Sustainable Beef

Genomic tools & Residual Feed Intake

J.A. Basarab, P.Ag., Ph.D.
Alberta Agriculture & Forestry
Livestock Gentec, University of Alberta

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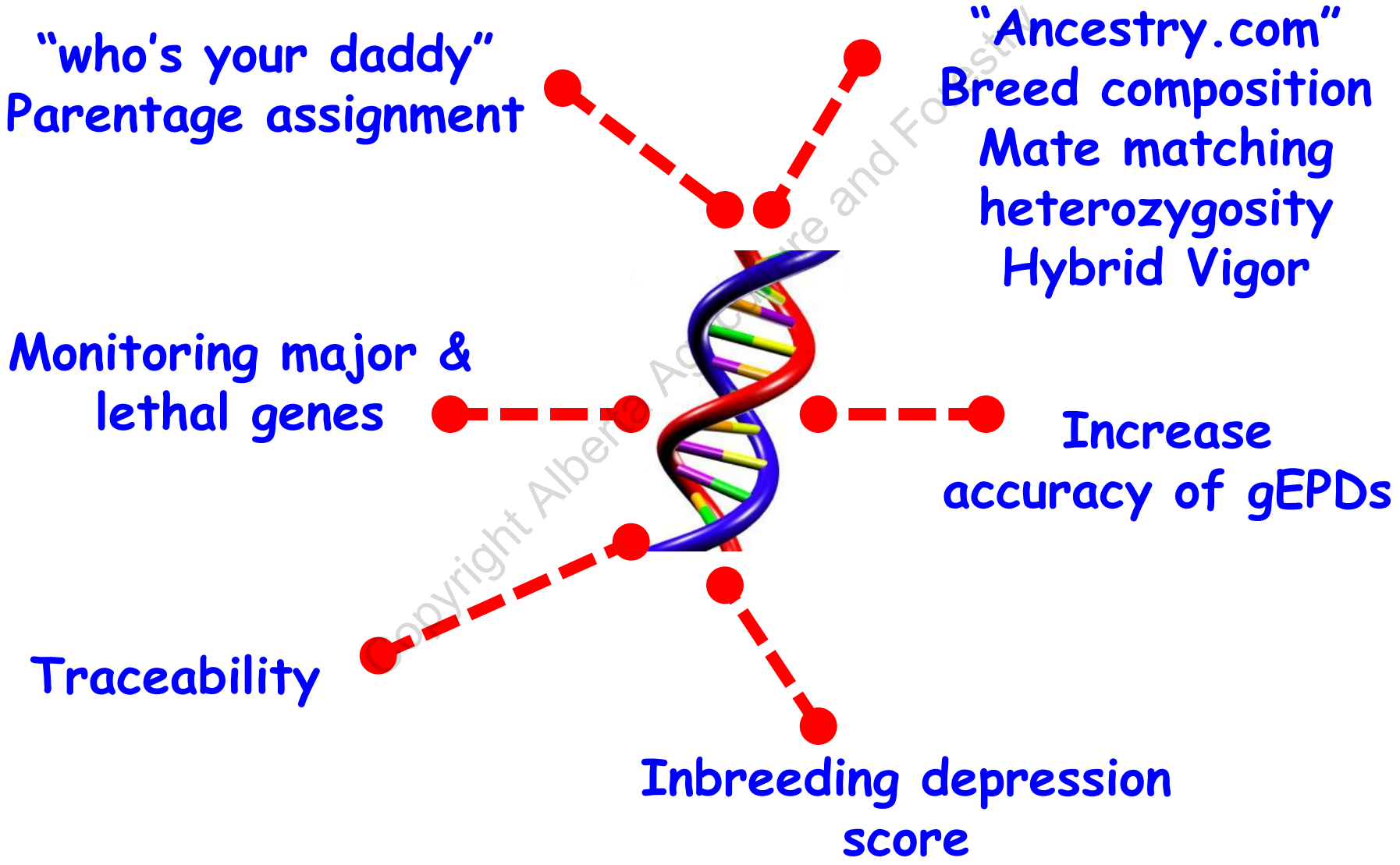
Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Improving feed efficiency, product quality, profitability, environmental impact and food security

MyHerdandMe.com

Genomic tools & potential value cattle production:



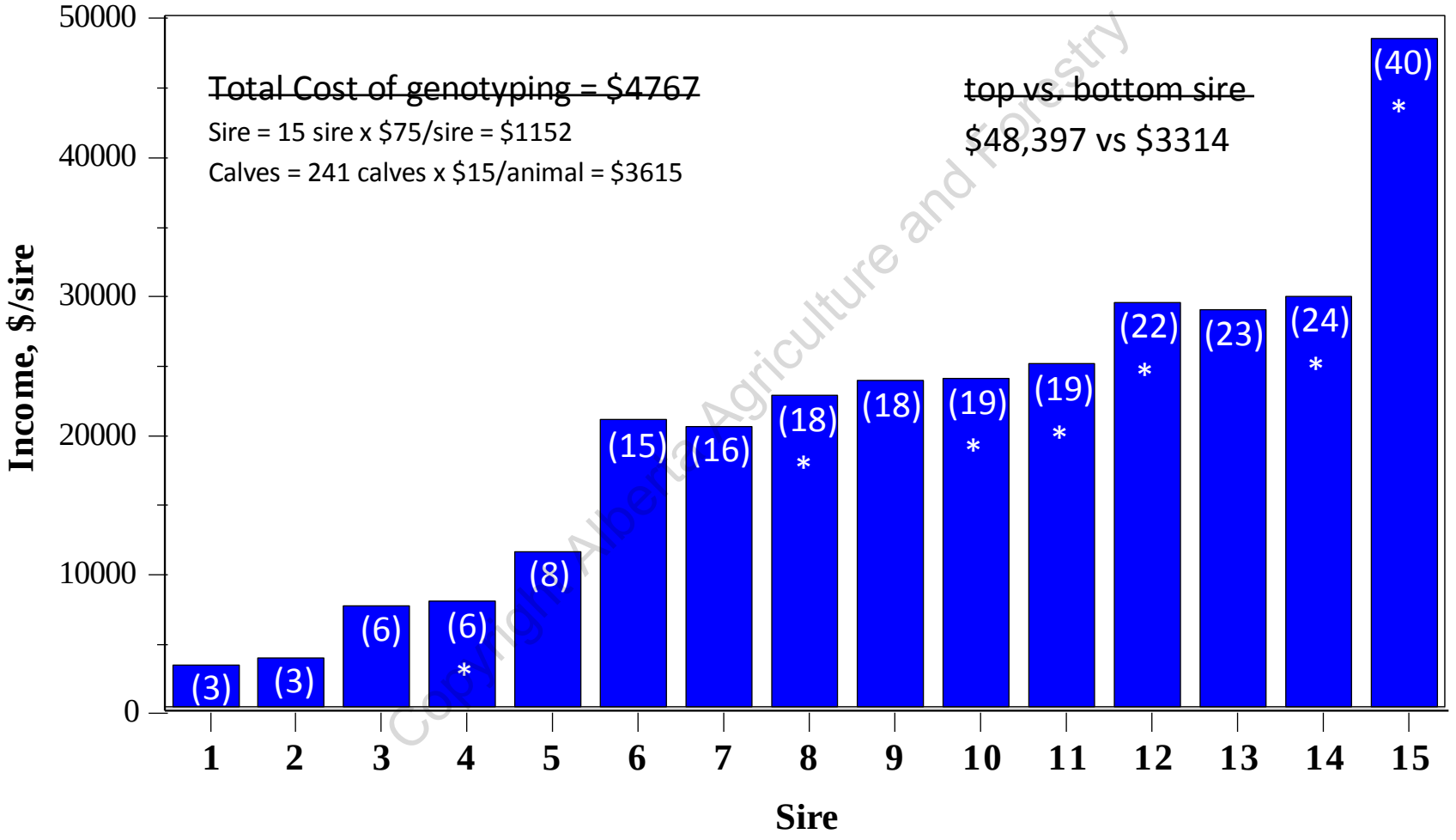
"who's your daddy"
Why It Pays to Parentage Test

- Lasting impact; progeny from sire can impact a herd for 10-25 years
- Developing replacement heifers approaches $2000
- Maintaining herd sire ~ $1800/year
- Parentage test $12-20/animal; 8 days turnaround
- Small price to pay for a long-term investment
- Record keeping is a pre-requirement

Adapted from Kathy Larson, Western Beef Development Centre, www.wbdc.sk.ca

Sire distribution by income and number of calves weaned (in parenthesis)

(15 sires; 280 cows; 241 progeny; $3/lb steers; $2.26/lb heifers, Nov 14, 2014, Clyde, AB)



*** refers to LOW RFI bulls (efficient); bulls not marked are HIGH RFI bulls (less efficient)**

Range in EPDs of sires from 3 different breeding programs for carcass value

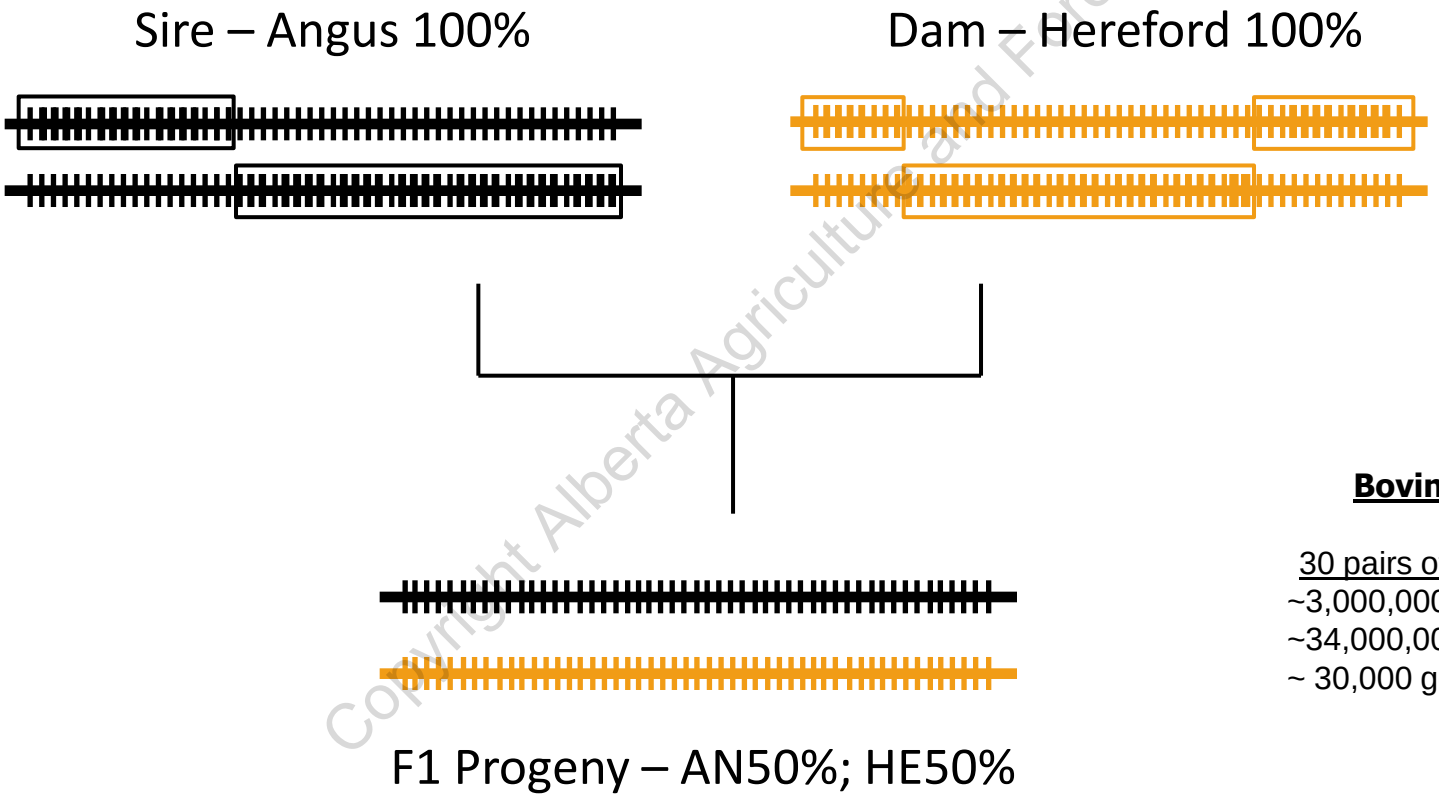
Breeding Program	sires used	EPD for carcass value $/head
1	29	$-186 to $-19/head
2	48	$ -22 to $ 95/head
3	15	$ 4 to $169/head

Conclusion: There is sufficient range in the genetic value of sires for carcass merit, and that selection amongst yearling bulls using carcass traits improve carcass value (MacNeil, Basarab and Manafiazar)

"Ancestry.com" for beef cattle

Genomic breed composition
Mate matching
Retained heterozygosity
Genomic Hybrid Vigor

Inheritance of DNA & recombination



Bovine Genome

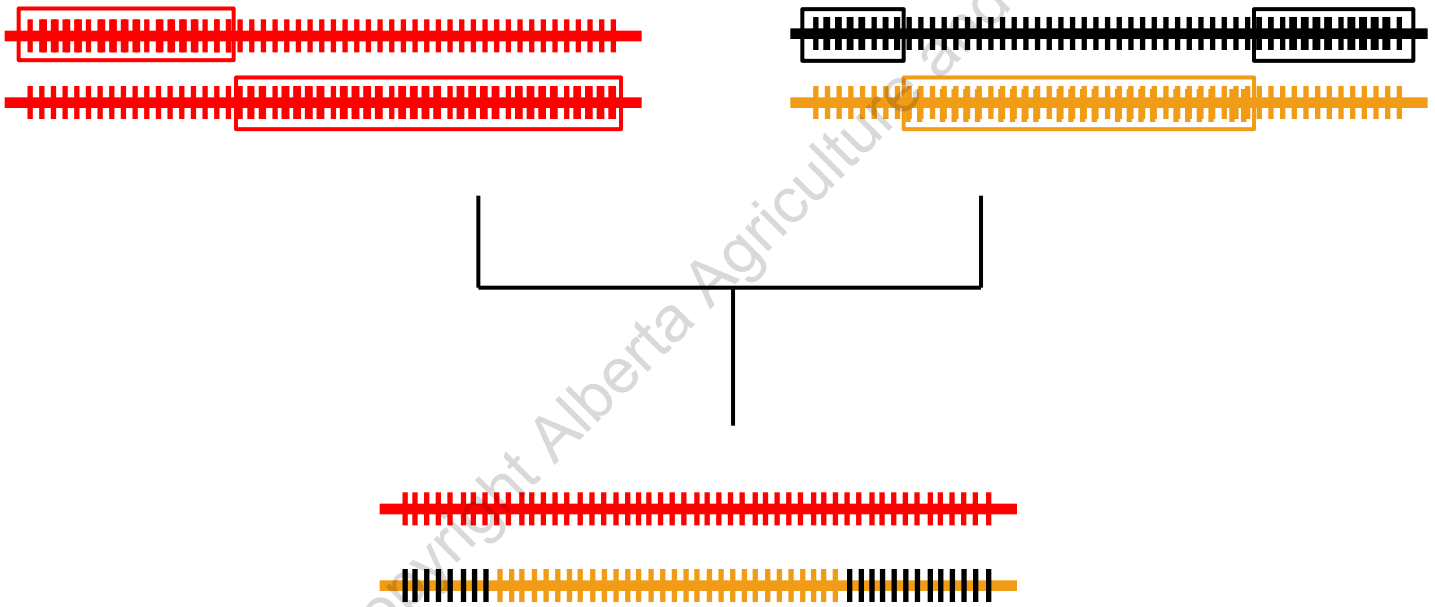
30 pairs of chromosomes
~3,000,000,000 bp
~34,000,000 variants
~ 30,000 genes

Adapted from Mehdi Sargolzaei and Steve Miller, University of Guelph

Inheritance of DNA & recombination

Sire – Simmental 100%

Dam – AN50%; HE50%



Progeny – Expected SM50%; AN25%; HE25%

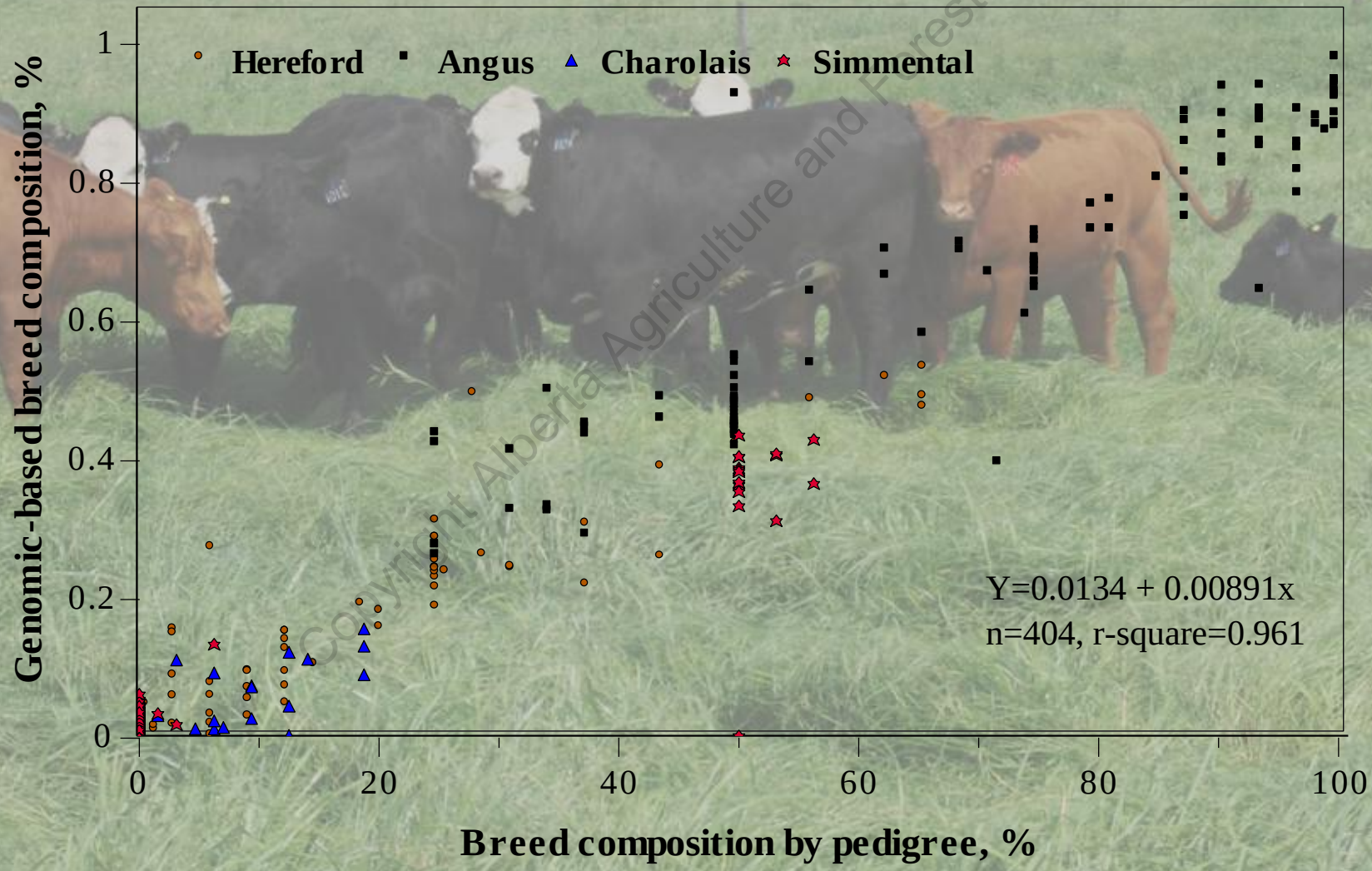
- Actual SM50%; AN15%; HE35%

Adapted from Mehdi Sargolzaei and Steve Miller, University of Guelph

Genomic breed composition

Relationship between breed composition by pedigree and genomic-based breed composition in crossbred beef heifers

(Lacombe Research and Development Centre; 2015 born, n=102)

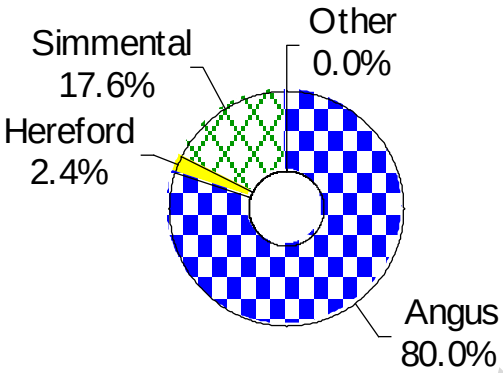


Genomic breed composition

MyHerdandMe ... genotyping for beef cattle

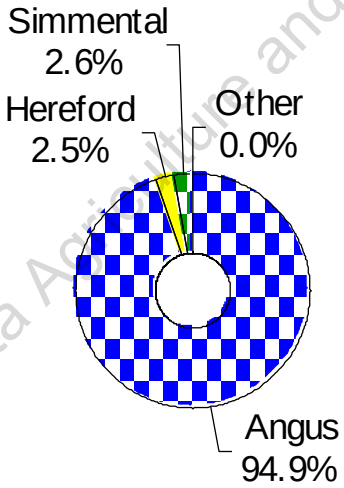
Genomic-based breed composition & retained heterozygosity

Heifer progeny



Total: 100

Red Angus bull



Total: 100

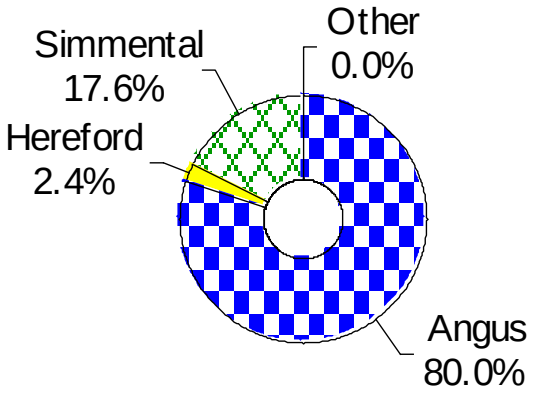
Retained Heterozgosity:	32.8%	19.8%

Angus **Hereford** **Simmental** **Other**

MyHerdandMe ... genotyping for beef cattle

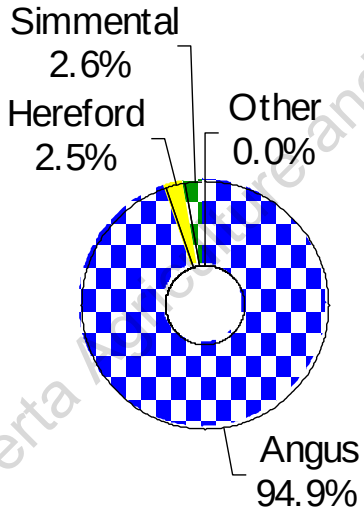
Genomic-based breed composition & retained heterozygosity

Heifer progeny



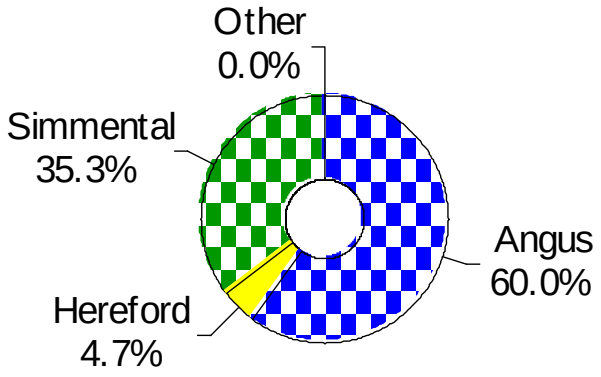
Total: 100

Red Angus bull



Total: 100

Crossbred cow

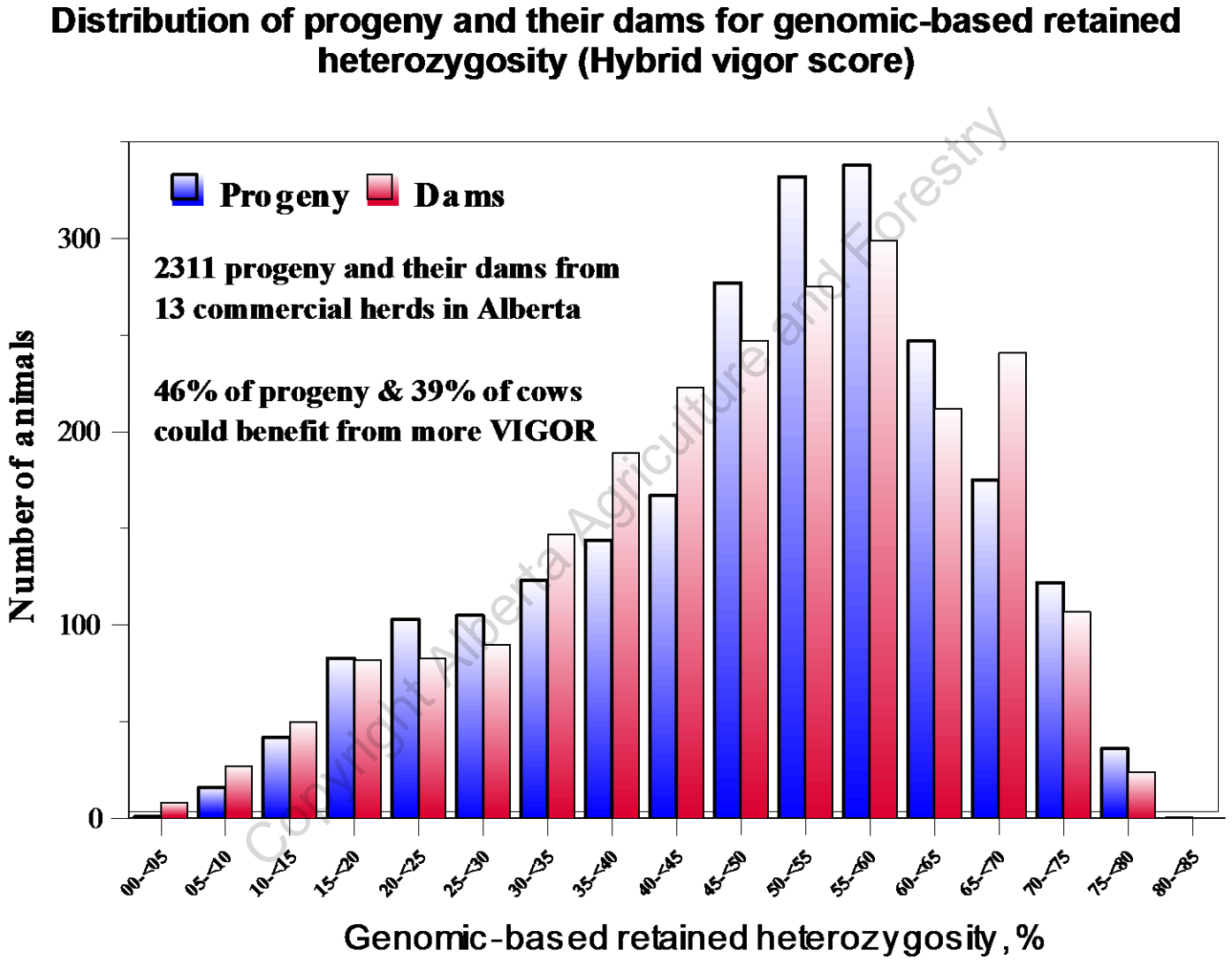


Total: 100

Retained Heterozgosity:	32.8%	19.8%	51.4

Angus **Hereford** **Simmental** **Other**

Is low %RH and reduced hybrid vigor an opportunity?



Yes, 46% of calves and 39% of cows would benefit from more VIGOR

Hybrid Vigor Score and RFI_{fat} in crossbred beef cattle.

Groups	Type	n	Vigor Score		Linear effect, kg DM/day per 1% increase in Vigor Score
			mean	SD	
DW	steer	109	49.5	9.4	-0.016±0.007
JM	steer	99	54.2	17.0	-0.007±0.005
LRC	heifer	95	41.5	18.8	-0.006±0.002
All		303	48.4	16.2	-0.008±0.002

Each 10% increase in Hybrid Vigor Score improves feed efficiency by 0.08 kg DM/d. Thus increasing Vigor Score from 30% to 60% would save $18/head in feed costs over 250 days of feeding.

Estimated increase in performance from different mating systems

Mating Type	Estimated increase in calf wean weight per cow exposed to breeding (%)
Pure breeds	0
2-breed rotation	15.5
3-breed rotation	20.0
Composites	
F3-5/8A, 3/8B;	10.9
F3 - 3/8A, 3/8B	15.3
F3 - 3/8A, 3/8B, 1/8C, 1/8D	16.0
F3 - 1/4A, 1/4B, 1/4C, 1/8D, 1/8E	18.2
F3 - 1/4A, 1/4B, 1/8C, 1/8D, 1/8E, 1/8F	18.9
F3 - 3/16A, 3/16B, 1/8C, 1/8D, 1/8E, 1/8F, 1/8G	19.8
F3 - 1/8A, 1/8B, 1/8C, 1/8D, 1/8E, 1/8F, 1/8G, 1/8H	20.4

Each 10% increase in %RH results in 2.3% increase in calf weight weaned per cow exposed to breeding

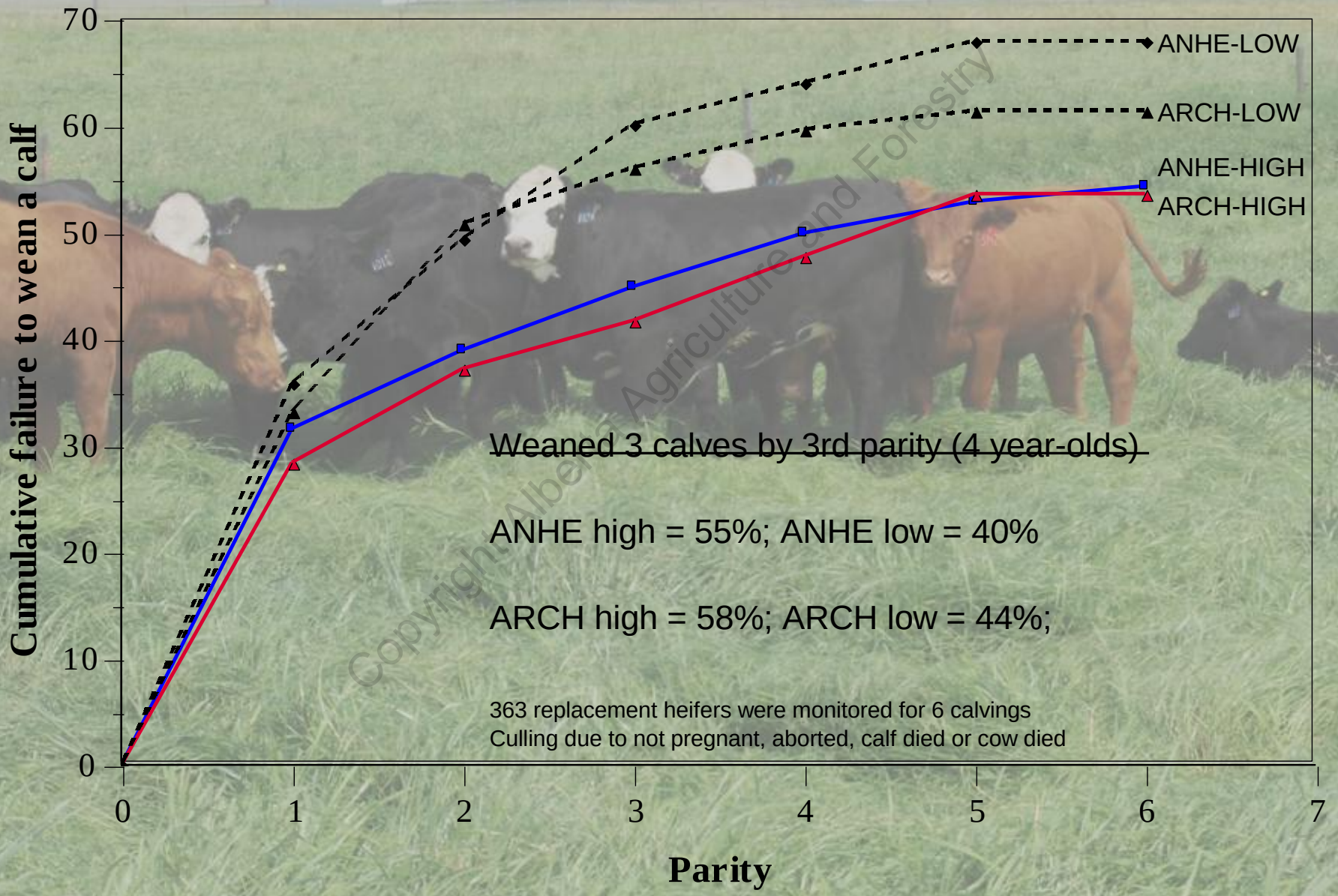
Gregory et al. 1990

Genomic Hybrid Vigor, longevity, and profitability

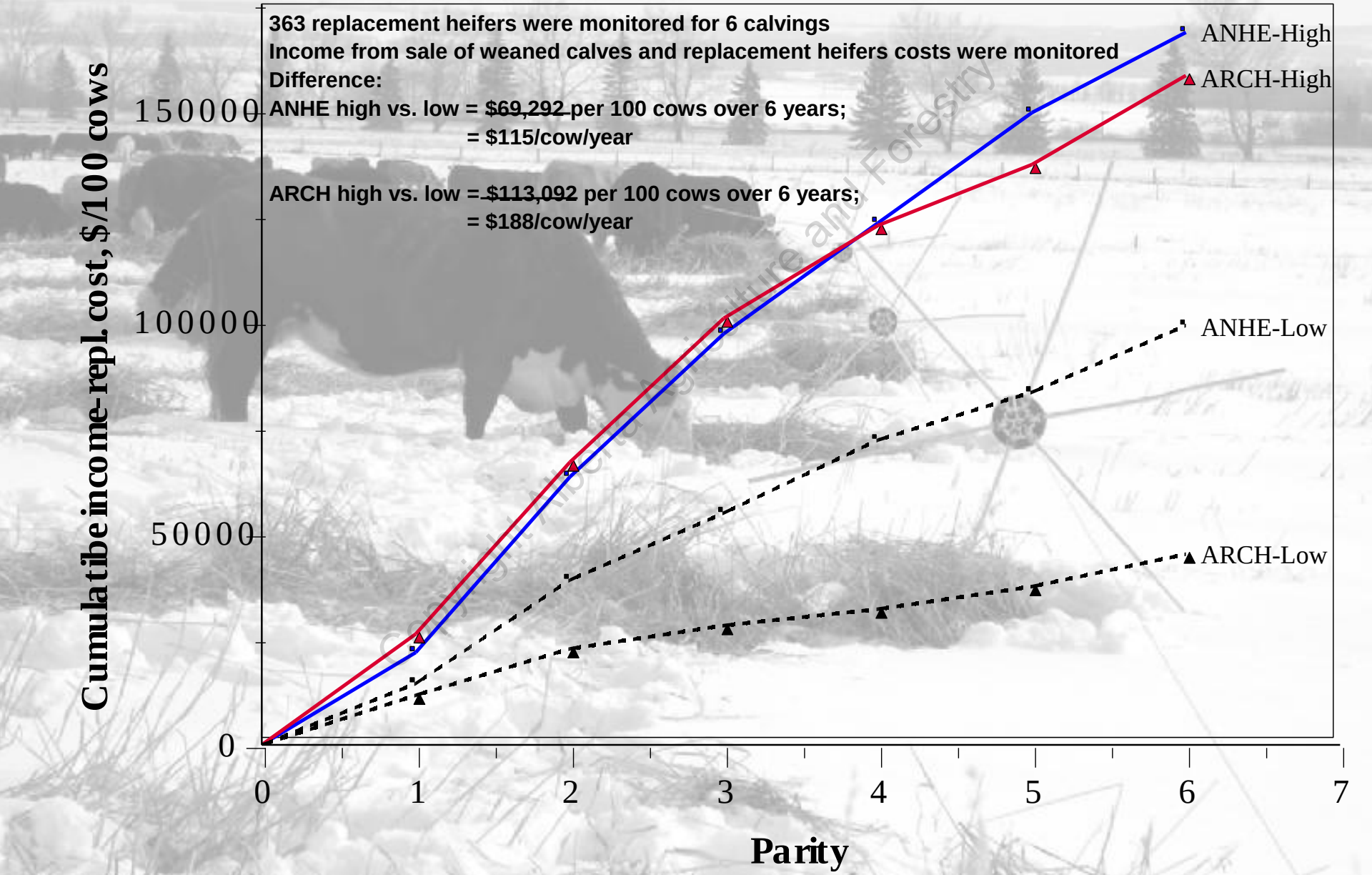
363 replacement heifers followed for 6 calvings

Two Biotypes: ANHE (easy fattening); ARCH

Genomic-determined hybrid vigor (high vs. low) and its affect on longevity over 6 calvings in ANHE and ARCH beef heifers



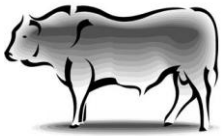
Genomic-determined hybrid vigor (high vs. low) and its affect on cumulative income over 6 calvings in ANHE and ARCH beef heifers



Increase accuracy of genetic evaluations (gEPDs)

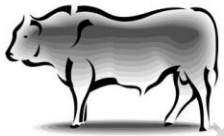
Increasing accuracy of gEPDs

- Pre-genomics, accuracy is increased by more phenotypes, better phenotypes and better pedigree recording

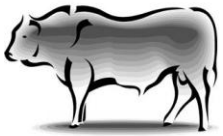


Acc=25%

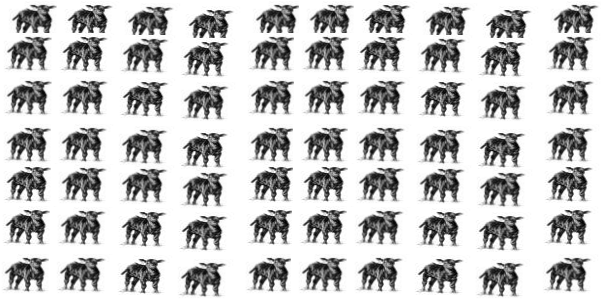
0



Acc=65%



Acc=90%

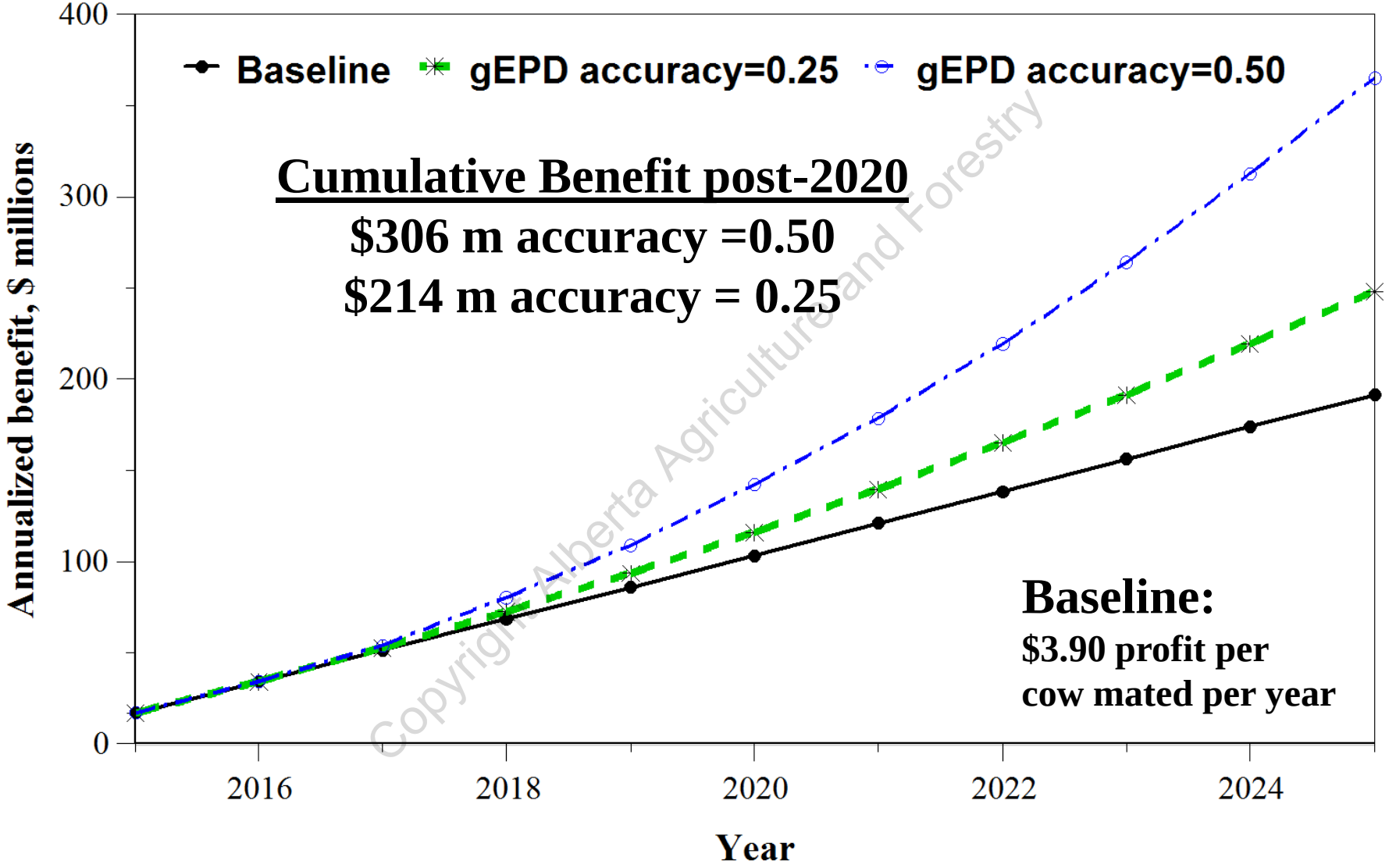


Improvement in reliability - beef

	Reliability - validation		
Trait	Traditional	Genomic	Progeny equiv.
Farm docility	0.29	0.44	3.6
Linear docility	0.30	0.45	3.6
Cow docility	0.28	0.43	3.6
Age first calv.	0.		6.8
Calv. Int.	0.		70.7
Survival	0.		87.2
Dir wean wt	0.24	0.34	1.8
Carc. Wt	0.31	0.43	2.3
Carc. Fat	0.29	0.41	2.7
Carc. Conf	0.29	0.41	3.1
Feed intake	0.19	0.34	2.0

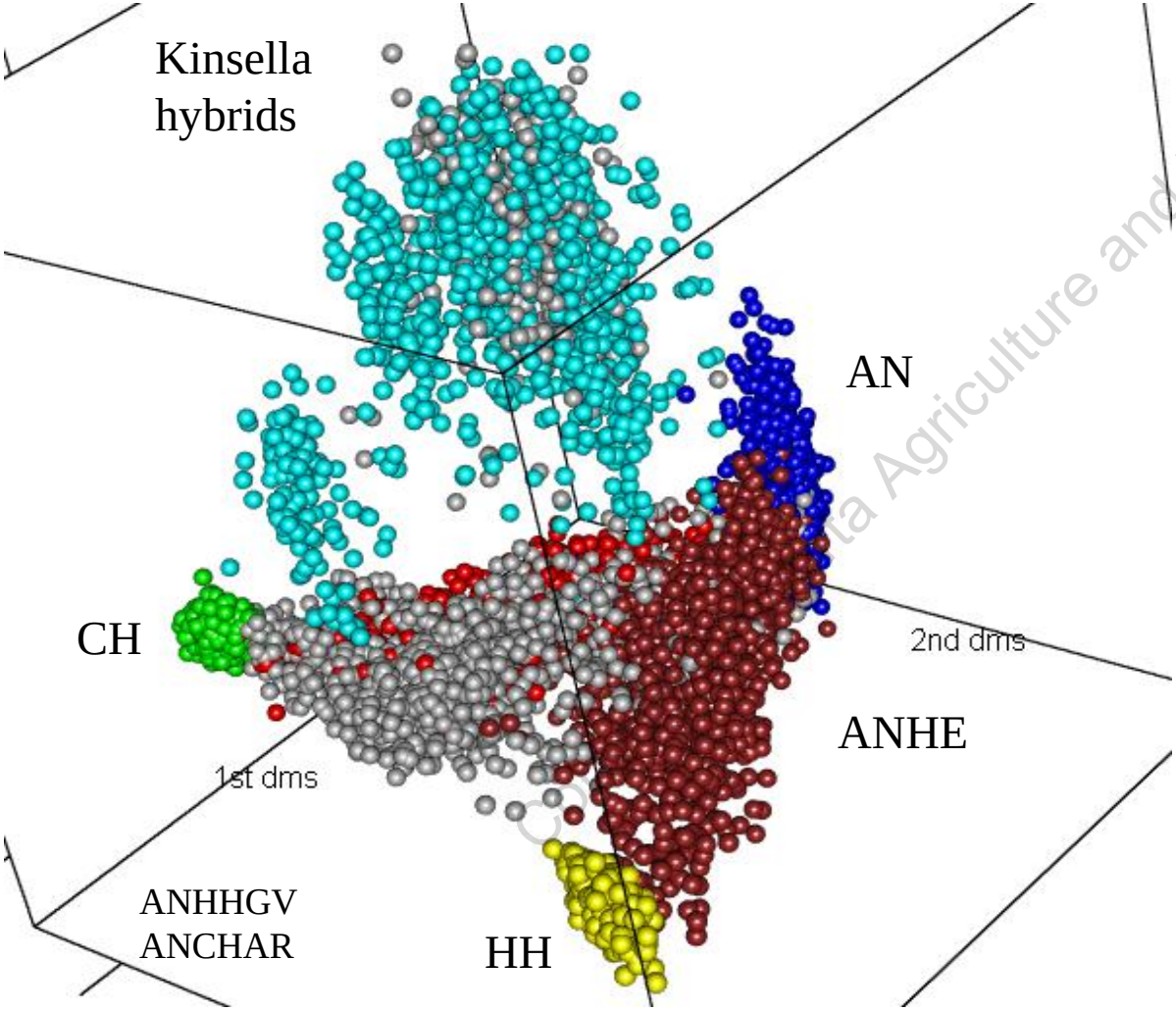
37% to 156% increase in reliability

Annualized benefit of current and future genetic selection programs for Canada's 4.7 million beef females (cows and replacement heifers)



Scenarios calculated with an annual discount rate of 7%, and 4.7 million cows bred, and the baseline had three base traits (birth, weaning and yearling weight). gEPD with 0.25 and 0.50 accuracy had adoption rates increasing in 5% increments starting at 10% in 2017 (adapted from Fennessey et al. 2013).

Prediction equation development (MBVs) for feed efficiency and carcass quality using 50k and imputed HD genotypes

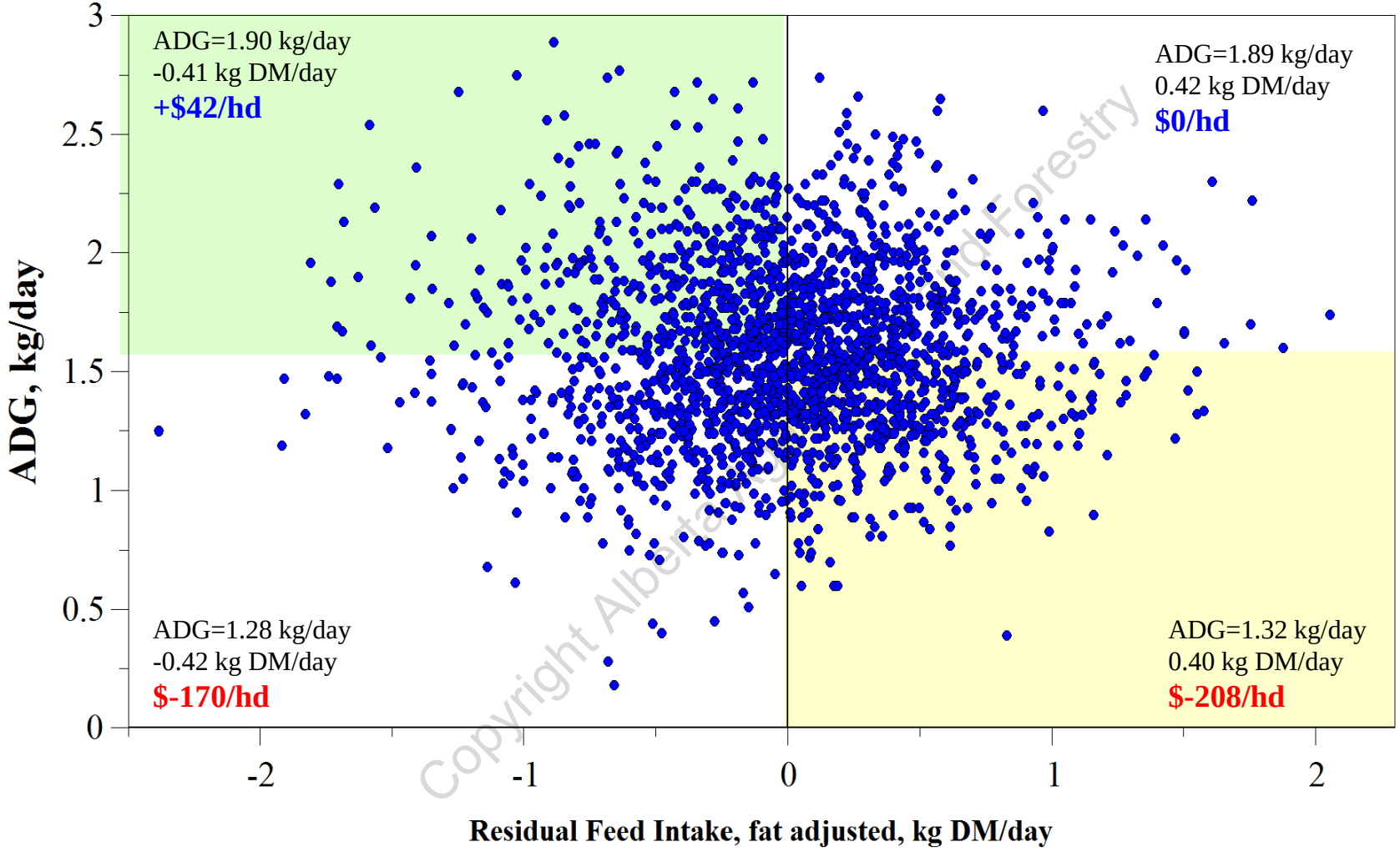


Correlation between adj. phenotype and MBV using the 50K chip and Bayes C in commercial crossbreds

DMI[1]	0.29-0.44
ADG_1	0.20-0.35
RFI[1]	0.21-0.36
Marbling[2]	0.30-0.47
Tenderness[2]	0.44-0.46

[1] Lu et al. 2015, submitted
[2] Akanno et al. 2014, JAS, 92:2896-2904

Correlations: RFI & Growth (2029 feeders)



Correlations (r_p & r_g) are near zero; Arthur et al. 2001; Crews et al. 2003; Basarab et al. 2003, 2013;
NOTE: Same feeder cost and price, transportation, vet & medicine, interest, yardage, death loss and marketing costs

Predicted vs. actual accuracy of gEPDs for commercial cattle project (Year 1)

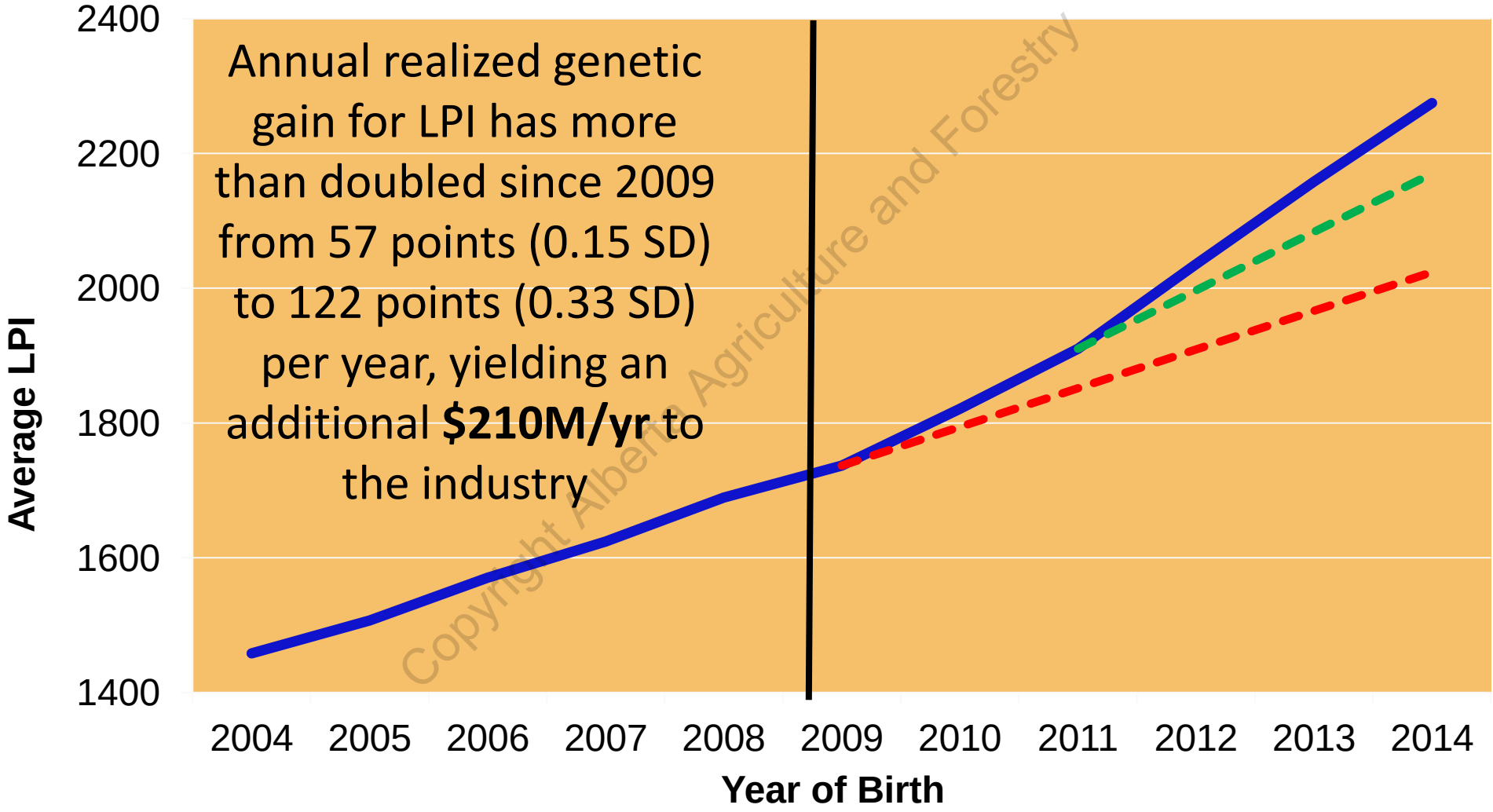
Traits	Predicted Mean	Actual Mean
Marbling	32.6	41.6
Grade fat, mm	35.0	36.2
Rib eye area, cm2	38.1	48.3
Lean Meat Yield, %	37.1	47.6
Yield Grade	no affect	-0.09 to 0.12
DMI, kg DM/day	2-5% improv.	-0.33 to -0.34

Summary of 20 studies from Australia, Canada, Ireland and USA

Conclusion

- **DNA testing is a valuable tool (>$200 return; cost <$20)**
- **Record keeping is a pre-requirement**
- **Accuracy of gEPDs are improving**
- **gEPDs and MBVs must be developed that perform in commercial crossbred cattle**
- **gEPDs/MBVs must be incorporated into value indices that perform in commercial cattle**

Impact of Genomics
Lifetime Profit Index (LPI)



Miglior et al. 2014. Advancing Dairy Cattle Genetics. Feb 17-19, Phoenix, AZ

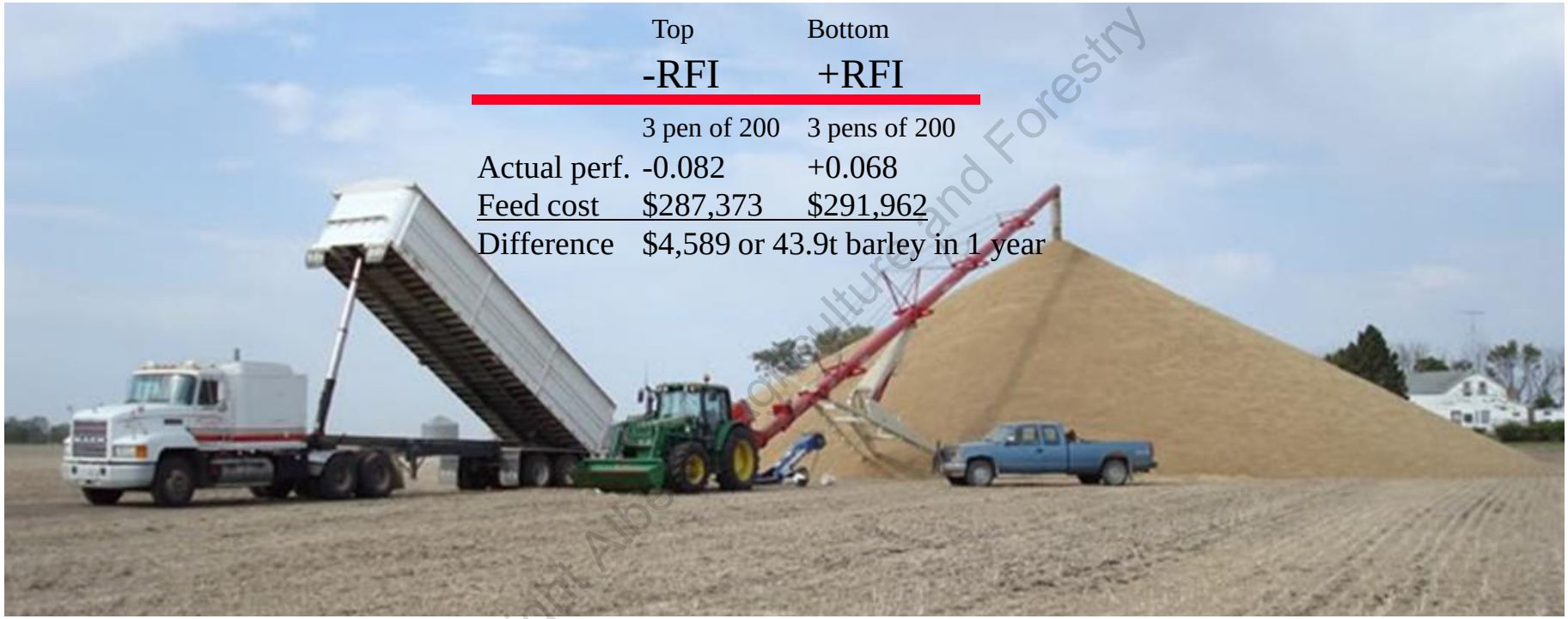
Economic Value: Ranking of sires based on their estimated breeding value (EBV) for RFI

Procedure: 1) Sort sires, with their progeny, from top to bottom in terms of RFI-EBV (n = 1200 progeny) and, 2) select 3 groups of 200 feeders (random) from –RFI (top efficient) and +RFI (inefficient) sires

Canfax West Trends 2014: Equal start (550 lb) and end (1350 lb) weights, ADG (3.25 lb/day), days on feed (246); base feed cost =$1.964/head/day; total costs = $2.816/head/day; average feed intake = 20.94 lb DM/head/day; feed barley price = $155/t. Sire EBVs predicted without progeny information.

Efficiency Groups	Pen	No of feeders	actual perf. kg DM/day	Feed Cost $/hd/day	day on feed	Total feed cost, $/pen	Difference $/600 head
Top sires	1	200	-0.137	$1.93568	246	$ 95,235	
	2	200	-0.007	$1.96255	246	$ 96,557	
	3	200	-0.103	$1.94271	246	$ 95,581	
					Total	$287,373	
Bottom sires	4	200	-0.002	$1.96359	246	$ 96,609	
	5	200	+0.128	$1.99046	246	$ 97,931	
	6	200	+0.078	$1.98013	246	$ 97,422	**$4,589 in 246 days**
					Total	$291,962	**or $11.35/feeder.year**

Ranking of sires based on their EBV for RFI



	Top -RFI	Bottom +RFI
	3 pen of 200	3 pens of 200
Actual perf.	-0.082	+0.068
Feed cost	$287,373	$291,962
Difference	$4,589 or 43.9t barley in 1 year	

161 lbs barley/feeder.year x 6,500 market ready feeders
524 Tons of Barley Saved!!!!!

Canadian Opportunities and Global Challenges

Canadian Opportunities

- $20 B/year industry
- Increasing global demand for meat
- $1 to $2.3B profit over 15yr
- Reduce GHG emissions and environmental impact
- Improve image and demand for Canadian beef
- GE^{3}LS shows increased willingness to pay for sustainable beef using genomics

Global Challenges

- Limited vertical integration
- many breeds, crossbreeding, natural mating
- Leading to weak genetic linkage among populations
- Low accuracy of genomic prediction
- Continually improve efficiency to be globally competitive
- safe, affordable, and environmentally responsible beef

Why It Pays to Parentage Test

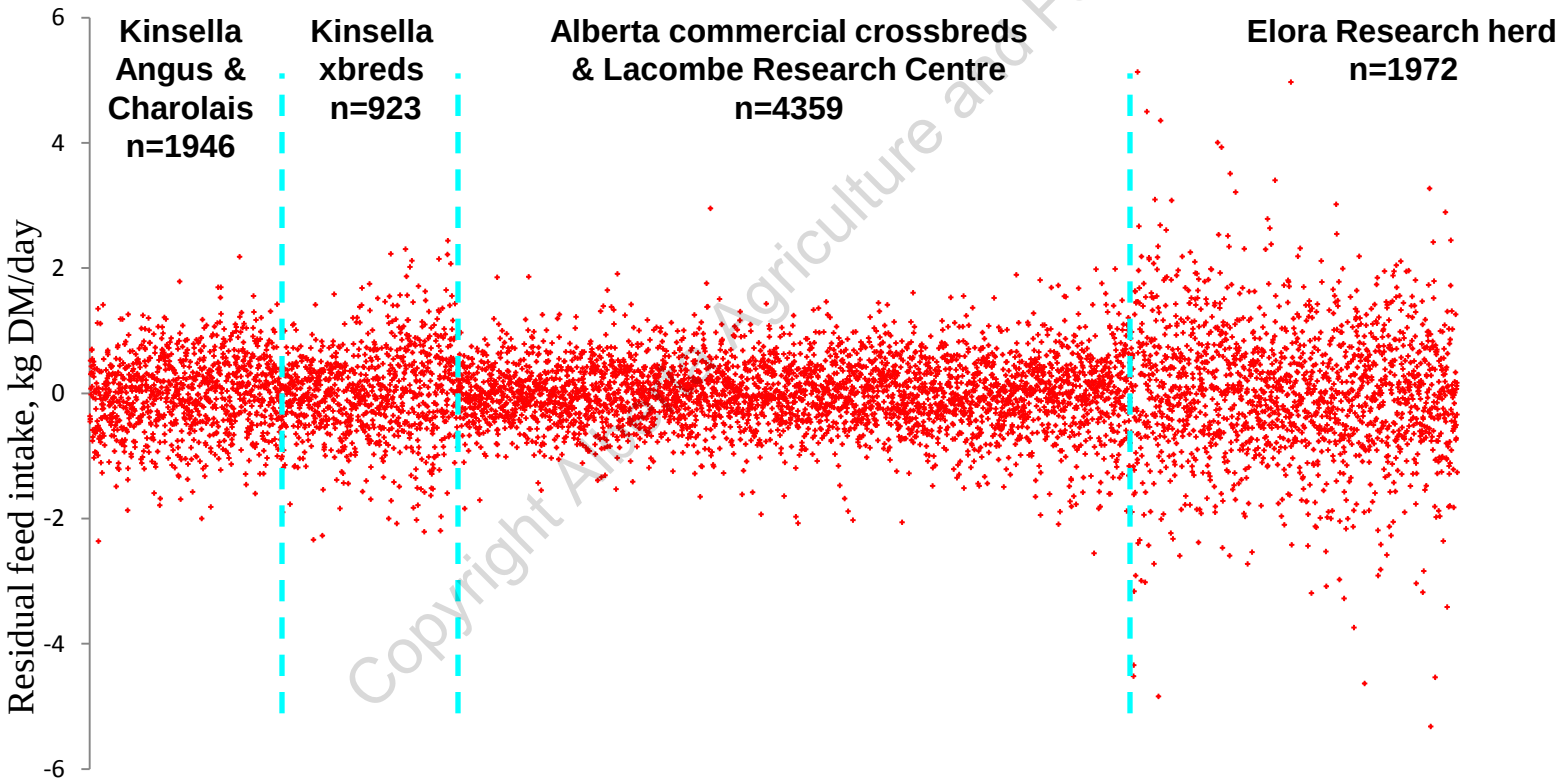
Herd sire: Purchase Price	**$4000**
Years of use	**4**
Cull value (2000 lb x $0.80/lb)	**$1600**
Depreciation cost ($4000-$1600)/4	**$600/yr**
Annual maintenance costs	**$800/yr**
Risk of loss (10% of purchase price)	**$400/yr**
Total costs per bull per year	**$1800**
Cost per female (25:1)	**$72**
Heifer replacement calf	**$1430**
Winter feed, bedding and yardage	**$260**
Summer grazing	**$100**
Cost of herd sire	**$72**
Total costs per replacement	**$1870**

Adapted from Kathy Larson, Western Beef Development Centre, www.wbdc.sk.ca

CANADIAN CATTLE GENOME PROJECT

Reference data base

- 9200 cattle with residual feed intake (RFI),
- DMI, ADG, body weight and composition
- All with 50k & imputed HD genotypes



Possible EPD changes

Accuracy %	Birth Wt	Wean Wt	Milk
10	±2.4	±10.4	±8.7
30	±1.8	±8.1	±6.8
50	±1.3	±5.8	±4.9
75	±0.8	±2.9	±2.4
90	±0.3	±1.2	±1.0