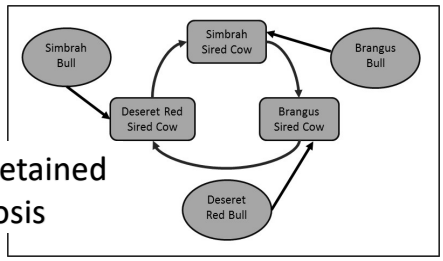
NEOGEN

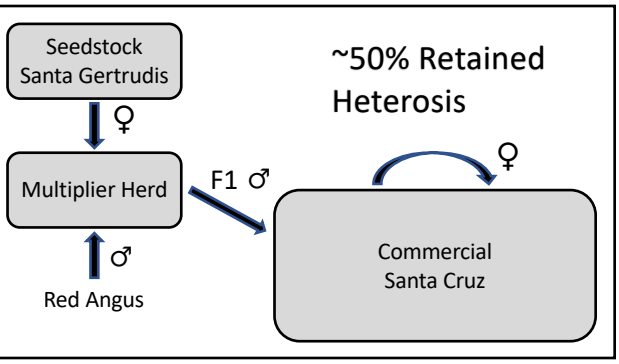
The Next Generation of Genetic Tools

John Genho

Deseret Ranches - Three Breed Rotation



78% Retained Heterosis

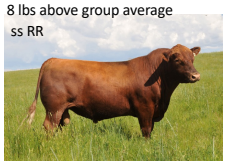


~50% Retained Heterosis

What is retained heterosis??

10 lbs above group average

8 lbs above group average



- S is worth 10 lbs of extra weaning weight
- R is worth 8 lbs of extra weaning weight
- Both are completely dominant

18 lbs above group average

9 lbs above parent average

Gregor Mendel

- Dominance
- Mendelian Segregation

F2 - Second Cross

	S R	S r	s R	s r
S R				
S r				
s R				
s r				

F2 - Second Cross

	S R	S r	s R	s r
S R	SS RR	SS Rr	Ss RR	Ss Rr
S r	SS Rr	SS rr	Ss Rr	Ss rr
s R	Ss RR	Ss Rr	ss RR	ss Rr
s r	Ss Rr	Ss rr	ss Rr	ss rr

F2 - Second Cross

Lose half of heterosis over F1

	S R	S r	s R	s r
S R	18 lbs	18 lbs	18 lbs	18 lbs
S r	18 lbs	10 lbs	18 lbs	10 lbs
s R	18 lbs	18 lbs	8 lbs	8 lbs
s r	18 lbs	10 lbs	8 lbs	0 lbs

13.5 lbs above group average
4.5 lbs above parent average

Don't confuse breed percentages with a breeding program

Three theories of heterosis

1. Dominance
2. Over Dominance
3. Epistatis

All three likely have an impact!!

9 : 3 : 1

Fertility/ Health Traits	Growth Traits	Carcass Traits
• Heifer Pregnancy • Cow Pregnancy • Cow Survival • Structure • Feedlot health	• Birth Weight • Calving Ease • Weaning Weight • Feedlot Gain • Feed Efficiency	• Marbling • Tenderness • Ribeye Area • Back Fat

Heritability

Heterosis

Why don't commercial producers use crossbreeding?

- Average herd size = 40 head.
- 9% of herds have >100 head.

F2 - Second Cross

	S R	S r	s R	s r
S R	SS RR	SS Rr	Ss RR	Ss Rr
S r	SS Rr	SS rr	Ss Rr	Ss rr
s R	Ss RR	Ss Rr	ss RR	ss Rr
s r	Ss Rr	Ss rr	ss Rr	ss rr

NRC Research Press

ARTICLE

Genomic retained heterosis effects on fertility and lifetime productivity in beef heifers

J.A. Basarab, J.J. Crowley, M.K. Abo-Ismail, G.M. Manafiazar, E.C. Akanno, V.S. Baron, and G. Plastow

Abstract: This study evaluated the effects of three genomic indicators of heterosis on female fertility and lifetime productivity, and quantified changes over 11 production cycles in a crossbred cow herd. Pedigree-based breed composition (pBC) was determined and used to calculate retained heterozygosity for 412 replacement heifers born from 2004 to 2014 at the Lacombe Research and Development Centre (AB, Canada). Heifers were followed as cows over 1050 mating opportunities, 11 production cycles, and five parities. Heifers and their sires (51) were genotyped and these genotypes were used to predict each animal's genomic breed composition (gBC) and three genomic indicators of heterosis: (1) retained heterozygosity (RHETg), (2) heterozygous proportion (*H*), and (3) retained heterosis (RHg). Correlations between pedigree and genomic breed fractions for Angus, Hereford, and Charolais were high (r_p = 0.74–0.94; $P < 0.001$). Genomic indicators of heterosis were highly related (r_p = 0.61 for RHETg vs. *H*; 0.71 for RHg vs. *H*; 0.96 for RHETg vs. RHg; $P < 0.001$). Each 10% change in RHETg resulted in 51 ± 20 d longer survival ($P = 0.011$) in the herd and 35.7 ± 15.2 kg more ($P = 0.019$) calf wean weight per cow exposed to breeding when

Genomic Indicators

$$RHET = 1 - \sum_{i=1}^{n\ breeds} breed\ proportion_i^2$$

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If animal is purebred:

$RHET = 1 - 1^2 = 0$

Genomic Indicators

$$RHET = 1 - \sum_{i=1}^{n\ breeds} breed\ proportion_i^2$$

If animal is 50% Breed1, 50% Breed2:

$RHET = 1 - 0.5^2 - 0.5^2 = 1 - 0.25 - 0.25 = 0.5$

Genomic Indicators

$$RHET = 1 - \sum_{i=1}^{n\ breeds} breed\ proportion_i^2$$

If animal is 50% Breed1, 25% Breed2, 25% Breed3:

$RHET = 1 - 0.5^2 - 0.25^2 - 0.25^2 = 0.625$

Genomic Indicators

$$RHET = 1 - \sum_{i=1}^{n\ breeds} breed\ proportion_i^2$$

$$H = \frac{Number\ Heterozygous\ Loci}{Total\ Number\ Loci}$$

SNP1	SNP2	SNP3	SNP4	SNP5	SNP6	SNP7	SNP8	H
0	2	1	1	2	0	1	2	0.38
1	2	0	0	1	0	0	2	0.25

Just an indicator – not true heterosis.

Basarab et al results

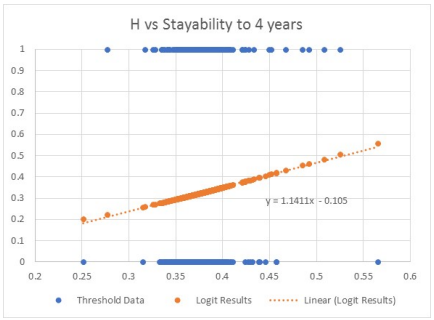
Heterosis Indicator	Pregnancy Rate	Stayability to 4YO
RHET (range 0-0.75)		
Effect	0.172 ± 0.088	1.12 ± 0.54
p-value	0.043	0.039
H (range 0.293 - 0.385)		
Effect	0.67 ± 0.78	7.88 ± 4.29
p-value	0.387	0.066

~1,000 commercial cows in Alberta

Breed composition mostly Angus, Hereford, Charolais

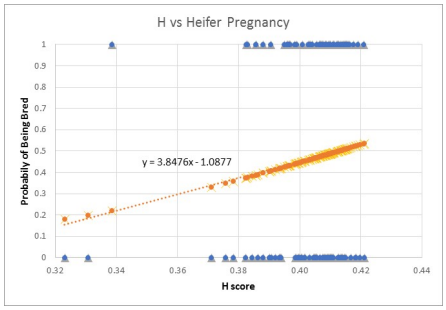
King Ranch

- 1,250 Santa Gertrudis and Santa Gertrudis X Red Angus crossed cows.
- Analyzed stayability to 4 years old.



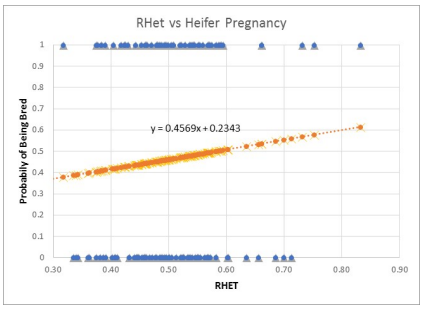
Eldon Farms

- 140 heifers wintered on fescue grass and bred on short season.
- Analyzed heifer pregnancy for H (percent heterozygosity).



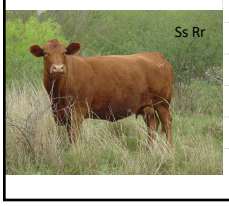
Eldon Farms

- 140 heifers wintered on fescue grass and bred on short season.
- Analyzed heifer pregnancy for RHET.



Cannot select for heterosis!!

F2 - Second Cross



	S R	S r	s R	s r
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S r	SS Rr	SS rr	Ss Rr	Ss rr
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Gregor Mendel

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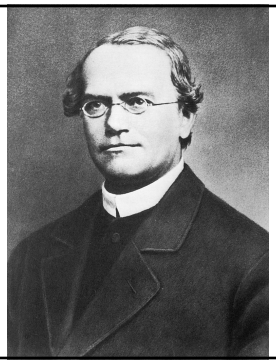

What is a breed?

Is there heterosis within a breed??

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Is there value to heterozygosity within a breed???

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Questions

John Genho