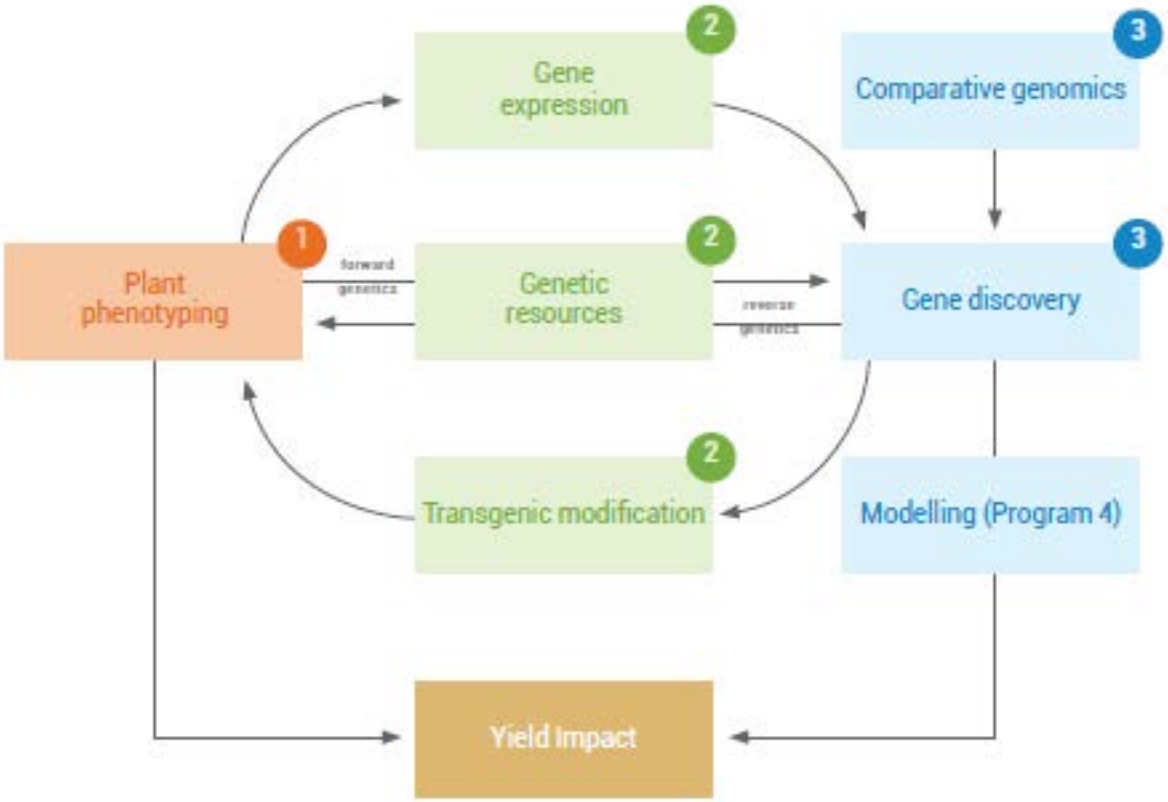
Anon

"Bob, I am going to project my data into 200 dimensional hyperspace"

Alex Ivakov

Should we shake off traditional trait-based surrogate approach in data analysis and map the digital data?

Show us your Phenes and Genes: Genome to Phenome / Phenome to Genome



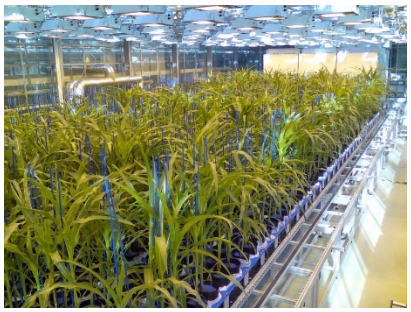
Mining variation in photosynthetic performance in both C3 and C4 crops and model species for germplasm and genes by:

- ***Phenotypic screening for variation in photosynthetic traits***
- ***Mining genome sequence for allelic variation in candidate genes***

Rice, wheat, Sorghum, model species

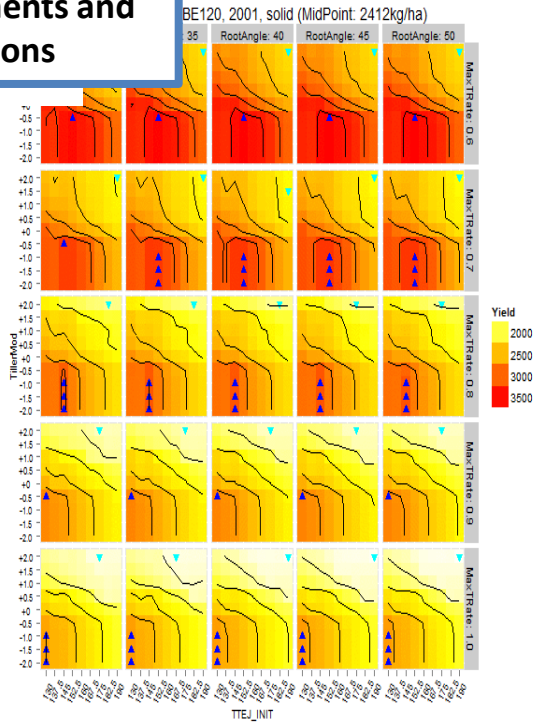
ARC CENTRE OF EXCELLENCE FOR translational photosynthesis

A Vision for In Silico Breeding?

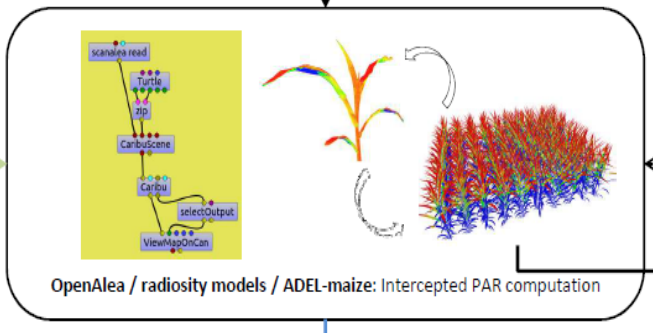


+

Evaluation of trait value across environments and seasons

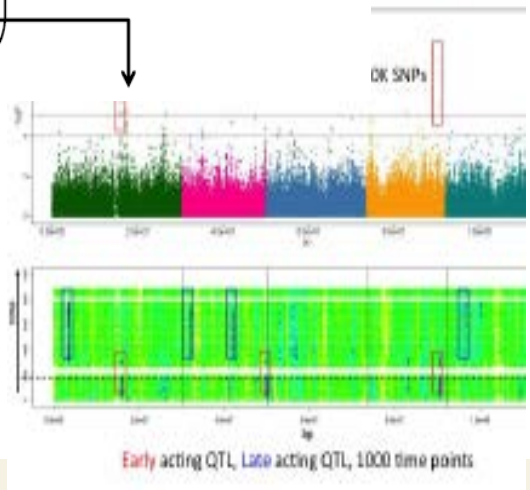


Environment (light quality and quantity; air temperature; VPD)



OpenAlea / radiosity models / ADEL-maize: Intercepted PAR computation

Predictive, structural and functional modelling; P2G G2P and informatics



ARC CENTRE OF EXCELLENCE FOR translational photosynthesis