The role of genetics in creating a sustainable future

Jennie Pryce (AVR, LTU, ICAR),
Caeli Richardson (AbacusBio/ICAR),

AGRICULTURE VICTORIA

THE HOUSE OF wellness

The House of Wellness TV: Season 7, Episode 1

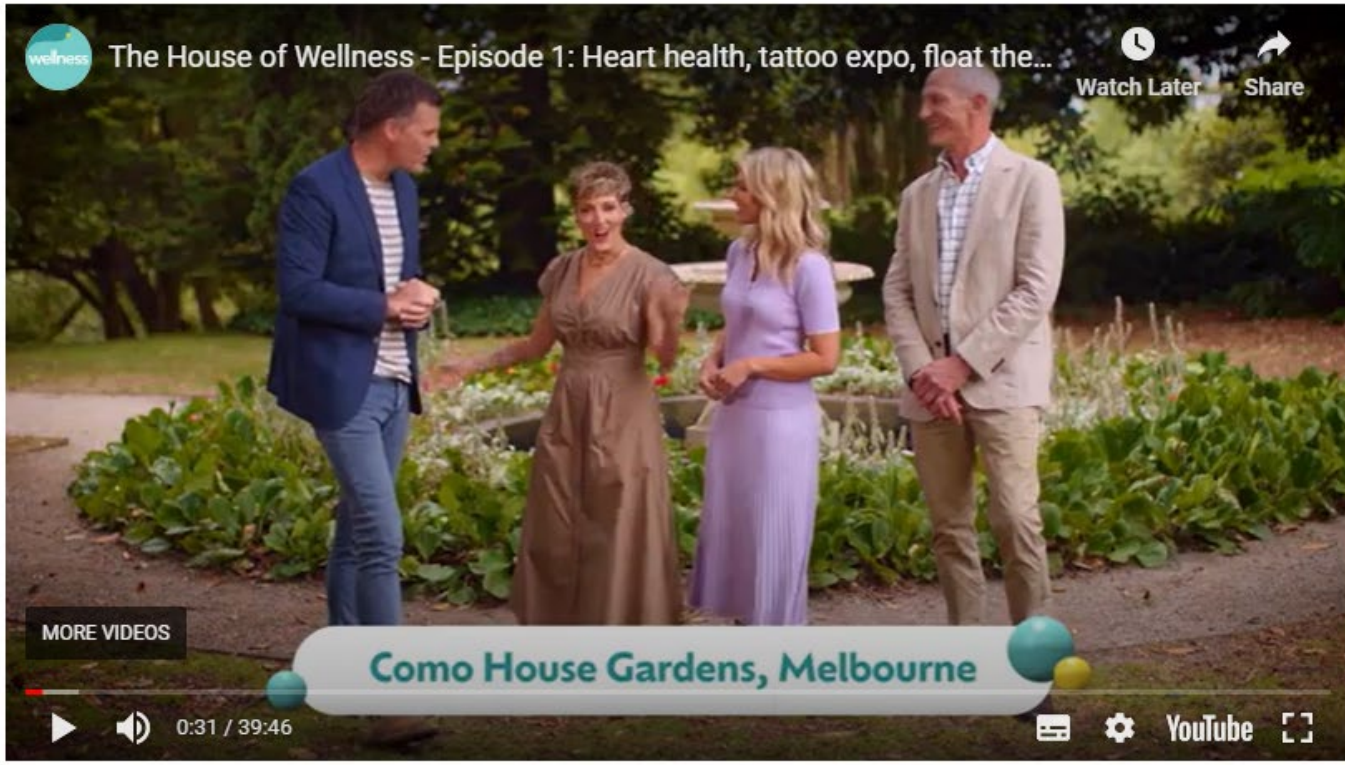
17 February, 2023

The pandemic made us kinder

A new malaria vaccine

What the colour of an emoji means

17 February, 2023



The House of Wellness TV show is back for 2023! This week, the team looks at heart health, the healing power of tattoos, float therapy and more. Watch the full episode.

The House of Wellness – Season 7, Episode 1

This week on The House of Wellness, we're looking at all things heart, from the best exercises to keep your ticker strong to broken heart syndrome and the meanings behind different coloured heart emojis.

Also this week:

- Meet the scientists are working towards breeding environmentally friendly cows.
- Jo Stanley uncovers the power and impact of tattoos with some of Australia's most skilled tattooists.
- Discover ways to relax the mind and body through float therapy with personal trainer Luke Hines.

Strategies to lower emissions intensity and gross emissions in ruminants

- Managing herd life and replacements bred
- Nutrition (e.g. lipids, concentrates) and inhibitors (e.g. 3-NOP)
- Vaccines and early life programming
- Feed efficiency
- Fertiliser optimisation
- On-farm energy savings
- Selecting for low CH4 production directly
- Breeding for higher producing cows (reducing emissions per kg product)

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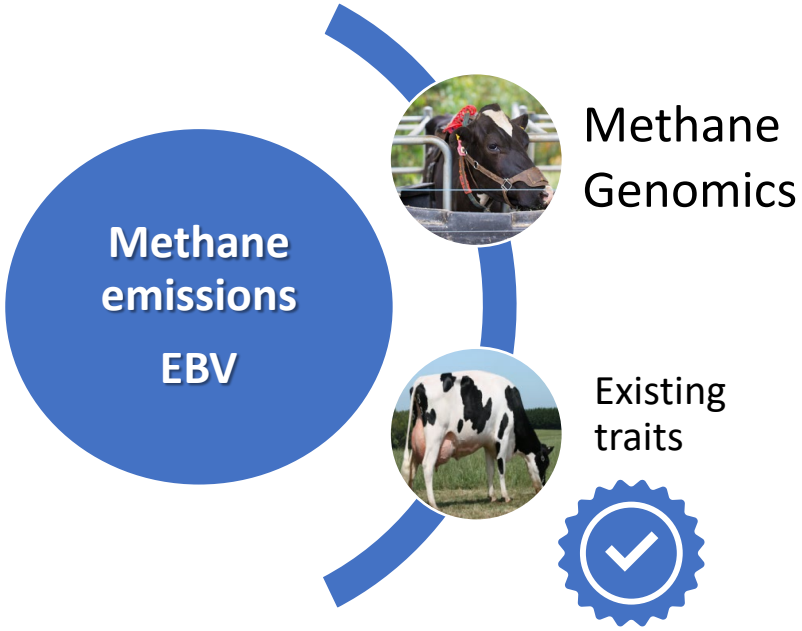
The Sustainability Index is the first step!



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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

Thuy Nguyen's talk shortly…….

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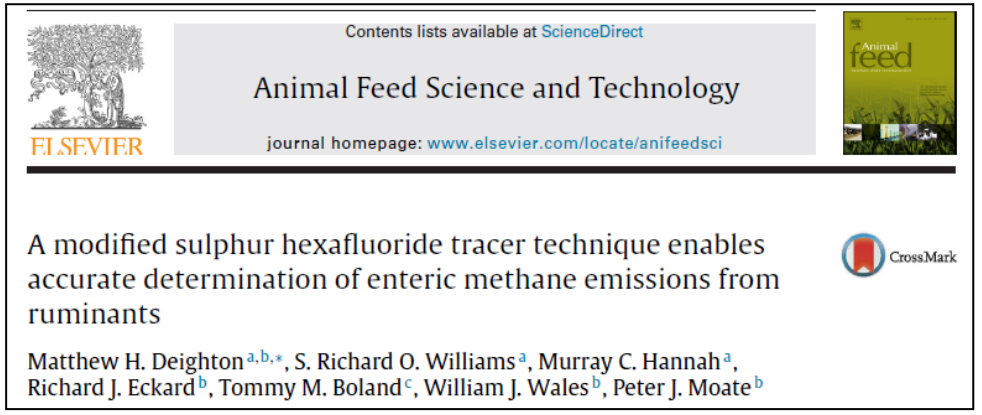
Measuring methane at pasture

- Feed intake, milk yield
- >500 cows with CH_4 emissions measured
- Ruminal fluid, faecal, milk, blood sampling for microbiome



Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

ELSEVIER

A modified sulphur hexafluoride tracer technique enables accurate determination of enteric methane emissions from ruminants

Matthew H. Deighton[a,b,*], S. Richard O. Williams[a], Murray C. Hannah[a], Richard J. Eckard[b], Tommy M. Boland[c], William J. Wales[b], Peter J. Moate[b]

Source: Ellinbank

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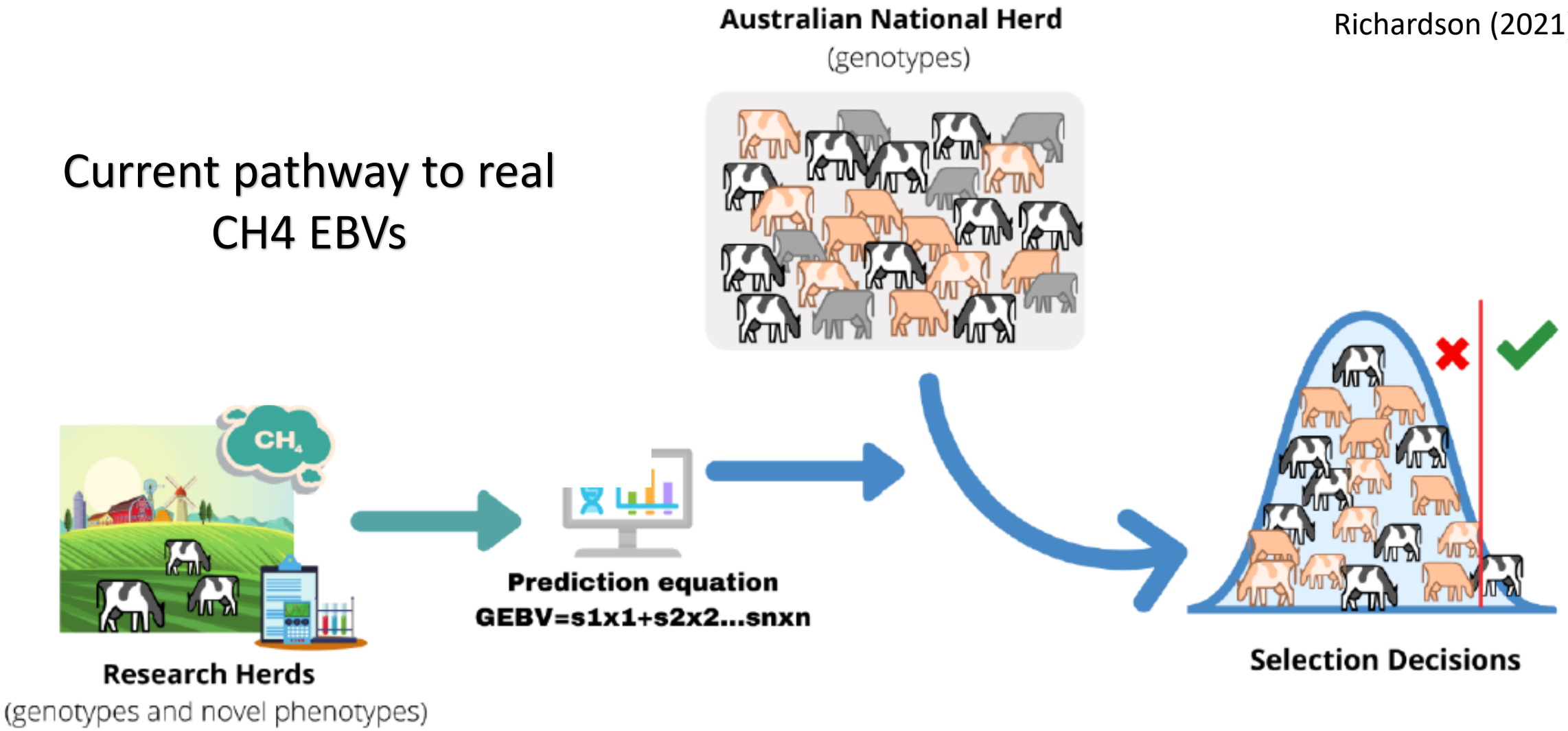
Current pathway to real CH4 EBVs

Richardson (2021)



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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

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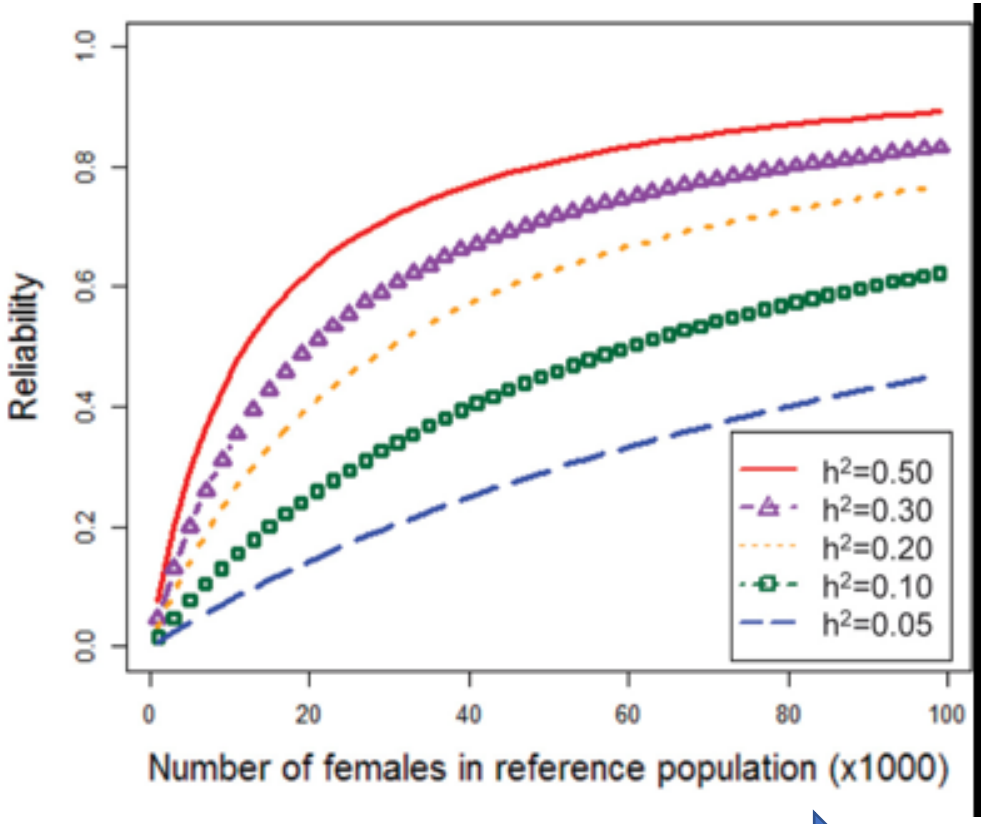
More data!



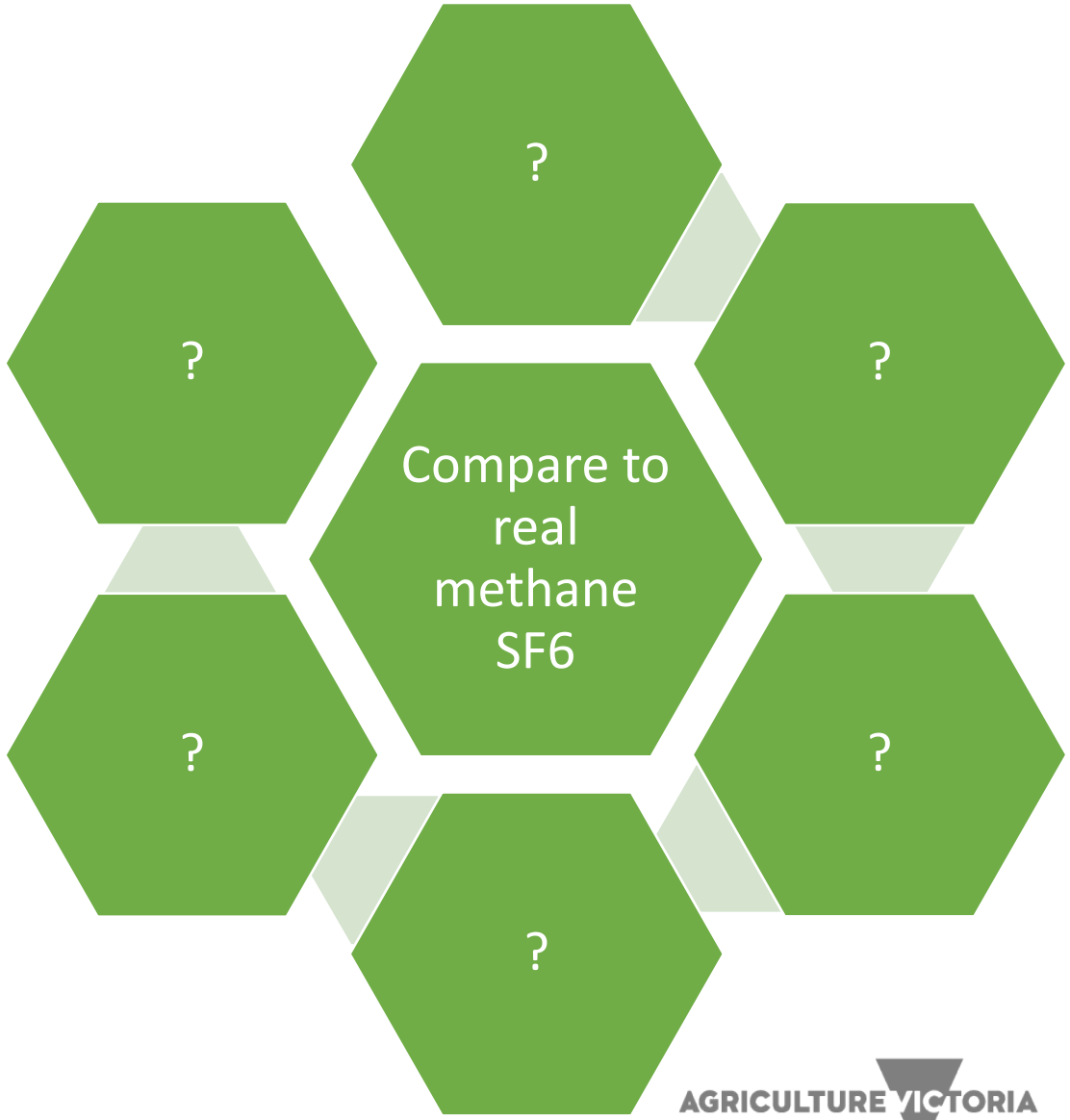
Shared ref popns, MIR, sensors

ELSEVIER

Journal of Dairy Science

Volume 97, Issue 12, December 2014, Pages 7905-7915

On the value of the phenotypes in the genomic era



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Ellinbank testing happening now

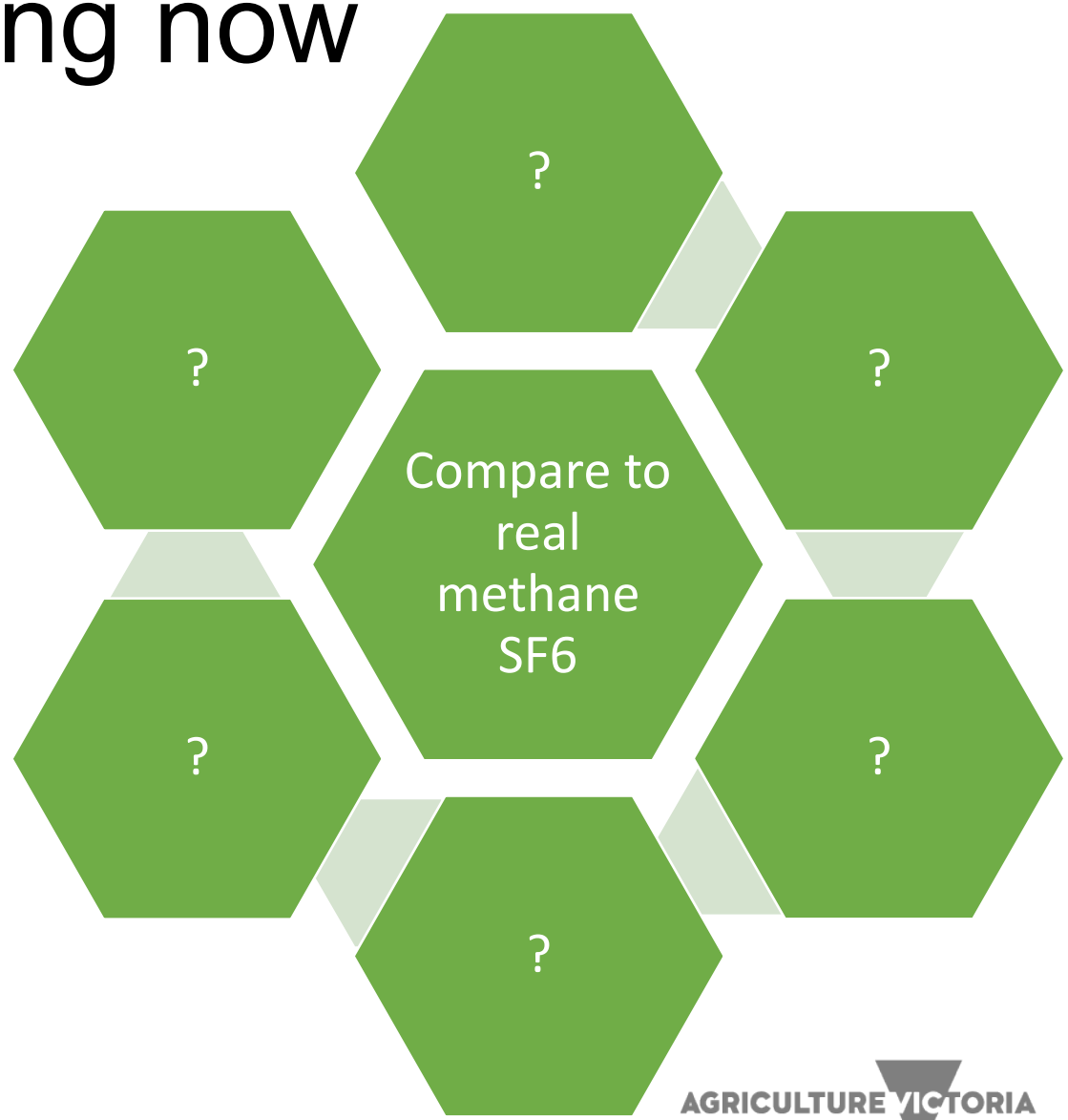
Animal (202
doi:10.1017/

Review: Sensor techniques in ruminants: more than fitness trackers

C. H. Knight†

University of Copenhagen, Dyrlægevej 100, Frederiksberg C, DK1870 København, Denmark

(Received 26 September 2019; Accepted 21 November 2019)



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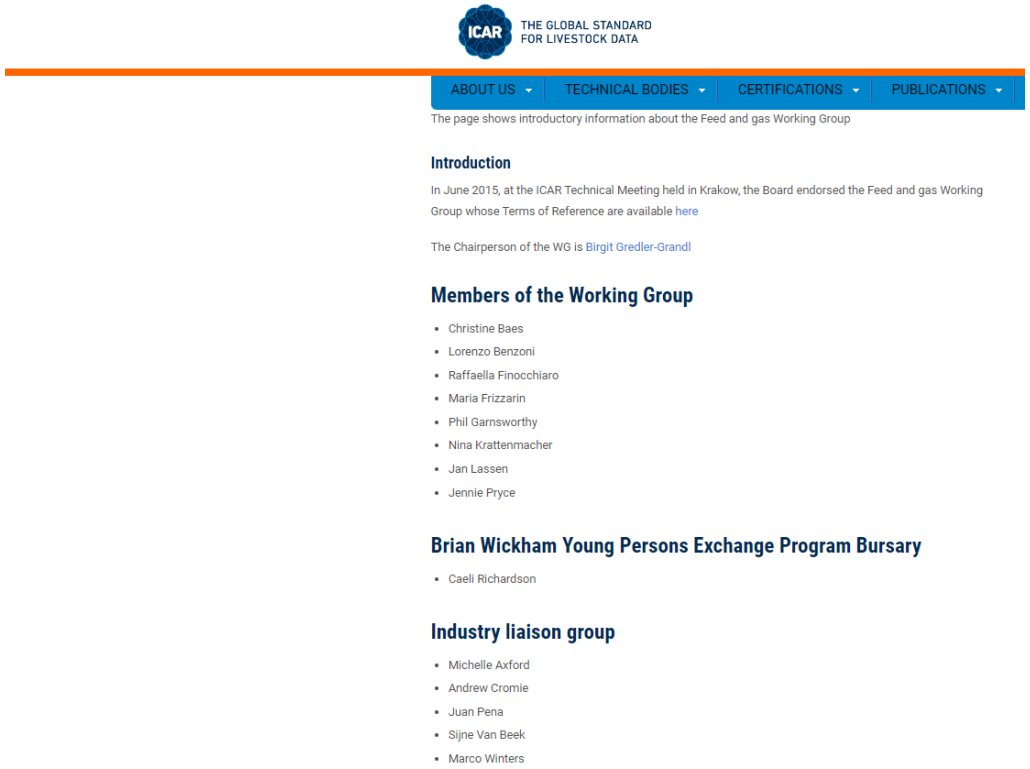
Working together….

- ICAR Working group - Feed and Gas
  - Focus on measuring CH4
  - How can we work together to get the best outcome
  - Open conversations essential!



THE Resilient Dairy GENOME PROJECT

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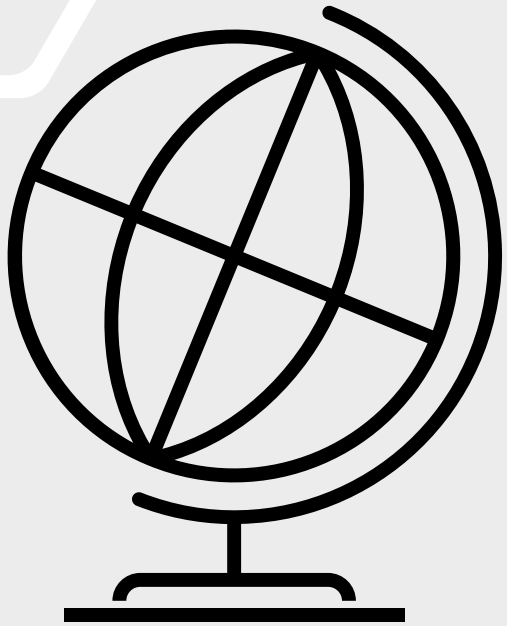
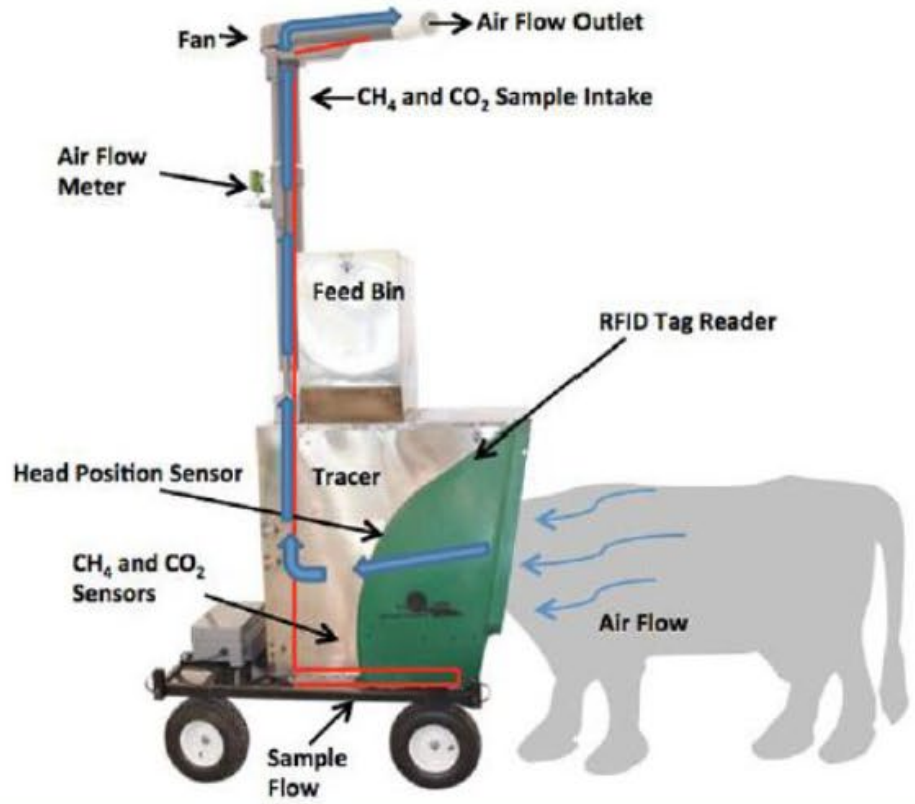
ICAR members – methane phenotyping

- New Zealand
- Canada
- Italy
- Netherlands



Greenfeed for methane measurement



NEW ZEALAND
AGRICULTURAL GREENHOUSE GAS
Research Centre

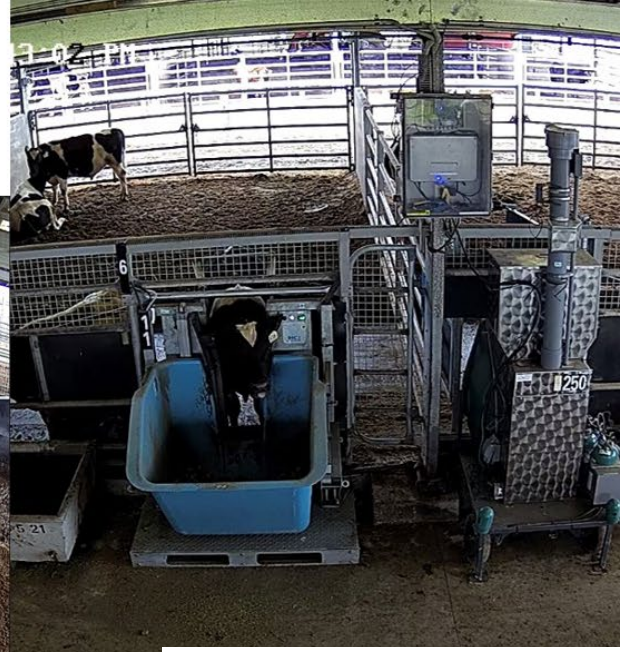
Breeding low methane bulls

Leading Partners in Science

agresearch DairyNZ Manaaki Whenua Landcare Research Lincoln University MASSEY UNIVERSITY NIWA PGgRc Plant & Food Research SCION

Lorna McNaughton LIC

Pen layout



Pen 2 - Back (8)
NEW ZEALAND AGRICULTURAL GREENHOUSE GAS Research Centre
Leading Partners in Science
agresearch DairyNZ Manaaki Whenua Landcare Research Lincoln University MASSEY UNIVERSITY
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Trial Design

0 ⟷ 7 d ⟷ 35 days

Training → Measurement

Rumen sampling

Bulls 6-15 months of age
3 x weekly liveweight measurements

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Leading Partners in Science
agresearch DairyNZ Manaaki Whenua Landcare Research Lincoln University MASSEY UNIVERSITY NIWA PGgRc Plant & Food Research SCION
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Lorna McNaughton LIC

UNIVERSITY of GUELPH

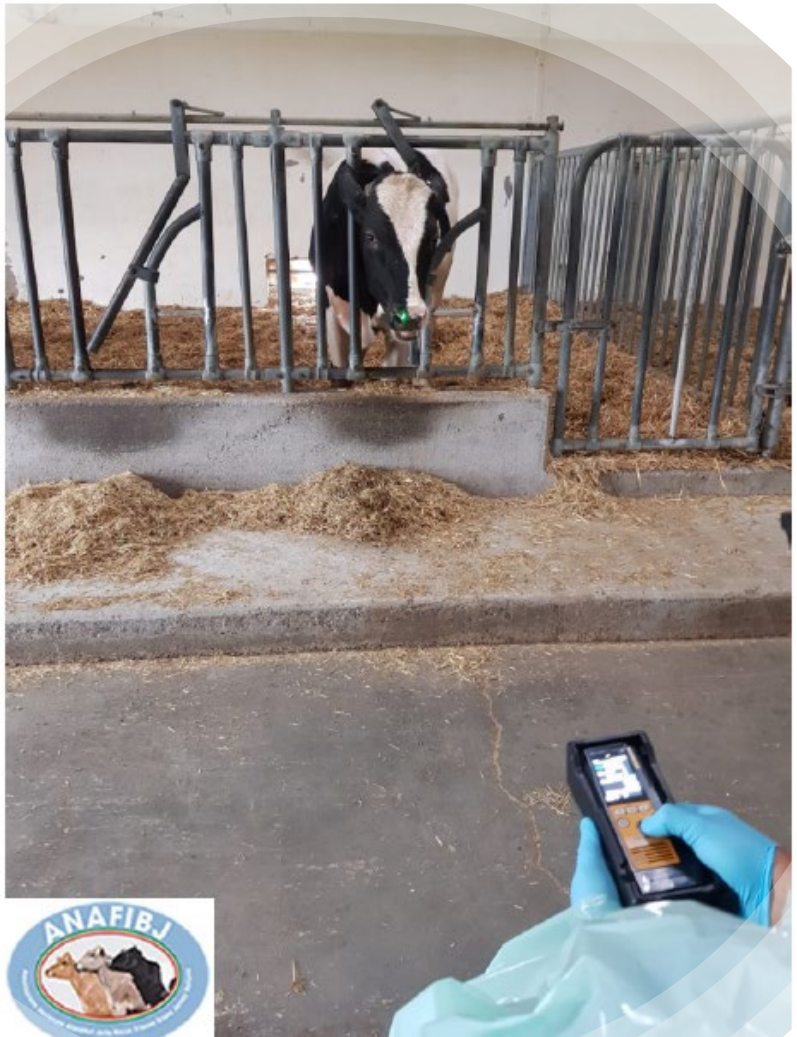
THE Resilient Dairy GENOME PROJECT

ENVIRONMENTAL SUSTAINABILITY EXPERIENCE AT ANAFIBJ GENETIC CENTER

Raffaella Finocchiaro
raffaellafinocchiaro@anafi.it
Lorenzo Benzoni
lorenzobenzoni@anafi

GREENFEED UNIT

...BER METHANE E...



Italy – ANAFIBJ

Italian Holstein, Brown and Jersey Breeders Association (ANAFIBJ)

Lorenzo Benzoni and Raffaella Finocchiaro

Feed efficiency

Research Farm Dairy Campus, NL

- Recording of individual feed intake in research and commercial farms
- RIC feed bins
- Several thousand cows in reference population for genomic evaluation for dry matter intake
- Cooperation between WUR and CRV

Measuring Methane emission

- **Climate Smart Cattle Breeding**
  - Goal is to have breeding values available for selection
  - Recording methane on 100 farms with methane sensors (sniffers)
  - ~ 15,000 phenotyped by end of 2023
  - Large-scale and long-term (2+ years) automated recording of CH

https://www.wur.nl/en/research-results/research-institutes/livestock-research/show-wlr/breeding-livestock-to-control-methane.htm

Contact:
roel.veerkamp@wur.nl
anouk.vanbreukelen@wur.nl
birgit.gredler-grandl@wur.nl

Sensors

Wearable sensors attached to halters

Methane sniffers for commercial farm settings

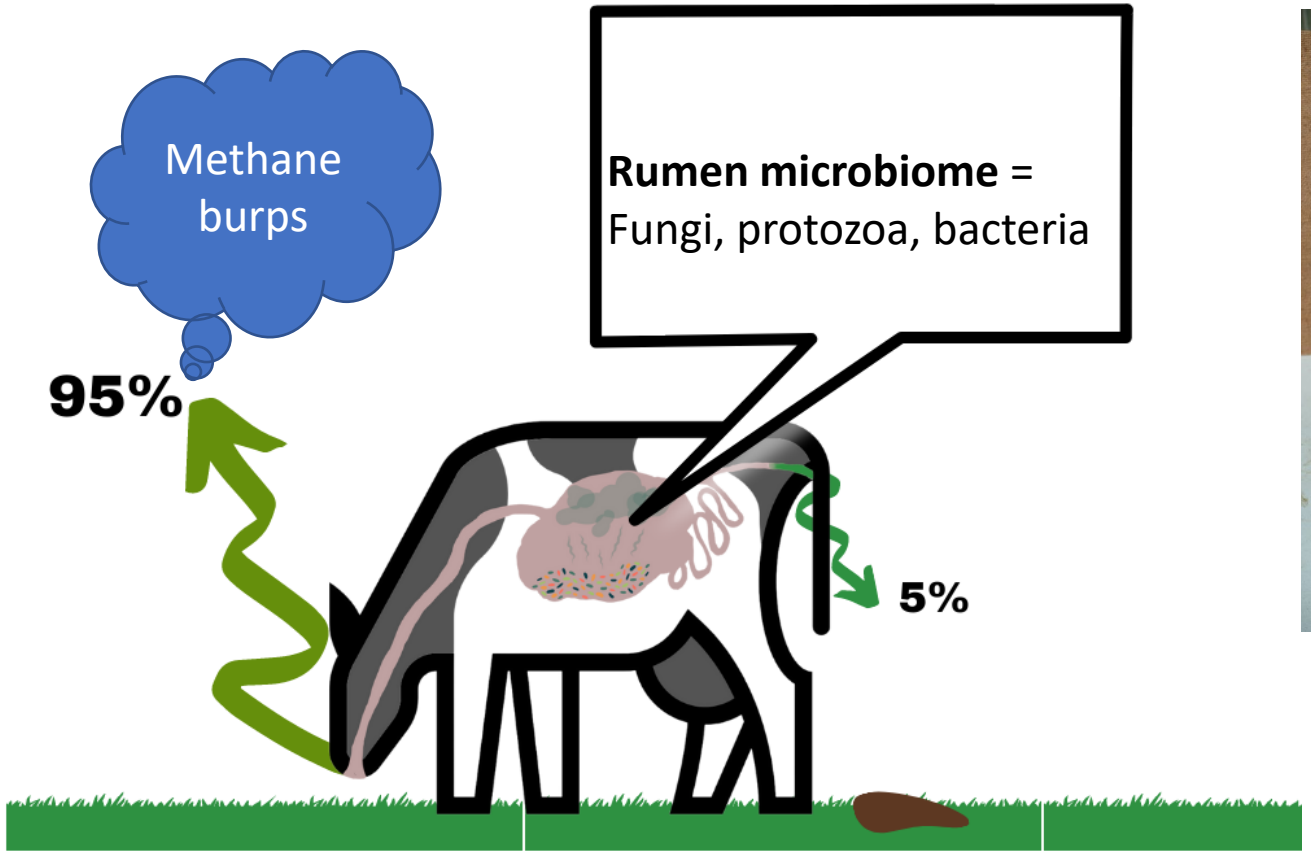
Photos: Aniruddh Desai, LTU

DairyBio

LA TROBE UNIVERSITY

All kinds of clever

Boris Sepulveda (AVR, LTU, DataGene)



A stomach tube is passed orally down the oesophagus into the reticulo-rumen. *Photos provided by L Marett.*

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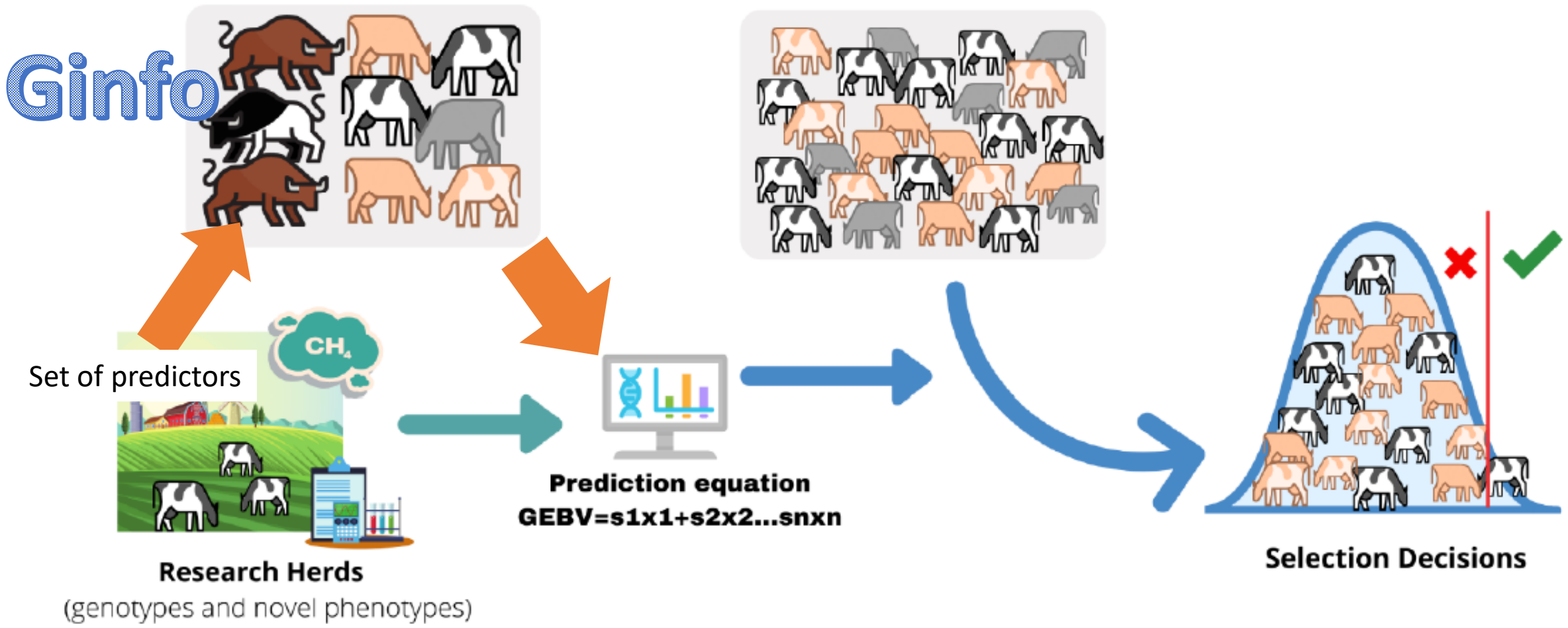
Taking the next step!

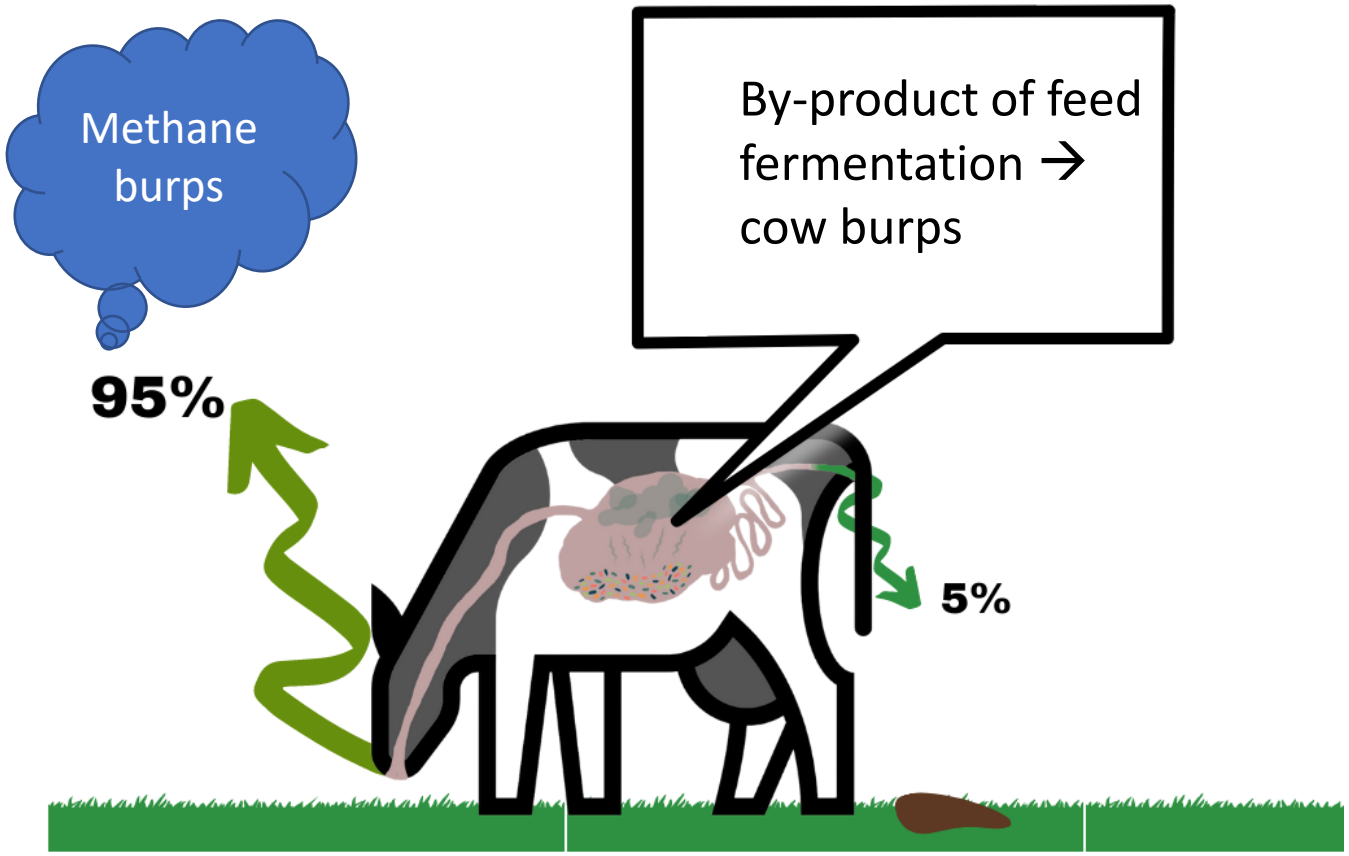
Richardson (2021)

New phenotypes and genotypes



Human activity contributing to global warming

- Meat and milk from ruminants provides important protein and nutrients for human consumption
- Human activity net temp increases of 1.1°C
- Livestock account for 6% of GHG
  - 1 cow emits ~100 kg methane/year
  - 3.5 billion ruminants worldwide



Caeli Richardson (2022)

ELSEVIER

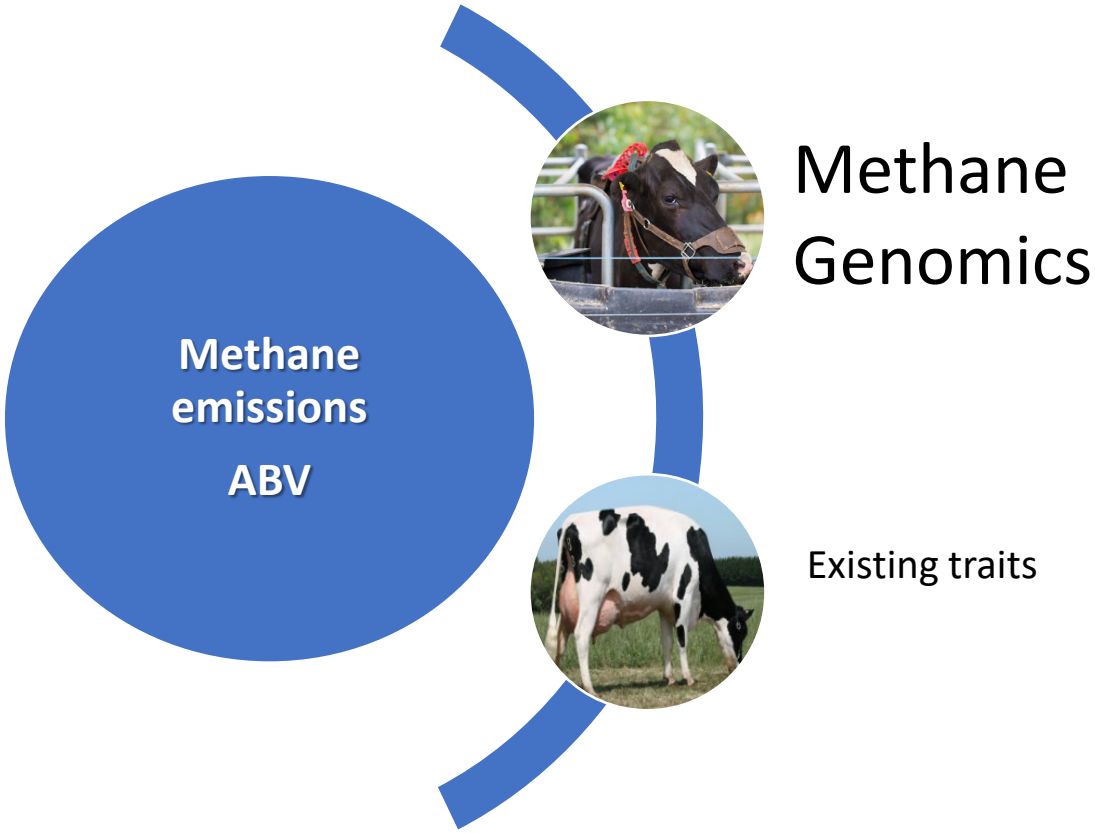
Animal

Volume 14, Supplement 1, 2020, Pages s2-s16

Review: Fifty years of research on rumen methanogenesis: lessons learned and future challenges for mitigation

K.A. Beauchemin [1] ✉, E.M. Ungerfeld [2], R.J. Eckard [3], M. Wang [4]

Genetics to reduce ruminant emissions



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Key points

- Sustainability index – reduces emissions intensity
- Mooving towards a future sustainability index with real “methane” data
- Data from Aussie farms imperative
- International effort and collaboration

“Anything that helps the environment is moosic to my ears!”

Dr Nick Carr, House of Wellness

“Anything that helps the environment is moosic to my ears!”

Dr Nick Carr, House of Wellness

With thanks

- Ellinbank – especially Peter Moate, Joe Jacobs and Leah Marrett (AVR)
- Ginfo farmers
- Caeli Richardson (AbacusBio)
- Aniruddh Desai (LTU)
- Boris Sepulveda (AVR, LTU)
- Birgit Gredler (WUR)
- Lorna McNaughton (LIC)
- Lorenzo Benzoni and Raffaella Finocchiaro (ANAFIBJ)
- Suzanne Rowe (AgResearch)
- Christine Baes (University of Guelph)

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Thank you and any questions?

DairyBio

VICTORIA State Government

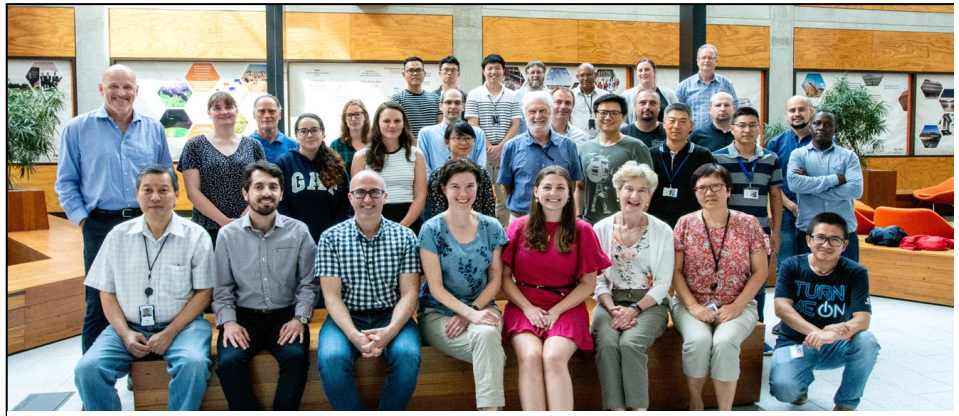
Dairy Australia

GARDINER FOUNDATION

Agriculture Victoria staff (Ellinbank)

DataGene Solutions for Herd Development

Ginfo farmers



Agriculture Victoria staff (Agribio)

"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.

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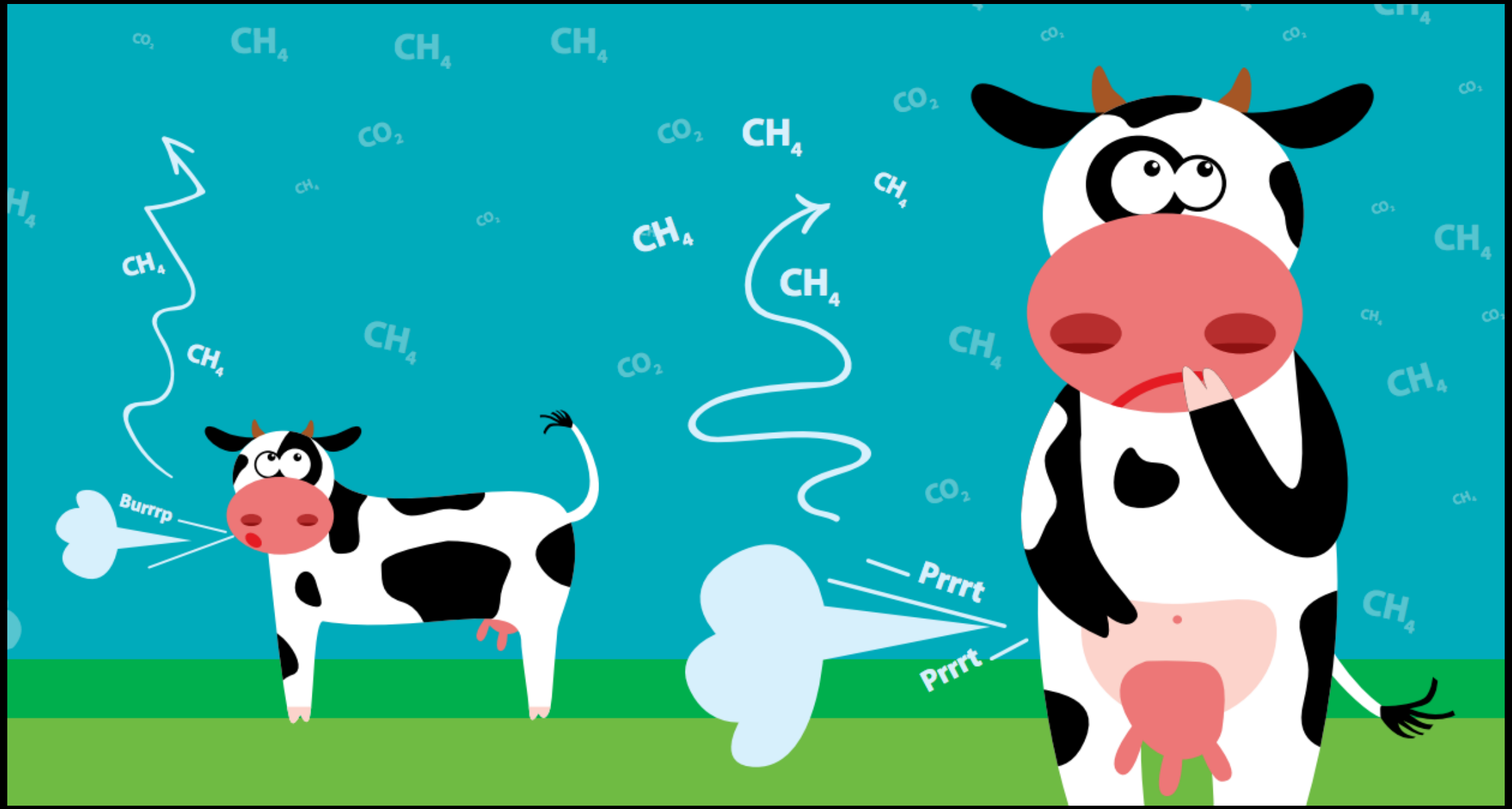
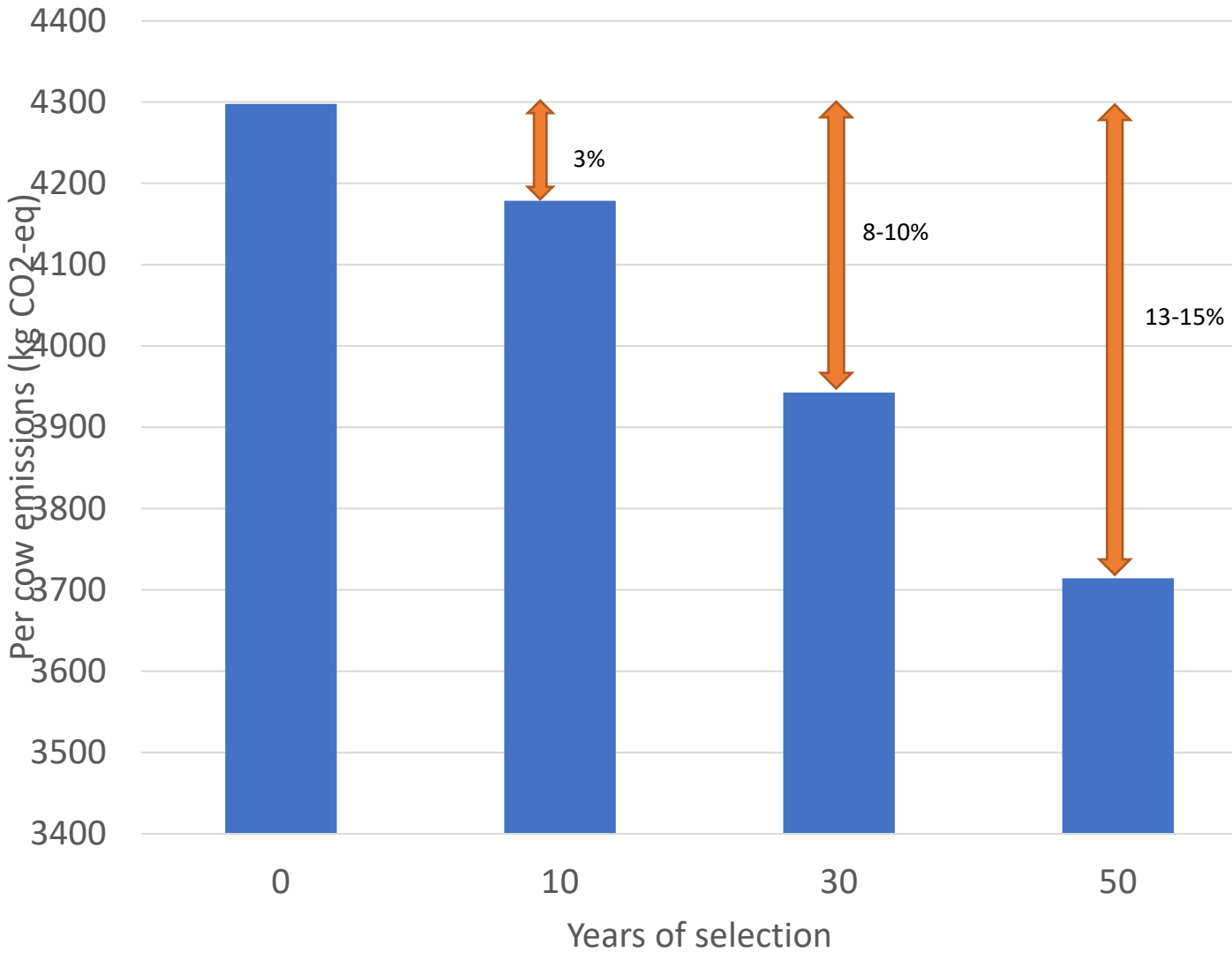


https://www.sciencejournalforkids.org/wp-content/uploads/2020/02/cows-article.pdf

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



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

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[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

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