Making innovative gains in genetics

DairyBio

@jenniepryce

Jennie Pryce

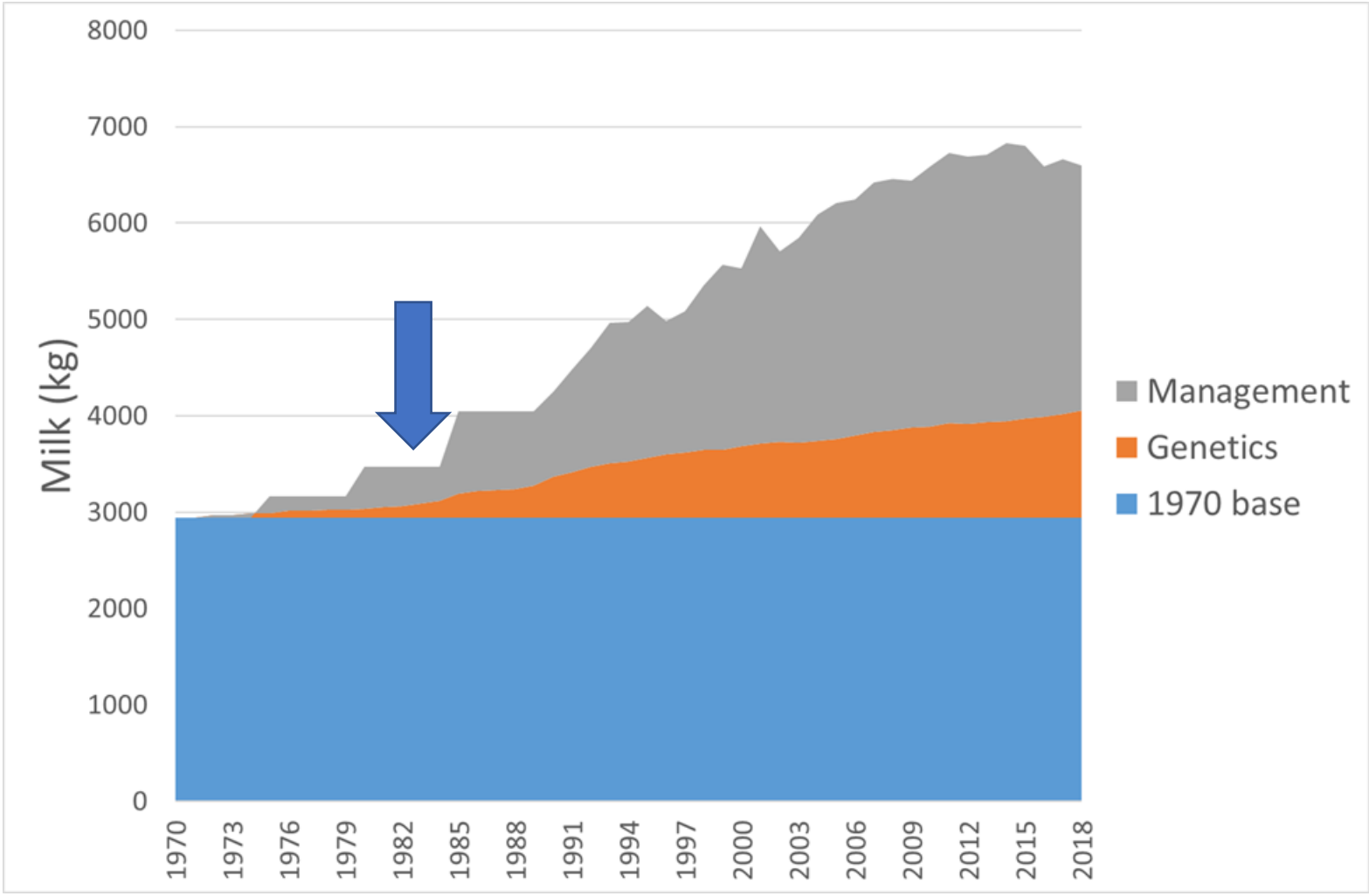
AGRICULTURE VICTORIA

DataGene
Solutions for Herd Development

Celebrating 40 Years of ABV's

14 March 2023, 7pm

All Seasons Resort Hotel Bendigo



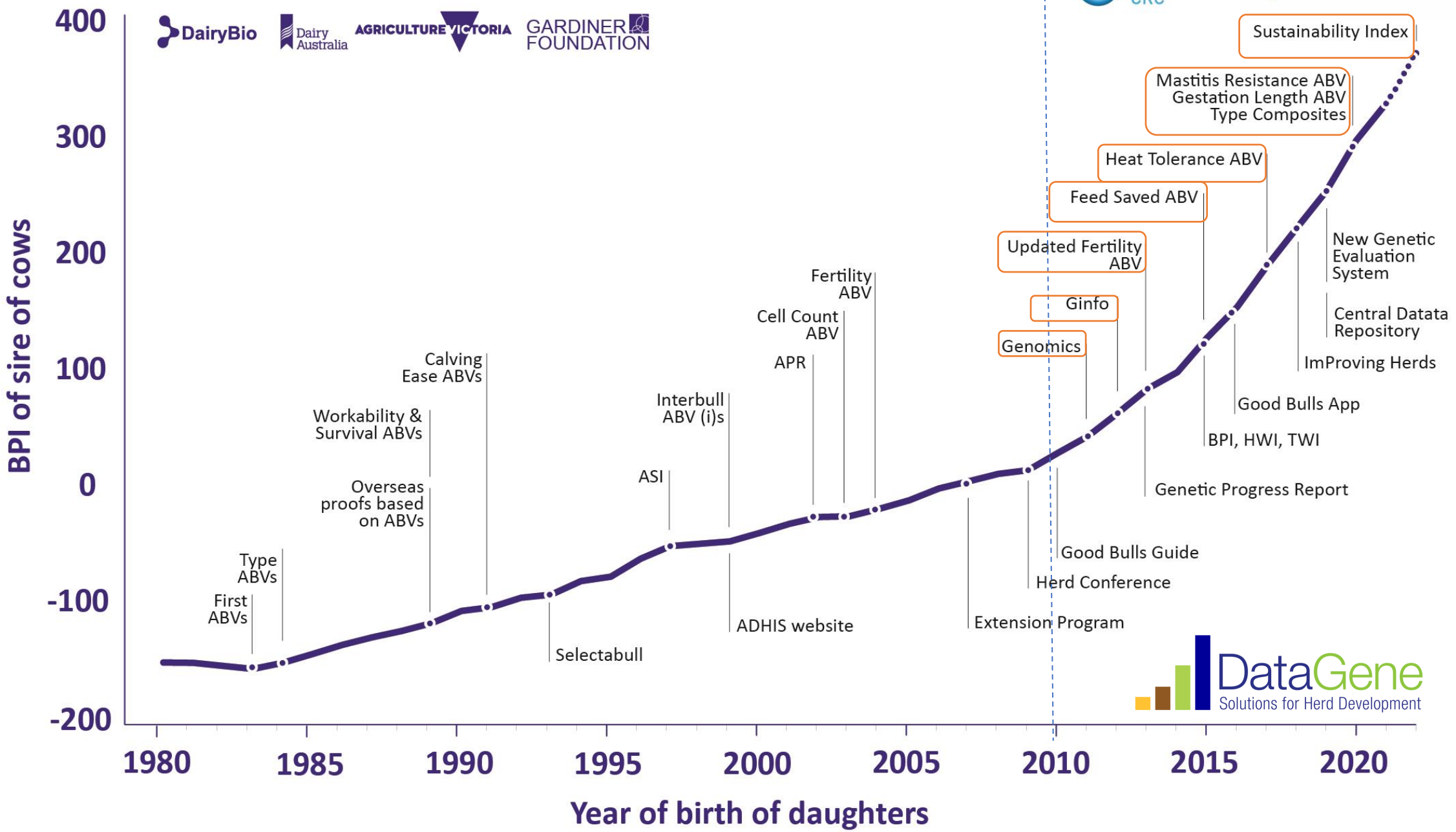
DataGene
Solutions for Herd Development

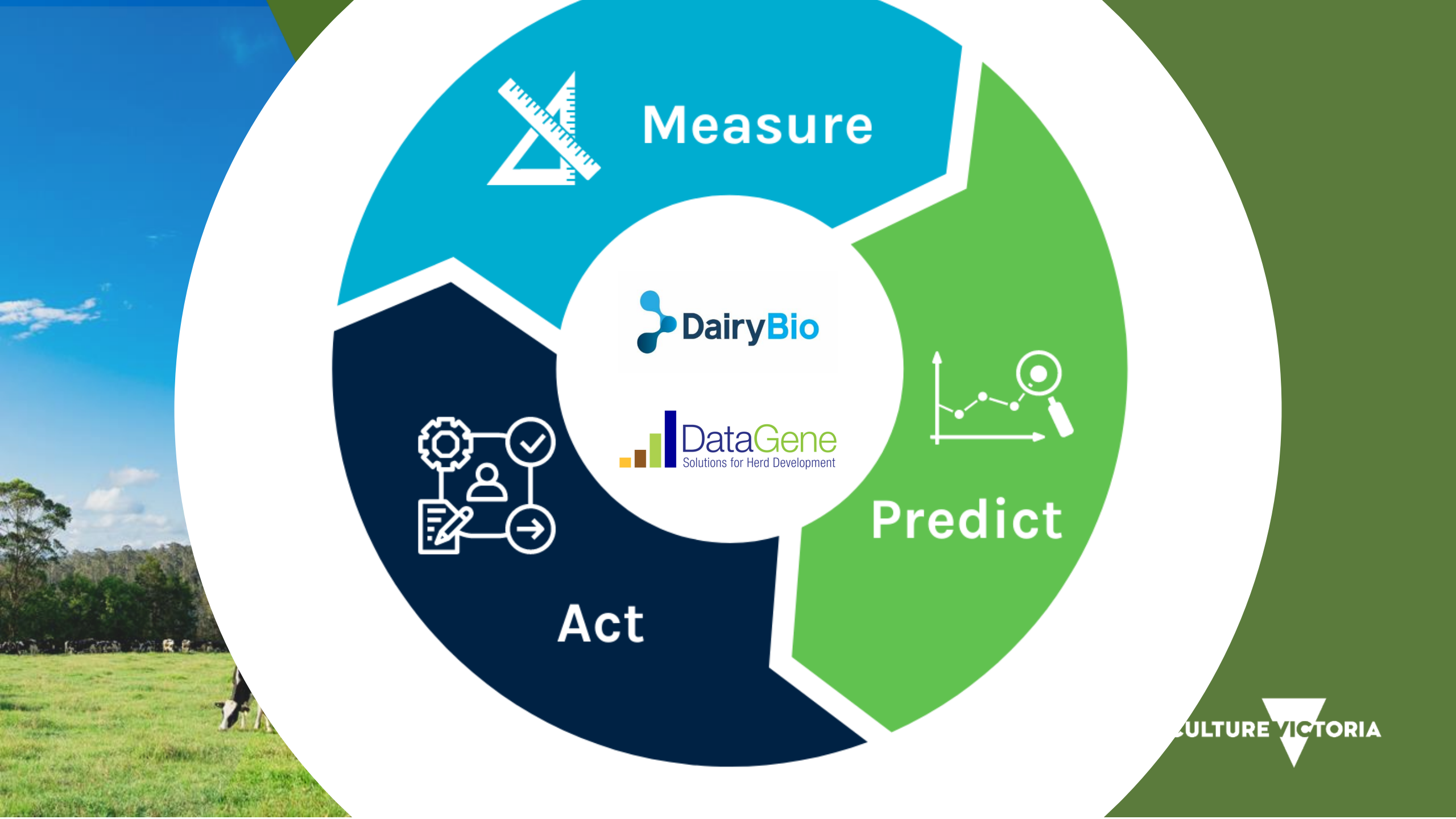
1970:
~5 litres Milk/kg liveweight

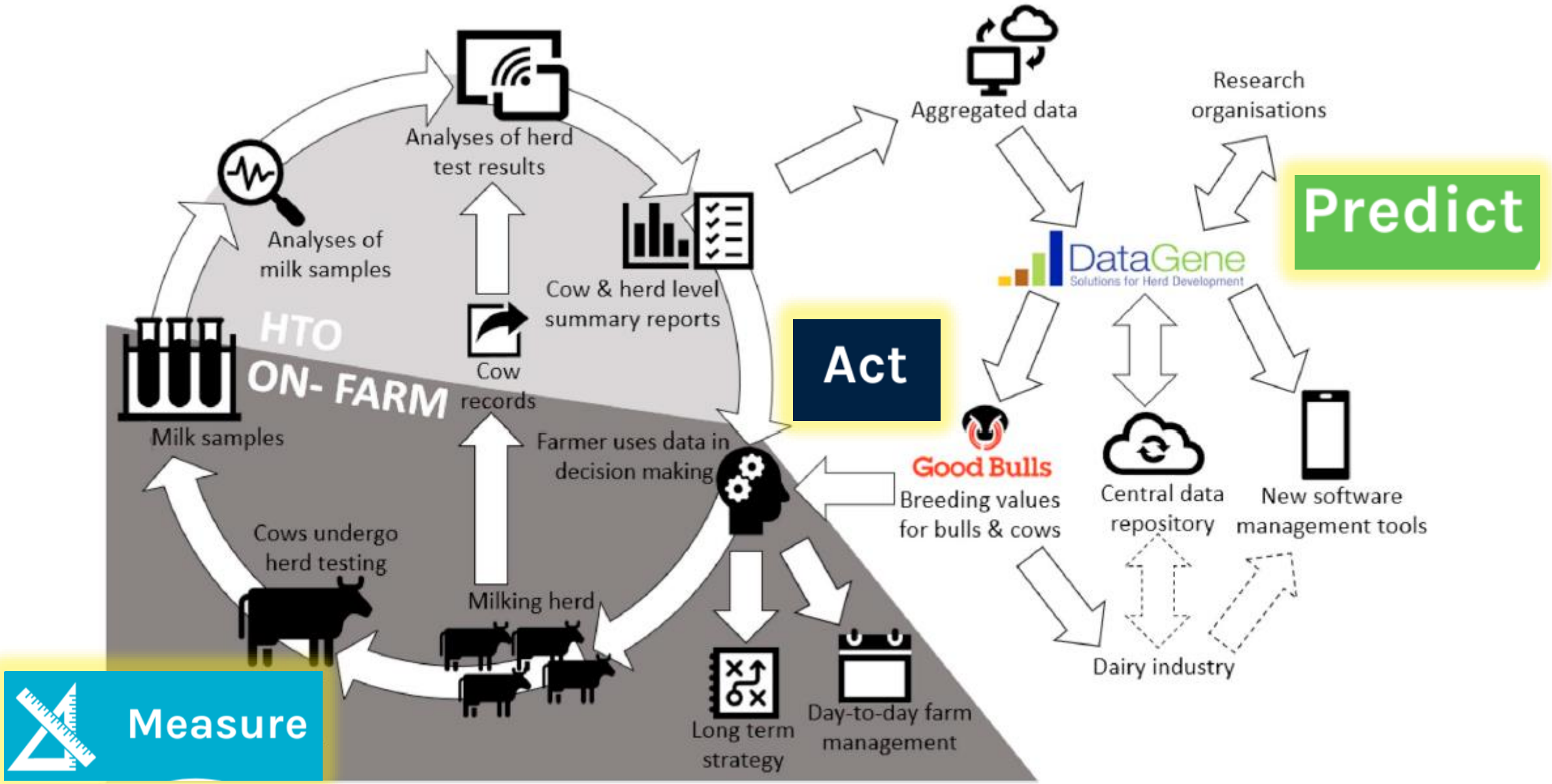
2018:
~10 litres Milk/kg liveweight

A doubling of production efficiency

Australian genetic trends (Holstein)




Measure
Predict
Act
DairyBio
DataGene
Solutions for Herd Development


Aggregated data
Research organisations
Predict
DataGene
Solutions for Herd Development
Analyses of herd test results
Analyses of milk samples
Cow & herd level summary reports
HTO
ON- FARM
Act
Cow records
Milk samples
Farmer uses data in decision making
Good Bulls
Breeding values for bulls & cows
Central data repository
New software management tools
Cows undergo herd testing
Milking herd
Dairy industry
Measure
Long term strategy
Day-to-day farm management

Pathway to farmers

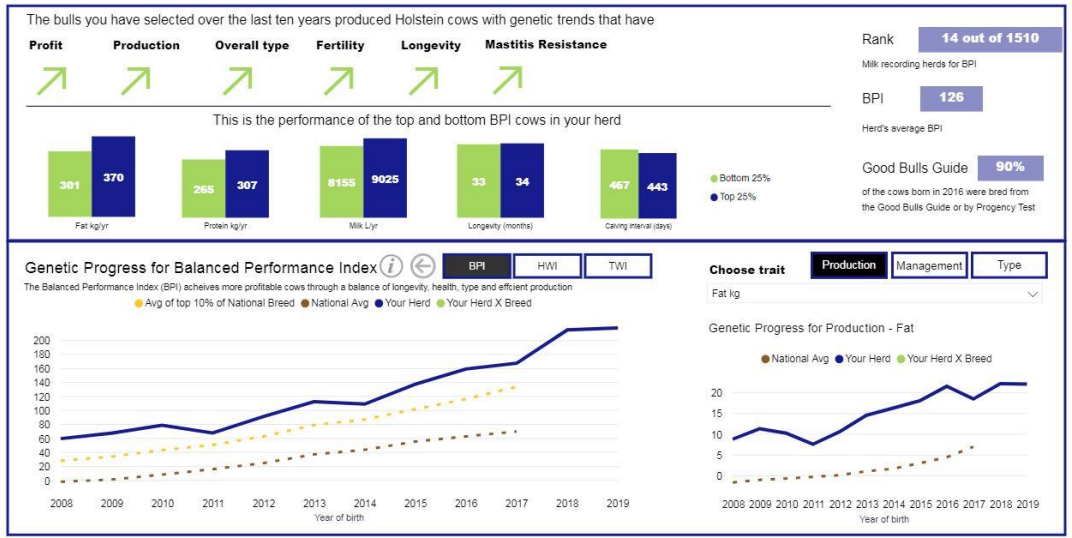
DairyBio

DataGene

Industry

DairyBio Dairy Australia GARDINER FOUNDATION VICTORIA State Government

DataGene Solutions for Herd Development

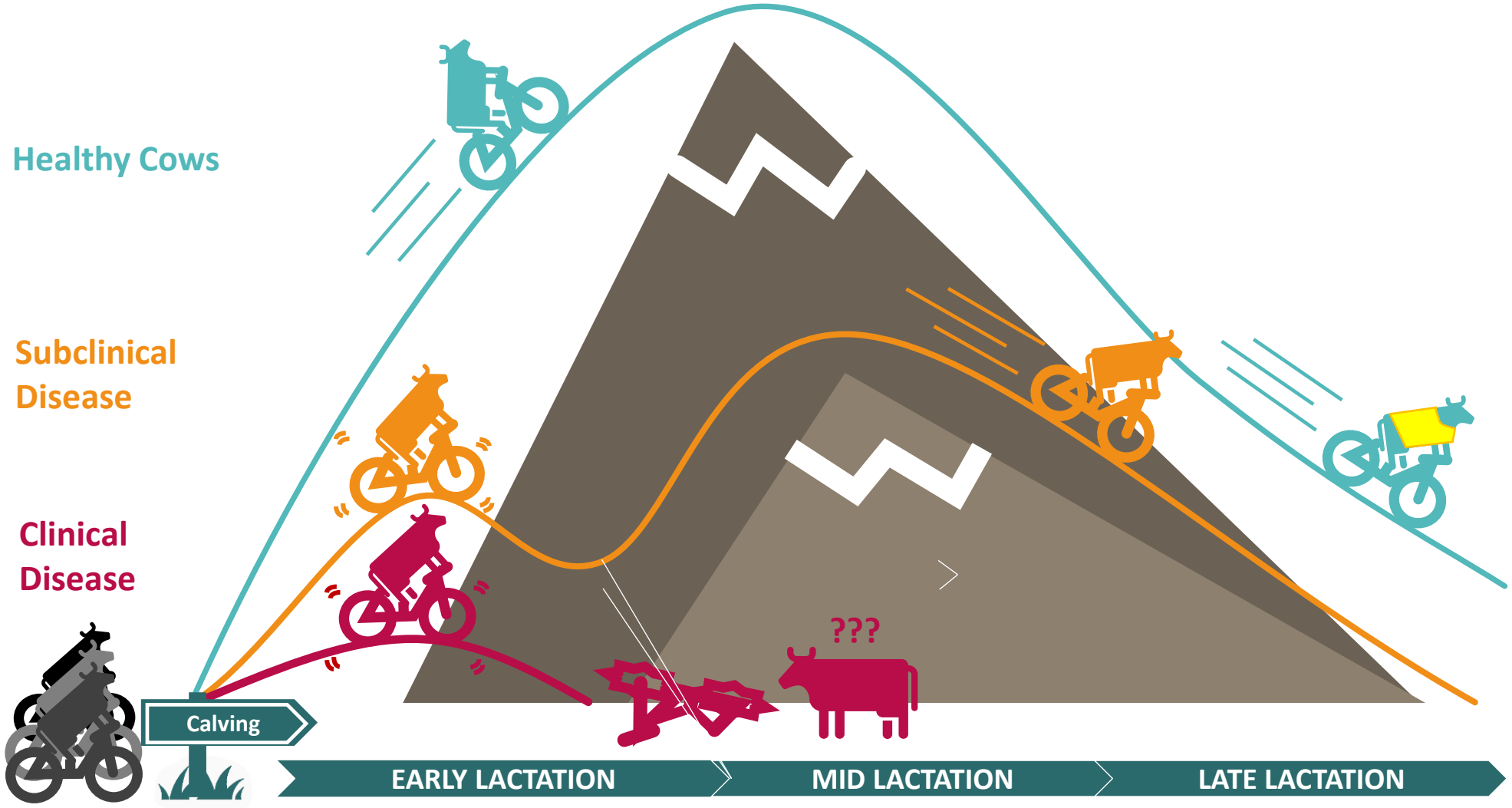


VICTORIA

Measure

Milk records	Calving dates	Mating dates	Health information (mastitis, lameness, repro etc) + dates
Calving ease	Temperament	Milking speed	Conformation
	Automated data (sensors/tags etc)	New traits…..	

AGRICULTURE VICTORIA



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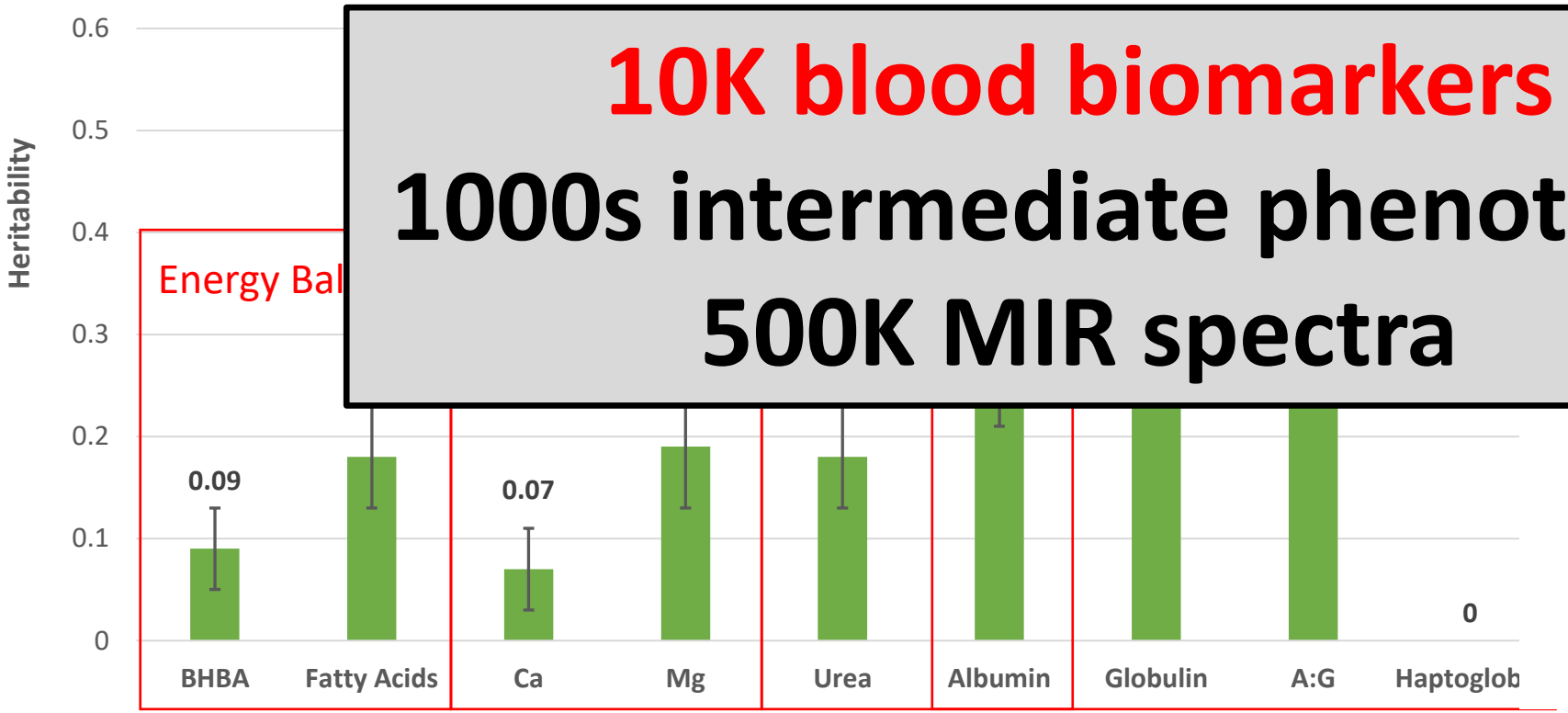
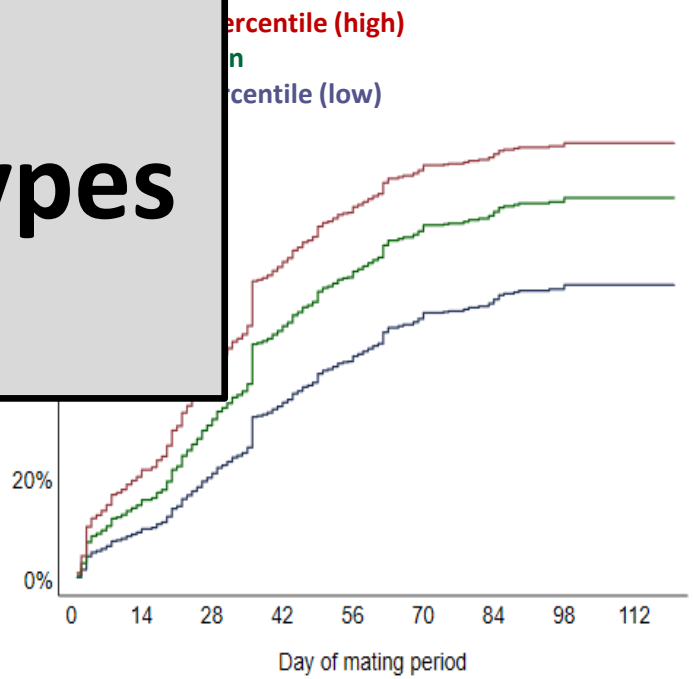
10K blood biomarkers

1000s intermediate phenotypes

500K MIR spectra





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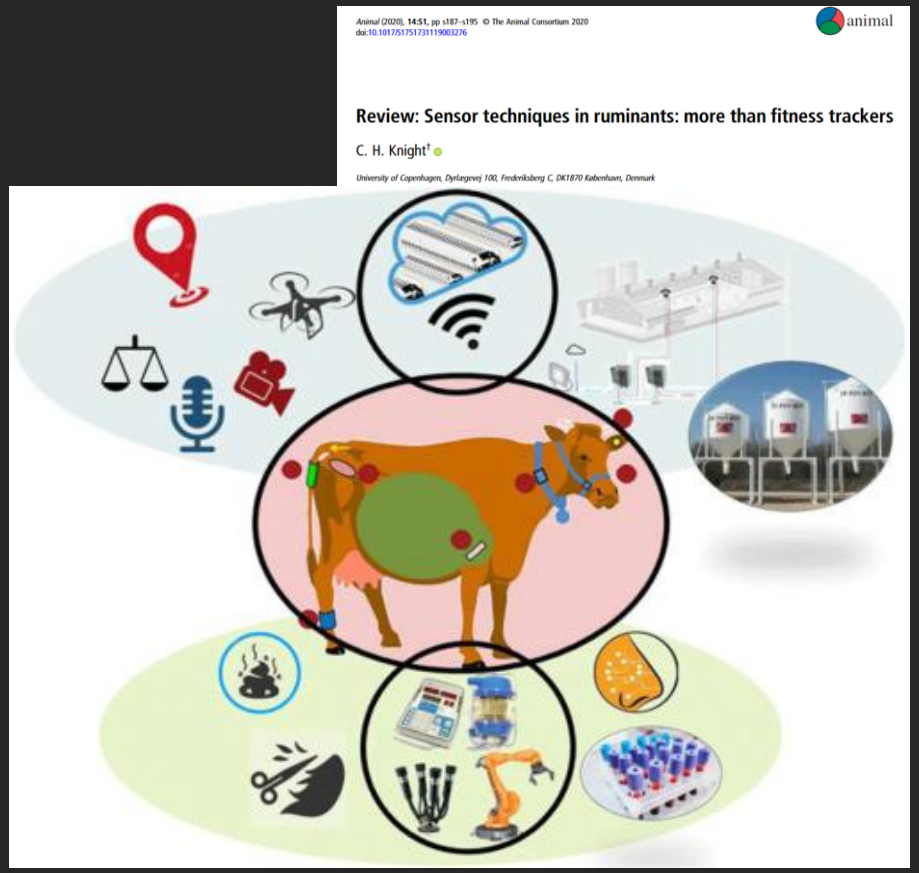
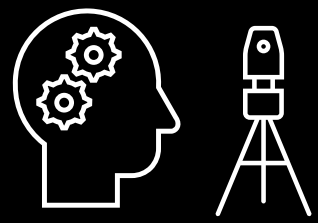


Automating measurements

Measure



World Congress on Genetics Applied to Livestock Production
Rotterdam | The Netherlands
3 - 8 July 2022

Smart phenotyping coupled with better methods to help solve our grand challenges

AGRICULTURE VICTORIA

Aviagen®

Measured CH4 data GEBVs

BS

Bolormaa Sunduimijid (DJPR) Yesterday 10:05 am

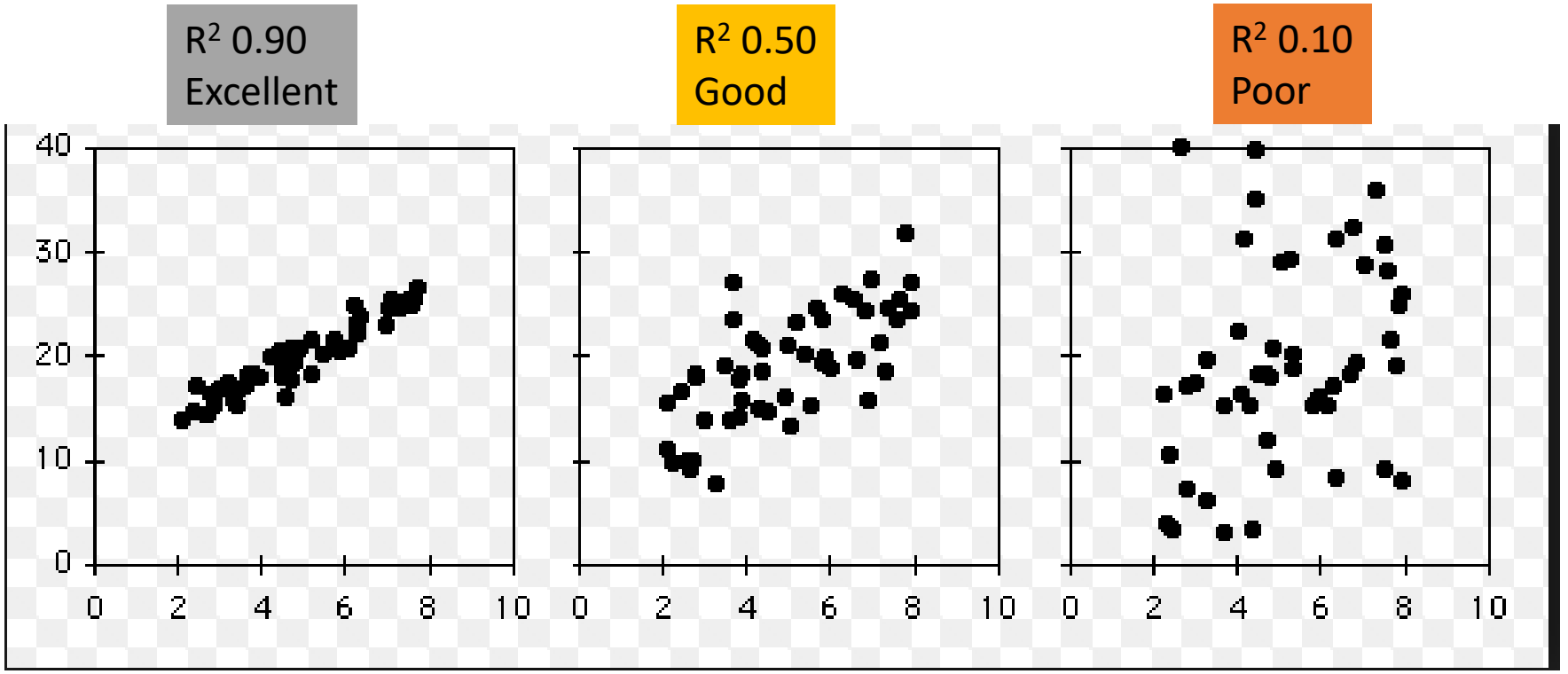
Table 3. Average weighted accuracies of GEBV of the 4-fold cross-validation populations using GBLUP with univariate and bivariate model

Yesterday 10:05 am 👍 1

DATAset	SNPset	trait	r	Acc.	Acc_s.d.	Acc_s.e.
AUS	50k	CH4	0.12	0.30	0.157	0.078
AUSnOVE	50k	CH4	0.13	0.32	0.100	0.050
AUS	HD	CH4	0.14	0.34	0.186	0.093
AUSnOVE	HD	CH4	0.14	0.35	0.124	0.062
AUS	50k	CH4ecm	0.12	0.29	0.272	0.136
AUSnOVE	50k	CH4ecm	0.12	0.31	0.154	0.077
AUS	HD	CH4ecm	0.13	0.32	0.280	0.140
AUSnOVE	HD	CH4ecm	0.14	0.36	0.195	0.097

aroung 30% in AUS

Reliability (R^2)



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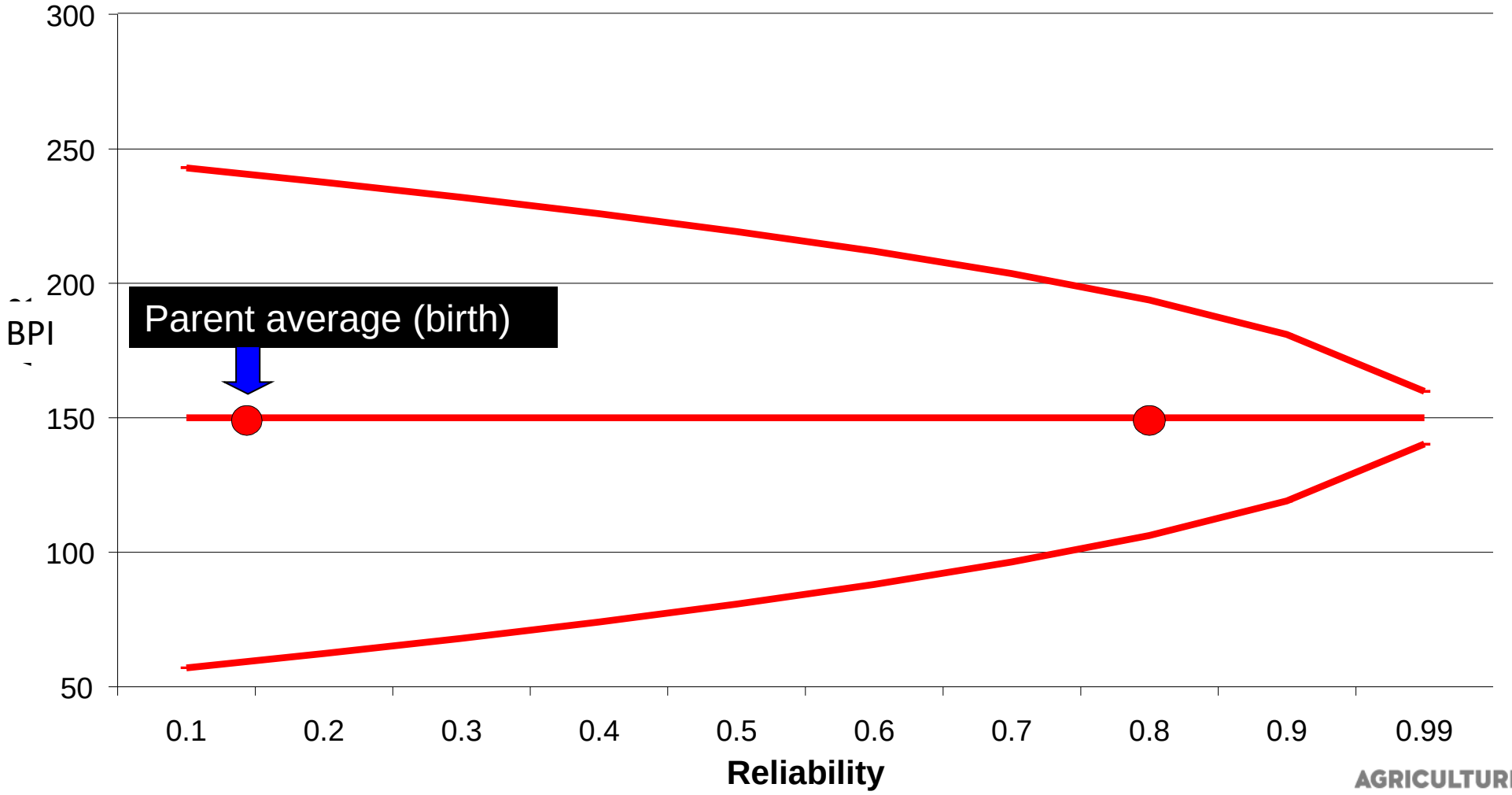
95% Confidence interval BPI at different reliabilities



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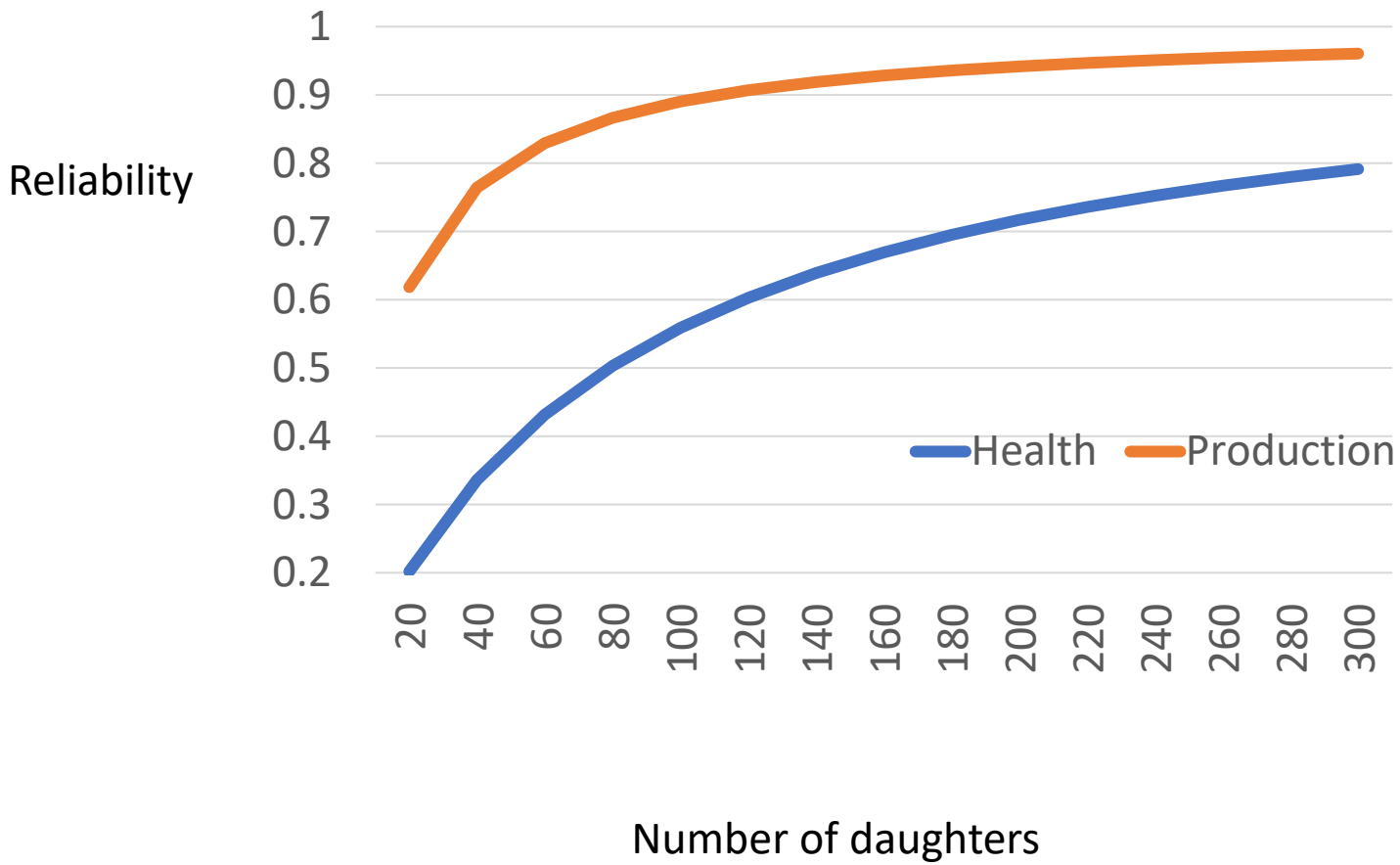
Progeny testing



80-100 daughters required to get reliabilities >50%

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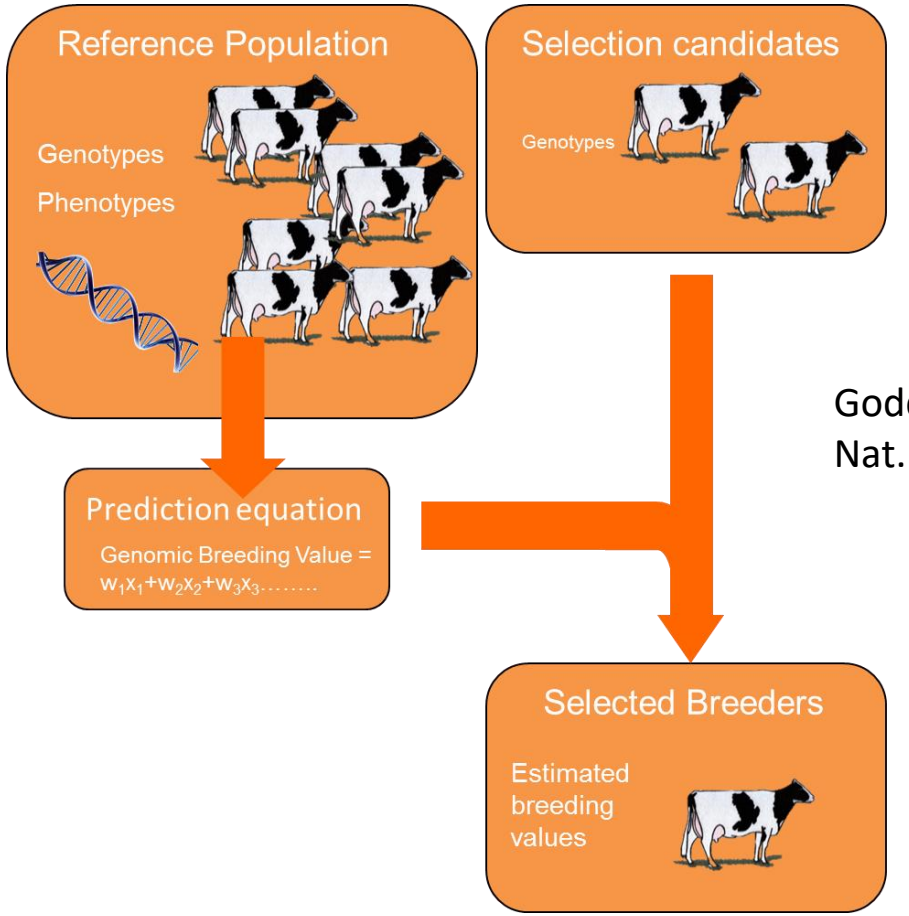
Genomic selection

JOURNAL ARTICLE

Prediction of Total Genetic Value Using Genome-Wide Dense Marker Maps FREE

T H E Meuwissen ✉, B J Hayes, M E Goddard

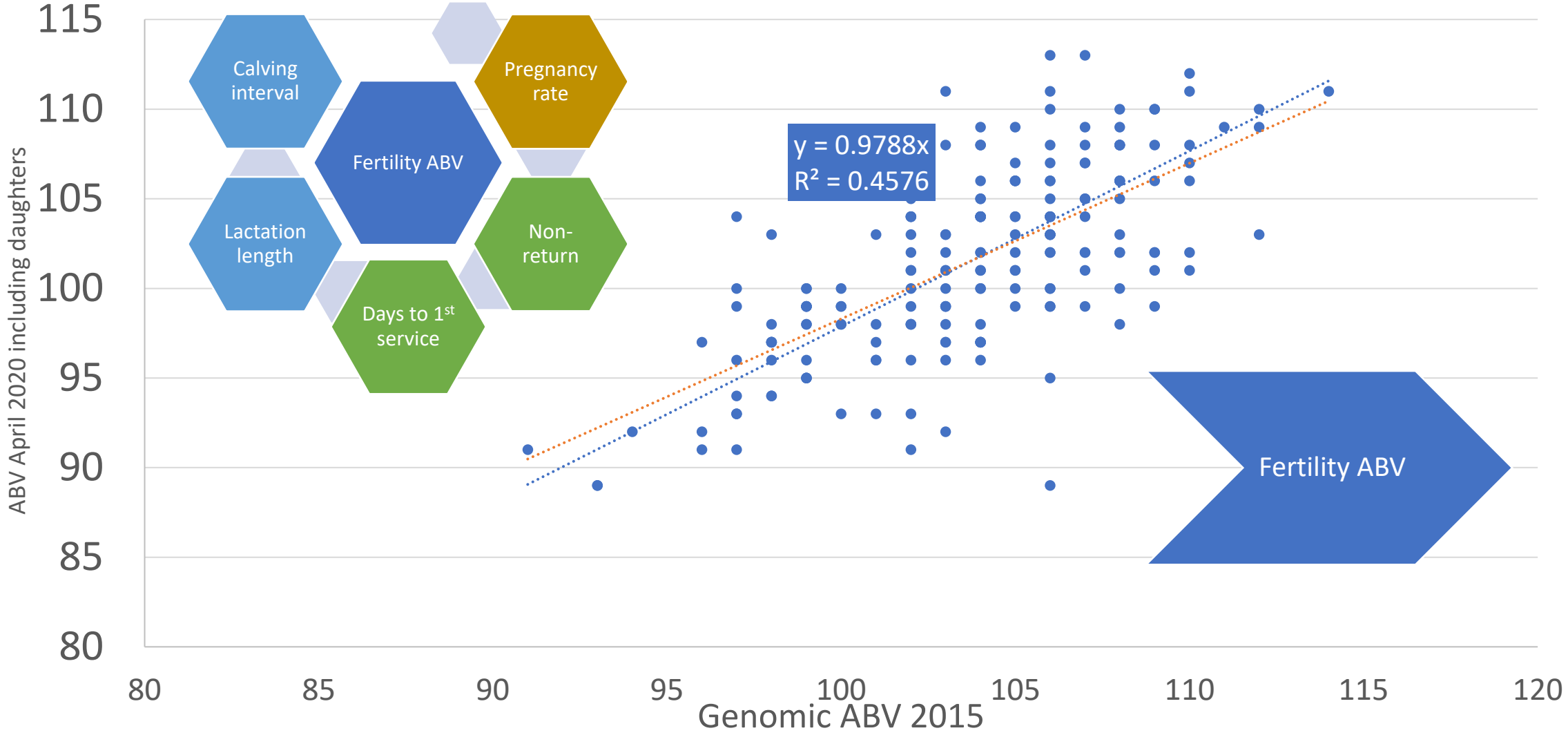
Genetics, Volume 157, Issue 4, 1 April 2001, Pages 1819–1829,
https://doi.org/10.1093/genetics/157.4.1819
Published: 01 April 2001 **Article history** ▾



Goddard & Hayes
Nat. Rev. Genet. 2009

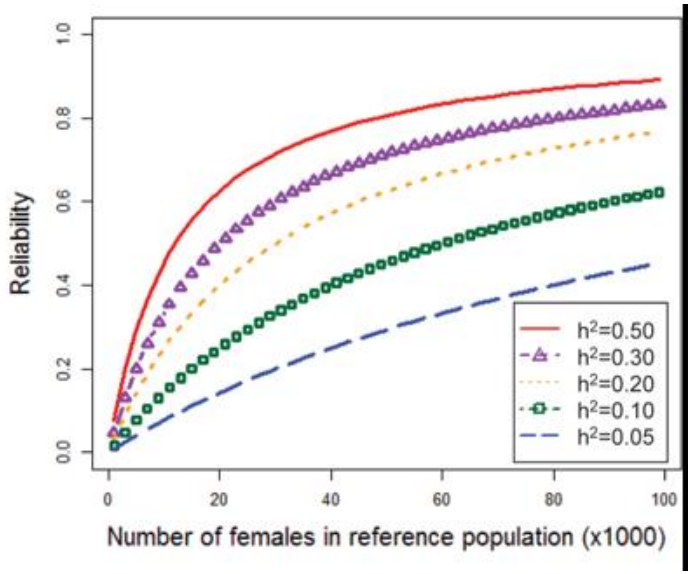
AGRICULTURE VICTORIA

Genomic only fertility ABVs of bulls in 2015 (as calves) and their ABVs in 2020 with (>50) daughters

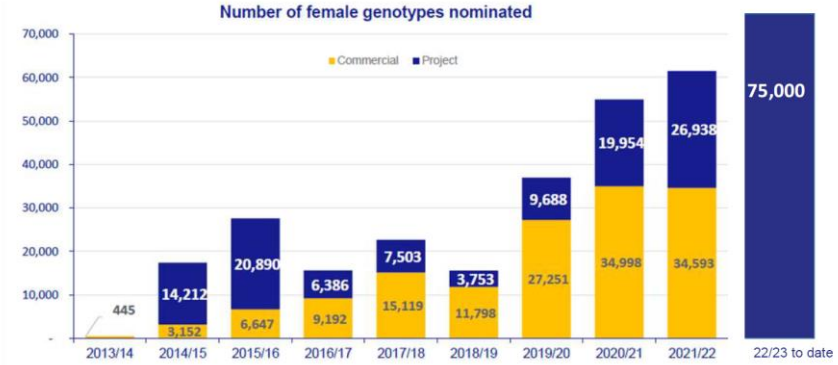



?
?
?
2208
1562
2199
1526
Genomic reliabilities (calves)
Protein 76%
Overall type 53%
Fertility 50%
Milking speed 61%
Reliabilities ABVs (7th lactation)
Protein 78%
Overall type 29%
Fertility 38%
Milking speed 37%
Year 0 Calf
Year 1 Yearling
Year 2 Lact 1
Year 3 Lact 2
Year 4 Lact 3
Year 5 Lact 4
Year 6 Lact 5
Year 7 Lact 6
Year 8 Lact7

How to increase genomic reliability



Metrics



DataGe
Solutions for Herd Develo

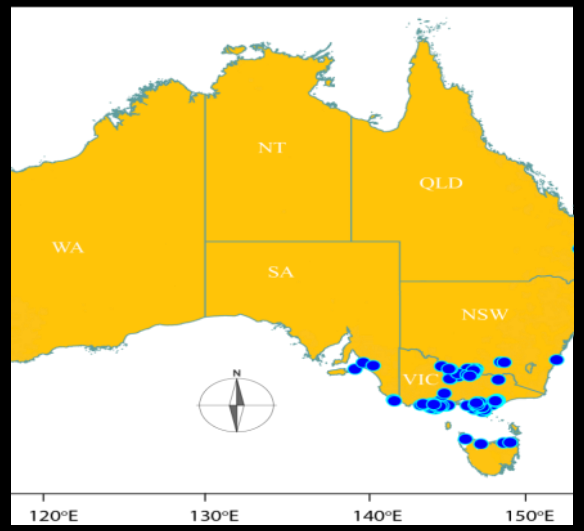
ELSEVIER

Journal of Dairy Science
Volume 97, Issue 12, December 2014, Pages 7905-7915

On the value of the phenotypes in the genomic era

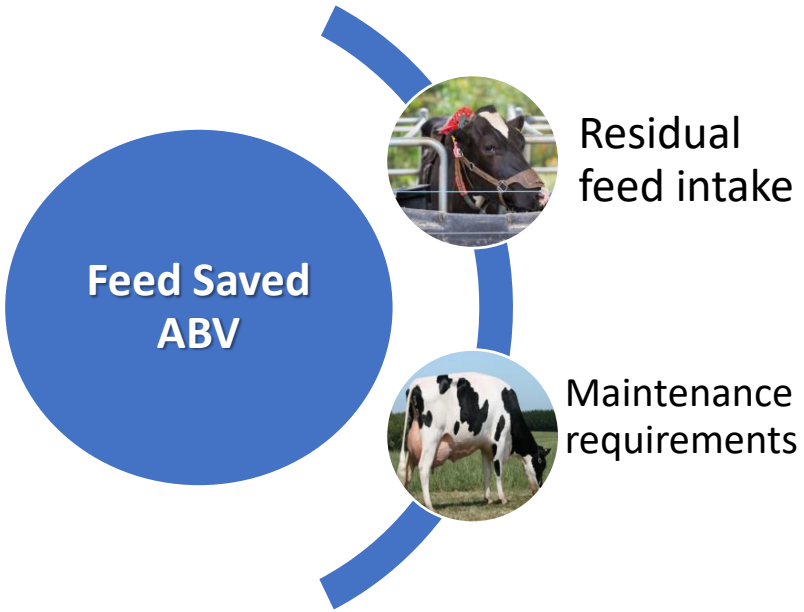
O. Gonzalez-Recio *, †, M.P. Coffey ‡, J.E. Pryce *, †, §

Reference populations



- Research herds
  1000s cows
  - Feed saved
  - methane
  - New..
- Ginfo
  30k+ cows
  - Health
  - Heat tolerance
  - New…

Feed Saved ABV – a world first!



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Solutions for Herd Development

Example Feed Saved ABVs

THE Good Bulls GUIDE

Holstein	BPI	FEED SAVED
BULL ID	BALANCED PERFORMANCE INDEX	FEED SAVED ABV
A	336	– 43
B	320	– 147
C	302	– 4
D	301	110
E	285	2
F	282	– 6
G	277	72
H	277	– 26
I	274	18
J	268	111
	$ profit/cow/year	kg feed saved /cow/year

J. Dairy Sci. 98:7340–7350
http://dx.doi.org/10.3168/jds.2015-9621

Hot topic: **Definition and implementation of a breeding value for feed efficiency in dairy cows**

J. E. Pryce,*†[1] O. Gonzalez-Recio,* G. Nieuwhof,*‡ W. J. Wales,§ M. P. Coffey,# B. J. Hayes,*† and M. E. Goddard*‖
*Department of Economic Development, Jobs, Transport and Resources and Dairy Futures Cooperative Research Centre, Agribio, 5 Ring Road, Bundoora, VIC 3083, Australia
†School of Applied Systems Biology, La Trobe University, Bundoora, VIC 3083, Australia
‡Australian Dairy Herd Improvement Scheme, 22 William Street, Melbourne, VIC 3000, Australia
§Department of Economic Development, Jobs, Transport and Resources, Ellinbank, VIC 3820, Australia
#SRUC, Easter Bush Campus, Midlothian EH25 9RG, United Kingdom
‖Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Parkville VIC 3010, Australia

CDCB
COUNCIL ON DAIRY CATTLE BREEDING

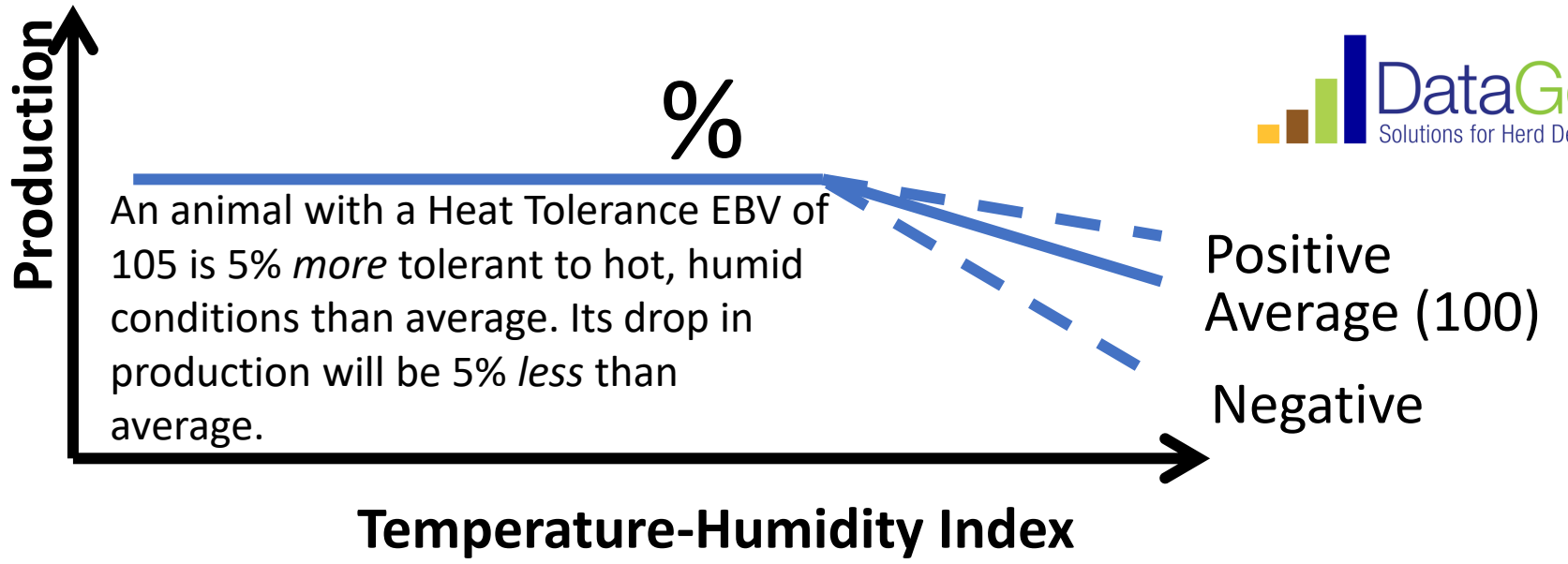
Trait Reference Sheet
November 2020

Feed Saved (FSAV)

INTRODUCTION DATE
December 1, 2020, and then in all subsequent weekly, monthly and triannual evaluations

BENEFITS OF TRAIT
- Feed costs can make up over half of the total costs on a dairy farm[1]. Selecting for more feed-efficient cows can reduce these costs and improve profitability.
- Improving the efficiency of dairy cows will help

Heat tolerance ABV



DataGene
Solutions for Herd Development

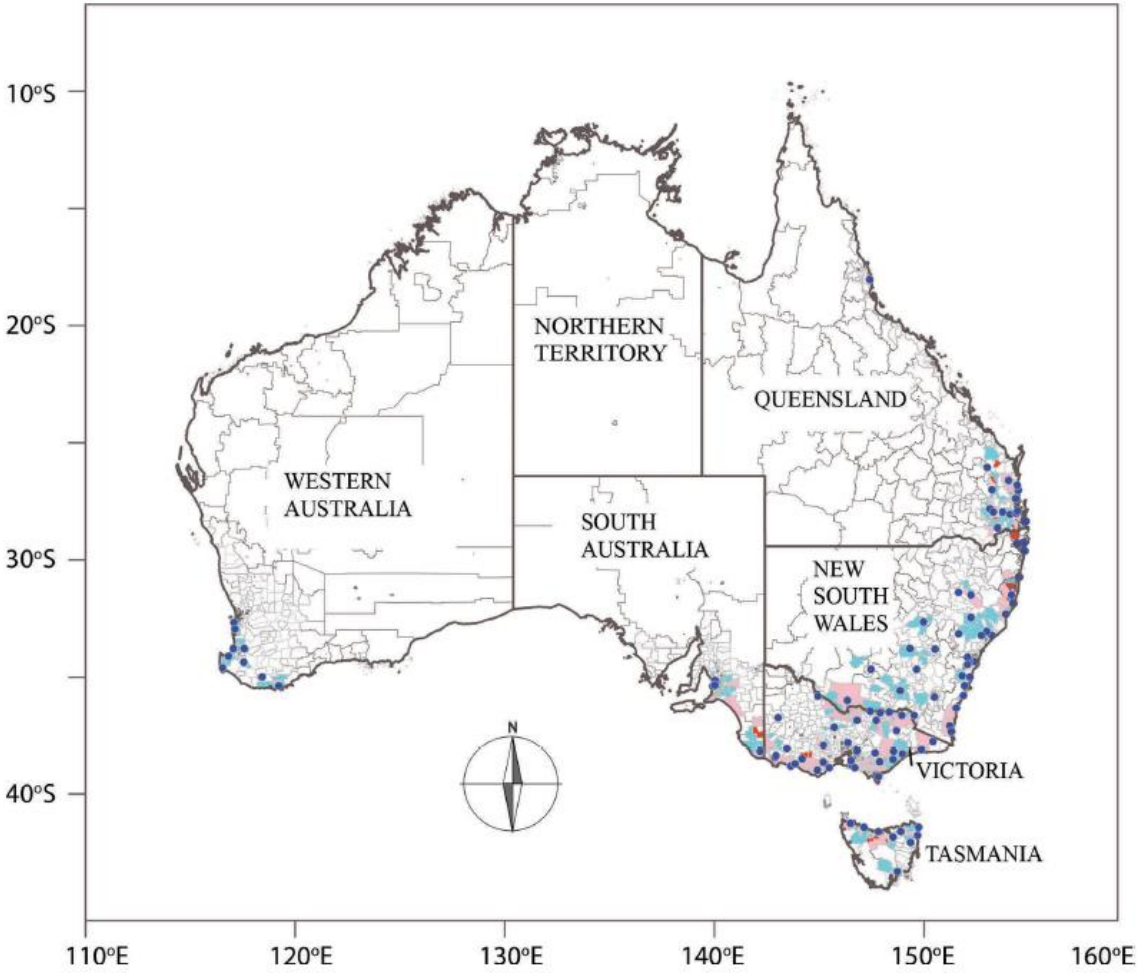
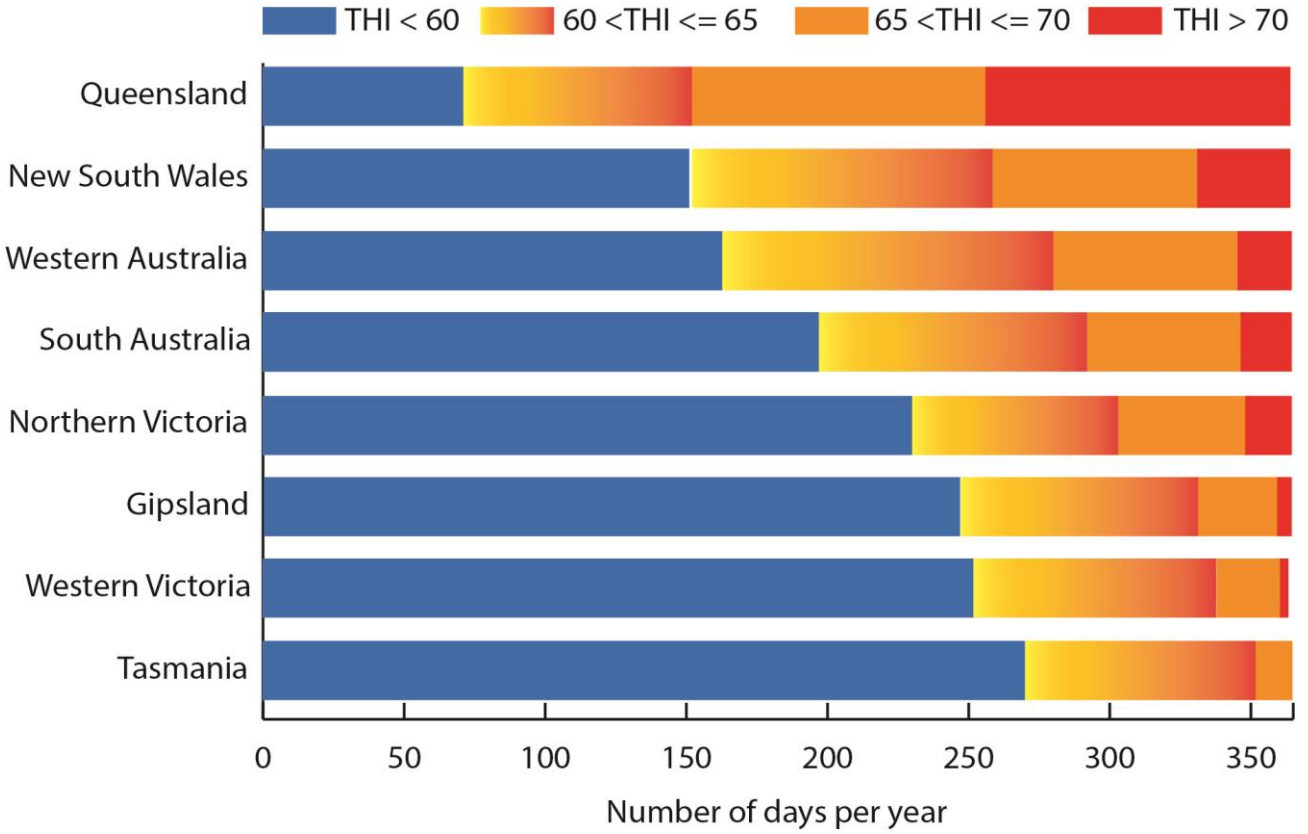


Figure 1. Locations of automatic weather stations and dairy herds for which climate and production data were used in the present study. Blue dots represent 105 weather stations. Pink, cyan, and red areas represent postcodes where both Holstein and Jersey herds, only Holstein herds, and only Jersey herds were located, respectively.



J. Dairy Sci. 99:2849–2862
http://dx.doi.org/10.3168/jds.2015-9685

Genomic selection for tolerance to heat stress in Australian dairy cattle

Thuy T. T. Nguyen,*[1] Phil J. Bowman,* Mekonnen Haile-Mariam,* Jennie E. Pryce,*† and Benjamin J. Hayes*†
*BioSciences Research Division, Department of Economic Developments, Jobs, Transport and Resources, and Dairy Futures Cooperative Research Centre, Agribio, 5 Ring Road, Bundoora, Victoria 3083, Australia
†La Trobe University, Bundoora, Victoria 3083, Australia

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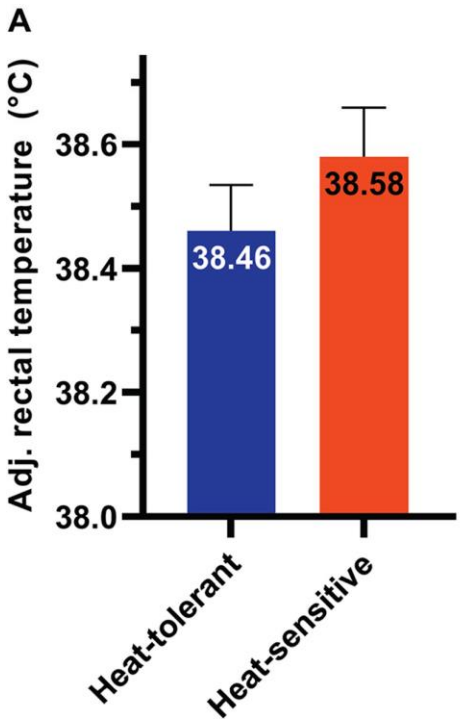
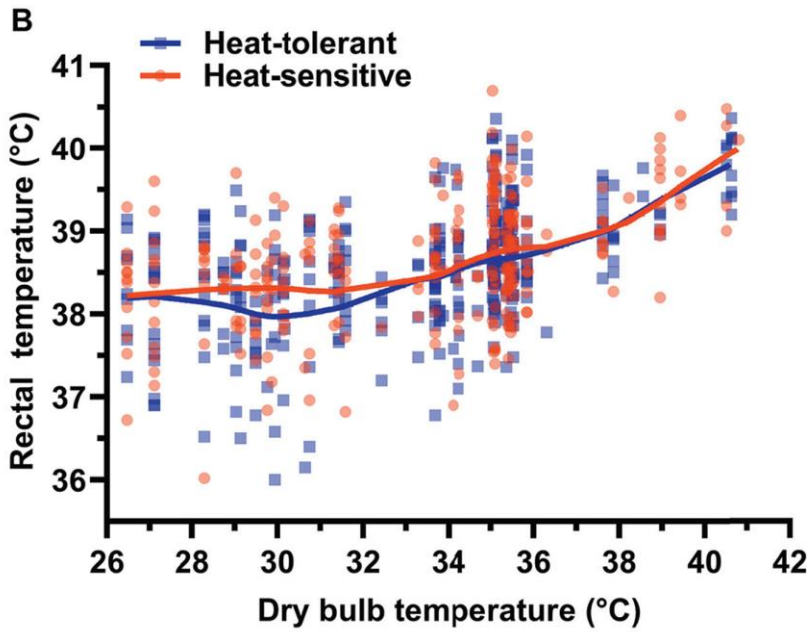
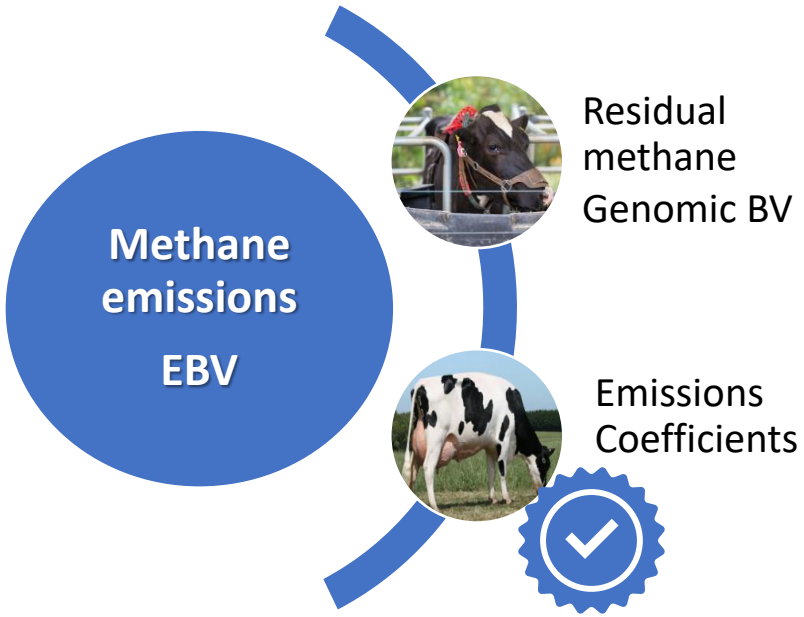




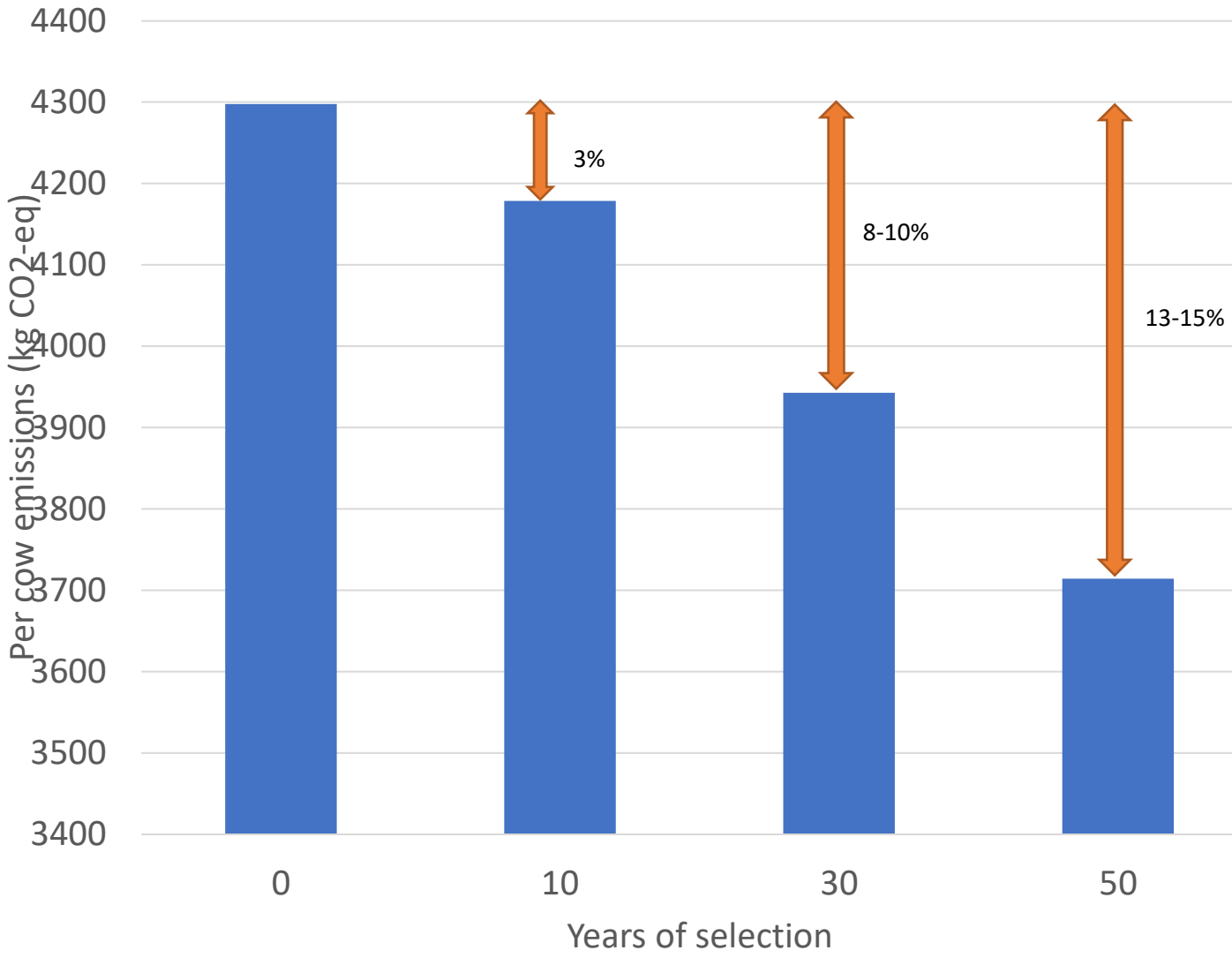
Heat tolerant cows keep cooler core body temperatures



Milk + Welfare + Env't = Profit

Driving down emissions with genetics

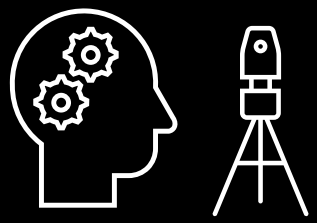
- Current emissions intensity 12.7 kg CO_2-eq/kg protein-eq
- By 2050:
  - Reduce gross emissions by 8-10%
  - Reduce emissions intensity by >20%
    (2.7 kg reduction of CO2-eq/kg protein)
- R&D required for 30-50 year targets



J. Dairy Sci. 105
https://doi.org/10.3168/jds.2021-21277

Reducing greenhouse gas emissions through genetic selection in the Australian dairy industry

C. M. Richardson,[1,2] P. R. Amer,[3] C. Quinton,[3] J. Crowley,[3] F. S. Hely,[3] I. van den Berg,[1] and J. E. Pryce[1,2]*
[1]Agriculture Victoria Research, AgriBio, Centre for AgriBioscience, Bundoora, Victoria 3083, Australia
[2]School of Applied Systems Biology, La Trobe University, Bundoora, Victoria 3083, Australia
[3]AbacusBio Limited, P.O. Box 5585, Dunedin, New Zealand



Consumer focus

www.nature.com/scientificreports

SCIENTIFIC REPORTS

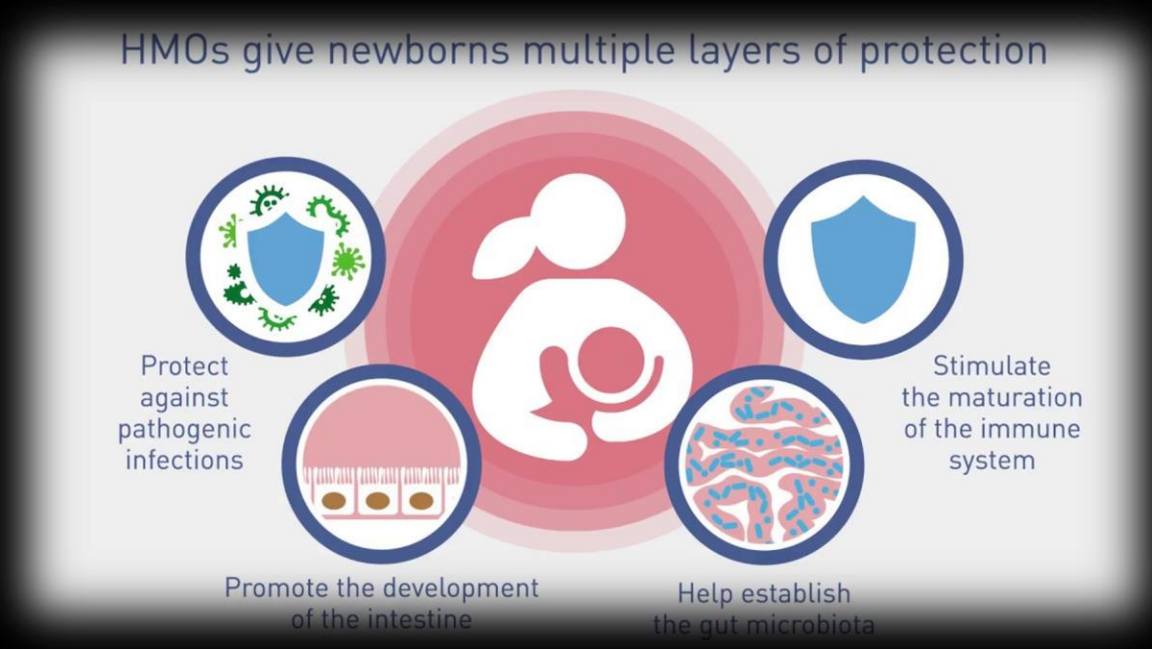
OPEN

Fine-mapping sequence mutations with a major effect on oligosaccharide content in bovine milk

Received: 23 July 2018
Accepted: 20 December 2018
Published online: 14 February 2019

Zhiqian Liu[1], Tingting Wang[1], Jennie E. Pryce[1,2], Iona M. MacLeod[1], Ben J. Hayes[1,3], Amanda J. Chamberlain[1], Christy Vander Jagt[1], Coralie M. Reich[1], Brett A. Mason[1], Simone Rochfort[1,2] & Benjamin G. Cocks[1,2]

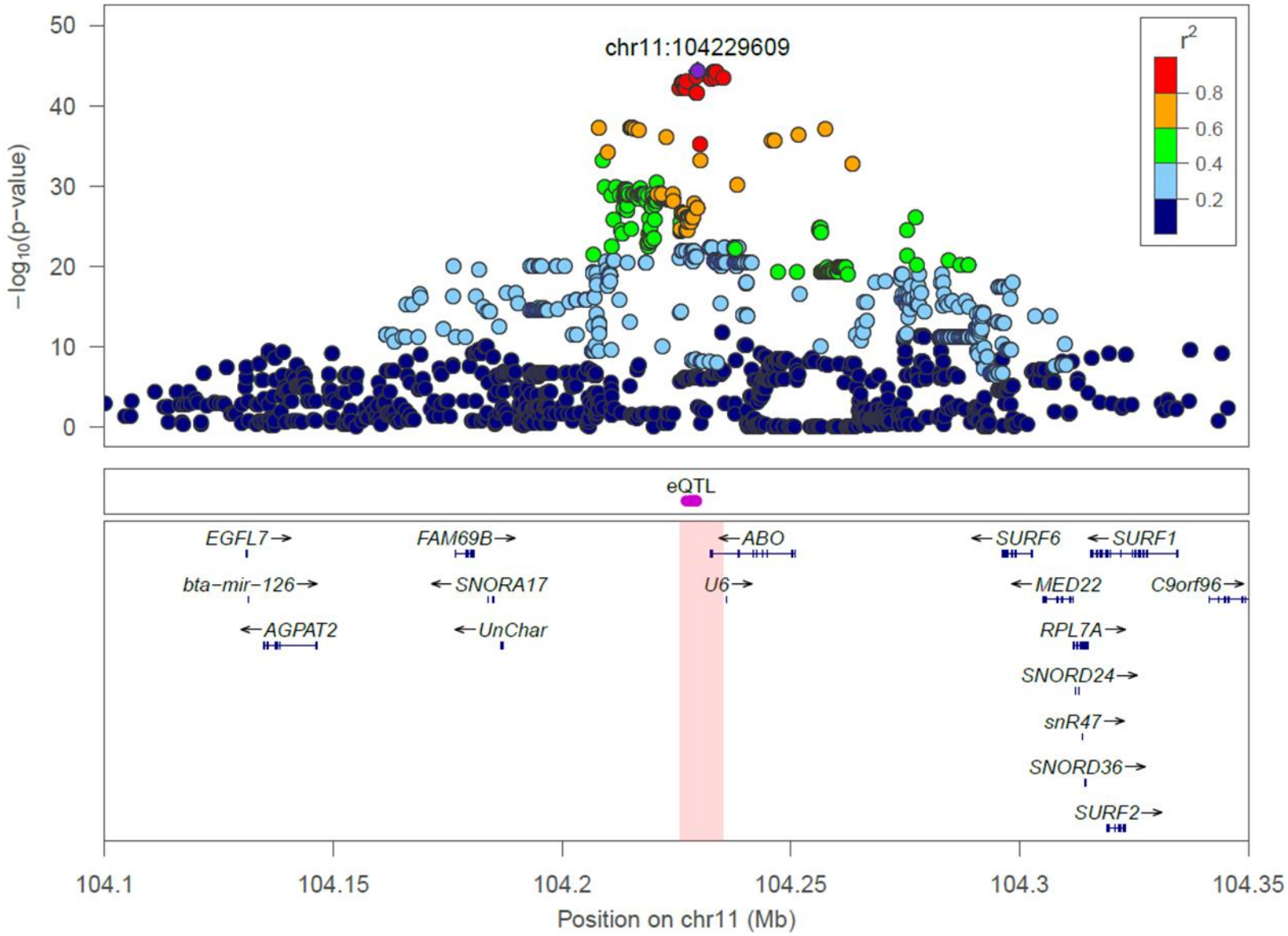
Human milk contains abundant oligosaccharides (OS) which are believed to have strong health benefits for neonates. OS are a minor component of bovine milk and little is known about how the production of OS is regulated in the bovine mammary gland. We have measured the abundance of 12 major OS in milk of 360 cows, which had high density SNP marker genotypes. Most of the OS were found to be highly heritable (h^2 between 50 and 84%). A genome-wide association study allowed us to fine-map

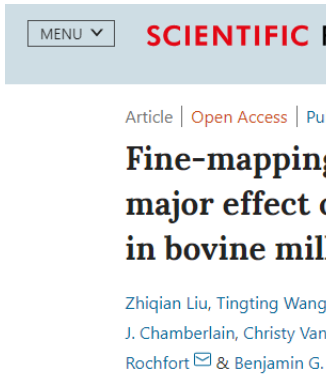


Oligosaccharides in cow's milk

- 330 Holstein cows
- 10 oligosaccharides
- Sequence genotypes

~80% of genetic variance




MENU SCIENTIFIC

Article | Open Access | Pu

Fine-mappin
major effect
in bovine mil

Zhiqian Liu, Tingting Wang
J. Chamberlain, Christy Van
Rochfort & Benjamin G.

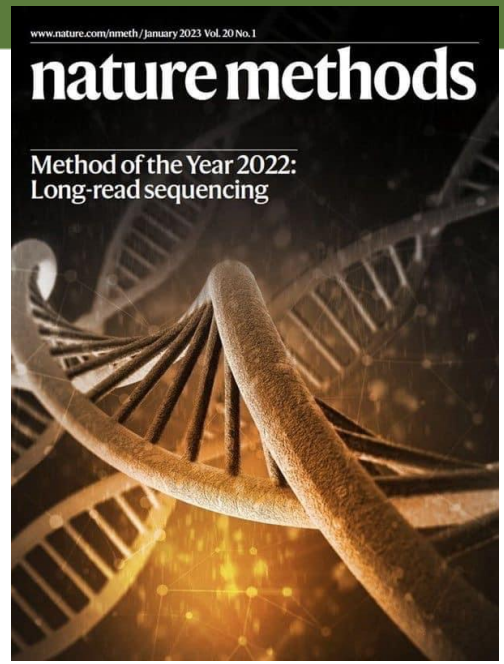
Reference Genotypes
Importation
Amputation
Imputation , etc

Target Genotypes
i_p_t_t_ _n
etc

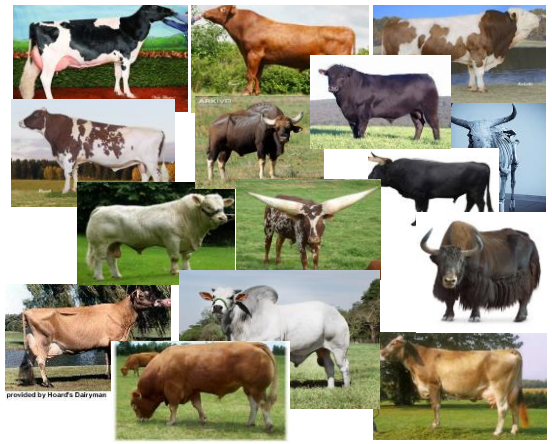
Imputed Genotypes
imputation

Short read

Long read



1000 Bull Genomes Project

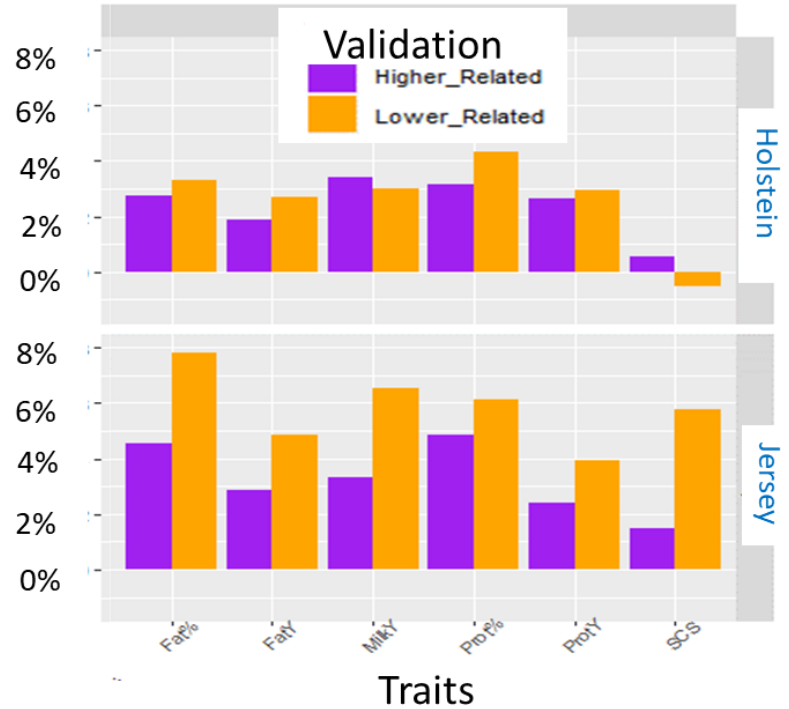


Short-read = "1000 Bull Genomes Project" (6,190)

OPEN ACCESS Freely available online PLOS | GENETICS

A 660-Kb Deletion with Antagonistic Effects on Fertility and Milk Production Segregates at High Frequency in Nordic Red Cattle: Additional Evidence for the Common Occurrence of Balancing Selection in Livestock

Naveen Kumar Kadri[1], Goutam Sahana[1]*, Carole Charlier[2], Terhi Iso-Touru[3], Bernt Guldbrandtsen[1], Latifa Karim[2], Ulrik Sander Nielsen[4], Frank Panitz[5], Gert Pedersen Aamand[6], Nina Schulman[3], Michel Georges[2], Johanna Vilkki[3], Mogens Sandø Lund[1], Tom Druet[2]*



Genetics Selection Evolution

Home About Articles Submission Guidelines

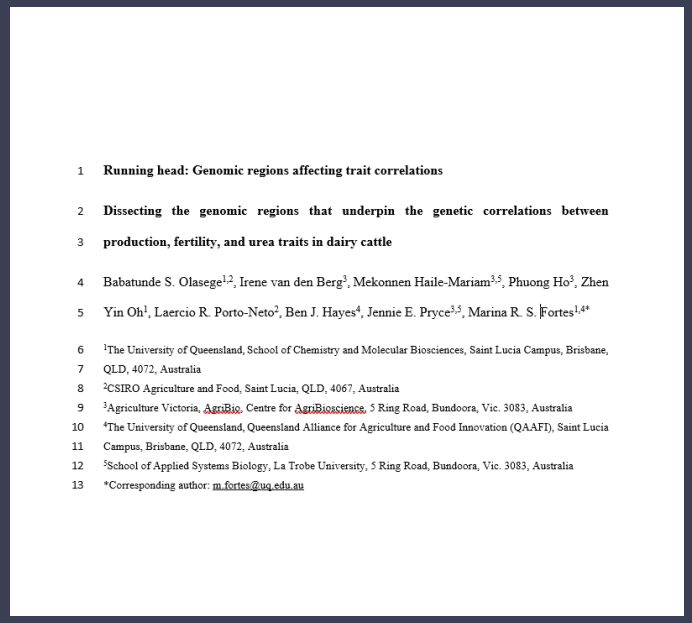
Research Article | Open Access | Published: 26 May 2022

Genetic variants associated with two major bovine milk fatty acids offer opportunities to breed for altered milk fat composition

Tim Martin Knutsen, Hanne Gro Olsen, Isaya Appelesy Ketto, Kristil Kindem Sundsaasen, Achim Kohler, Valeria Tafintseva, Morten Svendsen, Matthew Peter Kent & Sigbjørn Lien

Genetics Selection Evolution **54**, Article number: 35 (2022) | Cite this article

1712 Accesses | Metrics



Running head: Genomic regions affecting trait correlations

Dissecting the genomic regions that underpin the genetic correlations between production, fertility, and urea traits in dairy cattle

Babatunde S. Olasege[1,2], Irene van den Berg[3], Mekonnen Haile-Mariam[3,5], Phuong Ho[3], Zhen Yin Oh[1], Laercio R. Porto-Neto[2], Ben J. Hayes[4], Jennie E. Pryce[3,5], Marina R. S. Fortes[1,4*]

[1]The University of Queensland, School of Chemistry and Molecular Biosciences, Saint Lucia Campus, Brisbane, QLD, 4072, Australia
[2]CSIRO Agriculture and Food, Saint Lucia, QLD, 4067, Australia
[3]Agriculture Victoria, AgriBio, Centre for AgriBioscience, 5 Ring Road, Bundoora, Vic. 3083, Australia
[4]The University of Queensland, Queensland Alliance for Agriculture and Food Innovation (QAAFI), Saint Lucia Campus, Brisbane, QLD, 4072, Australia
[5]School of Applied Systems Biology, La Trobe University, 5 Ring Road, Bundoora, Vic. 3083, Australia
*Corresponding author: m.fortes@uq.edu.au

Fine mapping QTL associated with fertility in dairy cattle using gene expression

I. Van Den Berg[1], A.J. Chamberlain[1,2], I.M. MacLeod[1], T.V. Nguyen[1], M.E. Goddard[1,3], R. Xiang[1,3], B. Mason[1], S. Meier[4], C. Phyn[4], C. Burke[4], J.E. Pryce[1,2]

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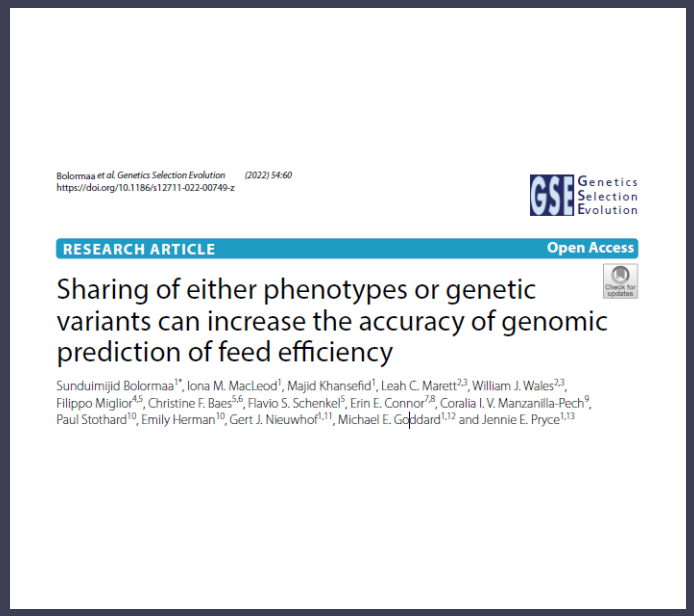

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Genetics Selection Evolution

RESEARCH ARTICLE Open Access

Sharing of either phenotypes or genetic variants can increase the accuracy of genomic prediction of feed efficiency

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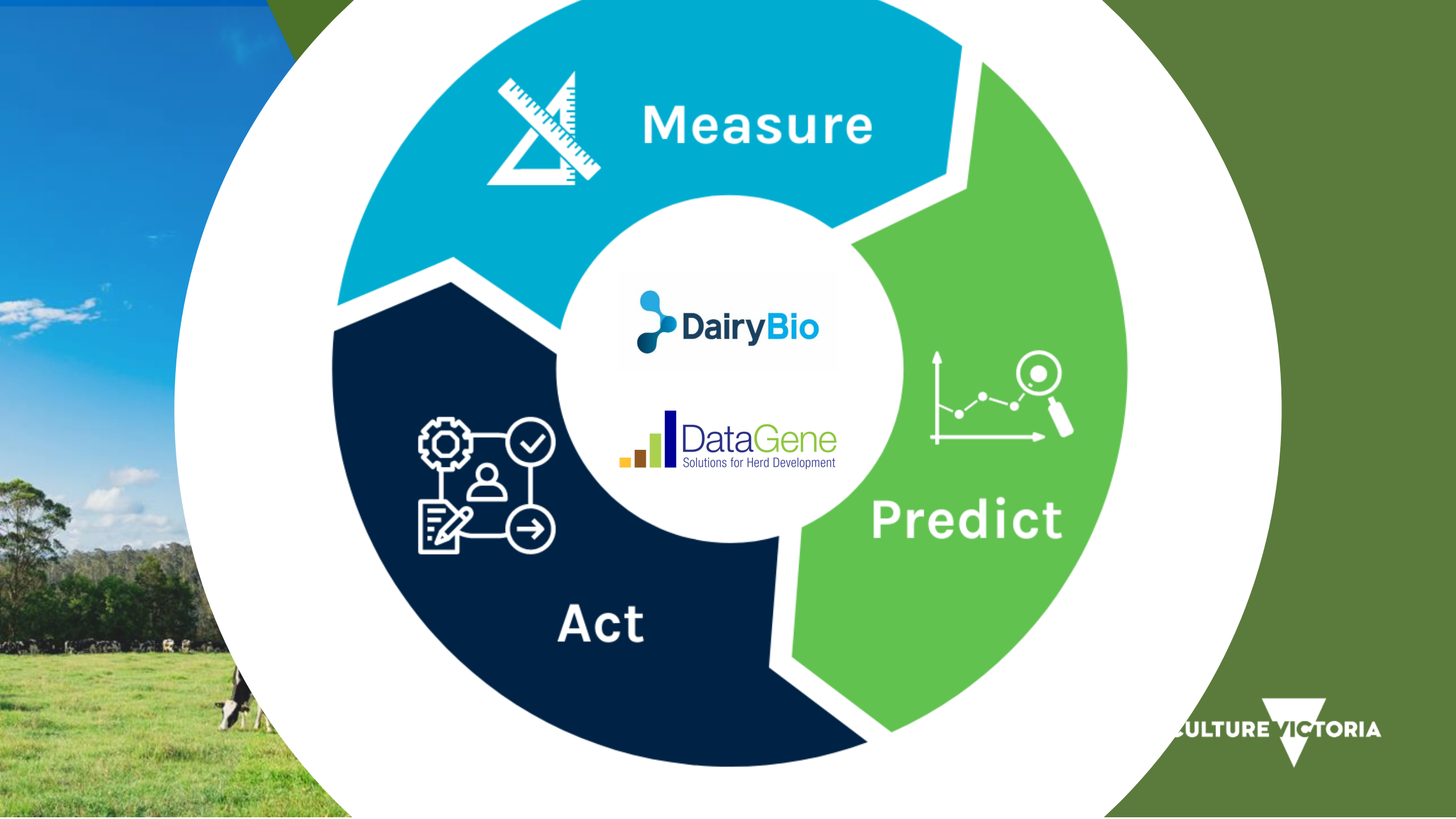
Using “gene level” knowledge


Measure
Predict
Act
DairyBio
DataGene
Solutions for Herd Development

Australia’s breeding indices

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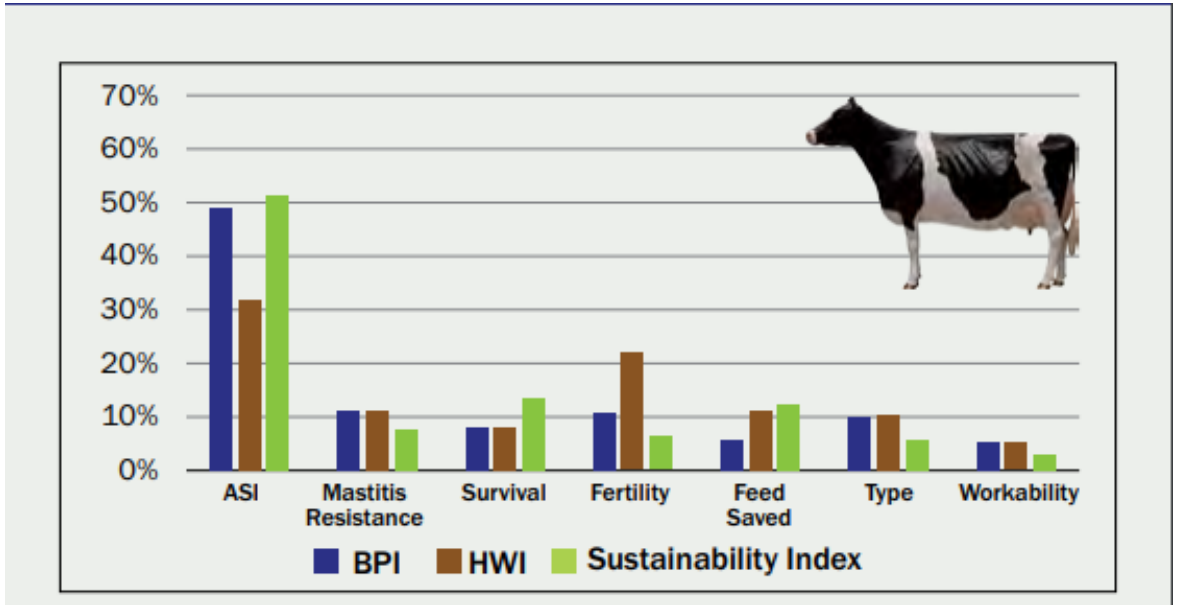
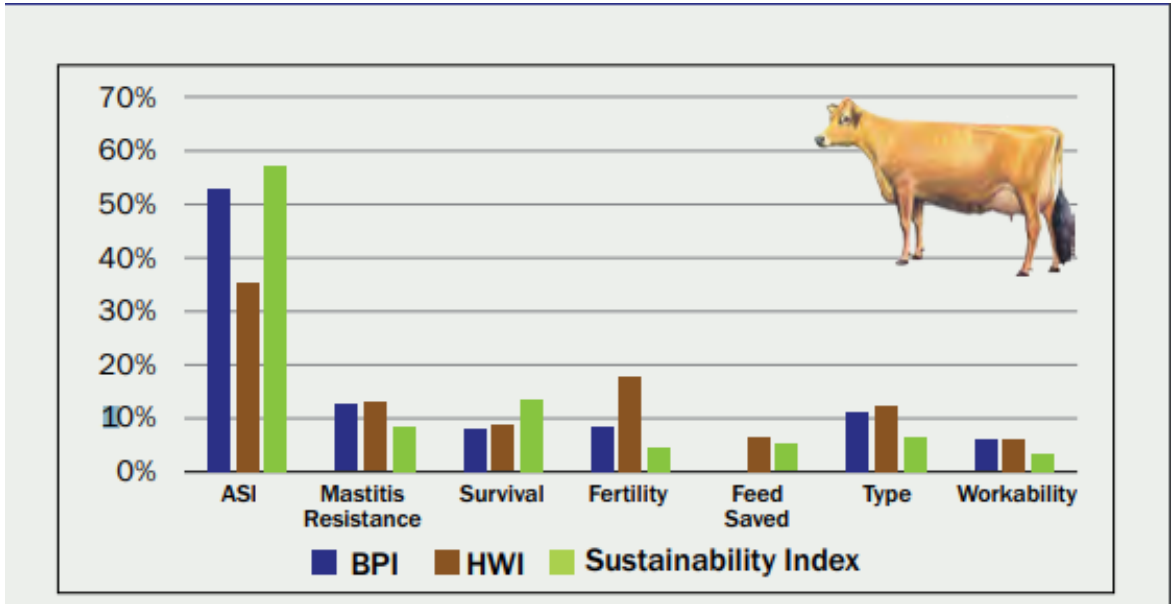
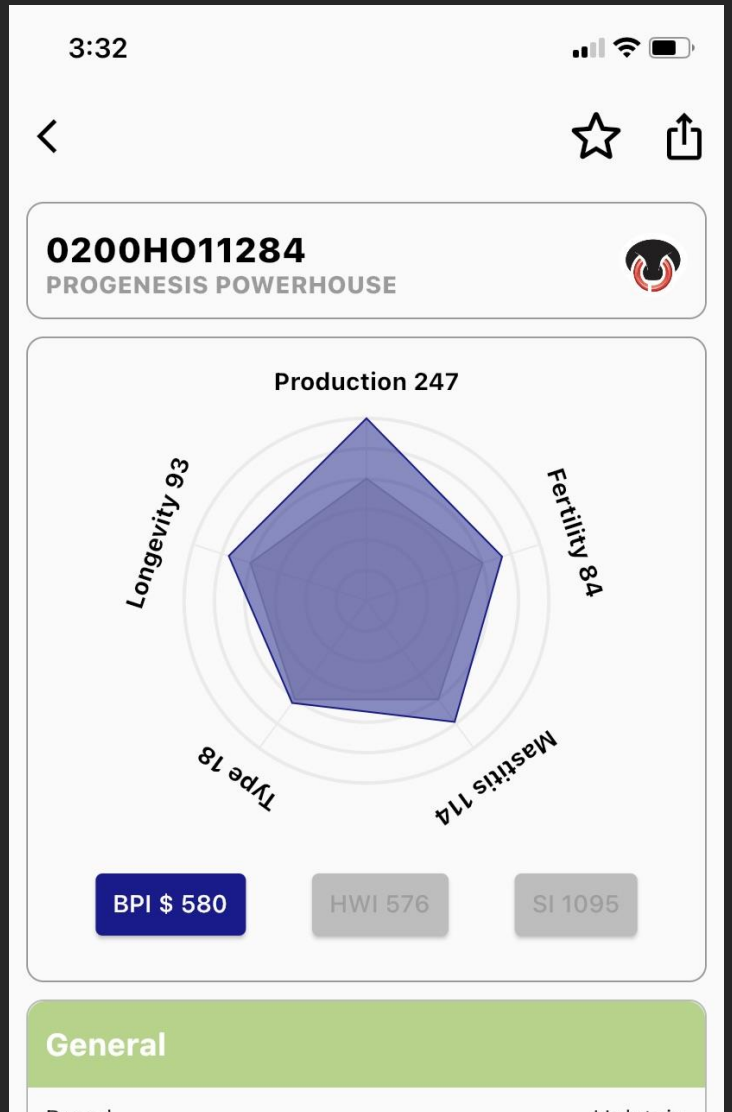




DataGene
Solutions for Herd Development

Balanced Performance Index (BPI)	Health Weighted Index (HWI)	Sustainability Index (SI)
$	Index units	Index units
Eg. BPI of 300 On average this animal returns $300/year more income over feed/herd costs. The average is 0.	**Eg. HWI of 280** This animal is 280 units greater for the desired objective than average. The Average is 0.	**Eg. Sustainability Index of 250** This animal is 250 units more efficient for emissions intensity than average. The average is 0.

A selection index simplifies selection



DataGene
Solutions for Herd Development

Good Bulls

Your breeding strategy

- Use the Good Bulls to pick your bulls
- Start with an Australian index
- Make secondary decisions if you wish:
  - What traits are important to you?
  - What traits are important to your customers?
- What traits do we need to breed for the future?

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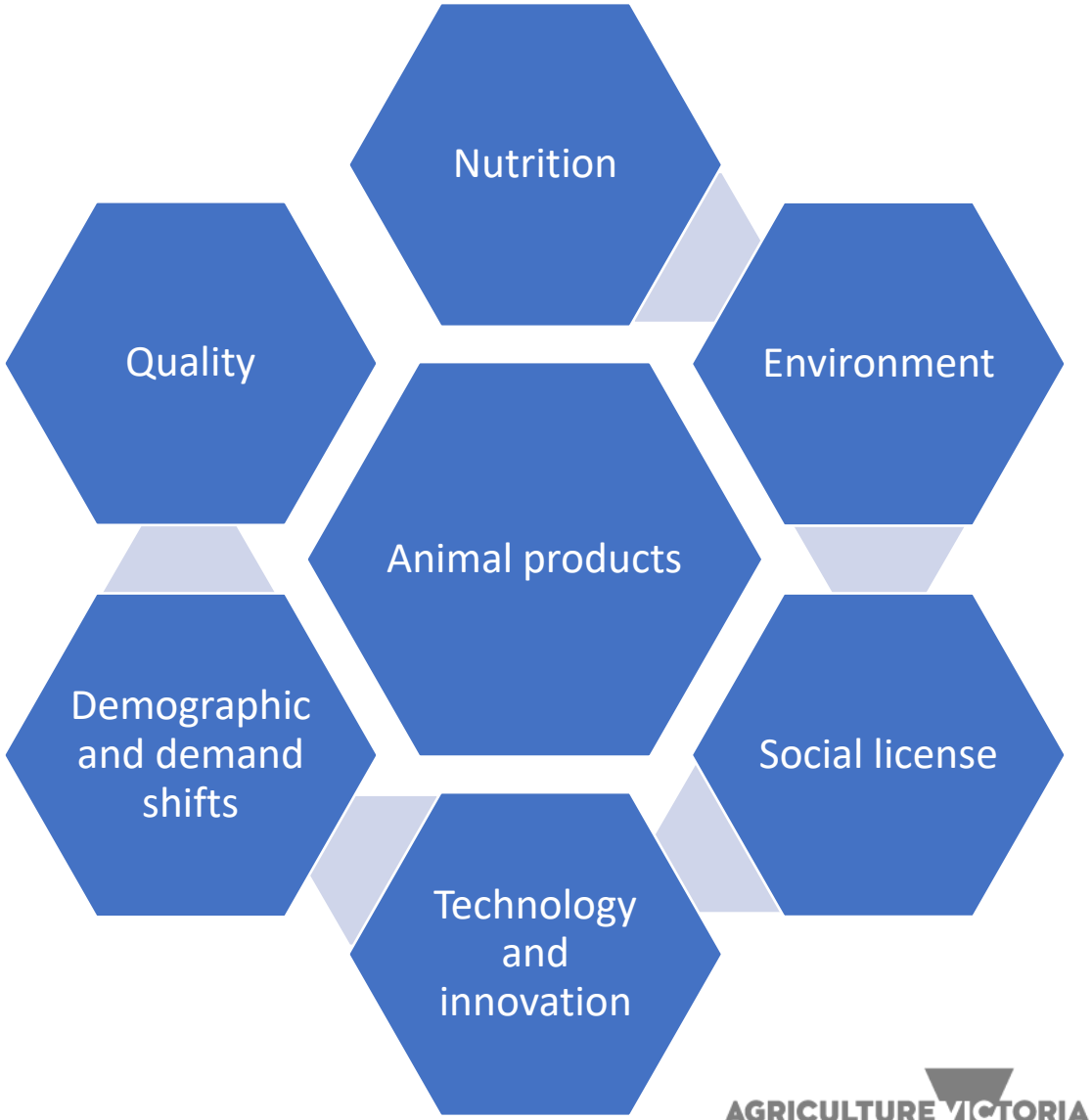
coles
Dairy Farmers

To answer, please scan the QR code on the screen or on your table

Future breeding focus

- **Importance** - agriculture around 4% of global GDP
- **Sustainability** –demand for quality food
- **Animal products** - societal issues (environment, welfare)
- **Global warming** – pro-active and re-active



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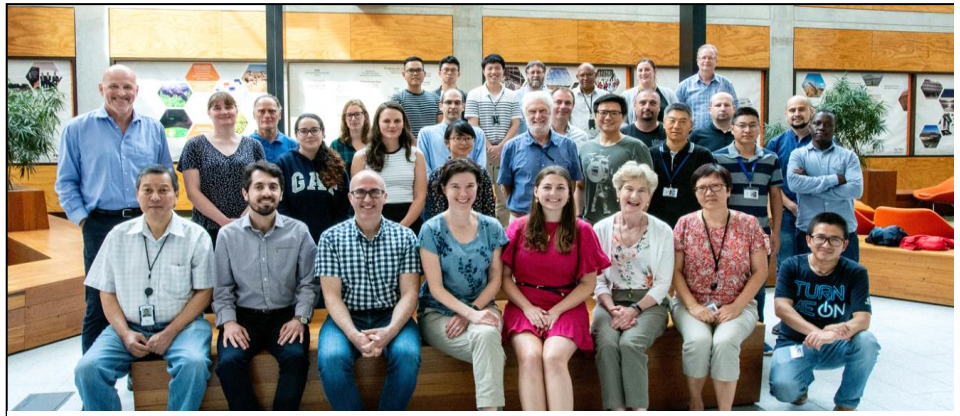
Thank you and any questions?

Agriculture Victoria staff (Ellinbank)



Agriculture Victoria staff (Agribio)

Ginfo farmers

"Ginfo is a great tool for the entire dairy industry by providing the latest genetic information and adding to genetic reliability. At an individual farm level, Ginfo means you have genetic accuracy because of genomic testing, and the ability to make informed selection decisions because of the access to early genomics on young heifers. There are a lot of really good farmers are involved in the Ginfo project so it also gives participants access a great network of progressive famers."
– Sam McCluggage Allansford, Victoria, milking 700 Holsteins.

"My herd is now a better, stronger and a lot more consistent herd today than it would have been were it not for the Ginfo project and the sum of these gains across all herds strengthens our whole industry…. Contributing my data to help validate the science and technology was not any inconvenience as we were already had good systems of recordkeeping of herd events and were herd testing monthly. Ginfo is about speeding up herd improvement and this has been a win-win; I would thoroughly recommend it."
– Ruth McGregor, Busselton, WA, milking 320 Holsteins.

"Ginfo has benefits for the broader dairy industry as well as the individual farm so I can't understand why more people aren't involved. The more information you have, the better armed you are to make the right decisions. Ginfo helps us identify which heifers to keep and rear and which ones to sell and then join the best cows to better bulls."
– Bev Carpenter, South Riana, milking more than 900 Holsteins across two herds.

"Anthea and I believe in the importance of an Australian Herd Improvement Industry and that genetic growth creates profit, so it is easy to be involved with something as important as Ginfo. One of the big advantages for us comes in the form of subsidized genome testing of our young stock. We genome test all our calves and use this information to help build our business strategy."
– Trevor Saunders and Anthea Day, Shady Creek, Gippsland, milking 750 predominantly Jersey.