The Resilient Dairy Genome Project

Adrien M Butty

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SABRE-TP, Zürich

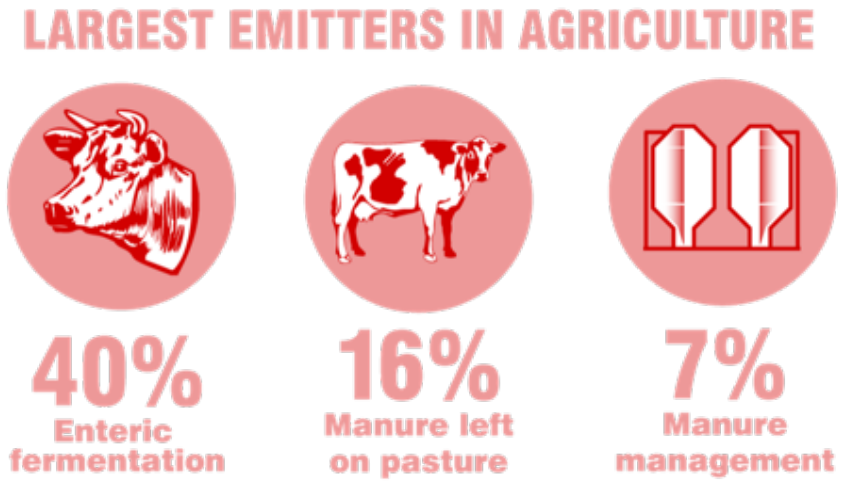
Outline

- Feed efficiency and methane emissions
- The Genome Canada Projects
- Outlook

Feed efficiency and methane emissions

Importance

- Continuous growth in demand for high quality milk protein (+238% in Asia in last 30 years)
- Increasing awareness of environmental impact from dairying
- Rising dairy farm input costs where feed represents more than 50% of operation costs



Why only now?

- Feed efficiency (FE) & methane emissions (ME) are two traits difficult to measure
  - expensive recording methods
  - strongly fluctuate from minute to minute

  ➔ No mass/routine recording possible

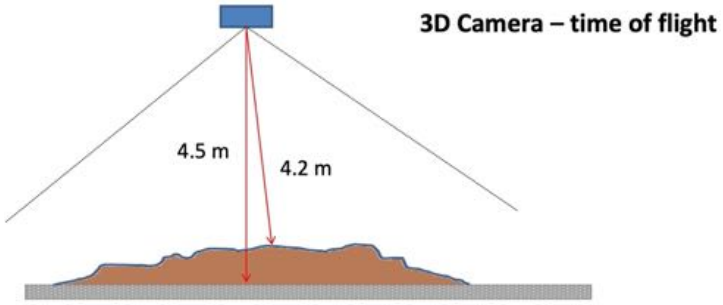
  → Traditional genetic evaluation impossible

  but…

  use of genomics makes accurate estimation of breeding values for these traits possible!

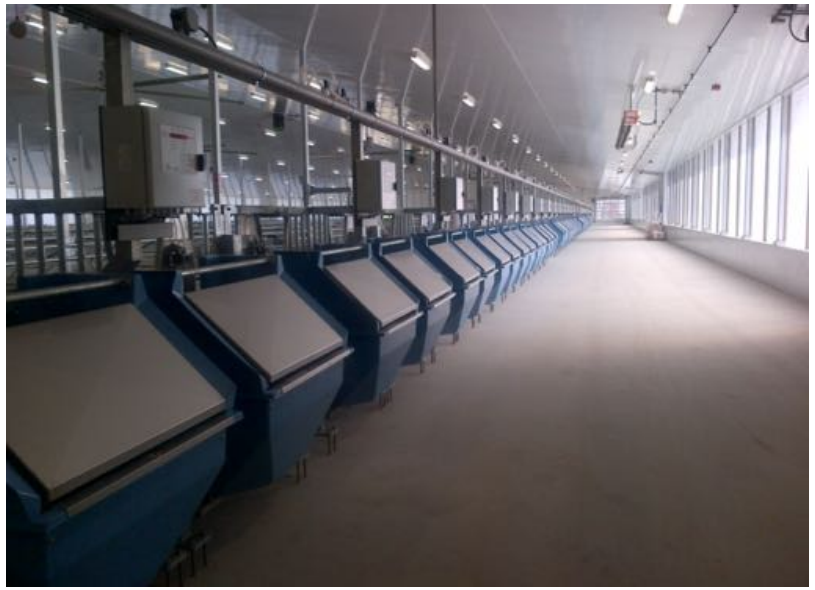
Data collection: Feed Efficiency

CFIT system



© Jan Lassen

Feed bins



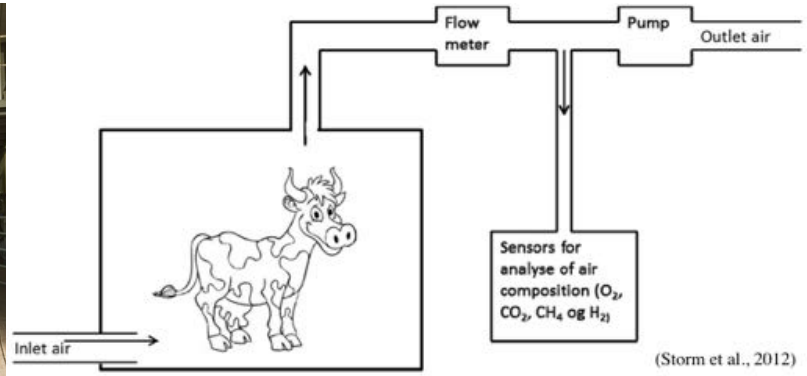
© Christine Baes

Feed table on scale

© AgroVet Strickhof

Data collection: Methane emissions

Respiration Chambers



(Storm et al., 2012)

Sulfur Hexafluoride (SF_6)

Laser Methane Detector

www.miningmagazine.com

Greenfeed

www.c-lockinc.com

Headbox

Selection goals for Feed Efficiency

Definition	Advantage	Disadvantage
Dry Matter Intake (g / day)	Direct improvement possible	Lowering of production level and loss of appetite
Feed conversion efficiency (kg Feed / kg Milk)	Well understood by farmers	Ratio trait, strongly linked to production
Production efficiency (kg BW / kg Milk)	Fits interests of the farmers	Ratio trait, strongly linked to production
Residual feed intake (DMI observed – DMI predicted)	Include corrections for correlated traits	Inversed values & higher complexity make it hard for farmers

Selection goals for Methane Emissions

Definition	Advantage	Disadvantage
Methane production (g/day)	Direct improvement possible	Lowering of production level and feed intake
Methane intensity (g/kg DMI)	Well understood by farmers	Ratio trait
Methane yield (g/kg milk or g/kg BW)	Fits interests of the farmers	Ratio trait
Residual methane production (g observed – g predicted)	Include corrections for correlated traits	Inversed values & higher complexity make it hard for farmers

Evaluations for feed efficiency are already applied

- Australia: Feed Saved Breeding Values
  - similar residual feed intake
  - expressed in kg DM
  - allows a BV for which higher values are better
  - introduced in April 2015

- The Netherlands: Dry Matter Intake Breeding Values
  - expressed in kg DM
  - implemented also in the Better Life Efficiency Index
  - introduced in April 2016

Evaluations for feed efficiency are already applied

- Canada: Residual Feed Intake Breeding Values
  - Single-step recursive model
  - Expressed in kg DM
  - Inversed values so that higher is better
  - Introduced in April 2021

- USA: Feed Saved Breeding Values
  - Multi-step genomic model
  - Expressed in kg DM
  - Introduced in December 2020

Both introductions resulted from the EDGP

THE Efficient Dairy GENOME PROJECT

Qualitas

The Genome Canada Projects

slides kindly shared by Dr. Christine Baes

Efficiency and Resiliency

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**

Efficiency and Resiliency

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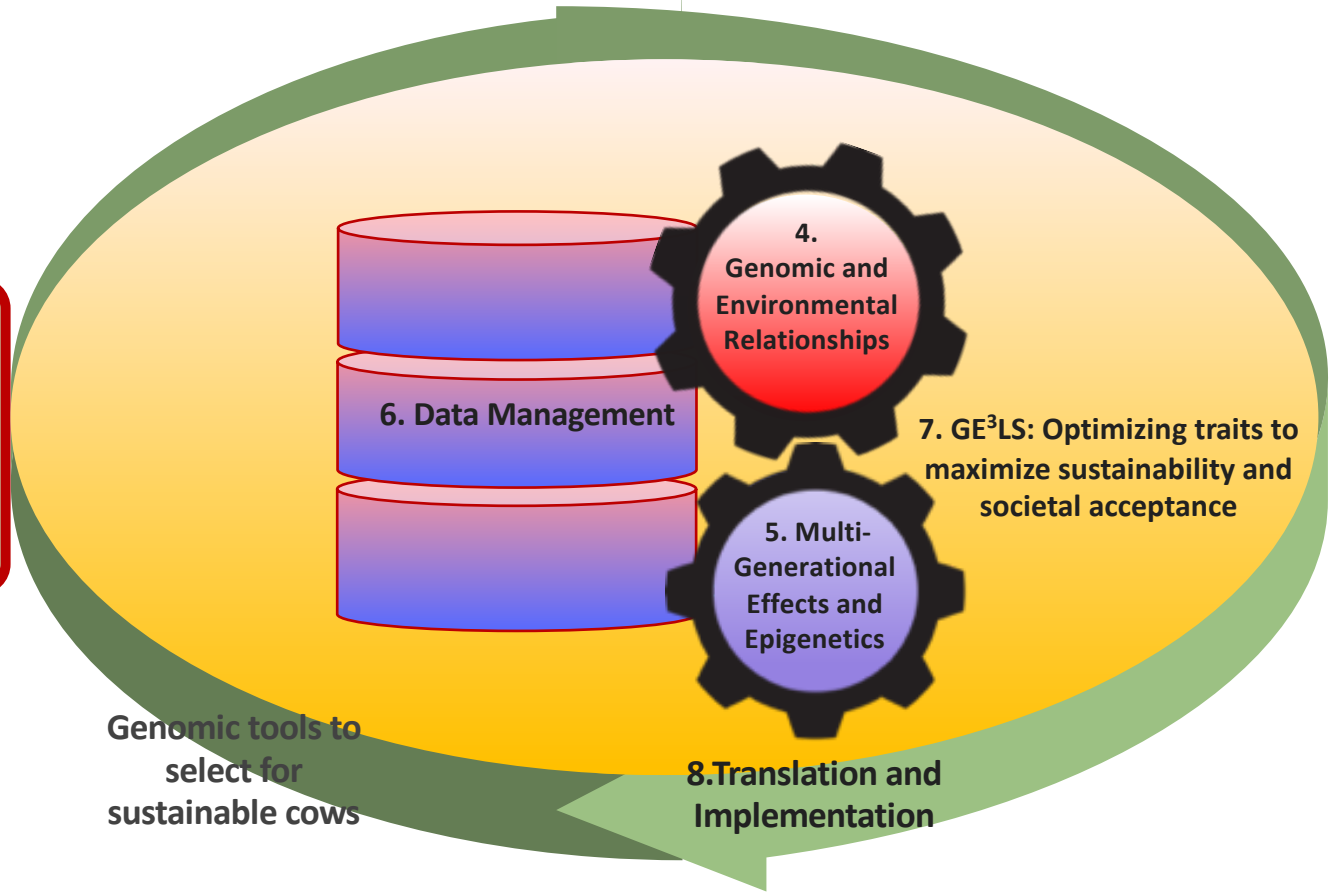
The Resilient Dairy Genome Project

1. “Closer-to-Biology” Fertility

2. Enhanced Disease Resistance

3. Feed Efficiency and Methane Reduction

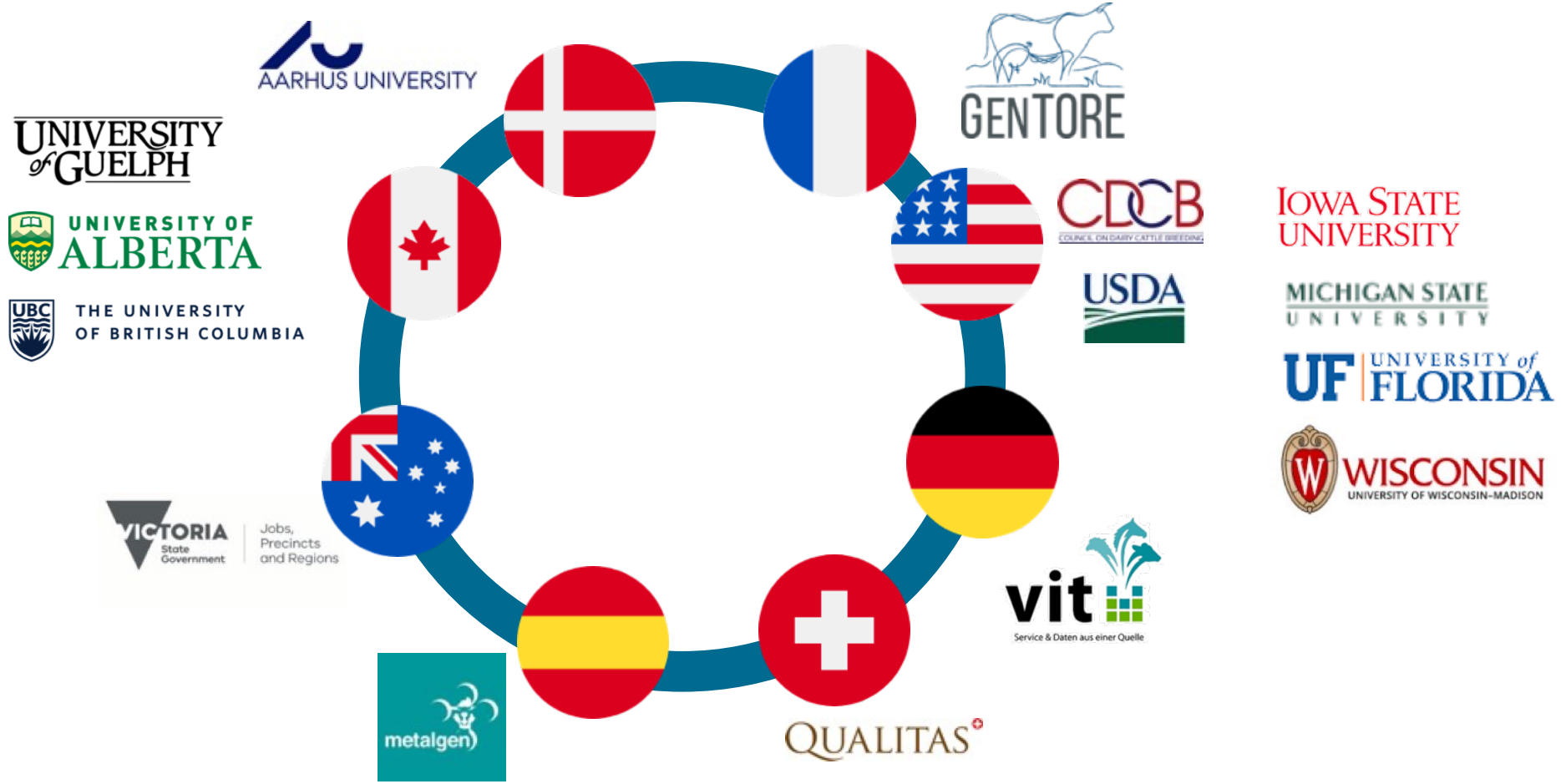


Feed Efficiency and Methane Emissions

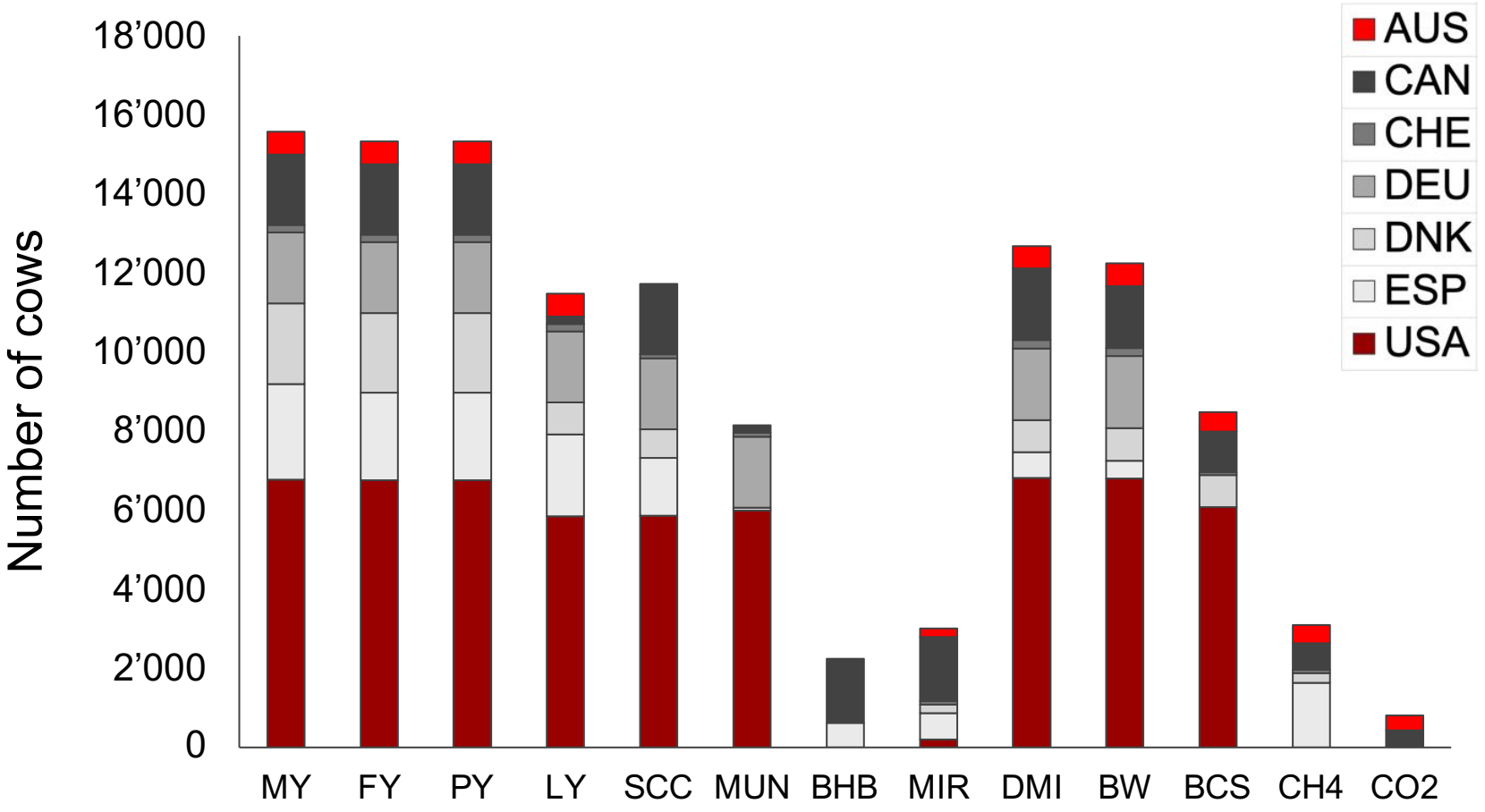
In order to conduct Feed Efficiency and Methane evaluations, six key data elements are required:

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 weights (as frequent as milk production data)
d) Routine feed analysis for continuous estimation of daily dry matter intake
e) Genotypes
f) Individual methane measurements

International partnerships

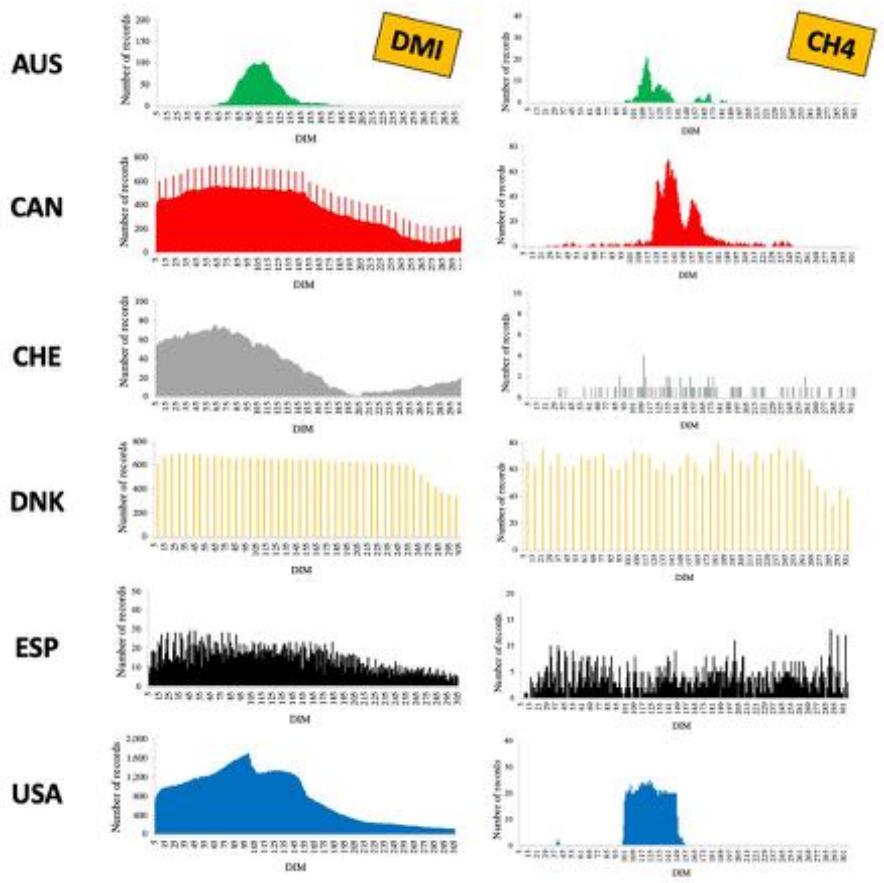


International database



Adapted from
Van Staavaren et al, in preparation

Data are recorded differently across countries



Different:

- Types of farm (research vs commercial)
- Housing (tiestall, outdoor, freestall)
- Parities
- Types of feed(ing)
- Methods of measure
- Frequencies of measure
- …

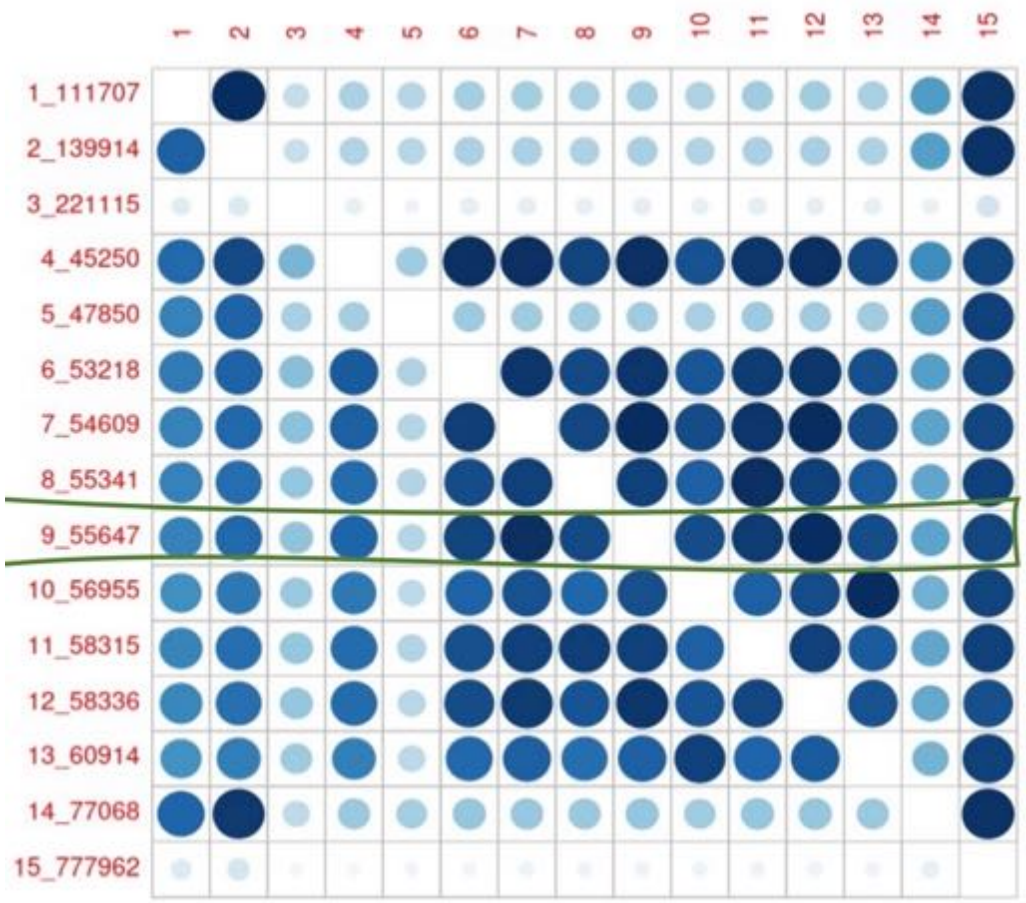
Adapted from
Van Staavaren et al, in preparation

Standardisation of phenotypes

		Dry Matter Intake (kg/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

Adapted from Van Staavaren et al, in preparation

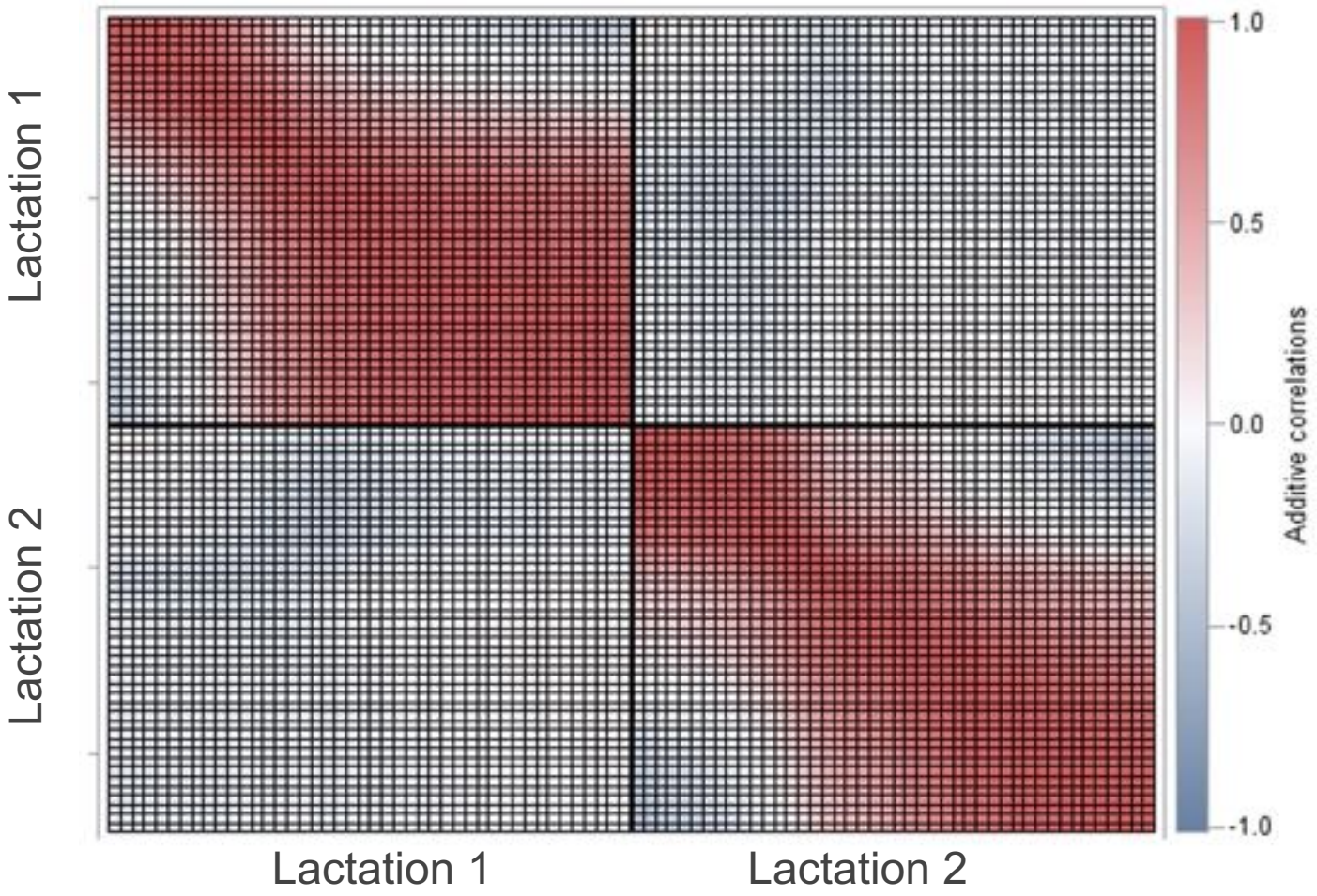
Standardisation of genotypes



- Imputation accuracy of 0.98 (±0.02) was reached only with RDGP genotypes.
- Most partners impute the RDGP genotypes with their pipeline and thus a bigger reference dataset.

Gerson Oliveira, unpublished

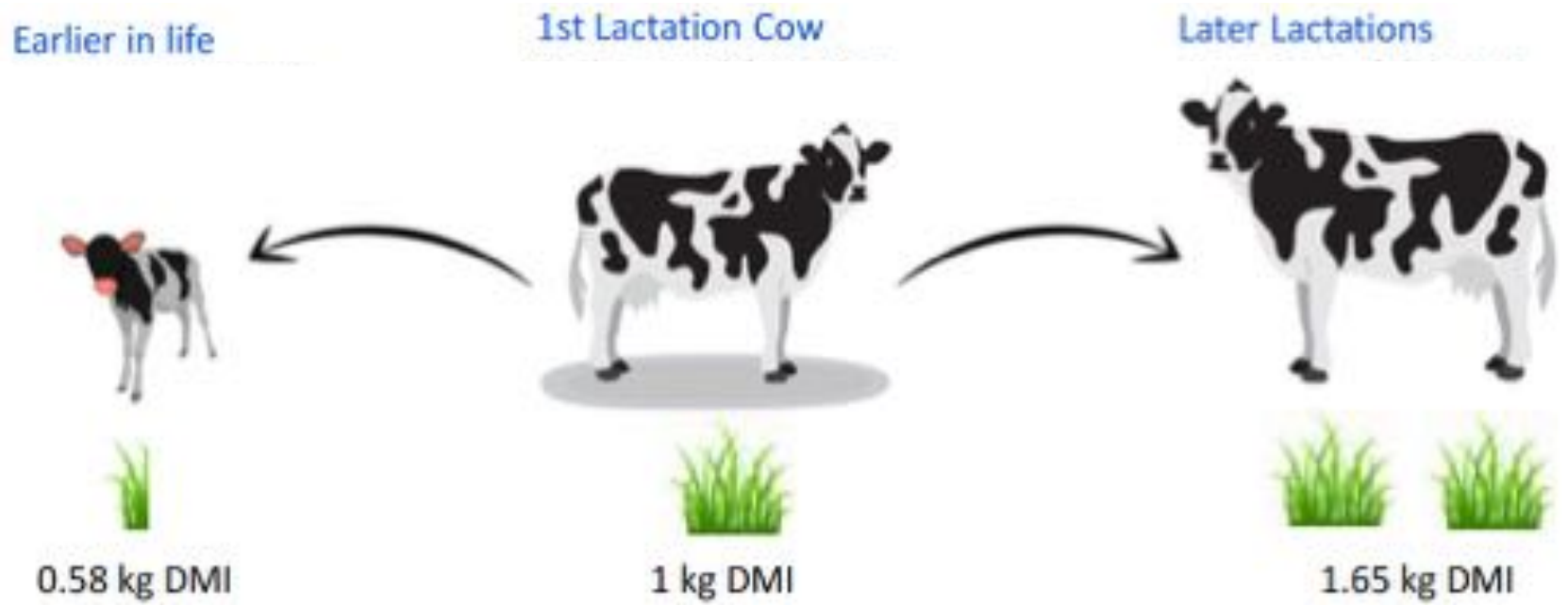
Dynamic behaviour of feed efficiency over time



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

What do I gain when my cow eat 1kg DMI less in her 1st 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

0.70 CHF

Adapted from Kistemaker & Richardson, 2022

What do I gain when my cow eat 1kg DMI less in her 1st lactation?

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

→ ~~$0.89~~ 0.70 CHF 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~~ 0.70 CHF 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~~ 7.42 CHF

Adapted from Kistemaker & Richardson, 2022

The RDGP Partners

THE
Resilient Dairy
GENOME PROJECT

www.resilientdairy.ca/

Outlook

The RDGP and Switzerland

- Data from Switzerland is the smallest in the database
- We can be partner of the RDGP as we were able to deliver high quality data from two research farms.
  - CH is the only country with data from respiration chambers in the RDGP
- As long as there is external founding (research project), we can stay in with few recorded animals

BUT

What will happen when the project ends?

The future of the RDGP database for CH

- Feed intake and methane emission data collection must be extended and made durable in CH
- Cheaper recording methods must be used on commercial farms
- Idea:
  - CFIT Technology for feed intake measurement
  - Sniffers for recording of methane emission

BUT

Validation of those methods in CH setup still needed

Thank you for your attention

adrien.butty@qualitasag.ch

@adributty

Credit: Mirjam Spengeler