Poznań University of Life Sciences
FACULTY OF VETERINARY MEDICINE AND ANIMAL SCIENCE
Department of Genetics and Animal Breeding

WAGENINGEN
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Genetic correlations between methane production and traits from Polish national evaluation

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NATIONAL SCIENCE CENTRE
POLAND
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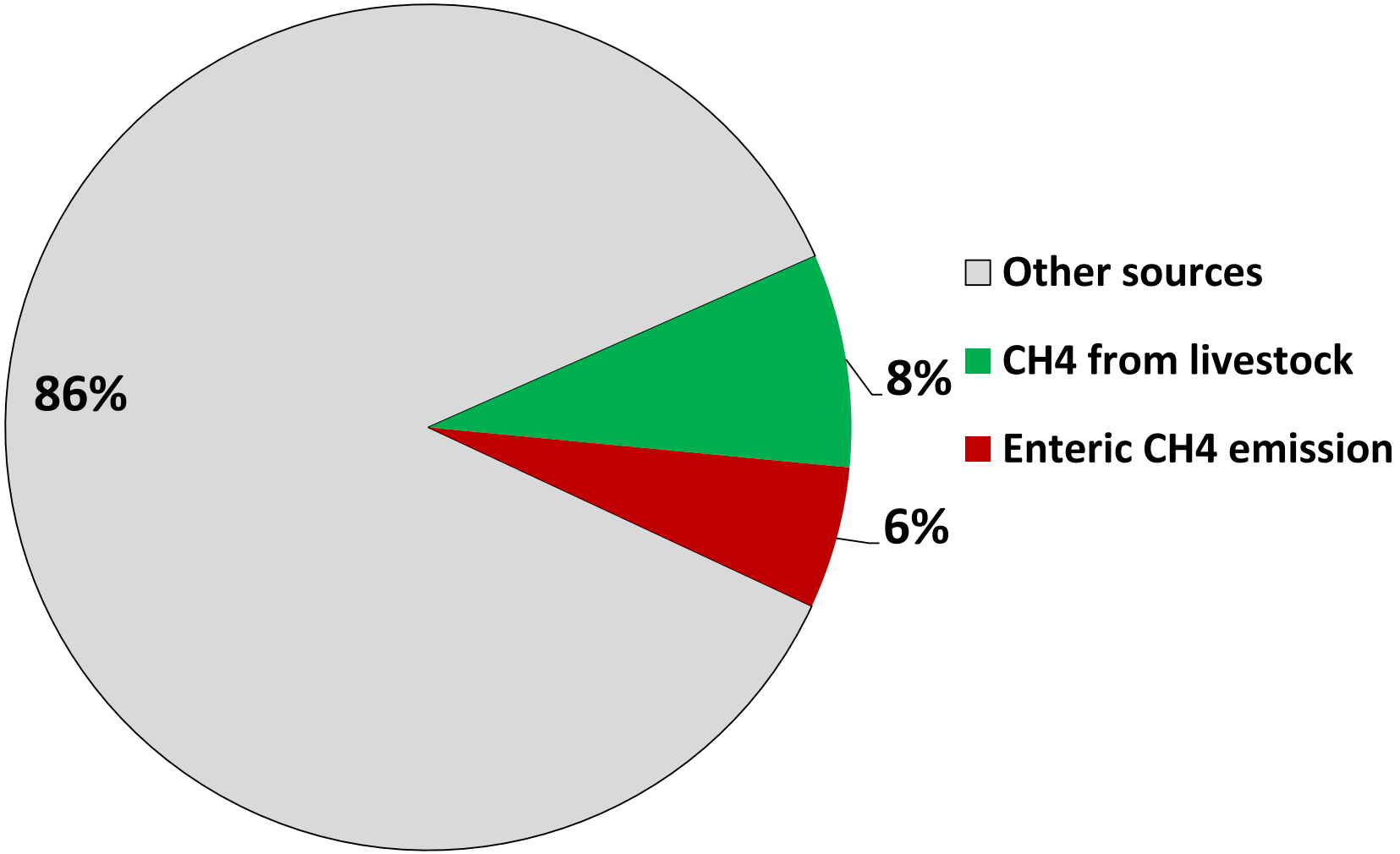
Ecology

CH_4 = Greenhouse gas

6% of the global temperature increase due to enteric CH_4



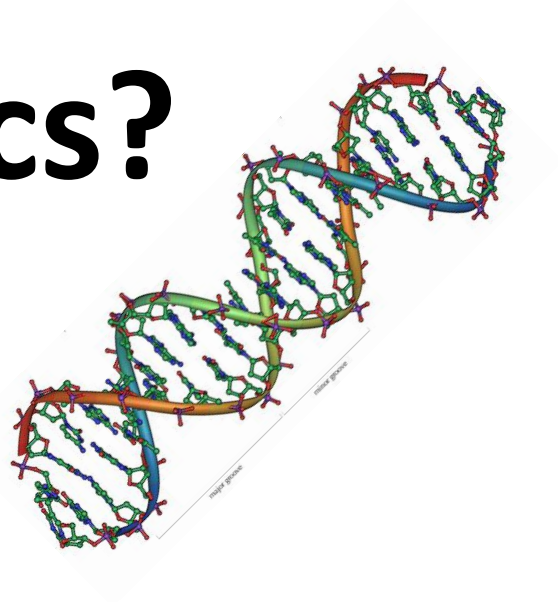
Reisinger and Clark, 2018


€CONOMY

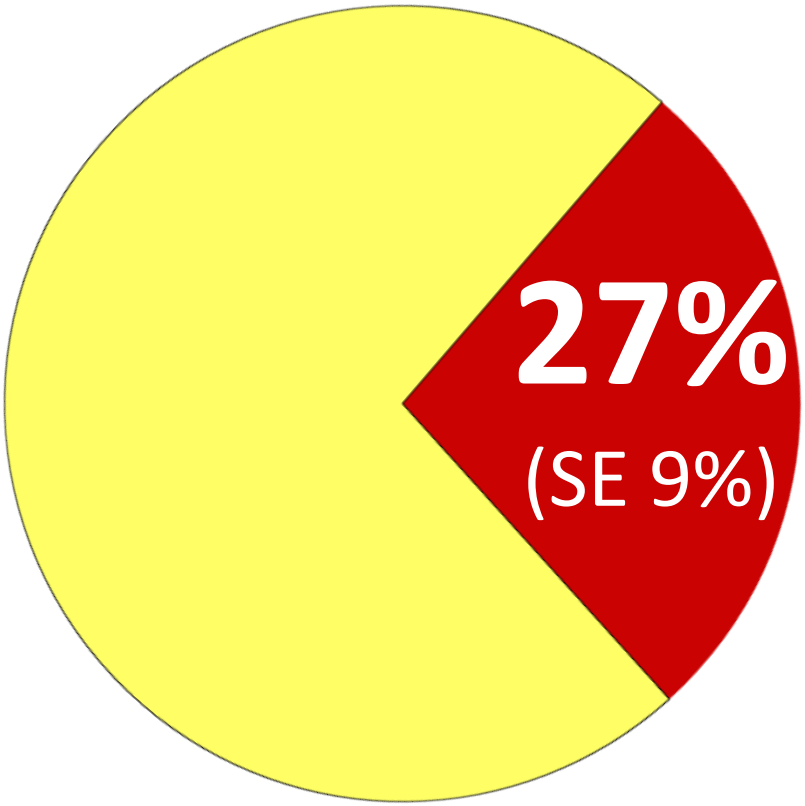
CH_4 emission means 2% - 12% feed energy losses

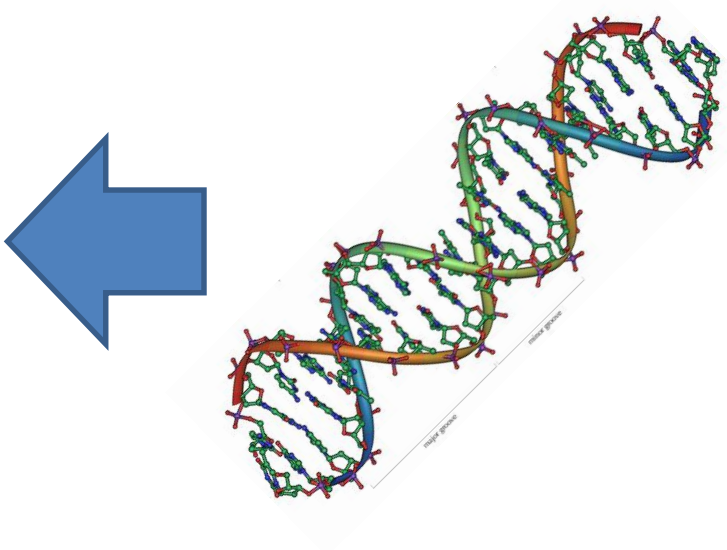
Blaxter, 1962; Johnson and Johnson, 1995

Any genetics?



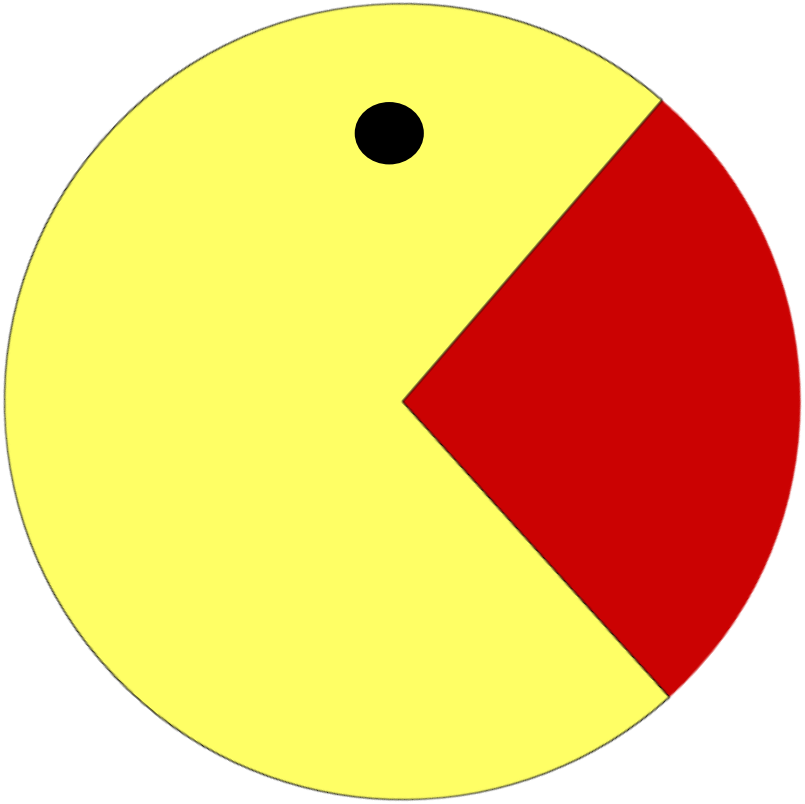
Over ¼ of variation in CH_4 is genetics

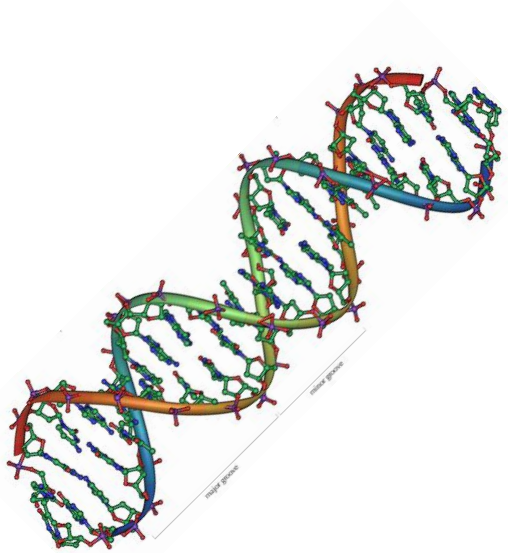




Pszczola et al. JAS, 2017

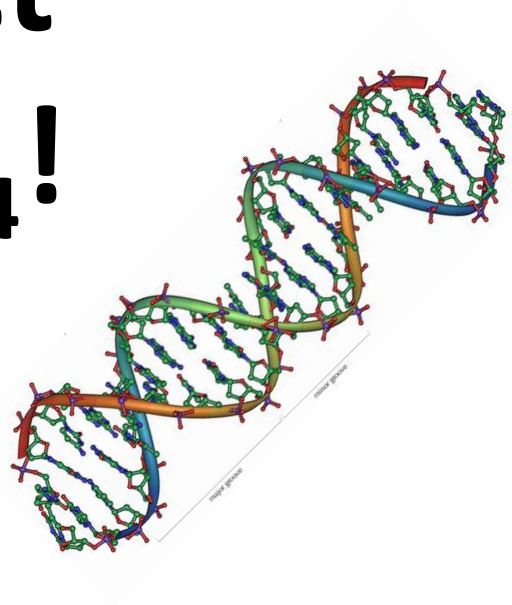
Over ¼ of variation in CH_4 is genetics



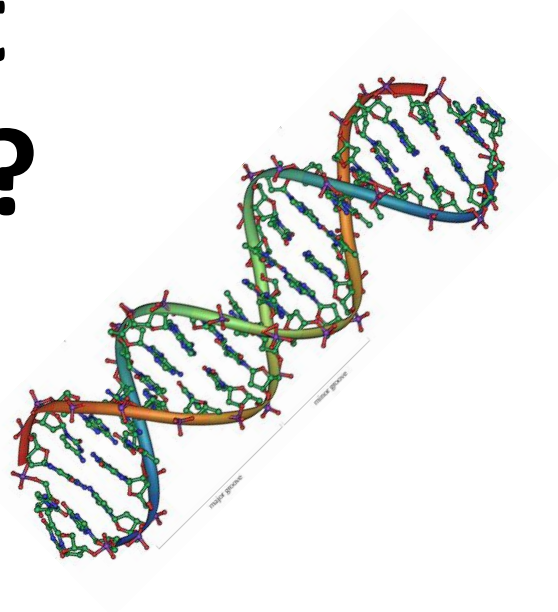


Pszczola et al. JAS, 2017

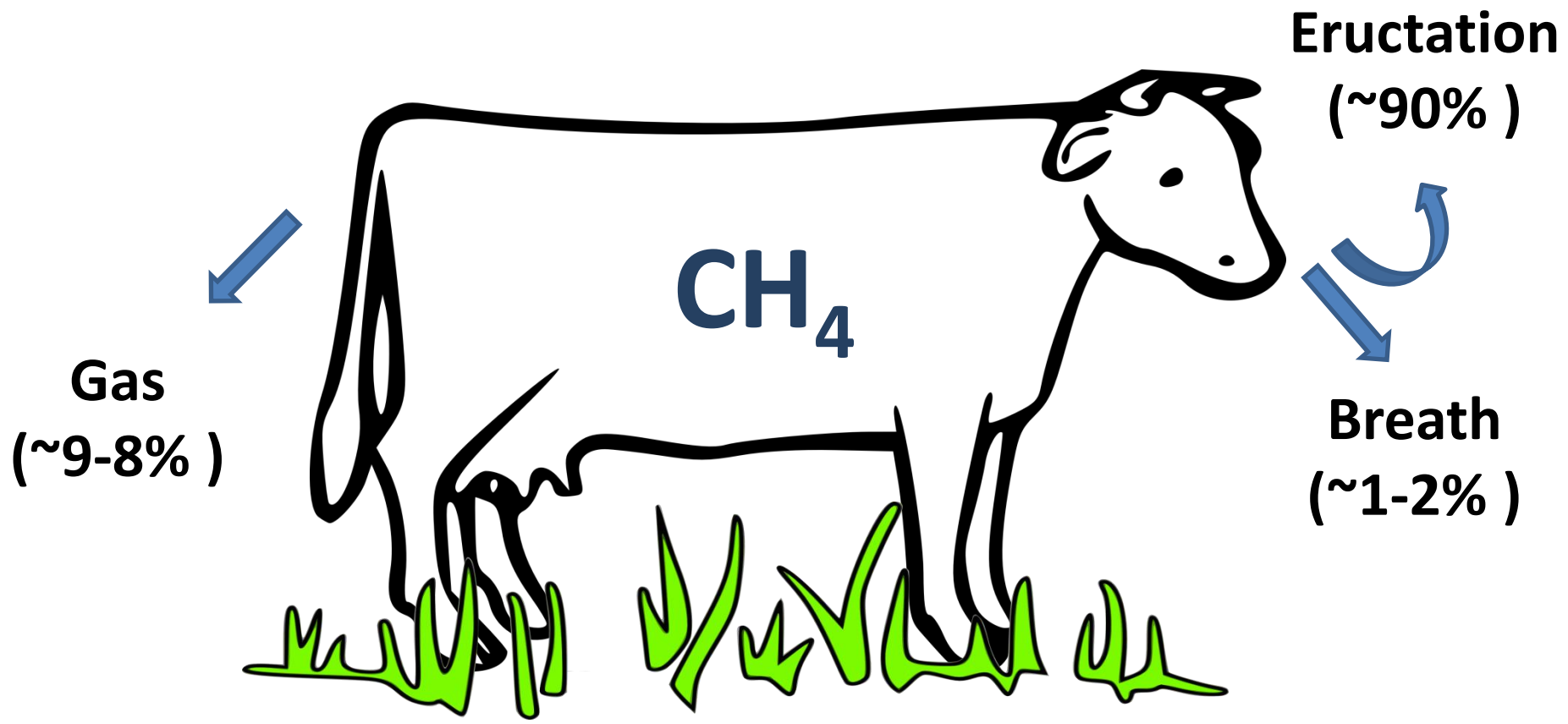
We can select for lower CH_4!



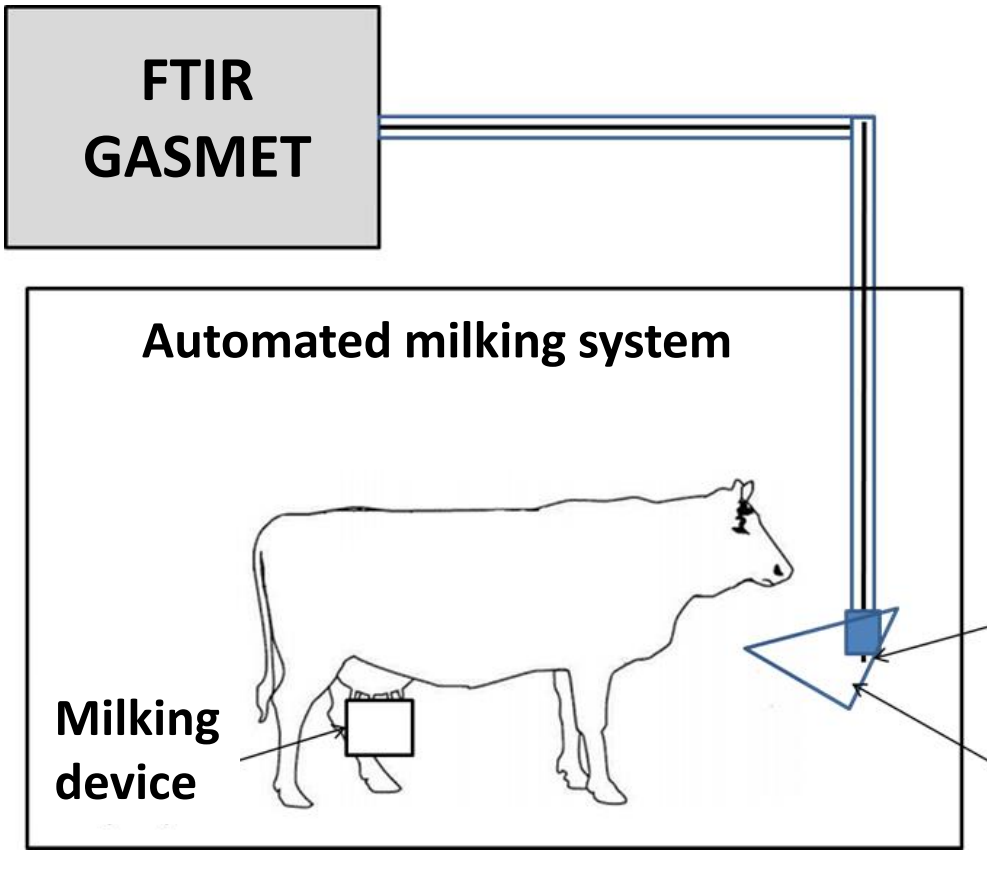
Should select for lower CH_4?



How to measure CH_4?


Eructation
(~90%)
CH_4
Gas
(~9-8%)
Breath
(~1-2%)

Measuring scheme



Long measuring period

Farm 1

14 months & 4 months

Farm 2

1 month

> 1.5 year

Number of animals

Farm 1

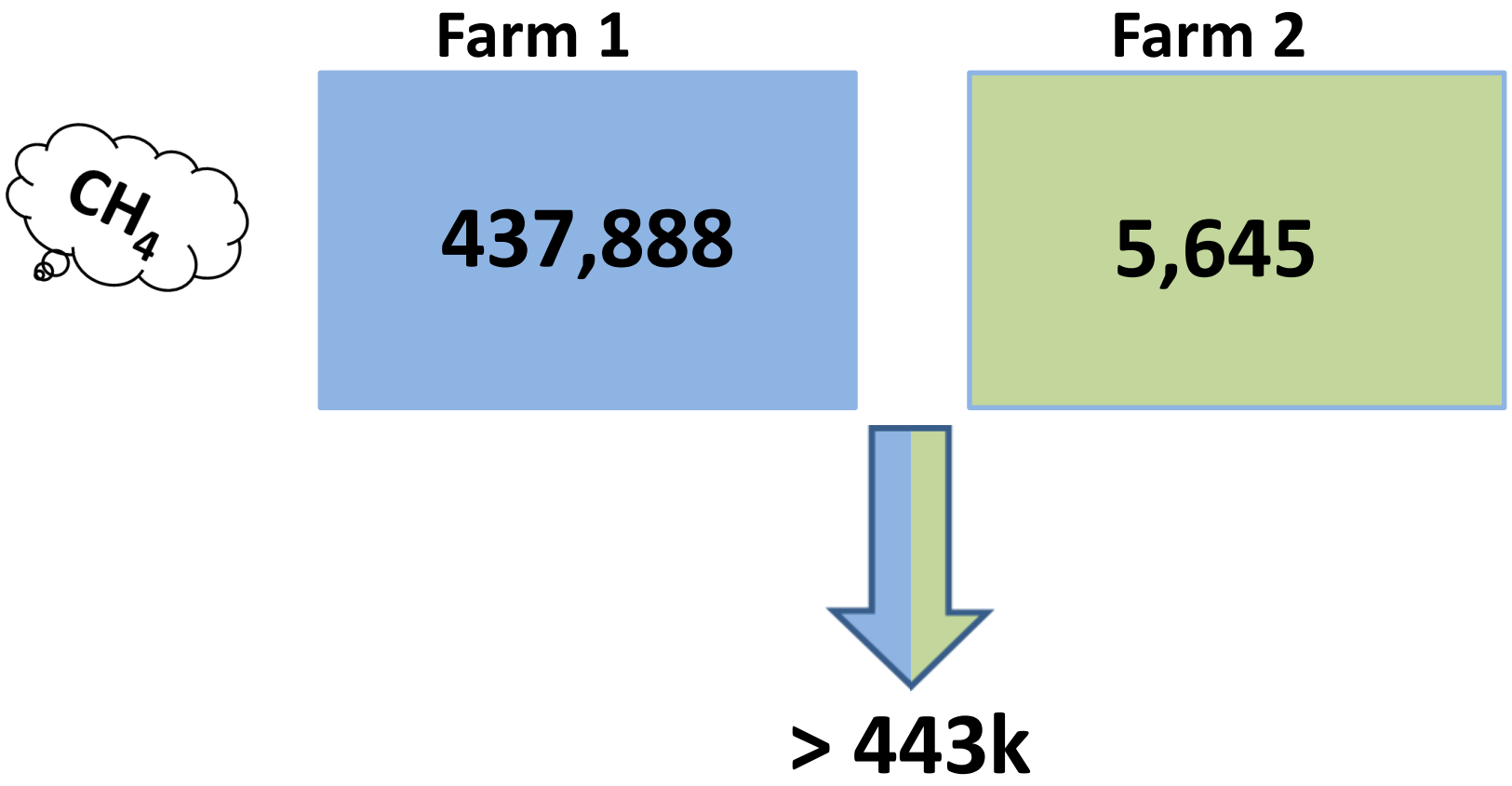
356

Farm 2

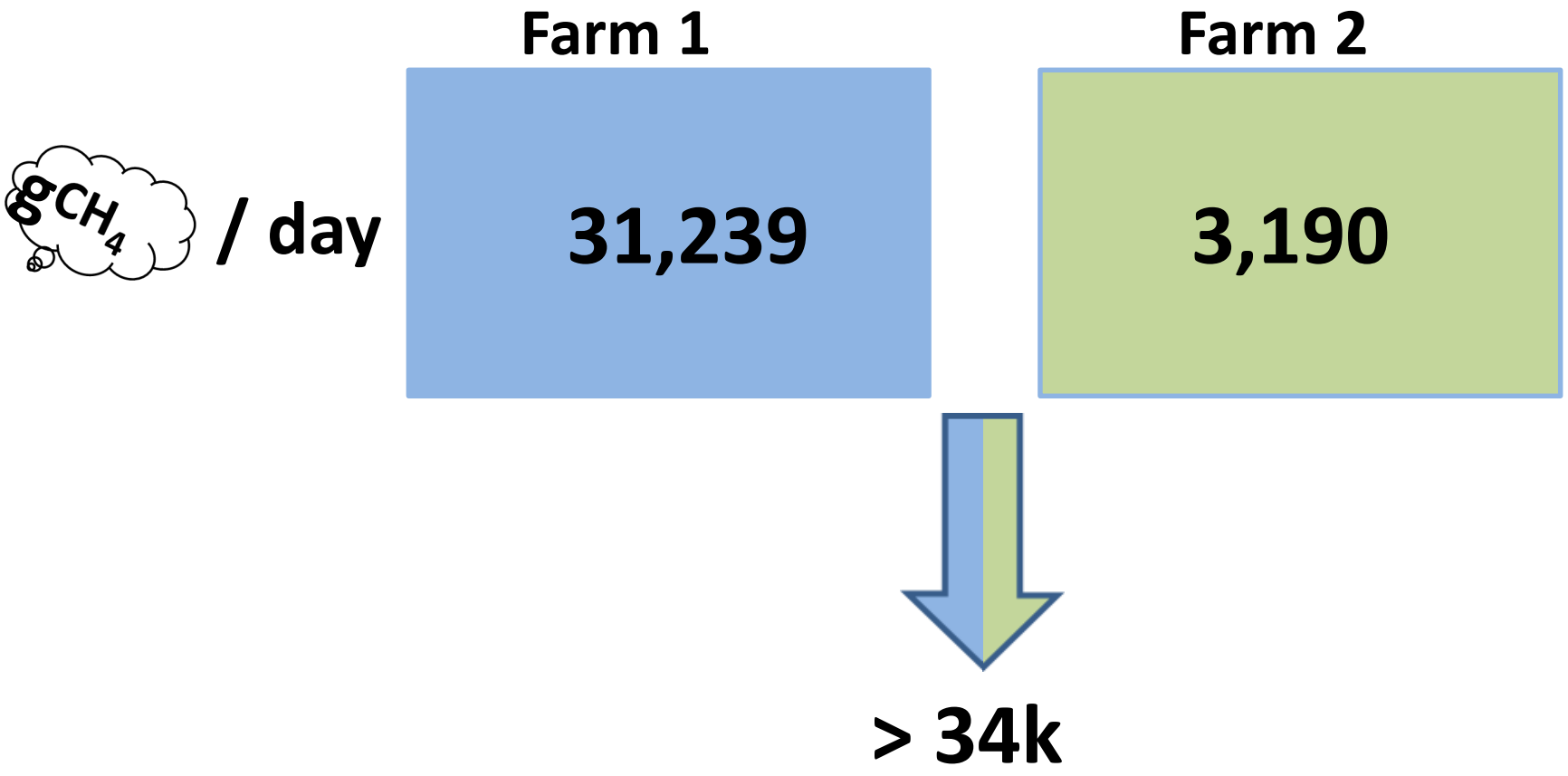
127

~ 500

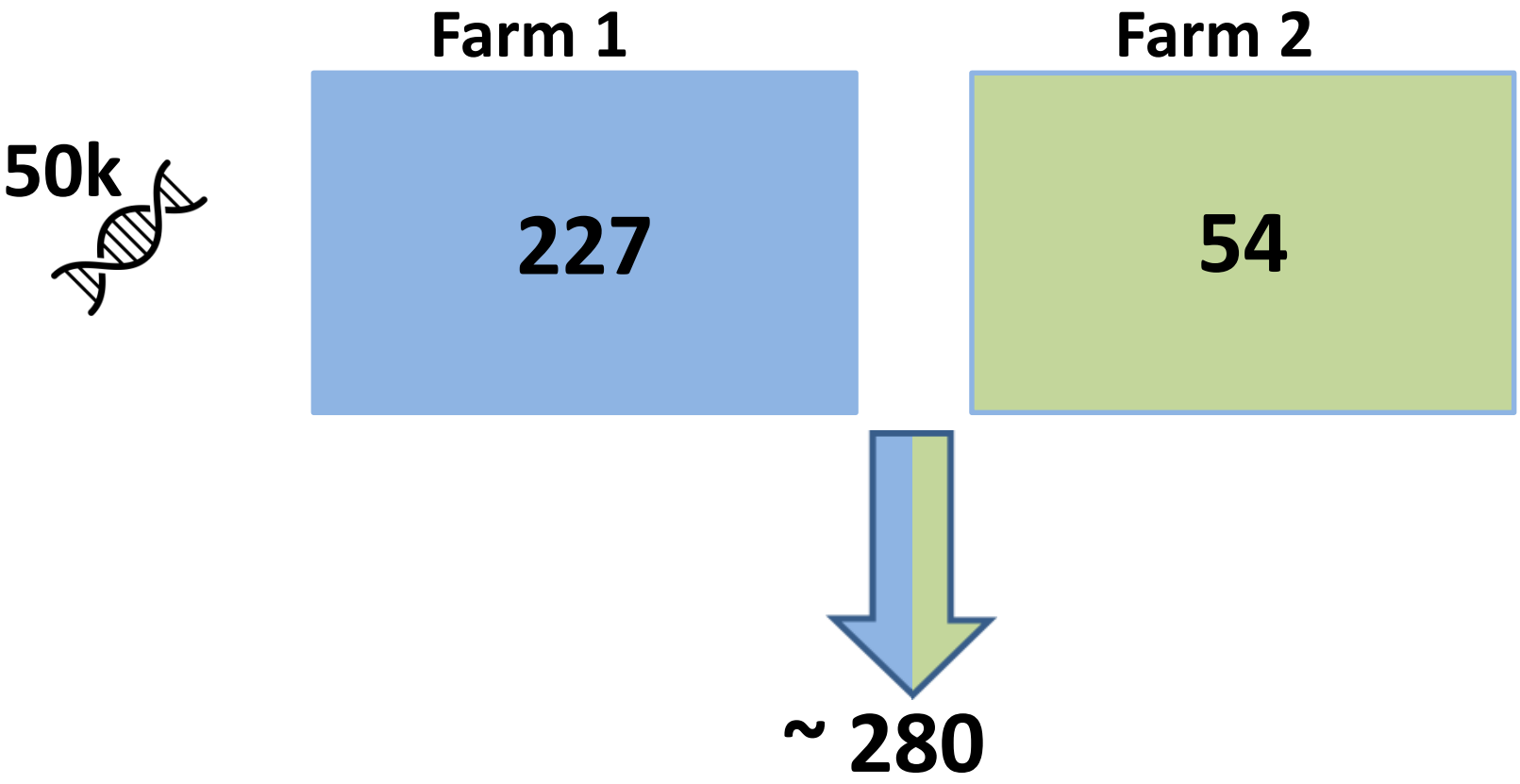
Number of observations



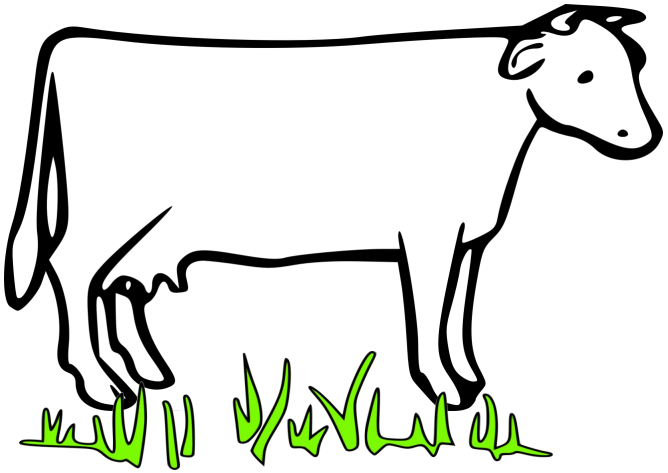
Number of daily observations

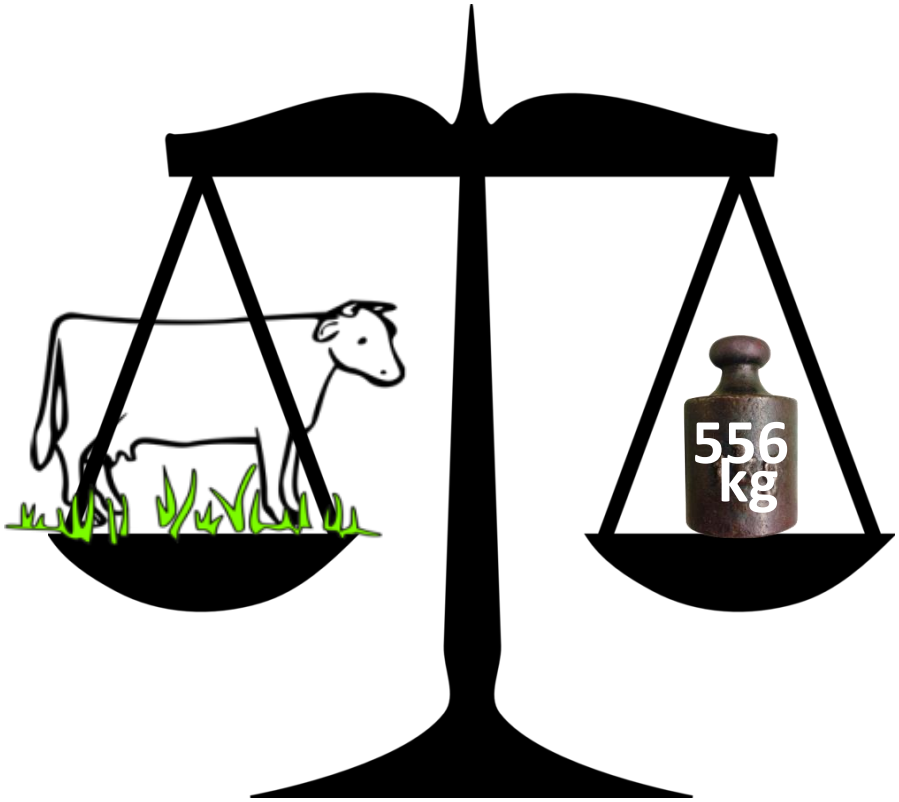


Number of genotyped animals

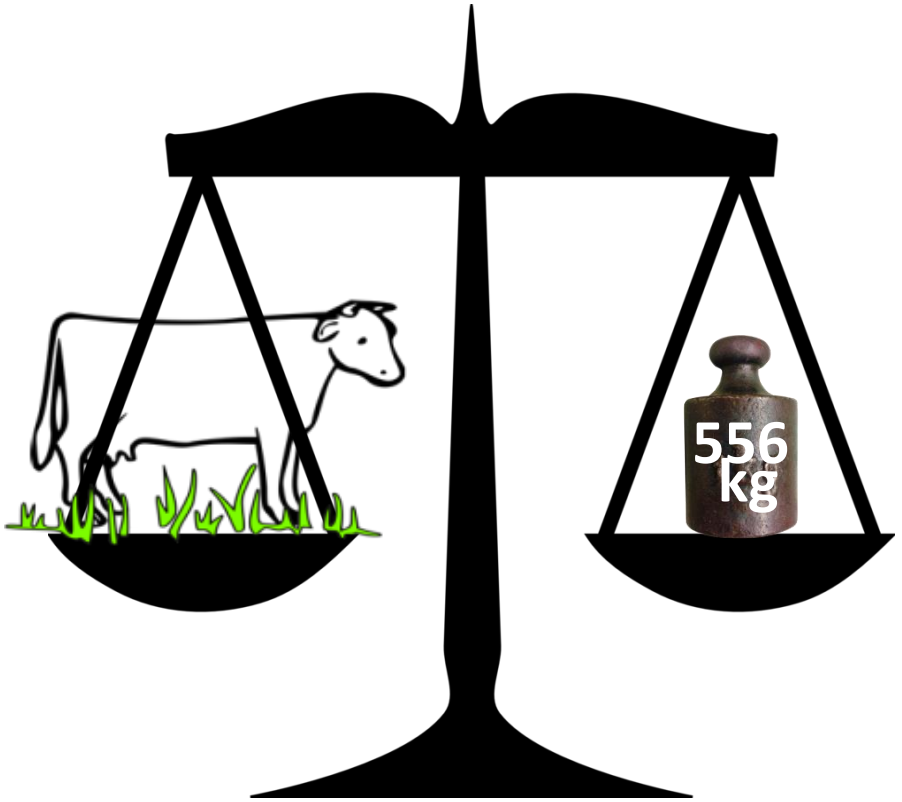


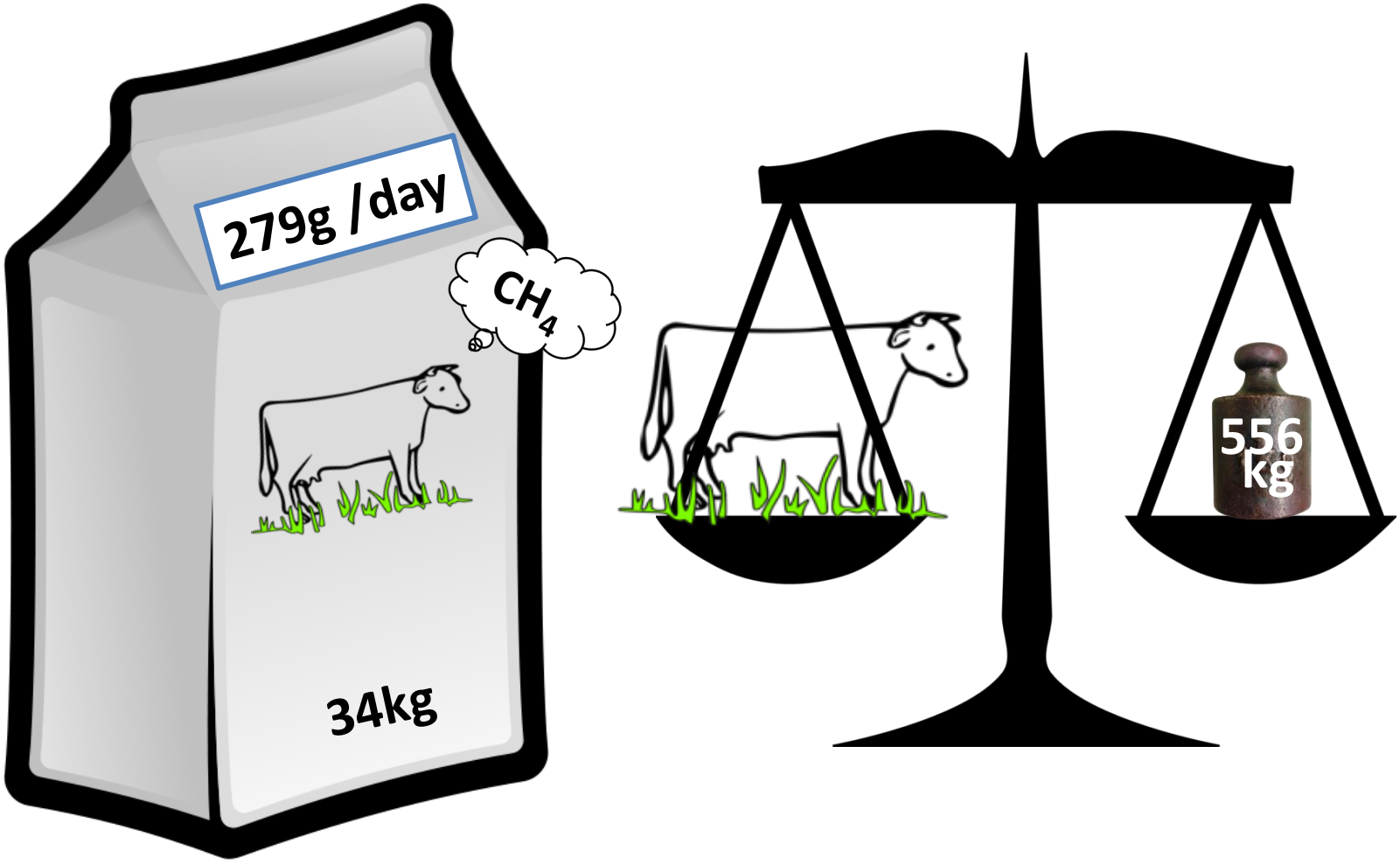
The average analyzed cow



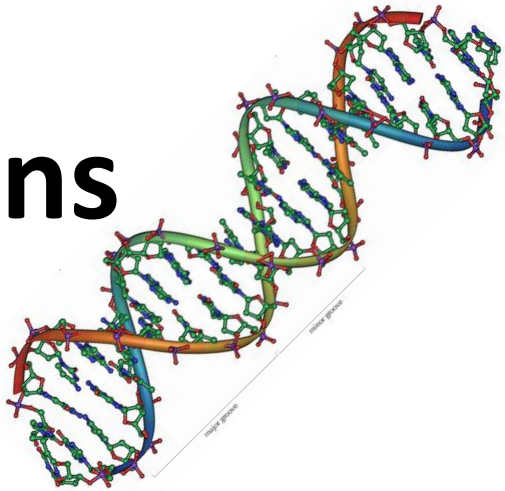

556
kg

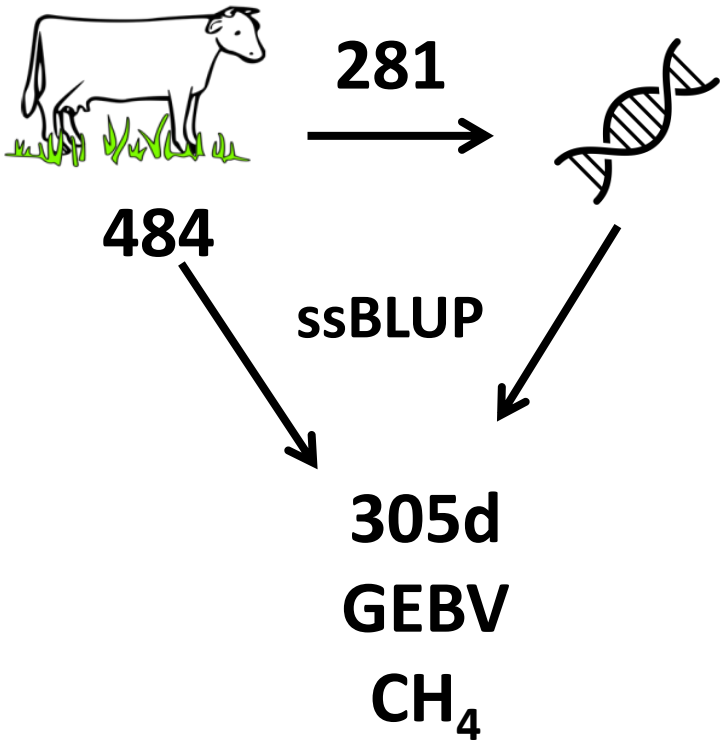

34kg

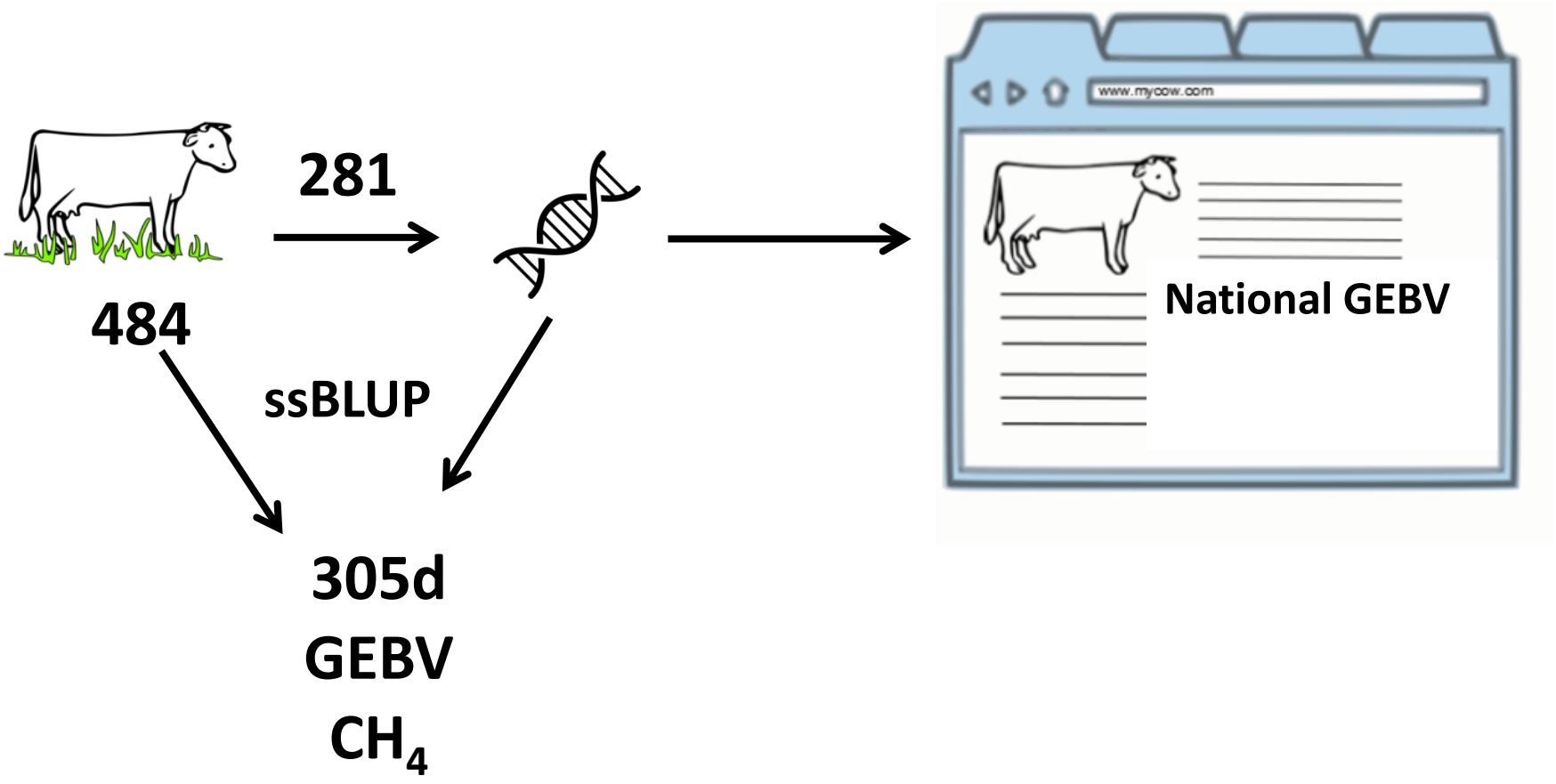

556
kg

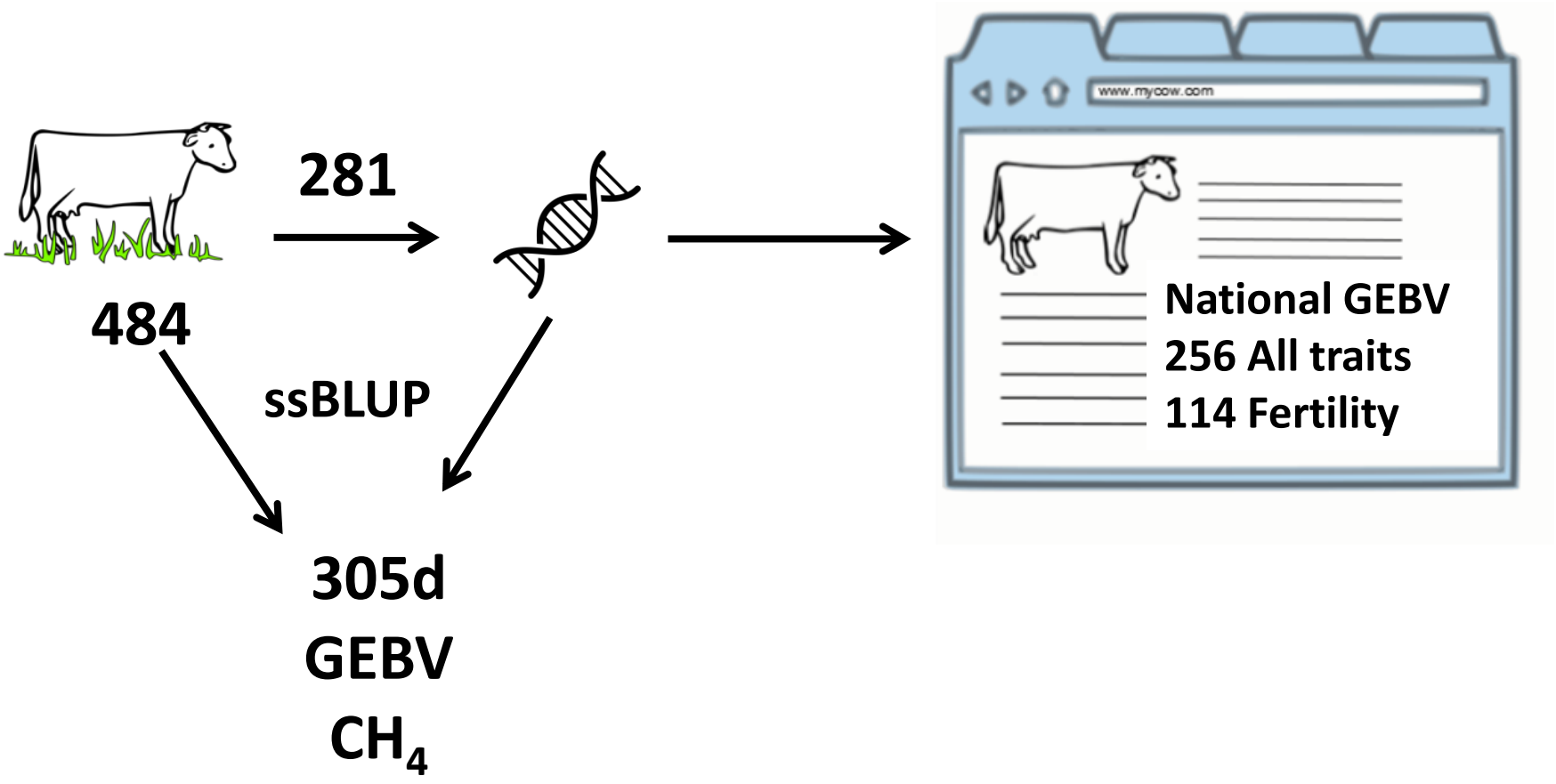

279g /day
CH_4
34kg
556 kg

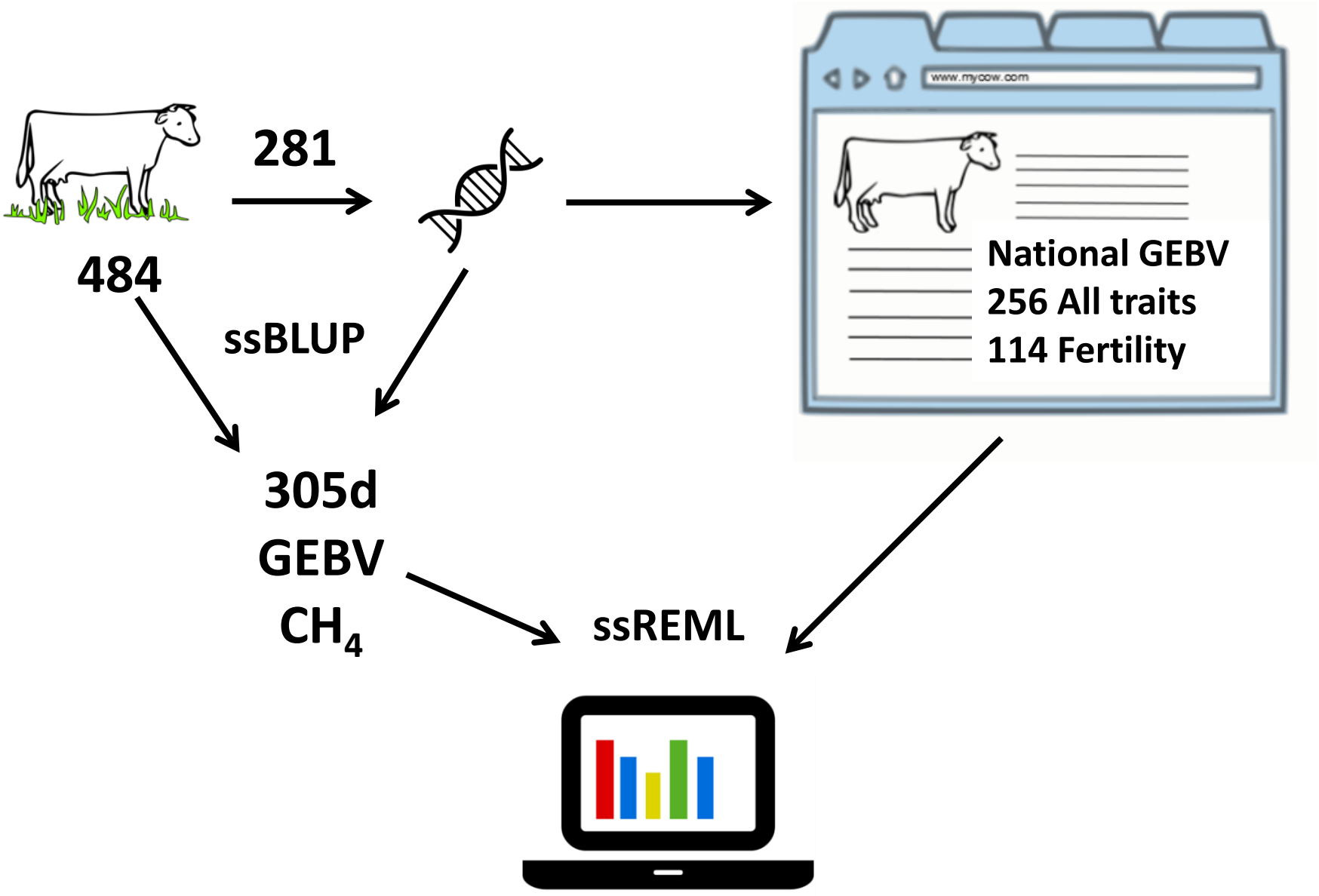
Estimating genetic correlations




281
484
ssBLUP
305d
GEBV
CH_4


281
484
ssBLUP
305d
GEBV
CH_4
www.myCow.com
National GEBV


281
484
ssBLUP
305d
GEBV
CH_4
www.myCow.com
National GEBV
256 All traits
114 Fertility


281
484
ssBLUP
www.mycow.com
National GEBV
256 All traits
114 Fertility
305d
GEBV
CH_4
ssREML

Estimating g. cor. – bivariate analyses

Phenotype → $dGEBV_i = \frac{GEBV}{r_i^2}$

Adjusted residuals → $w_{ij} = \frac{1 - h_j^2}{h_j^2} * \frac{r_{ij}^2}{1 - r_{ij}^2}$

Results

Genetic cor. **CH_4** with **production**

Genetic cor. **CH_4** with **production**

Fat yield(kg)	**0.21**
Milk yield(kg)	**0.15**
Protein yield(kg) **Protein(%)**	**0.07**
Fat(%)	**0.04**

S.E. = 0.06

Genetic cor. **CH_4** with **Health and longevity**

Genetic cor. **CH_4** with **Health and longevity**

Somatic cell count	**0.11**
Longevity	**-0.06**

S.E. = 0.07

Genetic cor. **CH_4** with **Fertility**

Genetic cor. **CH_4** with **Fertility**

Cow nonreturn	**0.08**
Heifer nonreturn	**0.01**
Calving interval	**-0.01**
Days open	**-0.04**

S.E. = 0.08

Genetic cor. **CH_4** with **Type traits**

Genetic cor. **CH_4** with **Type traits**

Size, Chest Width	**0.15**
Type and Conformation	**0.11**
Teat length	**-0.10**

S.E. = 0.06

Genetic cor. **CH_4** with (remaining) **type traits**

Mean = 0.02

SD = 0.05

Range = (-0.09 ; 0.08)

Remaining traits: Rump Width, Udder Width, Rear Teat Placement, Overall Conformation, Foot Angle, Rear Leg Set Rear View, Feet And Legs, Stature, Fore Udder, Udder, Body Depth, Udder Depth, Rear Udder Height, Dairy Character, Udder Support Central Ligament, Rear Leg Set Side View, Rump Angle, Front Teat Placement

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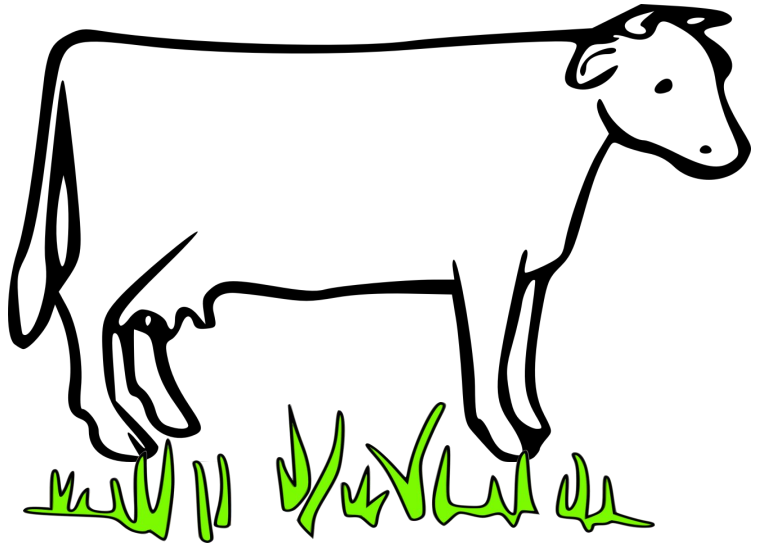

Selecting for CH_4 will only moderately influence traits in the current breeding goal.

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Estimating g. cor. – bivariate analyses

Phenotype → $dGEBV_i = \frac{GEBV}{r_i^2}$

Dist. of random animal effects → $N(\mathbf{0}, \mathbf{H} \otimes \mathbf{H_H})$

Dist. of residuals → $N\left(\mathbf{0}, \begin{matrix} \mathbf{D_j}\sigma_{e_j}^2 & \mathbf{0} \\ \mathbf{0} & \mathbf{D_j}\sigma_{e_j}^2 \end{matrix}\right)$

$\mathbf{D_j}$ - diagonal matrix containing $\frac{1}{w_{ij}}$ → $w_{ij} = \frac{1 - h_j^2}{h_j^2} * \frac{r_{ij}^2}{1 - r_{ij}^2}$

Genetic cor. **CH_4** with **production**

Traits	Estimate*	95% CI	
Fat yield (kg)	**0.21**	**0.09**	**0.33**
Milk yield (kg)	**0.15**	**0.03**	**0.27**
Protein yield (kg)	**0.07**	**-0.05**	**0.19**
Protein (%)	**0.07**	**-0.05**	**0.19**
Fat (%)	**0.04**	**-0.08**	**0.16**

*S.E. = 0.06

Genetic cor. **CH_4** with **Health and longevity**

Traits	Estimate*	95% CI	
Somatic cell count	**0.11**	**-0.03**	**0.25**
Longevity	**-0.06**	**-0.20**	**0.08**

*S.E. = 0.07

Genetic cor. **CH_4** with **Fertility**

Traits	Estimate*	95% CI	
Cow nonreturn	**0.08**	**-0.08**	**0.24**
Heifer nonreturn	**0.01**	**-0.15**	**0.17**
Calving interval	**-0.01**	**-0.17**	**0.15**
Days open	**-0.04**	**-0.20**	**0.12**

***S.E. = 0.08**

Genetic cor. **CH_4** with **type traits**

Traits	Estimate*	95% CI	
Size	**0.15**	**0.03**	**0.27**
Chest Width	**0.15**	**0.03**	**0.27**
Type And Conformation	**0.11**	**-0.01**	**0.23**
Overall Conformation	**0.06**	**-0.06**	**0.18**
Stature	**0.05**	**-0.07**	**0.17**
Body Depth	**0.03**	**-0.09**	**0.15**
Dairy Character	**-0.01**	**-0.13**	**0.11**

*S.E. = 0.06

Genetic cor. **CH_4** with **type traits**

Traits	Estimate*	95% CI	
Udder Width	0.08	-0.04	0.20
Fore Udder	0.03	-0.09	0.15
Udder	0.03	-0.09	0.15
Udder Depth	0	-0.12	0.12
Rear Udder Height	0	-0.12	0.12
Udder Support Central Ligament	-0.02	-0.14	0.10

*S.E. = 0.06

Genetic cor. **CH_4** with **type traits**

Traits	Estimate*	95% CI	
Foot Angle	**0.05**	**-0.07**	**0.17**
Rear Leg Set Rear View	**0.05**	**-0.07**	**0.17**
Feet And Legs	**0.05**	**-0.07**	**0.17**
Rear Leg Set Side View	**-0.02**	**-0.14**	**0.10**

*S.E. = 0.06

Genetic cor. **CH_4** with **type traits**

Traits	Estimate*	95% CI	
Rump Width	**0.09**	**-0.03**	**0.21**
Rear Teat Placement	**0.06**	**-0.06**	**0.18**
Rump Angle	**-0.03**	**-0.15**	**0.09**
Front Teat Placement	**-0.09**	**-0.21**	**0.03**
Teat Length	**-0.1**	**-0.22**	**0.02**

***S.E. = 0.06**