Genotyping dairy females

Jennie Pryce, Ben Hayes, Mike Goddard, Daniel Abernethy

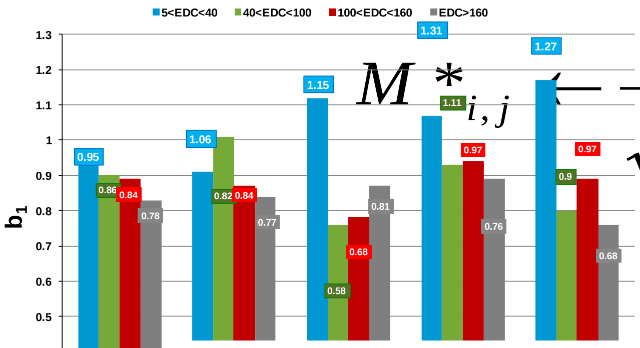
Australian Dairy Herd Improvement Scheme

Department of Environment and Primary Industries

State Government Victoria

biosciences research

$$G_{PvRII} = ZDZ'/m = ZD^{0.5}D^{0.5}Z'/m$$

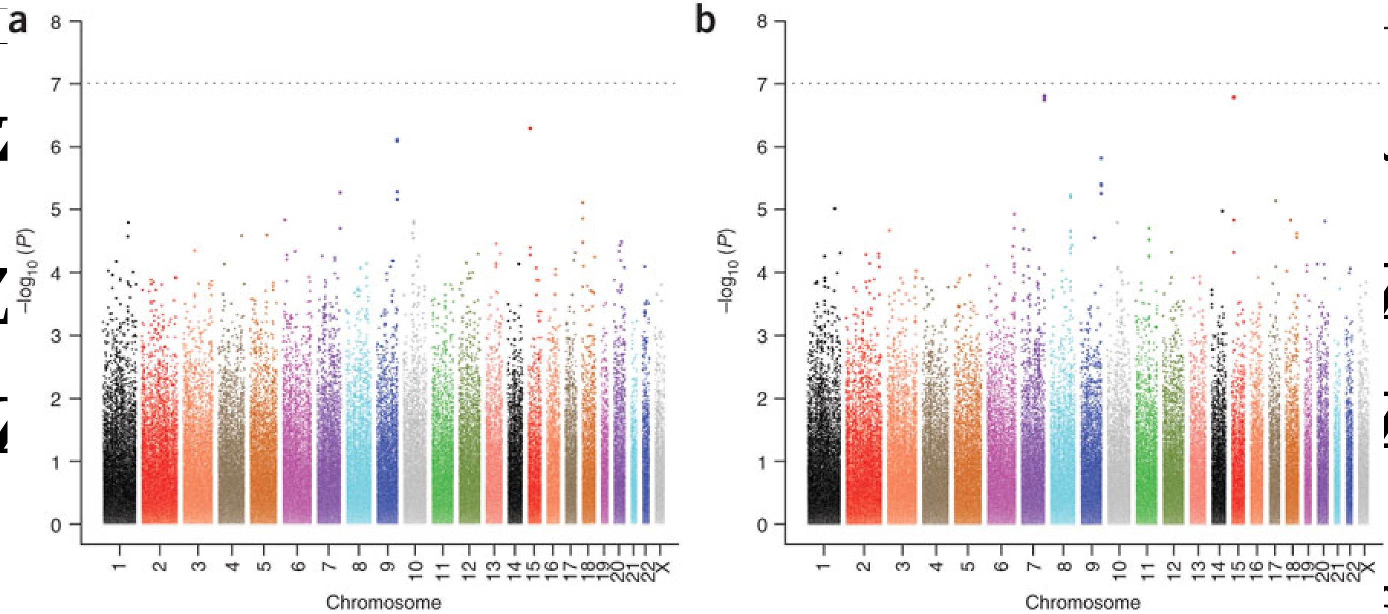


$$M^*_{i,j} \leftarrow \frac{\quad - 2p_{ij}}{\sqrt{2p_{ij}(1-p}}$$

```
SIRE                              DAM
Geno  01221  20110  01211         Geno  11211  21102  02121
Hpat  0_22_  20__0  0_2__         Hpat  __2__  2__02  02_2_
Hmat  0_22_  20__0  0_2__         Hmat  __2__  2__02  02_2_

SON 1                             SON 2
Geno  11211  20111  02121         Geno  51525  25151  51515
Hpat  0_22_  20_20  0222_         Hpat  0_22_  20__0  0020_
                                               _02  02_2_
```

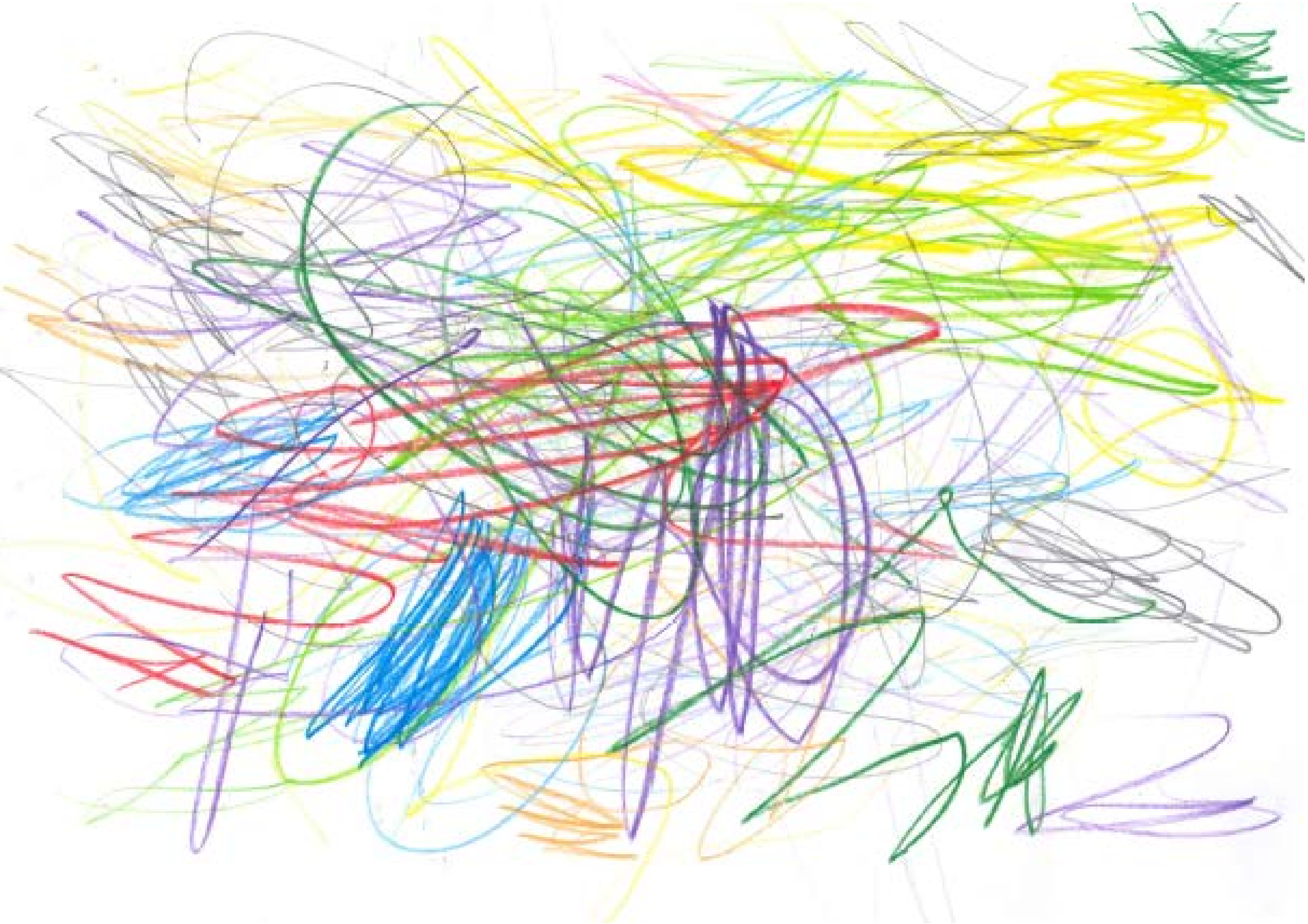
$$_{ij})$$

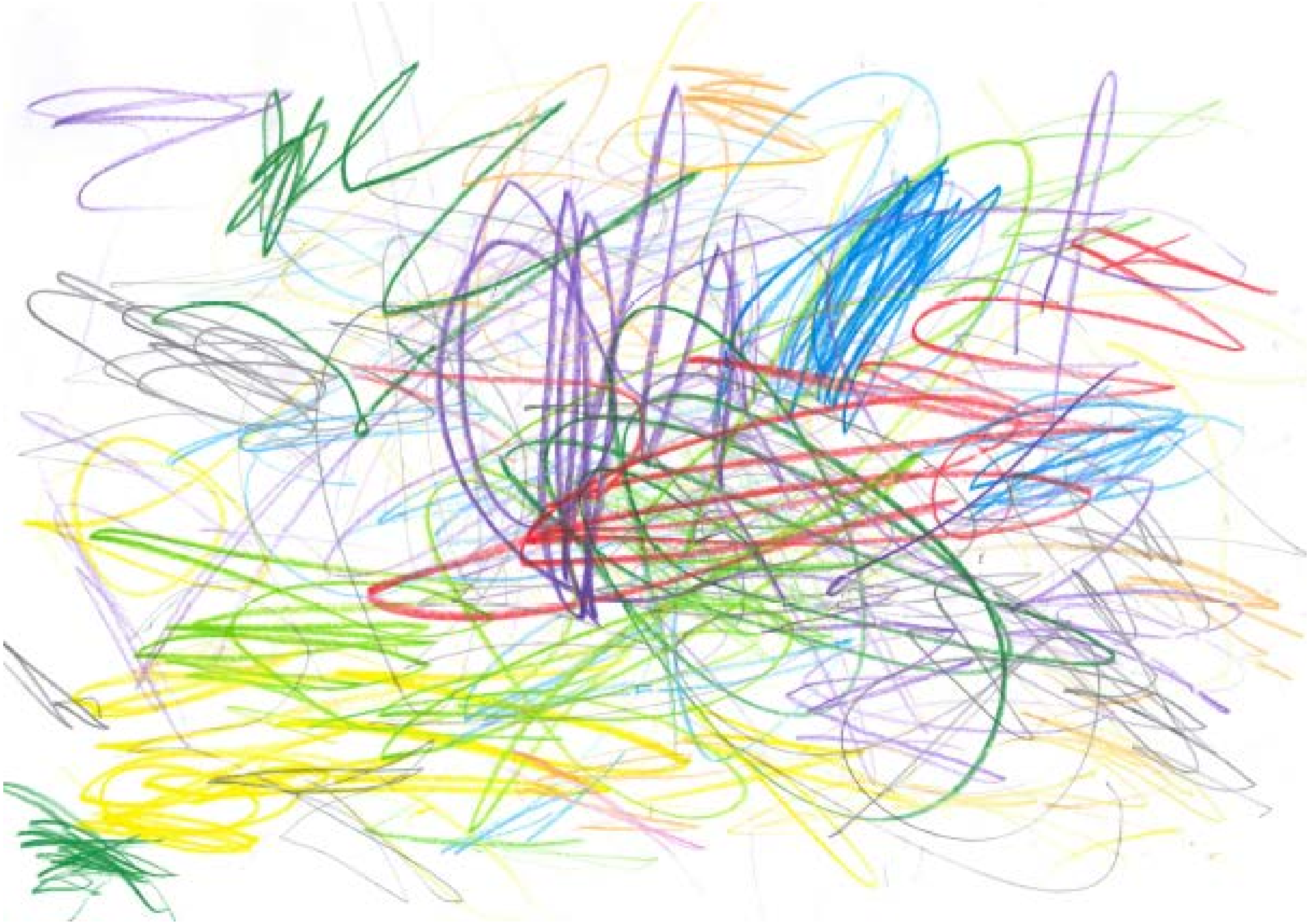


$$(\mathbf{Z'Z} \qquad {}_{G}\mathbf{G}^{-1})d\hat{g}v$$

$$\begin{bmatrix} \mathbf{Z_1'Z} & \\ \mathbf{Z} & \end{bmatrix} \qquad \begin{bmatrix} \mathbf{Z_1'y} \\ \mathbf{Z_2'y} \end{bmatrix}$$

$$d\hat{g}v = \frac{}{\sigma_a^2} \quad \hat{a} = \frac{}{\sigma_a^2} \quad \mathbf{GA}^{-1}\hat{a} = \frac{}{\sigma_a^2 \mathbf{A}}\hat{a}$$





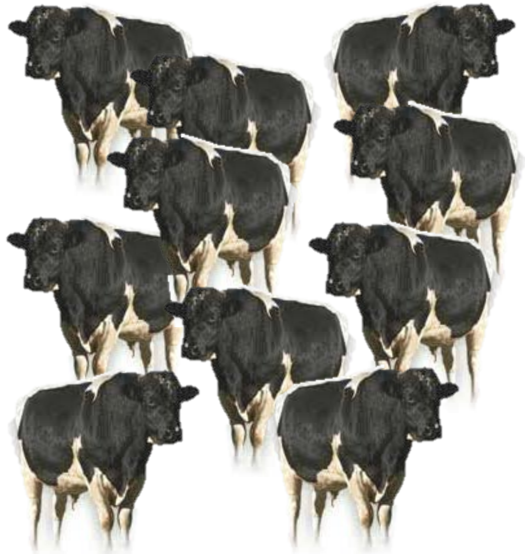
Potential benefits of genotyping females

- **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

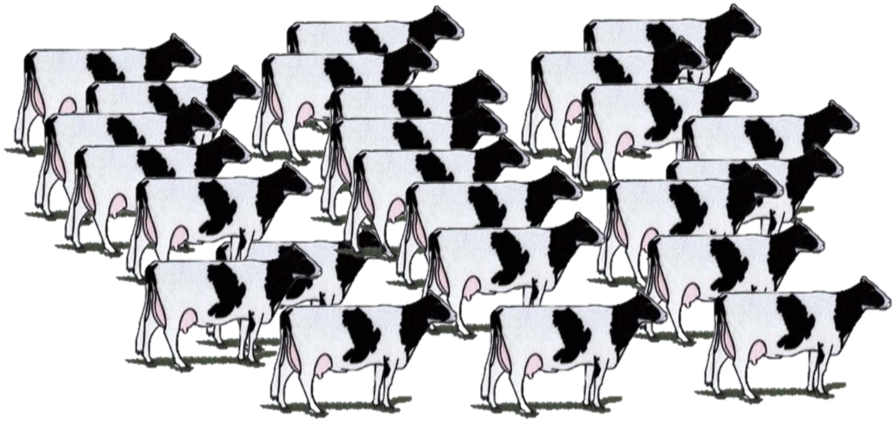
The contribution of females to the reference population

- 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

ADD 4-8% IN RELIABILITY



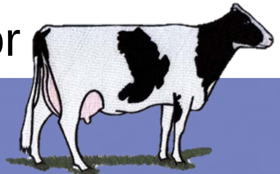
3571 bulls with
Australian daughters



8716 cows
deliberately selected
because of good data

Australian national DNA reference set

- or



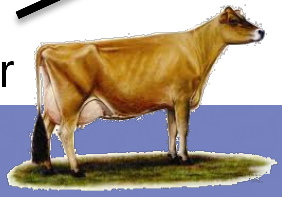
- Equivalent to having **30** daughters

917 bulls with
Australian daughters

3995 cows
deliberately selected
because of good data

Australian national DNA reference set

- or



- Equivalent to having **25** daughters

- New information source for calculating proofs

Ginfo

Genomic information nucleus

Dairy Futures CRC

- 10,000 Holstein genomes and Jernomics captured 1 time-point, *Ginfo* is designed to be on-going
- Work with herds with great data, rather than cows with great data
- The reference population needs updating, predictions of genomic breeding values deteriorate as the reference population differentiates from the general population

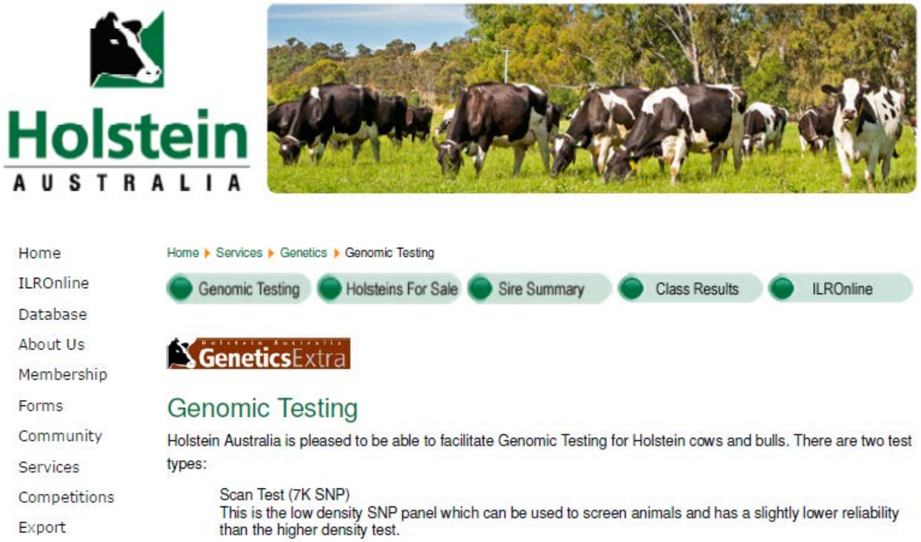
Genomic testing

- 9K (Scan test)
- 90K/50K (Full test)

~ AUSTRALIAN JERSEY GENOME TESTING~

Jersey Australia is pleased to be able to facilitate Genomic Testing for Jersey cows and bulls. There are two test types:

Scan Test (7K SNP) This is the low density SNP panel which can be used to screen animals and has a slightly lower reliability than the higher density test.
Standard Test (50K SNP) This is a higher density SNP panel which gives a higher reliability.



Genomic Testing

Holstein Australia is pleased to be able to facilitate Genomic Testing for Holstein cows and bulls. There are two test types:

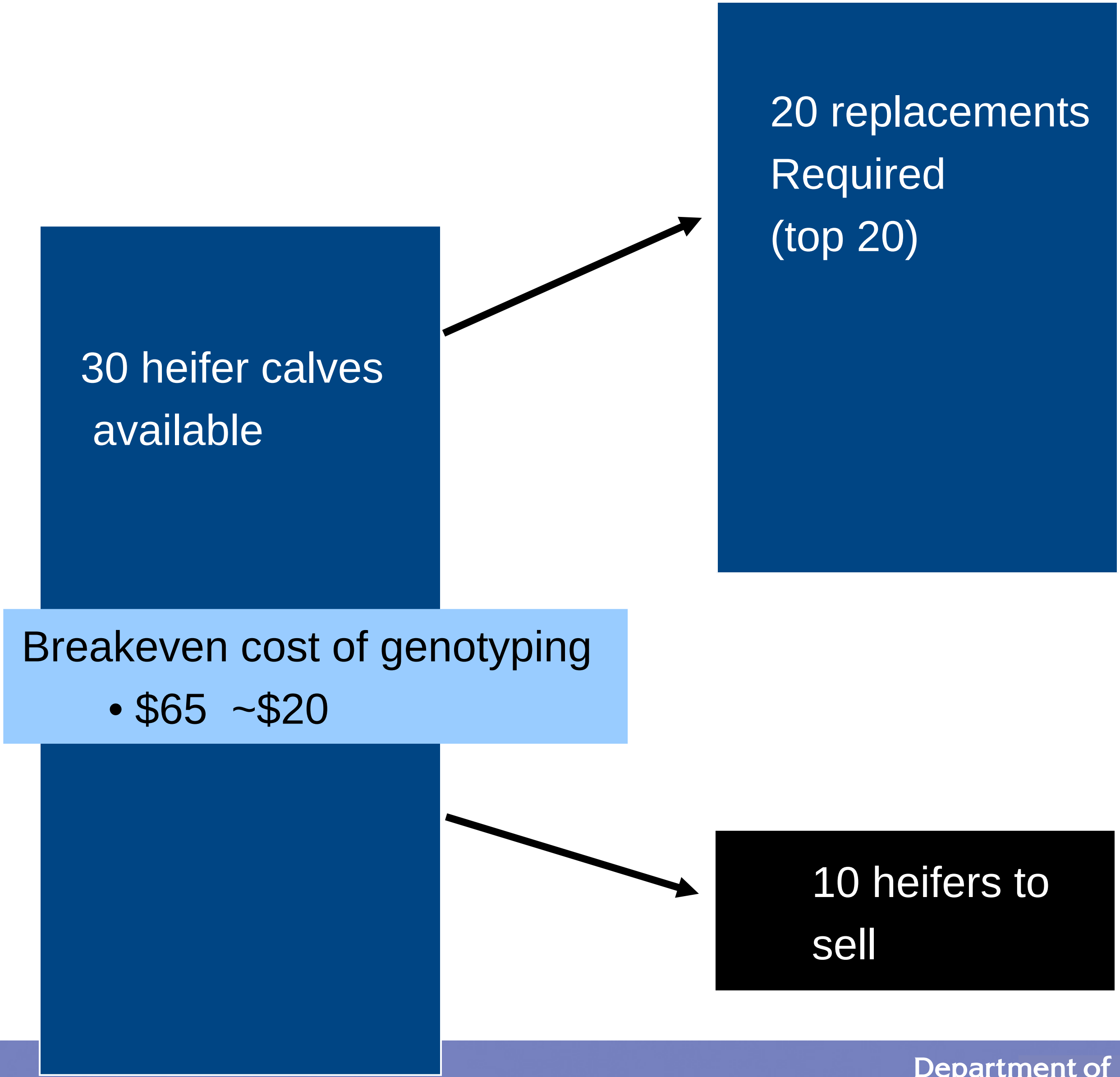
Scan Test (7K SNP)
This is the low density SNP panel which can be used to screen animals and has a slightly lower reliability than the higher density test.

- 9K gives 98% of reliability, unless poorly connected to reference set

Which animals to test?

- Herd bulls
    - 9k/7k
- Cows/Heifers for ET
    - 9k/7k,
    - 90k/50K if from genomic
- Heifers to enter herd
    - 9k/7k?
    - Cost benefit?

Replacements per 100 cows



30 heifer calves available

20 replacements Required (top 20)

10 heifers to sell

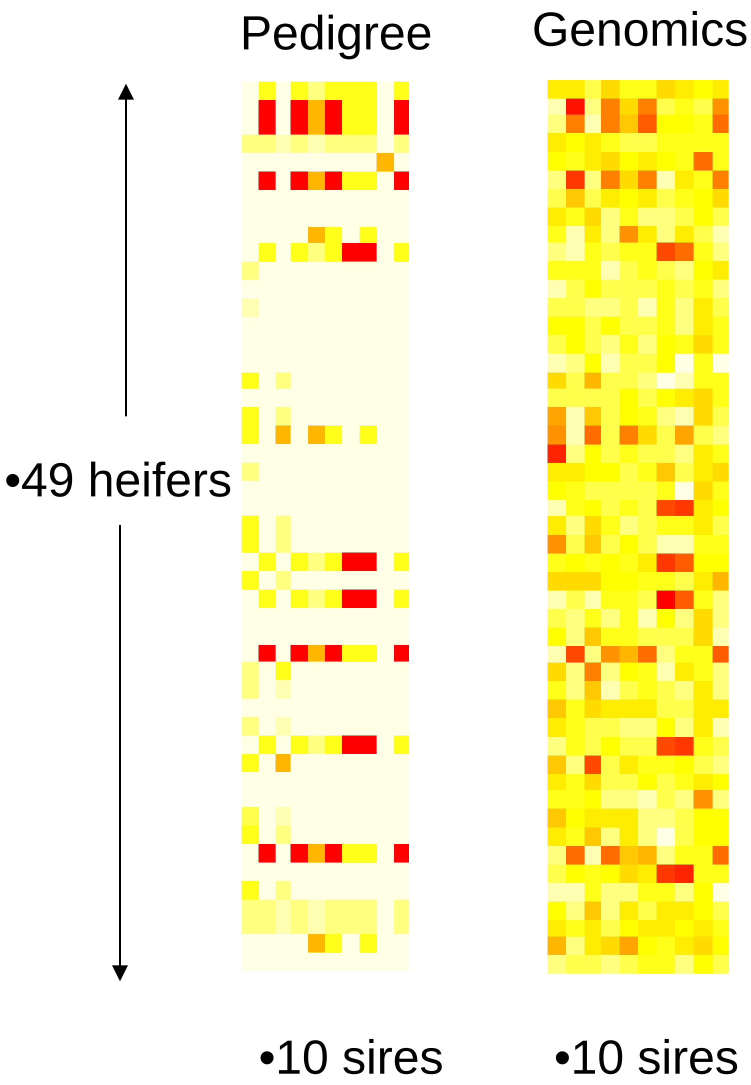
Breakeven cost of genotyping

- $65 ~$20

The dawn of the age of computerised mating plans

Aim: Control rate of inbreeding, while maintaining genetic progress in your breeding goal

- Select team of bulls
- Calculate relationships between males and females (i.e. potential inbreeding in progeny) at the DNA level
- Select the best mate for each heifer/cow



Each square represents the degree of relationship

Darker orange/red indicates closer relationships

Pryce et al (2012)

1% reduction in genomic inbreeding (worth $5) with no compromise to breeding objective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Novel strategies to minimize progeny inbreeding while maximizing genetic gain using genomic information

J. E. Pryce,[*†1] **B. J. Hayes,**[*†‡] **and M. E. Goddard**[*†§]
[*]Biosciences Research Division, Department of Primary Industries Victoria, 1 Park Drive, Bundoora 3083, Australia
[†]Dairy Futures Cooperative Research Centre, 1 Park Drive, Bundoora, Victoria 3083, Australia
[‡]La Trobe University, Bundoora, Victoria 3086, Australia
[§]Faculty of Land and Food Resources, University of Melbourne, Parkville 3010, Australia

Adding value to genomic testing

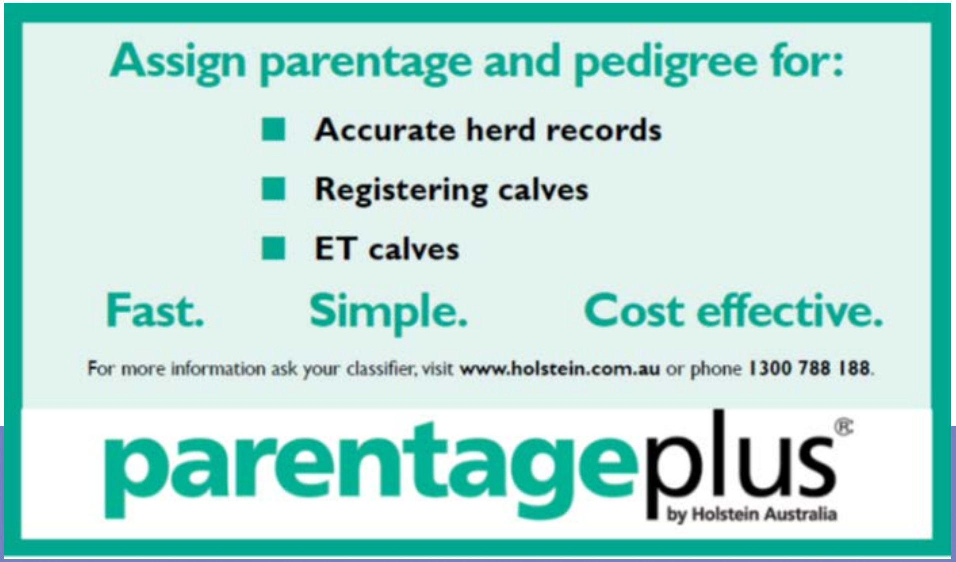
- Parentage
  - All animals genotyped 9K, 90K, automatically have parentage checked
  - Heifer -> A,A
  - Sire?
    - A,A or A,T Yes
    - T,T No!

Parentage discovery

- 8% of cows in DFCRC 10,000 cow Holstein genomes project had inconsistent parentage
- Herds selected were good record keepers
- Generally about 15% is expected error rate

Adding value to genomic testing

- Parentage discovery
  - “Discover” sires, dams
  - 160 SNP panel (Parentage PLUS)
  - no mis-matches in 160 SNP
  - 99% sires discovered, > 99% correct
  - Cows on 160 SNP, Heifers 9K?



Assign parentage and pedigree for:

- Accurate herd records
- Registering calves
- ET calves

Fast. Simple. Cost effective.

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by Holstein Australia

Adding value to genomic testing

- Genetic defects and useful traits? Many on 9K panel
  - Beta Casein A/B, Beta Lactoglobulin, Black/Red Coat Color, BLAD, Chondrodysplasia, Citrullinemia, DUMPS, Dun Color, Silver Color Dilutor
- Extras
  - CVM, Beta Casein A2, Brachyspina, Hypotrichosis_KRT71 (Rat tail)


Opportunity
Next Exit

Summary

- Genotyped females contribute to the genomic reference population (in Australia we have realized a ‘ 4-8% in reliability from 10k females)
- The cost-benefit of genotyping is case by case
  - Greater benefit when large number of surplus heifers (high selection differential)
  - Example given here value was $20
- Genomic mating plans add $5 for 1% reduction in inbreeding
- Parentage testing ($??)
- Added benefits e.g. specific conditions ($??)

Questions?