Global Methane Genetics:
a global program to accelerate genetic progress for reduced methane emission

Birgit Gredler-Grandl, C.I.V. Manzanilla-Pech, R. Banks, H. Montgomery, R.F. Veerkamp

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BEZOS EARTH FUND

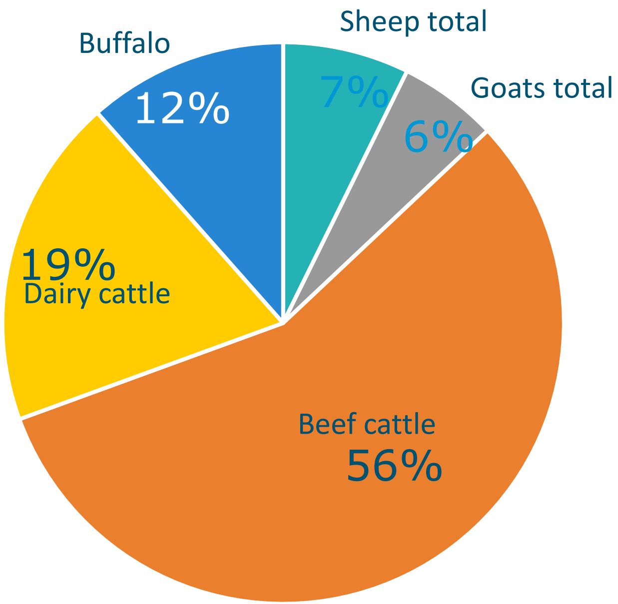
Global Methane Hub

2021 FAO Livestock e-Methane (kt)

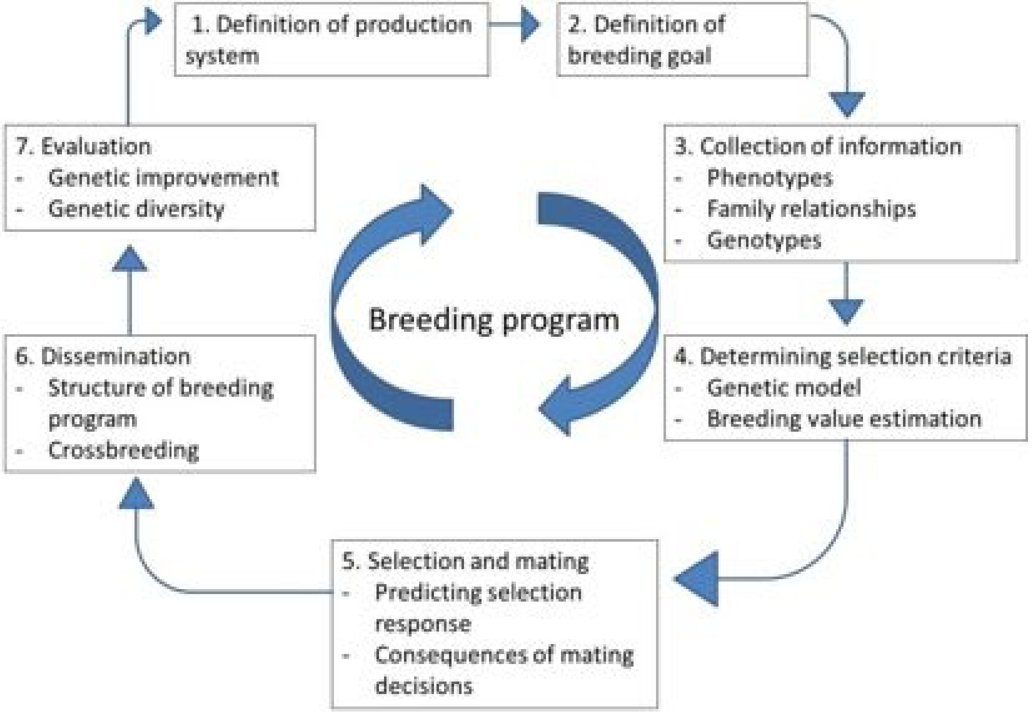
Tier 1 emissions

- Total enteric methane emissions from **5 major livestock species** was 97,384 (kt) in 2021.

Species	E-Methane Emissions (kt)
Beef cattle	54,973
Dairy cattle	18,550
Buffalo	11,217
Sheep	7,088
Goats	5,556



Animal Breeding as mitigation tool



- Clear trait definition
- Low-cost
- Large – scale
- Genetic variation
- Genetic correlation to other index traits

Recording techniques

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Recording techniques

Trait definitions

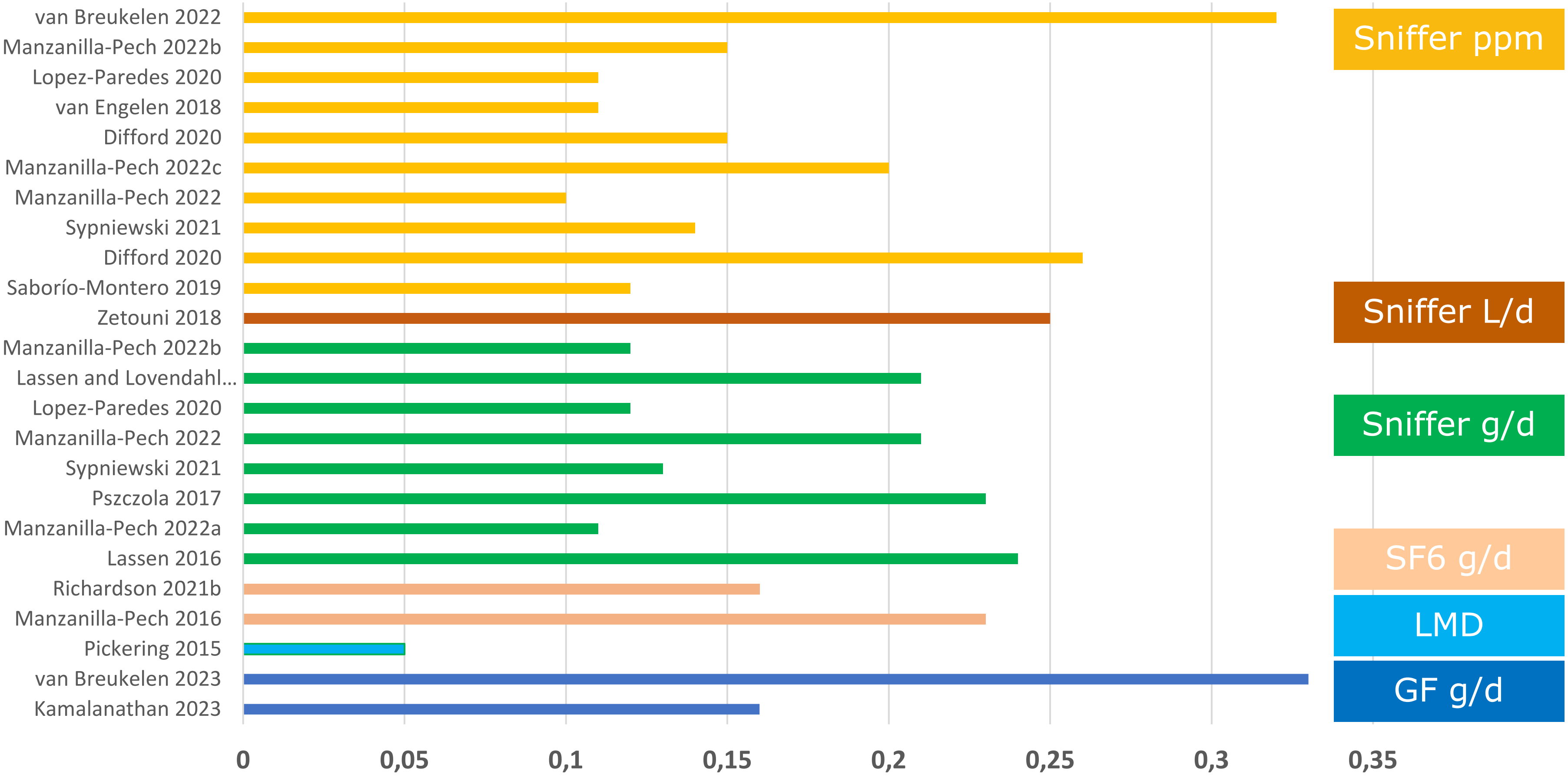
Methane production
g/day
Easy to understand
Climate targets

Methane yield
CH4 per unit of input
Ratio trait
Industry reporting

Methane intensity
CH4 per unit of output
Ratio trait
Industry reporting

Residual methane
Expected vs observed
Difficult to interpret

Heritability in dairy cattle



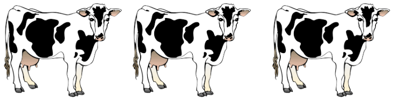
Genetic correlations between CH_4 and other traits

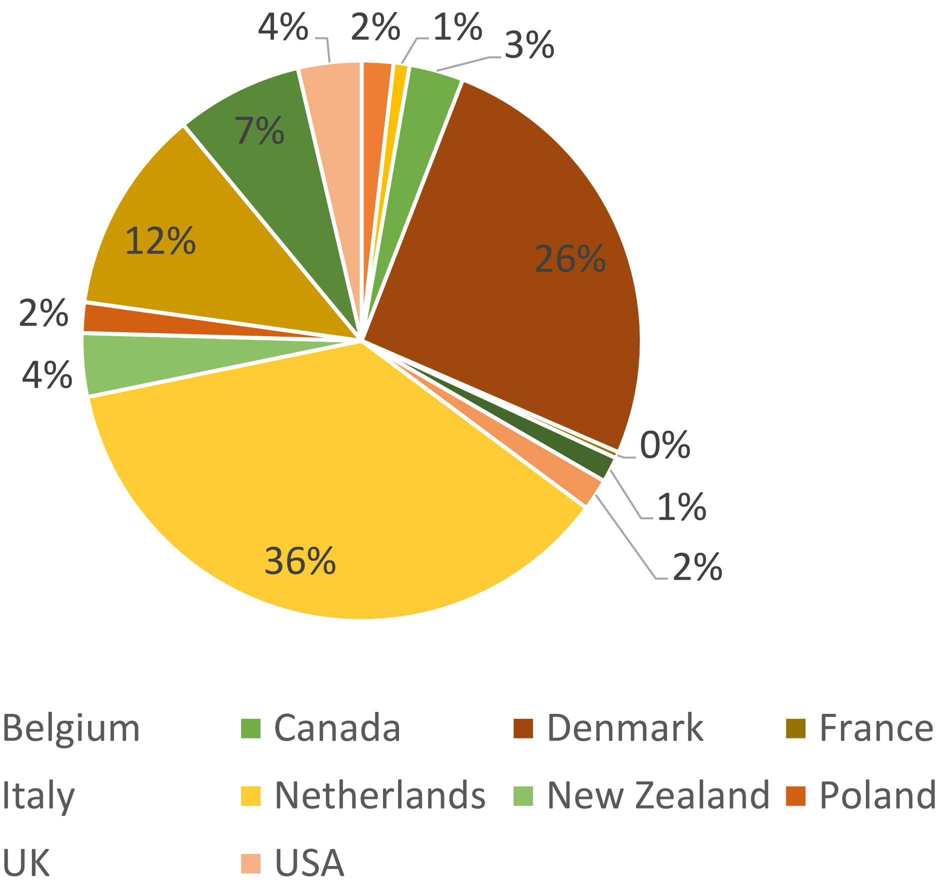
	Breed	CH4 trait	MKG	DMI	BW
Bakke et al. 2024	Norwegian Red	GF g/d	-	0.29 (0.05)	0.50 (0.09)
Lopes et al. 2023	HOL	GF g/d	0.33 (0.12)	0.83 (0.11)	0.68 (0.10)
Gonzalez-Recio, 2024	HOL	ppm	-0.05	0.27	-
Van Breukelen et. al. 2024	HOL	ppm	0.03 (0.06)	0.09 (0.10)	0.06 (0.06)

Session 1: N. Gengler, F. Tiezzi
Session 30: Anouk van Breukelen, Karoline Bakke

Number of CH_4 phenotyped - Holstein cattle

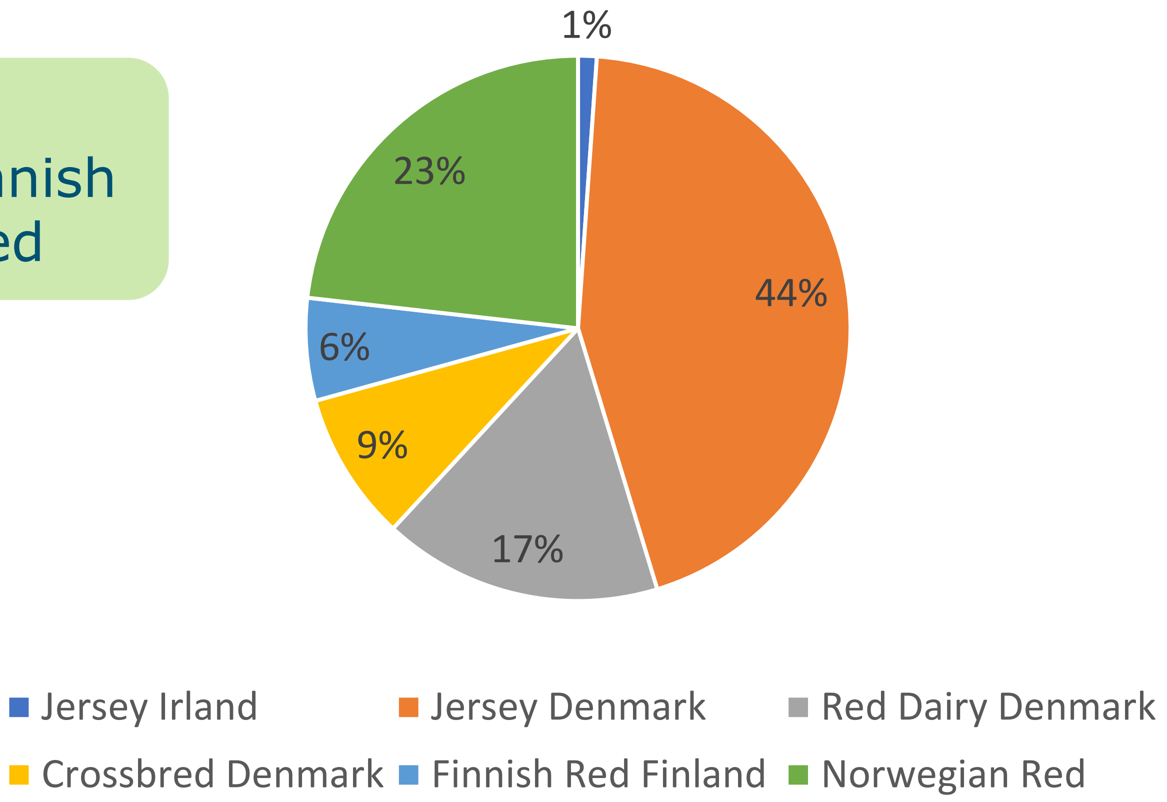
28,114
Holstein cattle





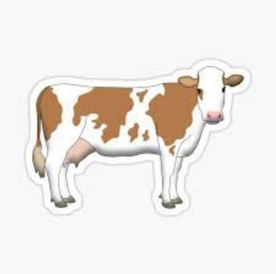
Number of CH_4 phenotyped cattle – Jersey and Nordic Red breeds

11,250
Jersey, Red Dairy, Finnish Red, Norwegian Red



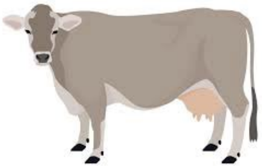
Number of CH_4 phenotyped cattle – Fleckvieh and Brown Swiss

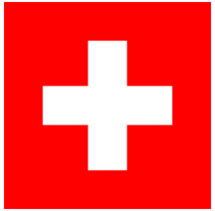
1,000 Fleckvieh and 200 Brown Swiss cows with GreenFeed



breed4green

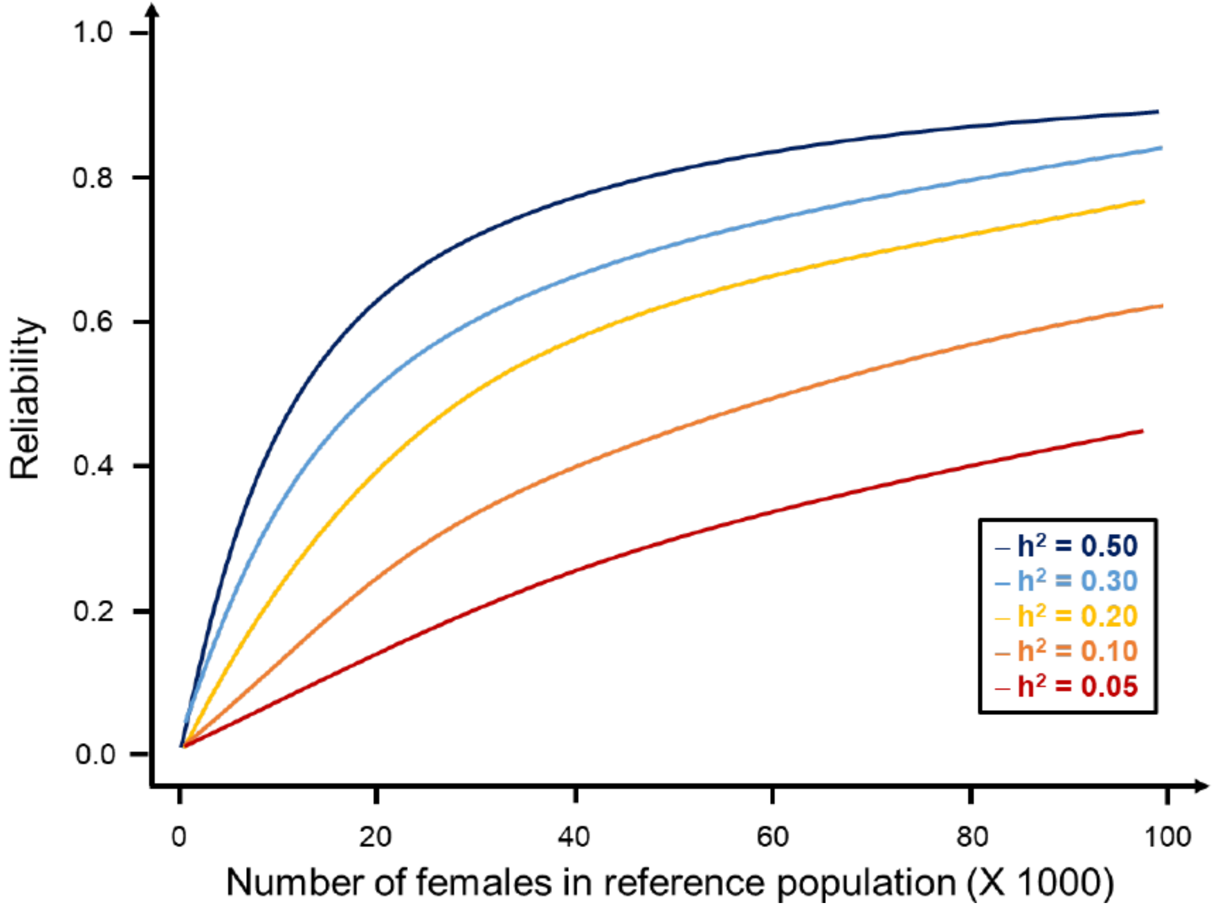
1,500 Brown Swiss cows with sniffers





CH_4COW

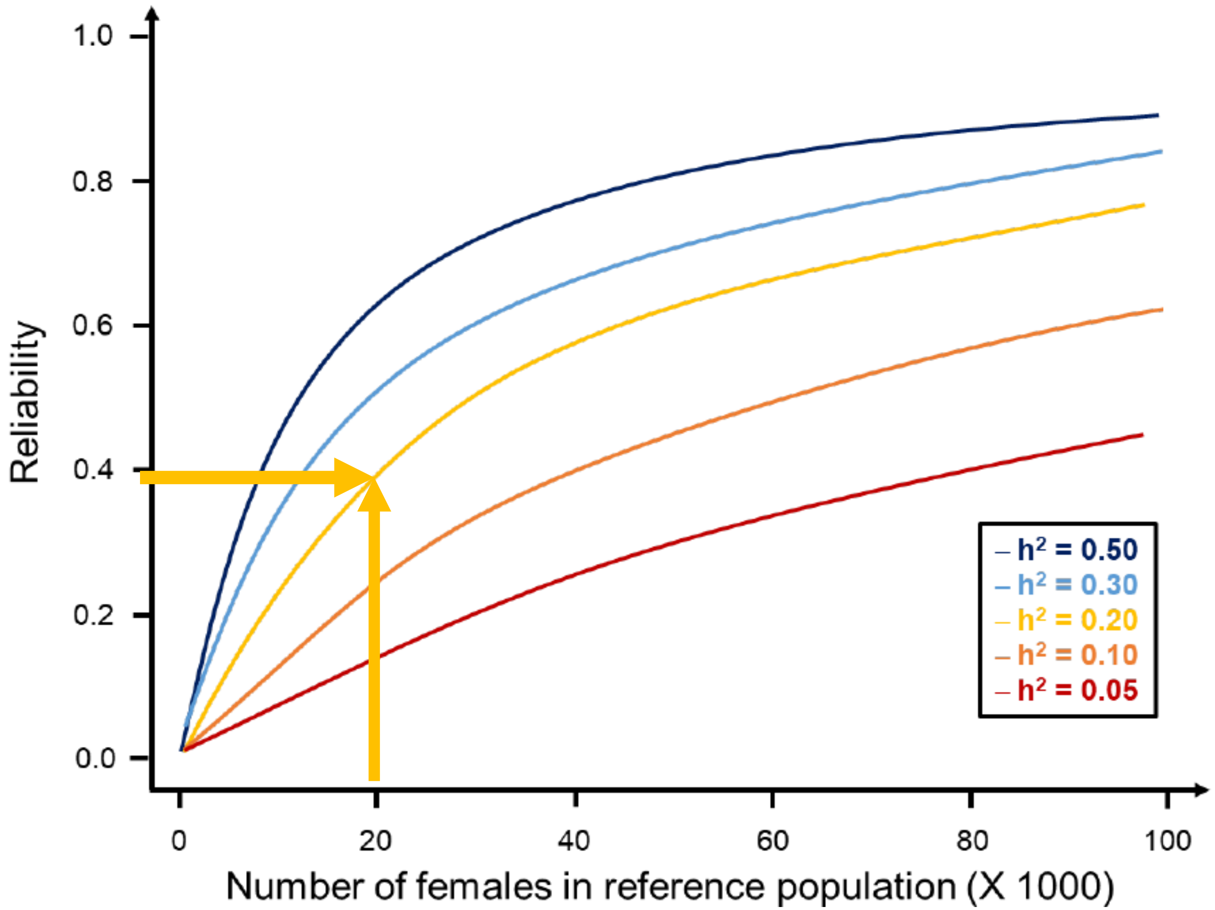
How many cows with phenotypes do we need?



Gonzalez-Recio *et. al.* (2014)

How many cows with phenotypes do we need?

Gonzalez-Recio *et. al.* (2014)



International across-country collaboration needed

Net Zero Dairy Genome Project

NDGP -> 20,000 CH_4 cows

Re-Livestock

RESILIENT FARMING SYSTEMS

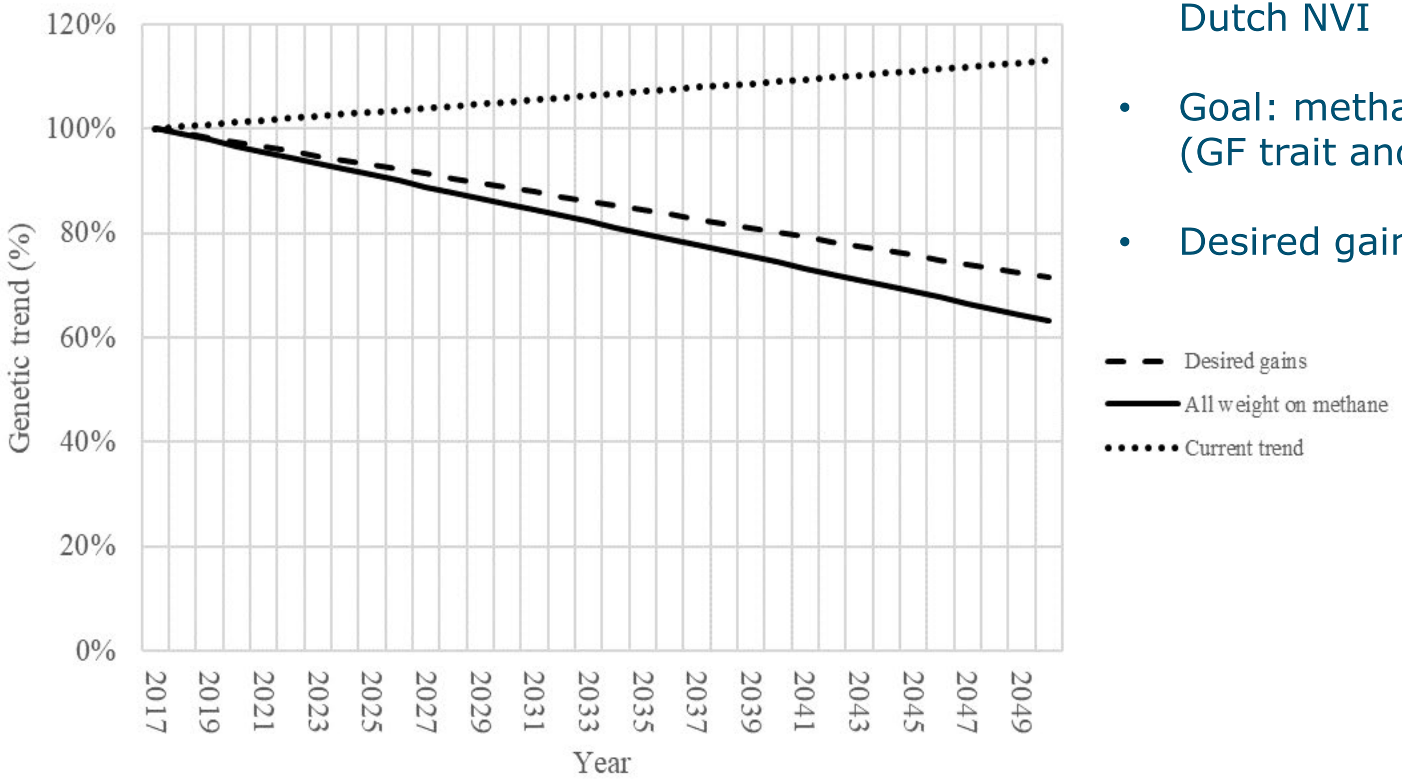
> 20,000 CH_4 cows

EAAP session 1: Coralia Manzanilla-Pech

Are we ready for implementation?

- Indirect selection: **We have already been doing it!**
  - e.g. Carbon sub index (ICBF), Sustainability index (AUS)
- Published breeding values for lower methane emission
  - CAN & ESP (2023)
  - NLD, DK, NO (and others?) 2025
- Direct selection: sustainable – balanced breeding goals:
  - Production
  - Health, fitness, welfare
  - Environment

Impact of genetic selection – genetic progress



- Selection index calculations for Dutch NVI
- Goal: methane production g/d (GF trait and sniffer trait, rg 0.76)
- Desired gain: -12.75 CH4 trait

PhD thesis
Anouk van Breukelen, 2024

Challenges and needs

Large reference populations

International harmonisation & standardisation in trait definition

Breeding indices

Adoption of genetics as mitigation tool:

- Farmers
- Dairy industry
- Stakeholder & policy maker
- Incentive systems

Global Methane Genetics (GMG)

Accelerating Genetic Progress to reduce methane in ruminants

BEZOS EARTH FUND

Global Methane Hub

Coordinator: Roel Veerkamp & Birgit Gredler-Grandl
Program for 5 years
Budget: US$ 20-30 million
Close collaboration with Global Methane Hub

Why? How? What?

- Genetic progress can make a **permanent** and **impressive contribution** to reducing methane output from livestock systems **globally**
- we aim to accelerate genetic progress and to implement breeding strategies for reduced methane emissions in Ruminants in the **global North and South**
- To support
    - **sharing of protocols** and **data**,
    - to **expand phenotyping**, **breeding program design**
    - **genetic evaluations**
    - development of **Global Livestock Genetics and Genomics Programs**

Protocols & network building

Data & phenotyping

Implementation: genetic evaluation & breeding program

Research & Phenotyping proposals

1) Working Groups

- WG1: Dairy global North
- WG2: Small ruminants
- WG3: Beef global North +
- WG4: Asia
- WG5: Africa
- WG6: South America
- WG7: Buffalo & ruminants

ICAR THE GLOBAL STANDARD FOR LIVESTOCK DATA

2) Database
- legal
- technical
- organisation

3) Animal breeding research

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Investment strategy – impact analysis

abacusbio.
BRIDGING SCIENCE & BUSINESS

	Cluster	Description
1	Dairy GN Intensive	Intensive, Holstein-dominated dairy systems in GN
2	Dairy GN Pastoral	Intensive, Holstein and crossbred pastoral dairy systems in GN
3	Dairy GS with GN Influence	GS systems with crossbred herds influenced by GN genetics
4	Dairy GS	GS systems incorporating a diverse range of indigenous breeds
5	Buffalo	Buffalo (milk & meat) predominately in GS
6	Beef Taurus GN	Intensive beef systems based on *Bos taurus* breeds in GN
7	Beef Taurus GS	Intensive and semi intensive beef systems based on Bos taurus breeds in GS
8	Beef Tropical semi-intensive	*Bos indicus* and tropical *Bos taurus* breeds managed in semi intensive systems in both GN and GS
9	Beef Indigenous	GS systems incorporating a diverse range of indigenous breeds
10	Small Ruminants GN meat	Intensive lamb and dual purpose systems in GN
11	Small ruminants GN other	Fibre and milking small ruminant systems in GN
12	Small ruminants GS	GS systems incorporating a diverse range of indigenous breeds

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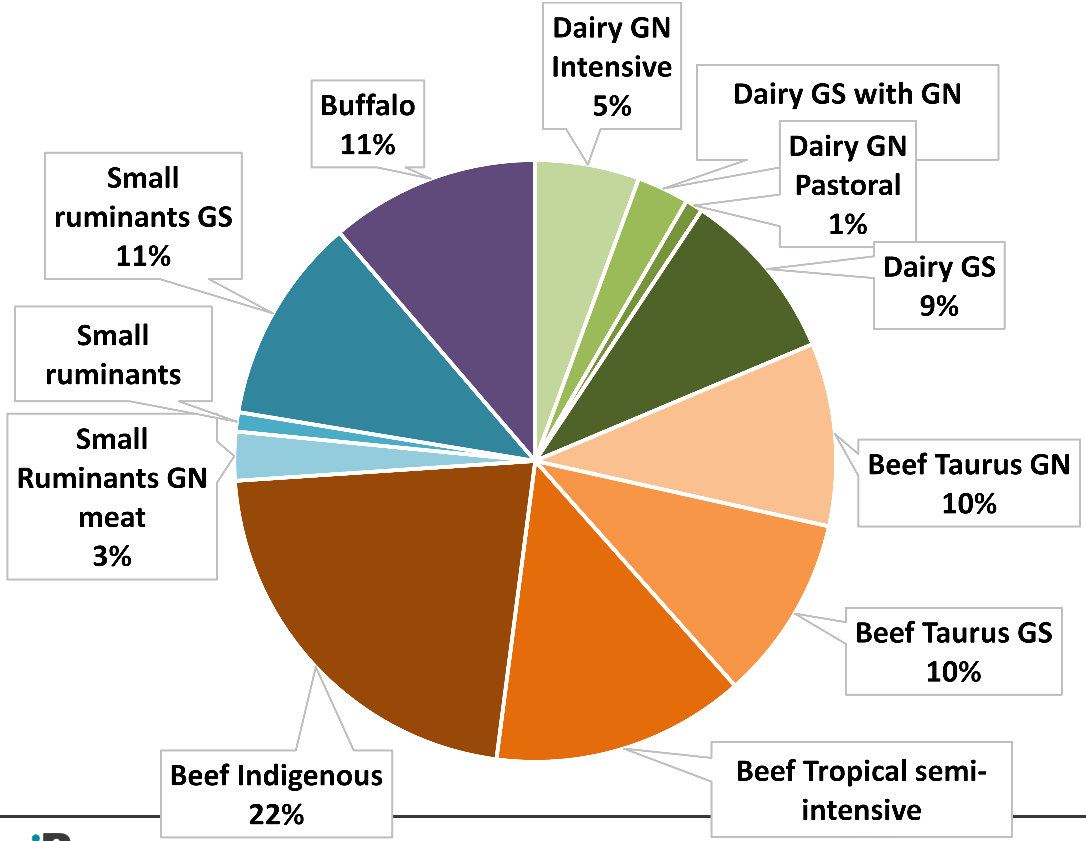
Comparison of e-Methane per group



Livestock Segment	Enteric methane Emissions (kt)
Dairy GN Intensive	5,565
Dairy GN Pastoral	928
Dairy GS with GN Influence	2,783
Dairy GS	9,275
Beef Taurus GN	9,776
Beef Taurus GS	9,888
Beef Tropical semi-intensive	13,548
Beef Indigenous	21,761
Small Ruminants GN meat	2,604
Small ruminants GN other	1,027
Small ruminants GS	11,056
Buffalo	11,217

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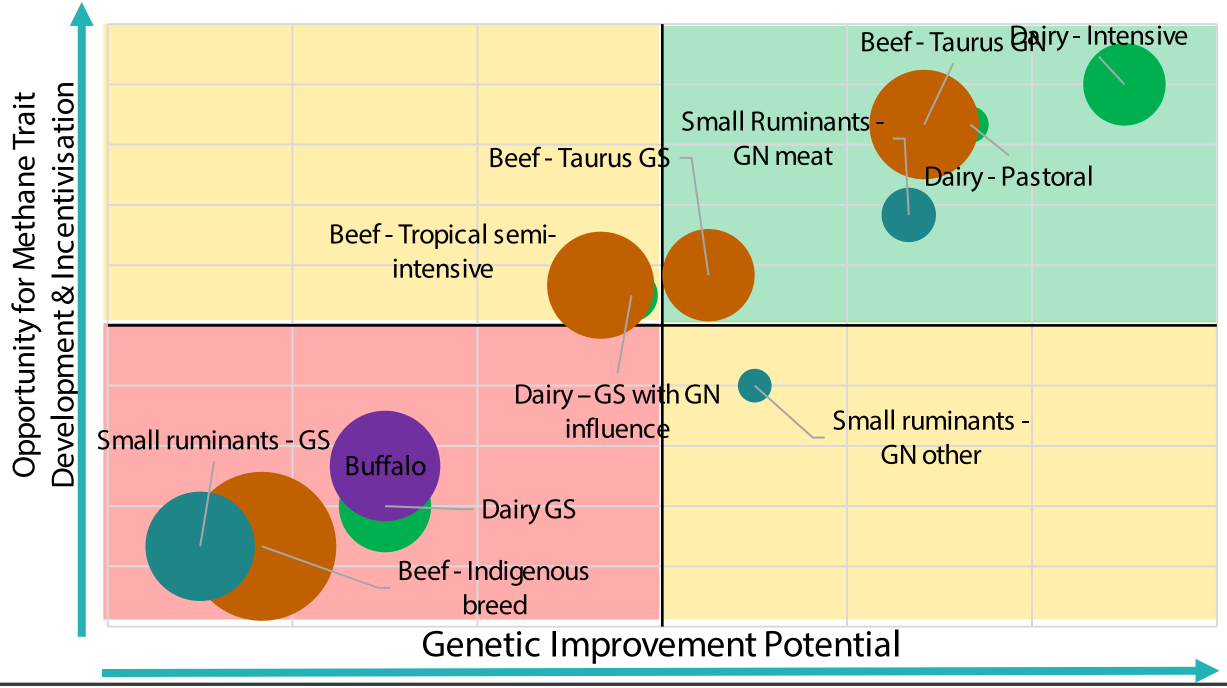
Global Methane Hub

Impact – Ease Matrix

Genetic improvement potential (Impact) versus **Opportunity for trait development** (Ease)



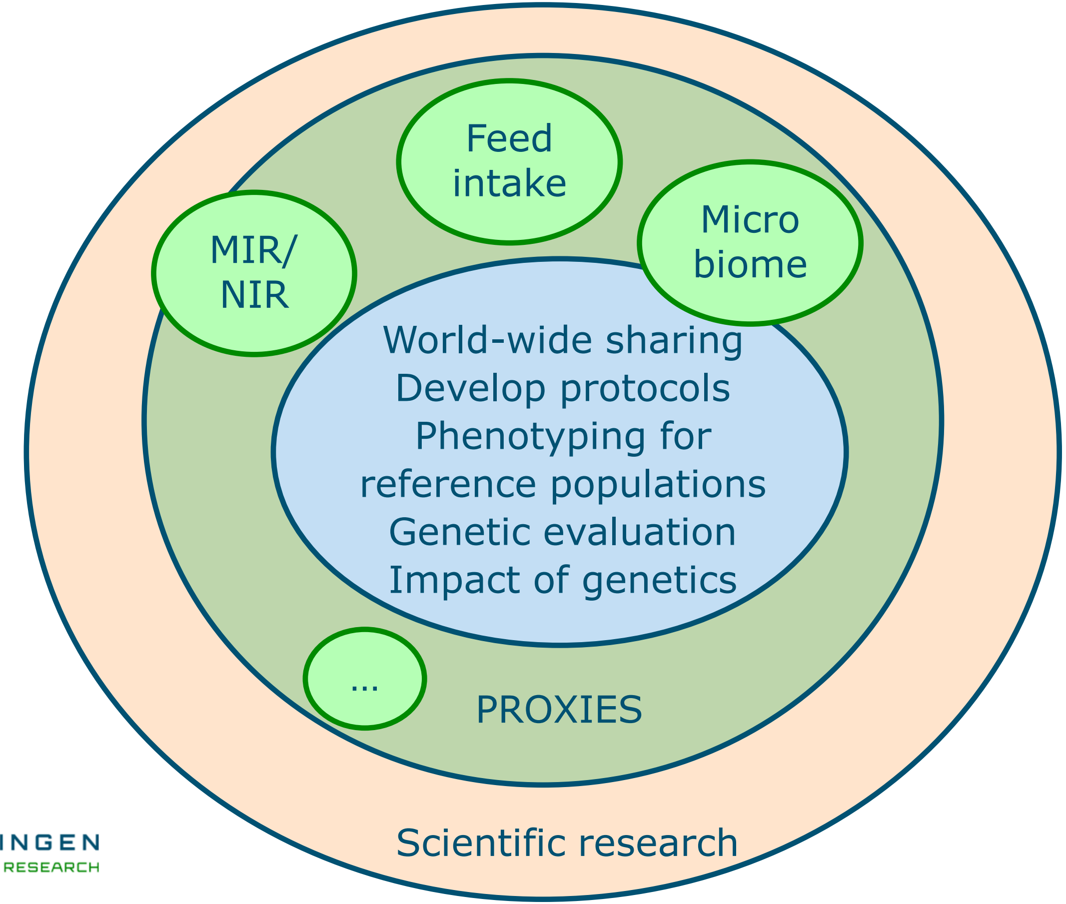
Impact Criteria

- Structure, alignment and coordination of genetic improvement sector
- Scale of addressable market
- Potential rate of genetic gain

Ease Criteria

- Industry complexity for methane trait development
- Access to infrastructure, research capability and resources
- Capacity to measure and incentivise emission reductions

Investment of Global Methane Genetics



Invest money
in the inner circle

Facilitate networks
linking with the two
outer circles.

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Focus of GMG – acceleration of genetic progress

Dairy program:
Holstein (~40k)
Jersey (~8k)
(Nordic) Red Breeds
Brown Swiss

South America
Beef & indigenous
(~7k)

Africa
Dairy & beef

India

Beef:
North America
(~6000)
Australia, Ireland,
UK, NZ (~18.5k)

World-wide sharing
Develop protocols
Phenotyping for
reference populations
Genetic evaluation
Impact of genetics

Microbiome:
Global reference
population
(~9.5k)

Sheep: global reference population
Australia & New Zealand
UK & Ireland
Uruguay (~ 17k)

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Focus of GMG – acceleration of genetic progress

Dairy program:

South America

Africa

Asia/India

Session 55: The holobiont concept
Tuesday, 9am

→ David Flossdorf

→ Renzo Bonifazi

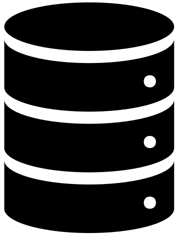
→ Oscar Gonzalez-Recio

→ Goutam Sahana

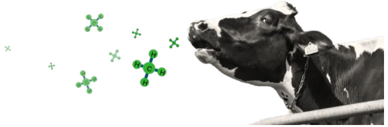
Microbiome:
Global reference population

Uruguay

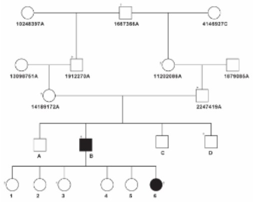
GMG - Database



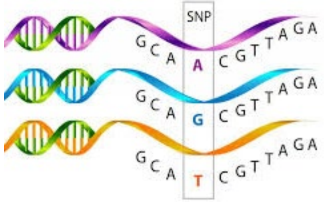
- Business requirement phase – collaboration ICAR, DataGene, Interbull, Lactanet, and others



- Methane phenotypes (any method), pedigree, genotypes
- Fair share policy – free riders!



- Cow equivalents established by the effective number of records (reliability) in genetic evaluation
- Requirement for all data paid by GMG – background data welcome
- …



Workshops – content driven task force - webinars

- ICAR Feed&Gas working group → icar.org
- Genetic progress in farm- and national credit analysis
- Webinar for policy makers about impact genetic progress
- Recording – pasture based systems
- SOP sniffer/GreenFeed –> re-visit
- SOP portable accumulation chambers
- Recording methane emission in small ruminants
- Microbiome platform/network – global collaboration
- …

Workshops – content driven task force - webinars

- ICAR Feed&Gas → icar.org
- Ger
- We
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- SO
- SO
- Re
- Mi
- …

Mailing list coming soon!

Contact us:

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Birgit.gredler-grandl@wur.nl

- Animal breeding is one of the important mitigation tools

- Cumulative and permanent

- Large reductions are possible

- Support farmers in reducing the environmental footprint of their farm with effective mitigation tools

Announcements

Re-Livestock
RESILIENT FARMING SYSTEMS

Hybrid course February 2025:

Re-Breeding for lower methane emissions: from farm measurement to genetic progress

Follow updates: re-livestock.eu

Announcements

9th GGAA

2025 · Nairobi, Kenya
5 - 9 October

International Greenhouse Gas & Animal Agriculture Conference

Join mailing list! Abstract submission opens soon!

https://ggaaconference.org/

Acknowledgements

BEZOS EARTH FUND

Global Methane Hub

Andy Jarvis

Hayden Montgomery
Rob Banks

ICAR Feed&Gas working group and collaborators

ICAR Feed&Gas
Christine Baes, Lorenzo Benzoni, Maria Frizzarin, Karoline Bakke, Raffaella Finocchiaro, Rasmus Bak Stephansen, Jan Lassen, Caeli Richardson, Jennie Pryce, Nina Krattenmacher

Donagh Berry
Mike Coffey
Beat Bapst
Amelie Vanlierde
Nicolas Gengler
Enyew Negussie
Christa Egger-Danner
Franciso Penagaricano
Oscar Gonzalez-Recio
Filippo Miglior

Pauline Martin
Kathrin Stock
Marcin Pszczola
Suzanne Rowe
Loran McNaughton

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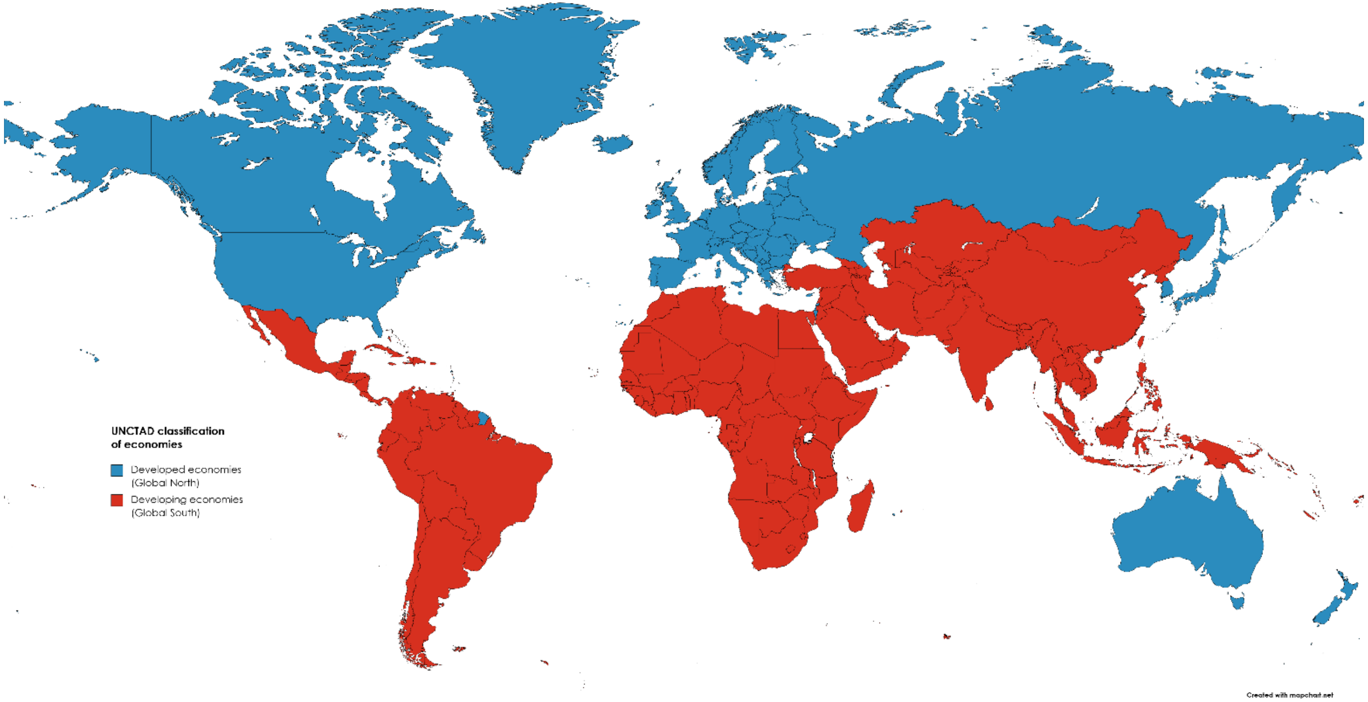
Genetic correlation Dutch NVI – CH4conc

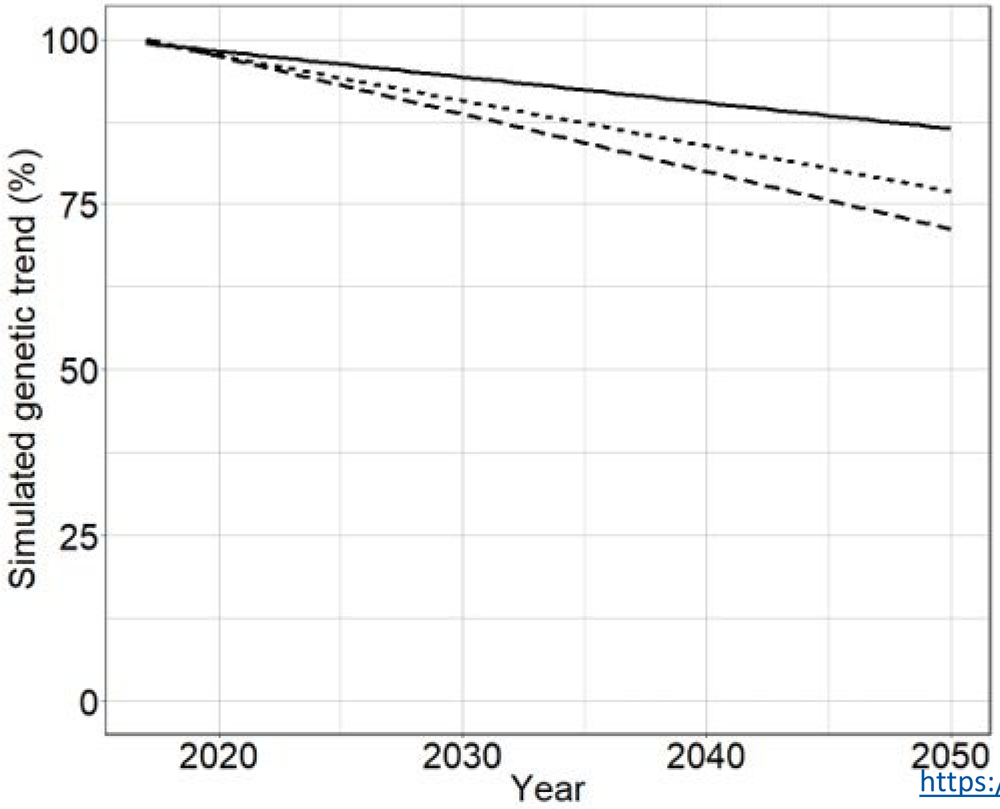
Trait	rg	Trait	rg
NVI	0.08	Direct calving ease (pnt)	0.19
Milk yield (kg)	-0.11	Maternal calving ease (pnt)	0.07
Fat yield (kg)	-0.08	Interval calving-first insemination (pnt)	0.23
Protein yield (kg)	-0.04	Interval first-last insemination (pnt)	0.21
Lactose yield (kg)	-0.18	Conception rate (pnt)	0.14
INET*	-0.07	Conception rate heifers (pnt)	0.30
Longevity (days)	-0.01	Udder health (pnt)	0.06
Functional longevity (days)	-0.01	Claw health (pnt)	0.23
Udder (pnt)	-0.09	Survival (pnt)	-0.22
Feet & legs (pnt)	-0.06	Saved feed cost for maintenance (euro)	0.21

Scope



Wikipedia

Impact of genetic selection

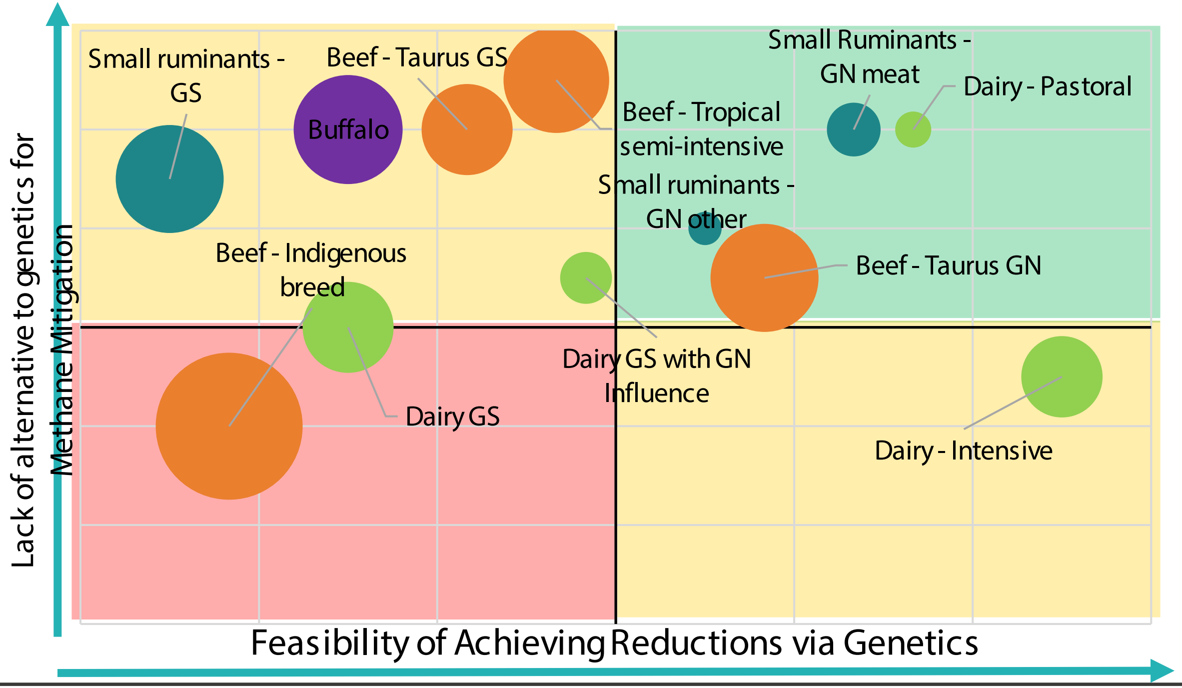


- Methane intensity (g/kg milk)
- Current trend
- Combined selection for CH4 and other traits
- Theoretical maximum (exclusively focusing on methane)

https://doi.org/10.1016/j.animal.2021.100294 (de Haas *et al.* 2021)

Feasibility - Alternative Matrix

Feasibility of achieving methane reductions (via genetics) versus **Lack of alternative to genetics for methane reductions**



Feasibility Criteria

- Structure, alignment and coordination of genetic improvement sector
- Scale of addressable market
- Potential rate of genetic gain
- Industry complexity for methane trait development
- Access to infrastructure, research capability and resources
- Capacity to measure and incentivise emission reductions

Lack of Alternative Criteria

- Applicability of other interventions
- Management opportunities