Ayrshire breeding for the future

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DairyBio

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Ayrshire breeding for the future

- Play to your strengths
- Differentiate – better than trying to compete with other breeds!
- Maintain diversity
- Long-term breeding objectives to accommodate future challenges
- Focus on your vision of the future

Ayrshire strengths

- Medium sized
- Ideal milk components
- Low mastitis
- Calving ease of dams
- Long productive life
- Adaptability to terrain and climates
- Diversity

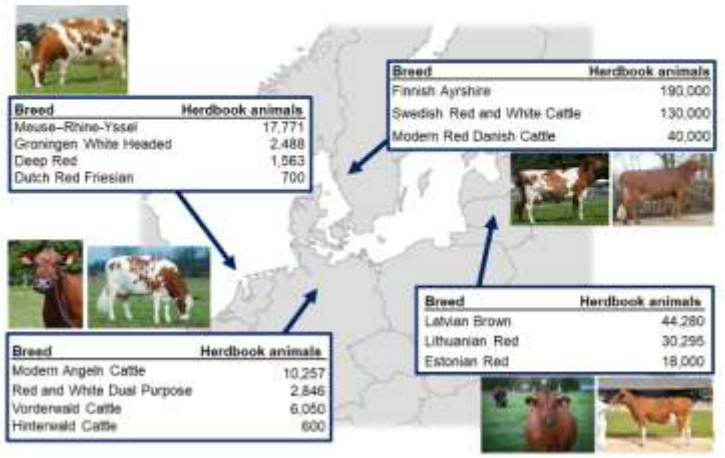
ReDiverse: Biodiversity within and between European Red Dairy Breeds – Conservation through utilization

Mario Calus and the ReDiverse Consortium

Mid-term COFUNDED Projects Seminar
10-11 April 2019, Wageningen (Netherlands)

EUROPEAN RESEARCH AREA ON SUSTAINABLE ANIMAL PRODUCTION

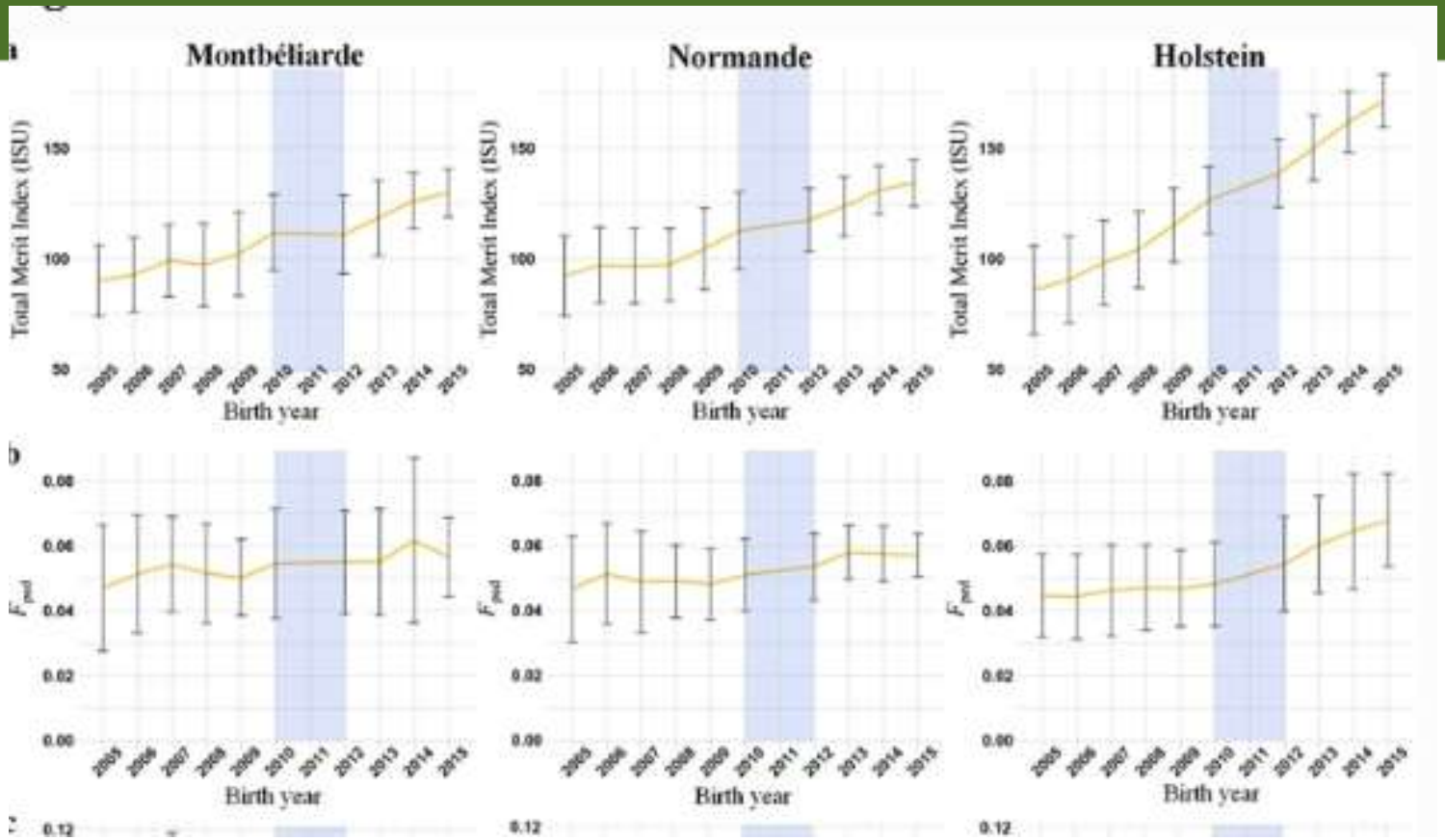
ERDB included in ReDiverse



Objectives

- Utilize unique genetic diversity of ERDB
- Develop novel breeding and management concepts for sustainable use of ERDB
- Develop genome based conservation strategy for ERDB

EU project ReDiverse



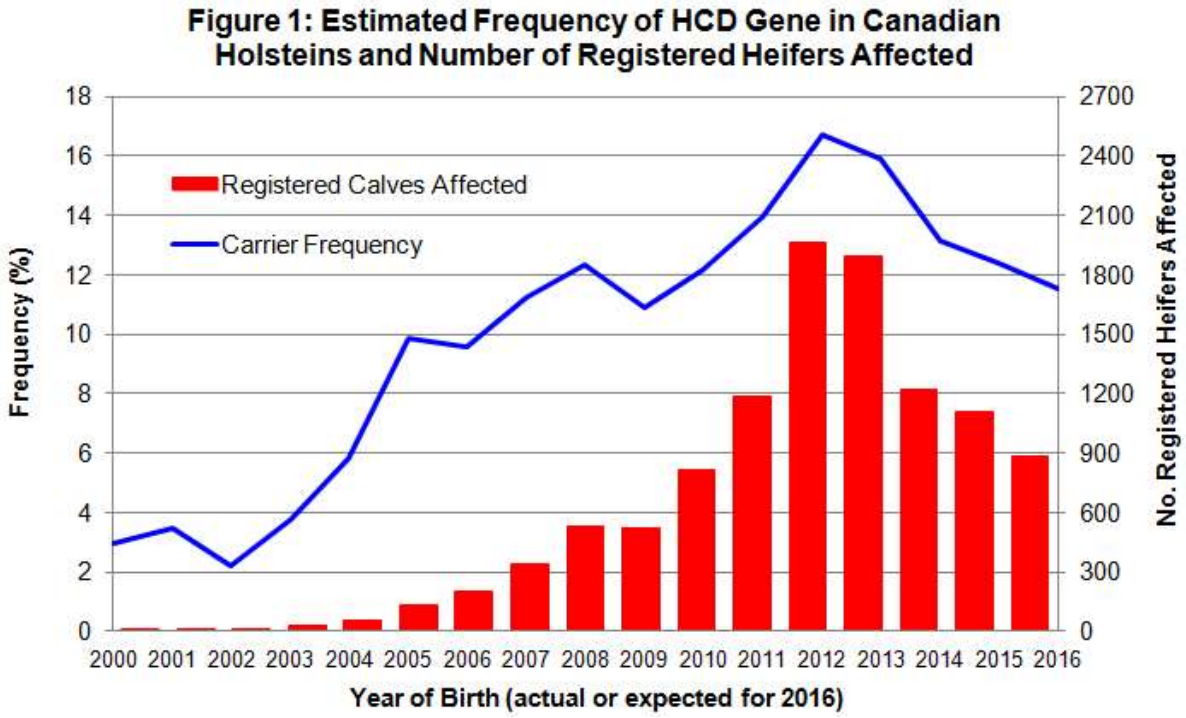
Holsteins have a “new” problem on the horizon…

- Genetic gain is soaring after introduction of genomic selection
- Rates if inbreeding accelerating too….
  - Concentration on few elite bulls

Source: Doublet et al. GSE 51 (2019)

Inbreeding increases risk of recessive disorders

Haplotype for cholesterol deficiency (HCD)



Source: CDN

INTERBULL BULLETIN NO. 49, Orlando, Florida, July 09 - 12, 2015

A New Holstein Haplotype Affecting Calf Survival

S. Kipp[1], D. Segelke[1], S. Schierenbeck[1], F. Reinhardt[1], R Reents[1], C. Wurmser[2], H. Pausch[2], R. Fries[2], G. Thaller[3], J. Tetens[3], J. Pott[4], M. Piechotta[5], W. Grünberg[5]

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[5] *Klinik für Rinder, Stiftung Tieraerztliche Hochschule Hannover, 30173 Hannover, Germany*

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INBREEDING DEPRESSION: The effect of 1% increase in inbreeding (Australia) in Holsteins (using genomics)

	1 % increase in inbreeding
Milk	-28 litres/year
Fat	-1.3 kg/year
Protein	-0.9 kg/year
Calving interval	0.2 days/year

Pryce et al GSE (2014) 46:71

1% increase in inbreeding worth about $10/year

Inbreeding

- Rates of genetic gain have doubled with genomics
- Rates of inbreeding have doubled with genomics
- Inbreeding in animals is similar to inflation in the economy
- No consensus on the best way to control inbreeding
- Dilemma for breeding companies, as controlling inbreeding likely to reduce competitive edge
- Some claim does not matter
- Can we afford to risk it?

Maintaining genetic diversity

- Managing genetic gain at the same time as diversity
- Breed conservation
- Providing genetic variation for future challenges
  - Animal welfare
  - Climate change
  - High value milk products

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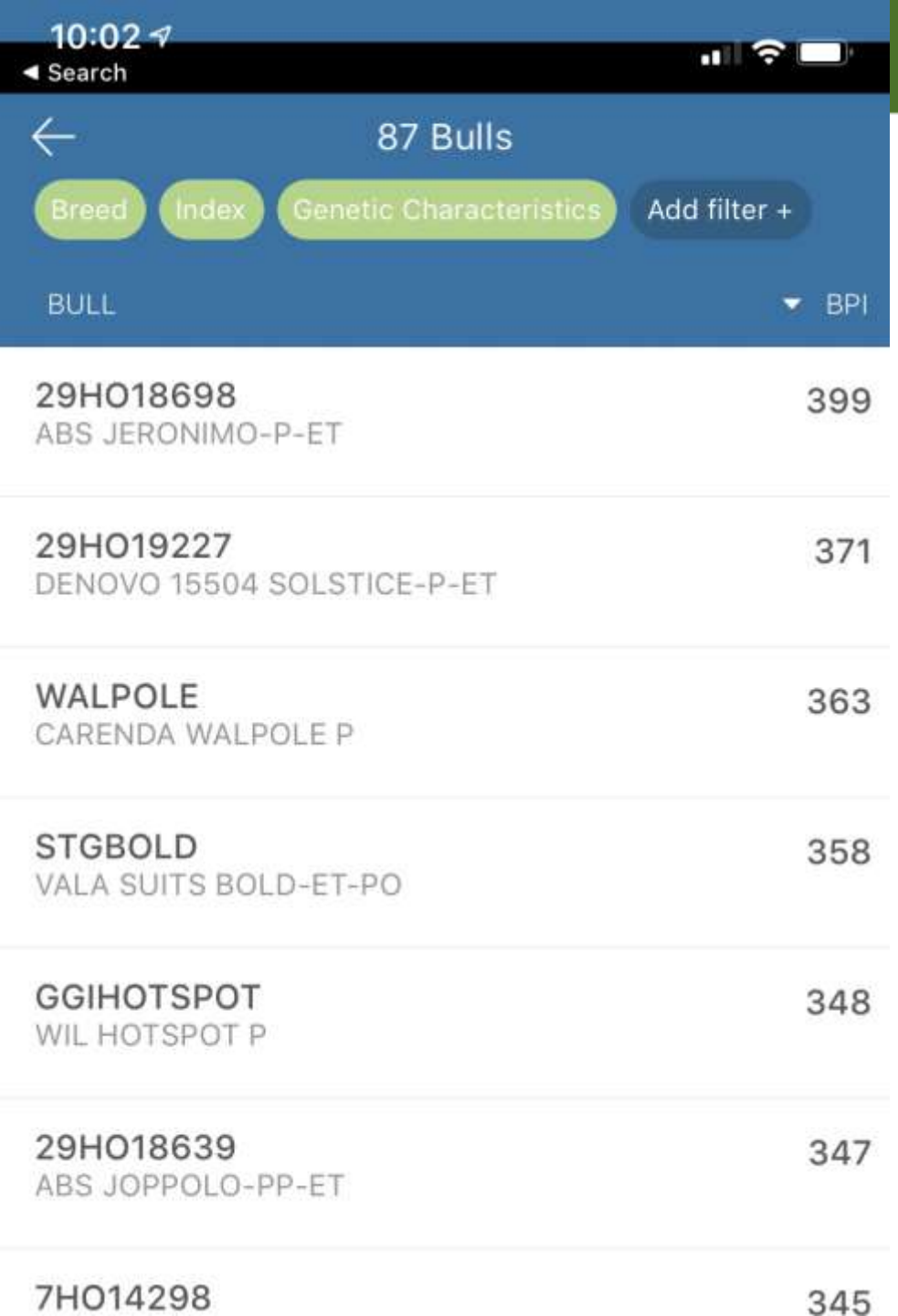

Dehorning using genetics

- High ranking Holstein polled bulls from narrow genetic base
- It would take > 20 years of classic breeding to reach 50% polled in population (Dorhorst, 2014)
- What about new gene editing techniques?

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Genome editing

Precise editing genome

Genome editing using TALENs

Nucleotides can be

- added
- deleted
- replaced

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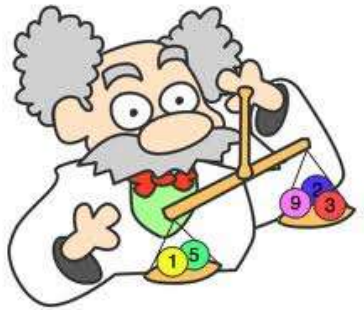
Genome editing=precision crossbreeding

- Uses variation already naturally present (e.g. in polled cattle)
- Precise crossbreeding – so get polled gene from e.g. Angus cattle and nothing else
- Regulatory issues and public perception?
- Balancing welfare versus genetic intervention?
  - Gene editing has been used to make pigs resistant to porcine reproductive and respiratory virus (available through Genus)
- Conundrum of acceptance?



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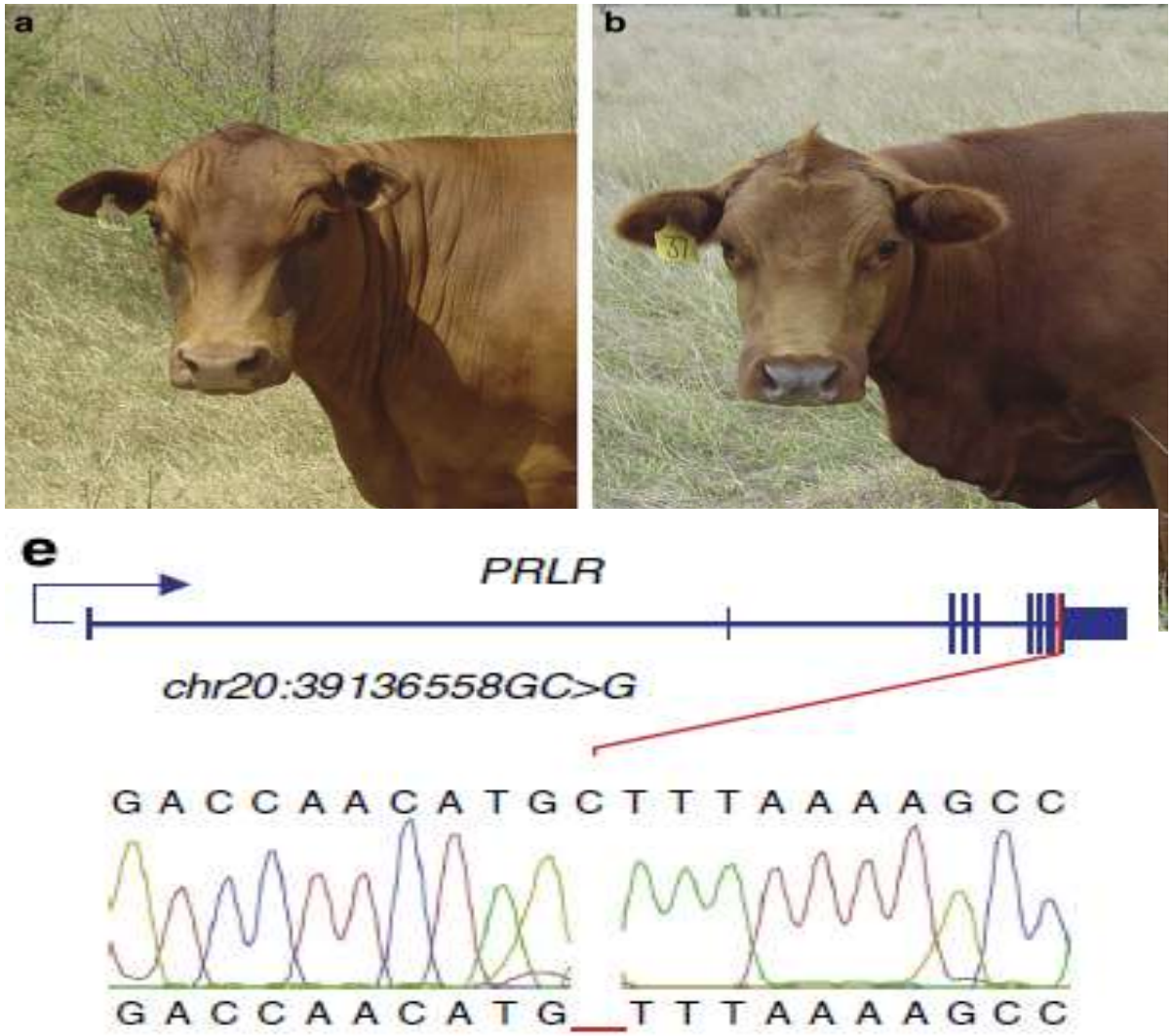
Use adapted breeds

- *SLICK* – mutation of large effect
- Senepol cattle – heat tolerant *Bos taurus* with slick coat
- Mutation in prolactin receptor
  - Littlejohn et al. 2014, Nat Comms, 5:5861
- Introgressed into Holsteins – less drop in milk production in summer
  - Dikmen et al. J Dairy Sci. 2014 97:5508.
- Gene editing target



Traditional crossbreeding

KIWIPOLE SLICK EROS

International ID: HOLNZLM000000516573

A2A2

6/16th NZ Jersey

6/16th Senepol for tropical robustness and homozygous slick gene

4/16th NZ Friesian for fertility, forage efficiency and moderate milk volume

Application

Liquid milk market

Cut and carry high to moderate heat stress Feedlot or high supplementary feed systems

Finding genes of value….

- Providing genetic variation for future challenges
  - Disease resistance
  - Climate change
  - High value milk products

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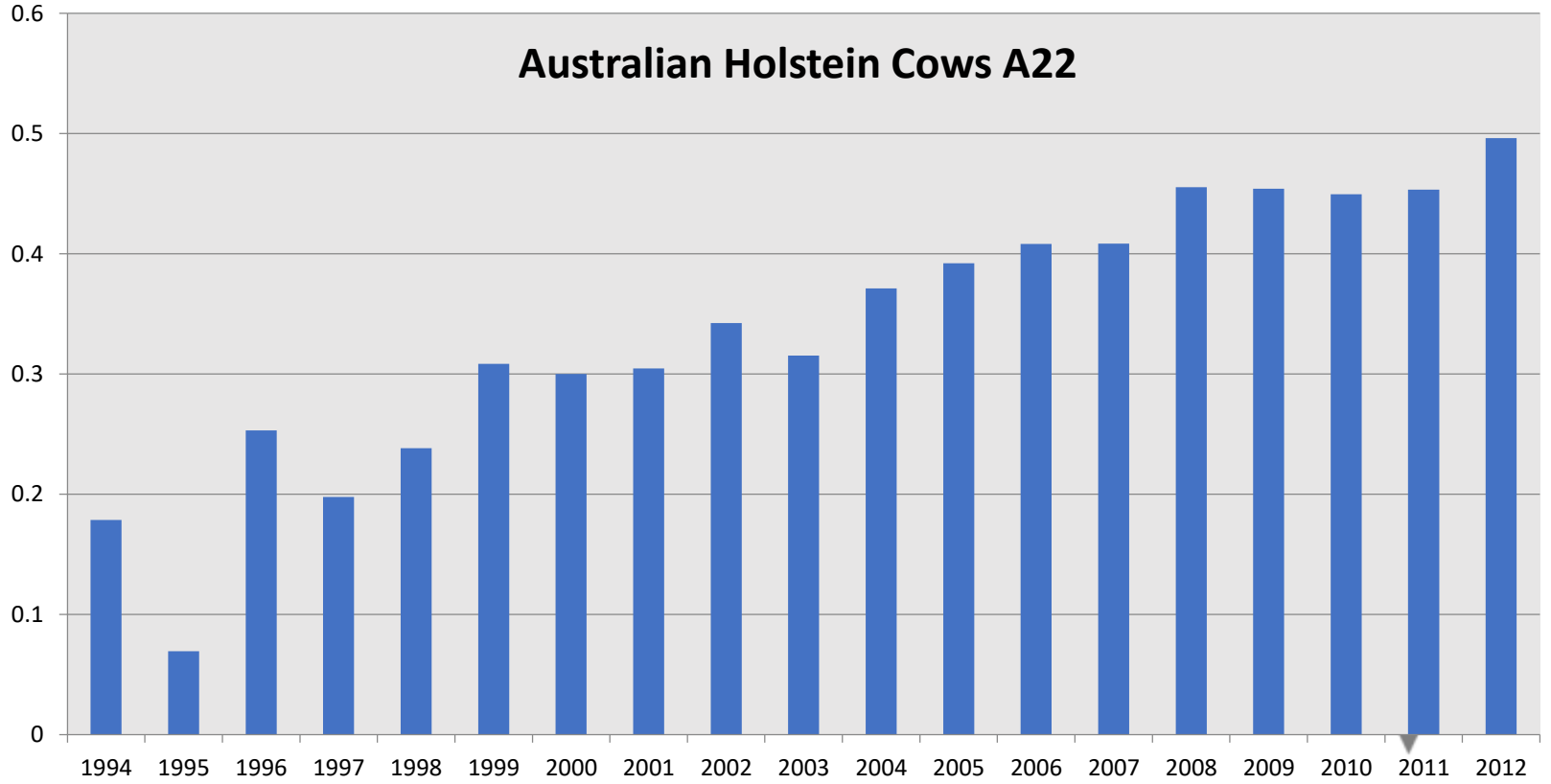
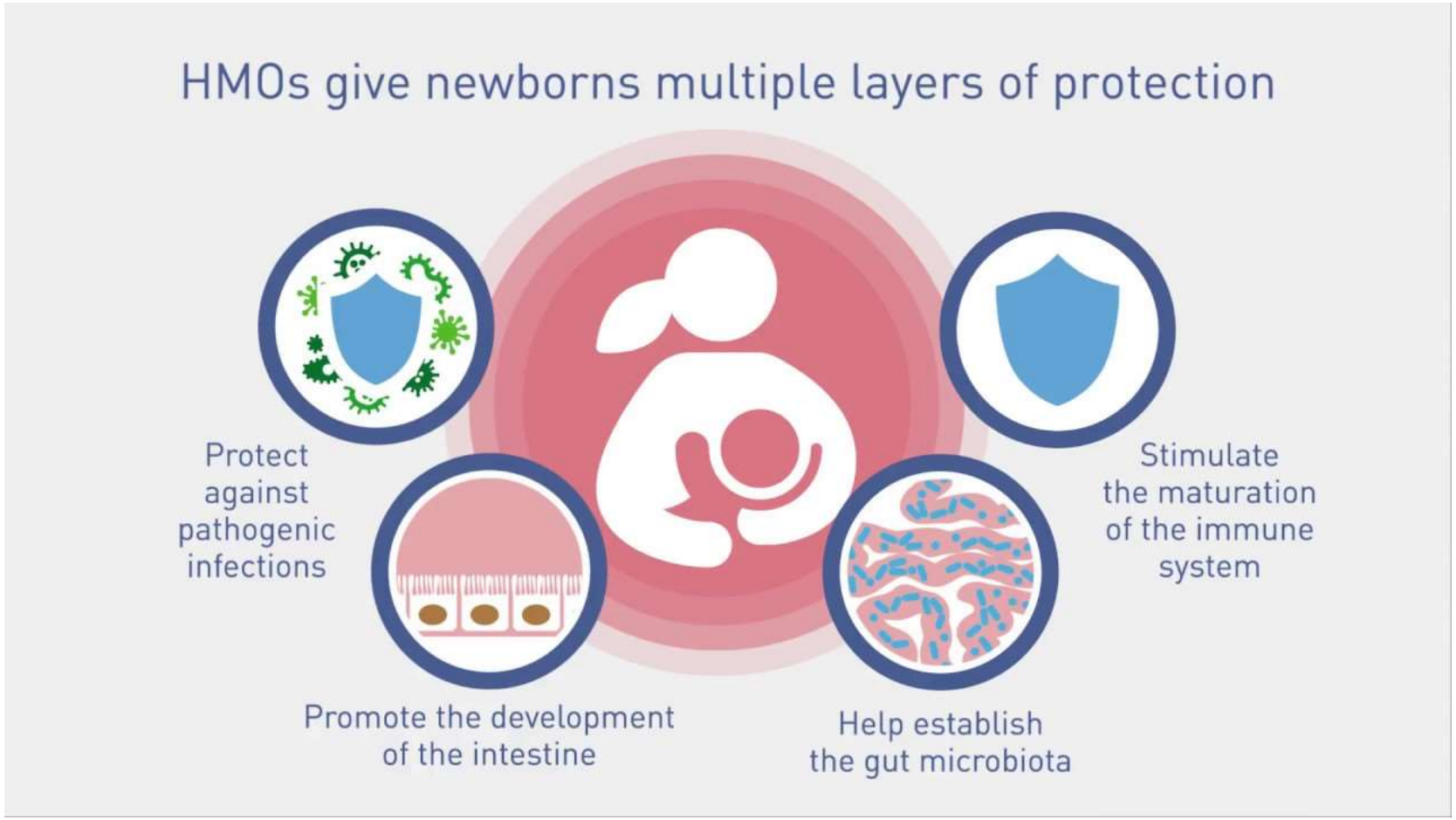
Holsteins selecting for A2

- Less than 20% A2 homozygous in early 1990s
- Now about 50%



Source: Iona MacLeod (Ag Vic)

Human milk oligosaccharides (HMOs)



Source: Nestle

Oligosaccharides in cow's milk

- 330 Holstein cows
- 10 oligosaccharides
- Sequence genotypes

~80% of genetic variance

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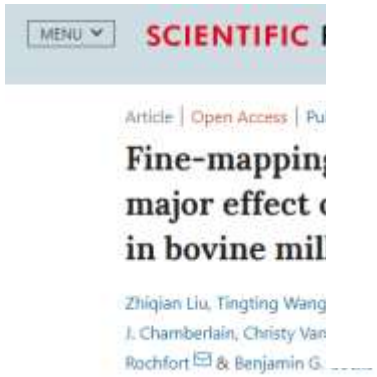

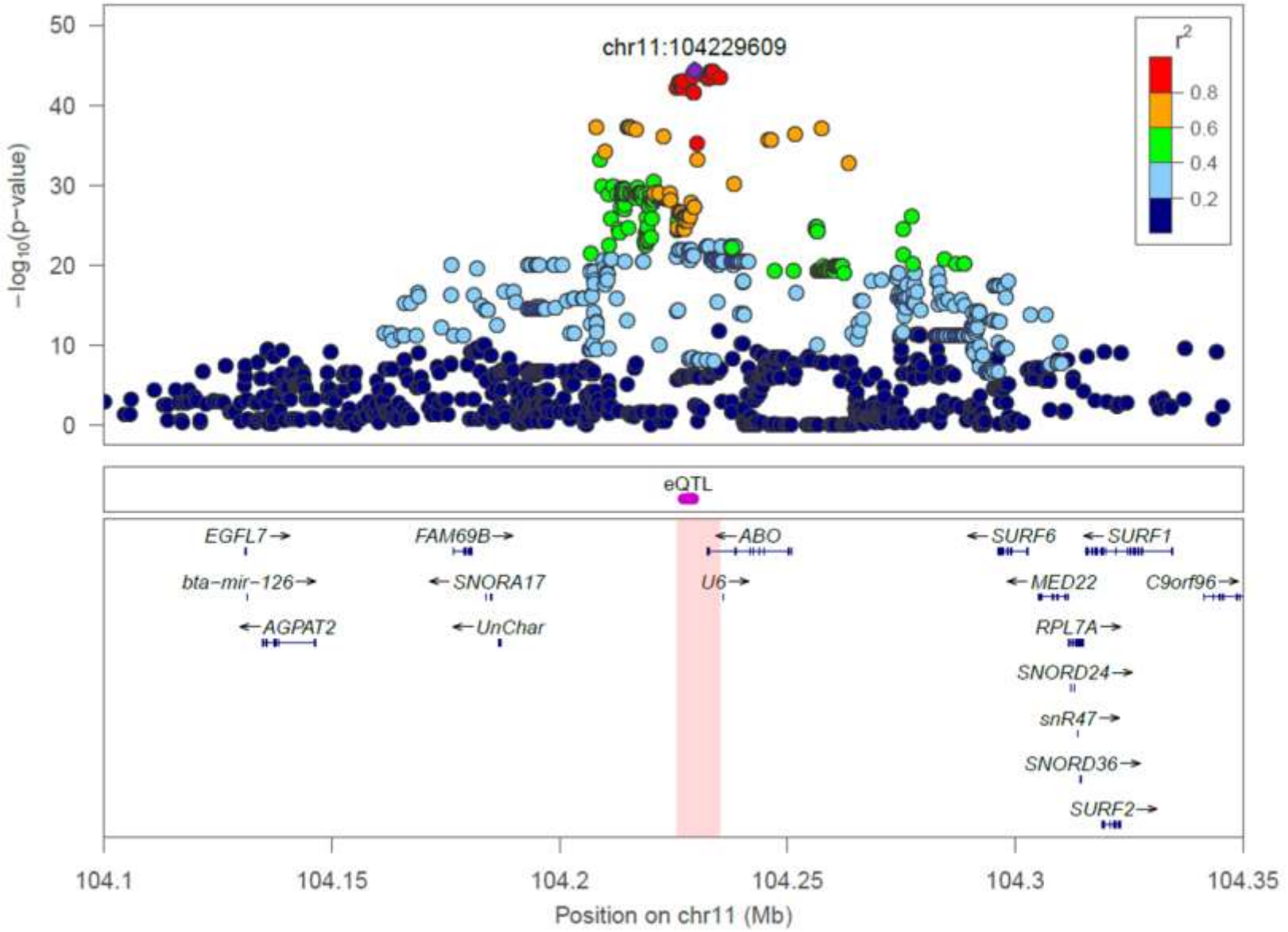

1000 Bull Genomes Project RUN 7

- >3000 sequenced animals (1600 dairy)
- > 50 Breeds: Dairy, Beef, Dual Purpose, Crosses, Composite









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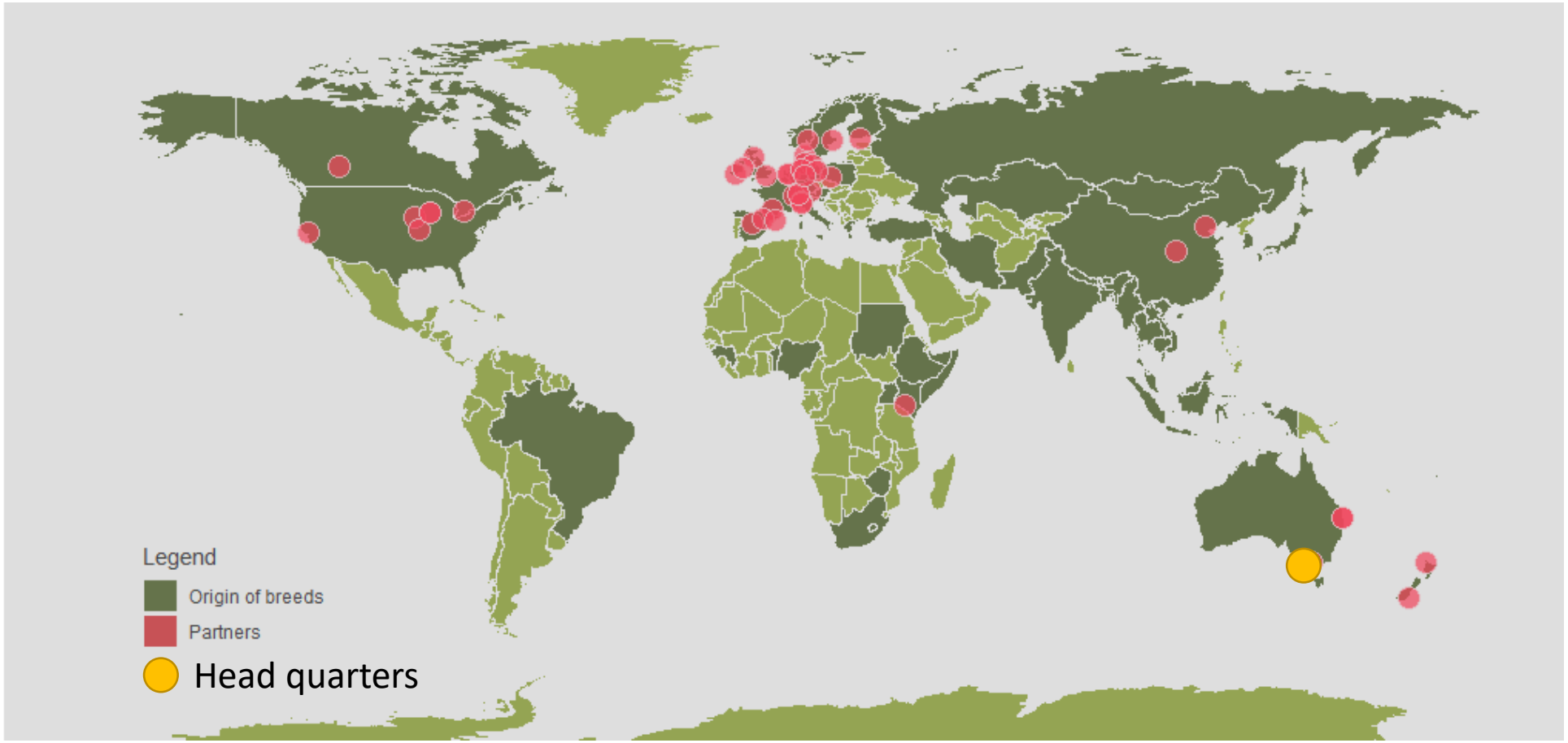
40 Partner Institutes



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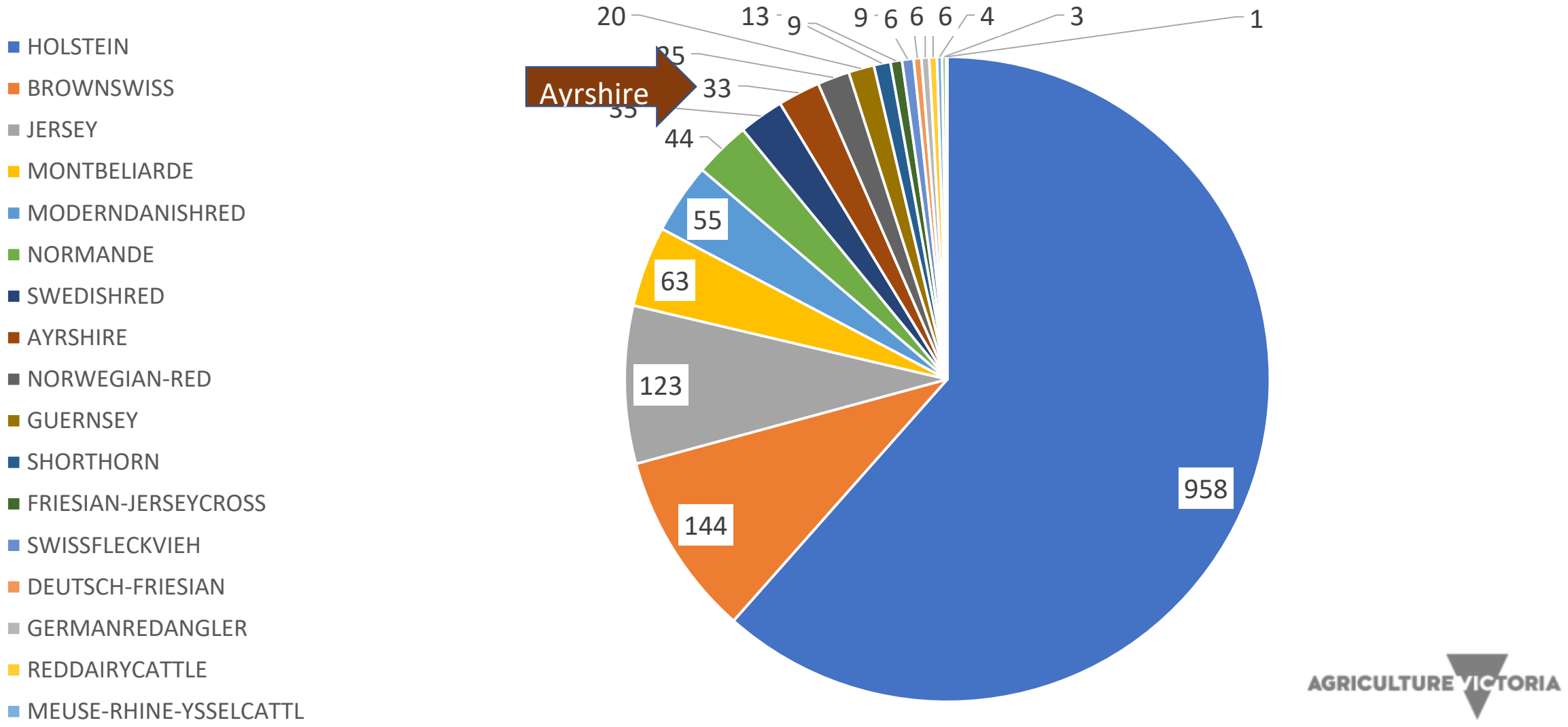
Dairy breeds of Run 7 of 1000 bulls



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1000 Bull Genomes Project

- Largest impact on discovery of deleterious mutations
- Accurate identification of causative genes
- Improvements to accuracy of genomic predictions
  - Largest gains in multibreed populations
  - Best results from preselecting genes
- Better improvements will come from identification of variants of small effect
  - Computationally efficient methods that can utilise full sequence
  - Utilising biological information

Providing research for a vibrant future in Australian dairy

1. **Higher and more robust reliability of breeding values**
    1. Global database genome sequence
    2. Increased reliability with sequence
    3. Develop inexpensive genotyping
    4. More efficient genomic prediction
    5. Routine delivery of higher reliability breeding values

2. **World leading genomic services**
    1. Gestation length and calving ease
    2. Red breed genomics
    3. Feed efficiency
    4. Heat tolerance

3. **Novel health and resilience traits**
    1. Mastitis
    2. Lameness
    3. Metabolic resilience
    4. Methane emissions

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4. **Massive throughput phenotyping**
    1. Provide data to underpin ABV development
    2. Develop novel management tools that use mid-infra-red spectral data
5. **CRV collaboration**
    1. Better genomic predictions for crossbreds
    2. Large Oceania cow reference population
    3. Joint development of new trait breeding values

6. **Improved fertility**
    1. Better breeding values for fertility
    2. Impact of timed AI

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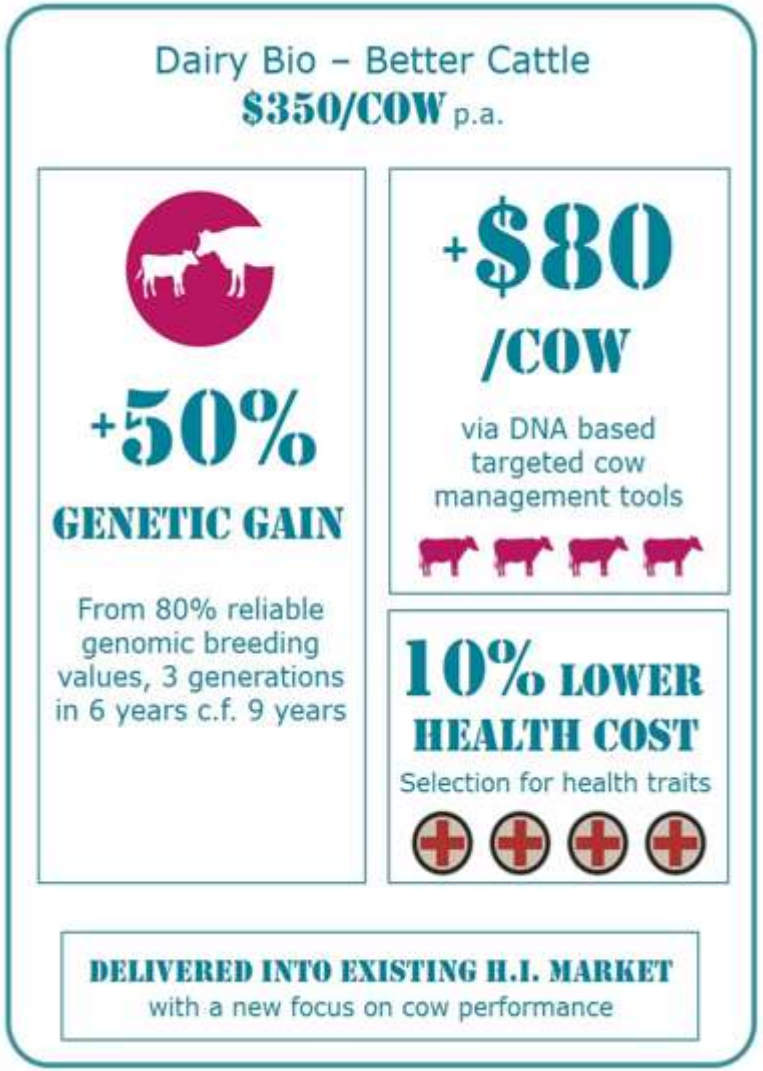
Australian research to impact pathway

Reliability/robustness of genomic breeding values, crossbreds

Breeding value maintenance (improve reliability)

Breeding values for new traits

DataGene
Solutions for Herd Development



Ayrshire breed into the future

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- Differentiate – better than trying to compete with other breeds!
- Maintain diversity
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- Focus on your vision of the future

Acknowledgements

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Zhiqian Liu

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GARDINER FOUNDATION