

Utilizing Genomics and Phenomics in CIMMYT wheat breeding

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Outline

- Genomics & phenomics in breeding pipeline
- Key learnings
- New directions



Collaboration



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BILL & MELINDA
GATES foundation



Breeding cycle at CIMMYT

P1 x P2



F1 or Backcross



F2...F5/F6
(selected bulk)



**International
yield trials**



**Yield trials (2
years)**



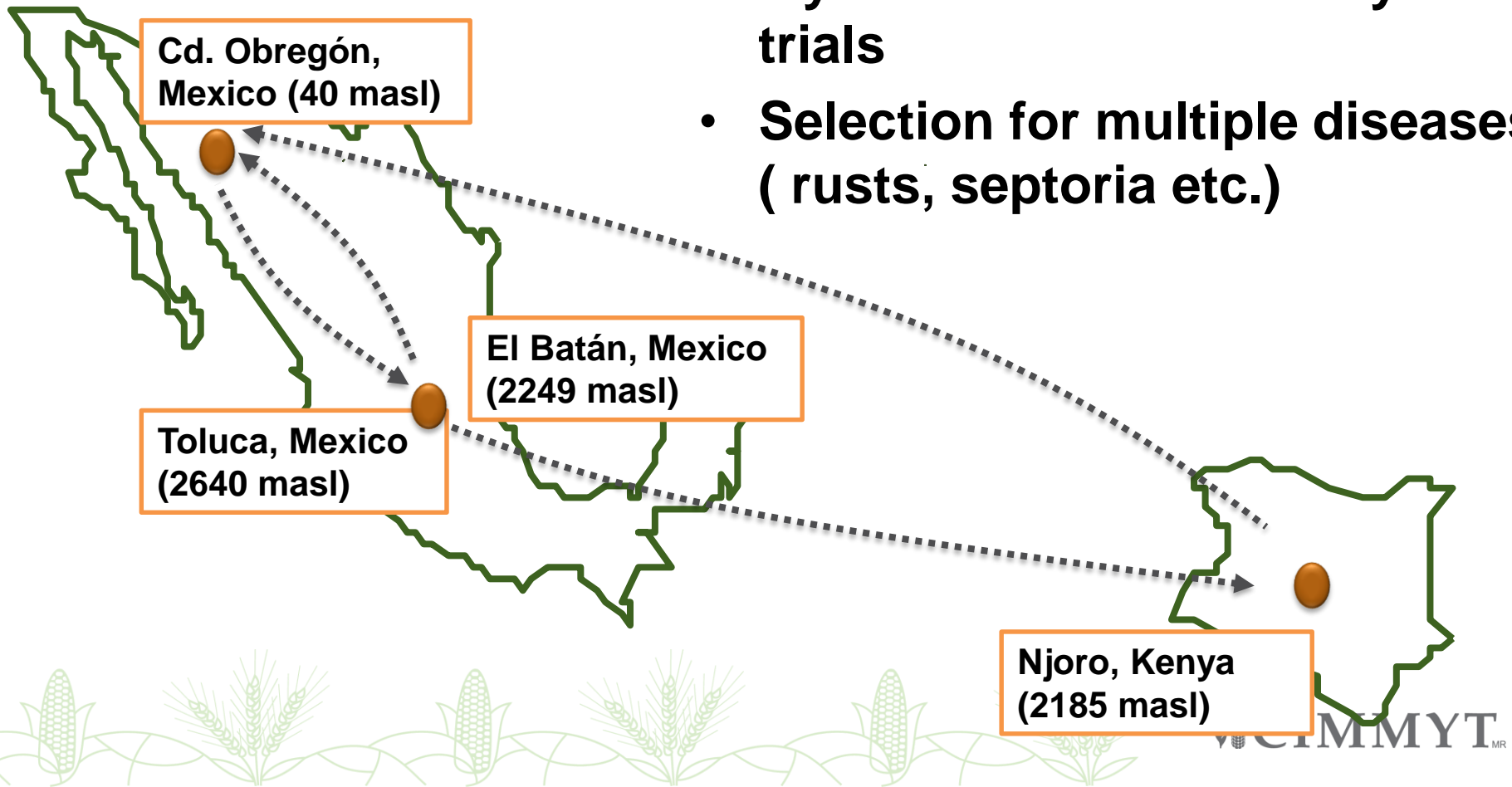
**Head to row /
plant to row**
(small plots)



Rapid cycling of breeding materials (Field based selection)

*Mexico (Cd. Obregon-Toluca/El Batan)- Kenya
International Shuttle Breeding*

- 4 years from crosses to yield trials
- Selection for multiple diseases (rusts, septoria etc.)



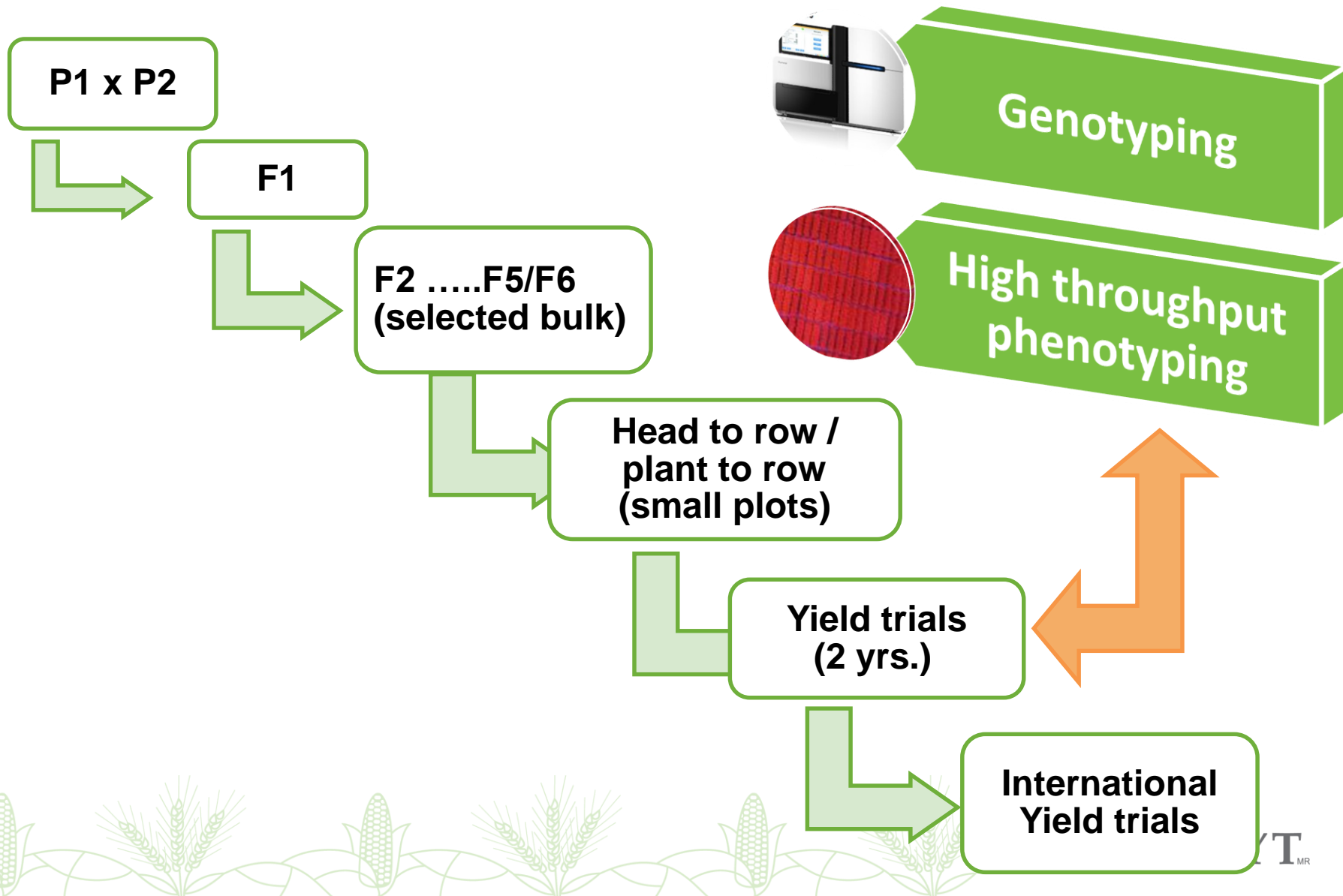
Objectives

Improving genetic gains :

- **Reducing the breeding time**
- **Improving selecting efficiency**
- **Phenotyping under diverse environment**



Integrating technologies



Strategy

1st year yield trial (~10,000 lines)

**2nd year Multi-environment
yield trial (~1000 lines)**

Irrigated

**Irrigated (beds &
flats)**

**Drought (severe &
moderate)**

Heat



Cd. Obregon, Mexico

1st year yield trial(~10,000 lines)

2nd year Multi-environment yield trial (~1000 Lines)

Pedigree Information

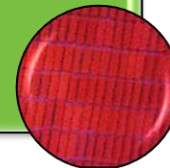
- GBS markers (KSU)
- 10,000 lines each year for 4 years

Genotyping



- Ariel phenotyping
- Thermal and hyperspectral camera

High throughput phenotyping



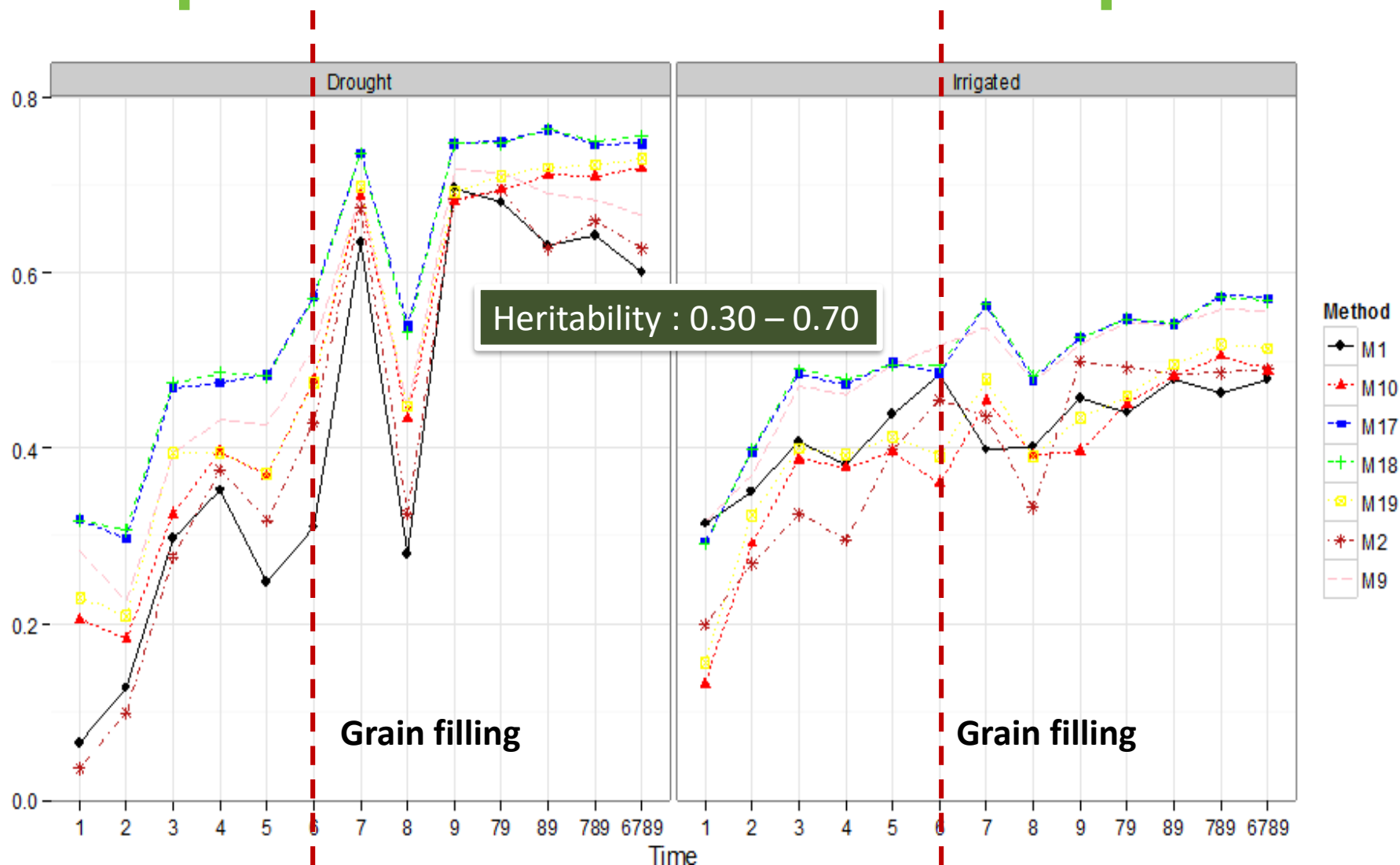
Modelling & performance prediction

Phenotyping

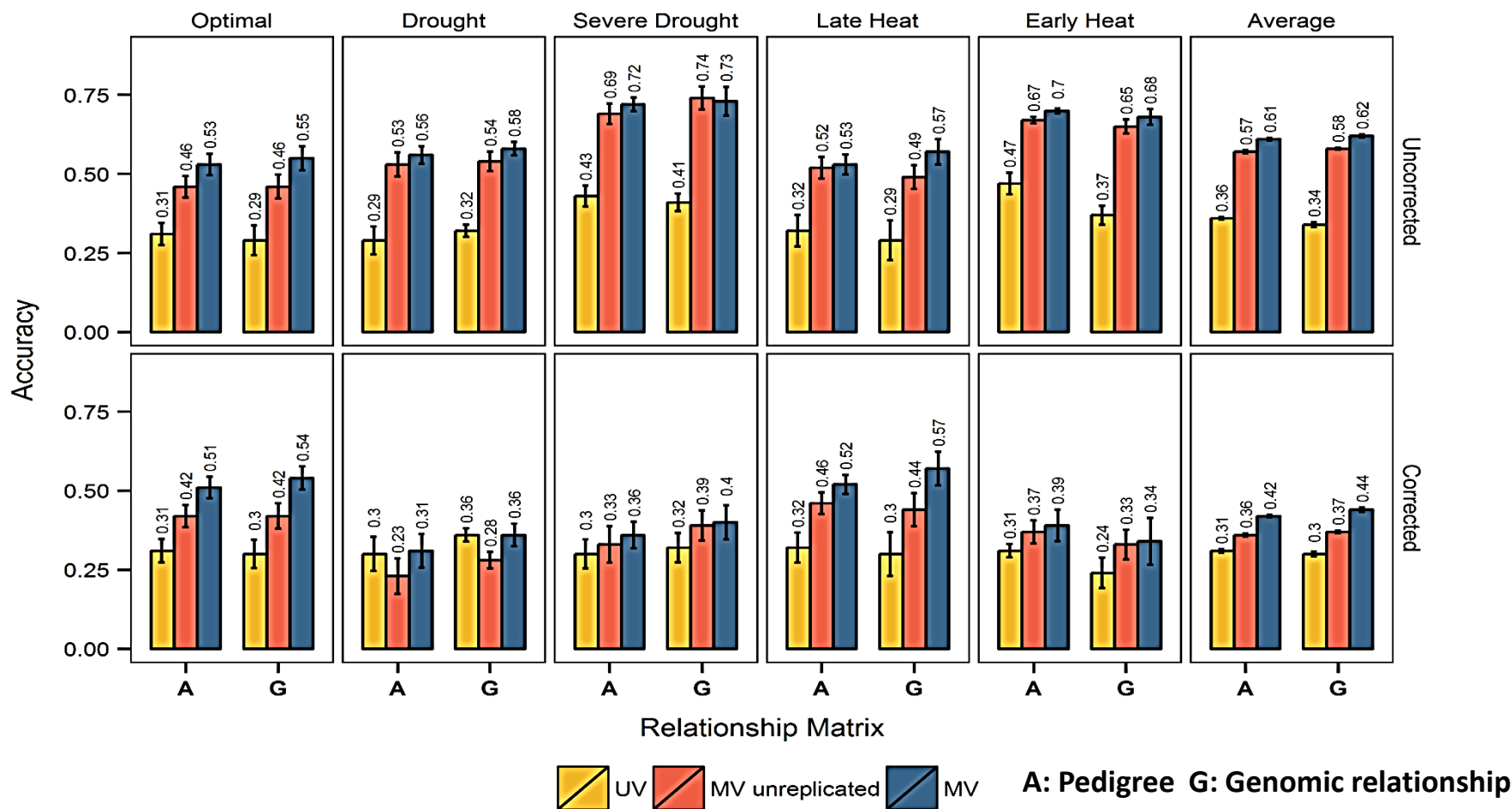
- Key questions
 - Association of traits measured through high throughput phenotyping (HTP)
 - All bands vs indices (R-NDVI, G-NDVI, Canopy temperatures)
 - Timing of data collection



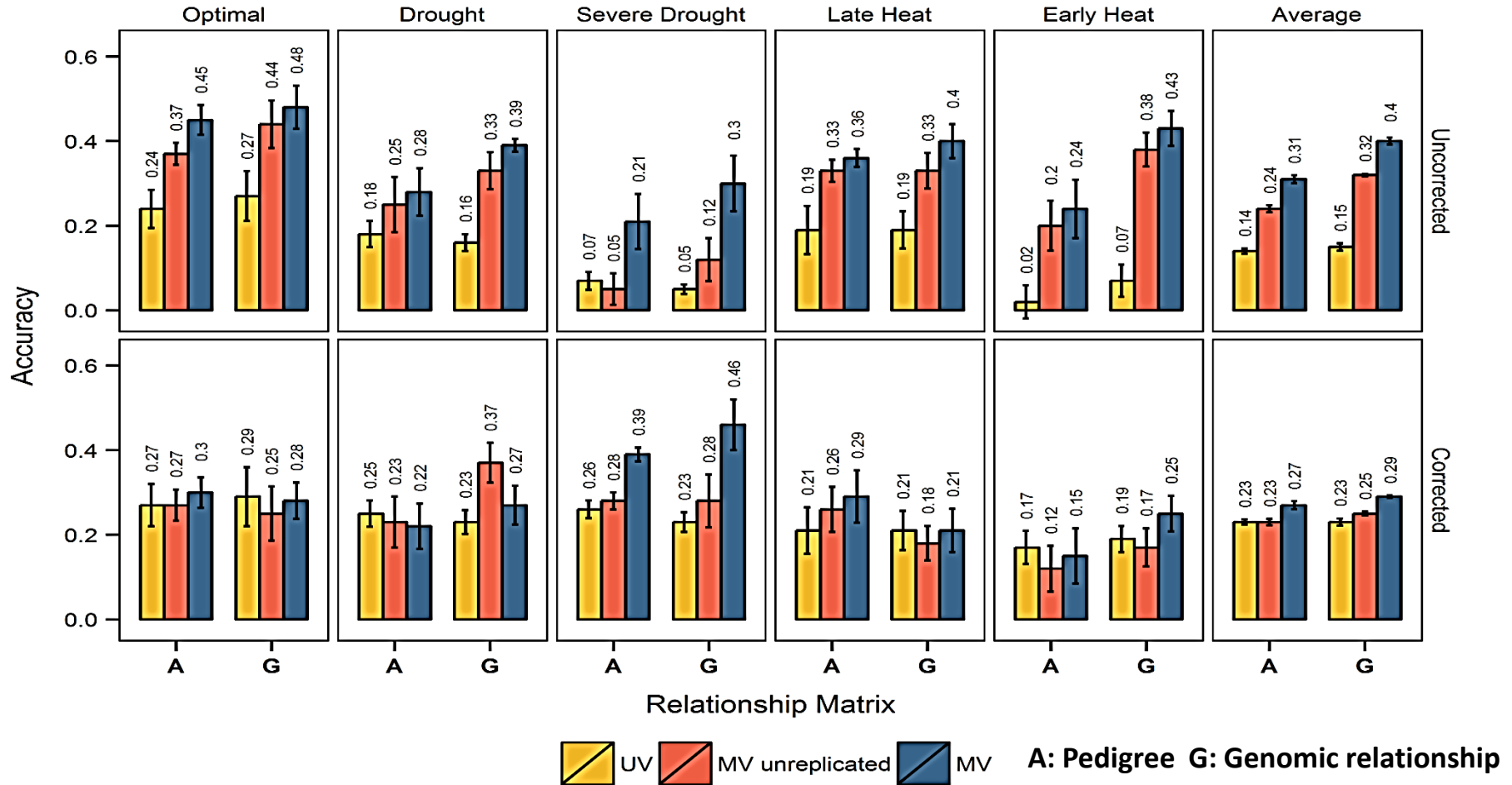
Comparison of models & time points



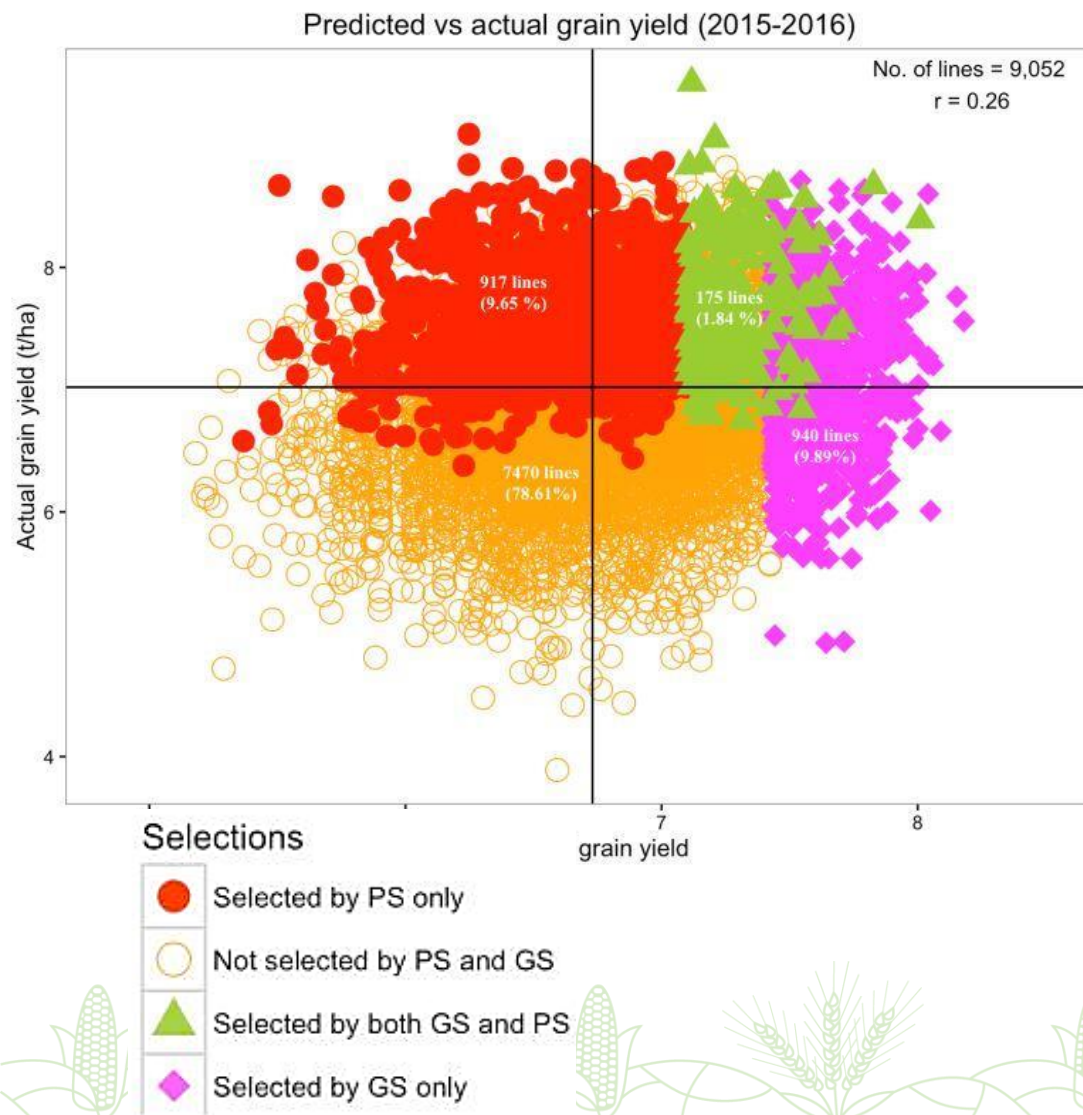
Within environment predictions using multivariate (HTP indices) model



Across environment using multivariate (HTP indices) model

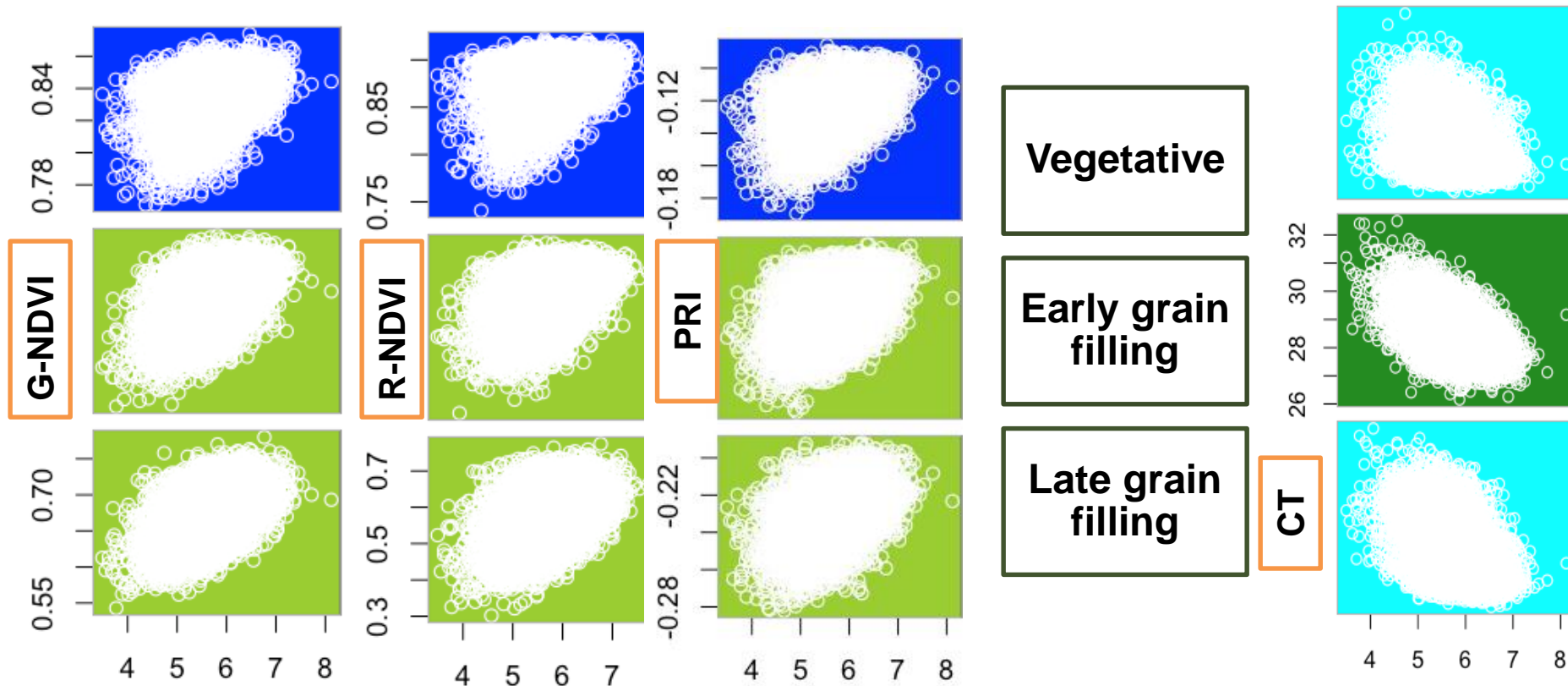


1st year yield trial(~10,000 lines)



- **Grain Yield : Predicted vs Balance**
- **Rejected:**
 - Sib with better performance
 - Seed color, height
- **Evaluations underway in 2016/2017**

Grain yield association with..



0.40-0.50

0.30-0.40

- (0.20- 0.30)

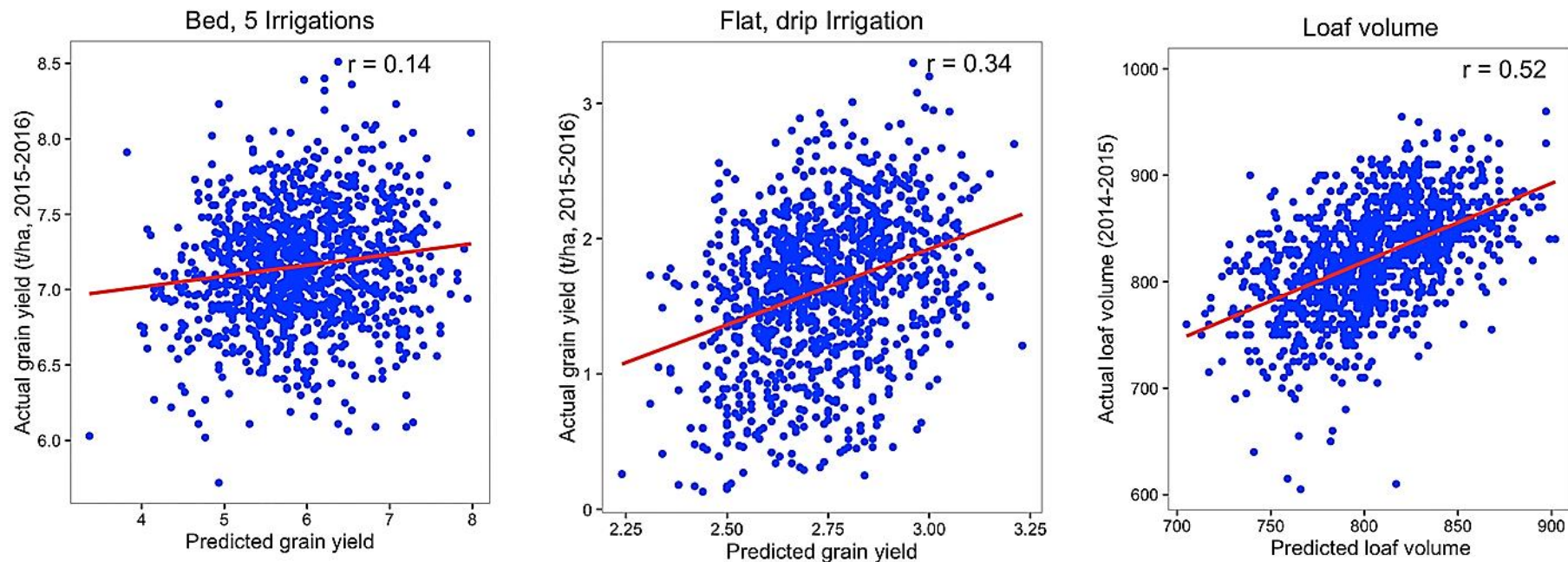
- (0.40-0.50)

NDVI – Normalized difference vegetation index, PRI – Photochemical reflectance index, CT – canopy temperatures

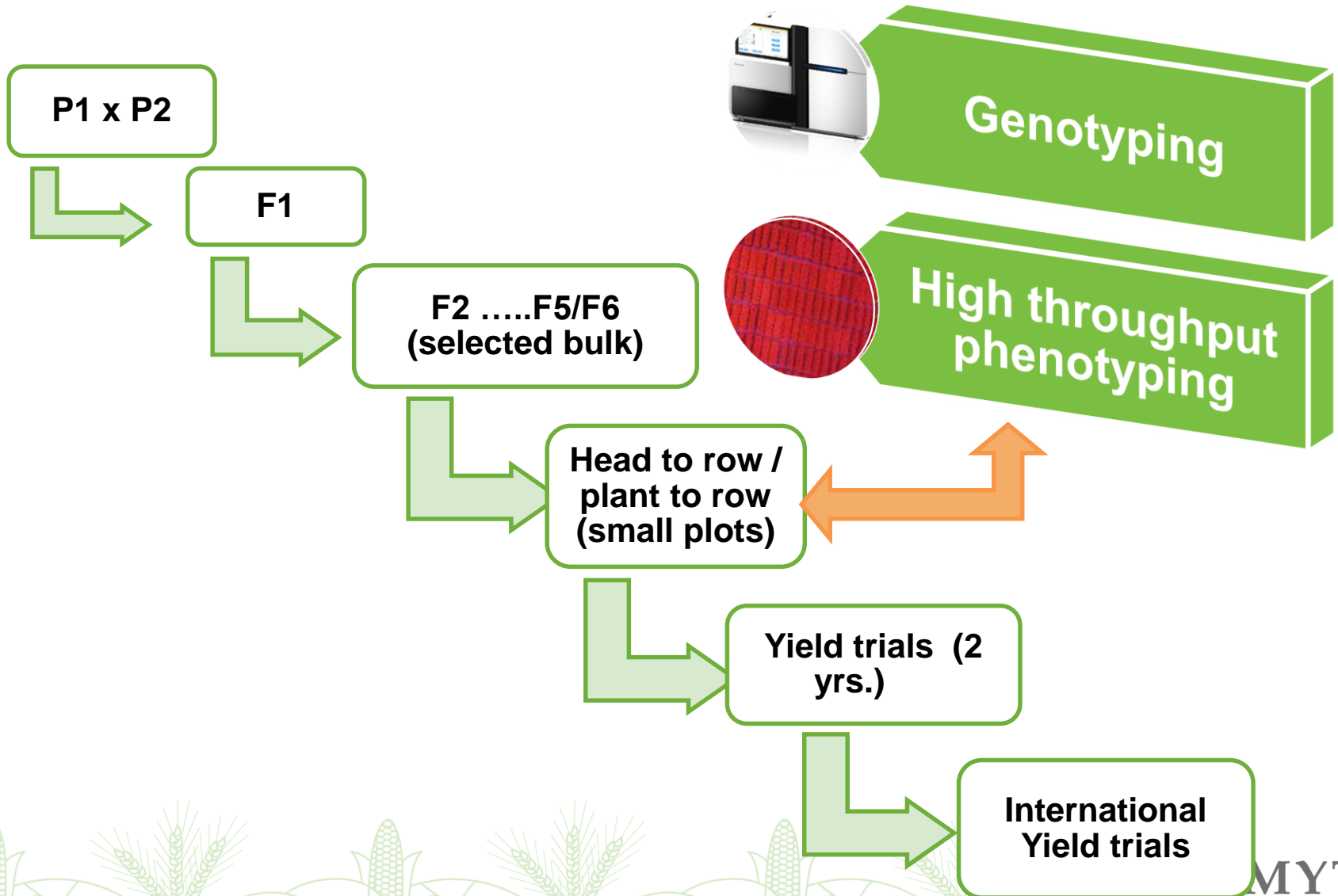
Forward predictions vs Balance

1st year yield trial(2014)

**2nd year Multi-environment
yield trial (2015)**



New Directions



Head rows/plant to rows



- **50,000-70,000 head rows of 1m for visual selection**
- **GS or HTP could aid the selection process**
- **Data collection on way**



Predictions across locations



- Selected Yield trials evaluated
 - Bangladesh (Jamalpur)
 - India (Ludhiana, Jabalpur, Pusa)
 - Faisalabad
- Phenotyping and performance prediction ongoing



Summary

- Potential of genomics and phenomics in improving selection efficiencies
- Further work in including GxE to improve prediction
- GWAS is also being used to standardize GS models (Sehgal et al. 2016, Poster No. 179)





Thank you for your interest!

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