THE Resilient Dairy GENOME PROJECT

SVT Tagung 2022, Zollikofen, Switzerland
@BaesC1

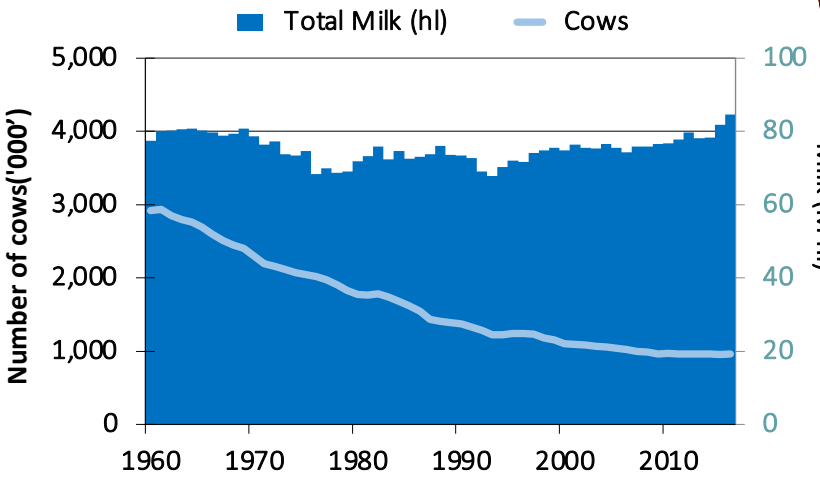
Reducing Methane emissions and improving feed efficiency through breeding

Christine Baes
Professor and Canada Research Chair in Livestock Genomics, Centre for Genetic Improvement of Livestock, University of Guelph
Adjunct Professor, University of Prince Eduard Island
Dozentin, Institut für Genetik, Vetsuisse Fakutät, Universität Bern

UNIVERSITY of GUELPH
IMPROVE LIFE.
UNIVERSITÄT BERN
CGIL
DAIRY at GUELPH CANADA'S DAIRY UNIVERSITY

1

1/3 of the cows – same amount of milk



2

Large Genomic Research Projects in Dairy

THE Efficient Dairy GENOME PROJECT

- 2015-2020, $10.3M
- Filippo Miglior, Flavio Schenkel, Paul Stothard

- International database for Feed Efficiency and Methane Emissions
- Australia, Canada, Denmark, Switzerland and USA

- **Single Step genomic evaluation for FE launched in Canada in April 2021**

THE Resilient Dairy GENOME PROJECT

- 2020-2024, $12.5M
- Christine Baes, Marc-André Sirard, Ronaldo Cerri, Paul Stothard

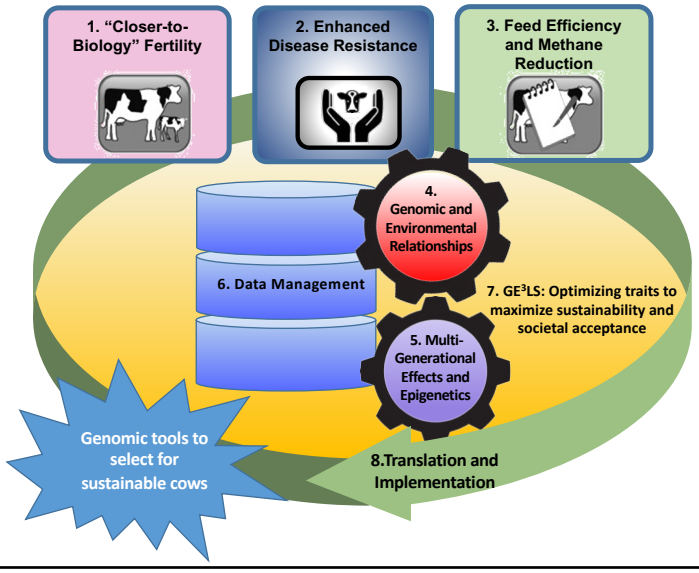
- Closer-to-biology fertility traits
- New health trait evaluations (Johne's, Leukosis, Respiratory Diseases, Calf Health)
- Further analysis of Feed Efficiency & Methane Emission data
- Evidence-based epigenomic data to complement genetic selection strategy
- Same EDGP partners + Brazil, Spain and Germany

- **Development of Genomic Evaluations for Resiliency**

3

3

The Resilient Dairy Genome Project



4

Feed Efficiency

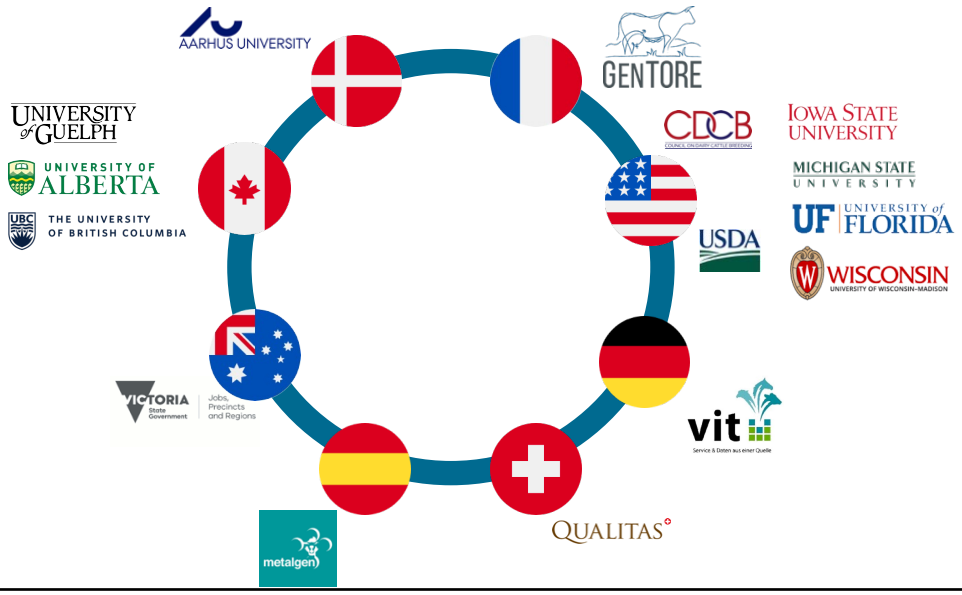
In order to conduct Feed Efficiency and Methane evaluations, six key data elements are required:

a) Daily feed intake (full lactation or at least from 5 to 150-200 DIM)
b) Milk production data (once a week, or once every two weeks)
c) Body weight (as frequent as milk production data)
d) Routine feed analysis for continuous estimation of daily dry matter intake
e) Genotypes
f) Individual methane measurements

5

5

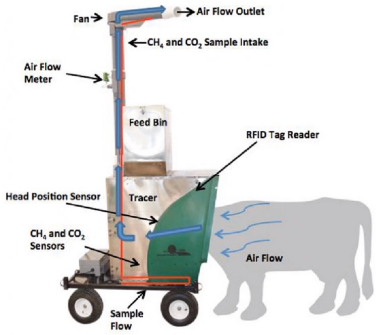
National and international partnerships



6

6

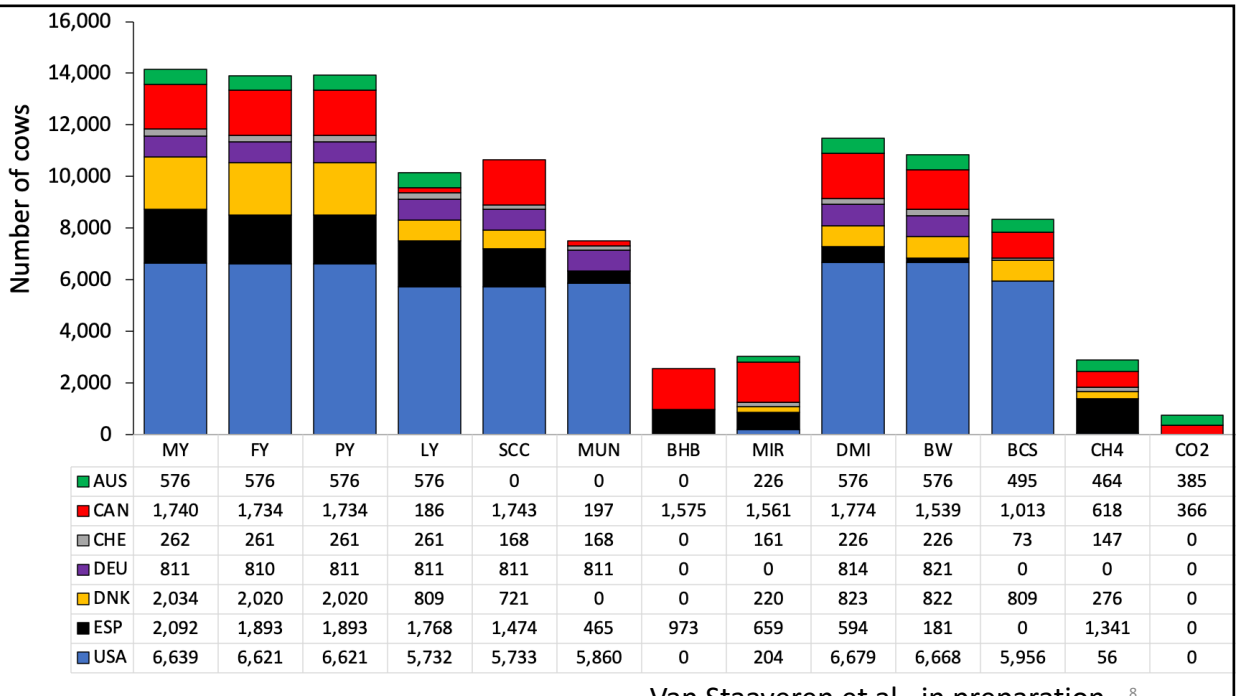
Feed Efficiency and Methane Emissions



Dataset goals:

- **Feed efficiency:** 17,000 cows
- **Methane emissions:** 7,800 cows

7

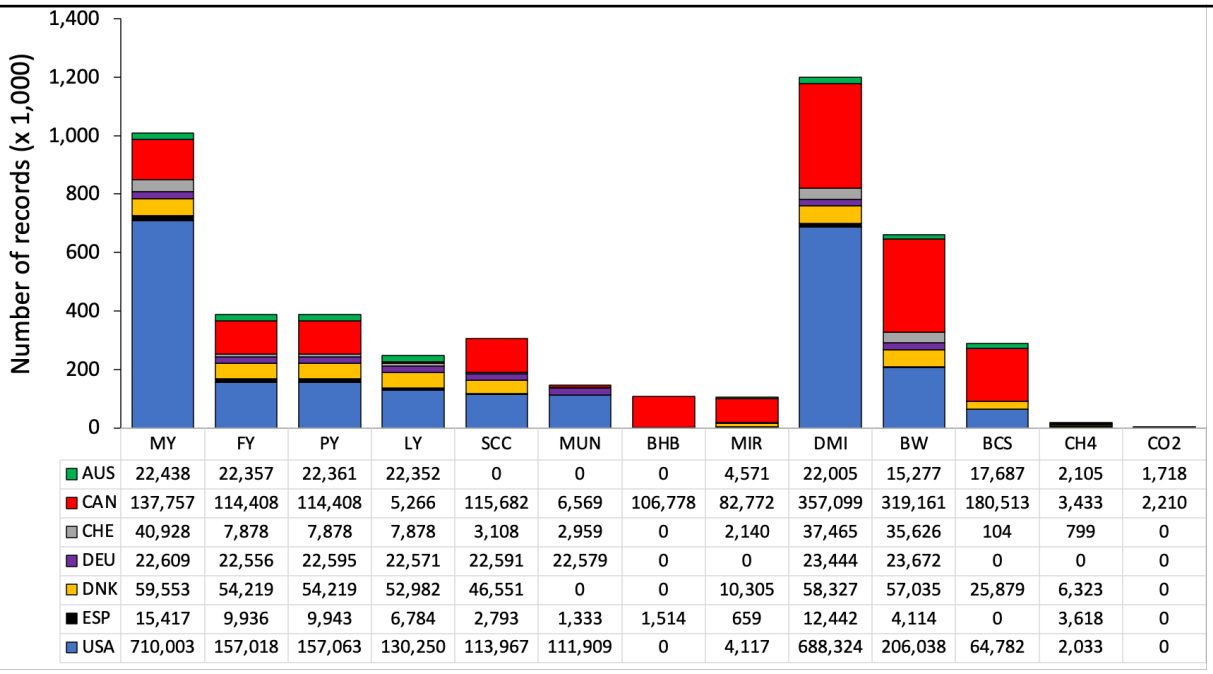


	MY	FY	PY	LY	SCC	MUN	BHB	MIR	DMI	BW	BCS	CH4	CO2
AUS	576	576	576	576	0	0	0	226	576	576	495	464	385
CAN	1,740	1,734	1,734	186	1,743	197	1,575	1,561	1,774	1,539	1,013	618	366
CHE	262	261	261	261	168	168	0	161	226	226	73	147	0
DEU	811	810	811	811	811	811	0	0	814	821	0	0	0
DNK	2,034	2,020	2,020	809	721	0	0	220	823	822	809	276	0
ESP	2,092	1,893	1,893	1,768	1,474	465	973	659	594	181	0	1,341	0
USA	6,639	6,621	6,621	5,732	5,733	5,860	0	204	6,679	6,668	5,956	56	0

Van Staaveren et al., in preparation

8

8

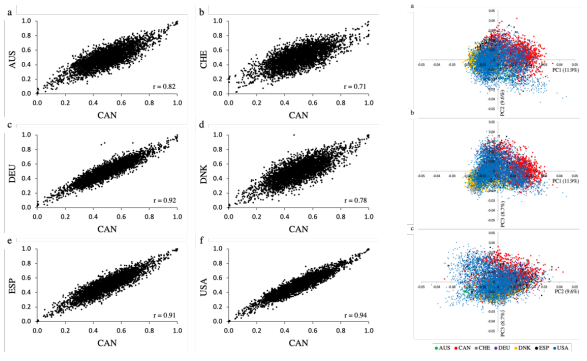


	MY	FY	PY	LY	SCC	MUN	BHB	MIR	DMI	BW	BCS	CH4	CO2
AUS	22,438	22,357	22,361	22,352	0	0	0	4,571	22,005	15,277	17,687	2,105	1,718
CAN	137,757	114,408	114,408	5,266	115,682	6,569	106,778	82,772	357,099	319,161	180,513	3,433	2,210
CHE	40,928	7,878	7,878	7,878	3,108	2,959	0	2,140	37,465	35,626	104	799	0
DEU	22,609	22,556	22,595	22,571	22,591	22,579	0	0	23,444	23,672	0	0	0
DNK	59,553	54,219	54,219	52,982	46,551	0	0	10,305	58,327	57,035	25,879	6,323	0
ESP	15,417	9,936	9,943	6,784	2,793	1,333	1,514	659	12,442	4,114	0	3,618	0
USA	710,003	157,018	157,063	130,250	113,967	111,909	0	4,117	688,324	206,038	64,782	2,033	0

Van Staaveren et al., in preparation 9

9

Standardisation of Phenotypes and Genotypes



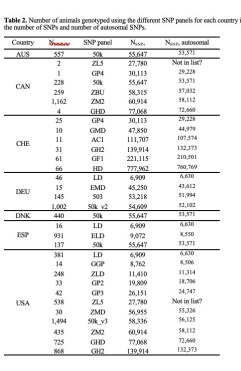
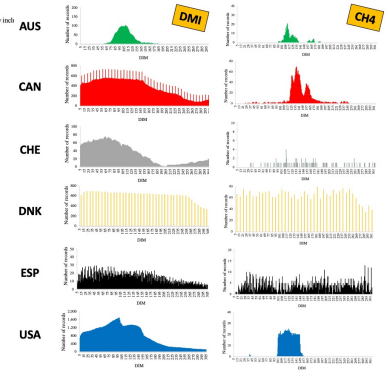


Table 2. Number of animals genotyped using the different SNP panels for each country incl the number of SNPs and number of autosomal SNPs.

Country	$N_{animals}$	SNP panel	N_{SNP}	N_{SNP}, autosomal
AUS	557	50k	55,647	53,571
CAN	2	ZL5	27,780	Not in list?
	1	GP4	30,113	29,228
	228	50k	55,647	53,571
	259	ZBU	58,315	57,032
	1,162	ZM2	60,914	58,112
	4	GHD	77,068	72,660
CHE	25	GP4	30,113	29,228
	10	GMD	47,850	44,979
	11	AC1	111,707	107,574
	31	GH2	139,914	132,373
	61	GF1	221,115	210,501
	66	HD	777,962	760,769
DEU	46	LD	6,909	6,630
	15	EMD	45,250	43,612
	145	50	53,218	51,994
	1,002	50k v2	54,609	52,102
DNK	440	50k	55,647	53,571
ESP	16	LD	6,909	6,630
	931	ELD	9,072	8,550
	137	50k	55,647	53,571
USA	381	LD	6,909	6,630
	14	GGP	8,762	8,506
	248	ZLD	11,410	11,314
	33	GP2	19,809	18,706
	42	GP3	26,151	24,747
	538	ZL5	27,780	Not in list?
	30	ZMD	56,955	55,326
	1,494	50k v3	58,336	56,125
	435	ZM2	60,914	58,112
	725	GHD	77,068	72,660
	868	GH2	139,914	132,373



Van Staaveren et al., in preparation 10

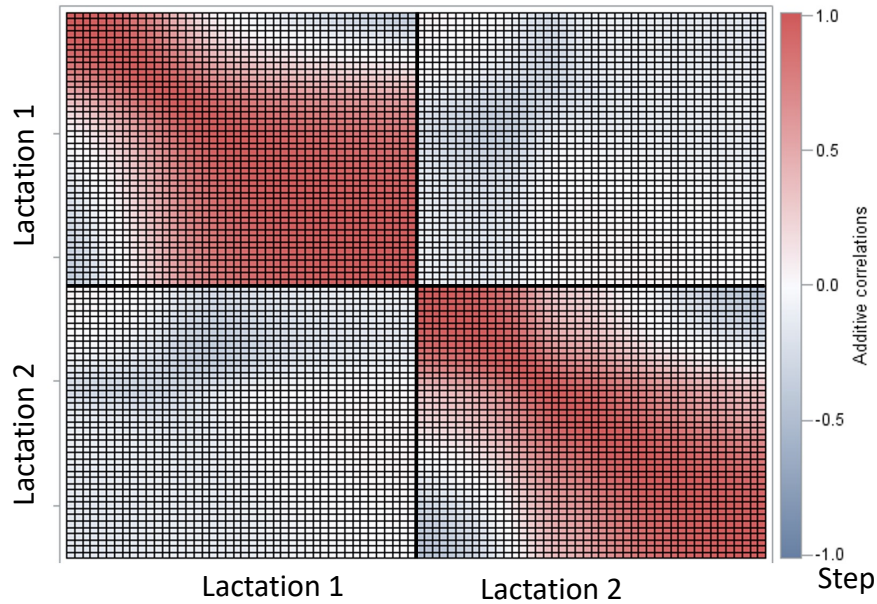
10

Standardisation of Phenotypes and Genotypes

		Dry Matter Intake (g/day)			CH_4 (g/day)			
	N (cows)	Mean	SD	CV (%)	N (cows)	Mean	SD	CV (%)
AUS	15.989 (430)	23,55	4,36	18.5	1.311 (284)	486	87	17.9
CAN	45.524 (1.606)	21,98	5,40	24.6	3.591 (652)	453	109	24.0
CHE	28.705 (174)	21,31	3,88	18.2	572 (71)	439	73	16.8
DNK	13.963 (665)	22,19	3,85	17.4	6.192 (270)	354	63	17.9
ESP	10.908 (583)	22,99	4,56	19.8	3.066 (1.160)	181	65	35.9
USA	545.133 (5.560)	24,02	5,16	21.5	1.894 (52)	469	88	18.8

Van Staaveren et al., in preparation 11

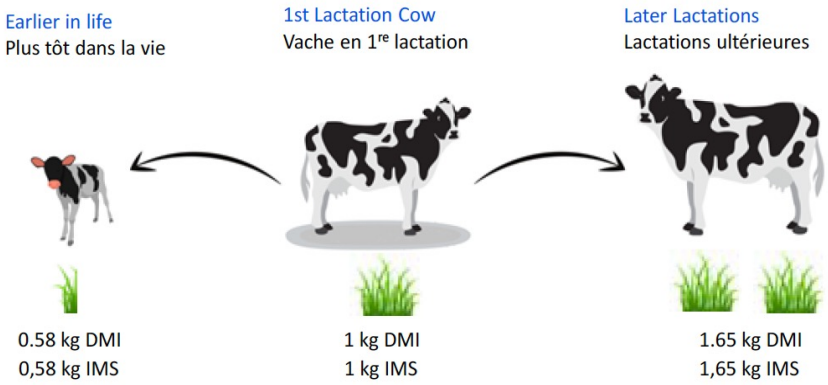
Dynamic behaviour of feed efficiency over time



- Each pixel represents one week of lactation, with a total of 88 weeks of lactation when combining 1st and 2nd parity.

Stephansen et al., 2022 12

1 kg of more efficiently converted Dry Matter Intake (DMI) during the cow's first lactation



- 0.58 + 1.00 + 1.65 = 3.23 kg Dry Matter + 0.055 kg Methane
- Total savings of $0.89 / kg DM / cow / lifetime

Kistemaker & Richardson., 2022

13

1 kg of more efficiently converted Dry Matter Intake (DMI) during the cow's first lactation

- 1 kg of more efficiently converted Dry Matter Intake (DMI) during the cow's first lactation

→$0.89 in lifetime savings per 1 kg of Dry Matter saved in first lactation

Feed Efficiency evaluations reduce Dry Matter Intake (DMI) by 53 kg per 5 RBV points

- After peak in first lactation
- 10.6 kg per RBV point

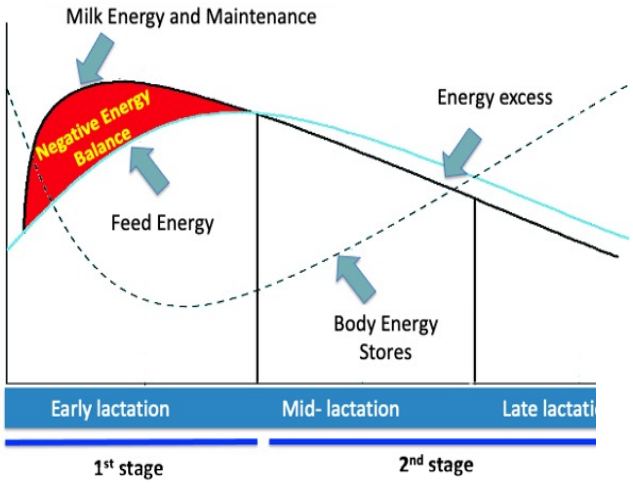
- Combine 10.6 kg with $0.89 per kg

→1 point RBV increase in Feed Efficiency in a sire's proof is expected to reduce feed cost in daughters by $9.43

Kistemaker & Richardson., 2022

14

Translation and Implementation



- Single-Step Evaluation: **April 2021**
- Three Traits:
  - Dry Matter Intake (DMI)
  - Energy Corrected Milk (ECM)
  - Metabolic Body Weight (MBW)
- Two Lactation periods:
  - 5-60 Days in milk
  - 61-305 Days in milk

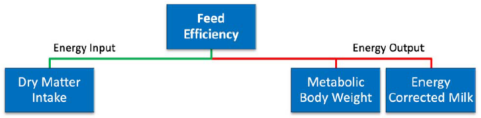


Diagram adapted from Hoffman et al. 2000; Chud et al., 2020; Jamrozik & Kistemaker 2019

15

15

Summary

- Feed Efficiency and Methane Emission data difficult to obtain, but industry and government are very motivated
- International collaborations required both short and long term
  - Standardization of data challenging
- Feed Efficiency (and likely methane emissions) change over time
  - Appropriate and careful modelling required
- Additional data / expertise required for full leverage of information (e.g. microbiome, other “Omics” technologies, physiology, etc.)

16

16

Outlook

- Short term (August 2022)
  - Include Feed Efficiency in indexes (LPI und Pro$)
  - Develop Breeding value estimation for methane
  - Ensure data collection continues smoothly
- Midterm (2023 - 2024)
  - ”Resiliency Index” development
- Longer term (> 2024)
  - Ensure long-term data collection – ideal to keep current partners
  - International collaboration extremely important due to high cost of data

17

17

Acknowledgements

THE Resilient Dairy GENOME PROJECT
www.resilientdairy.ca/

18

…and thanks to a fantastic team!

19