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College of Agriculture
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Rice Research Station



Modeling in Plant breeding

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What is prediction-based breeding?



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Year & lines

1 = 20K

2 = 8K

3 = 1K

4 = 500

5 = 50

6 = 5

7 = 1

Phenotype

Image analysis (HTP)

Accurate characterization

Complex and simple traits

Replace/compliment

Traditional trait evaluation

\$50 / plot

Genotype

Genomic selection

Reduce costs

< \$5 / line

Complex and simple traits

Reduce the funnel length

Increase the funnel width

Environment

Envirotyping

Stability over years

Across many locations

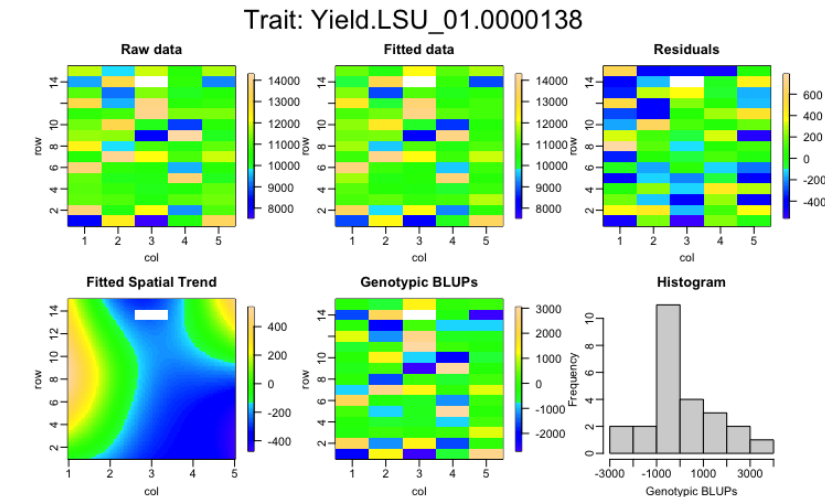
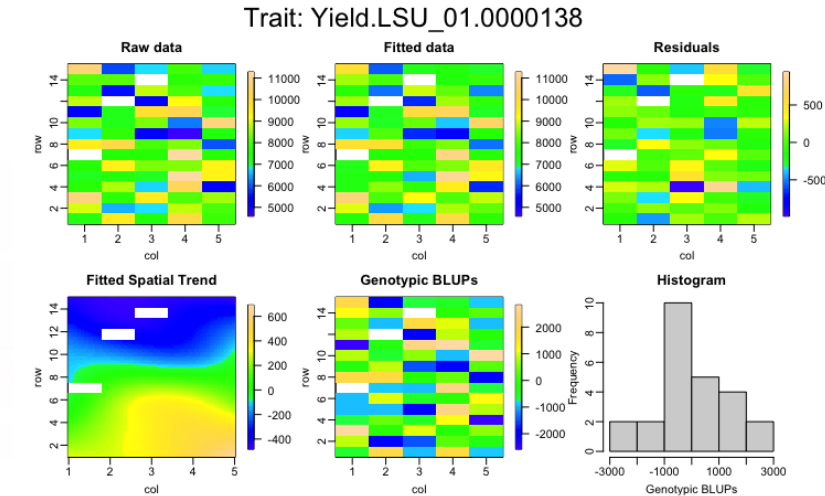
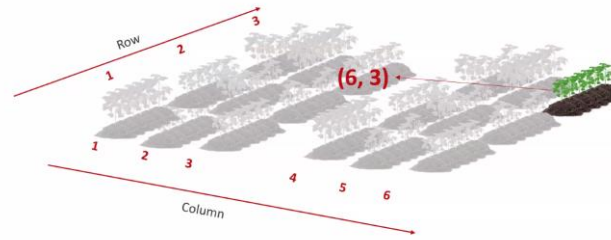
The best genotype

for each location

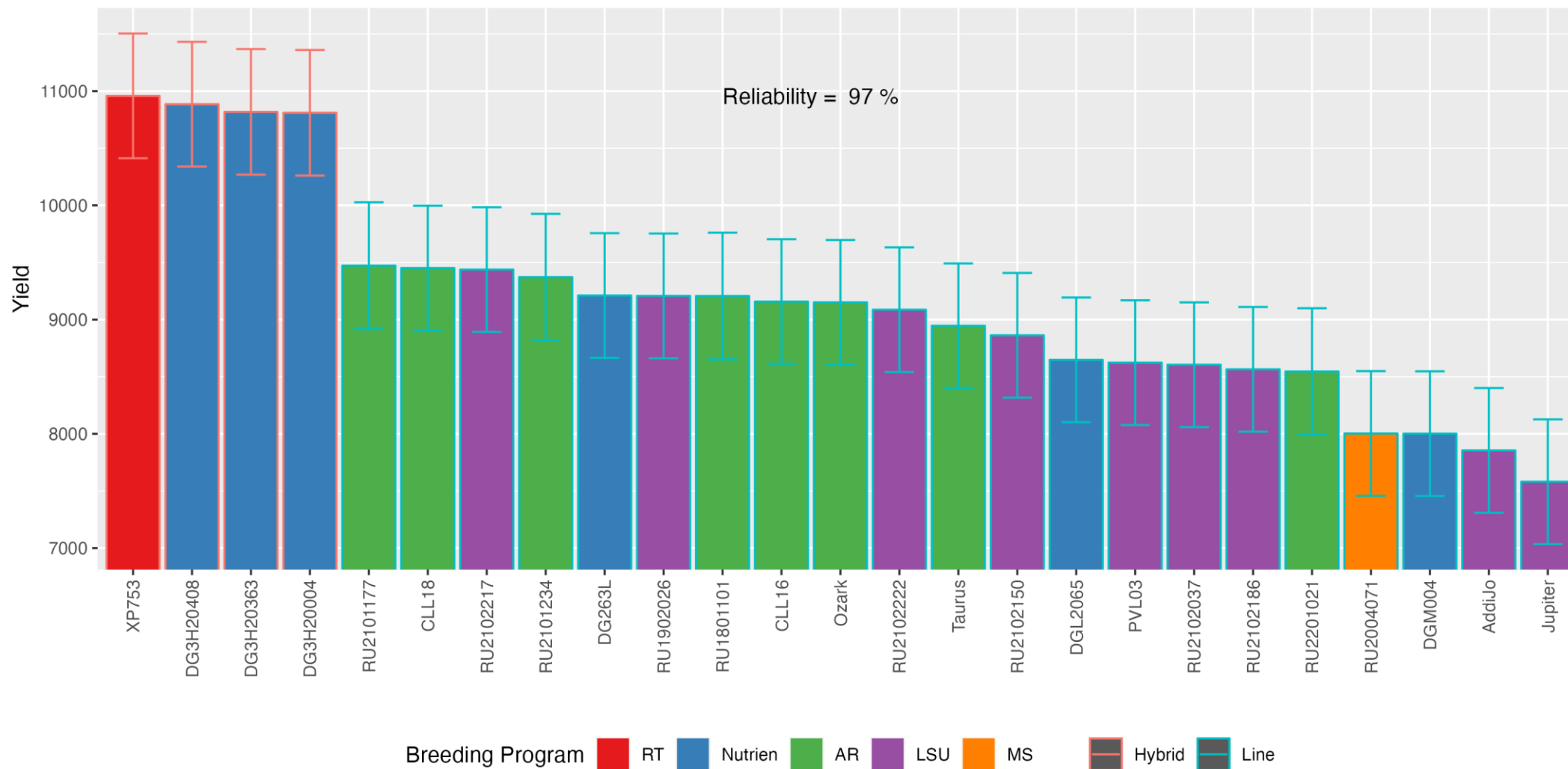


Modelling using spatial variation

- 18 locations – Pre-Commercial
- Mixed model equation
- Spatial variation information
- Heritability (selection accuracy):
- $H^2_g: V_g / V_p$
- Using the classical method: 0.88
- Using the current approach = 0.97

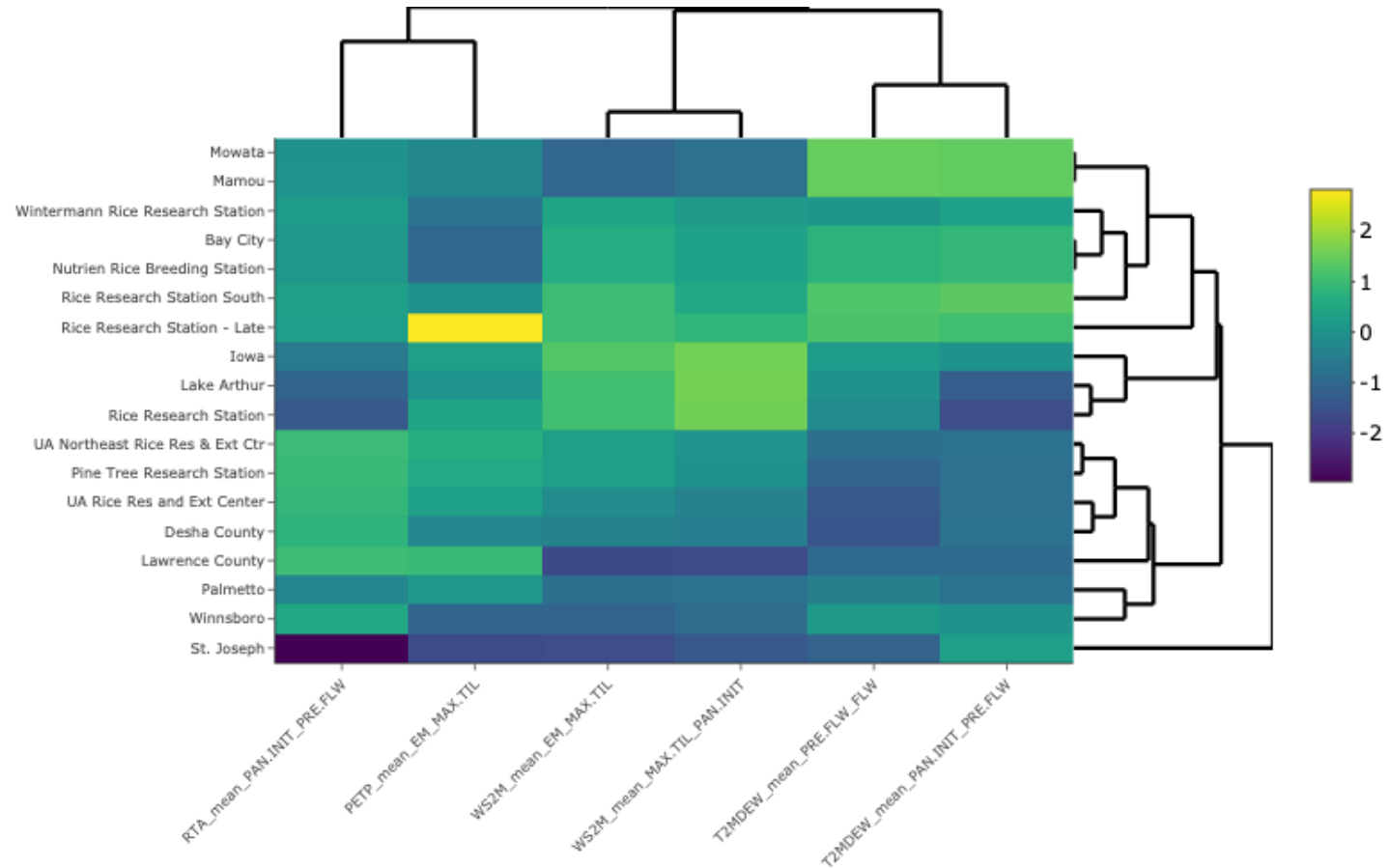


Predicting performances and confidence intervals

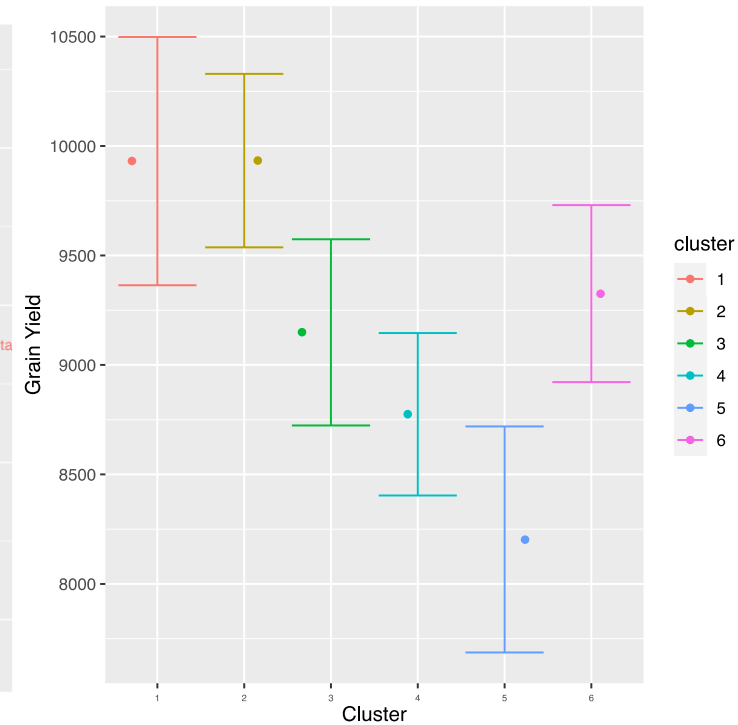
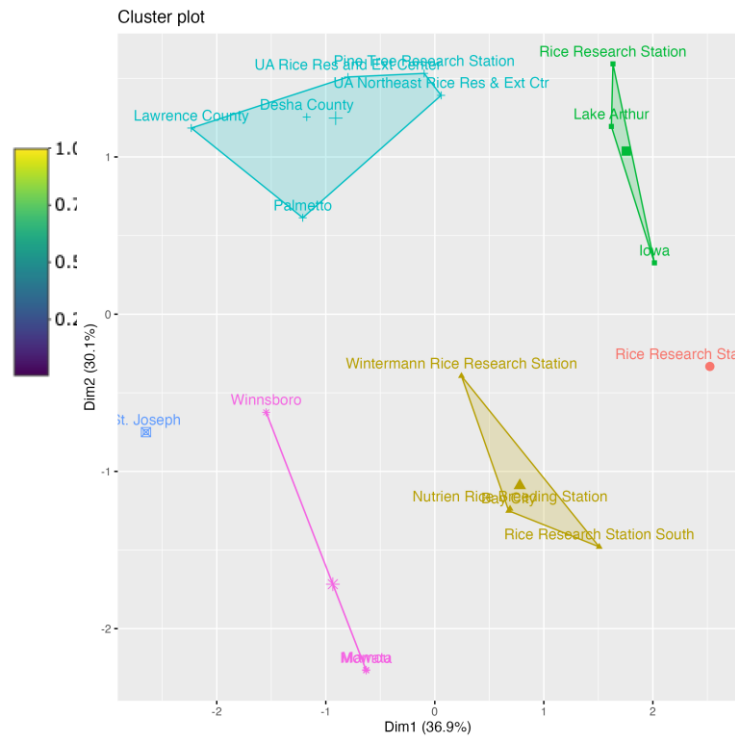
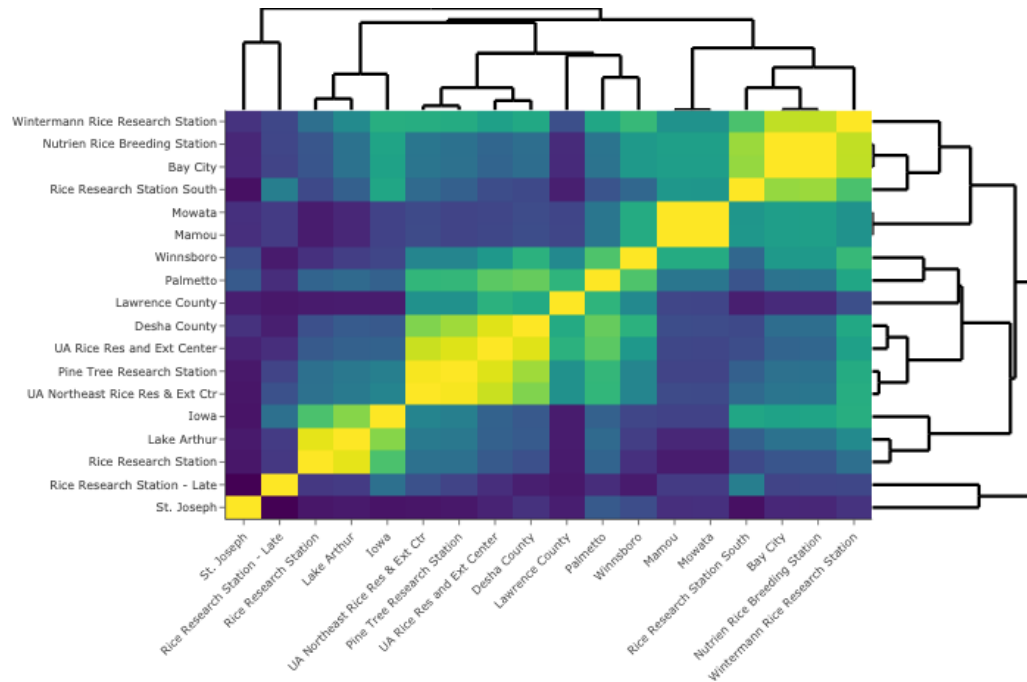


Predictions using historical weather data

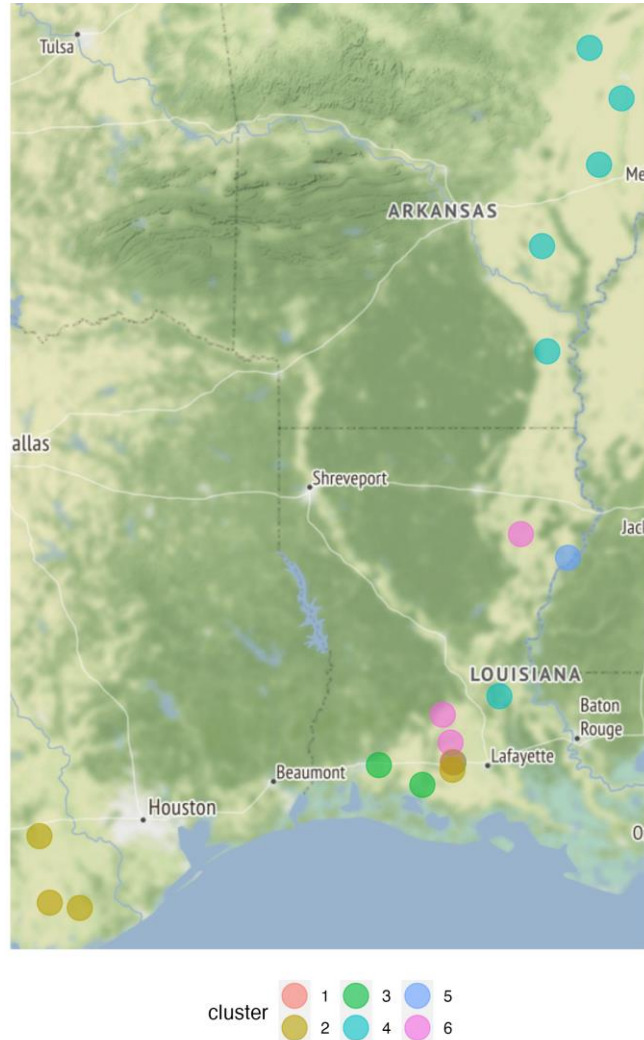
- 18 locations – Pre-Commercial
- 10 years of weather data - NASA
- During rice growing season
- Adjust to rice response
- 2 years of yield data
- Predictions:
- Linear mixed models
- Artificial Intelligence



Predictions using historical weather data

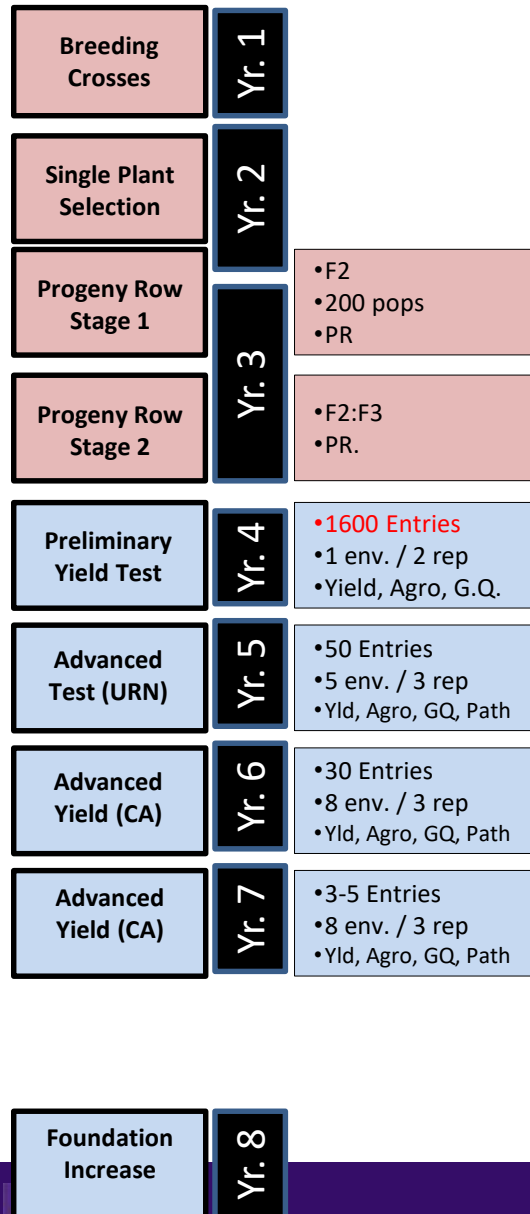


Predictions using historical weather data

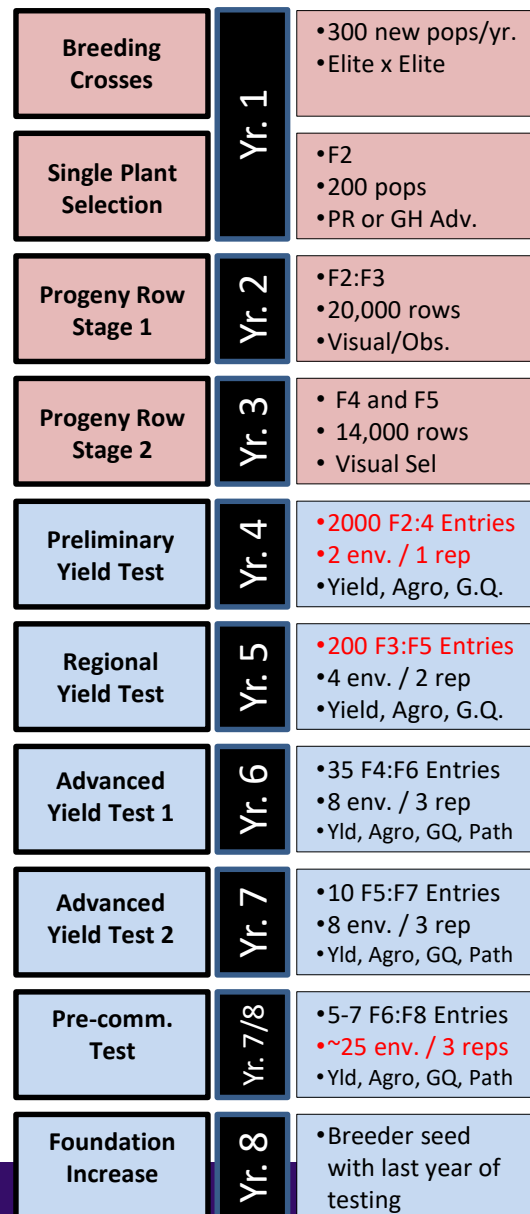


- Consequences:
- Better allocate trials in advance, matching the demand
- Borrow information from other regions
- Support the rice breeding program to recommend/identify the best variety for each location
- Reduce costs and increase precision

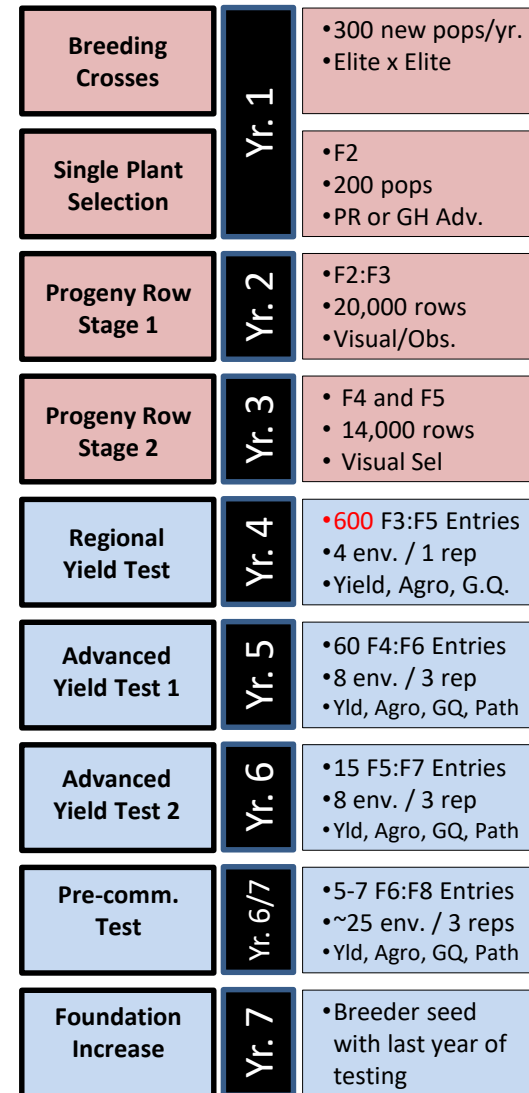
Previous



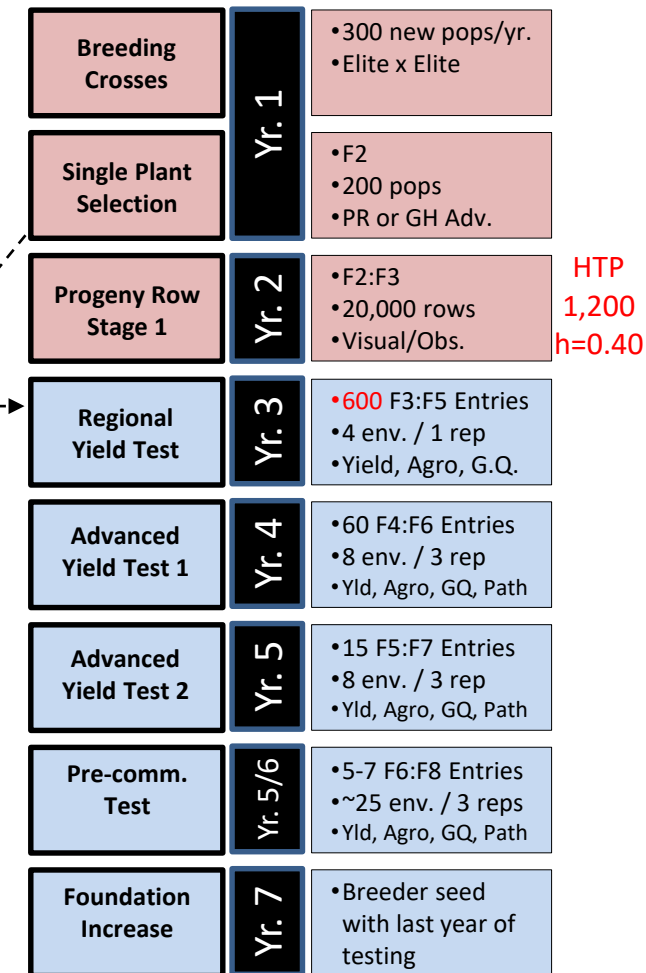
Current Trad



GS in F3



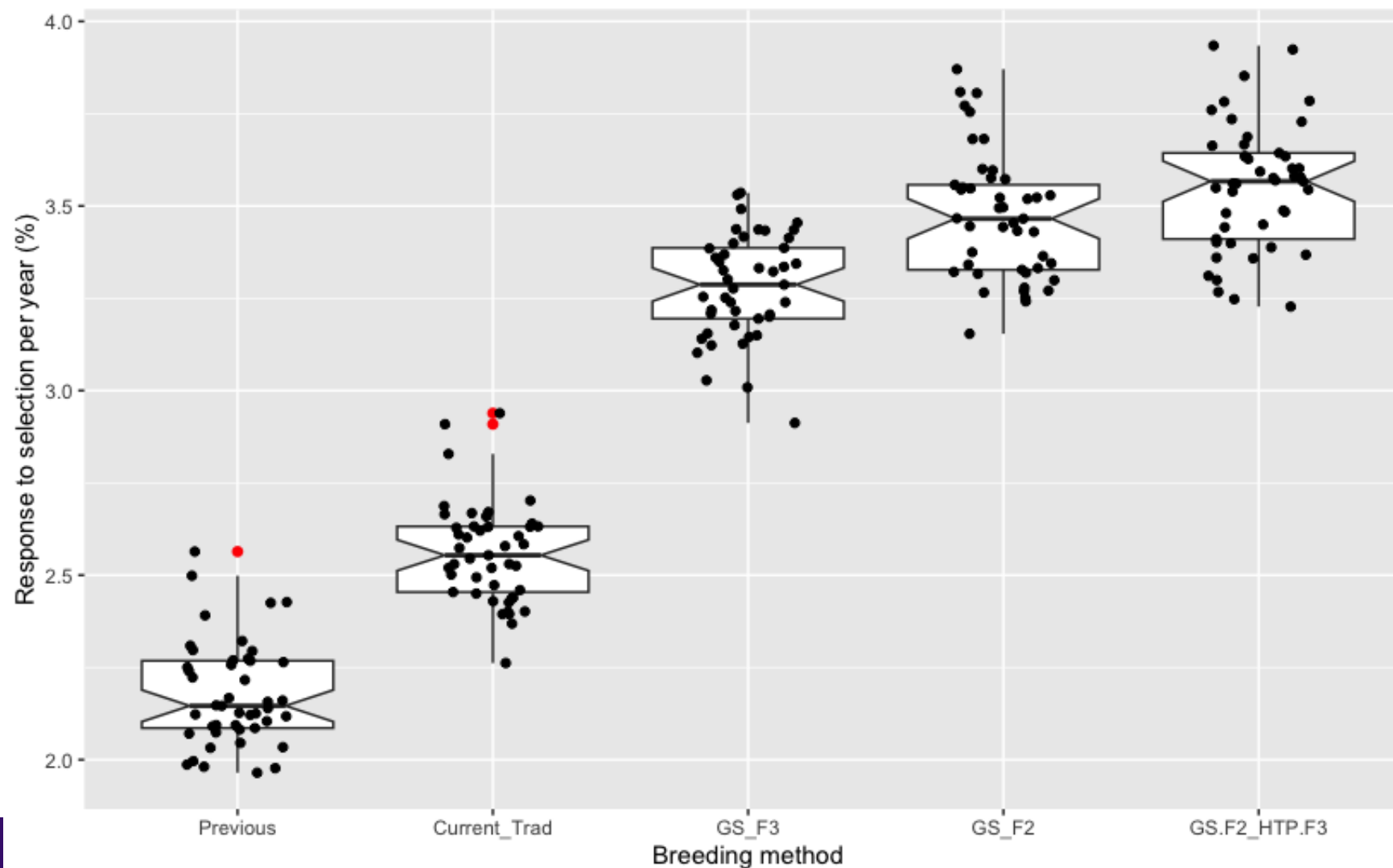
GS in F2



• 160 pops x 48 lines (8k lines)
WGP

HTP
1,200
h=0.40

Optimizing breeding schemes



Next steps

- Extrapolated the envirotyping analyses to all counties in the US that have rice
- Develop image-based indices to select for:
 - *Sheath blight and blast resistance*
 - *Overall performance in early breeding stages (F_3 row plots)*
- Make the analytic pipelines available on web-based platforms - **all breeding stages, including Genomic Prediction**
- Optimize breeding numbers - **crosses, parents, progeny size, optimal parent contributions...**



Thank you!

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