Genomic Selection in the UF Strawberry Breeding Program

Salvador A. Gezan, Luis Osorio, Sujeet Verma and Vance Whitaker
University of Florida

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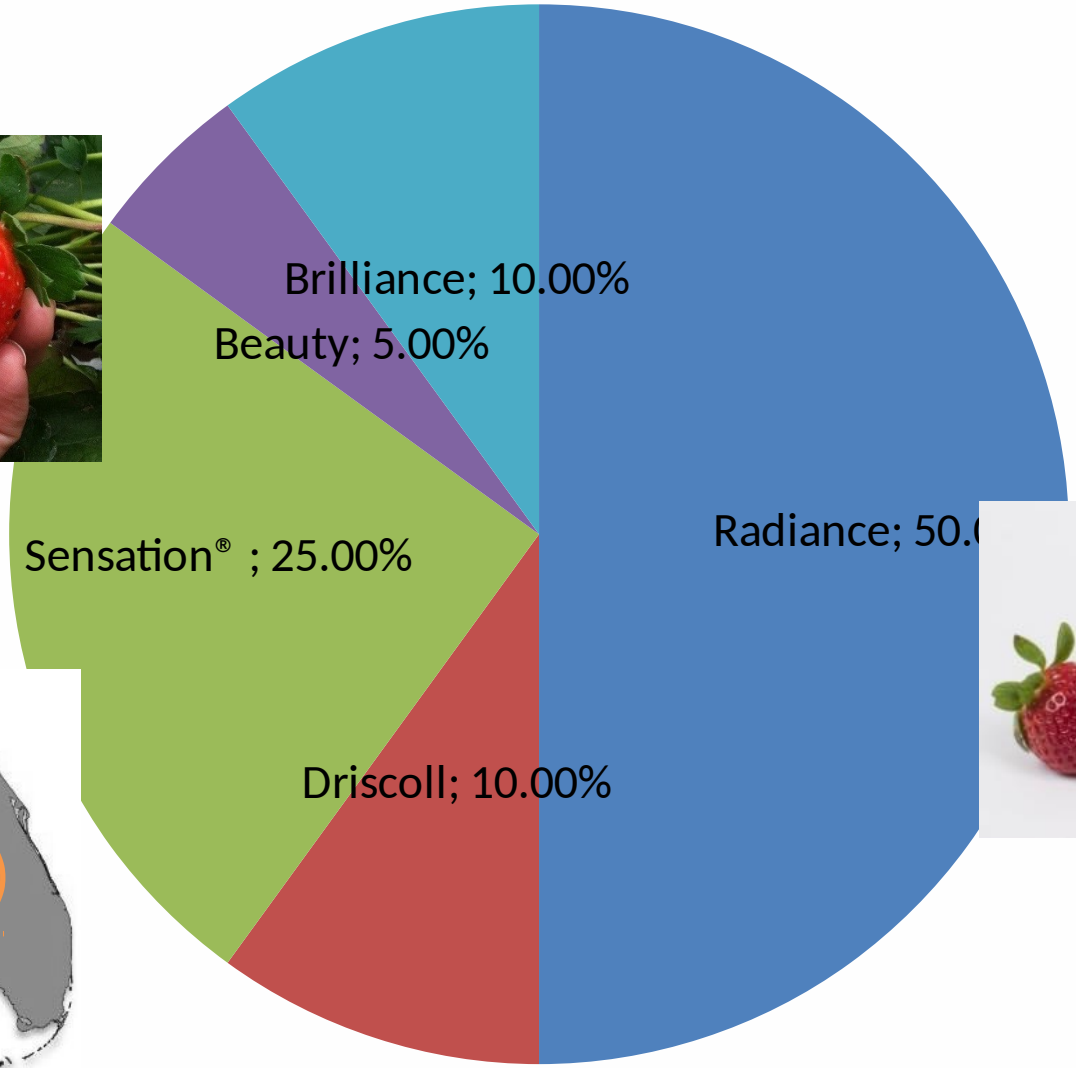
DISEASE RESISTANCE × HORTICULTURAL QUALITY

Breeding in Florida since 1948

UF IFAS UNIVERSITY of FLORIDA

Florida Acreage 2018-19




‘Florida Radiance’

UF IFAS
UNIVERSITY of FLORIDA

the Sweet Sensation

TELL US HOW THEY TASTE!

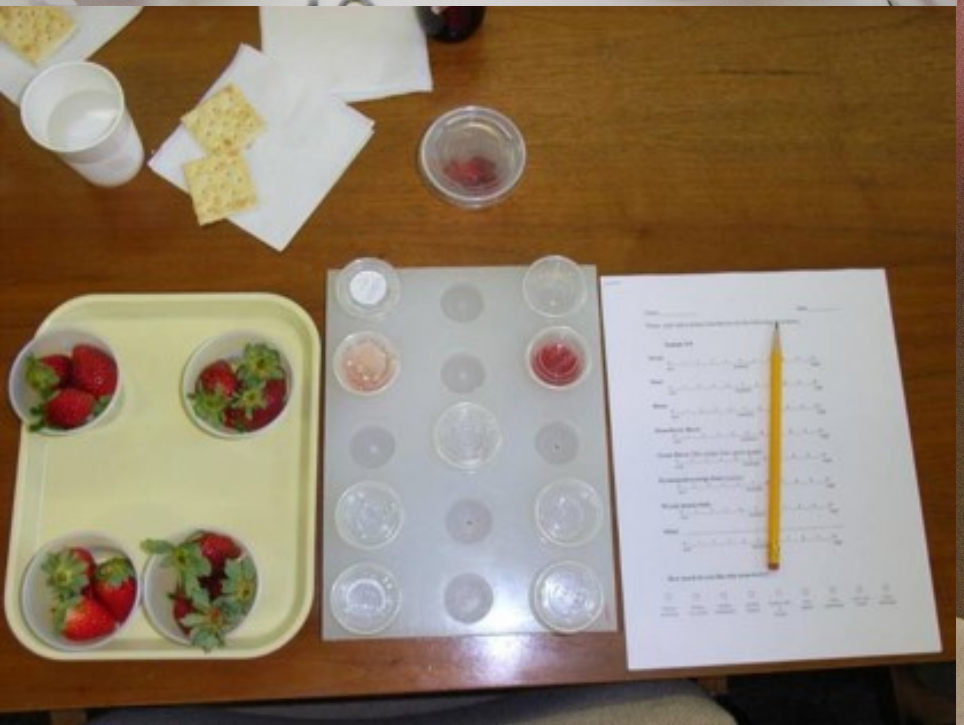
OPEN LID FOR DETAILS AND A CHANCE TO WIN AN iPad.

Fresh from Florida.


‘Florida Beauty’


‘Florida Brilliance’


116
317
847
629



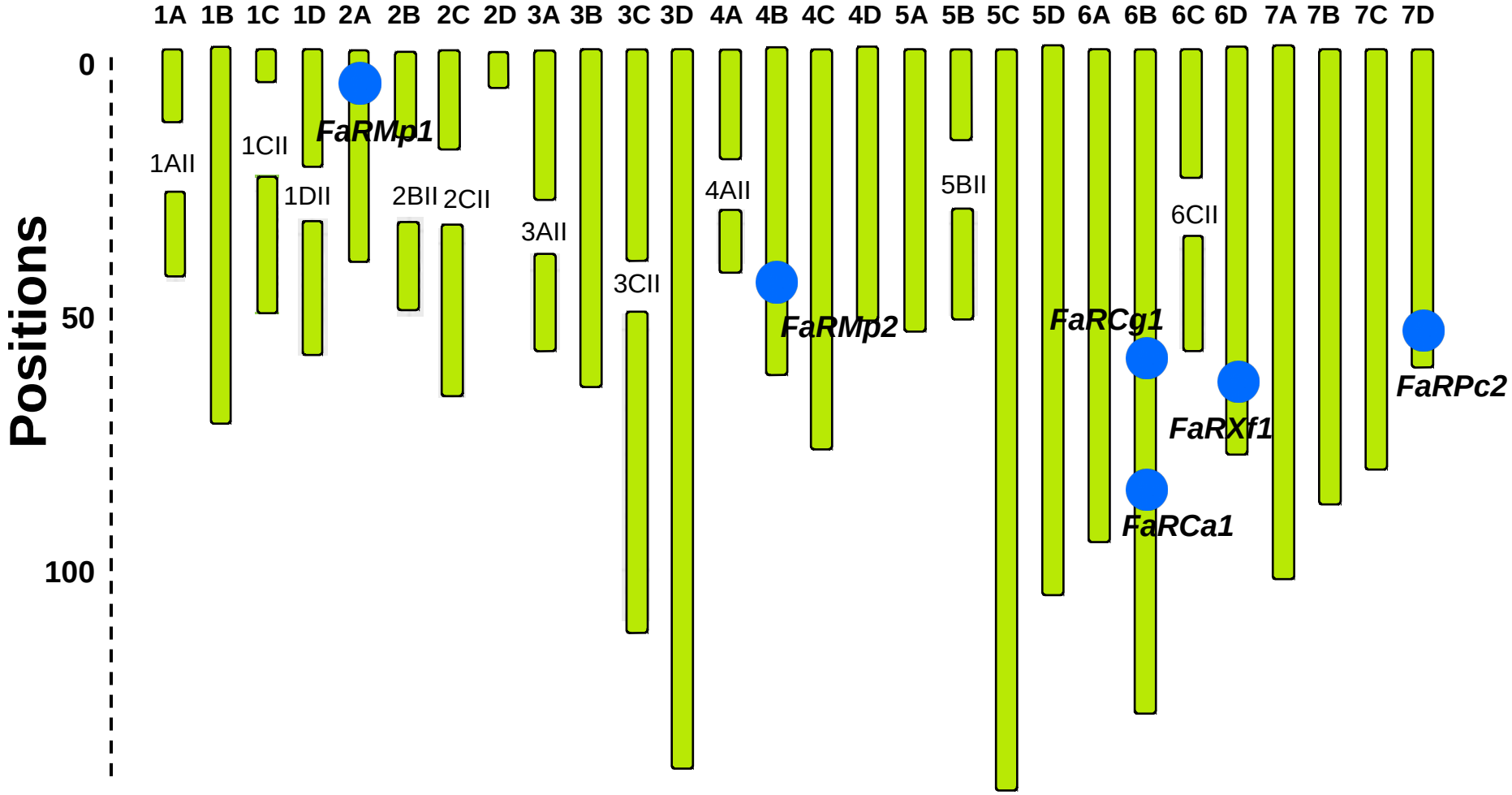

DELL

Breeder ← Nursery Grower ← Fruit Grower ← Shipper ← Wholesaler/ Retailer ← Consumer

Clonal multiplication	Disease resistance	Firmness	Fruit Size	Sweetness
Breakage resistance	Yield	Size consistency	Gloss	Internal color
Low chilling requirement	Rain resistance	Shape	Color uniformity	Freshness
Virus tolerance	Low cull rate	Color after cooling	Shelf life	
	Skin toughness			

$r_a = -0.76$

DR QTL on UF Genetic Map



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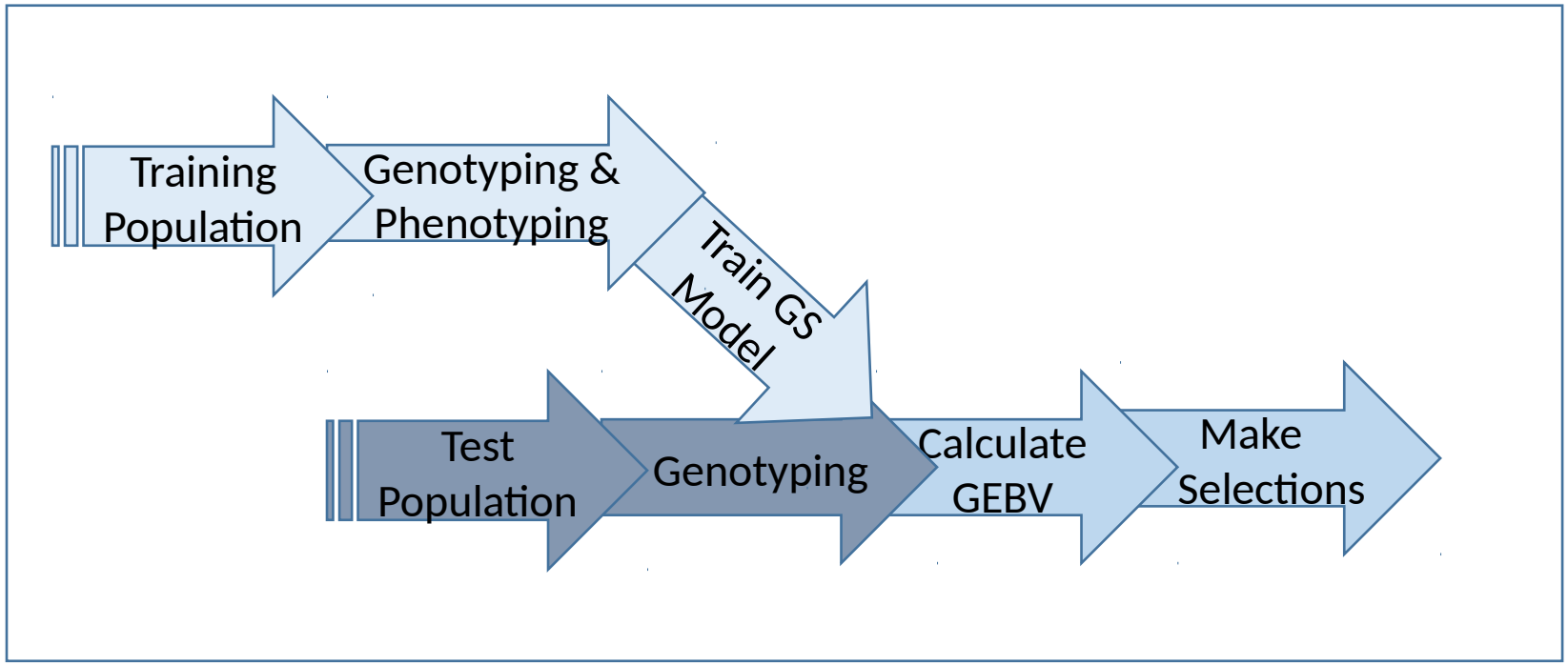
UF Strawberry Breeding Cycle

2014-15 2015-16 2016-17 2017-18

Cross → MASS → Seedlings → Adv. Sel. → Cross

Genomic Selection Process



(From Heffner *et al.*, (2009)

Parent GS Research Objectives

- Explore GS models in true validations
- Effects of multiple training cycles on predictive ability (PA)
- Effects of marker density on PA
- Integrating GS into the breeding strategy

GS Field Trials

Experimental Design

- *Two advanced selection trials (Yr.1, Yr.2)*

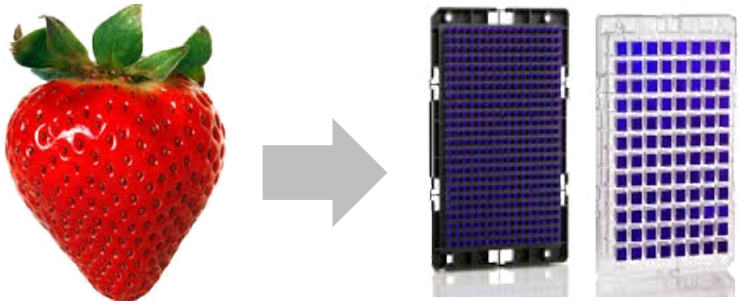
  RCBD, 5 blocks, 300-400 cloned genotypes

Phenotyping

Trait		Unit
Average Fruit Wt	(AWT)	grams
Soluble Solids (Brix)	(SSC)	%
Early Marketable Yield	(EMY)	grams
Total Marketable Yield	(TMY)	grams
Total Cull Fruit	(TC)	%

GS Methods

Genotyping



90K IStraw90 Axiom® SNP array

Affimetrix & RosBREED

(Bassil and Davis et al. 2015)

- Marker Quality Control
- ~9000 SNPs

Analyses

- Models GBLUP, Bayes B, Bayes C, and RKHS
- BGLR (Perez P., de los Campos, G. 2010)

Comparison of GS Models

- Predictive Ability: $corr(y, \hat{g})$
- PBLUP: traditional pedigree-based estimates (no markers)
- Genetic Gain Efficiency from Parent Selection (5%,10%): $\hat{g}_{inc}/\hat{g}_{com}$

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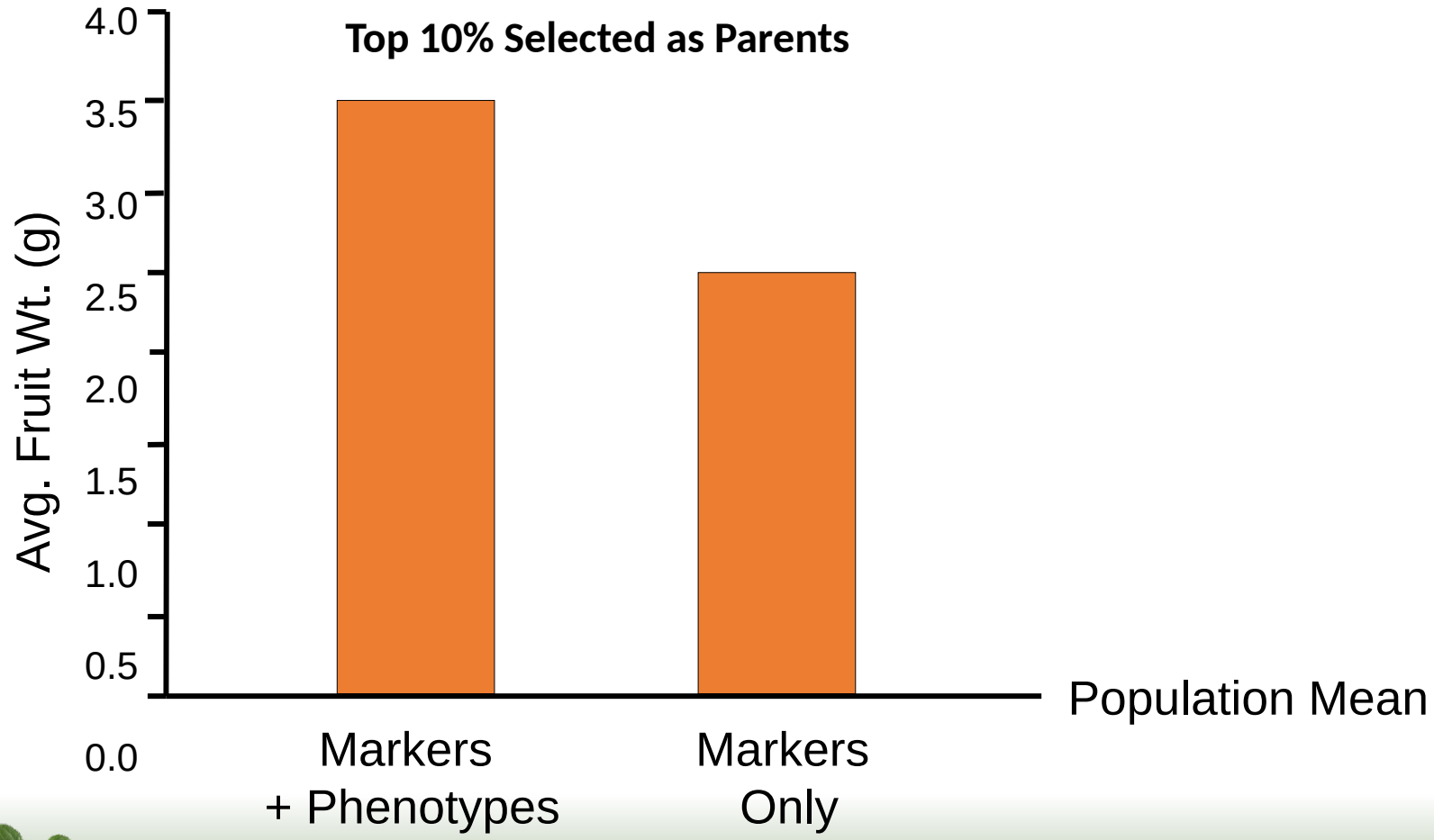
GS Results

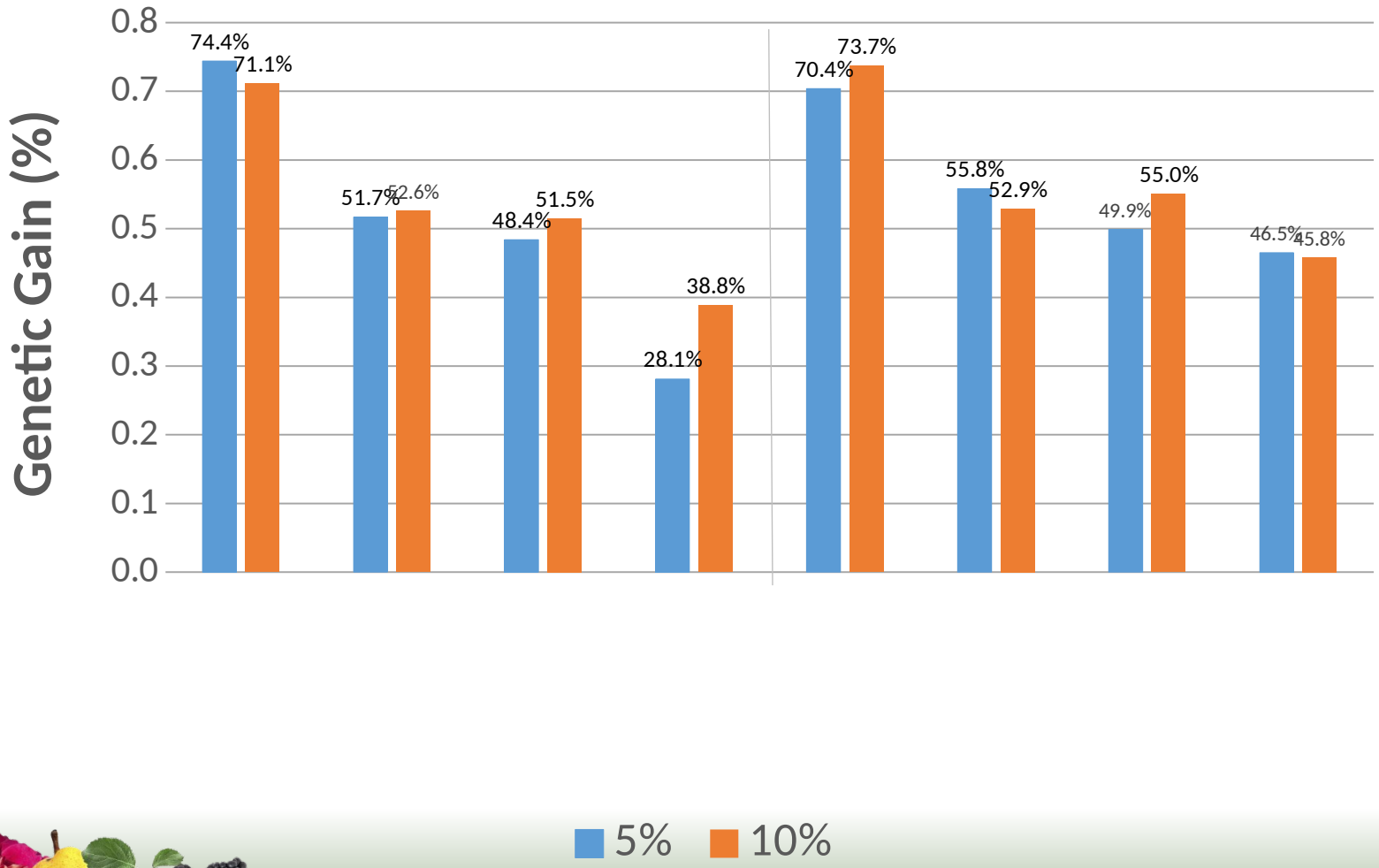
Predictive Ability – Year 1 to predict Year 2-

Trait	PBLUP	GS Models			
		GBLUP	Bayes B	Bayes C	RKHS
AWT	0.44	0.49	0.49	0.49	0.52
SSC	0.37	0.43	0.44	0.44	0.45
TMY	0.24	0.31	0.35	0.34	0.33
TC	0.14	0.32	0.35	0.35	0.32

GS Genetic Gain Example



Parental GS Genetic Gains



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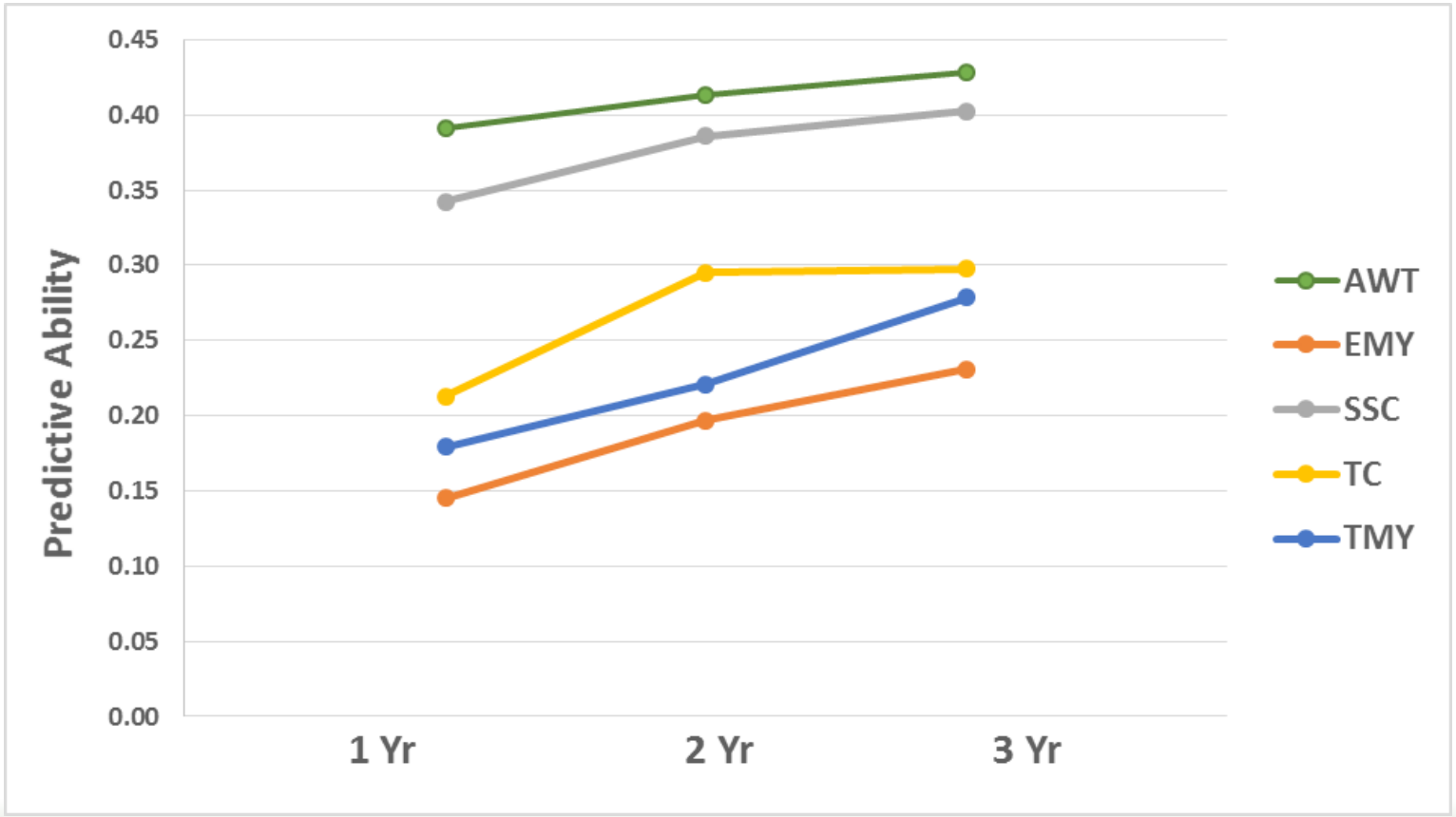
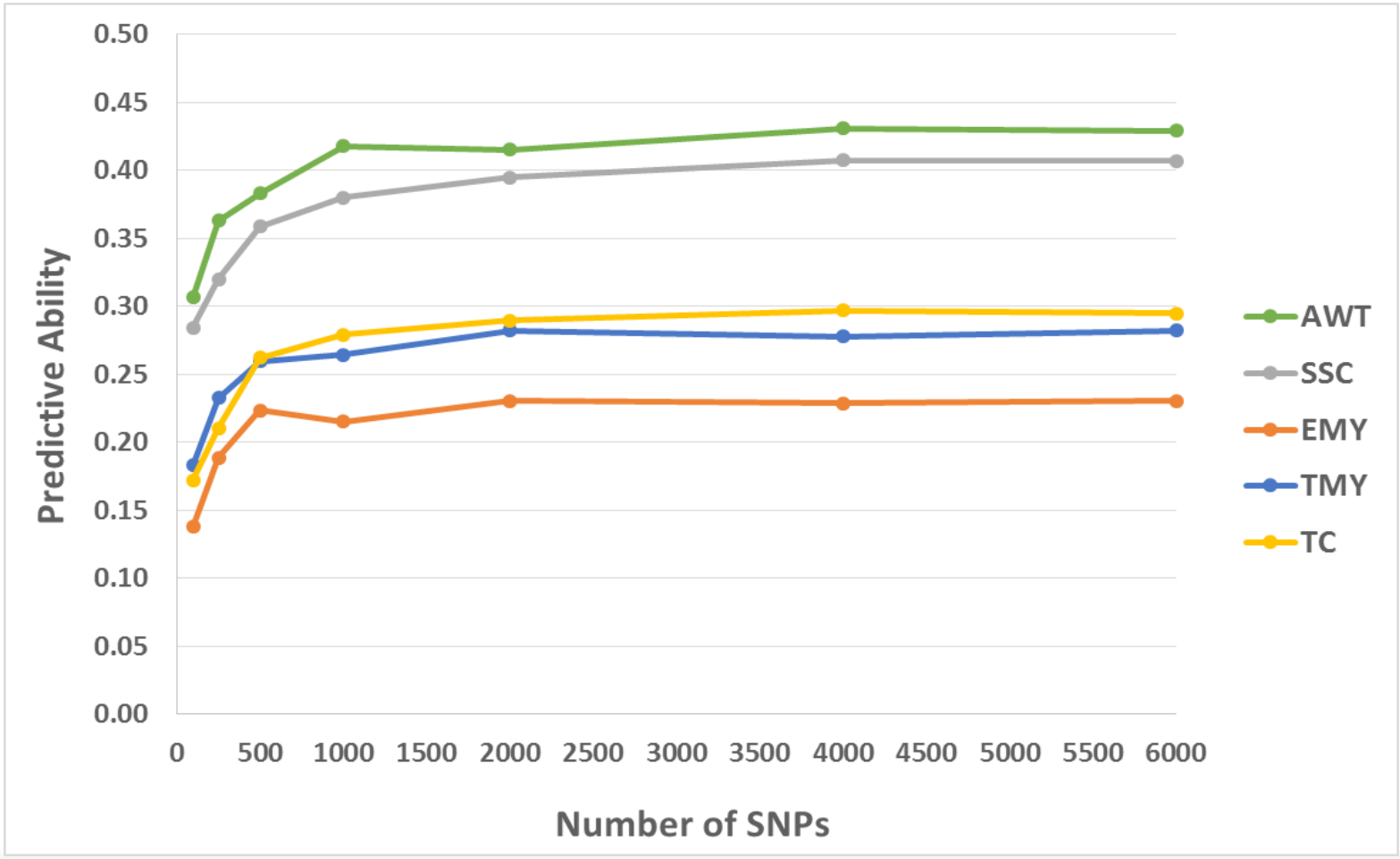
Multiple Years of Training

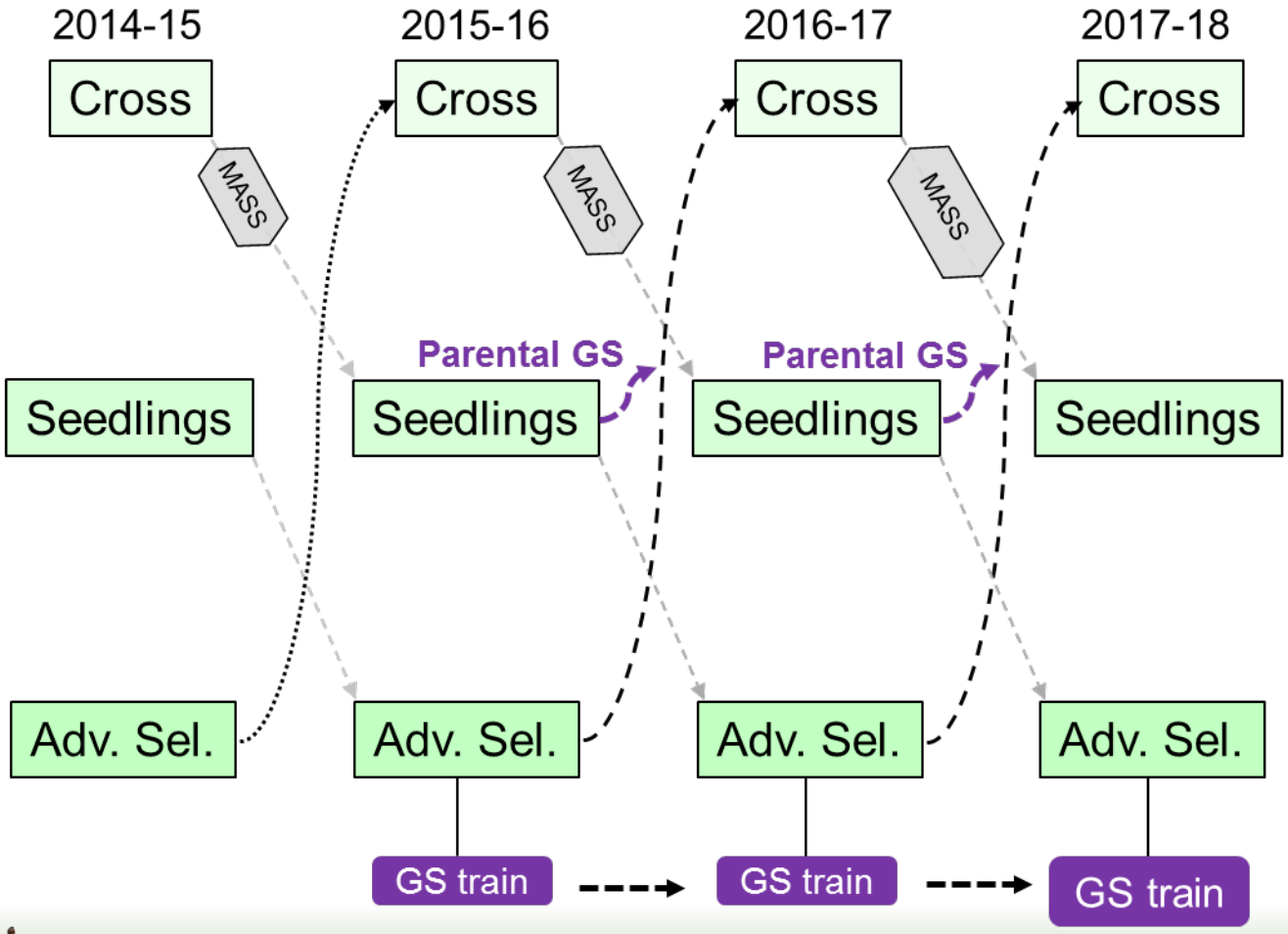
Bayes B ~ 9,000 SNPs



Random Marker Selection



GS for Parent Selection



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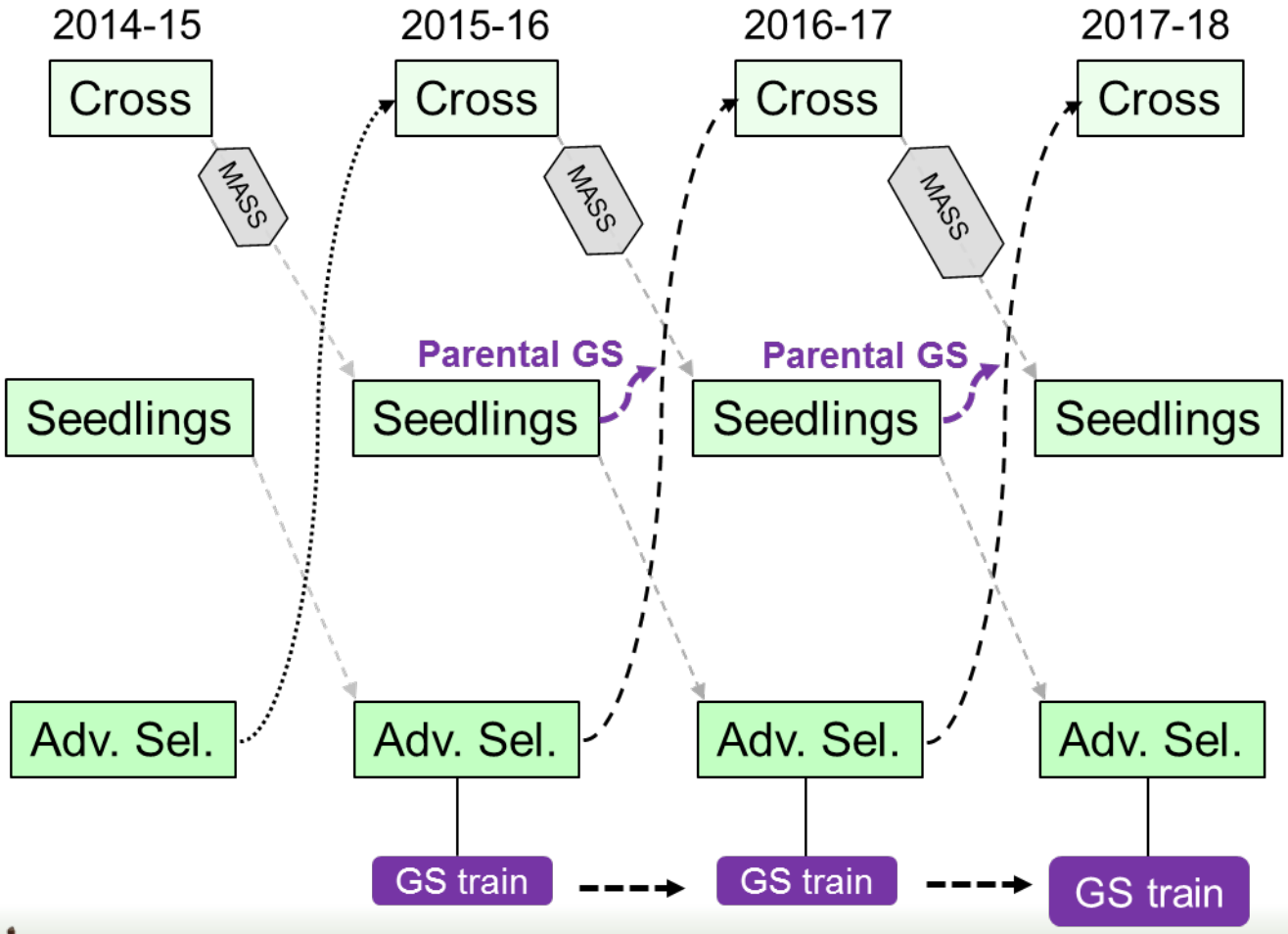
How This Works Practically

- **Sept - Oct**: Predict BVs for *Objectively Measured Traits* for Advanced Selections for which no data is available (selected as seedlings previous year)
- **Nov - Dec**: Early-season field observations for all *Visually Evaluated Traits*
- **Jan - Feb**: Select 5-7 new parents for immediate crossing (typically 35-45 total parents per year)
- **Outcome**: for a portion of the parents, breeding cycle reduced from 3 years (minimum) to 2 years

GS for Parent Selection



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Can we use GS for seedling selection?

- Explore GS within families to predict seedling performance
- How do we evaluate the performance of this method?
- How would we integrate GS with MASS for major loci?

Within-Family GS Experiment

Trial Design

Planted: 10/2018
RCBD: 3 Replications
Families: 6
Seedlings: 75/Fam
Total N: 450 seedlings

	Males			
Females	A	B	C	D
A		x	x	x
B			x	x
C				x
D				

Model Evaluation (02/2018)

TNT **TST**

A/* + B/* = 300 A*B =75

TRN = Families with Common Parents (4)

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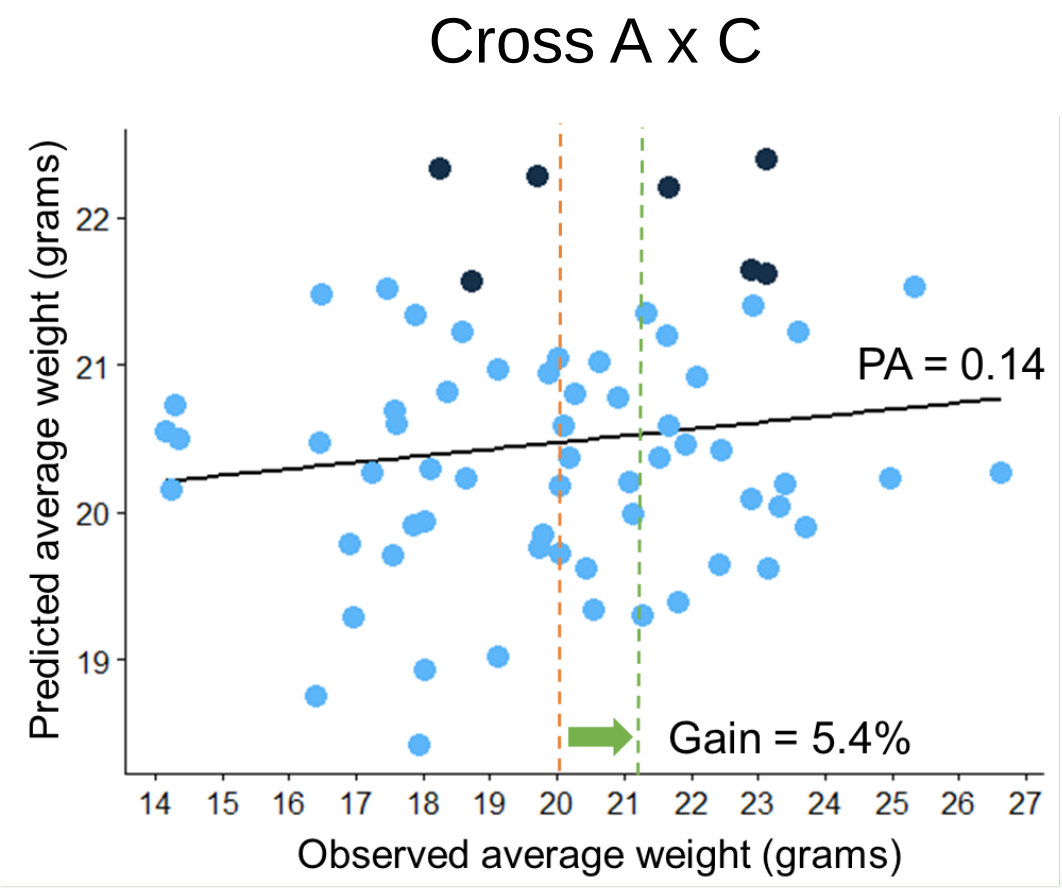
Within-Family GS Experiment



Within-Family GS Experiment

	AWT	EMY	SSC	TC	FRM
Seedling Selection (PA)	0.28	0.16	0.13	0.28	0.24
Gain Over Family Mean (top 10%)	4.4%	14.1%	9.3%	14.1%	15.6%

Within-Family GS Experiment

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Yearly Breeding Gain Last 5 Years (%)	2.7%	5.7%	-1.2%	0.5%	--

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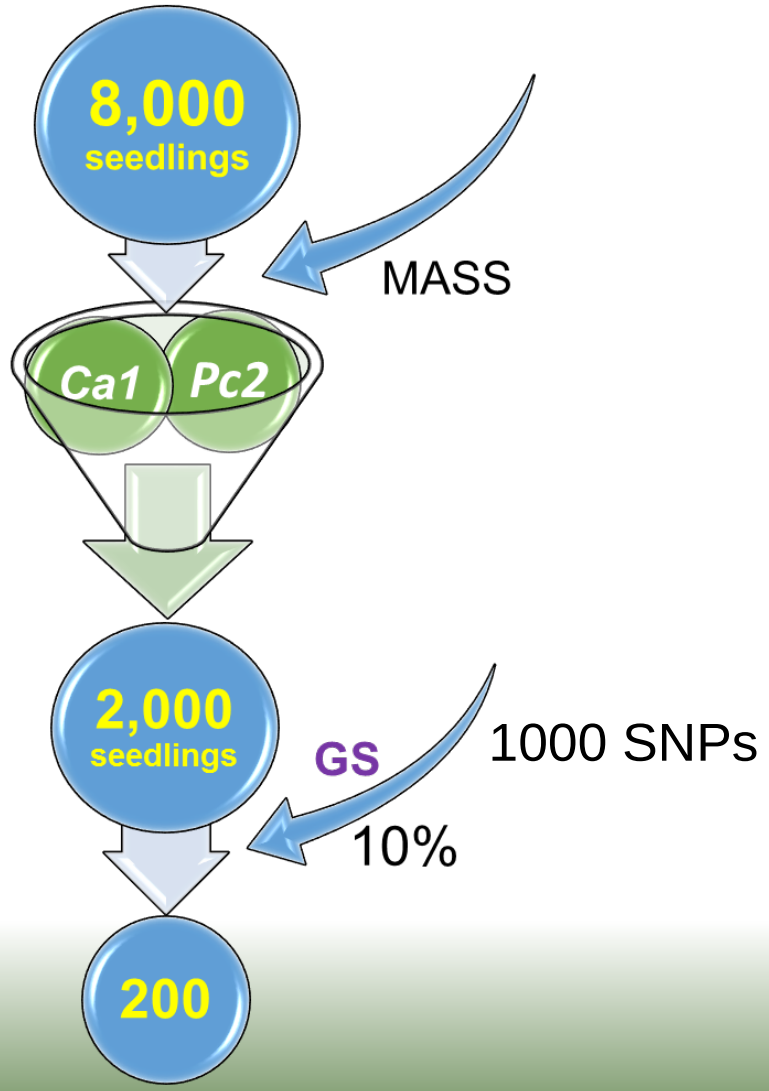
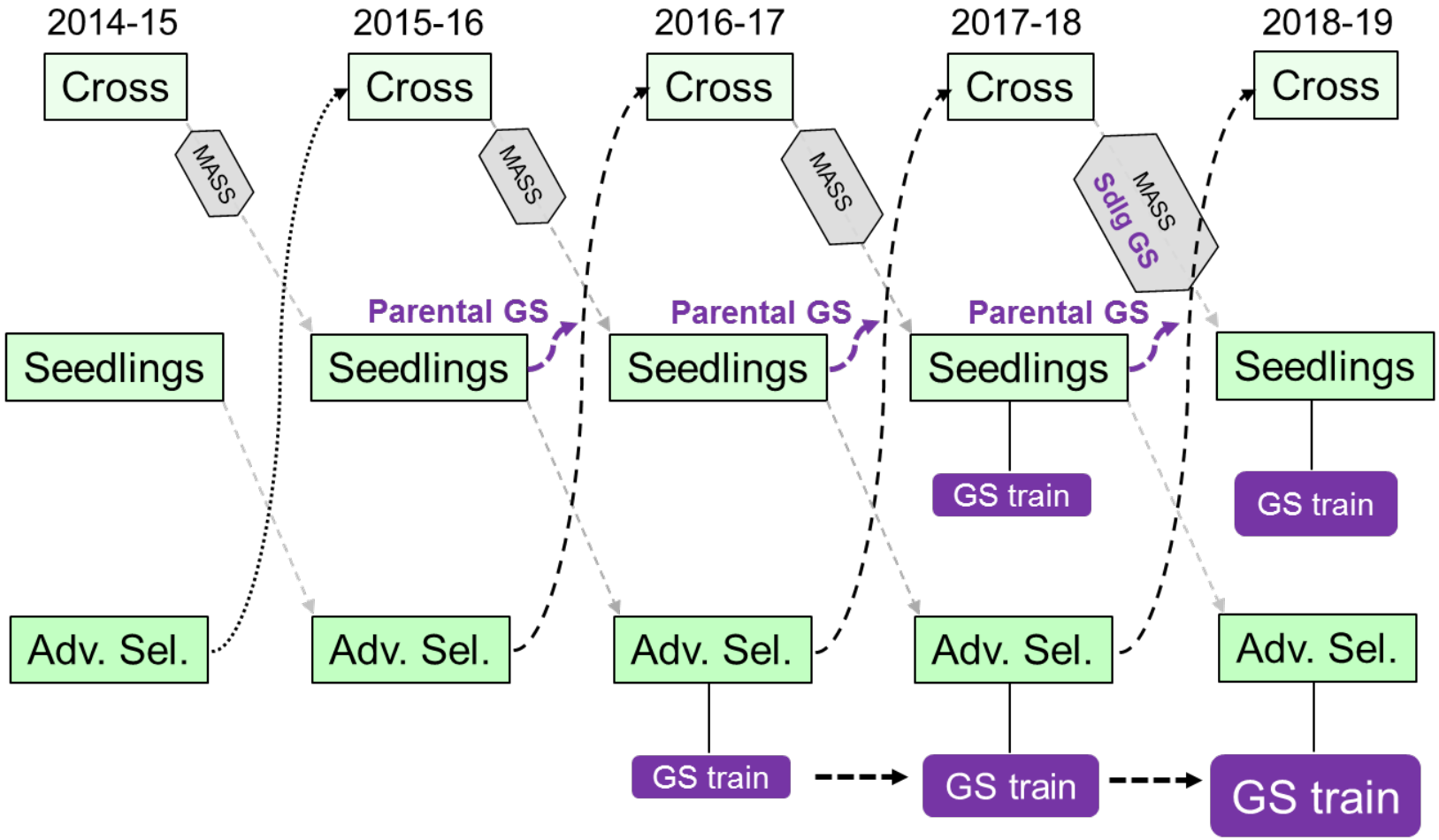
For Seedling GS in UF strawberry program only 500 SNPs needed

Hypothetical WF GS for Cross





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Summary

- **<u>GS for Parent Selection</u> allows accelerated use of new parents in crossing, reducing length of cycle**

- **<u>GS for Seedling Selection</u> could increase gains for complex traits if cost-effective, low-density genotyping available**

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