Genomic Selection Impacts

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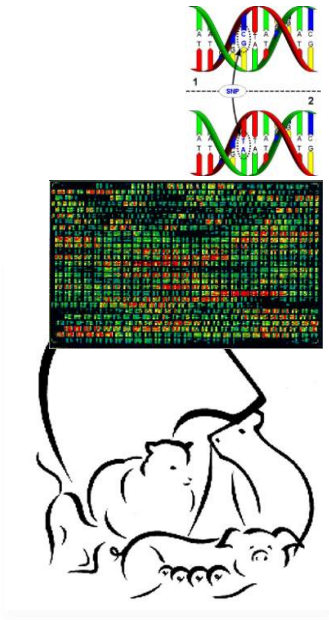
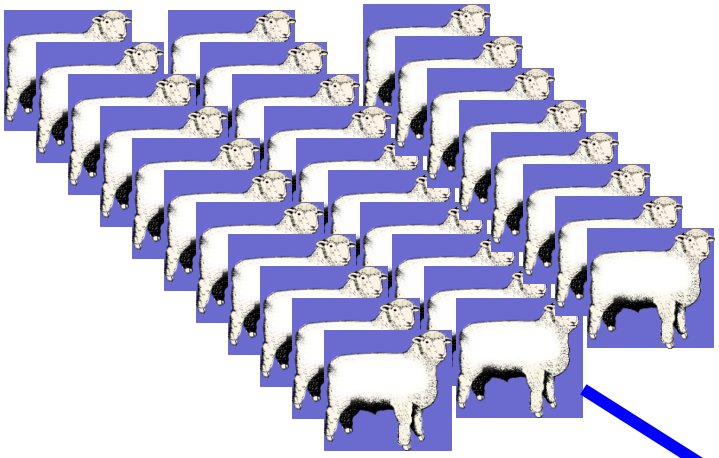


Genomic Prediction: basic idea



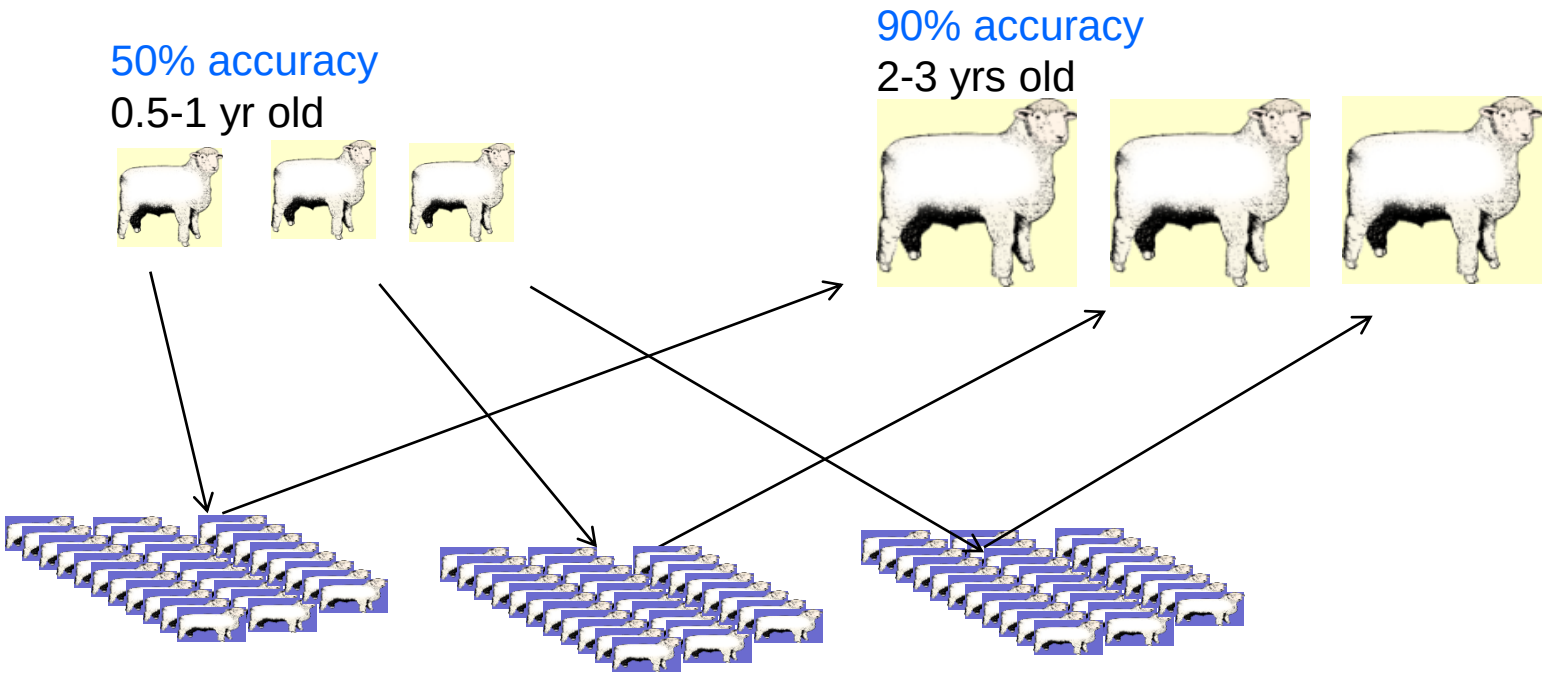
Reference population

young rams

3) Computer centre can predict breeding value for young rams
based on genomic relationship, combines it with other info

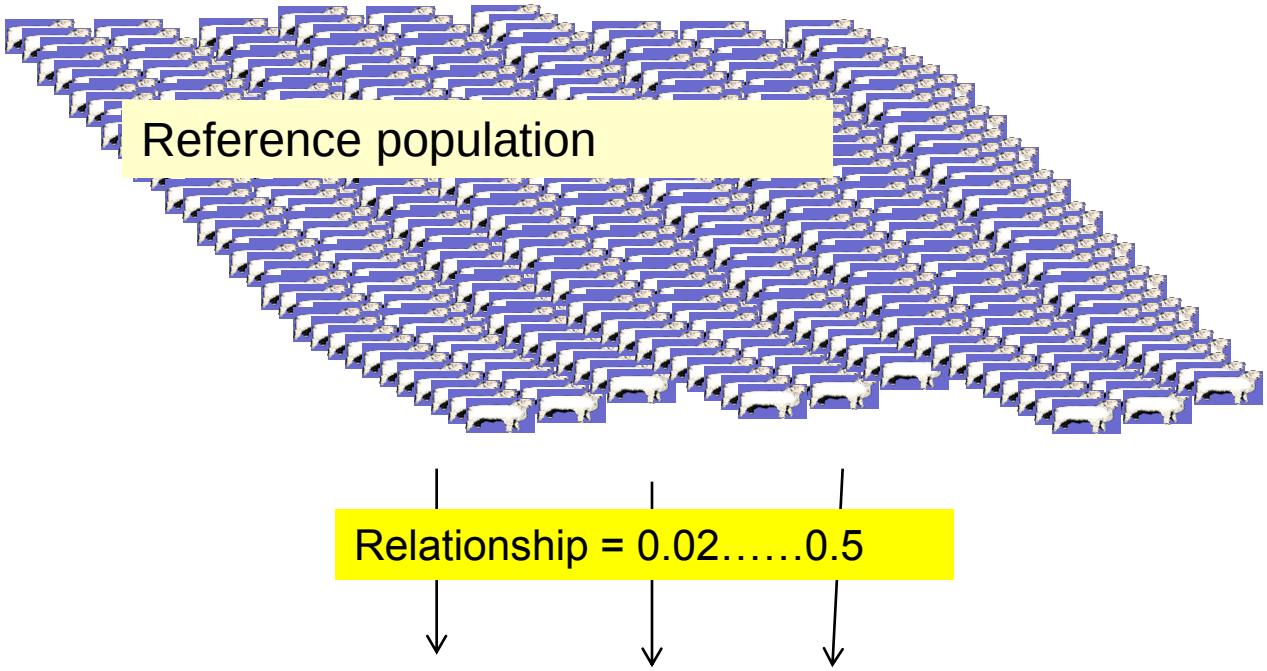
Can predict breeding value of young animals for 'any trait' measured in reference

Compare: Progeny Testing

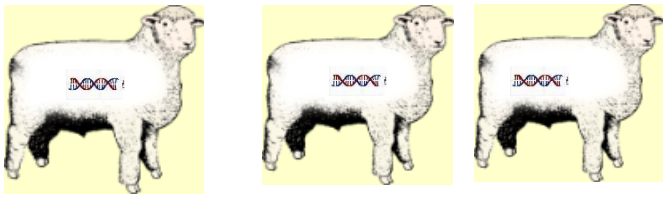


Each progeny group only informs one sire

Genomic Testing



70% accuracy
0.5-1 yrs old



One large reference population informs all young rams

EBV accuracy increased at young age

Genomic Selection: Benefit

Overall:

More accurate prediction of genetic merit for breeding objective

Specific:

Traits that are usually difficult to improve

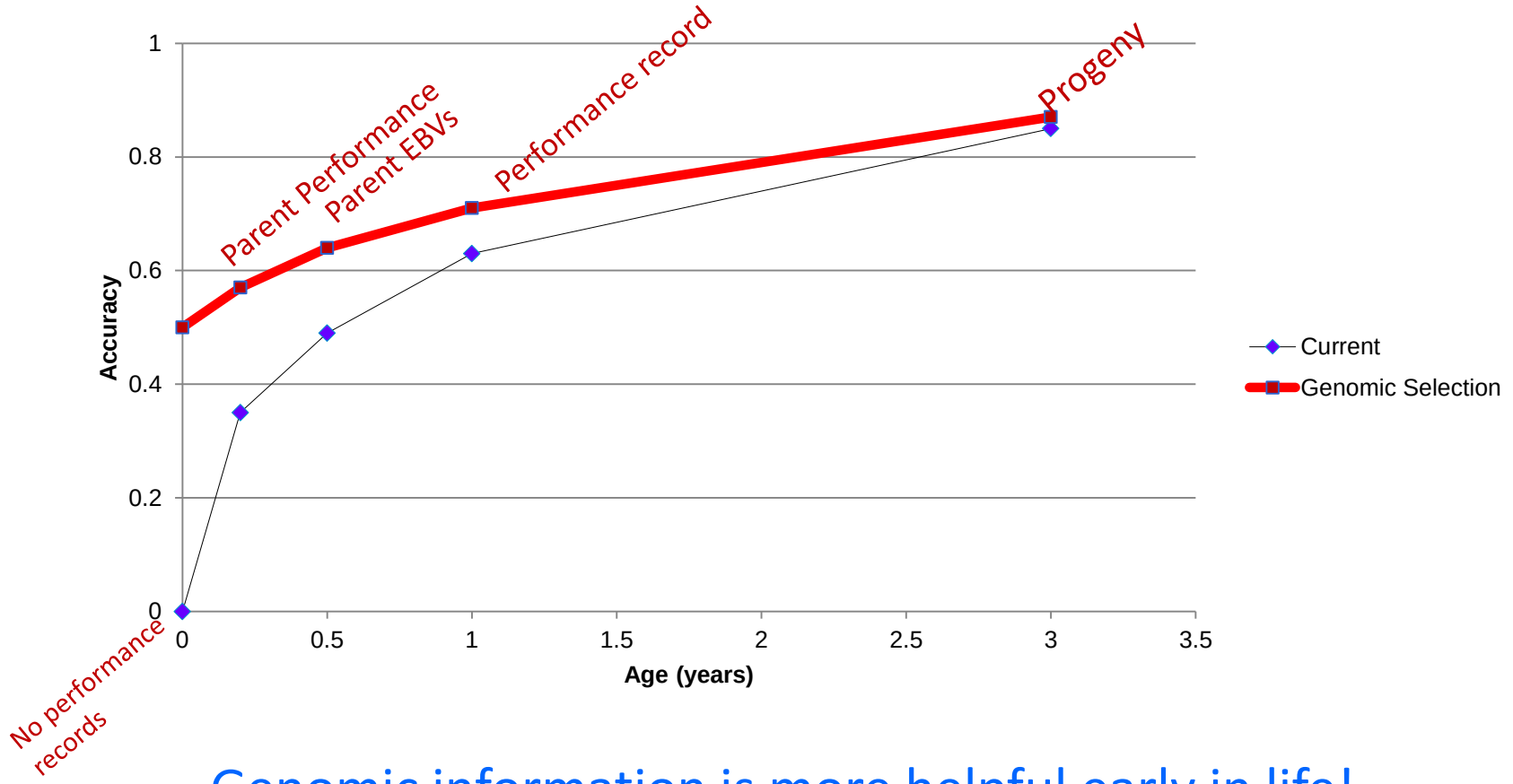
- difficult or expensive to measure
- can not be measured early
- low heritability

e.g.

- Carcass traits
- Lifetime time wool production
- Reproductive rate
- Parasite resistance

Accuracy of predicting a breeding value

- increases as an animal gets older -



Genomic information is more helpful early in life!

Assumed heritability = 25%; Accuracy of genomic test = 50%

Potential benefits of GS - some principles

% increase in EBV accuracy (male 1yo) and genetic gain

	$h^2 = 0.1 = r^2$		$h^2 = 0.3 = r^2$	
Trait Measurability	%Δ Acc	%Δ Gain	%Δ Acc	%Δ Gain
< 1 year, both sexes	15	7	7	7
> 1 year, both sexes	68	19	59	37
>1 year, females only	119	27	112	52
on Corr. Trait, $r_g = 0.9$	20	12	20	26
on Corr. Trait, $r_g = 0.5$	67	50	76	86

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These effects underestimated due to not accounting for Bulmer effect

Shifting the *trait* balance with genomic selection

	Current Selection	
	Accuracy	Response
Weight kg	0.71	0.79
Dressing %	0.26	0.23
Saleable meat yield %	0.33	0.29
Overall Merit $Index	0.58	2.03

Shifting the *trait* balance with genomic selection

	Current Selection		Genomic Selection		Difference
	Accuracy	Response	Accuracy	Response	
Weight kg	0.71	0.79	0.75	0.76	-4%
Dressing %	0.26	0.23	0.59	0.42	83%
Saleable meat yield %	0.33	0.29	0.60	0.46	59%
Overall Merit $Index	0.58	2.03	0.69	2.43	20%

Note: not only more gain overall, but shift to HTML traits

Benefits across Species

	% extra gain	impact
• Early trait	small	small
		accuracy/ gen int
• Late Trait	moderate	gen int/acc
• Sex limited trait		
– females only, late	very large	gen int
– Males only early	small to modest	acc/gen int

Benefits - Dairy

- Extra gain ~100%
- Breeding objective dominated by sex-limited trait
- No more progeny testing (save money)
- Very much shorter generation intervals
- More use of reproductive technologies
- Potential to select on hard to measure traits
  but only if these are being measured!
- Commercial males have more chance to be selected
- AI companies can easily afford testing
- Widely used in the industry

Benefits - Beef

- Extra gain ~25-50%
- Breeding objective has some hard to measure traits
- More emphasis on carcass and meat, less on growth
- More emphasis on females reproductive rate
- Somewhat shorter generation intervals
- More use of reproductive technologies
- Potential to select on hard to measure traits
  but only if these are being measured!
- Genotyping cost can be high for breeders

- Who pay for the reference population?

Benefits – Pigs & Poultry

- Extra gain ~50%?
- More emphasis on meat quality, Feed Efficiency?
- Sex limited traits
- shorter generation intervals in layers
- Potential to select on hard to measure traits
  but only if these are being measured!
- Genotyping cost can be high?

Conclusion

- Genomic selection can benefit breeding programs
- A challenge to implement:
  - cost to breeders
  - Need for phenotypes → reference population / multi breed
- Reference population needs to contain (indirect) relatives of selection candidates – *at this stage*
- Reference population needs to be continuously updated