
Technologies for Precision Breeding at IRRI



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Tobias Kretzschmar



Precision Breeding to Increase Genetic Gains



- Reliable germplasm verification & tracking



- Fast line fixation through RGA



- Accurate multi-environment phenotyping



- Optimized Genotyping (cost - benefit)



- Robust data management (G4R & B4R)



- Integrated P x G x E data analysis (GOBII)



- Focused trait development (bottlenecks)

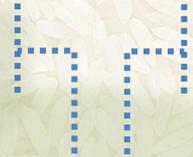


- Targeted genetic manipulations (CRISPR)

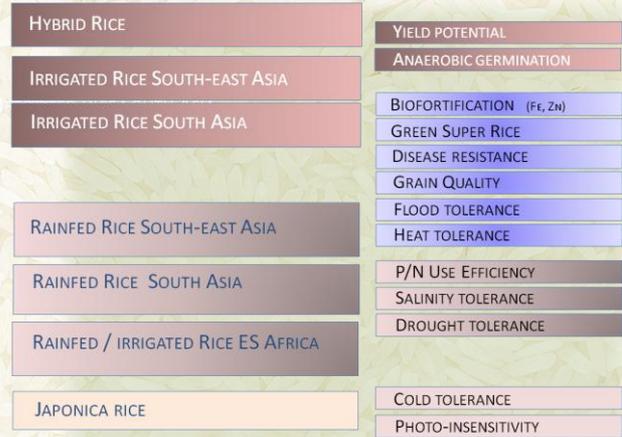


Web-based Information Management System

Phenotype studies



Product Development

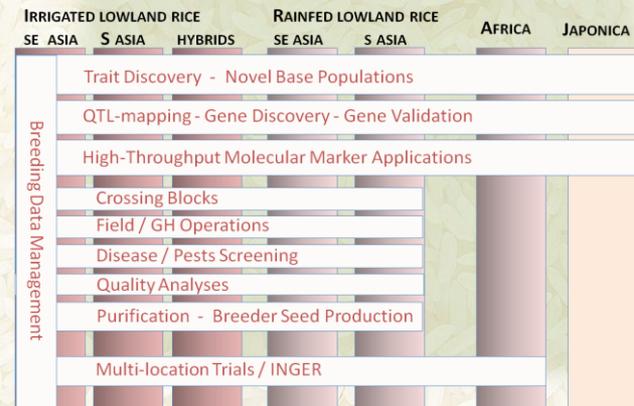


Source: E.Nissila. The new structure of IRRI's Breeding Pipelines

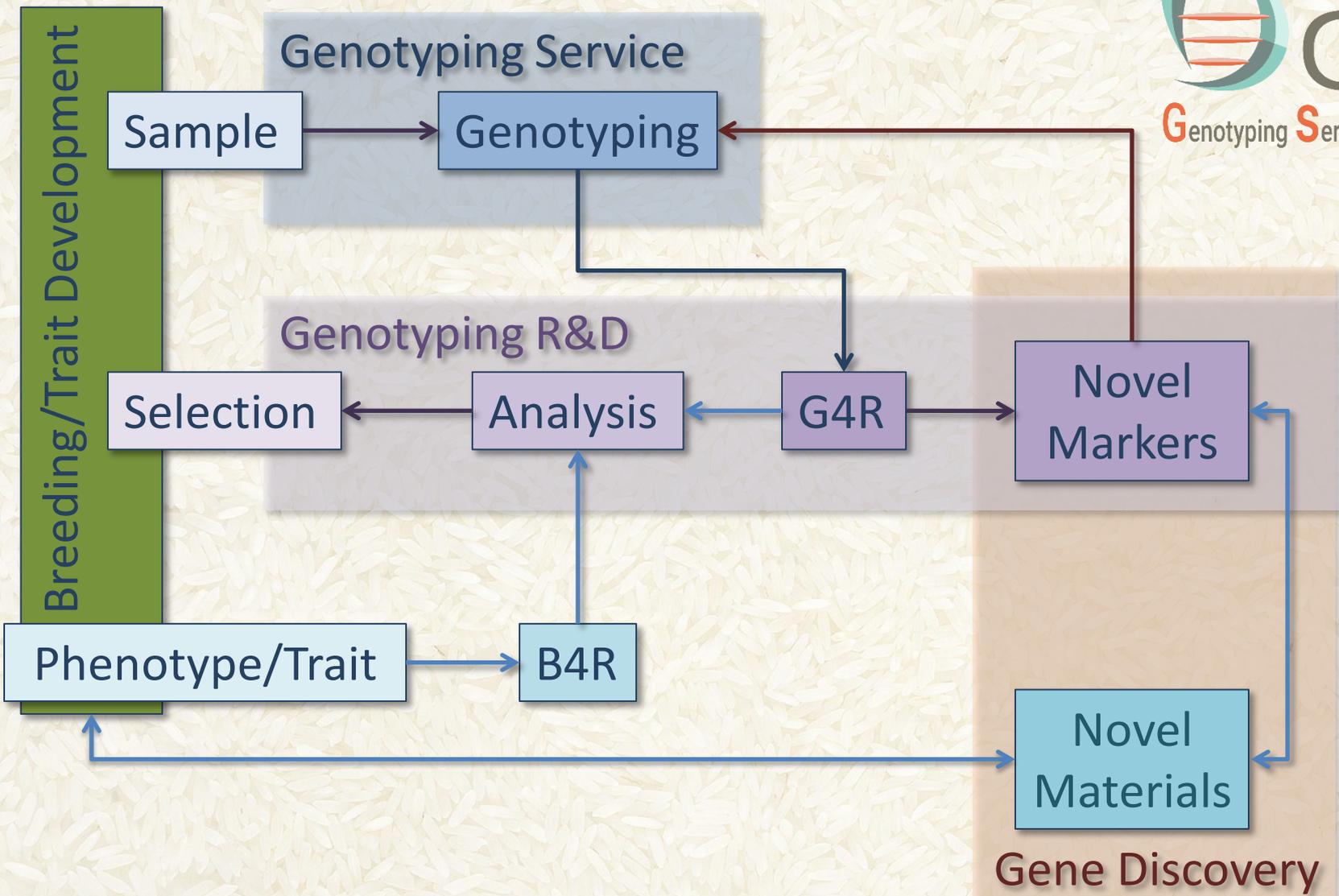
Cross-cutting R&D

Interoperability using web services

Use of modern IT solutions



GSL Breeding Support Structure



Genotyping Service: From sampling to data analysis



PlantTrack
Tissue sampling
96-well



Oktopure
DNA extraction
8 x 96-well



Twinkle
fluorometer
96/384-well
DNA QC



Marker platforms 
24 x 192 Fluidigm
96 x 96 Fluidigm
6000 x 24 Infinium



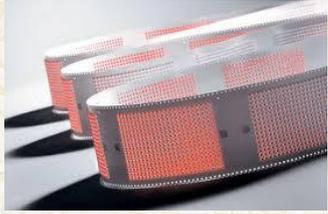
Genotyping Service: Low & Medium density platforms



Fluidigm



Infinium 6k
Illumina



KASP
Douglas Array



Amplicon Panels
Illumina

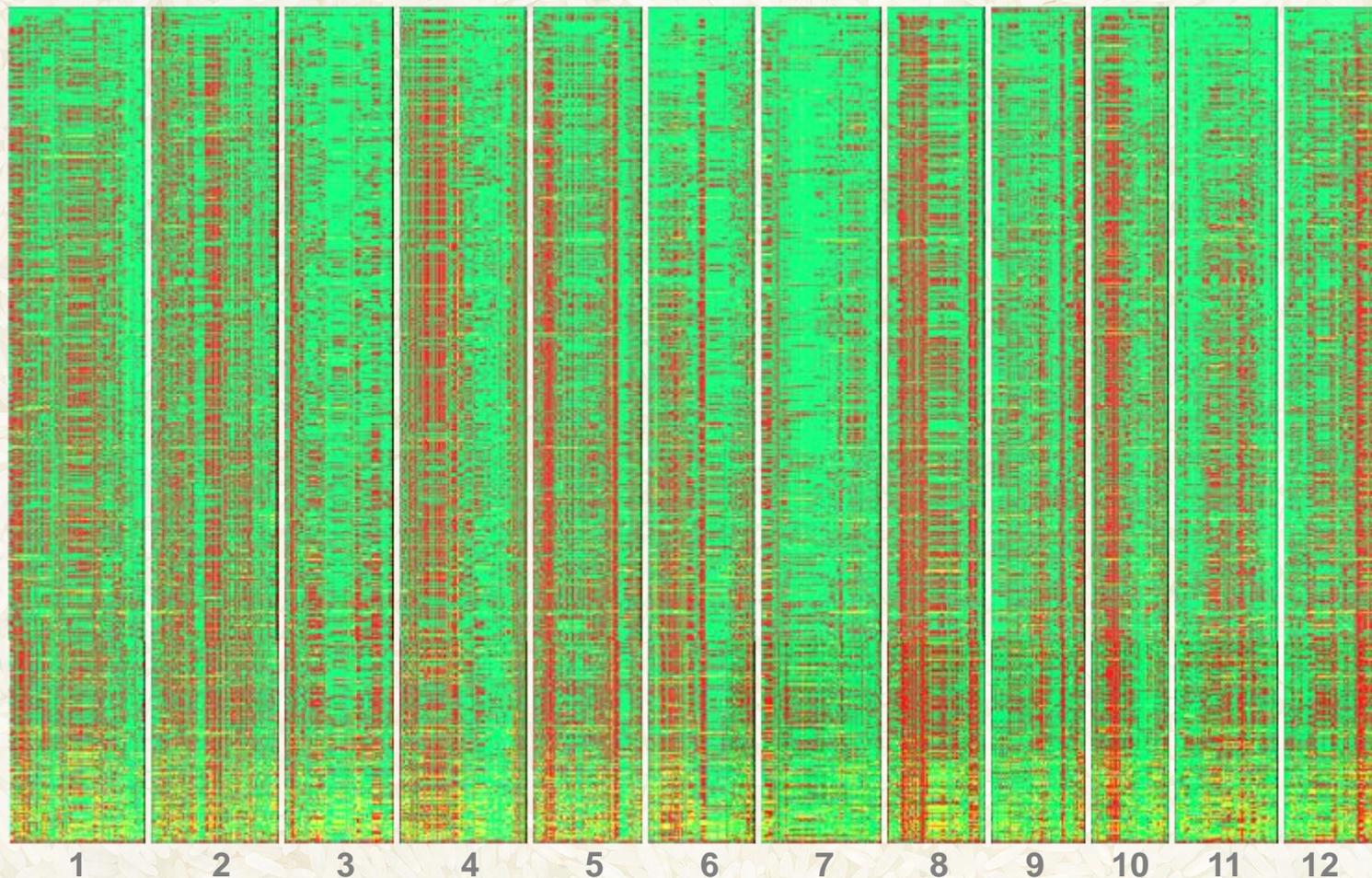


Applications:

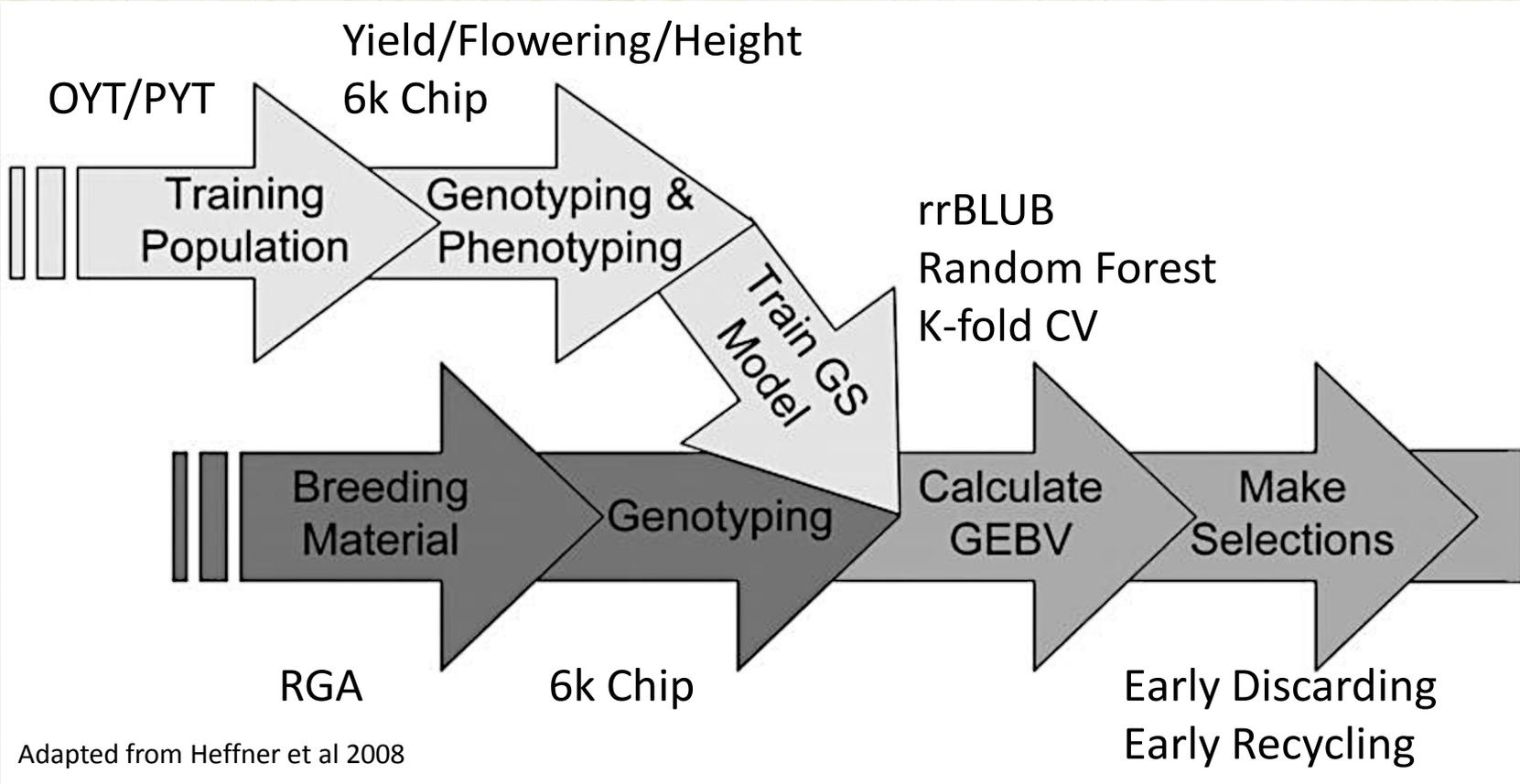
- Trait Markers in MAS
- Foreground in MABC
- Recombinant Markers

Applications:

- Parental Selection/Survey
- Genomic Prediction
- QTL mapping
- DNA Fingerprinting



- GREEN = IR64; RED \neq IR64; YELLOW = HET
- 1786 poly markers, 1154 lines, 2569 (60%) monomorphic markers were removed
- 20 lines and 251 markers removed for call rate <10%



GS = Genomic Selection

GEBV = Genomic Estimated Breeding Value

K-fold CV = cross validation to establish accuracies

RGA = Rapid Generation Advancement

OYT/PYT = Yield Trials

$$R = \frac{irS_g}{L}$$

Selection Intensity i Selection Accuracy r

Genetic Standard Deviation S_g

Generation Interval L



Potential Advantages of Genotype-based Selections

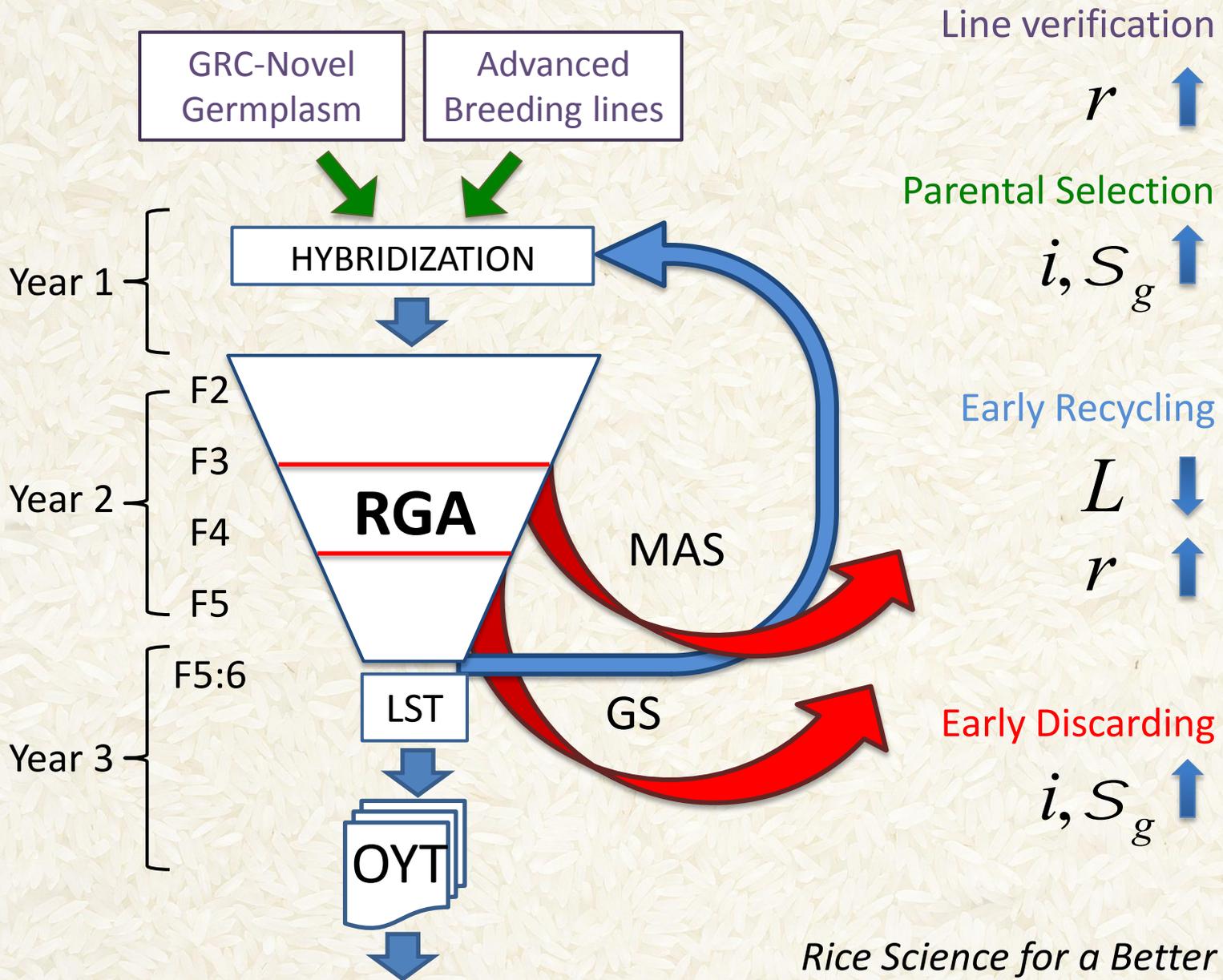
S_g ↑ Parental selection

i ↑ Early discarding; first stage screening based on genomics only

r ↑ Line verification and tracking; quality control

L ↓ Early recycling; reduce stages to variety release

Genotyping in precision breeding



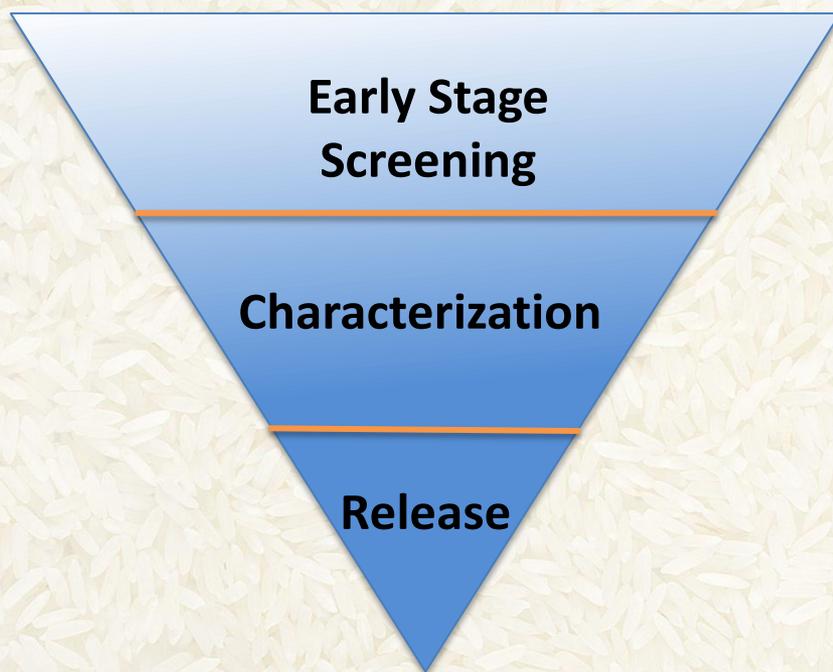
Re-Shaping the Breeding Funnel

Widen the funnel

Discard lines with low likelihood of success based on MAS and GS (GEBVs)

⇒ Increase lines screened without increases in yield trial plot load

⇒ Increase selection intensity



Shorten the funnel

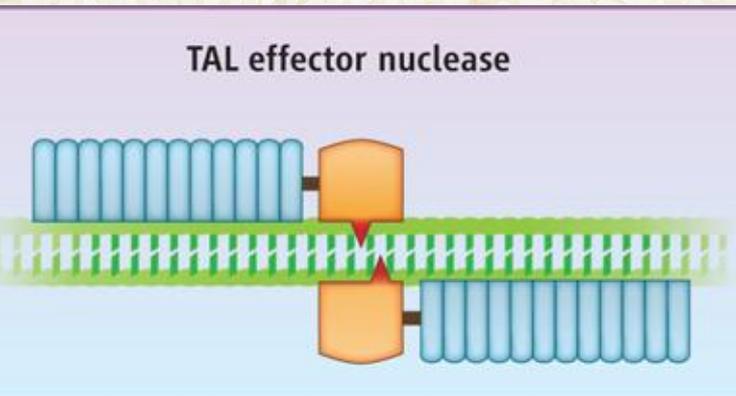
Replace the first stage of screening with GS and make recycling decisions earlier

⇒ Reduce generation interval



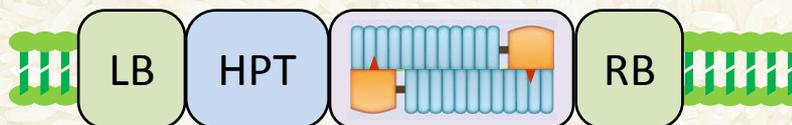


TAL effector nuclease



Genome Editing: Precise modifications at a specific locus; **free of transgenic traces**

T-DNA



Gene of interest

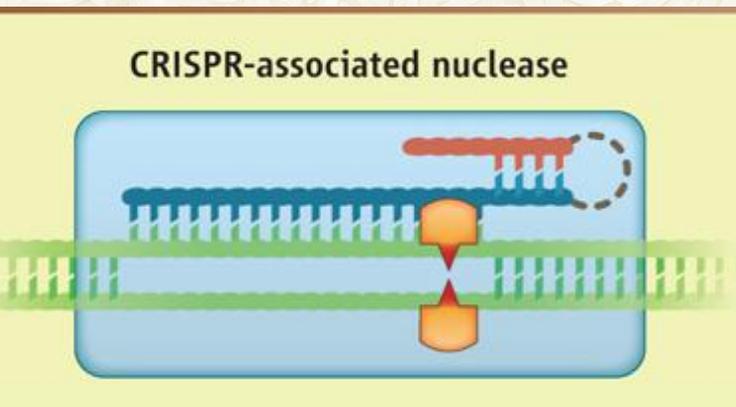


The T-DNA insertion only **delivers** the tool that makes the product



Oost, 2013

CRISPR-associated nuclease



Oost, 2013

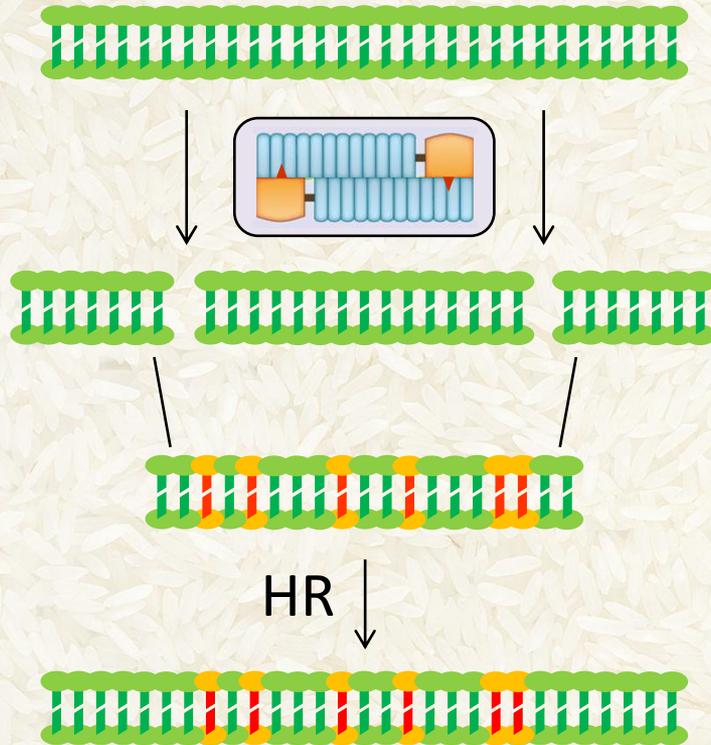
Introgressions without linkage drag



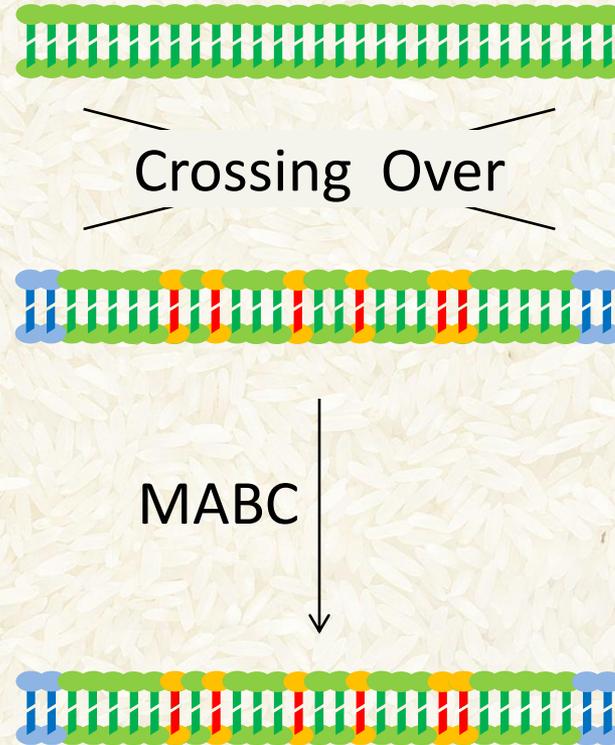
Genome Editing:
Insertion via homologous recombination (HR)



Breeding Equivalent:
QTL Introgression;
Wide Hybridization



=> Allele replacement



=> Near Isogenic Lines (NILs)



Projects and funding acknowledgments



Genotyping Service

Mayee



Genotyping R&D

Maria



Gene Discovery

Toshi



QTL Deployment

Damien

BILL & MELINDA
GATES *foundation*

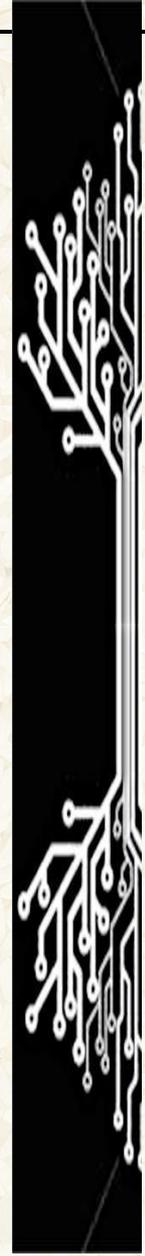
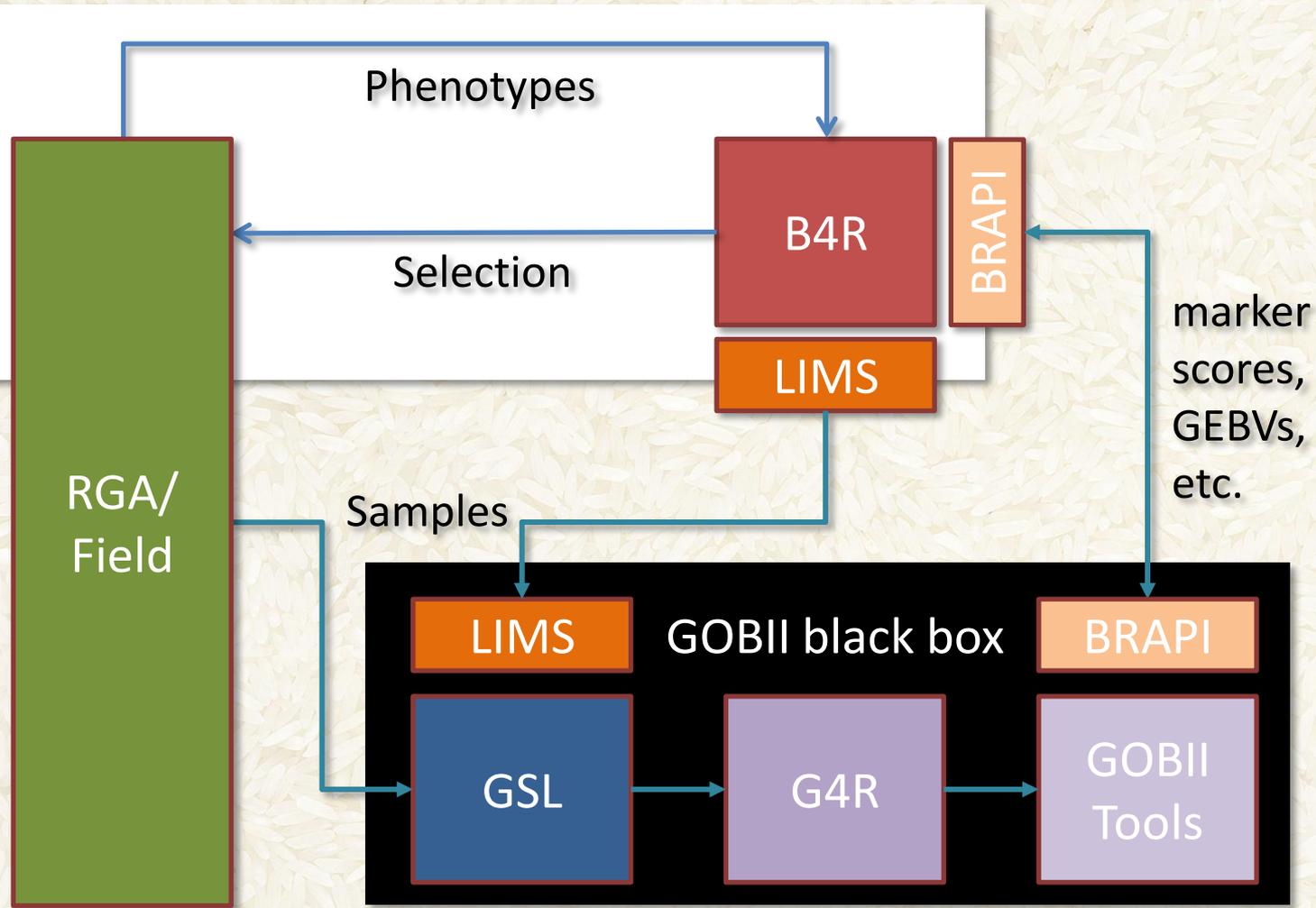
TRB

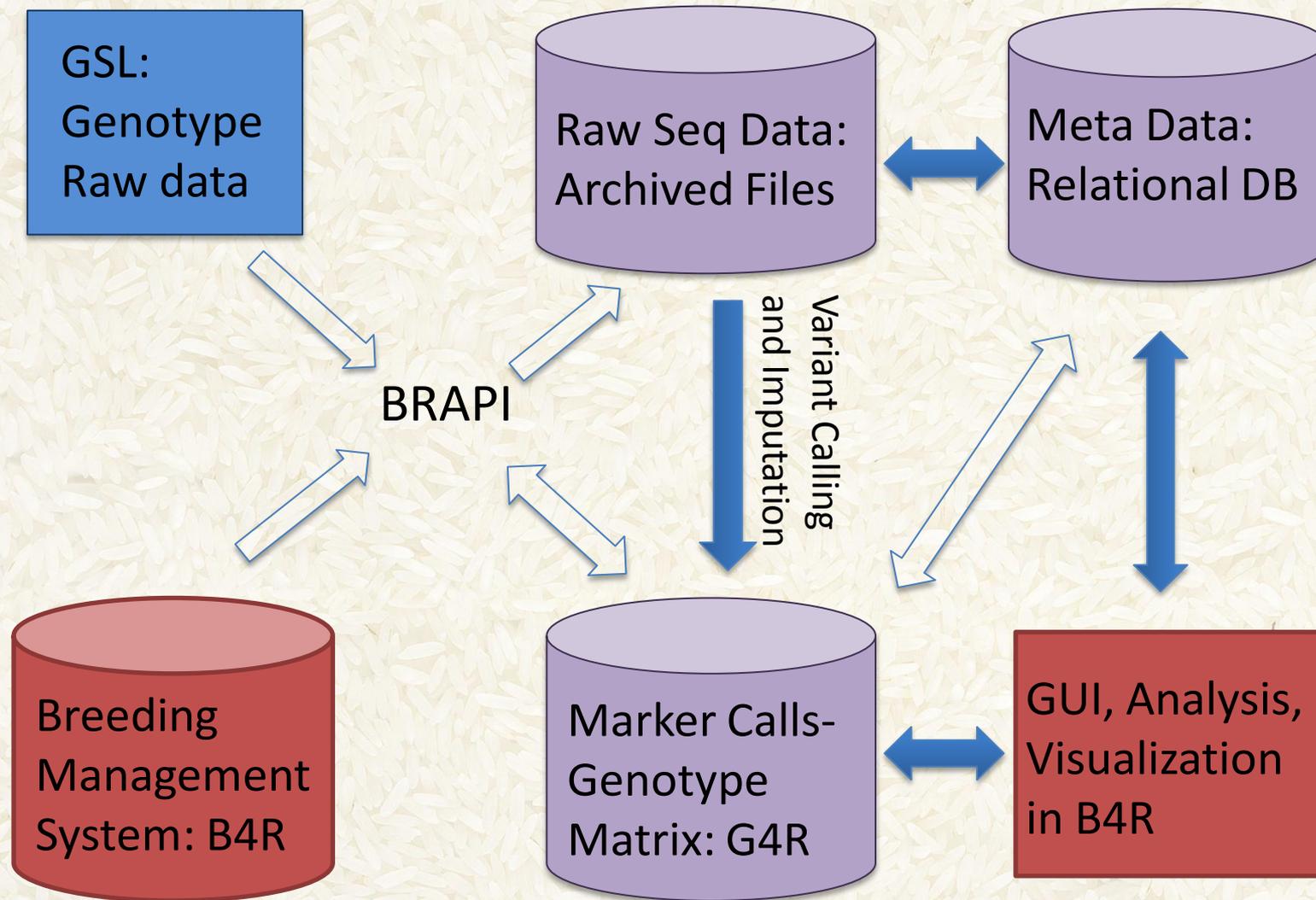
Transforming Rice Breeding

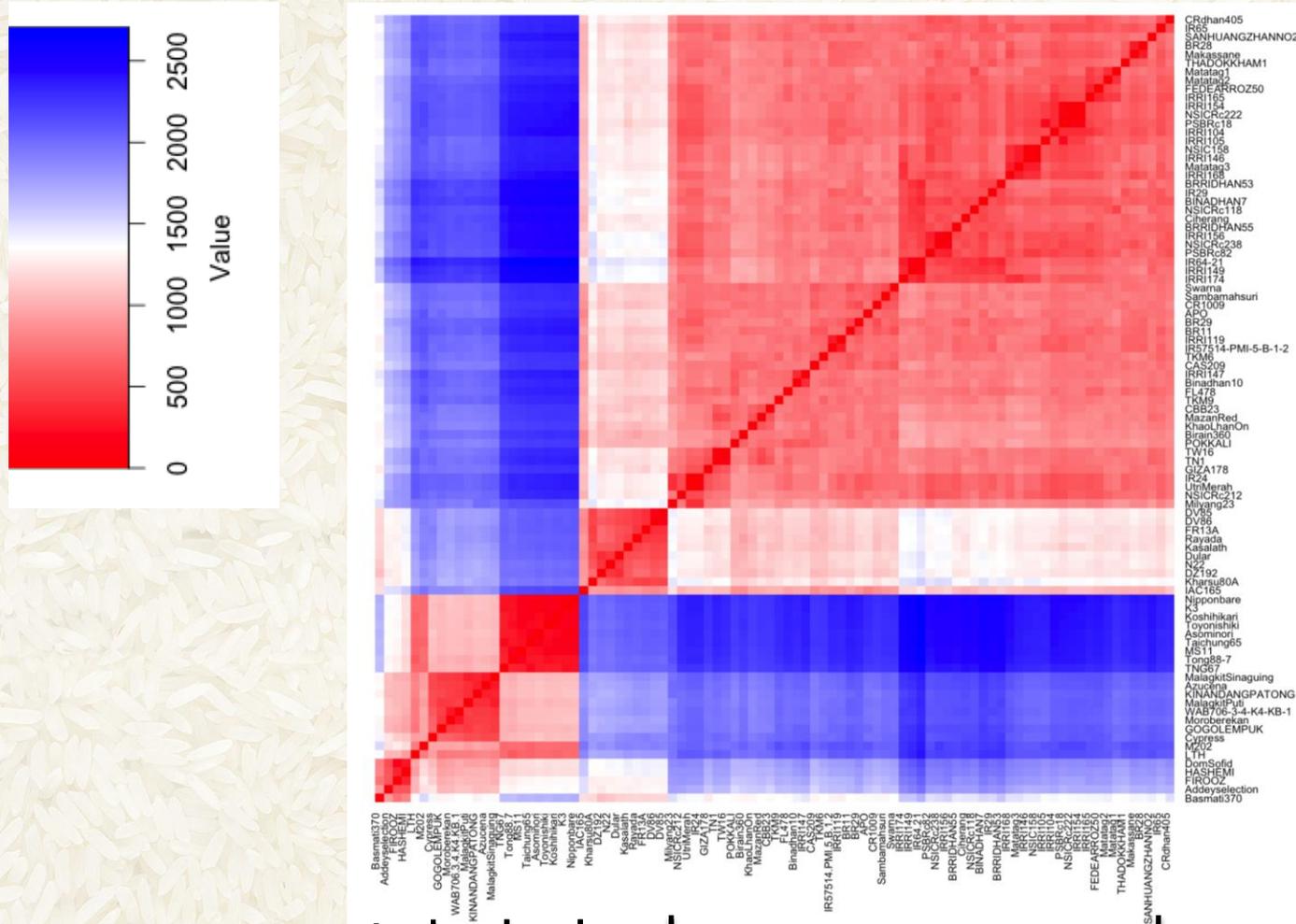
GOBII

Genomics Open-source
Breeding Informatics Initiative

Breeding Support Structures







indica

aus

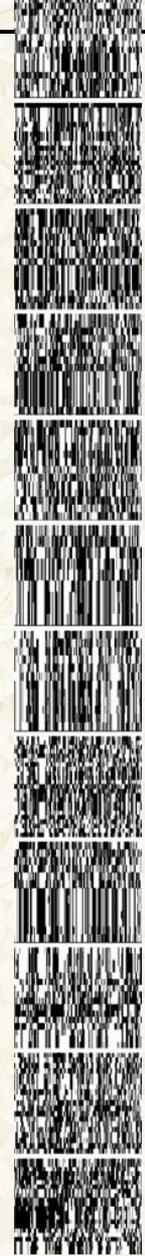
TE Japonica

TR Japonica

aromatic

aromatic TR TE aus indica

Japonica



Data management

- Master data
- Processes



Site Maintenance

- Users & groups
- Documentation
- Support

Data migration

- Hardcopy to file
- Migrate files



Data production

- Study creation
- Study management
- Task management
- Data collection
- Data analysis



Operational Studies

- Study creation
- Field layout
- Study management



Data collection

- Data terminal
- Online recording
- Offline recording
- Field lab for tablets



Processes & Services

- Service request
- Task management

