Improving carcass traits by selection in five beef cattle breeds

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Study objective

Why to improve carcass composition?

- Effective production of animal protein for human consumption
- Control of carcass quality

Main beef breeds in Finland
British breeds: Hereford, Aberdeen Angus
Swiss breed: Simmental
French breeds: Charolais, Limousin

Objectives
1) Estimate heritabilities and genetic correlations for carcass weight, carcass conformation and carcass fat for five main breeds

2) Compare alternative selection scenarios to quantify the way genetic correlations constrain breeding of the three traits

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Data

Carcass weight, conformation and fat recorded in five slaughter houses

Carcass conformation and fat recorded with EUROP scoring:

- Conformation (1-15): 1 = poor and 15 = extensive muscularity
- Fat (1-5): 1 = low fat and 5 = extensive fat

Breeding objective: Increase weight and conformation, avoid extensive fat

Breed	Phenotyped animals	*n* offspring per bull (mean; range)	*n* herds per bull (mean; range)
Hereford	19539	14.1 (1-181)	2.8 (1-50)
Ab. Angus	13598	13.3 (1-99)	2.9 (1-55)
Simmental	6879	12.4 (1-151)	2.7 (1-34)
Charolais	13611	13.3 (1-134)	2.7 (1-45)
Limousin	15072	14.8 (1-290)	2.6 (1-50)

+ pedigree back to 60’s

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Statistical model

For carcass weight, conformation and fat:

Random effects

- $Animal_j$ random genetic effect of an animal j (j = 1-nro of animals)
- $Error_{ijklmno}$ random residual term

Fixed effects

- $HerdYear_k$ herd-year interaction (k = 1-number of combinations)
- $DamAge_l$ age class of a dam of an individual j (l = 1-7)
- $BirthSeason_m$ season of the birth date (m = 1-5)
- $Twin_n$ twin or as a singleton birth (n = 1-2)
- $Gender_o$ gender (o = 1-2)
- b_{Age1}(Gender) linear regression coefficient of age for each gender
- b_{Age2}(Gender) quadratic regression coefficient of age for each gender

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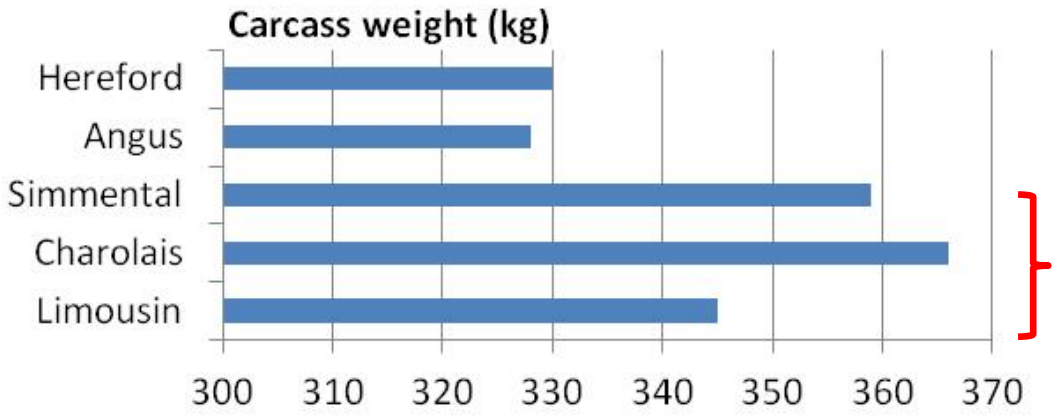
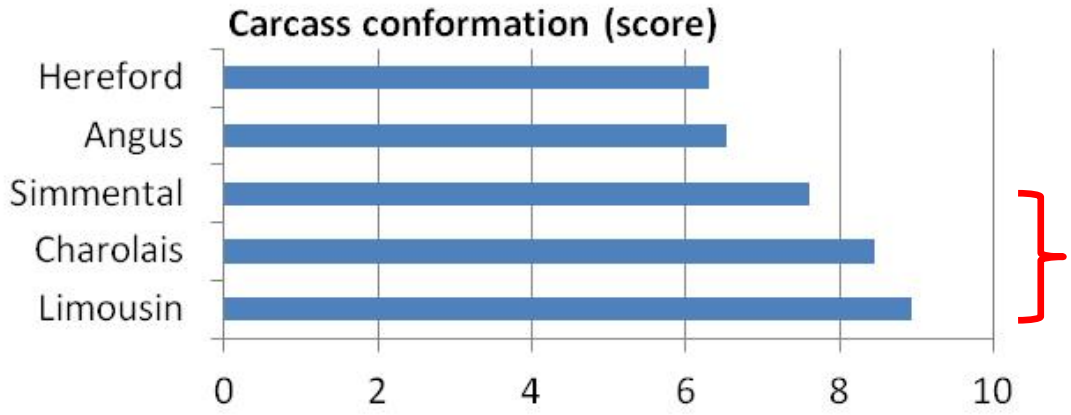
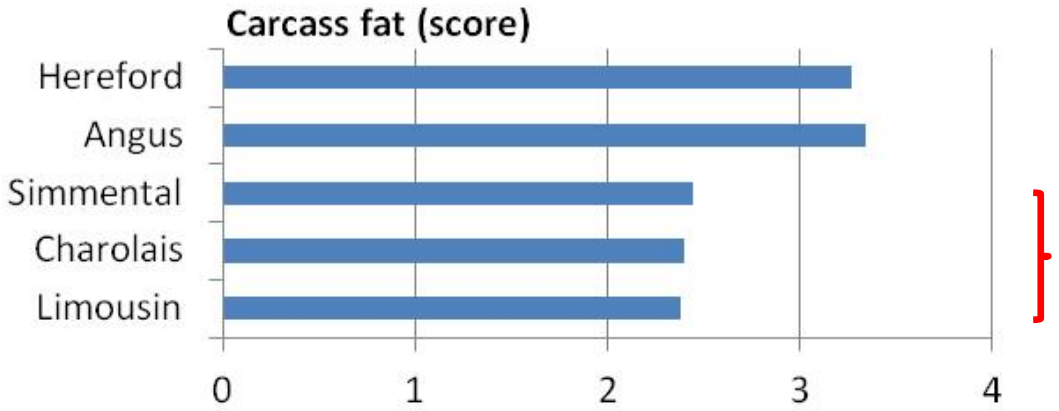
Trait means



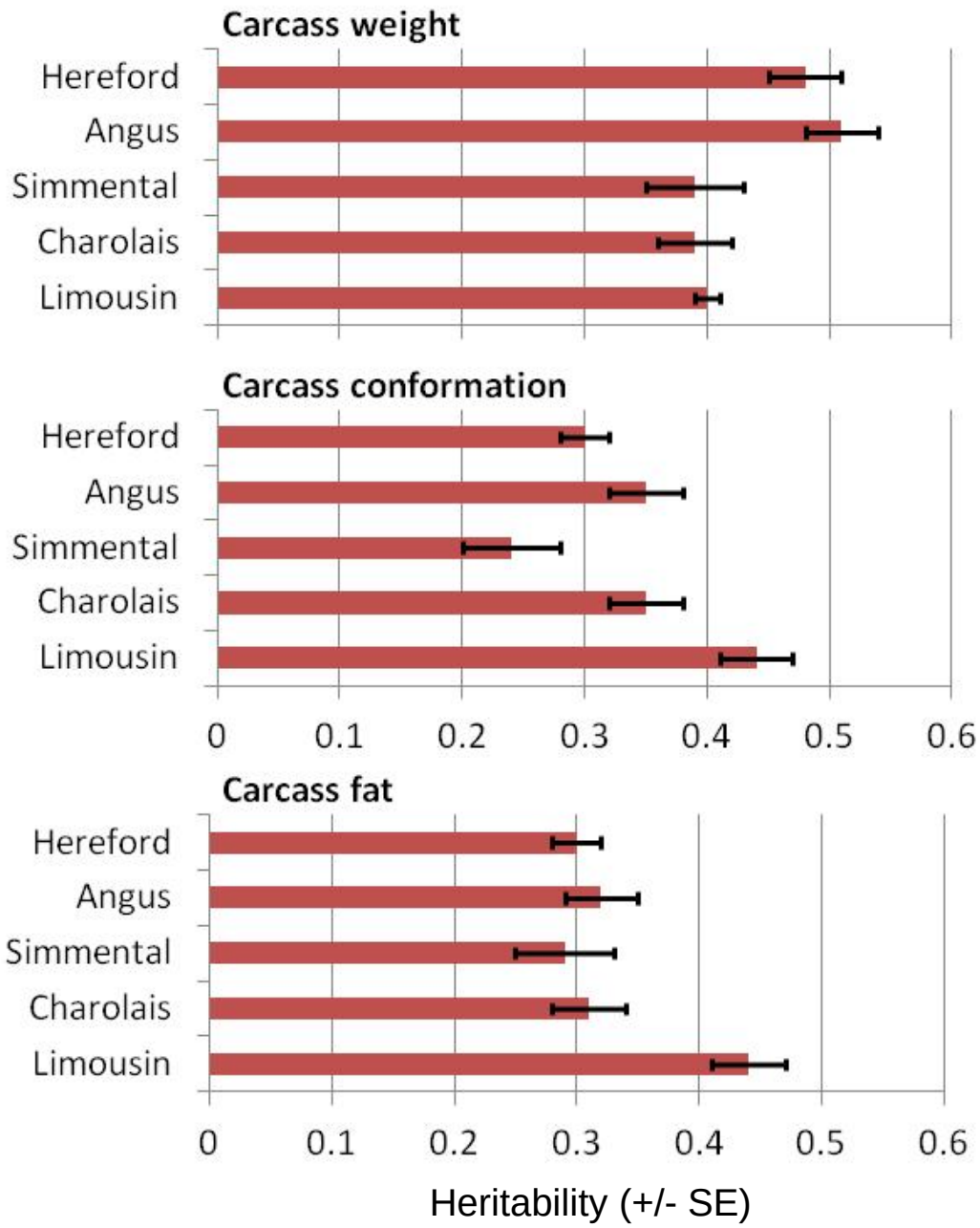
High carcass weight



High muscularity



Low fat



Trait heritability

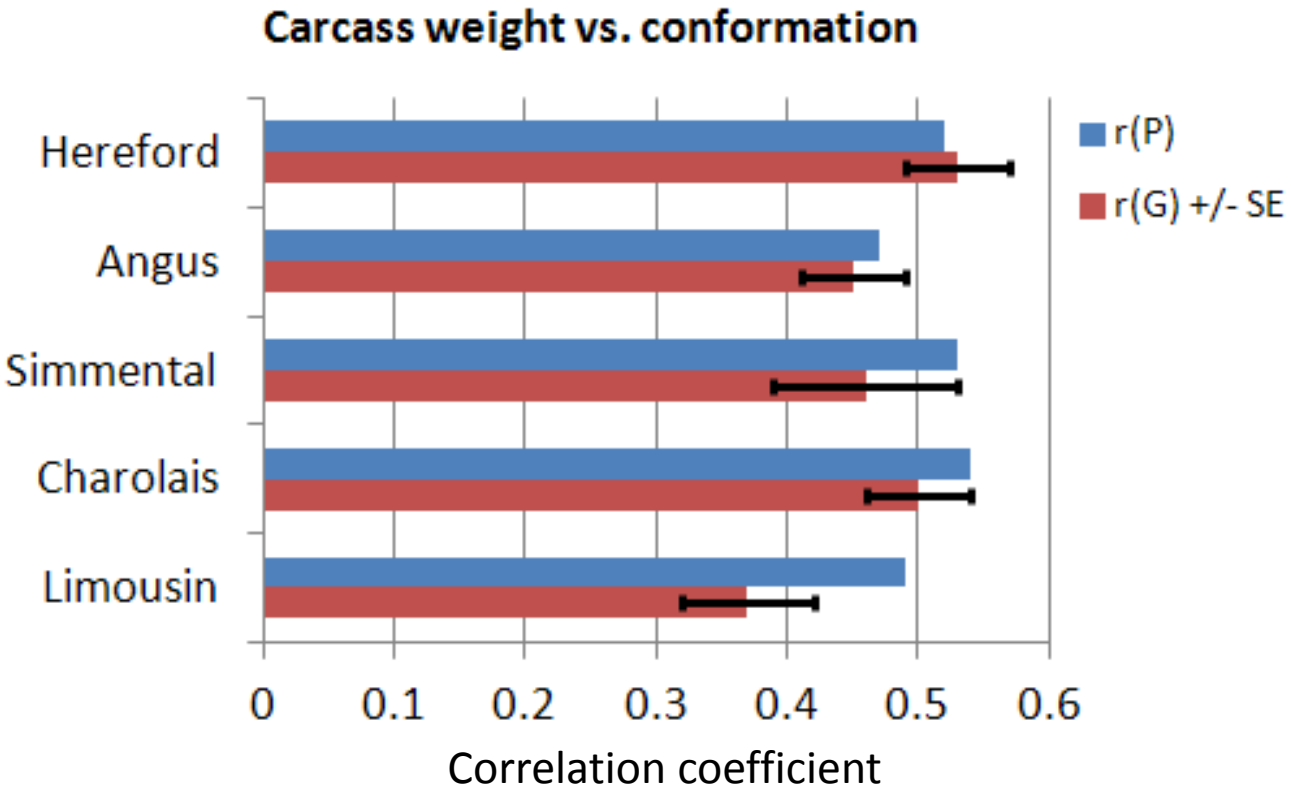
Our data, average h^2 of 0.43 (weight), 0.34 (conformation), and 0.33 (fat)

In literature, average h^2 of 0.31, 0.23, and 0.21

(More O'Ferrall et al. 1989; Dijkstra et al. 1990; Hirooka et al. 1998; van der Werf et al. 1998; Liinamo et al. 1999; Parkkonen et al. 2000; Eriksson et al. 2003; Hickey et al. 2011; Vesela et al. 2011)

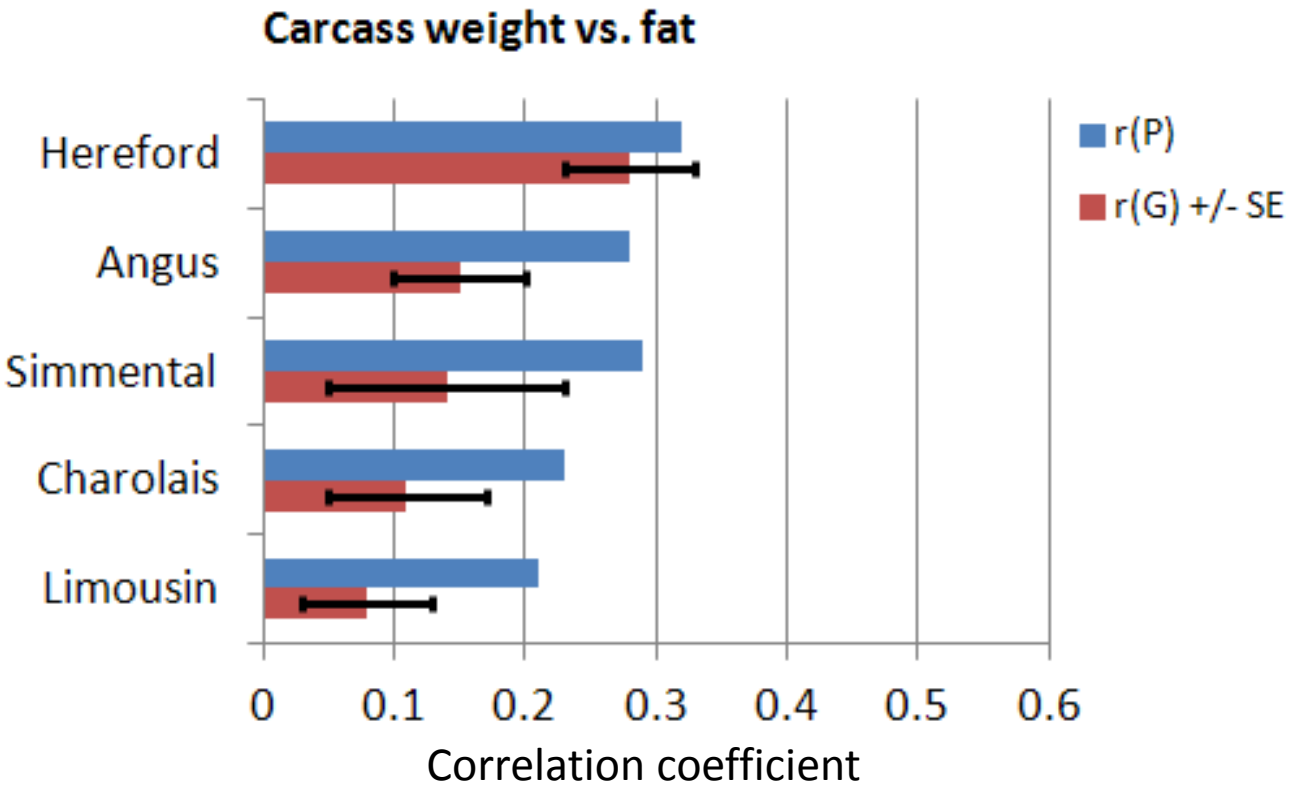
➡ Pattern the same, overall level higher in our data

Trait correlations



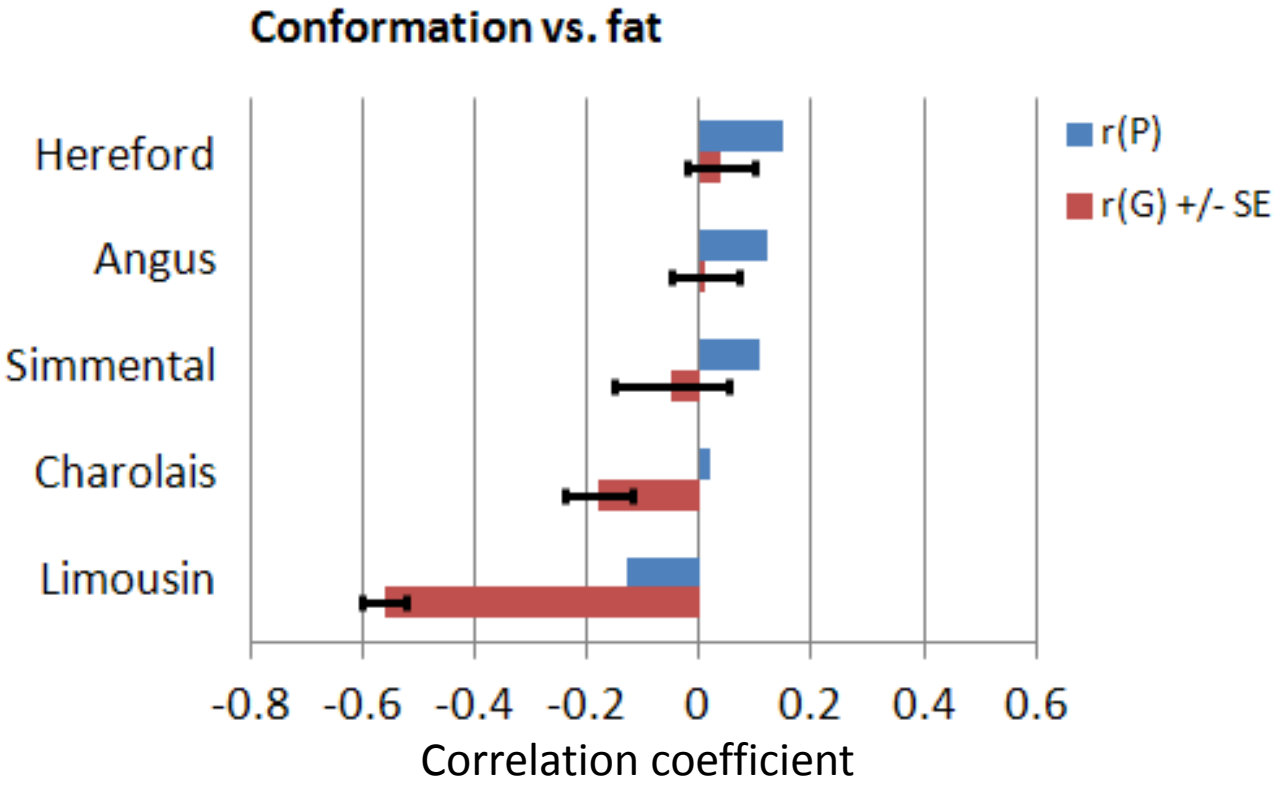
High weight – High muscularity
Favourable for all breeds

Trait correlations

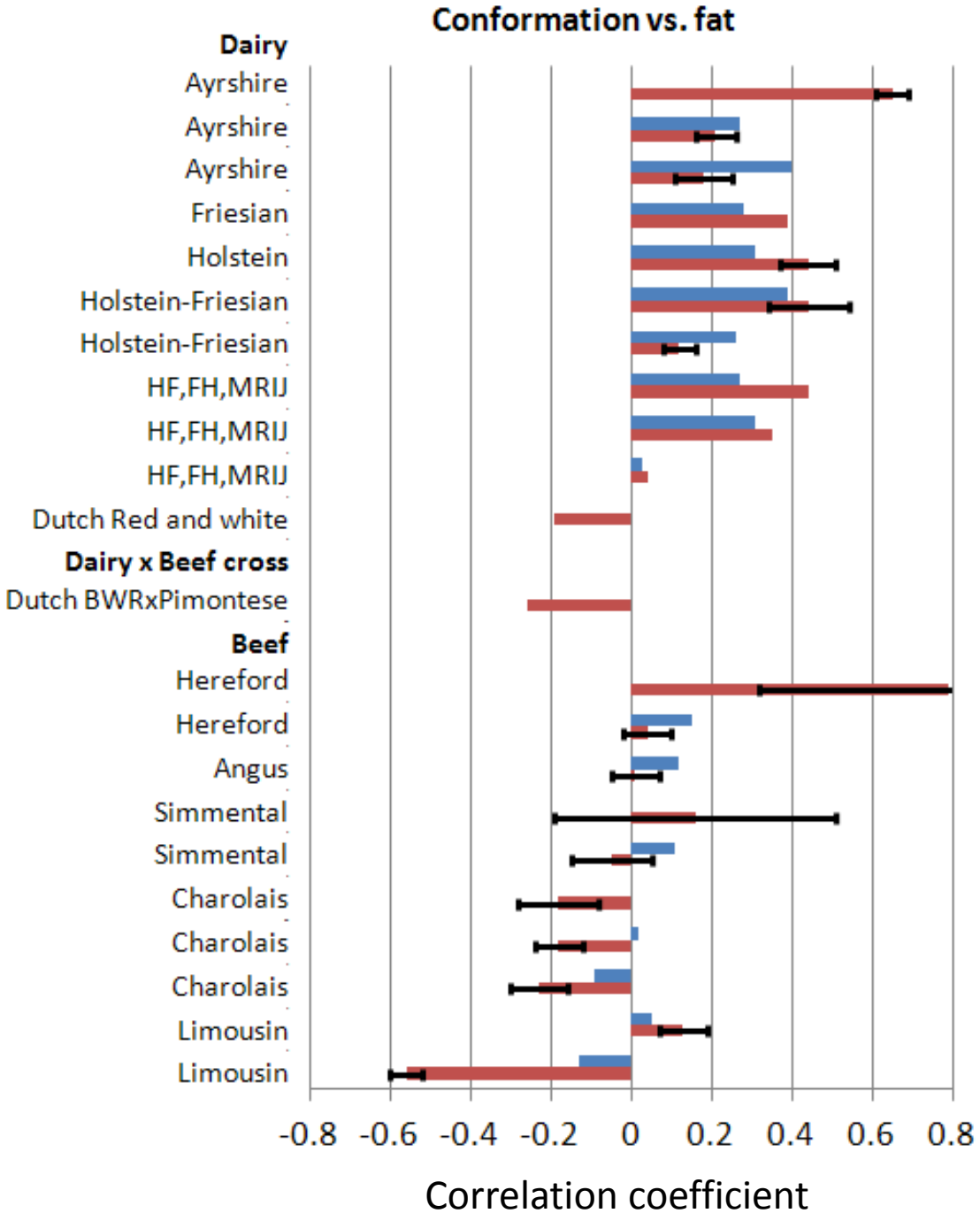


High weight – High fat
Unfavourable especially in British breeds

Trait correlations



More favourable in French breeds (High muscularity and Low fat - relationship)



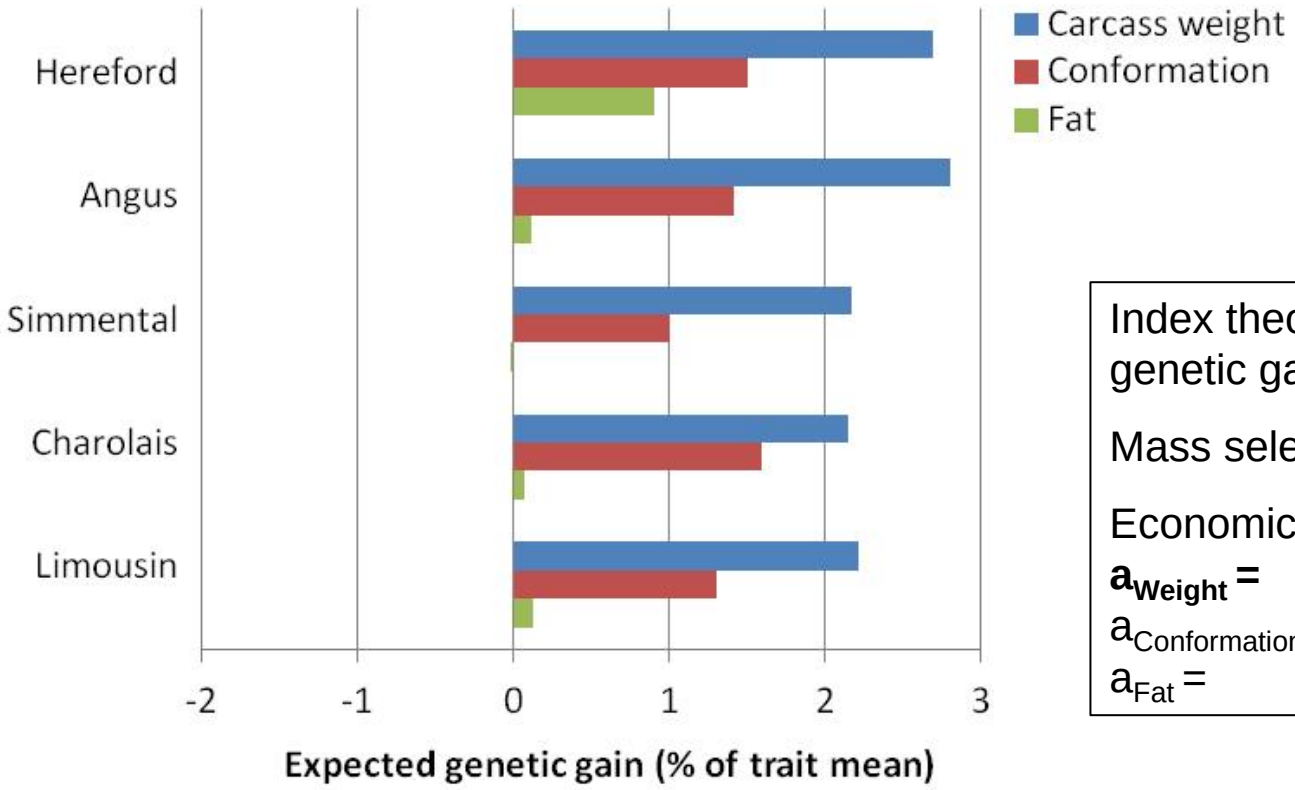
Breed differences

In dairy, unfavourable 'high conformation-high fat' relationship

In large body-sized beef, favourable 'high conformation-low fat' relationship

References (More O'Ferrall et al. 1989; Dijkstra et al. 1990; Hirooka et al. 1998; van der Werf et al. 1998; Fouilloux et al. 1999; Liinamo et al. 1999; Parkkonen et al. 2000; Eriksson et al. 2003; Hickey et al. 2011; Kause et al. EAAP)

Selection response: Selection for weight



Index theory calculations for genetic gain (Hazel 1943)

Mass selection with intensity = 0.5

Economic values used:

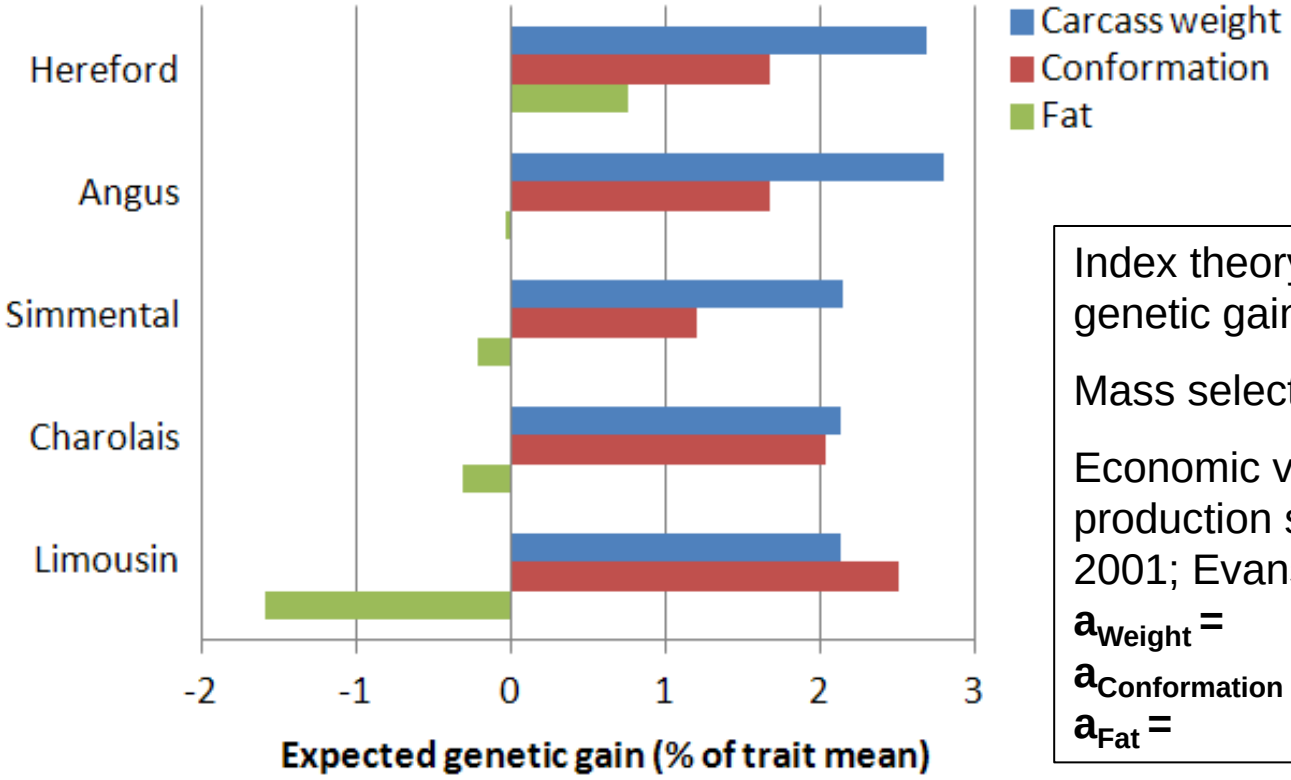
a_{Weight} = 1 €

$a_{Conformation}$ = 0 €

a_{Fat} = 0 €

➡ Consistent increase in weight and conformation (modest)

Selection response: Economic values



Index theory calculations for genetic gain (Hazel 1943)

Mass selection with intensity = 0.5

Economic values used for Irish production system (Amer et al. 2001; Evans et al. 2012)

a_{Weight} = 2.95 €

$a_{Conformation}$ = 14.77 €

a_{Fat} = -7.86 €

➡ Breed-specific responses with carcass fat decreasing in continental breeds

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Conclusions

Genetic variation exists for carcass weight, carcass conformation and carcass fat

Simultaneous improvement of carcass weight and conformation easy in all breeds

For fat, unfavourable correlation with carcass weight especially in Hereford (British breed)

Breed difference - Correlations of fat more favourable in large-body sized and muscular continental breeds