

**Improving meat yield and quality in cattle-
stand back and let the geneticists take over!!**

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Breeding for any given trait

1. Must be important

- Economic / social / environmental



2. Must exhibit genetic variability

- Show me a trait that doesn't!!!



3. Should ideally be measurable (at a low cost) or genetically correlated with a measurable trait

- Predictor traits – (e.g., ultrasound)



Heritability (h^2)

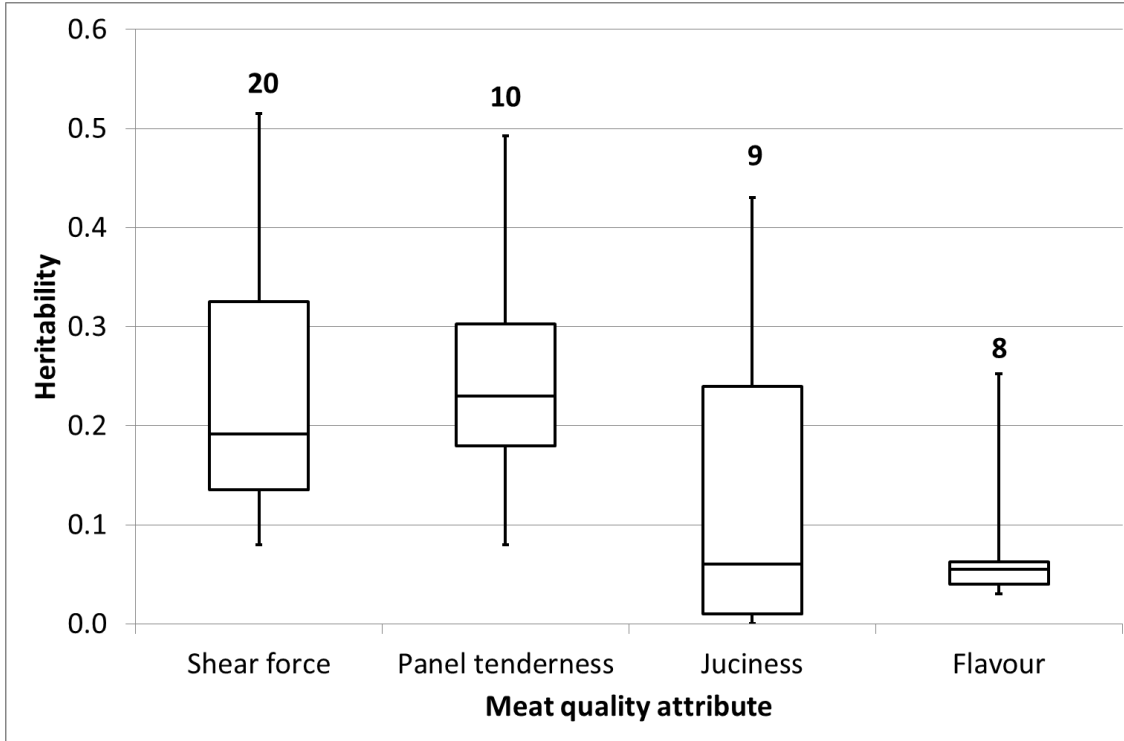
- The proportion of variability amongst similarly treated individuals that is due to genetic effects



Similar gender, same farm-date, same abattoir, same age.....

What of the remainder is genetic?

Heritability (h^2) - quality



Why so different?

Heritability (h^2) – why differ?

$$h^2 = \frac{\text{Genetic var}}{\text{Phenotypic var}} = \frac{\text{Genetic var}}{\text{Genetic var} + \text{"noise"}}$$

Variant effect

Frequency of variants

Extent of variant segregation

Mode of gene action



Heritability (h^2) – why differ?

$$h^2 = \frac{\text{Genetic var}}{\text{Phenotypic var}} = \frac{\text{Genetic var}}{\text{Genetic var} + \text{"noise"}}$$

Data “errors”

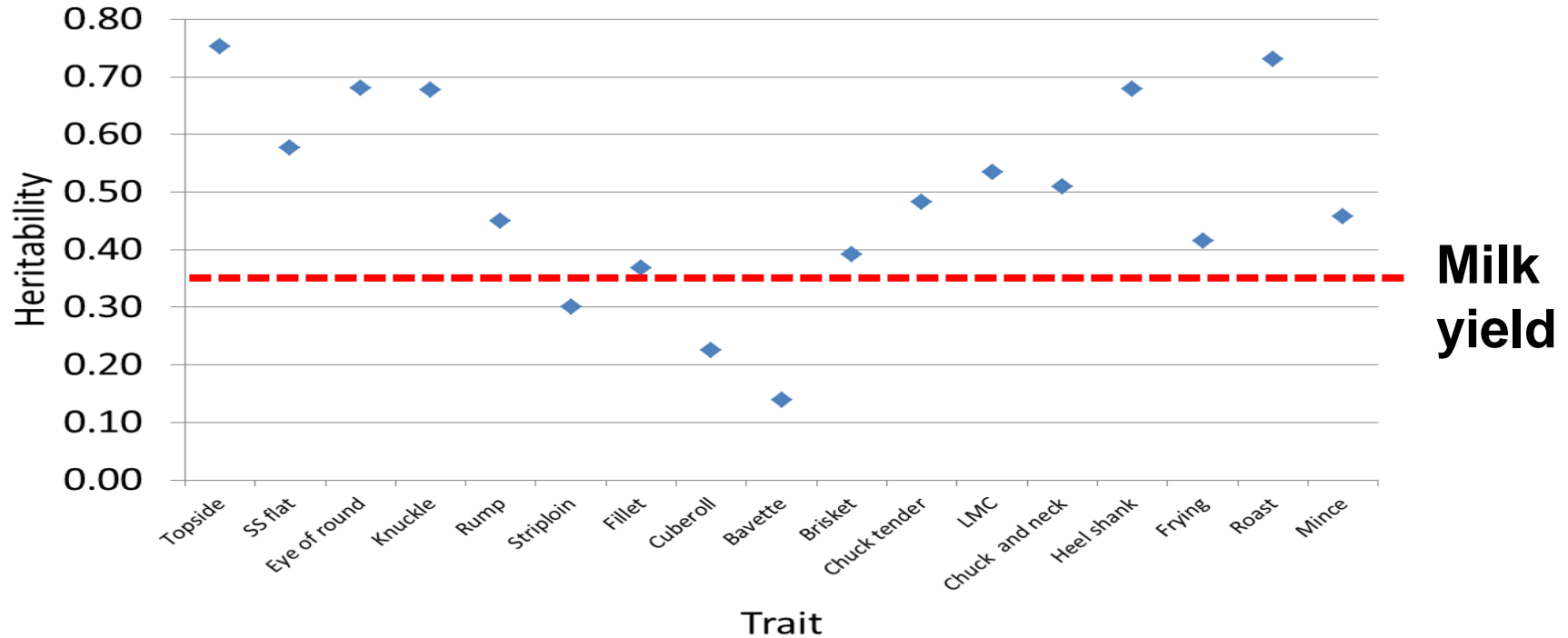
Pedigree errors

Number of repeated records

Incomplete / inappropriate statistical model

$$\frac{\partial}{\partial a} \ln f_{a, \sigma^2}(\xi_1) = \frac{(\xi_1 - a)}{\sigma^2} f_{a, \sigma^2}(\xi_1) = \frac{1}{\sqrt{2\pi\sigma}} \exp\left\{-\frac{(\xi_1 - a)^2}{2\sigma^2}\right\}$$
$$\int \mathcal{T}(x) \cdot \frac{\partial}{\partial \theta} f(x, \theta) dx = M\left(\mathcal{T}(\xi) \cdot \frac{\partial}{\partial \theta} \ln l(\xi, \theta)\right)$$

Heritability (h^2) – primal yields



Heritability (h^2) – mis-conceptions

1. Remaining variability ($1-h^2$) is management
 - Parentage errors 10%: 0.23 → 0.28

Heritability (h^2) – mis-conceptions

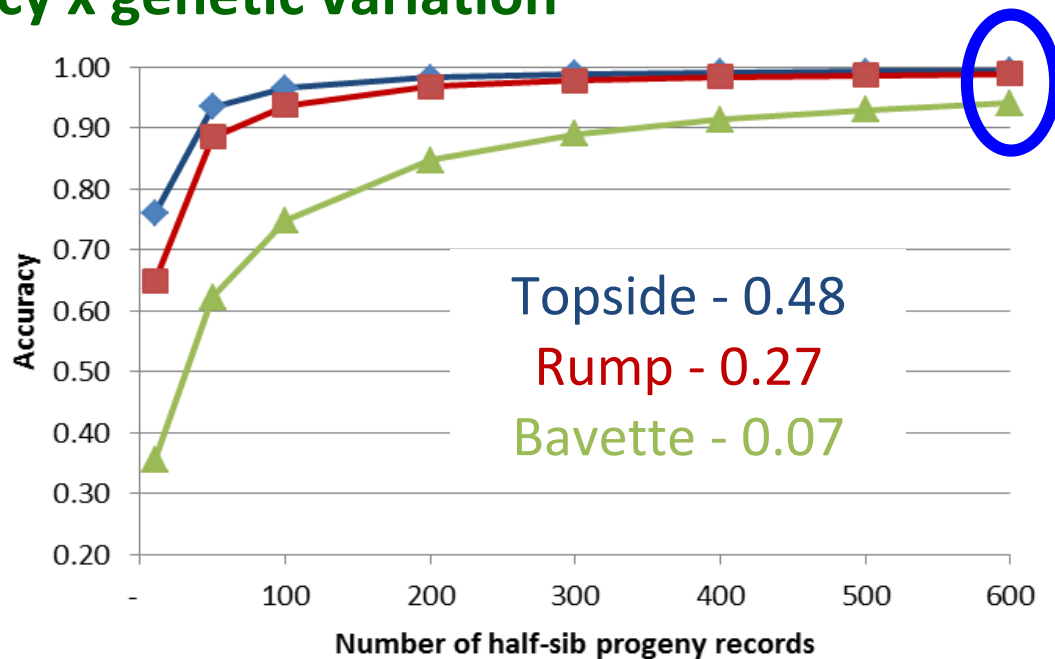
1. Remaining variability ($1-h^2$) is management
2. Low h^2 = little genetic variance

$$h^2 = \frac{\text{Genetic var}}{\text{Phenotypic var}}$$

Heritability (h^2) – mis-conceptions

3. Low heritability translates to slow genetic gain (ΔG)

- $\Delta G = \text{intensity} \times \text{accuracy} \times \text{genetic variation}$
- $\text{Accuracy} = f(N, h^2)$



Heritability (h^2) – mis-conceptions

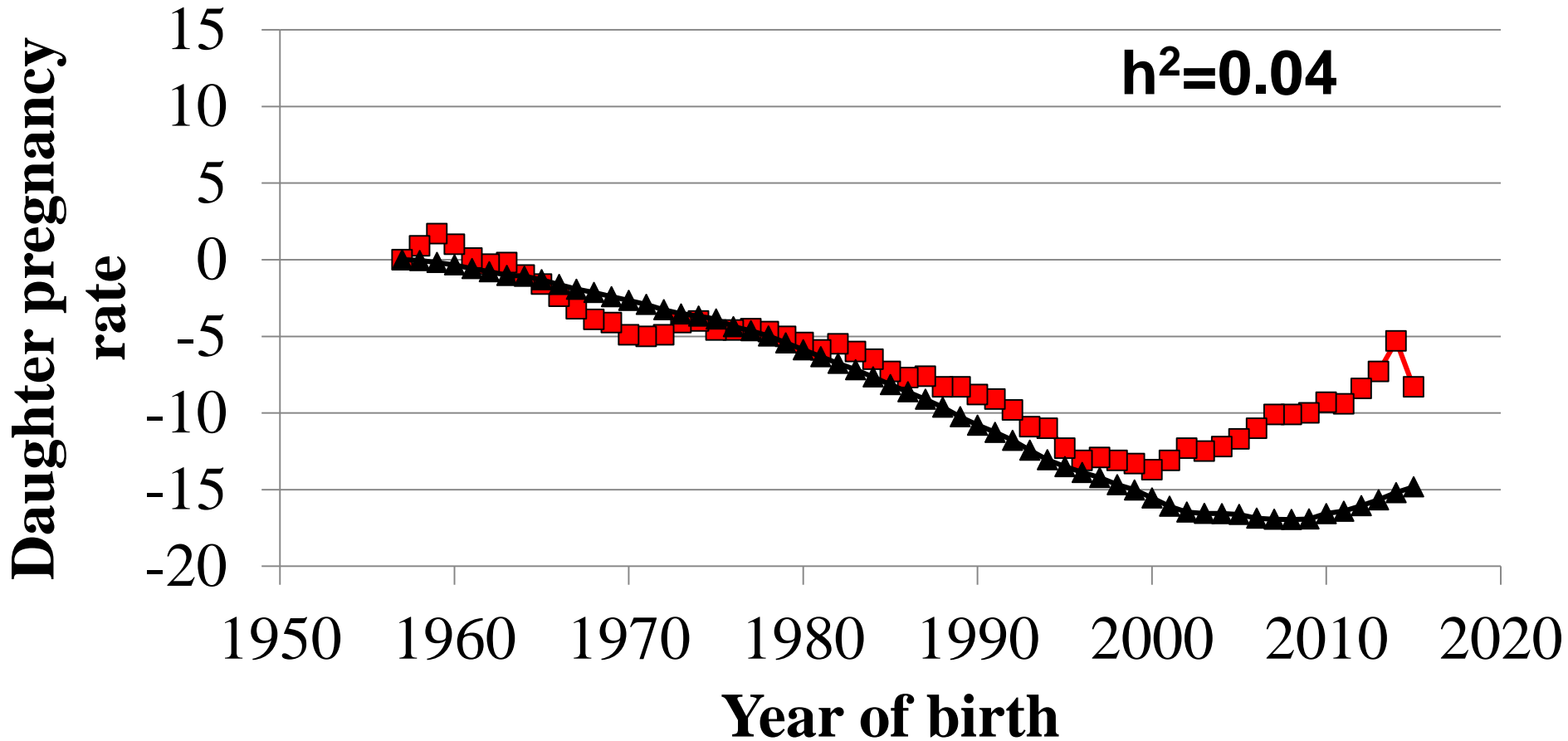
4. Low heritability implies little benefit of breeding

- Heritability is how much of variation is due to genetics

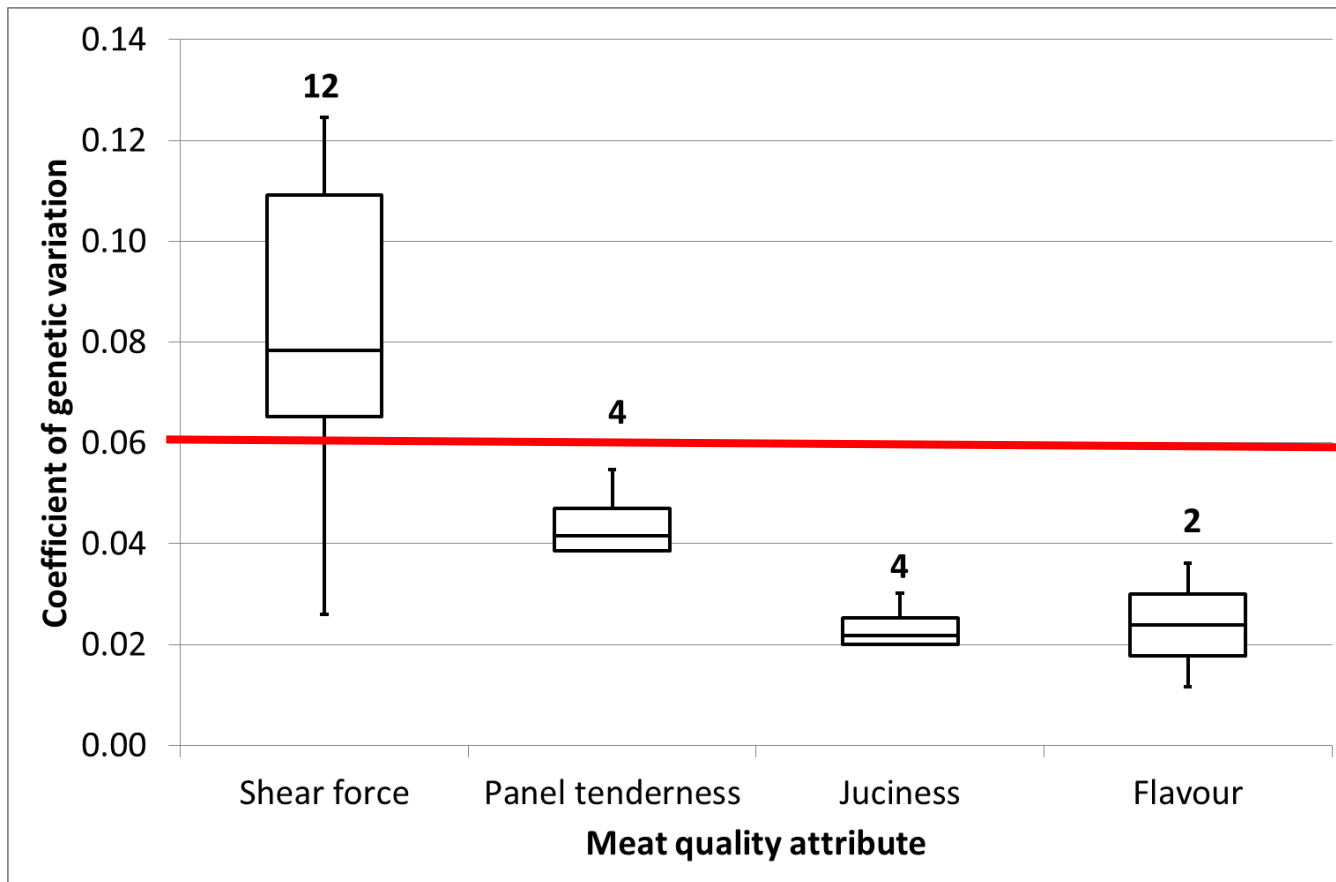
NOT

- How much of the (potential) change in performance is/was genetic

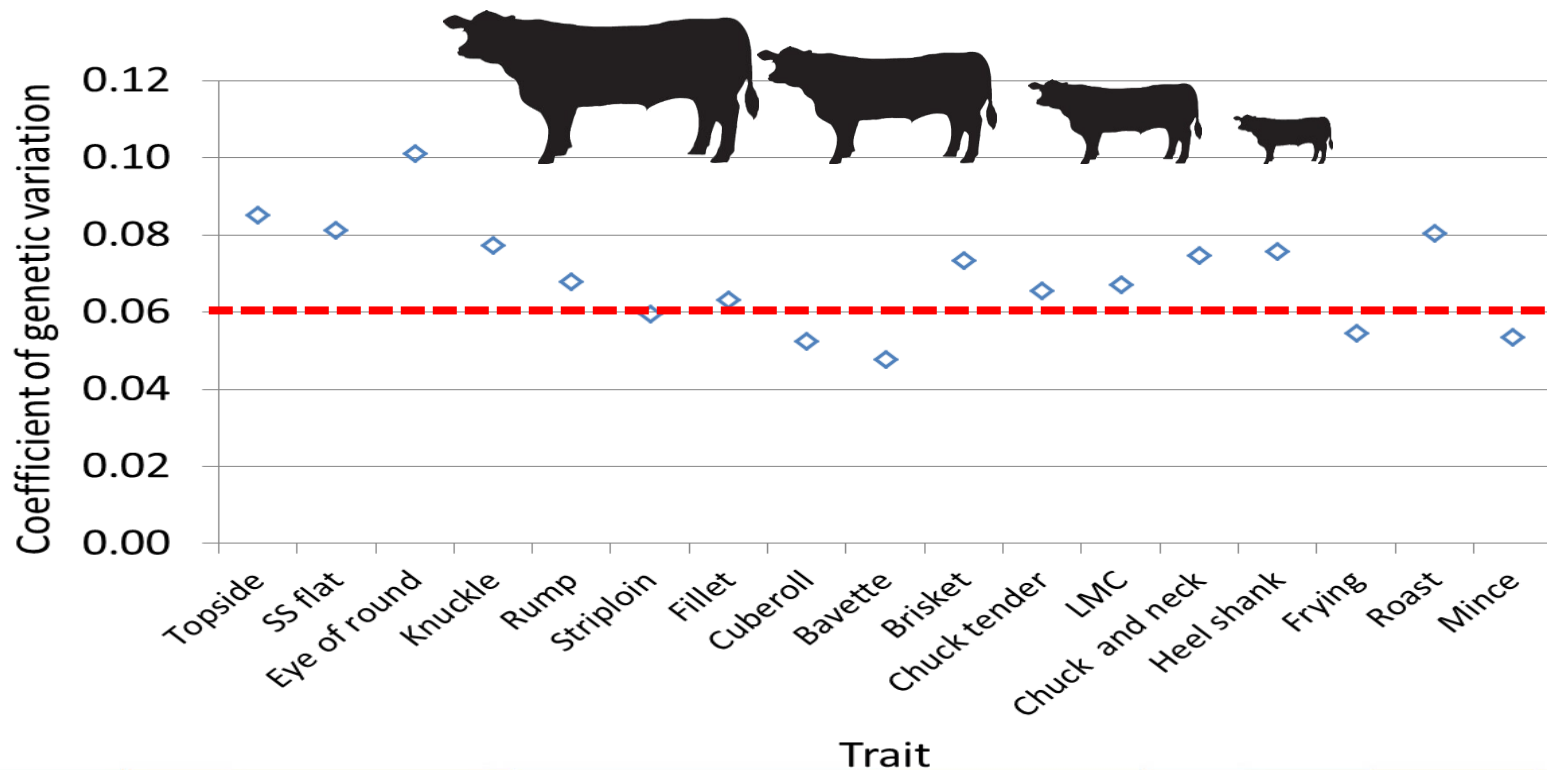
Heritability (h^2) – mis-conceptions



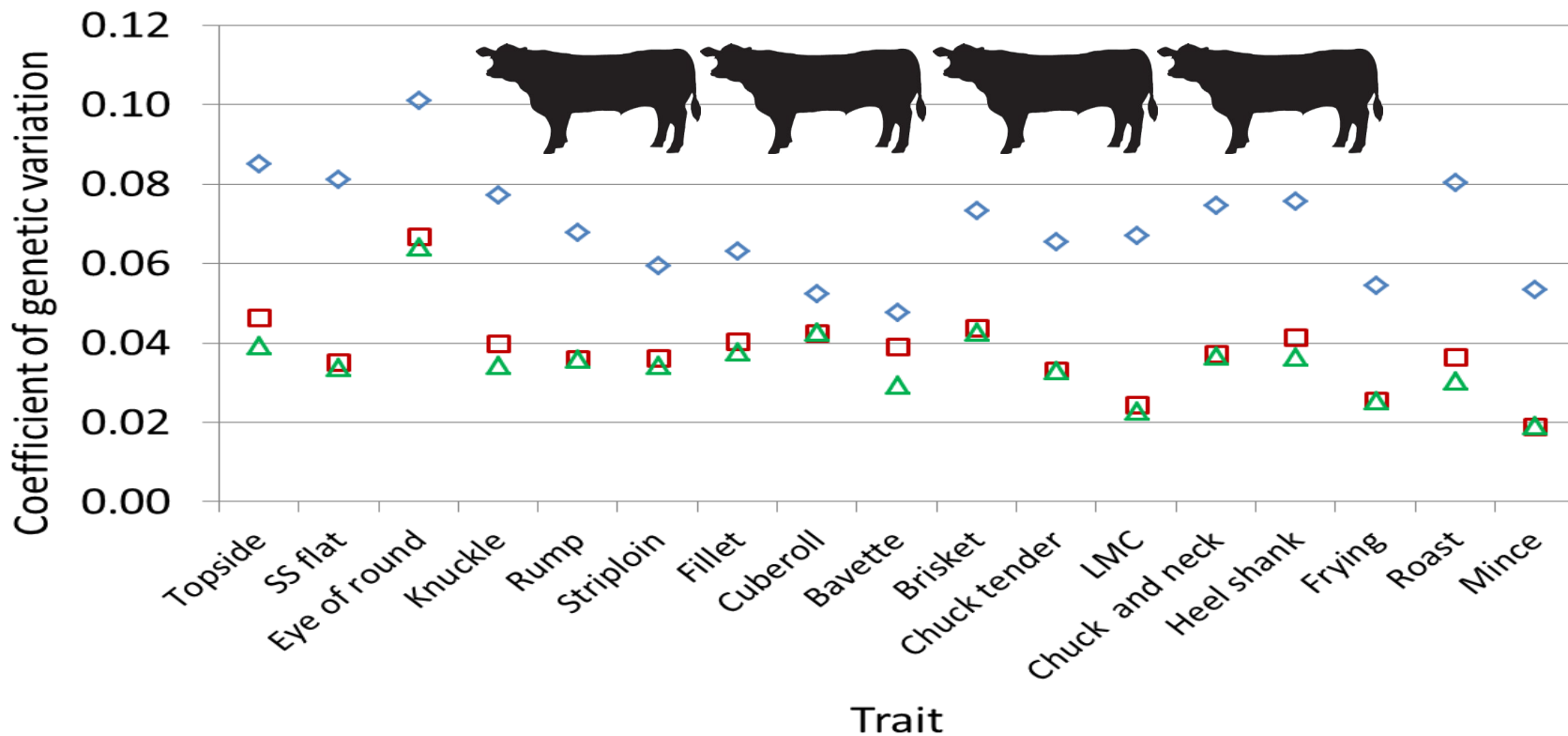
Coefficient of genetic variation - quality



Coefficient of genetic variation - yield




Coefficient of genetic variation - yield



Genetic evaluations - validation

| Genetic merit group | Rump (kg) (n=11,841) | |
|---------------------|-------------------------|-----|
| Low | 12.35 | |
| Medium | 13.02 | |
| High | 13.76 | 13% |
| Very high | 14.05 | |



Genomics

1. (Targeted) Marker assisted selection
 - “Find the genes”
2. Whole-genome enabled selection (Genomic selection)
 - “We don’t need no stinking genes”

Genome wide association

Imputed 635,000 animals to Whole Genome Sequence

25,400,000,000,000 genotypes

Bulls with
high reliabilities



Accurate
Phenotype



Dataset: 29,675 Bulls -> min 5 progeny; avg reliability ~80%



Angus
2,495



Charolais
11,725



Hereford
1,272



Holstein
2,439



Limousin
10,111



Simmental
1,633

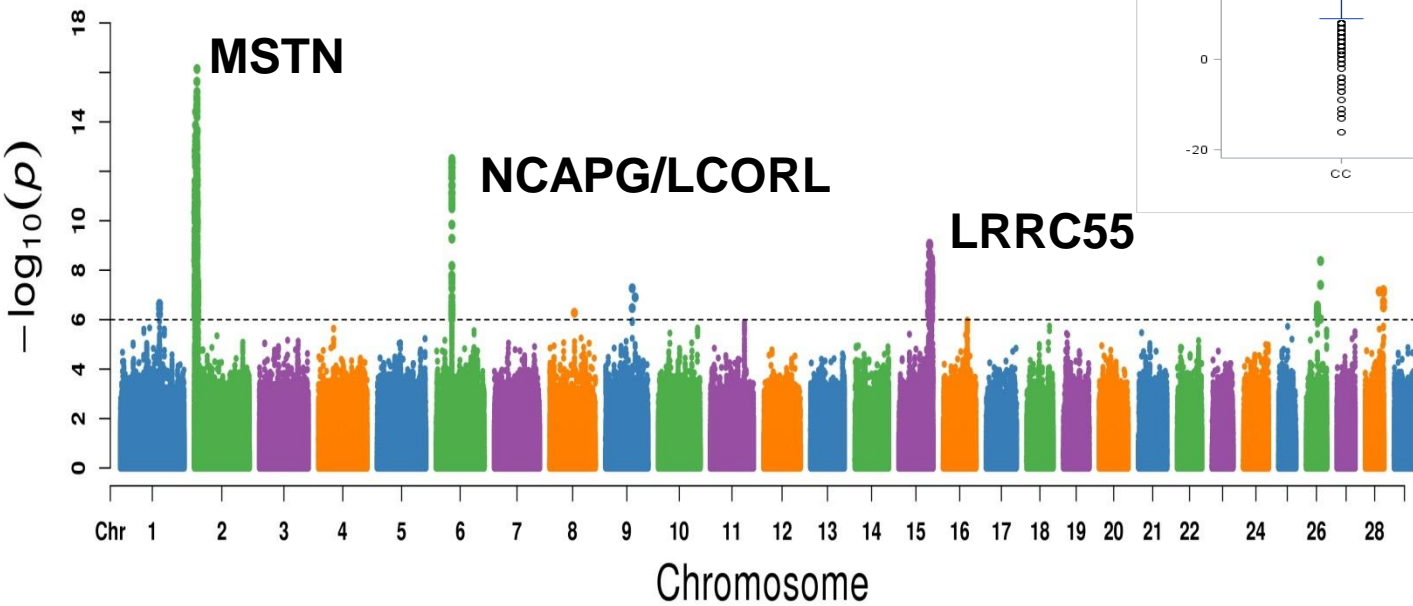
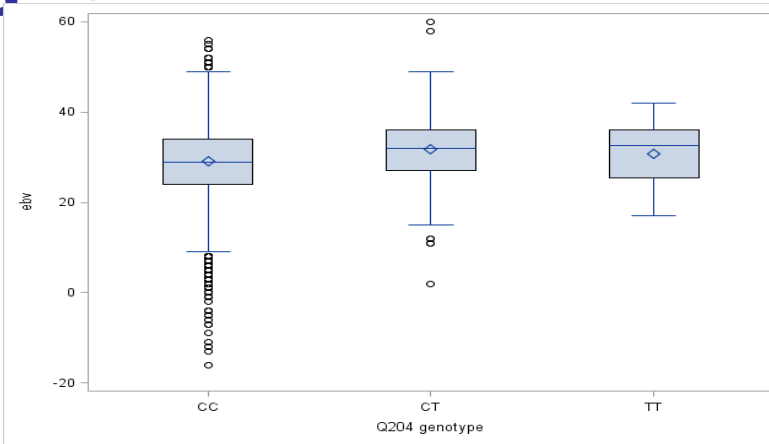
Carcass weight

MSTN Q204X

P-value= 2.19×10^{-15}



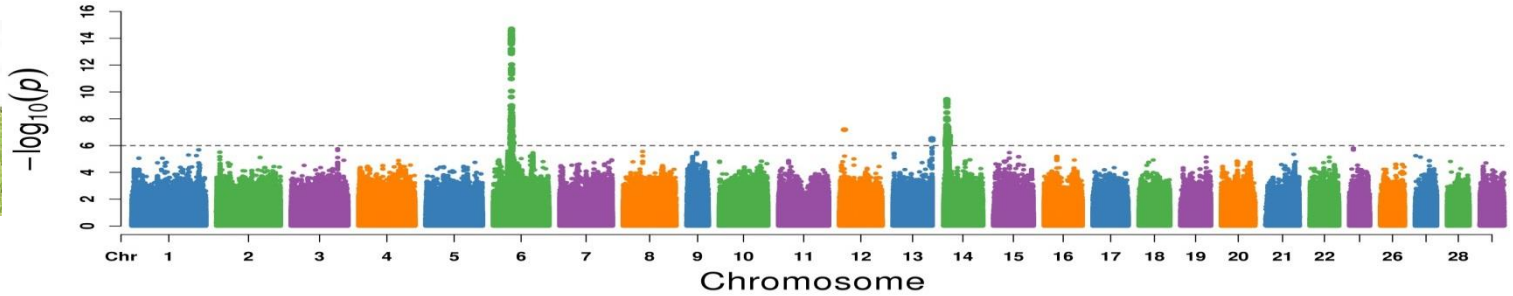
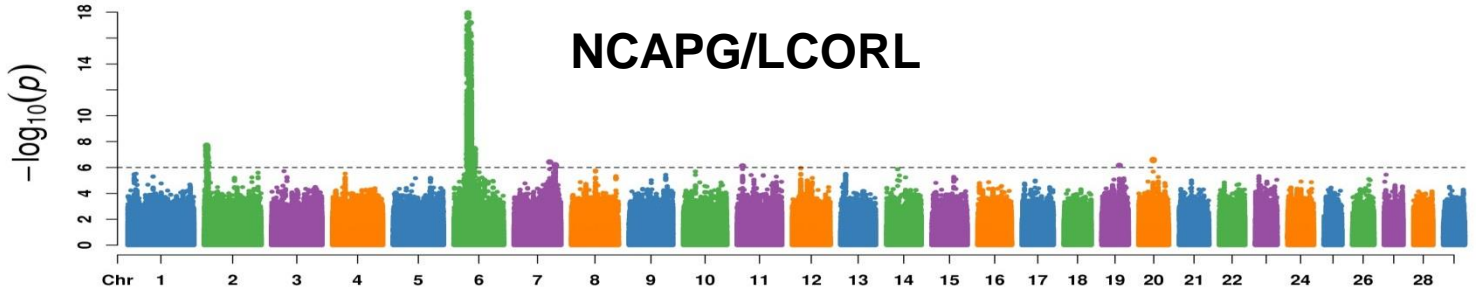
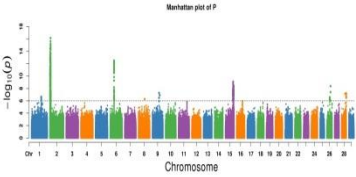
Charolais



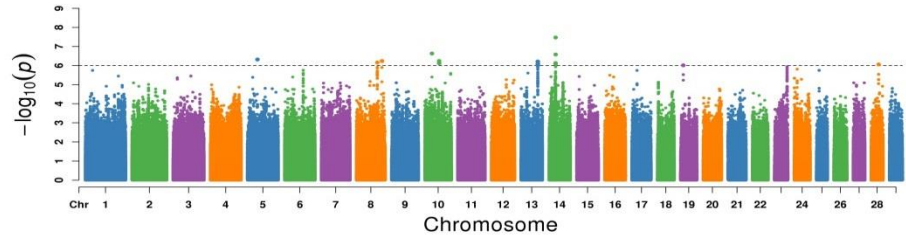
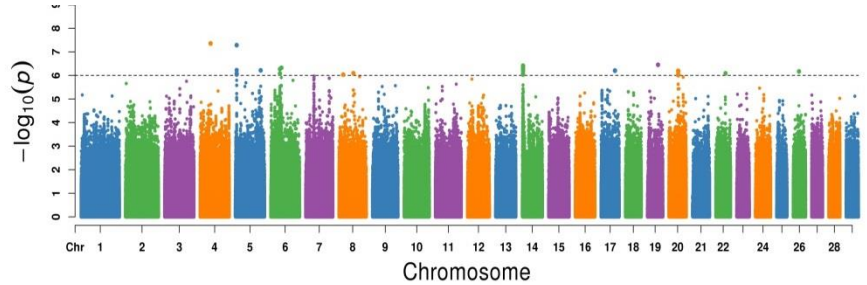
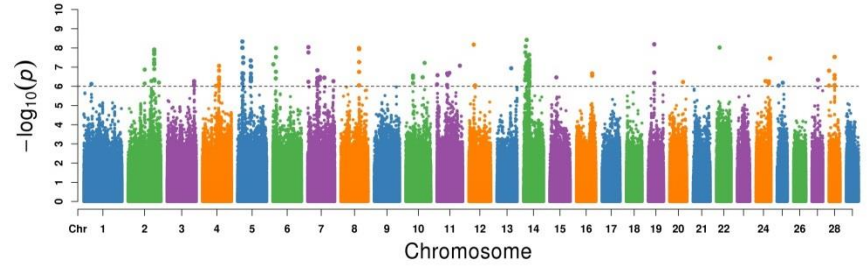
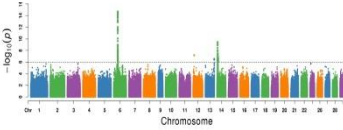
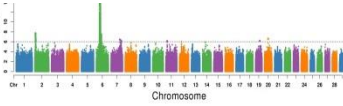
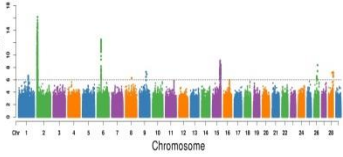
Explains 1.07% of EBV variance



Carcass weight



Carcass weight

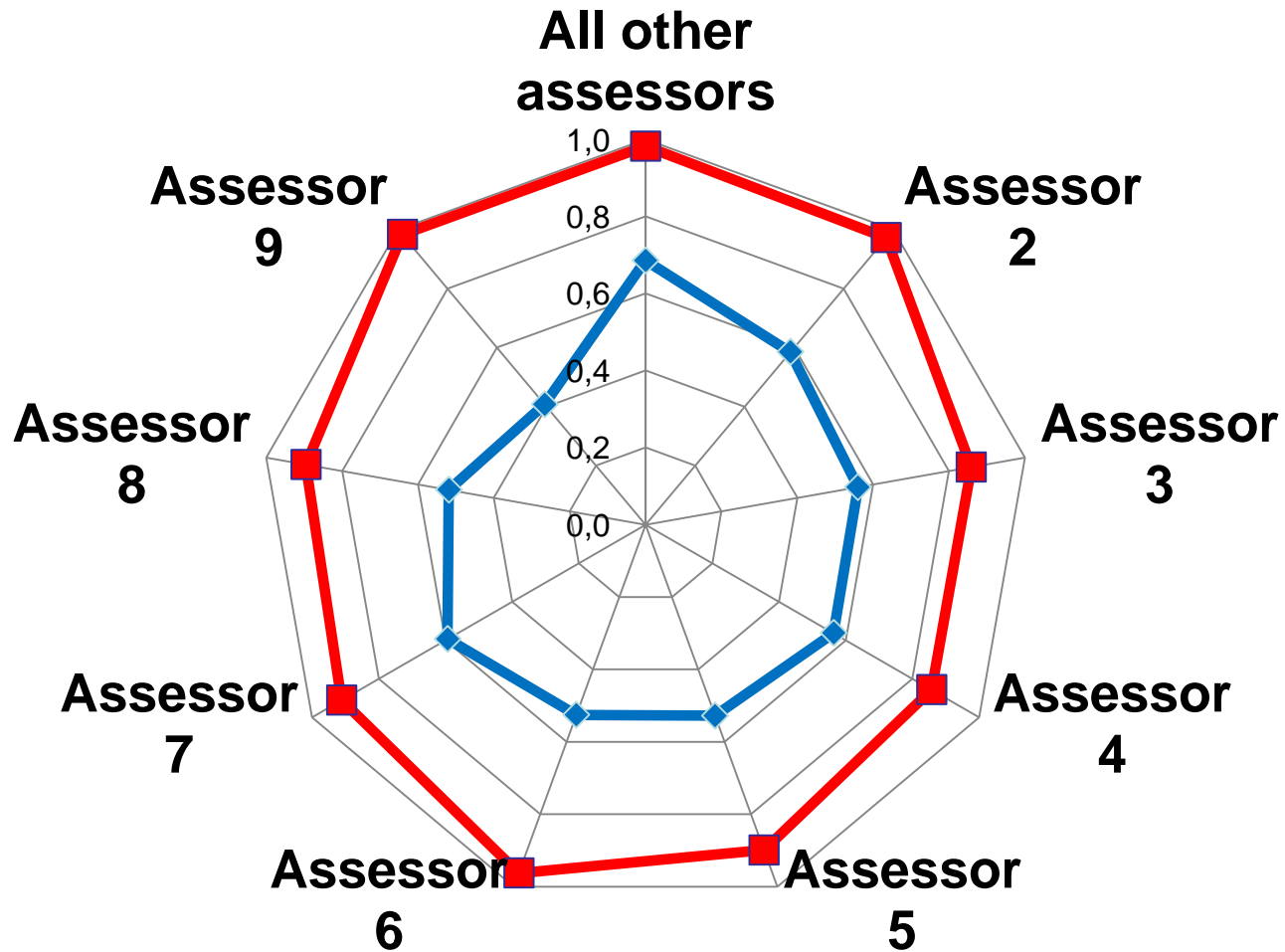


No strong association
in the other breeds



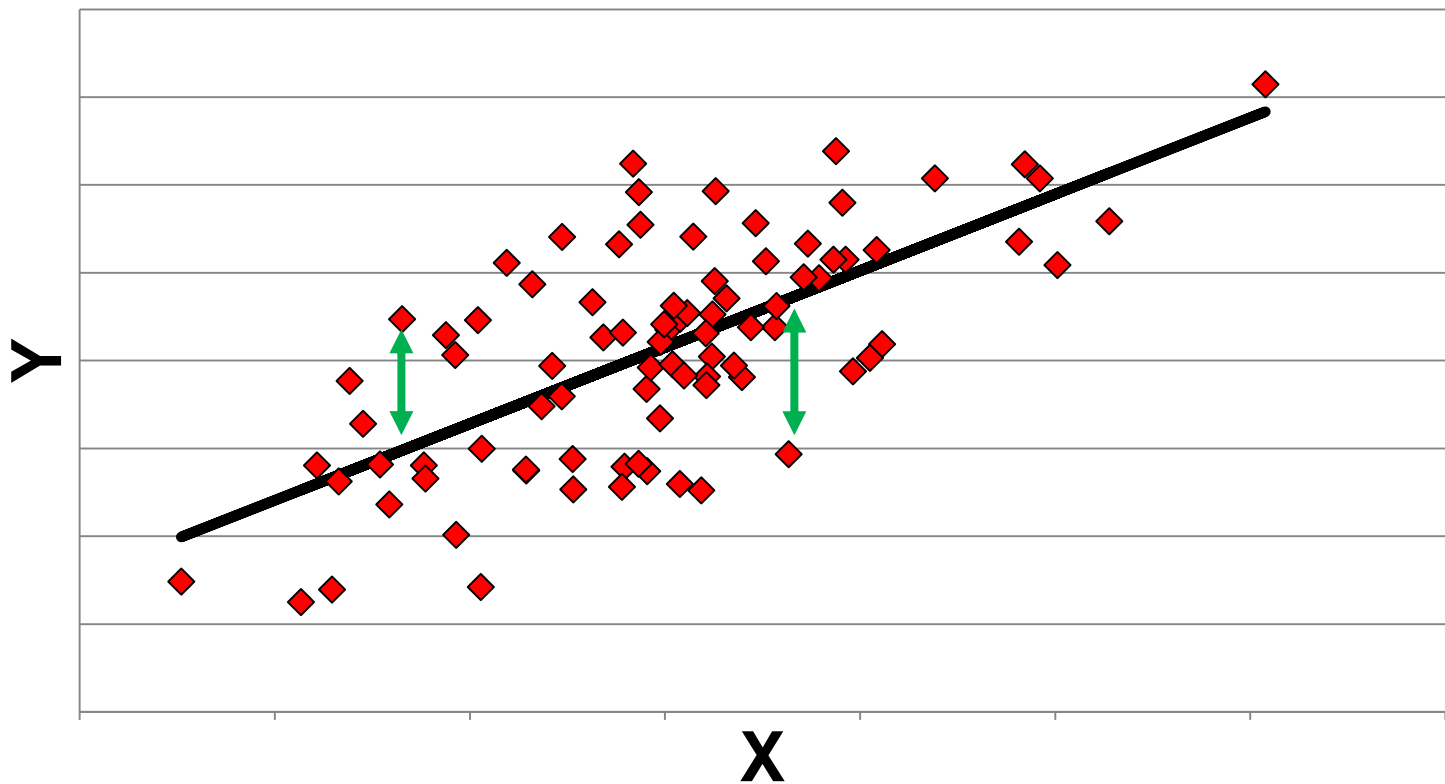
Food for thought....

Breeding for sensory ... on the cheap



(Feed) efficiency – the easy way

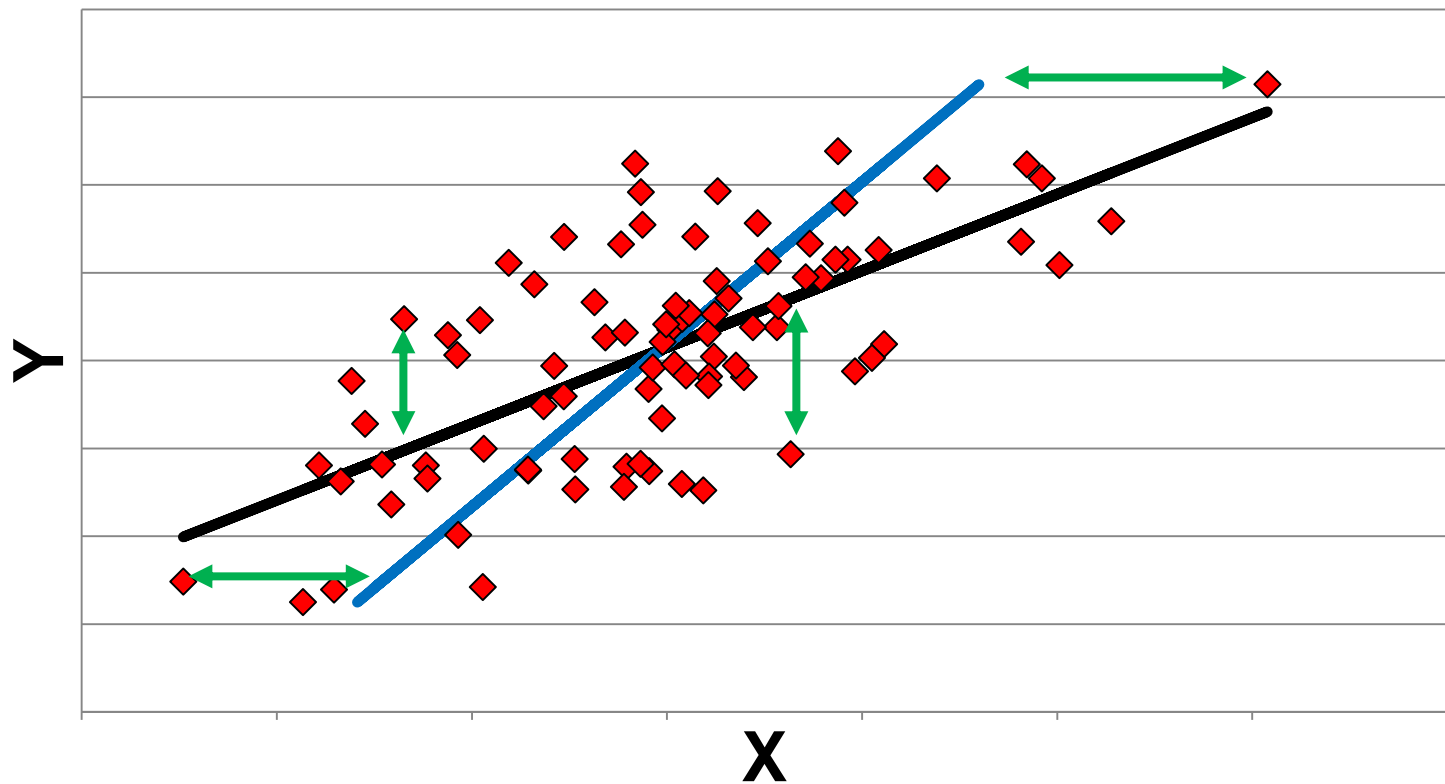
Carcass weight = Treatment + age + other effects



$$\hat{\beta}_{Y,X} = \frac{\text{cov}(Y,X)}{\text{Var}(X)}$$

(Feed) efficiency – the easy way

Carcass weight = Treatment + age + other effects

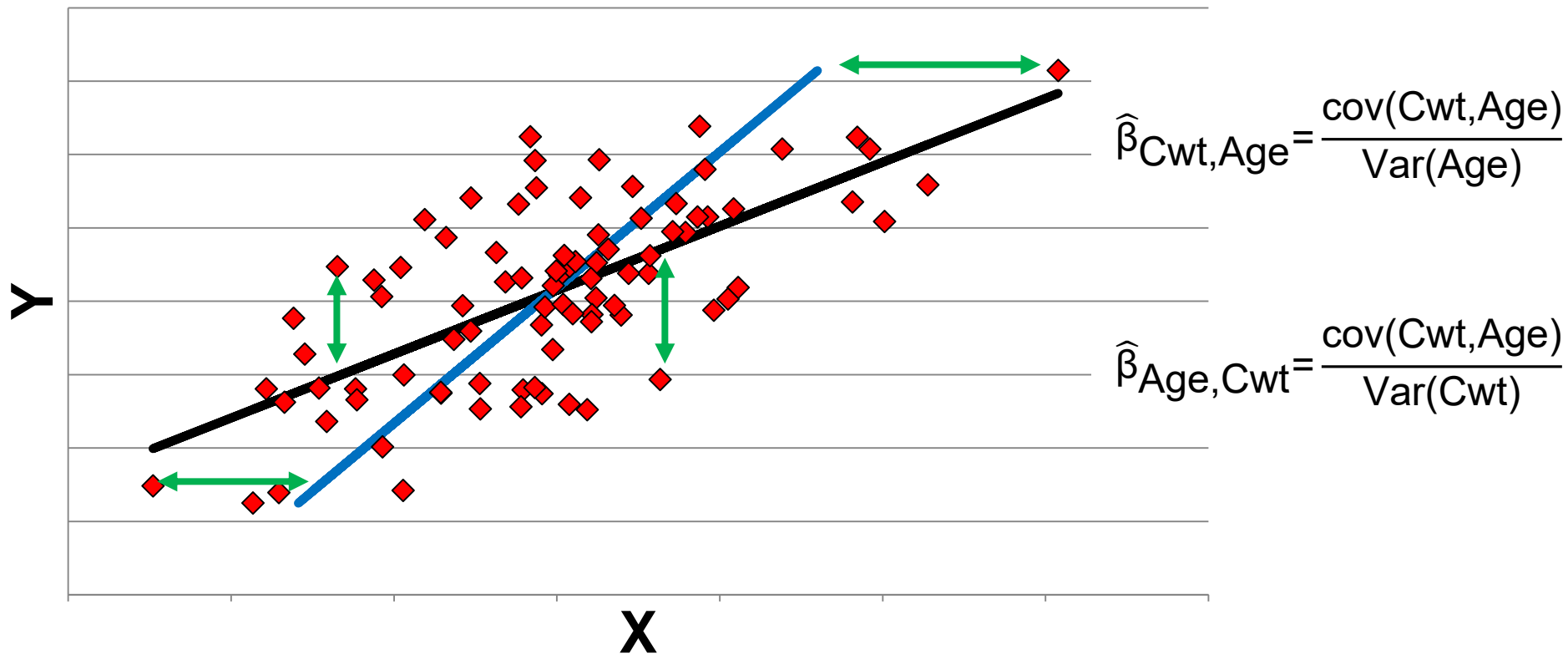


$$\hat{\beta}_{Y,X} = \frac{\text{cov}(Y,X)}{\text{Var}(X)}$$

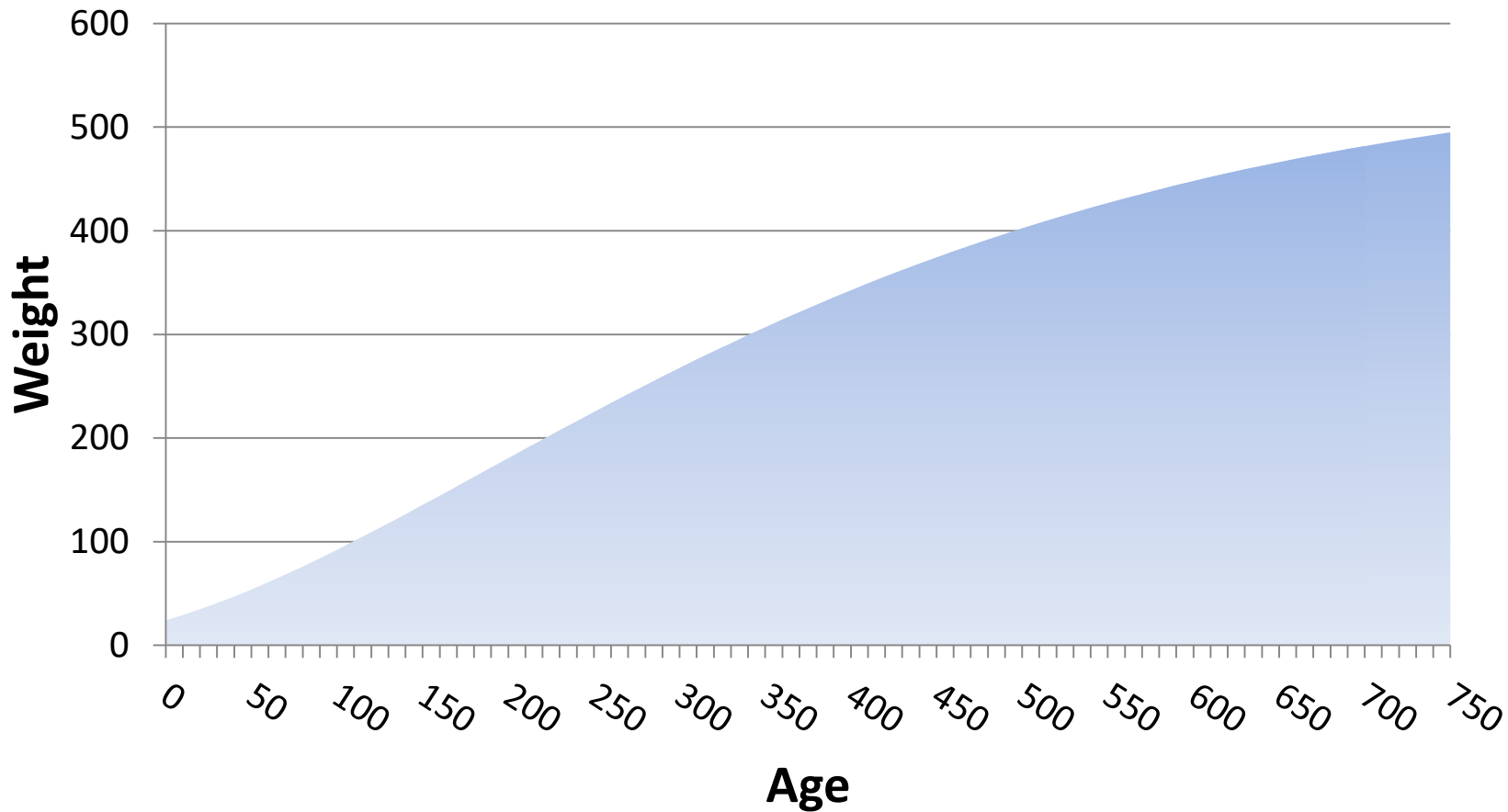
$$\hat{\beta}_{X,Y} = \frac{\text{cov}(X,Y)}{\text{Var}(Y)}$$

(Feed) efficiency – the easy way

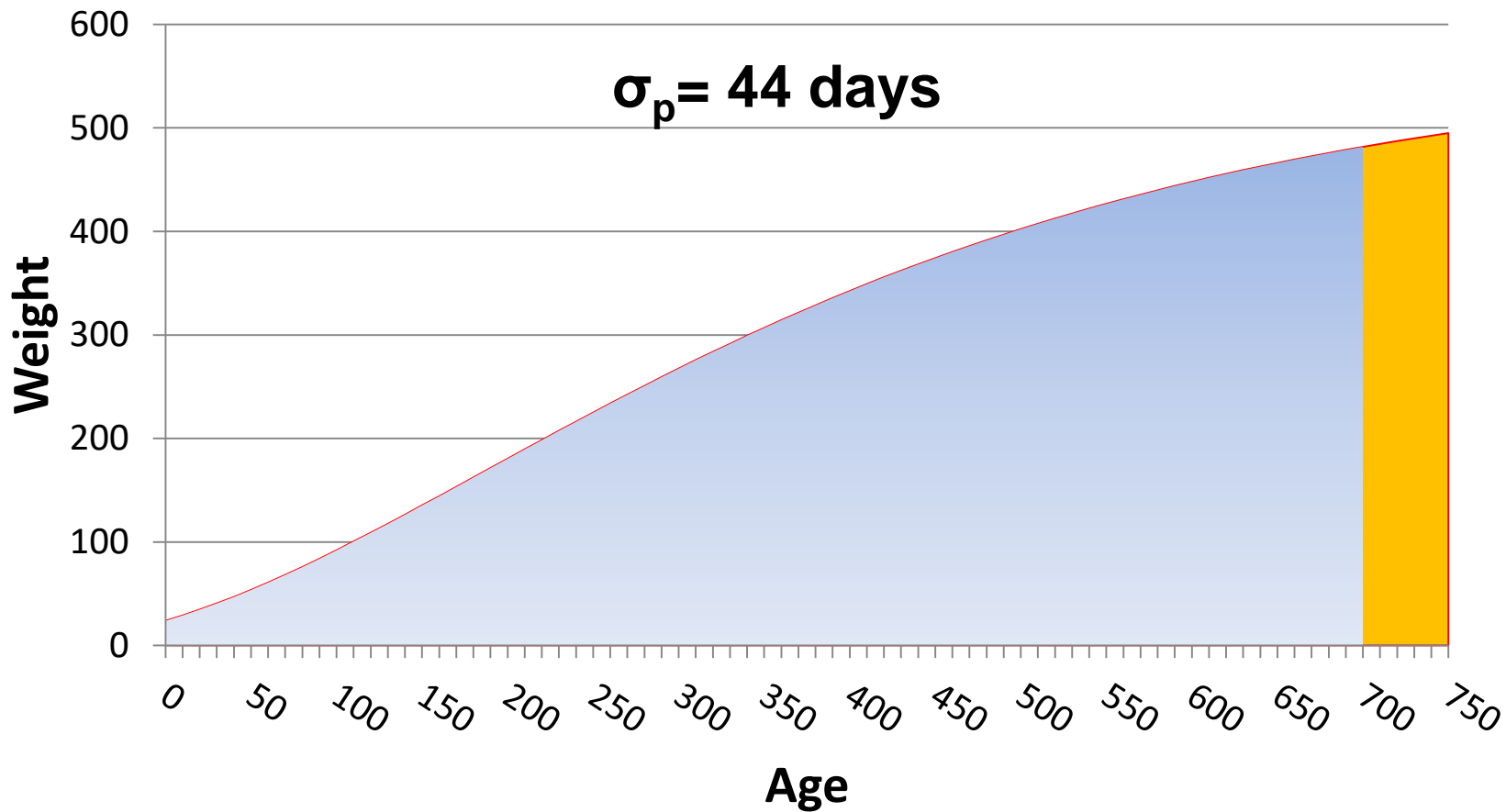
Carcass weight = Treatment + age + other effects



(Feed) efficiency – the easy way



(Feed) efficiency – the easy way



(Feed) efficiency – fifth quarter



OR



**Low
inputs**



**Low
revenue**

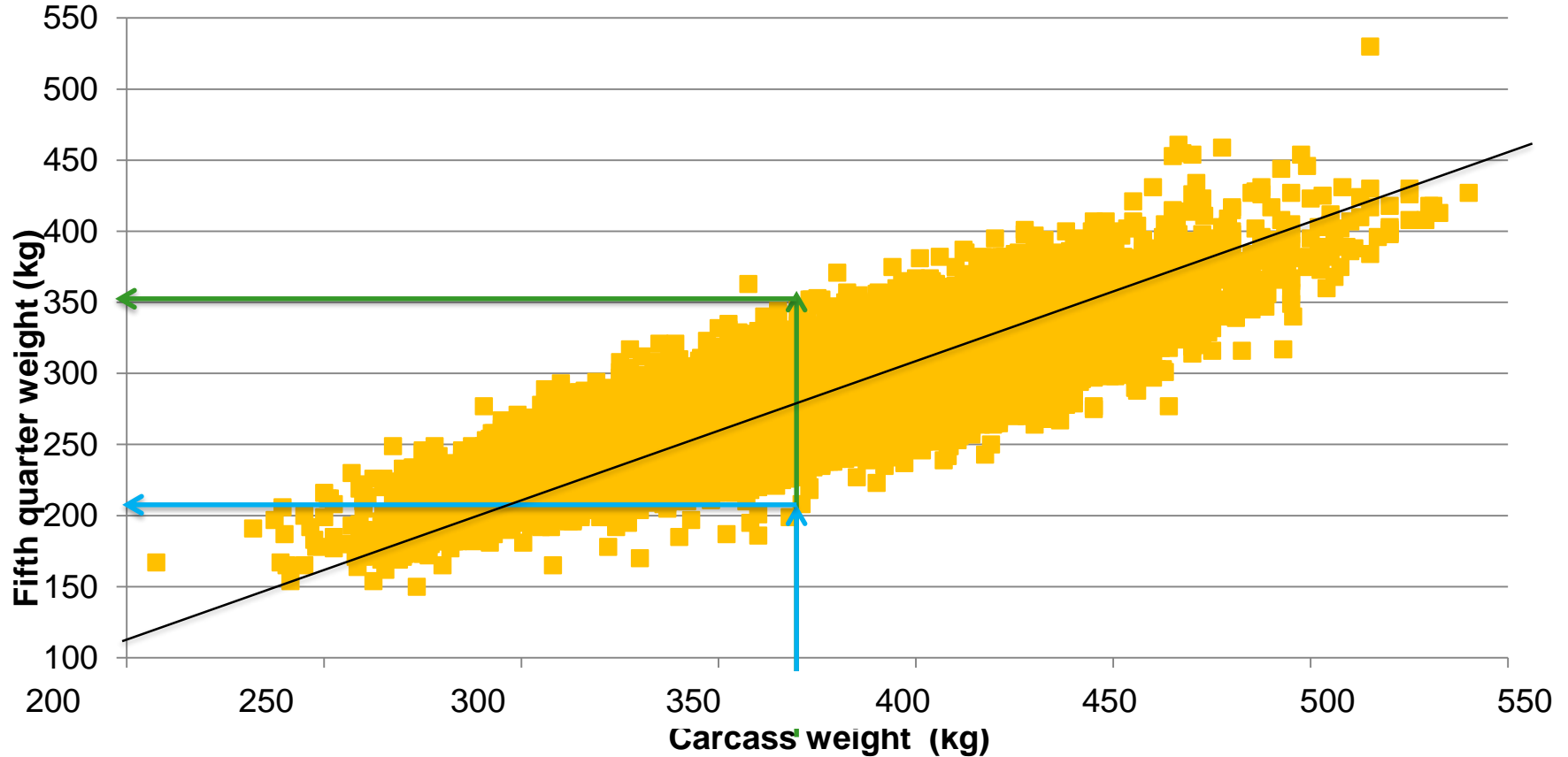


High inputs



High revenue

(Feed) efficiency – fifth quarter



Take home messages

- **Breeding has a lot to offer**
- **Heritability does not necessarily affect population-wide genetic gain**
 - **Just impacts how hard we need to work**
- **May be more than one way to skin the cat**

Acknowledgement

- **Financial support**
 - **Meat technology Ireland**
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