



Heterosis: Effects on Stayability

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Road Map

- ▶ Heterosis – What is it?
- ▶ Stayability
 - Measure of cow productivity
- ▶ Influence of crossbreeding on Stayability



Hybrid Vigor or Heterosis

An increase in performance of crossbred individuals relative to that of the average of their purebred parents.

An "un-doing" of accumulated inbreeding depression

Most notable trait increases:

- Lowly heritable
- Fertility
- Survivability



Hybrid Vigor is the result of gene combination value

$$P = \mu + BV + GCV + E$$

BV = Additive genetic value
 GCV = Gene interactions which yield heterosis
 Non-Additive

$$AA\ bb\ CC \times aa\ BB\ cc$$

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 Aa bB Cc

Heterosis Values

Trait	Value (%)
Birth Weight	3.0
Weaning Weight	5.0
Feed Conversion	-1.0
Yearling Weight	6.0
Age at puberty	-5.5
Fat thickness	6
Cow wn. Wt / cow exposed	18
Cow lifetime productivity	25
Stayability	12

Value is representative of the F₁ cross.

Stayability

» Background

Stayability

- Stayability Defined
 - Probability of surviving to a specific age given the opportunity to reach that age.
- Initial Impetus
 - Cows need to remain in production to generate enough revenue to offset the costs of development and maintenance.
 - 5 calves → 6 years of age
 - Herd profitability
 - Cows remaining past their break even age must compensate for those culled.
 - 53 - 77% of the value of maternal indexes

Evaluation of Stayability

- Data collection
 - Relatively easy
 - Collection of calf information
- Contemporary grouping
 - Breeder of the cow
 - Breeder of each calf
- Observations - 0 vs 1
 - Threshold model
 - Resulting predictions are expressed as a probability
- Interpretation
 - Sire A, EPD of 0
 - Sire B, EPD of 10

Stayability Trends

Genetic Trends for Stayability

ΔG/year ~ 0.33 percent to 1.23 percent

Stayability Issues

- Age at which individuals begin to receive observations.
 - Female animals - Observation at 6 years
 - Sires - 8 years for first observation
- Affects Accuracy → Genetic progress

$$\Delta G (\text{per yr}) = \frac{(i \times r_{\text{trueBV, EBV}}) \times \sigma_g}{L}$$
- How do we get higher accuracy?
 - Correlated traits
 - Measured at earlier ages
 - Phenotypes other than stayability.
 - Use more data

Aggregate Stayability

- Stayability to 6 years of age is heritable.
 - What about 3 year? 4 year? 5 year?
 - Are they heritable?
 - What is their "genetic" relationship to 6 year stayability?

	Stay3	Stay4	Stay5	Stay6
Stay3	0.15	0.79	0.56	0.64
Stay4		0.17	0.67	0.55
Stay5			0.18	0.88
Stay6				0.20

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- Four separate evaluations
 - Combine ST3, ST4, ST5, ST6 using index techniques into an aggregate ST6 evaluation.
 - Minimum, average, maximum accuracy increase
 - 0.00, 0.07, 0.32

Multi-breed Stayability

» Heterosis

Use data on all animals

- ▶ Multi-breed stayability
 - Crossbred data not typically included in evaluations
 - Account for base breed differences
 - Adjust out heterosis
- ▶ Genetic Model: $P = \mu + G + GCV + E$
- ▶ GCV - Gene Combination Value
 - Gene interactions resulting in Heterosis / Hybrid Vigor
 - Not transmittable.

What factors influence genetic improvement?

$$\Delta G / yr = \frac{i\sigma_{BV}r_{BV,EBV}}{L}$$

- ▶ Selection Intensity - How choosy we are as breeders.
- ▶ Genetic Variation - Variation of genes in population.
- ▶ Accuracy of Selection - How good our prediction is.
- ▶ Generation Interval - How long animals are in the herd.

Multi-breed Stayability

- ▶ Account for heterosis and main breed effects

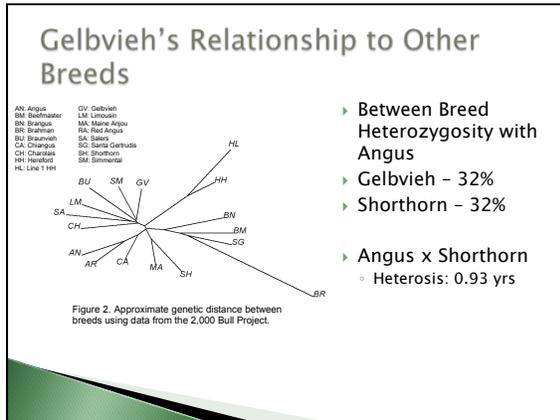
$$RHV = 1 - \sum_{i=1}^n p_i p_d$$
 - RHV 0 - Straight Bred
 - RHV 1 - F1 cross
- ▶ Analysis
 - Categorical - 0 / 1
 - Contemporary group, heterosis, main breed effect
- ▶ Literature heterosis values
 - Cow longevity
 - Stayability

Heterosis' Influence On Stayability

- ▶ Results
 - ↑ in heterosis corresponded to an ↑ in stayability
 - Effect increased with age endpoint
 - ST3 → 5.4%
 - ST4 → 9.2%
 - ST5 → 10.9%
- ▶ Comparison to literature
- ▶ Literature suggests ↑ heterosis corresponds to ↑ longevity
 - As much as 38% depending on the cross.

Multi-breed Stayability

- ▶ Questions
 - How does our 11% increase compare to literature?
- ▶ Problems
 - No literature heterosis estimates for Stayability
 - All are reported in cow longevity
 - No Gelbvieh x Angus estimates found



Longevity vs Stayability → Simulation

- ▶ Simulated two herds
 - Base herd
 - Herd with an 11% increase in 5 year Stayability
- ▶ Calculated an average age for each herd
 - Base herd – 5.29 years
 - Stayability herd – 6.06 years
 - Increase of 0.77 years.
- ▶ Literature estimate for Angus x Shorthorn – 0.93 years

Implications

- ▶ First reported estimates of heterosis influence on stayability
- ▶ American Gelbvieh Association
 - Implemented in a multi-breed stayability evaluation

Questions?