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Commercial Soybean Breeding in a Changing World

Les Kuhlman, Ph.D.
DuPont Pioneer

Personal Introduction

- Born and raised in Manhattan, KS (Go Cats!)
  - One generation removed from the family farm
- B.S. in Agronomy, Kansas State Univ., 2001
- M.S. in Plant Breeding, Texas A&M Univ., 2005
- PhD in Plant Breeding, Texas A&M Univ., 2007
- Hired by DuPont Pioneer to start the Lawrence Soybean Research Center in 2007

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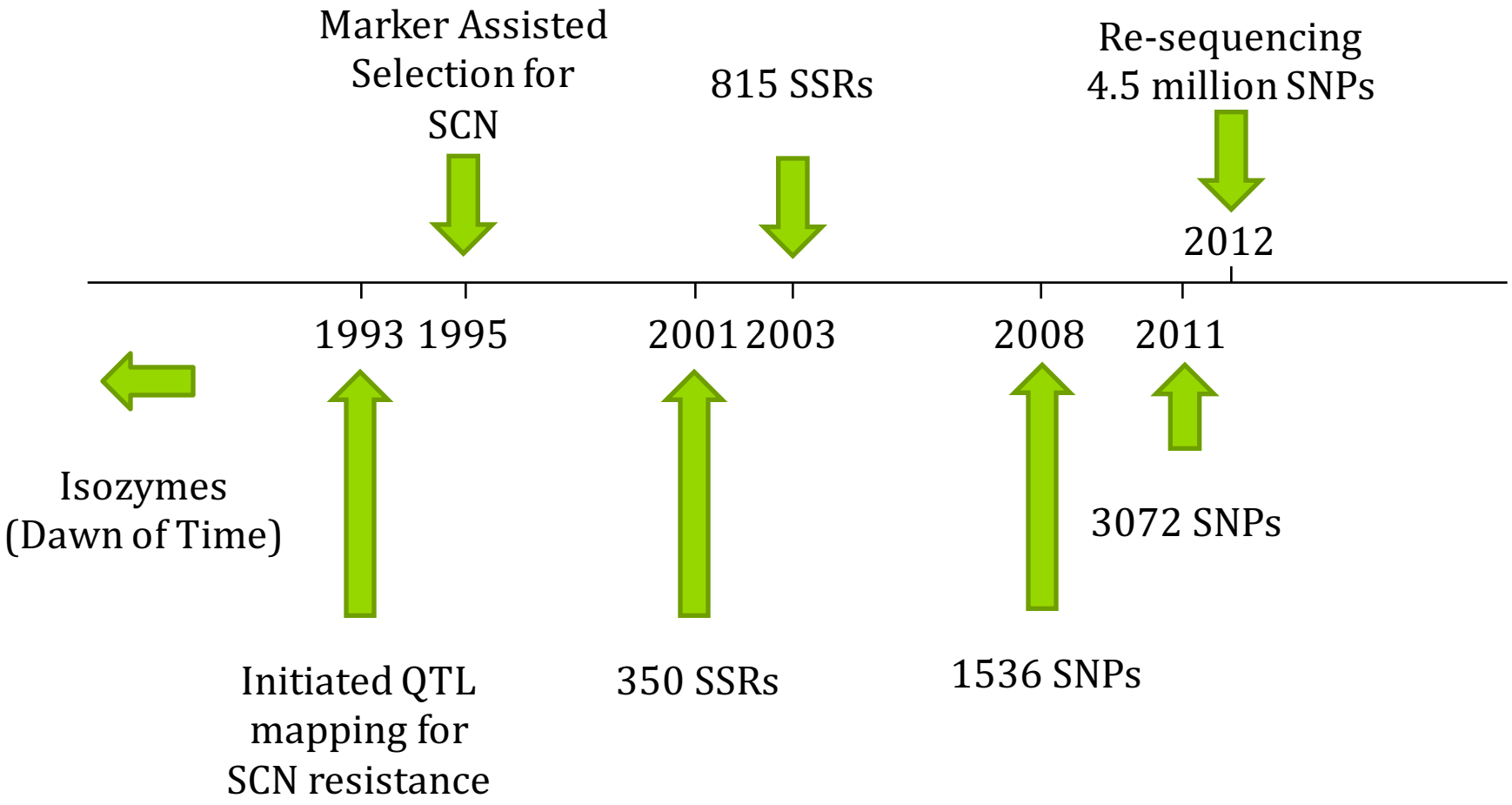
Pace of Change



Today's challenge is to turn this data into information which can be used to create value.

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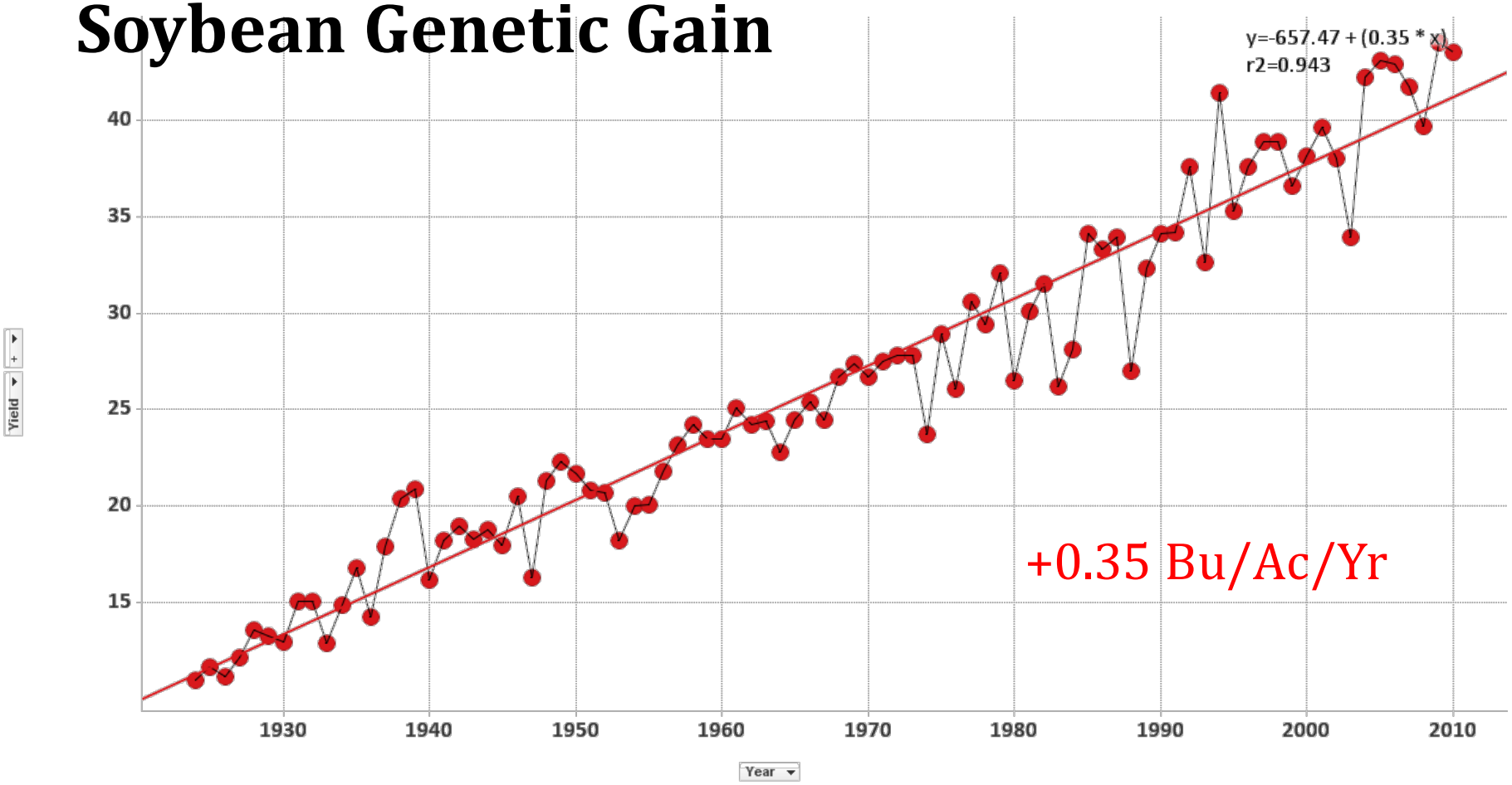
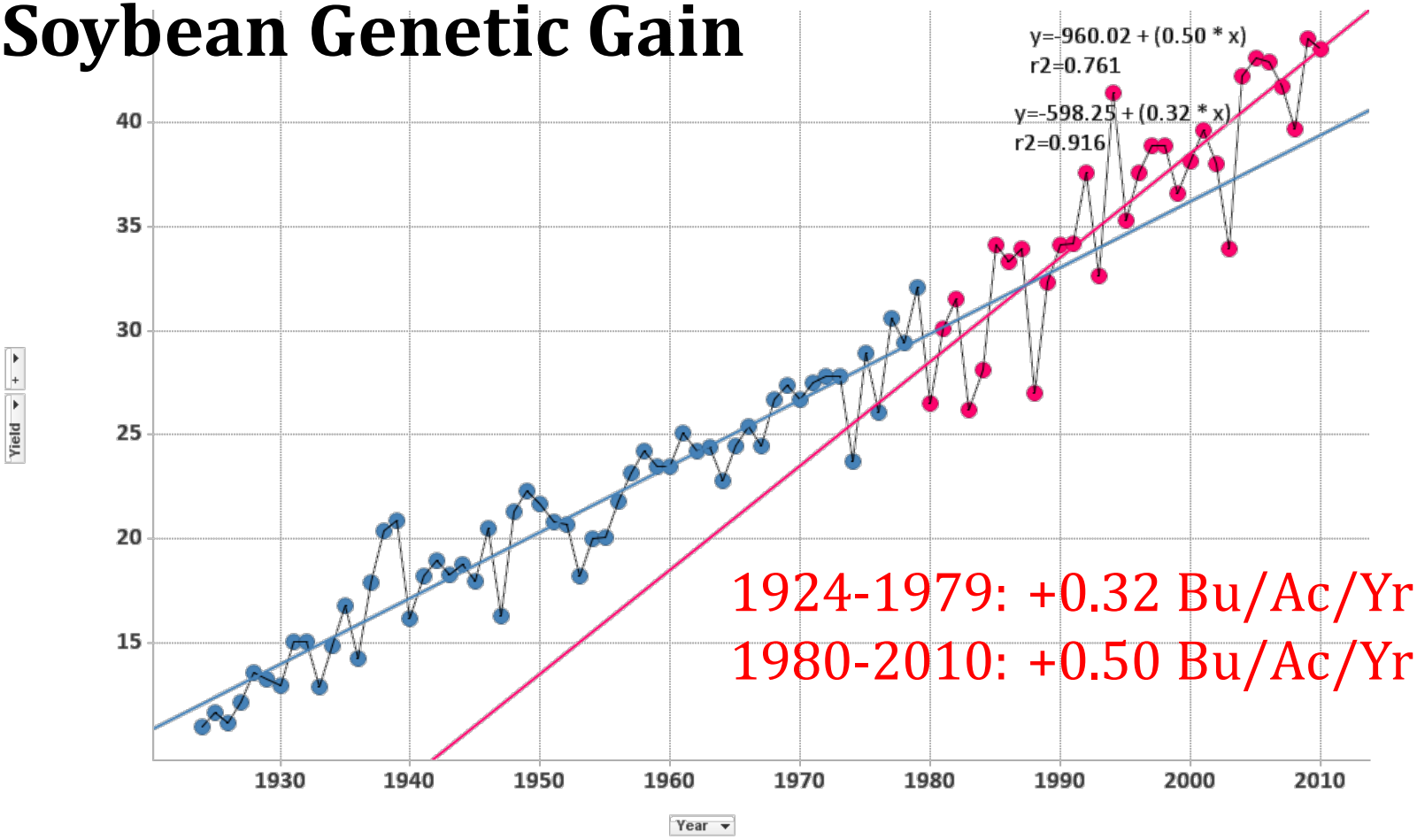
Soybean Genetic Gain



U.S. Soybean Yields 1924 - 2010

National Agricultural Statistics Service – February, 2011

Soybean Genetic Gain



U.S. Soybean Yields 1924 - 1979, 1980 - 2010

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National Agricultural Statistics Service – February, 2011

Commercial Breeding

- Highly focused on our customers
  - Are your breeding targets capturing value?
- Resourced to win
- Always looking for that edge to increase genetic gain
  - If you aren't…your competitors are.
- Highly collaborative

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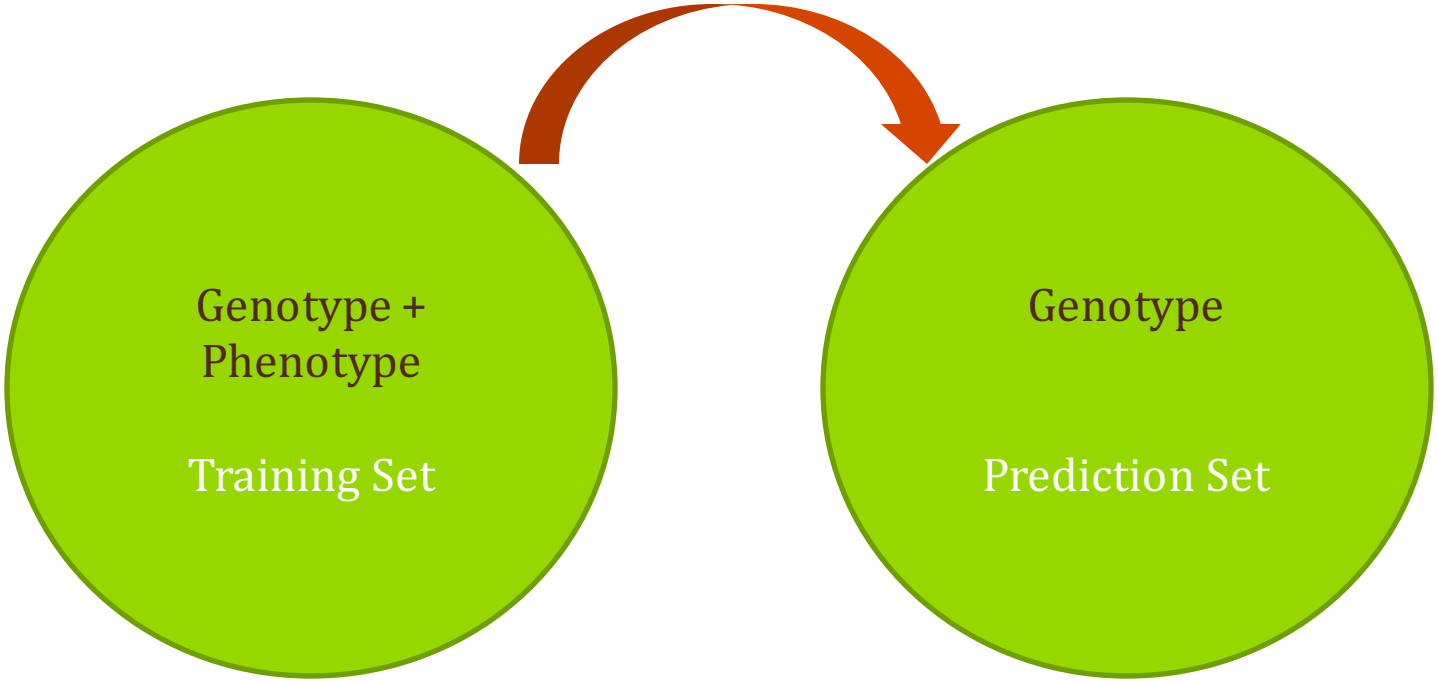
Whole Genome Predictions



Train your model using genotype and phenotype and then apply it to genotypes

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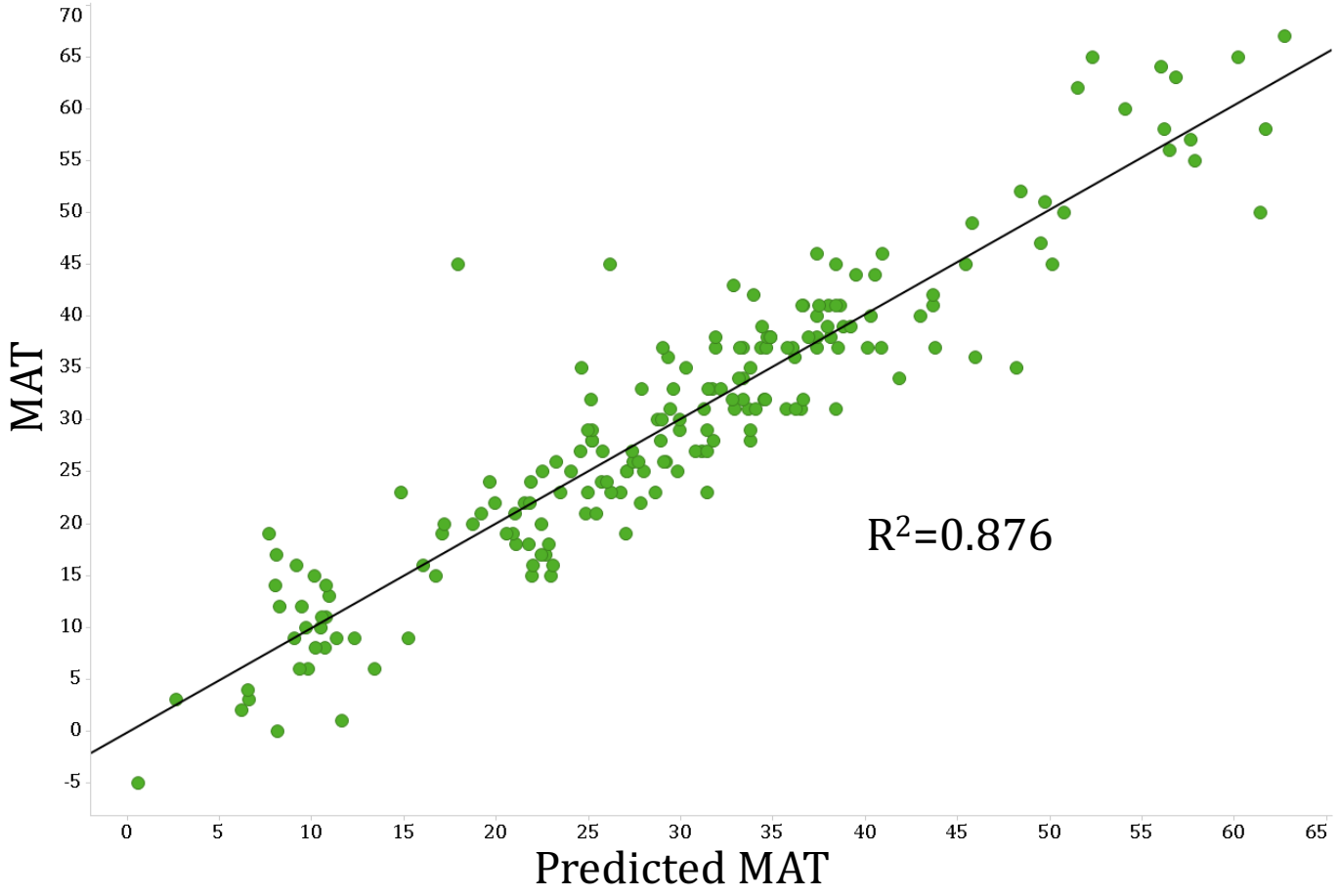
WGP for Soybean Maturity



Regression showing phenotypic maturity vs cross-validated WGP predictions. The estimation set includes 191 individuals representing soybean parents important to the germplasm pool.

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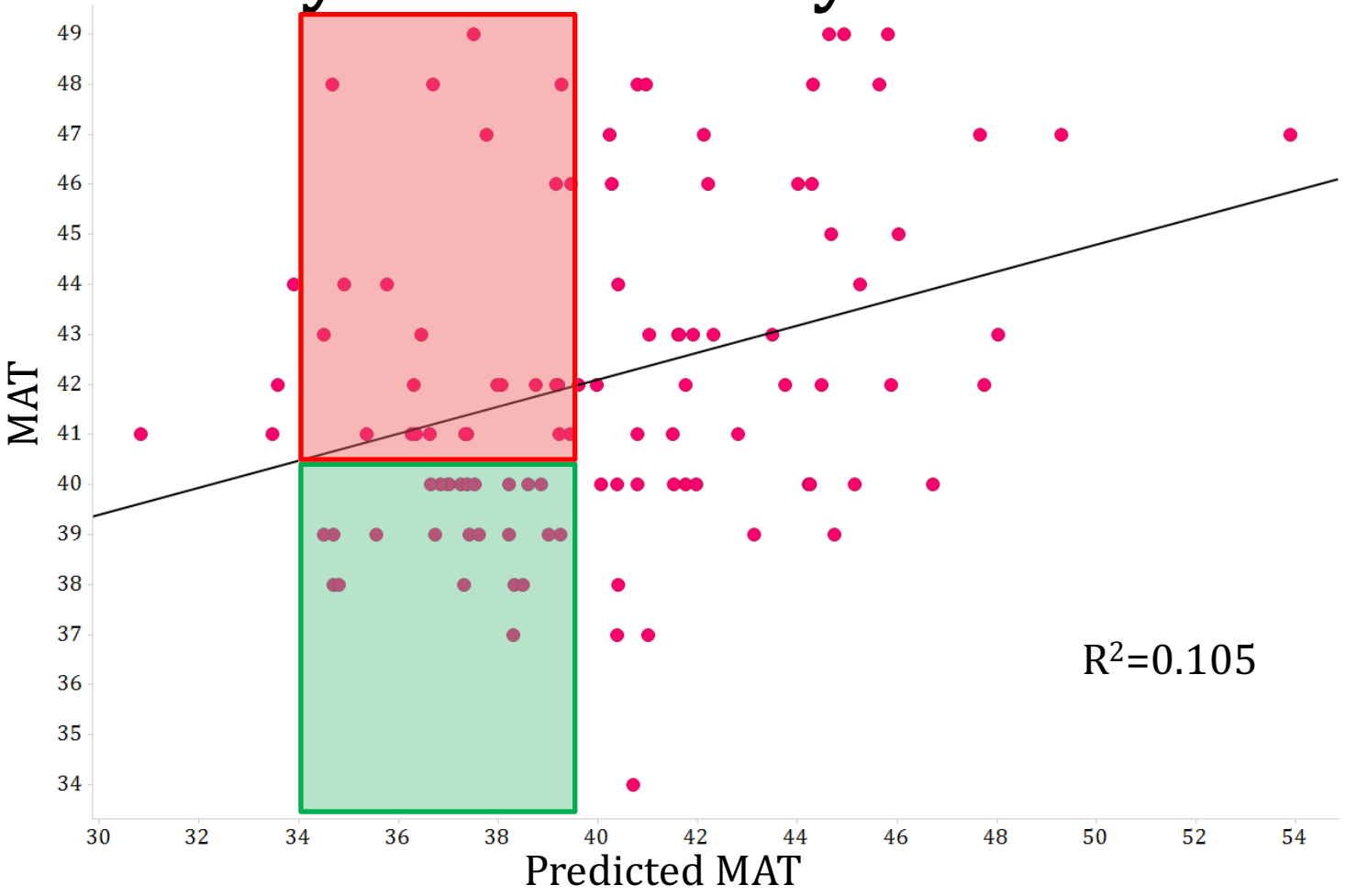
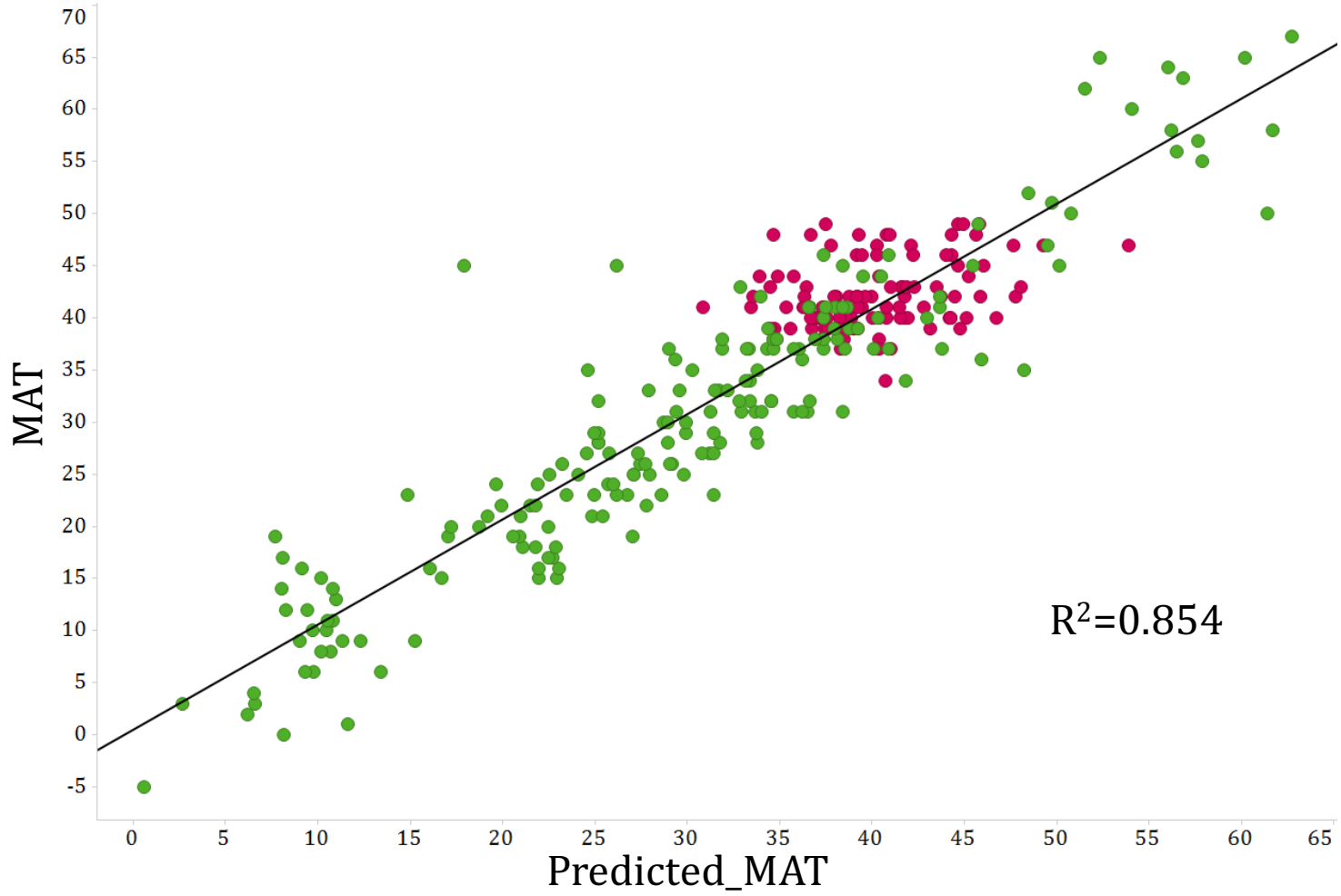
WGP for Soybean Maturity



Regression showing the maturity predictions, using the same estimation set, onto a group of 108 experimental varieties in my breeding program.

WGP for Soybean Maturity



Both prediction sets together. This isn't a problem with the predictions, but a problem of our perspective.

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Whole Genome Predictions

- Key learnings:
  - Perspectives of a breeder are often different from other scientists conducting research
  - Breeders must be capable and willing to ask really good questions
  - Its all about…communication

- Plant breeding lesson #1: Understand your data.

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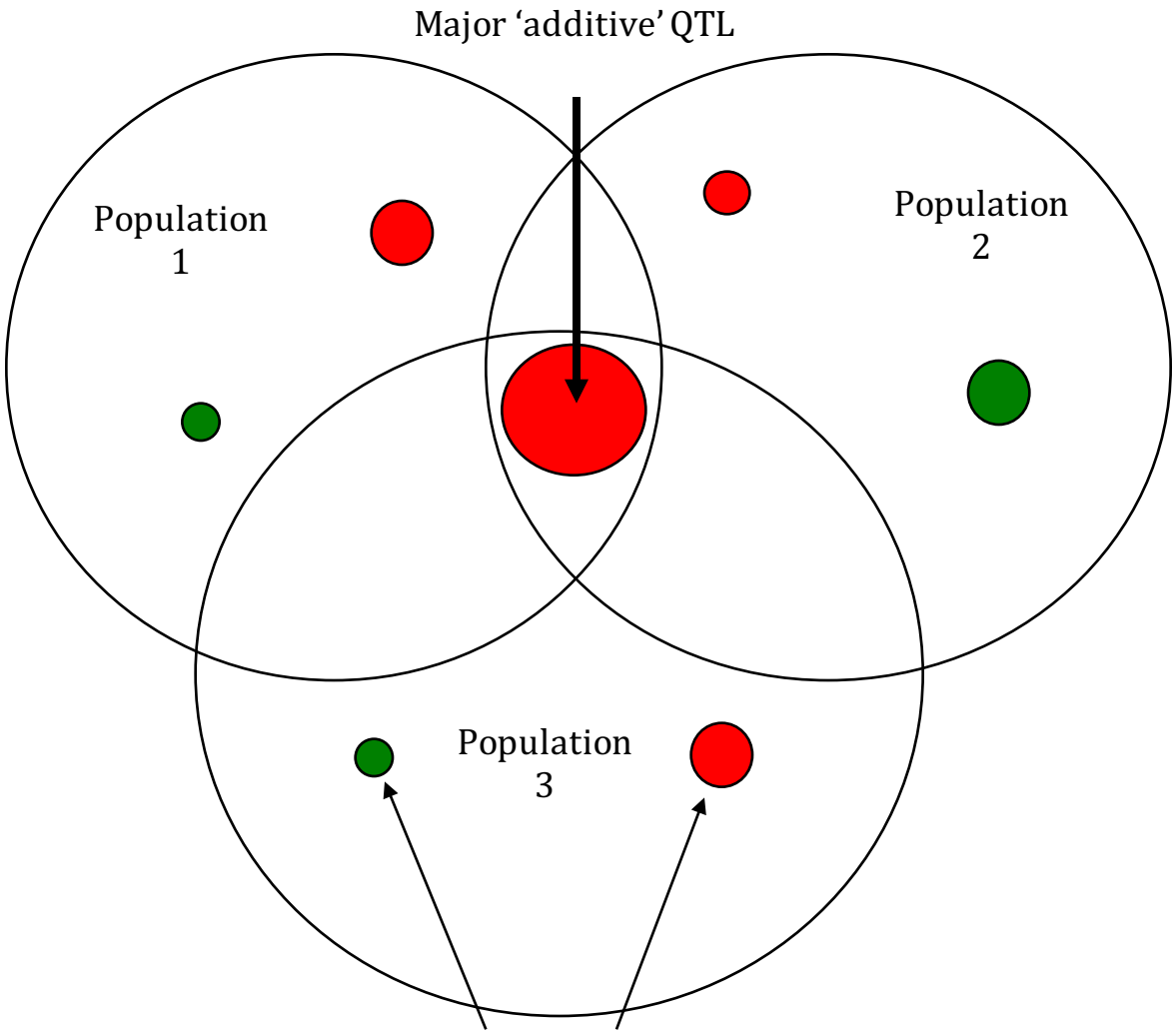
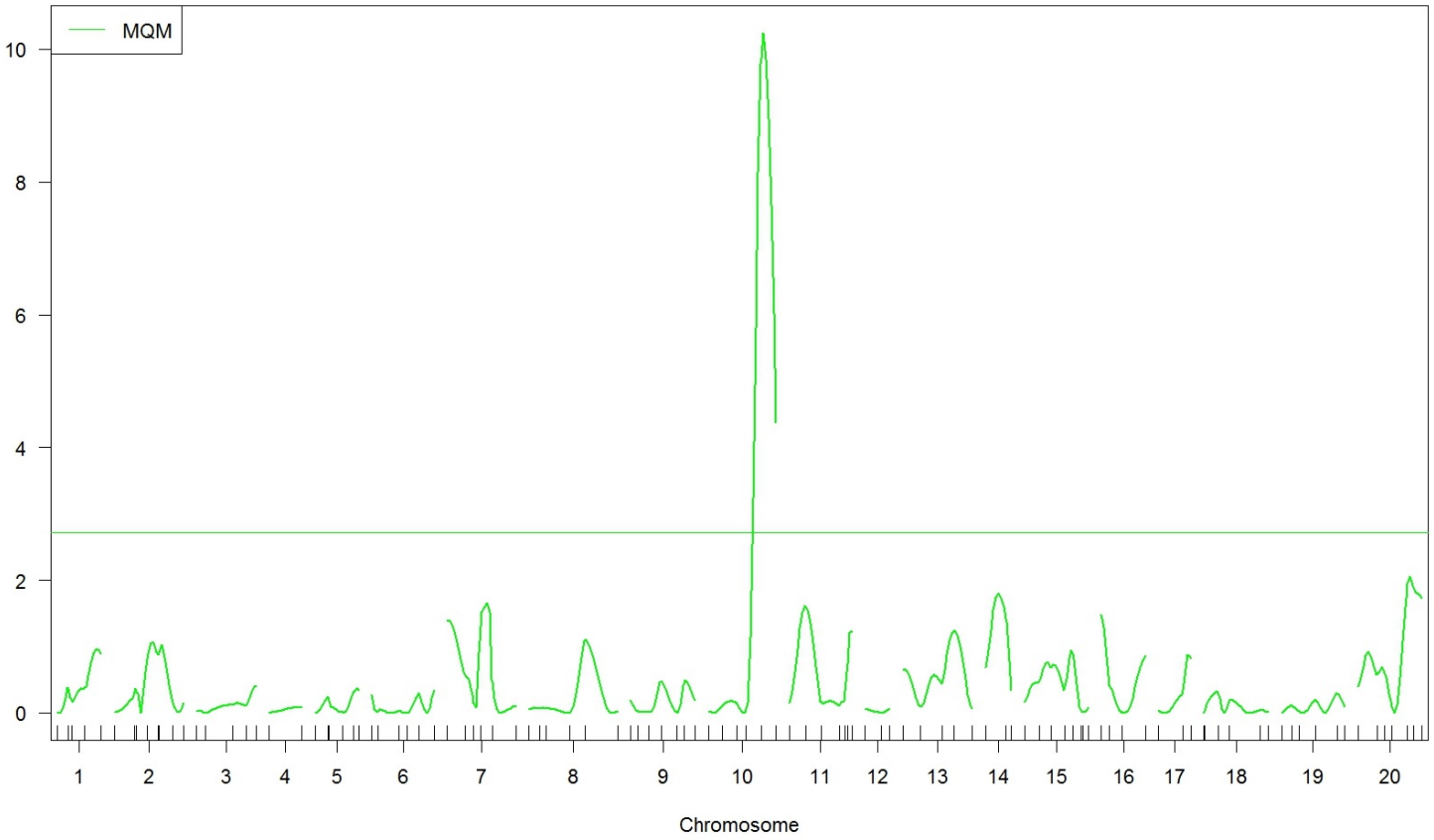
Quantitative Traits



These QTL did not 'validate' across populations.

Ex. 1: Quantitative Traits



QTL mapping yield in an elite population

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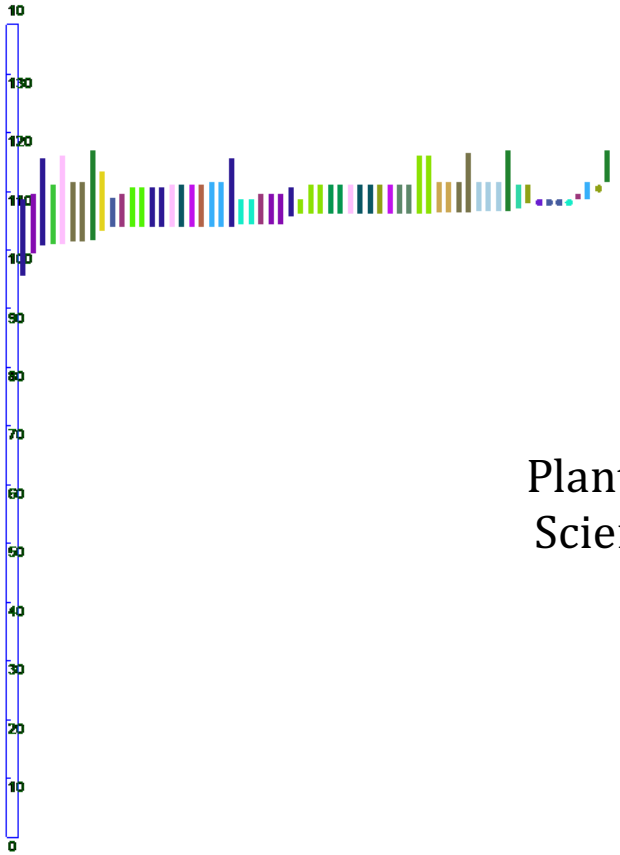
Ex. 1: Quantitative Traits

E-gene = 108cM



Ch 10

Plant Breeding Lesson #2: Scientific skepticism pays dividends

- Multiple populations confirm a yield gene on Ch 10 between 100-110cM
- Major maturity gene sits at 108cM; yield and maturity are strongly correlated

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Ex. 2: Quantitative Traits

- For an important soybean fungal trait:
  - 2 significant medium effect QTL have been identified in a mapping population
  - 2 different medium effect QTL were identified in a different population
  - Heritability of the phenotype >0.7
  - WGP has shown low predictive power
- As a breeder my instinct says this is an additive trait with many medium effect QTL

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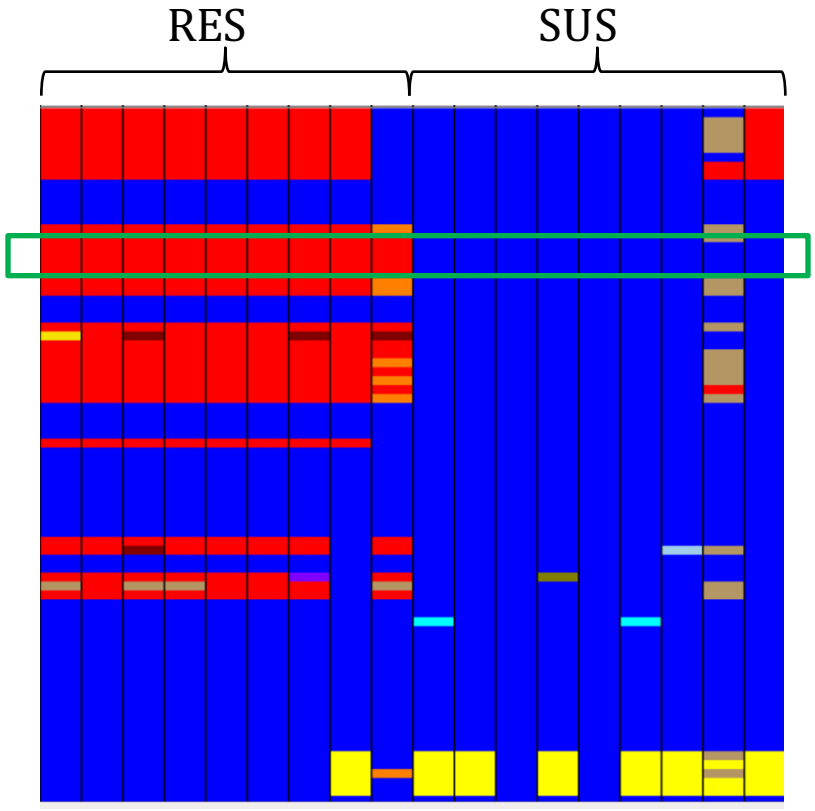
Ex. 2: Quantitative Traits



Plant Breeding Lesson #3:
Know the basics

- Parents classified as carrying the RES or SUS copy of the QTL
- Using high density data, haplotypes created in small windows (10kb)
- Patterns emerge which match our genetic understanding
- The same patterns are not present in lower density genetic data

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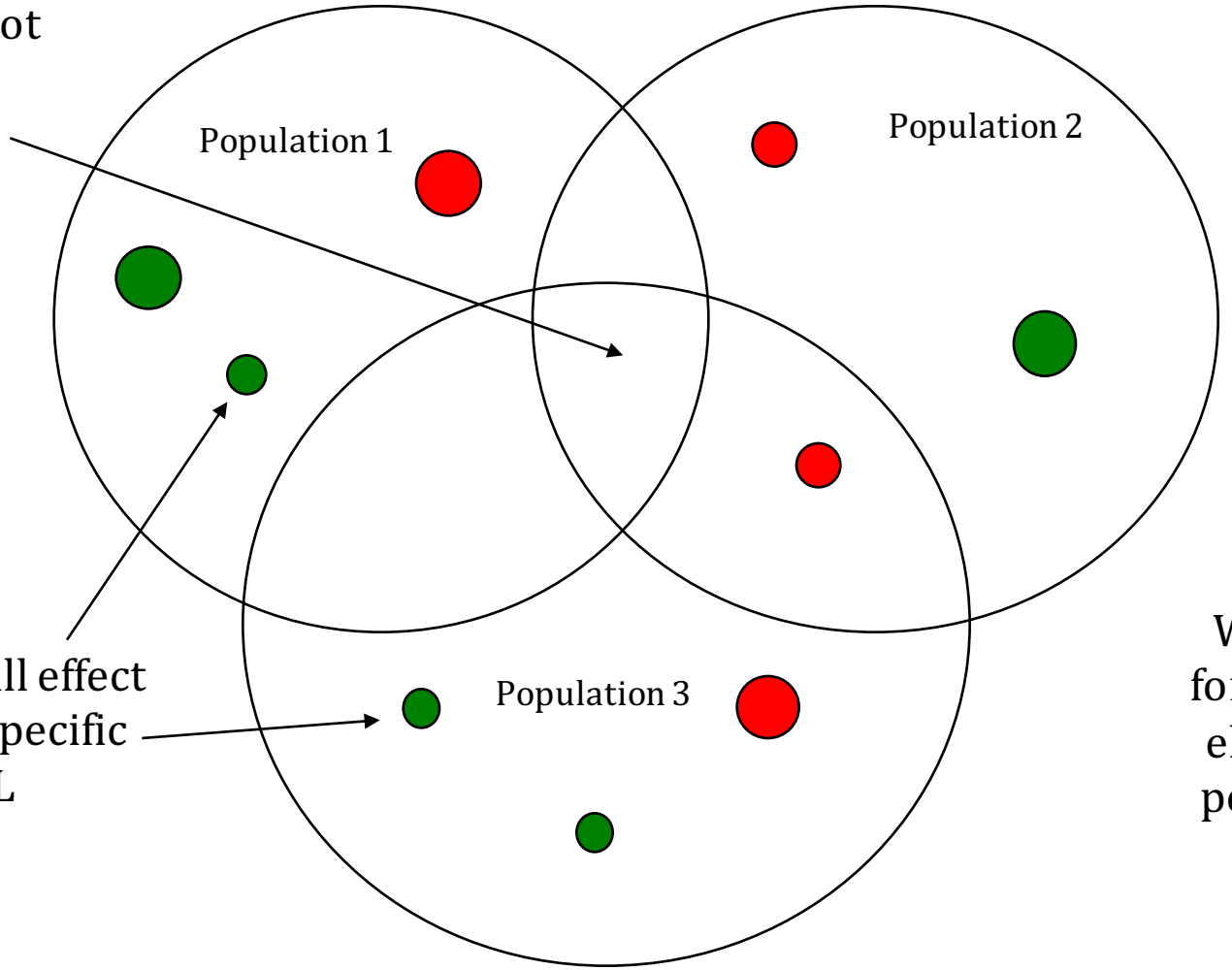
Ex. 3: Quantitative Traits

Large effect QTL do not exist



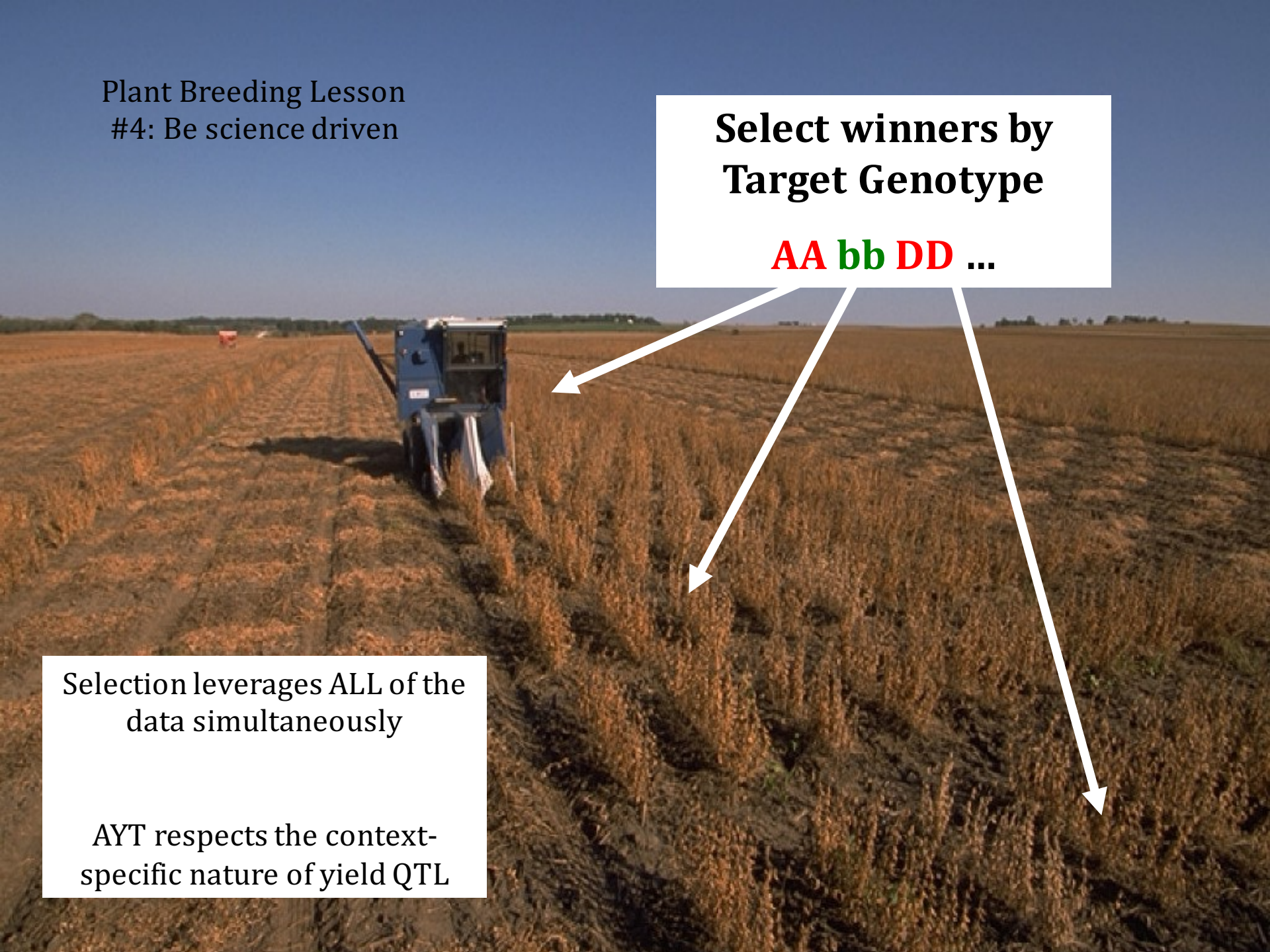
Many small effect context specific QTL

WGP efficacy for yield within elite breeding populations is low

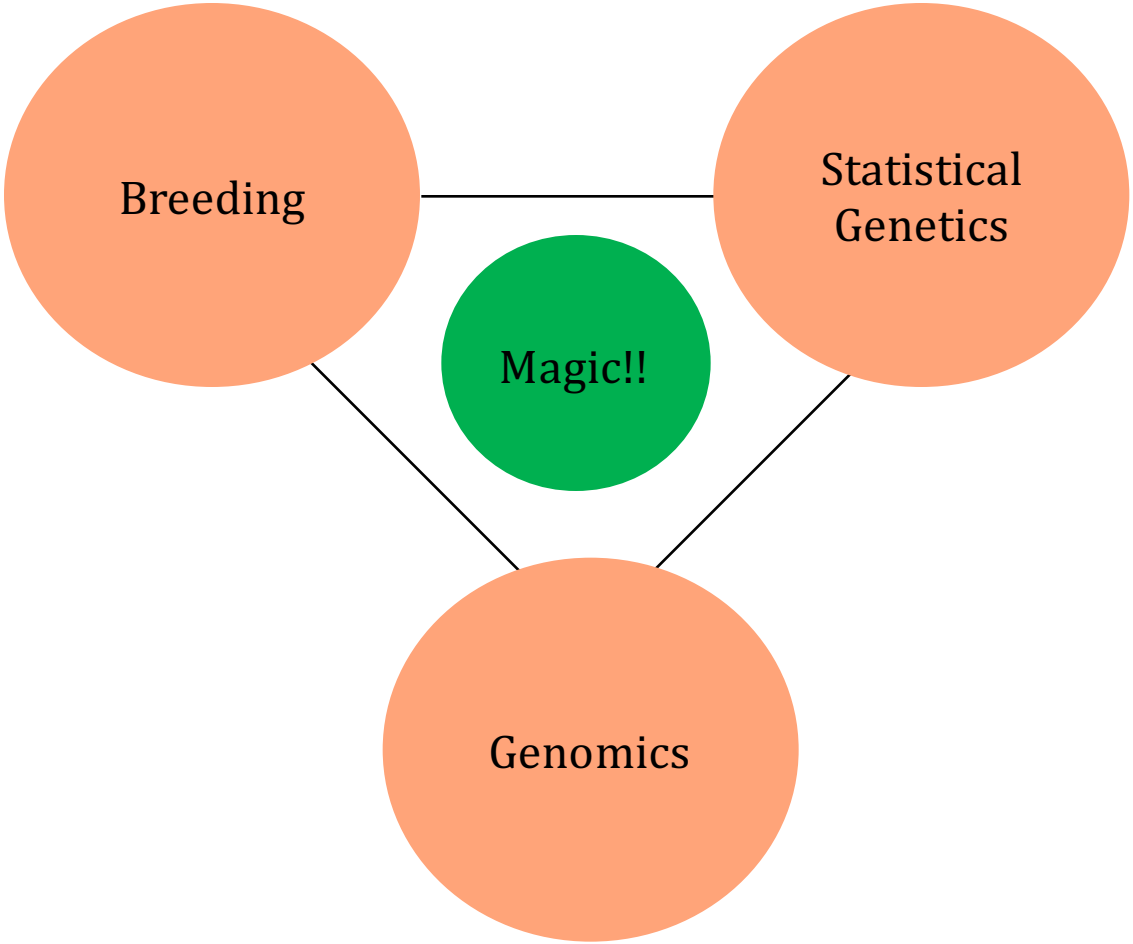
Yield QTL are context specific. How do we take this paradigm and apply it to breeding?

Ex. 3: Quantitative Traits

- AYT-Context Specific Mapping (CSM)
  - Each bi-parental population is genotyped and phenotyped (estimation set = prediction set)
  - Populations must be large enough to estimate genetic effects
  - No effort is made to apply predictions from one family to another – everyone is independent
  - Predicted yield is better than the phenotype


Plant Breeding Lesson
#4: Be science driven
Select winners by
Target Genotype
AA bb DD ...
Selection leverages ALL of the data simultaneously
AYT respects the context-specific nature of yield QTL

Holy Grail



It is all about the people and how they communicate

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Conclusions

- Plant breeding is all about the basics
  - Understand your data
  - Be skeptical
  - Apply the basics
  - Be science driven
- What is the most important lesson I learned?

You must see the process through from beginning to end.

– Norman Borlaug

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Questions?

Thank you to my excellent collaborators:

- Jon Massman
- John Woodward
- Jordan Spear
- Don Kyle

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