Genotyping dairy females

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Victoria
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Potential benefits of genotyping females

Improve the reliability of genomic selection

Provide farmers with new management tools

1) Identify elite females (or males)
2) Best heifers to become replacements
3) Certainty of parentage
4) Avoid inbreeding
5) Avoid genetic defects

The contribution of females to the reference population

- As genomic selection replaces progeny-testing of bulls, risk that the reliability of genomic BVs will decrease
  - Distance between reference and predicted population increases (e.g. Lillehammer et al., 2010)
  - Especially a risk for small populations (McHugh et al, 2011)

The contribution of females to the reference population

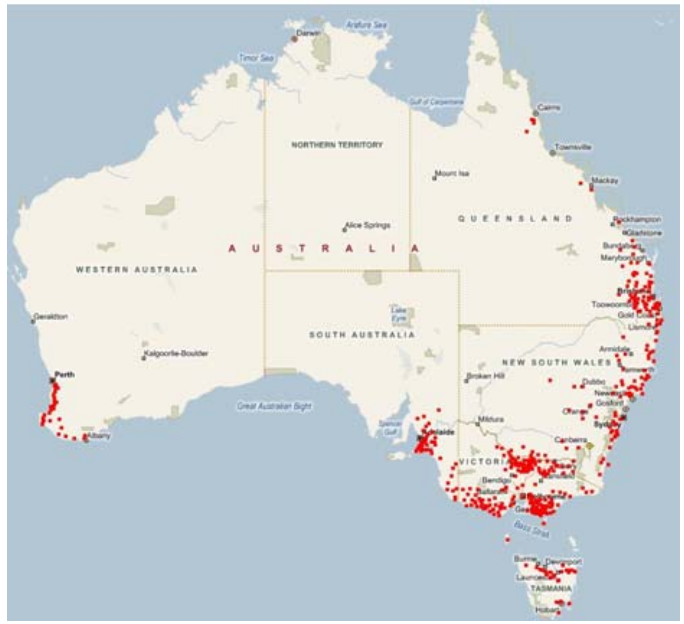
- Strategies to reduce deterioration in reliability:
  1. Exchange genotypes between countries
  2. User denser SNP chips and better statistical tools
  3. Genotype females to include in the reference population

The contribution of females to the reference population

- Genotyped females need to be incorporated cautiously
  - Preferential treatment a risk
  - Randomly selecting females may be more beneficial

10,000 Holstein cow project

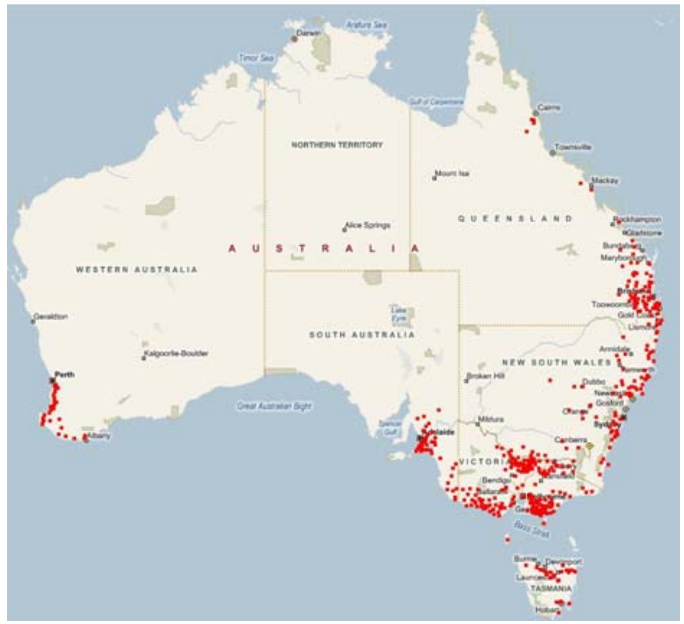
- Genotype 10,000 cows with excellent records
  - ✓ fertility, survival, production
- Collaboration with > 75 Herds Australia wide, and Holstein Australia
- Work closely with Australian Dairy Herd Improvement Scheme (ADHIS) to implement, quality control
- *Improve reliability of ABVg towards level approaching proven bull*



10,000 Holstein cow project

Tasks

- ✓ Collect samples – **10,114 collected**
- ✓ Genotype for 50,000 DNA markers (SNPs)
- ✓ Deliver to ADHIS - **9,900** passed quality control
- ✓ Enhance ADHIS system to handle cows in reference set
- ✓ Quality check results, assess impact on ABVg reliabilities for young bulls, etc
- o Results back to farmers



Jer-nomics project

Genotype ~ 4,000 Jersey cows with excellent herd recording data

Increase reliability of Jersey genomic breeding values

Collaboration with > 75 Herds, Jersey Australia

Tasks

- 3900 samples collected, DNA extracted,
- Samples genotyped
- Same pipeline as 10K Holsteins

Genotyped animals

Number of animals in reference population:

12,649 Holstein (~10k females)

5,204 Jerseys

Effect on reliability of adding genotyped females

4-8% improvement

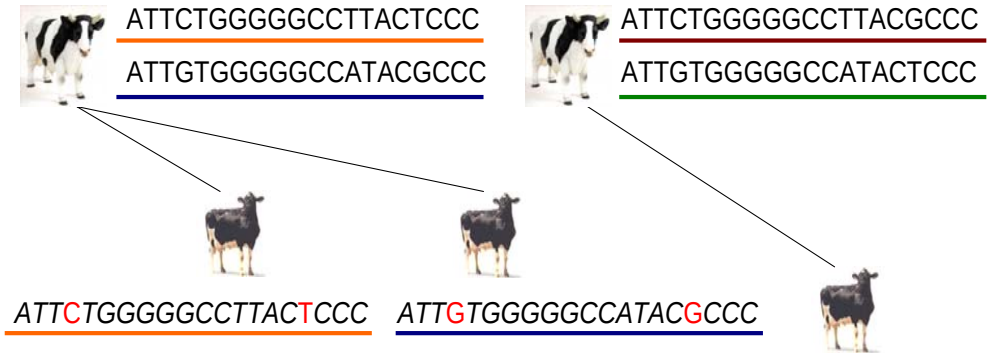
The reliability of genomic breeding values of 437 young bulls

Trait	Bulls only	Bulls + cows	Change
Protein	54	61	7
Fat	54	61	7
Milk	54	61	7
Survival	30	36	6
Fertility	33	37	4
Somatic cell count	43	51	8

1000 Bull genomes project

- Sequencing still more expensive than SNP chip genotyping
- Alternative strategy
  - *Sequence key ancestors and impute genotypes from sequenced animals into all animals genotyped with SNP chips*
- Common need for reference genotype file from sequence

- 1000 bull genomes project
  - ✓ Provide a database of genotypes from sequenced bulls
  - ✓ Global effort!



Using sequencing to increase the reliability

- The causative mutations are in the data set!
- Genomic prediction
  - No longer have to rely on LD with SNP
    - Higher accuracy of prediction (rare variants)?
    - Better persistence of accuracy across generations
  - Better prediction across breeds?
    - SNP-QTL associations more consistent across breeds

The genomic era is here. How can dairy farmers use the technology?

How much can farmers afford to pay for genotyping?

- **Select replacements**
- **Mating plans to control inbreeding**
- **Achieve certainty in parentage of individual cows**
- Avoid genetic defects
- Selling pedigree heifers at a premium

Replacement heifers

Aim: Calculate the benefit of genotyping (7k), based on keeping the best heifers as replacements

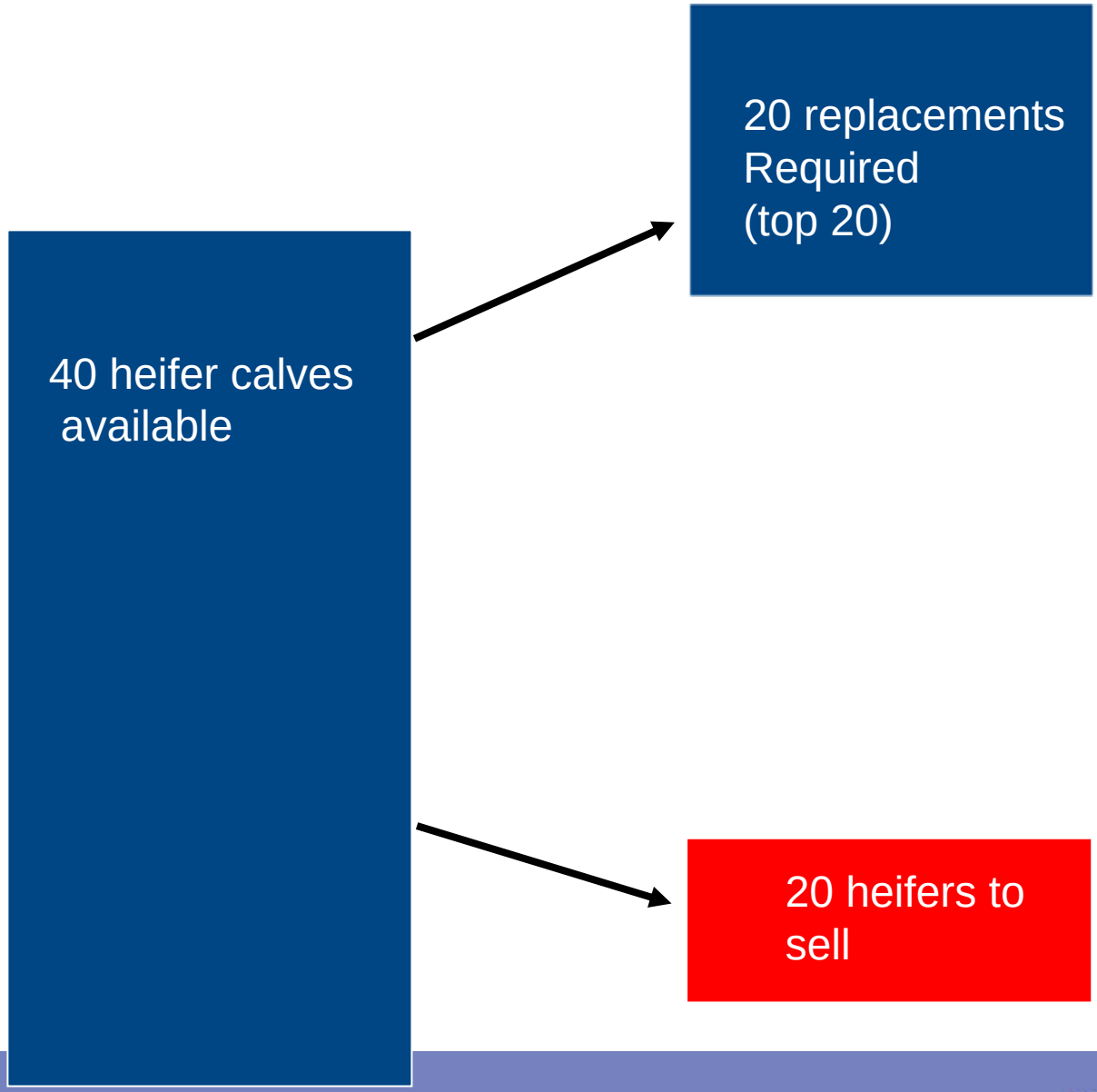
Assumptions

Reliability of parent average (30%)
Reliability of EBV(g) (60%)
1 unit of EBI = €1 extra profit
SD of EBI = €62

1) Selection on parent average not possible
2) Selection on parent average replaced with selection using EBV(g)s

Selection index theory

Replacements per 100 cows



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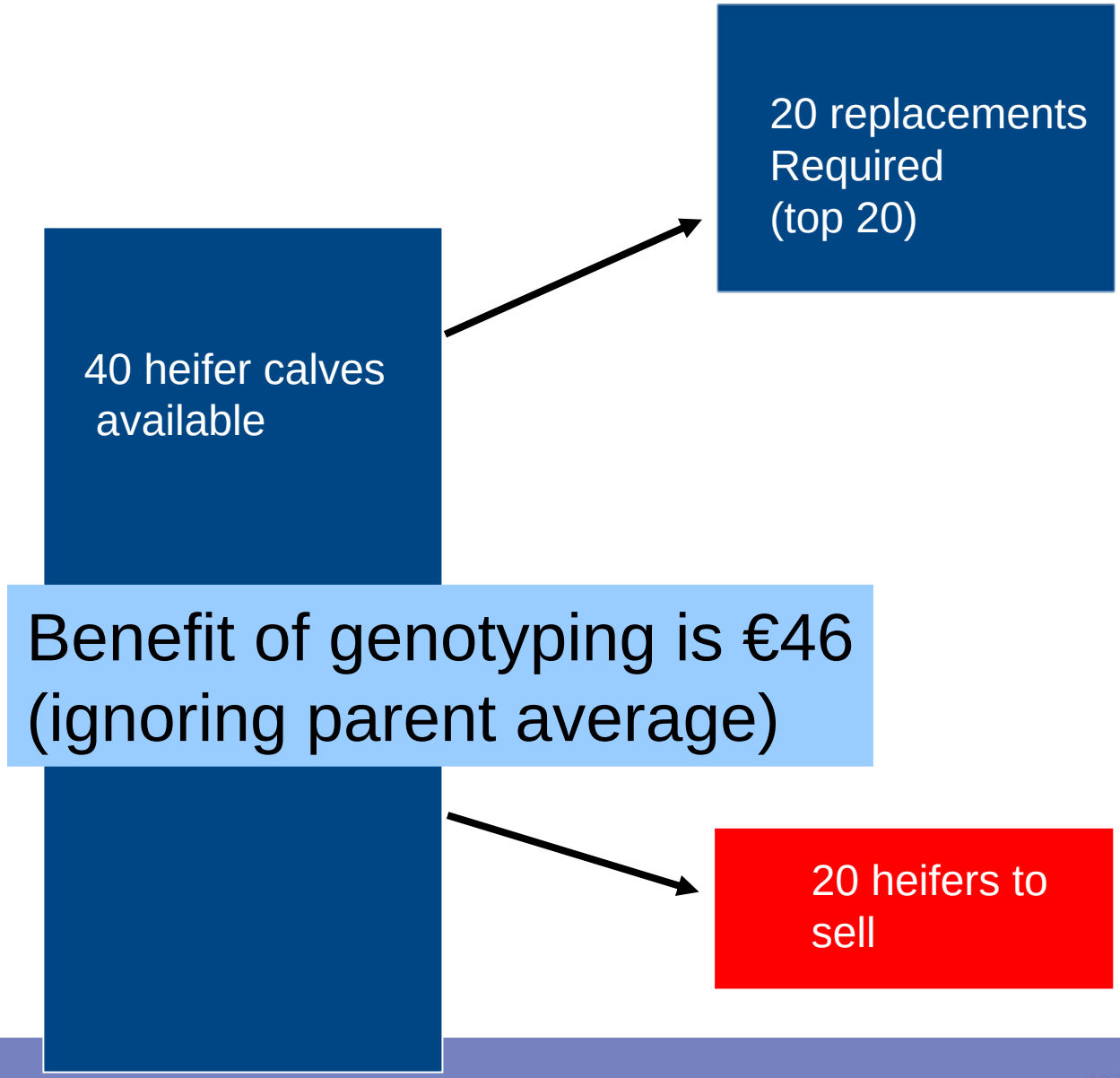
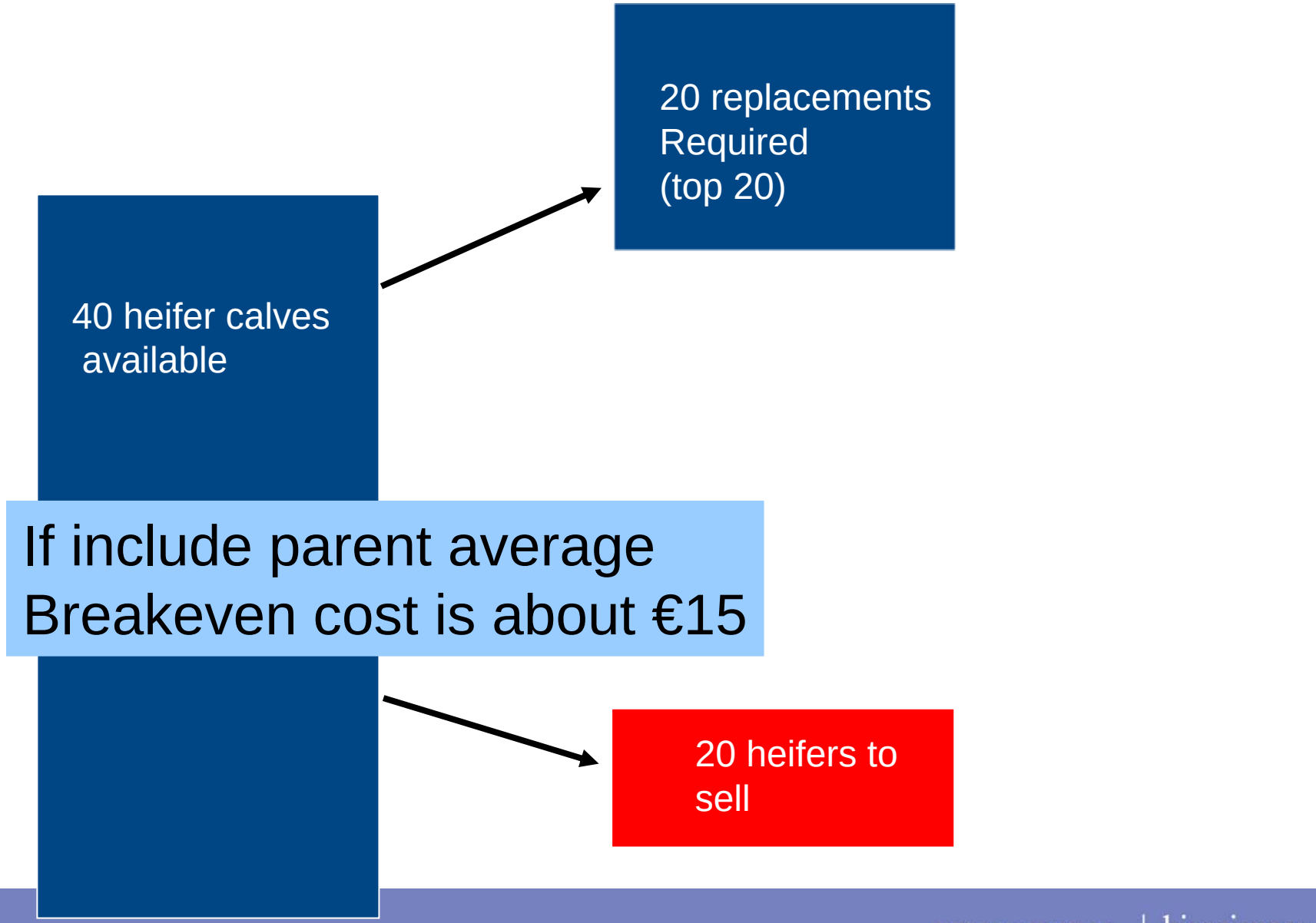
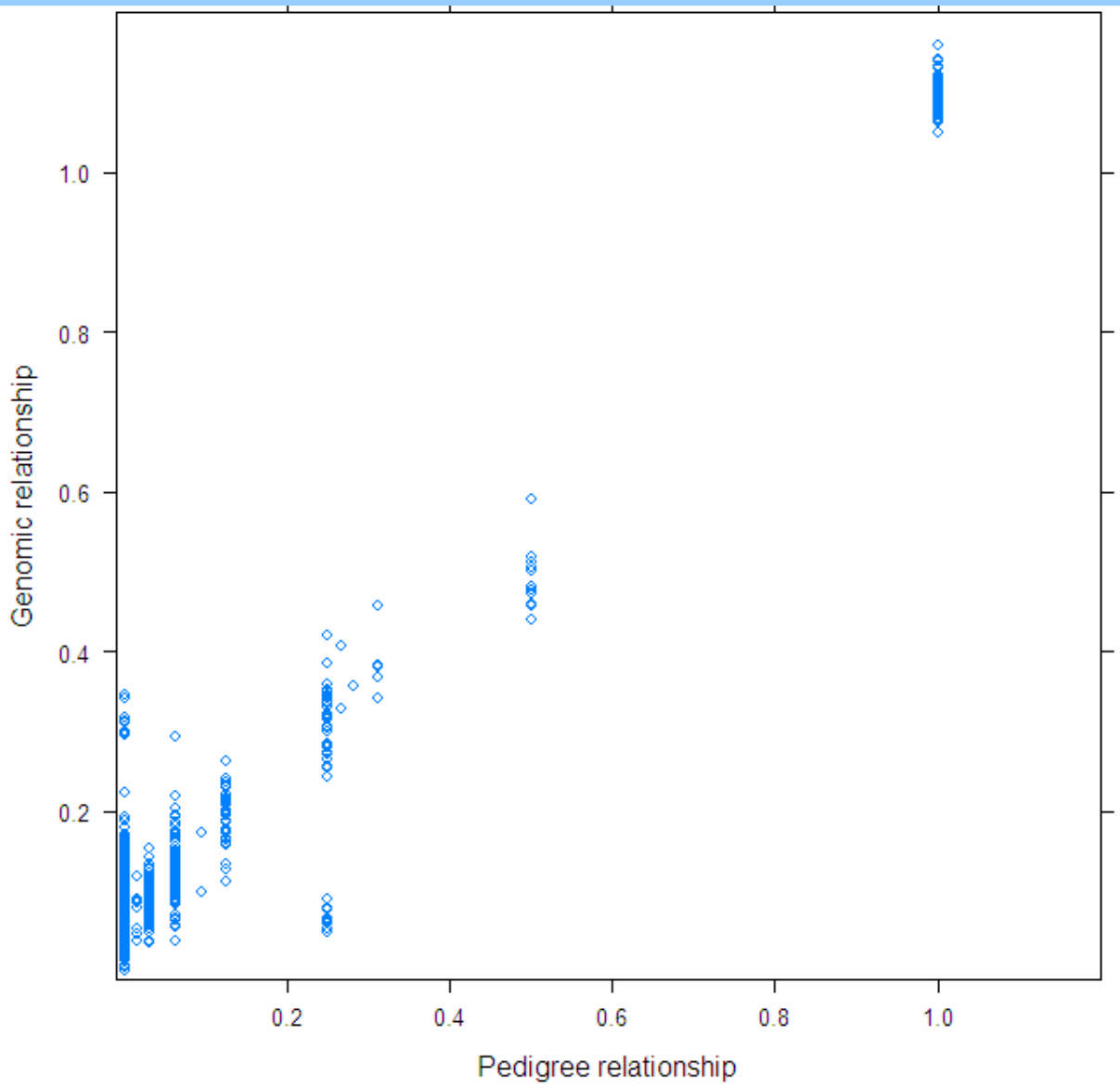


Replacements per 100 cows



Genomic relationships compared to pedigree relationships



Impact of strategies on inbreeding and value/cow/year

Method of controlling inbreeding	Genomic inbreeding	Pedigree inbreeding
Genomics	2.5% ($12.50)*	1.1% ($5.50)
Pedigree	1.4% ($7)	1.5% ($7.50)

$12.50*4 = $50 per lifetime or €39

Parentage verification

Useful for large herds (especially seasonal calving systems)

Match calves to sires and potentially dams (if available)

	SNP Panel				
	50K SNP	3K SNP	300 SNP	150 SNP	100 SNP
Number of sires matched	100%	100%	100%	98%	87%
Number of sires matched correctly (of those matched unambiguously by the program	100%	100%	100%	98%	97%

What's it worth? (at €29 test)

	Net benefit genotyping	Net benefit pedigree
Selecting best replacements top 50%	€46.18	€76.94
Controlling inbreeding	€11.09	€5.54
Parentage	€28.11	
TOTAL	€85.38	€82.48

What's it worth? (at €15 test)

	Net benefit genotyping	Net benefit pedigree
Selecting best replacements top 50%	€74.18	€76.94
Controlling inbreeding	€11.09	€5.54
Parentage	€28.11	
TOTAL	€113.38	€82.48

What's it worth? (at €15 test)

	Net benefit genotyping	Net benefit pedigree
Selecting best replacements top 50%	€74.18	€76.94
Controlling inbreeding	€11.09	€5.54
Parentage	€28.11	
TOTAL	€113	2.48

€30.90

Conclusions

Adding females to the reference population increases reliability by up to 8% in Australia

Genotyping females is profitable at €29, benefits become very attractive at €15

Acknowledgements

Dairy Future's Co-operative Research Council

ADHIS