Breeding for improved feed efficiency and reduced enteric methane of dairy cattle

Yvette de Haas and Roel Veerkamp

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1918 — 2018

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History

UNIVERSITY OF ILLINOIS

Agricultural Experiment Station.

URBANA, NOVEMBER, 1901.

BULLETIN No 66.

INDIVIDUAL DIFFERENCES IN THE VALUE OF DAIRY COWS.

By WILBER J. FRASER, Instructor in Dairy Husbandry, College of Agriculture and Chief in Department of Dairy Husbandry, Agricultural Experiment Station.

Common observation teaches us that different cows produce different amounts of milk and butter-fat in the same period of time, but it does not inform us whether the food consumption differs in proportion to yield, or whether one cow may actually manufacture more than another out of the same amount of feed. The question then arises, will two cows fed on like feeds make the same returns, and, if not, will the yield be in the ratio of the feeds consumed.

Journal of Heredity (1911) os-6:295-300

countries. They have become widely disseminated in Sweden and Norway, and there are now control associations in Finland, Russia, Germany and Scotland. In most places an attempt is made to carry out the weighing and valuation of the feed, as in Denmark; but, in some parts of Norway, where the cows subsist entirely on grass in the summer and on hay and straw in the winter, it is thought that the estimate of the feed will be too inaccurate, and therefore the work of the control assistant is limited to managing the test milking, testing for butter fat, and keeping a record of the milk and butter yield.

Where there is no record of the consumption of feed, there will be no basis for a fair comparison of the milk and butter yield in the various herds, because the amount of feed will always affect the yield of butter; but, even without a record of the feeding, the "control" will give every farmer valuable information regarding the yield of milk and butter of the individual cows, so that he can positively distinguish the best, the good, and the poor cows; and he gets an opportunity to find those cows that give particularly rich milk, which is of immense importance, if it is, as we believe, that giving rich or poor milk is for each cow a peculiar and inherited quality.

NOTE.—
1 pound, Danish, is the same as 1.12 English.
1 Krone = $.268.
1 Ore = 1/100 Krone = ¼ cent.

[Presented by the Committee on Cooperation in Animal Breeding.]

Translated from the Danish manuscript.

COW-TESTING ASSOCIATIONS.

COLON C. LILLIE, *Coopersville, Mich.*

A cow-testing association is a cooperative business association among the dairy farmers of a community for the purpose of testing their cows for economical production. Each cow is charged with the food she consumes and given credit for the butter fat she produces for the entire year at market prices. A competent person is employed by the association to go from farm to farm and weigh and compute the ration, weigh and test the milk and keep accurate records of the same.

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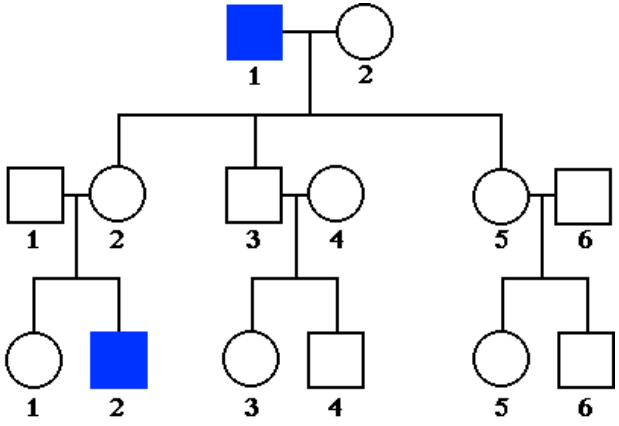
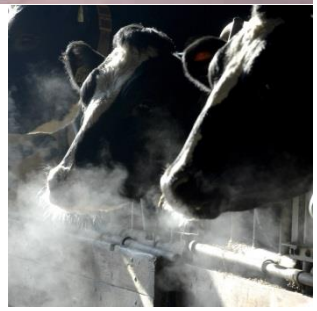
Traditional breeding

Pedigree



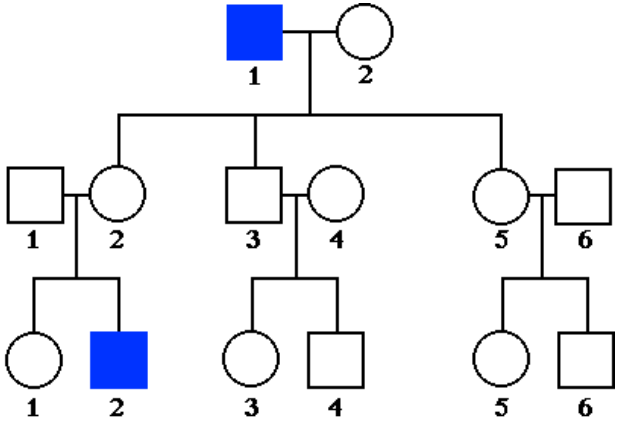
Phenotypes

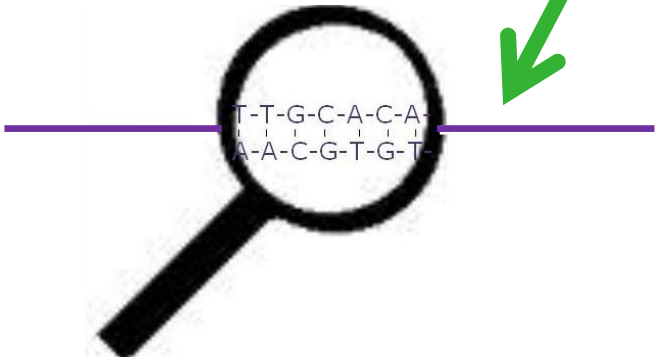


Estimated breeding value (BLUP)

Genomic selection

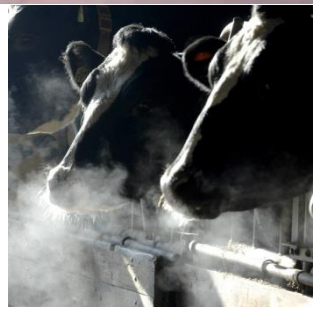
Pedigree





Genomic breeding value

Phenotypes



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In The Netherlands

We developed (a procedure to predict) feed intake (DMI) breeding values for Dutch bulls and cows

First genetic evaluation in 2014

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DMI data

- Data from 1990 onwards:
  - Data providers
    - Wageningen Livestock Research
    - ILVO
    - Trouw Nutrition
    - Schothorst Feed Research
    - AVEVE
  - CRV
    - Alders herd – 240 cows
    - in 2019: 4 more herds to follow

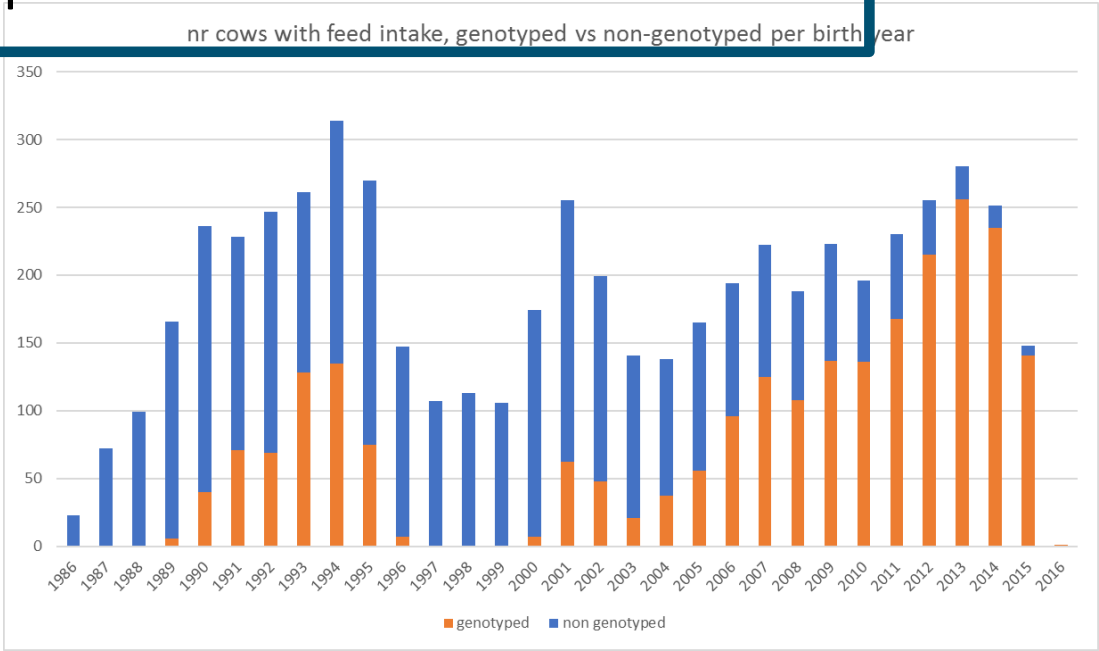
DMI data in December 2018

5649 cows with DMI data

- 2380 cows with data and genotypes
- 3269 cows with data without genotypes

5649 total cows from 1085 sires

- 530 sires with genotypes
- 555 sires without genotypes



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Predictor traits

- Genomic EBV DMI directly from DMI genetic evaluation combined with national EBV for four predictor traits:
  - Kg milk
  - Kg fat
  - Kg prot
  - Live weight

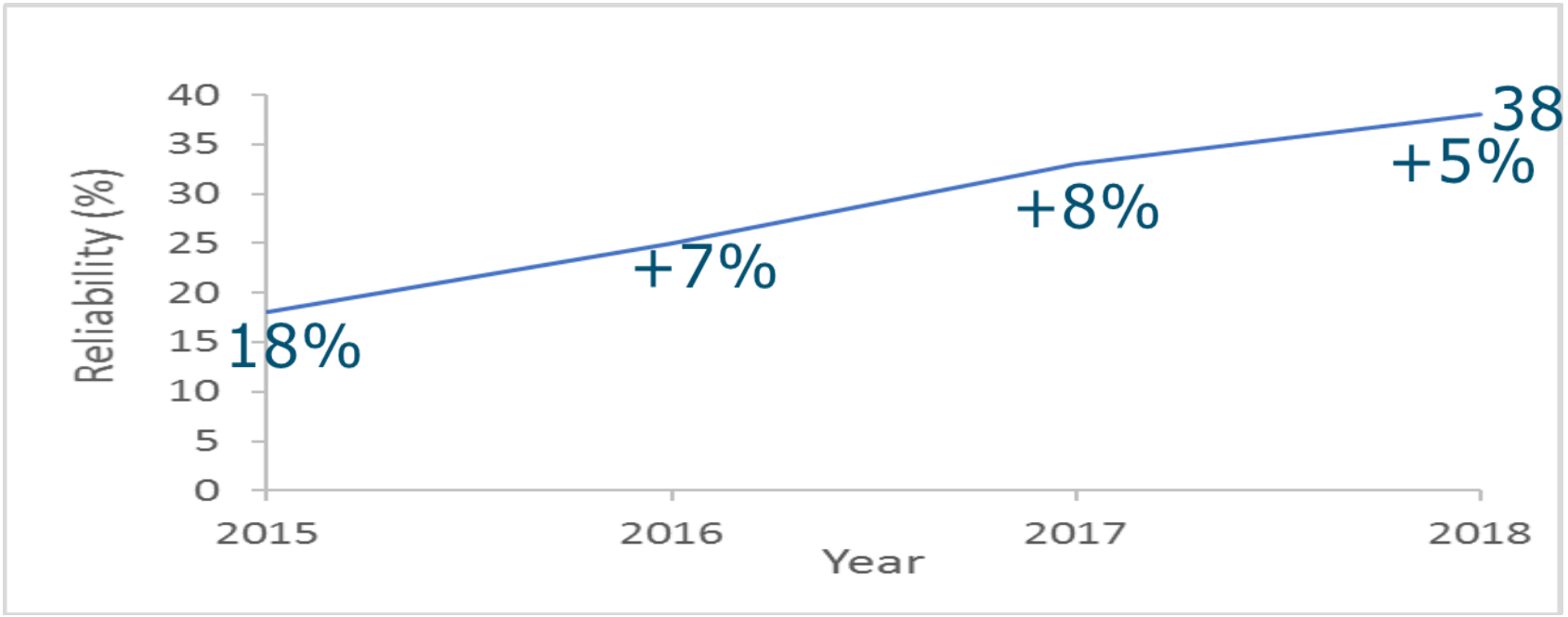
Genetic correlations

	DMI1	DMI2	DMI3
Kg milk	0.55	0.58	0.56
Kg fat	0.58	0.60	0.58
Kg prot	0.59	0.61	0.59
Live Weight	0.67	0.45	0.41

- Selection index weighted based on reliabilities
- Model reliabilities

Reliabilities DMI – only genomics

2015	2016	2017	2018
55,437 rec	+ 22,391 rec	+ 51,610 rec	+ 30,510 rec
2,249 anim	+ 965 anim	+ 1,149 anim	+ 1,082 anim
123 exp	+ 429 exp	+ 368 exp	+ 182 exp
2,922 lact	+ 1,502 lact	+ 2,529 lact	+ 1,409 lact



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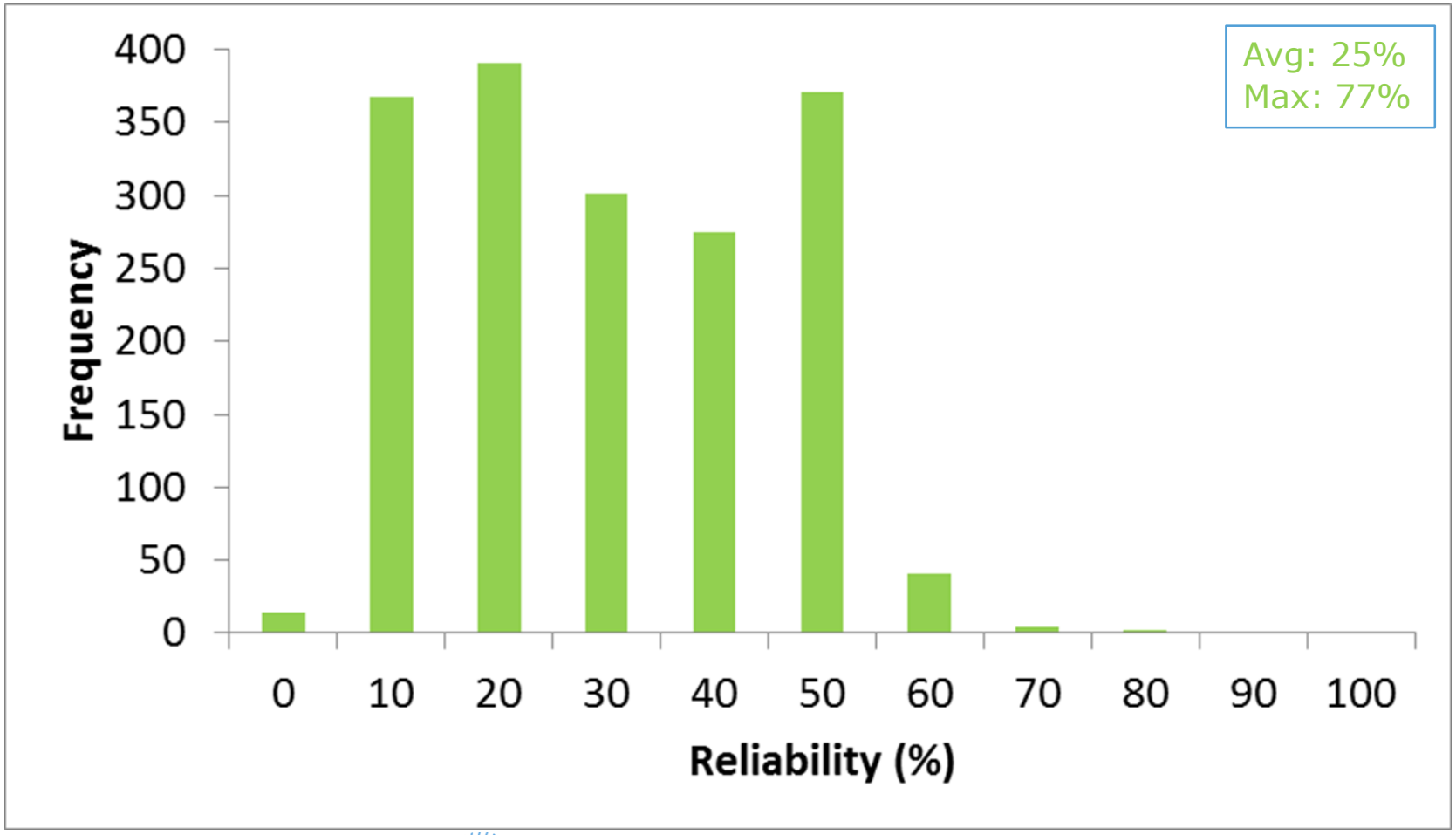
Reliabilities for bulls with genomic predictions, but no daughters with DMI



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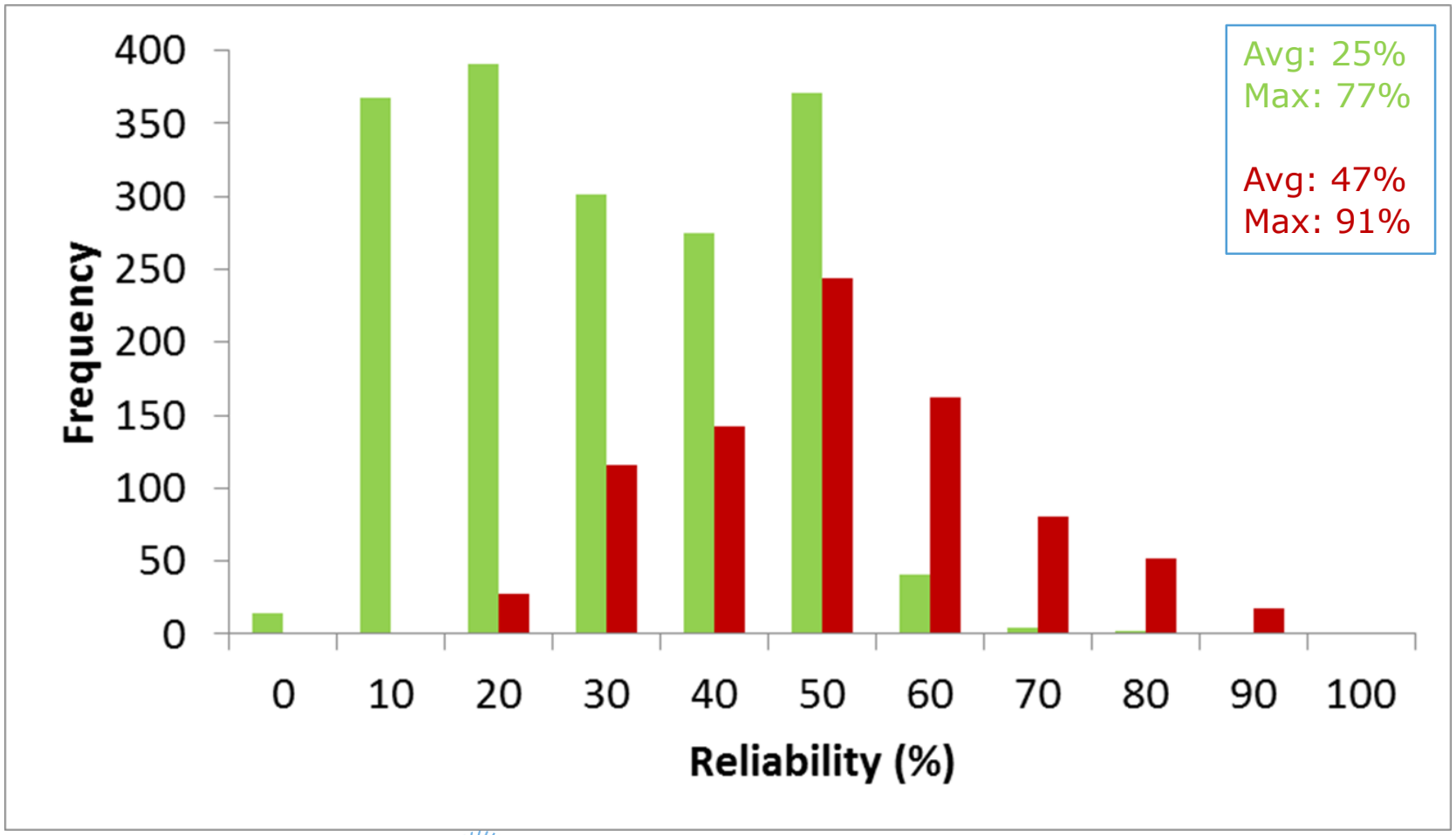
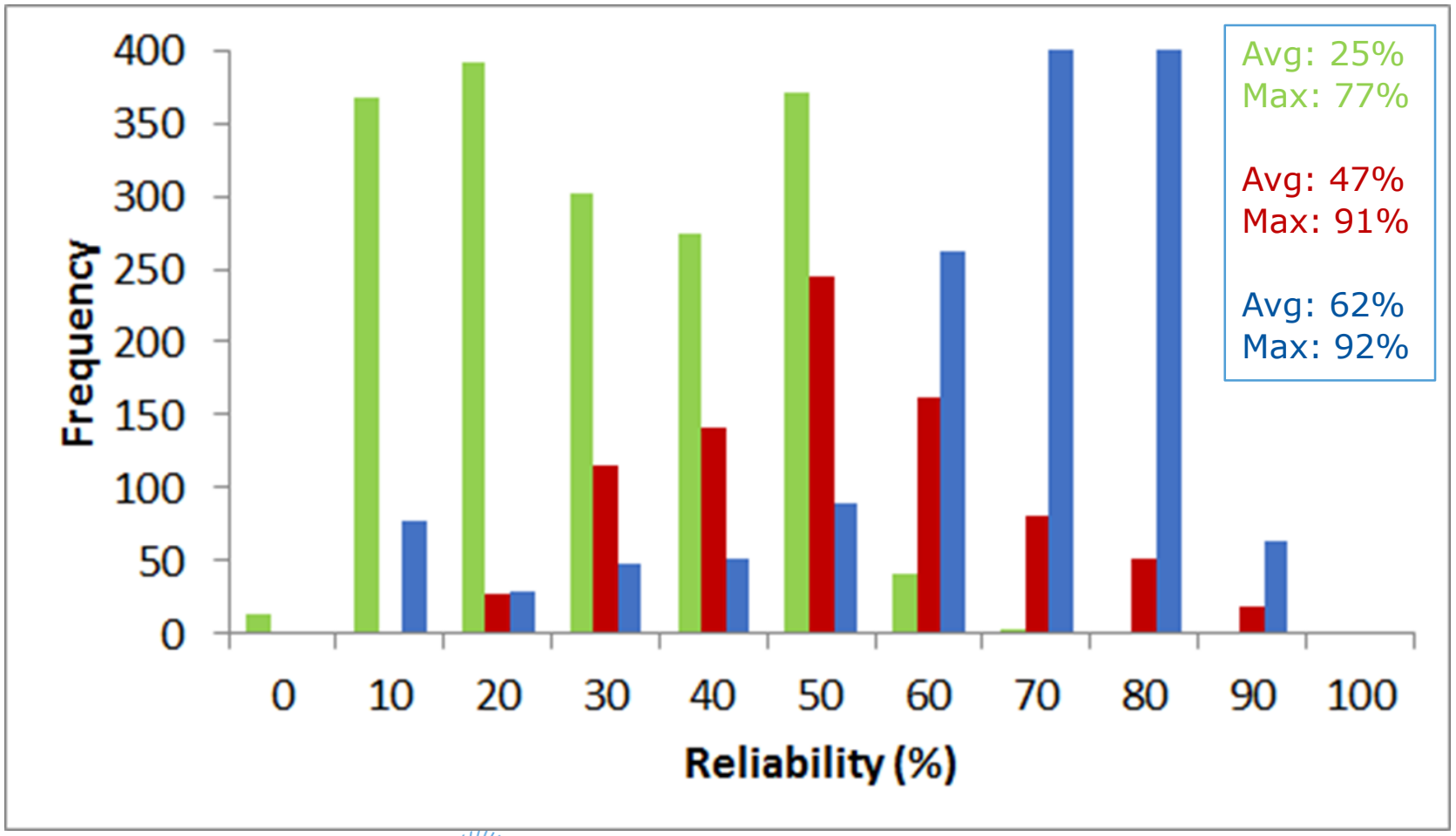
Reliabilities for bulls with genomic predictions ánd daughters with DMI



Reliabilities for all bulls in pedigree of genetic evaluation DMI + predictors



Saved Feed Cost (SFC)

- SFC = saved feed cost for maintenance
  = feed intake – feed for production

  -> feed for:
  maintenance
  difference in digestion
  activity

- Unit: euro/lactation

To sum up:

- >5600 cows with feed intake data
  - Increase over the years (about 1000/year)
  - Increase in genomic reliability
- DMI used to define SFC
  - SFC part of NVI
- Big step to breed for efficient cow

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Cows ruminate

Ruminants account for up to 18% of the world CH_4 production

>90% of CH_4 excreted through the breath

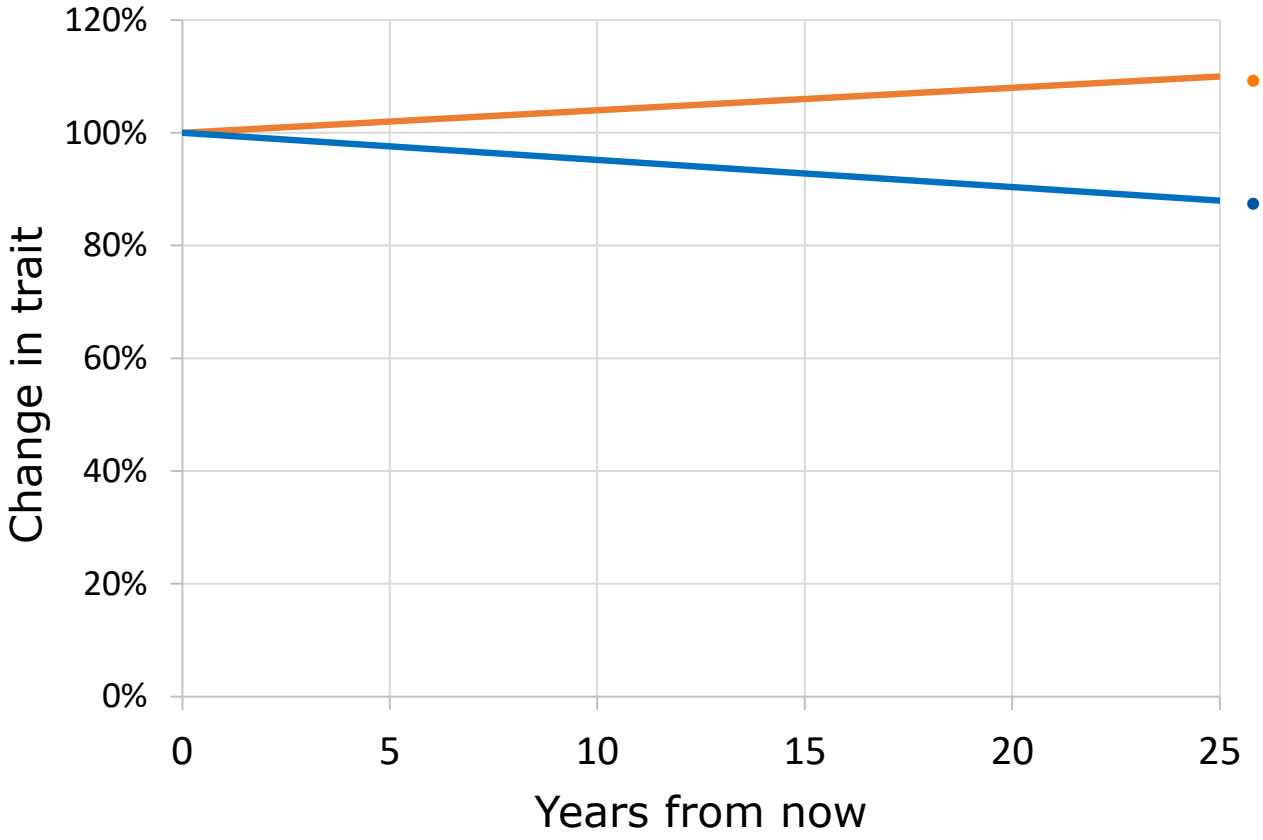
Animal nutrition
Microbes
Genetics

Climate agreement - *klimaatakkoord*

- **Objective** (for NL) is to achieve a greenhouse gas (GHG) emission reduction of 49% in 2030 (compared to 1990) (*and of 95% in 2050)*

- In 1990 – total GHG emissions were 228 megaton CO_2-eq
- In 2030: this has to be reduced to 116 Mton
  - The current mitigation strategies will enable a reduction to 165 Mton
  - The climate agreement has to bridge the gap of 49 Mton

If we continue to do what we already do:



- Methane, g/d
- Methane, g/kg milk

Current pop. means:

CH_4: 392 g/d
Milk: 9000 kg (305 d)
Intensity:
16g CH_4/kg milk

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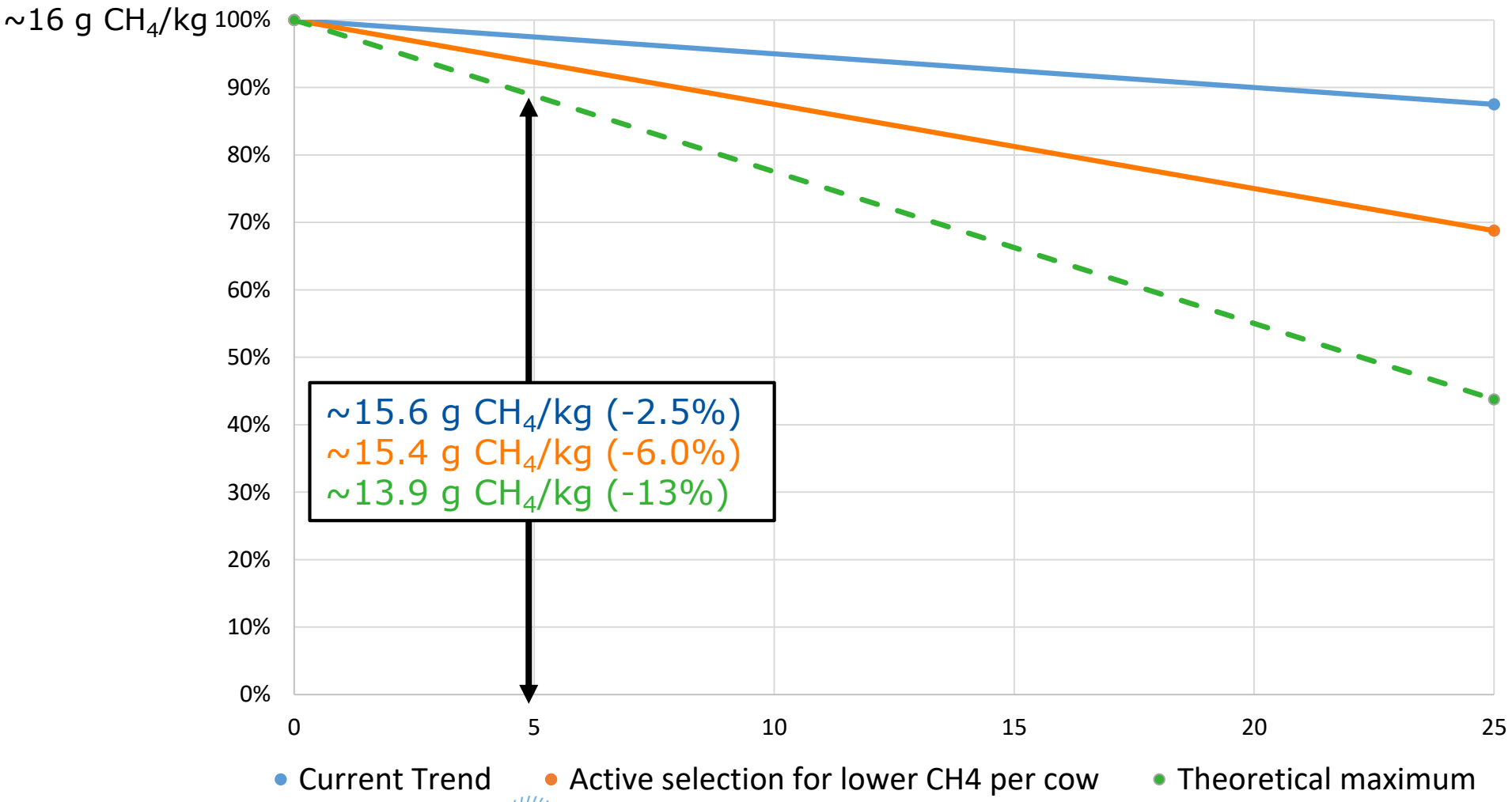
This is what breeding can do:



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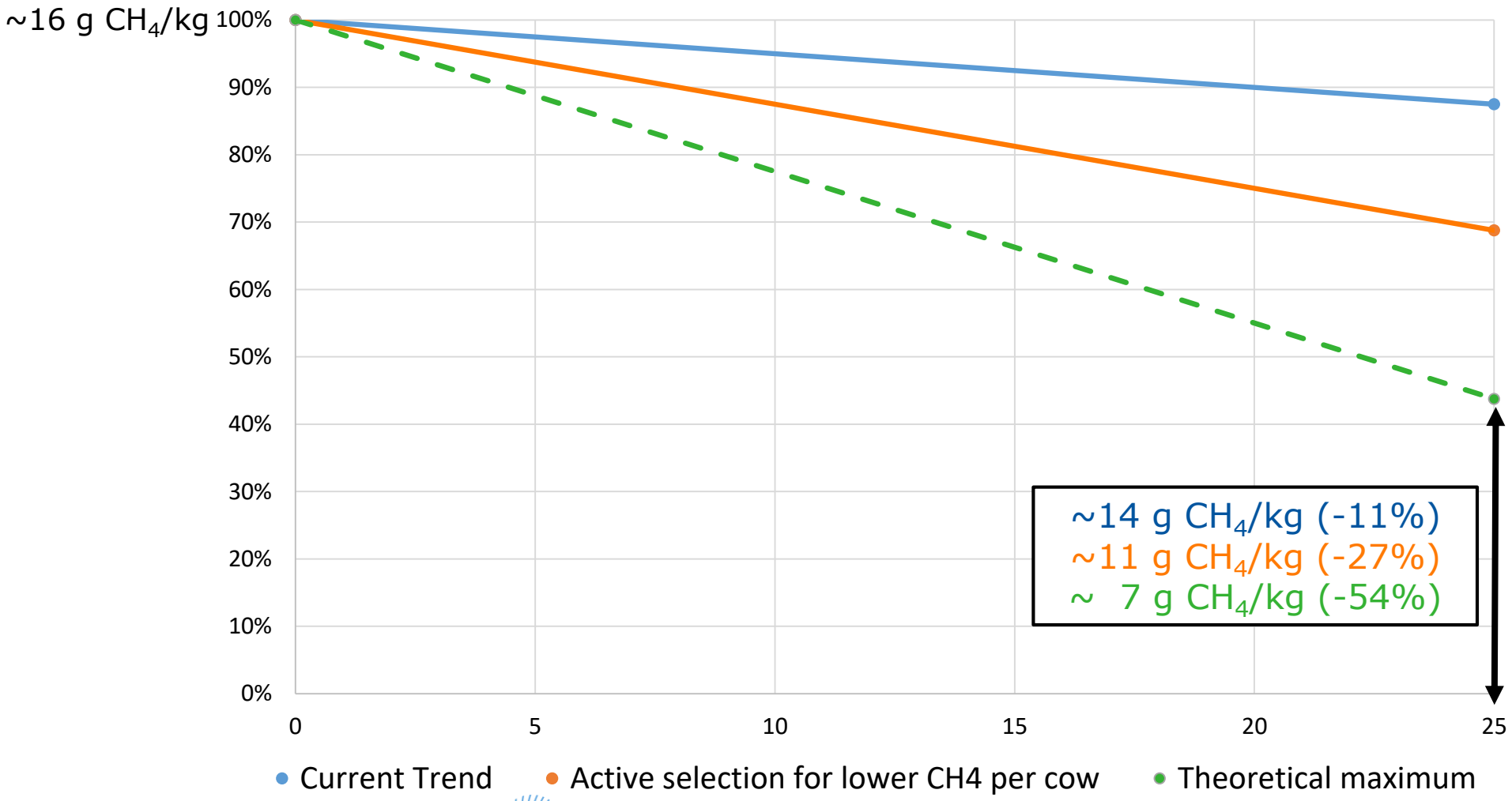

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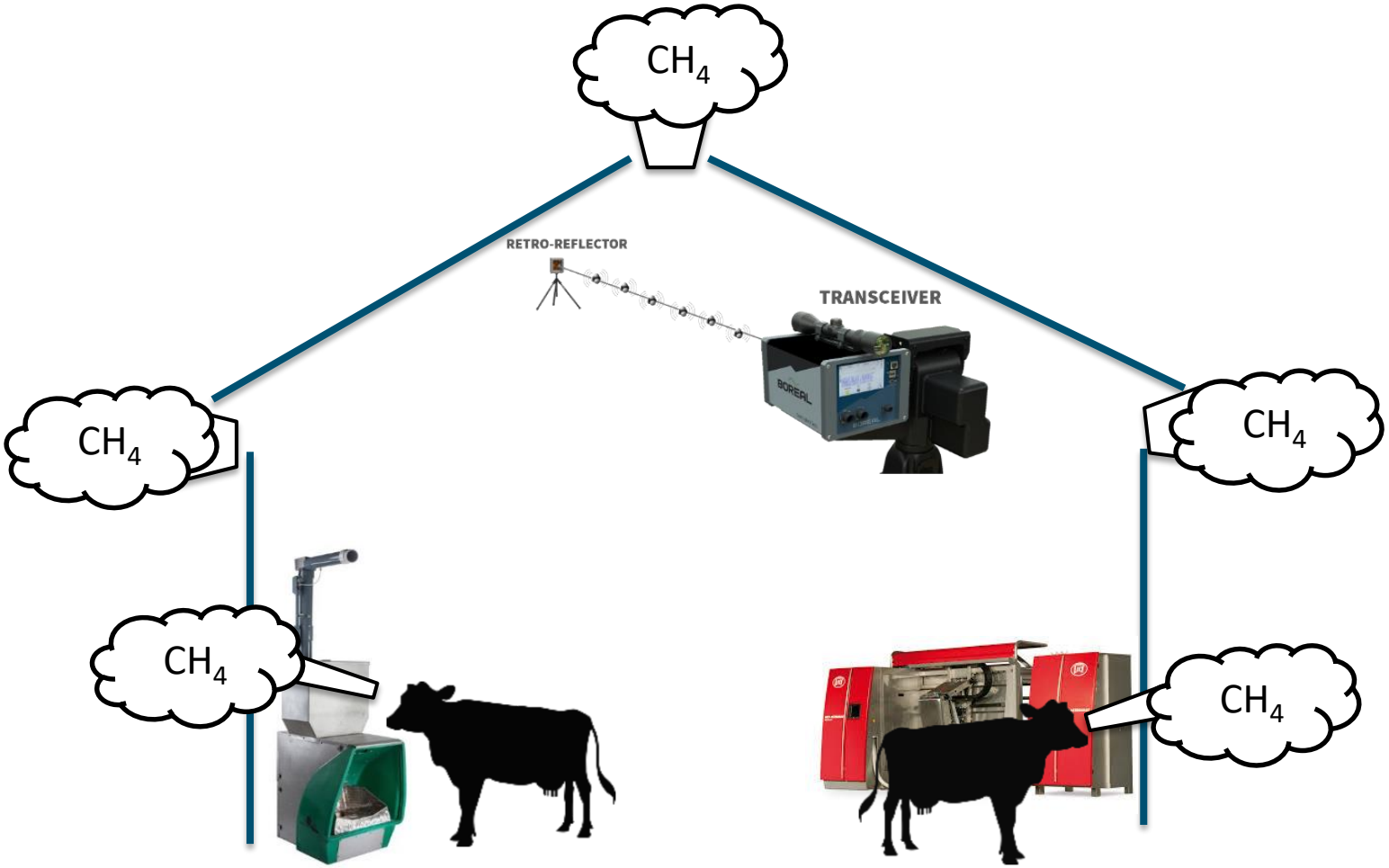
That is why we are collecting data on farm



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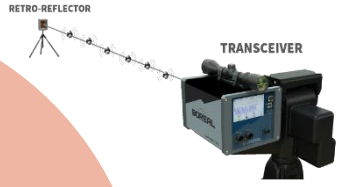


Barn
(18)

5

11

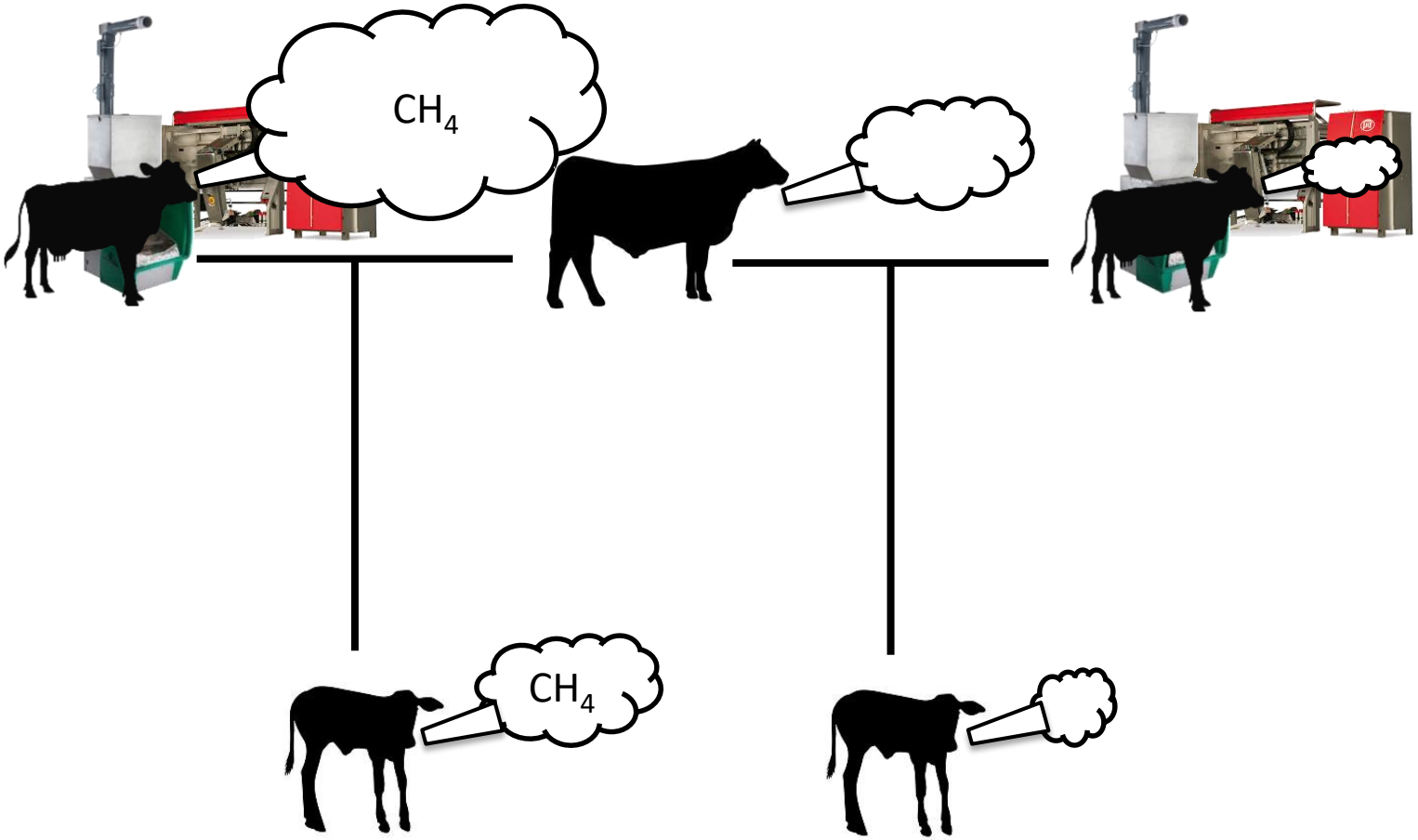
3

GreenFeed
(18)

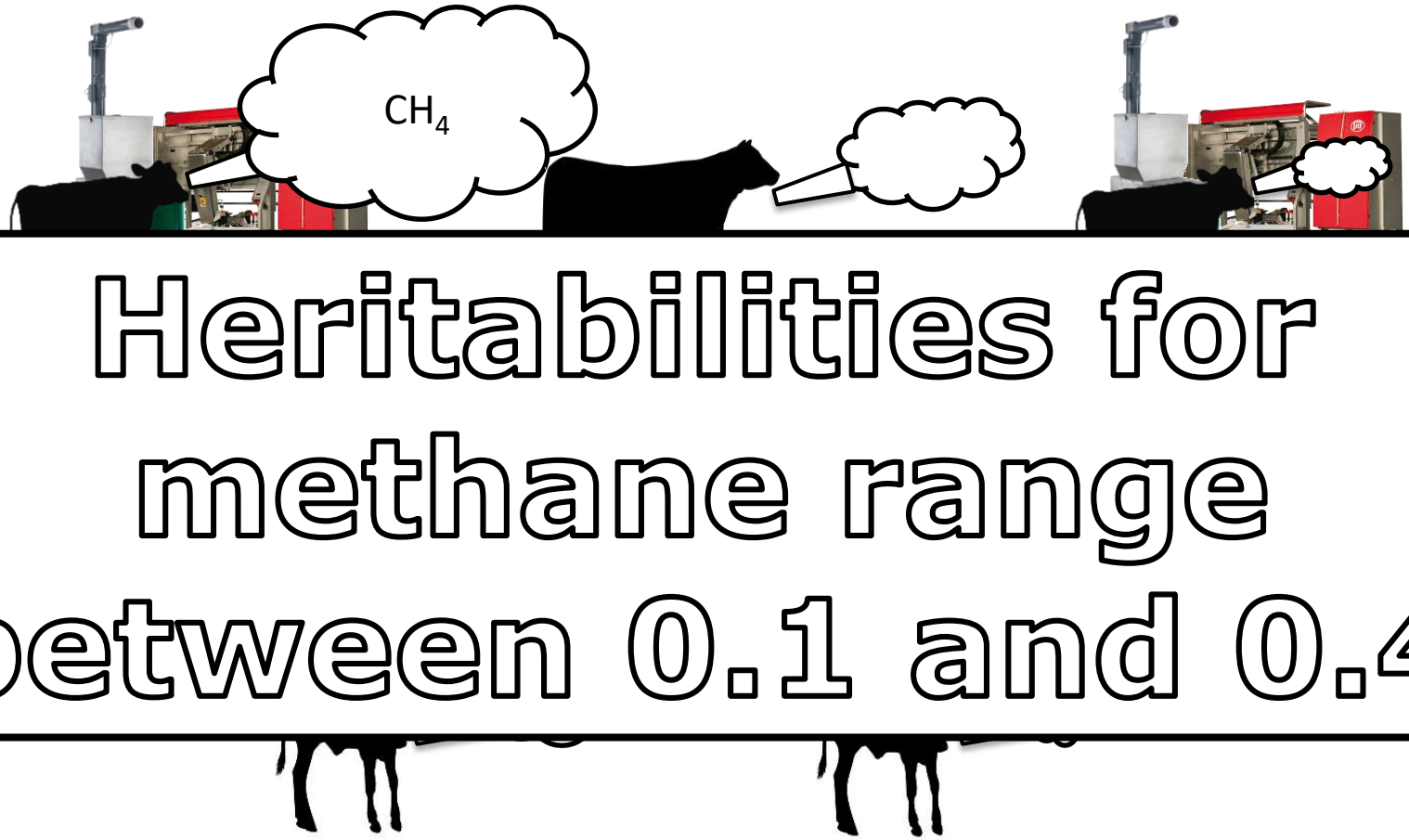
8

Sniffer
(15)

Towards a breeding value for methane

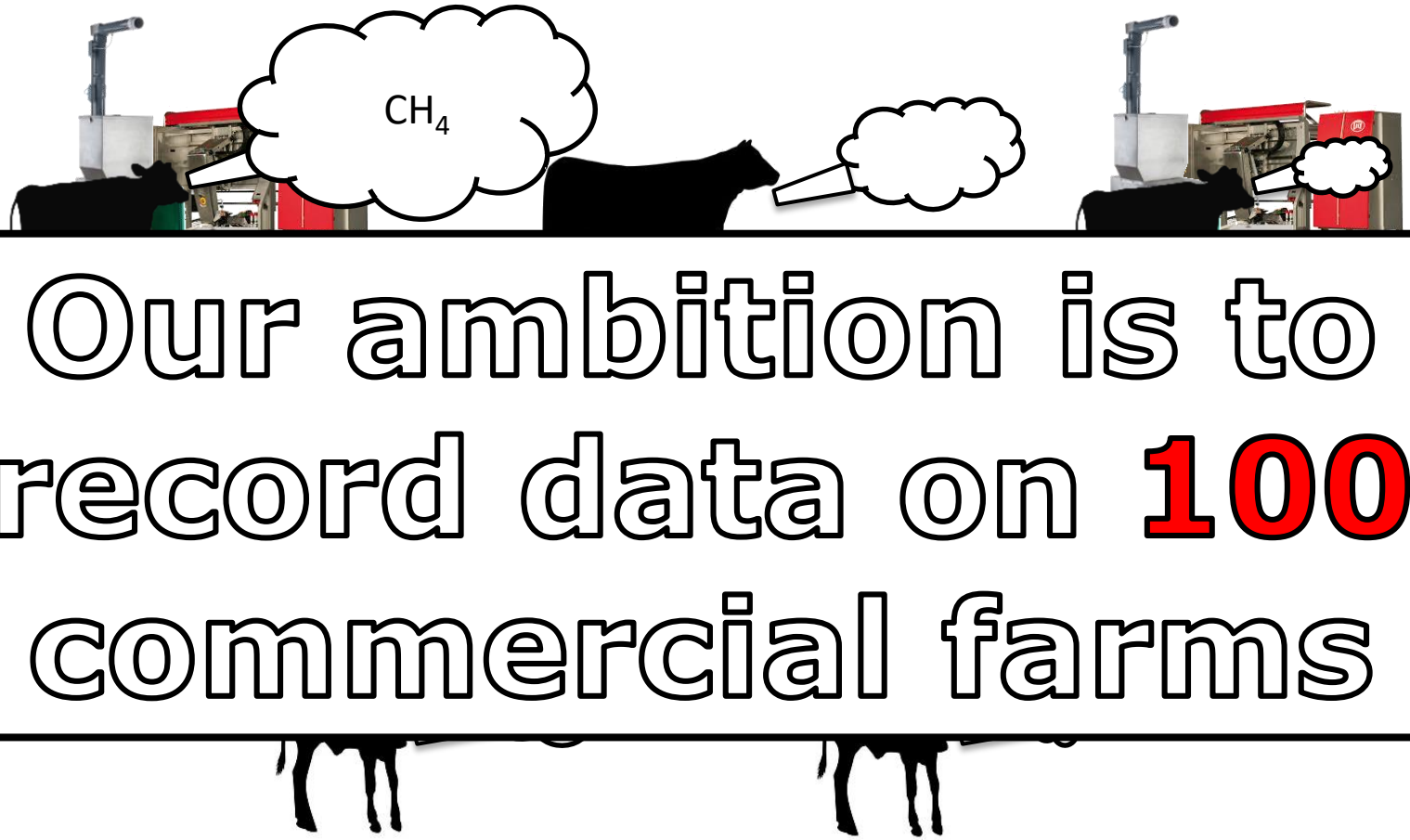


Towards a breeding value for methane



Heritabilities for methane range between 0.1 and 0.4

Towards a breeding value for methane



Our ambition is to record data on 100 commercial farms

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Take home messages

- Genomics did open the era of breeding for novel traits
  - Large reference populations are still needed
- Successful publication of EBV for feed intake and feed efficiency in the Netherlands
- Working towards breeding as mitigation tool to reduce enteric methane emissions of dairy cattle

Thank you!

Ministerie van Landbouw,
Natuur en Voedselkwaliteit

BREED4FOOD

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CRV

Schothorst Feed Research

AVEVE
Groep AVEVE

trouw nutrition
a Nutreco company

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