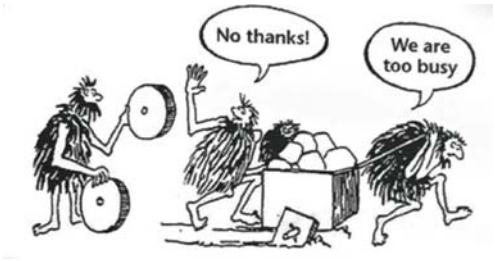
Where can the greatest economic value of genomic testing be found?



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- Allied industry
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- My wife and daughters
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United States Department of Agriculture
National Institute of Food and Agriculture

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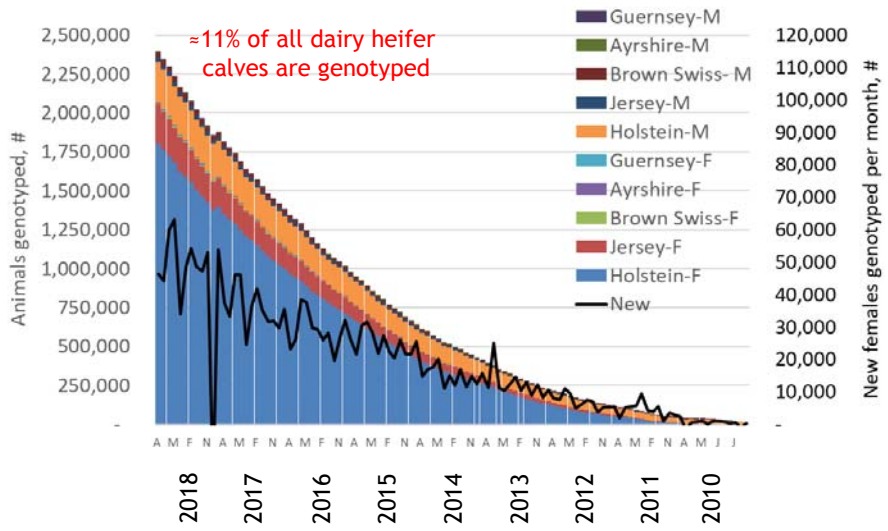
Overview

1. Concepts, simpler analysis
2. Make more dairy heifer calves than needed?
3. Use beef semen to sell crossbred calves?
4. Other considerations
5. Take home messages

Number of dairy cattle genotyped in the USA (August 2018)



https://queries.uscdcb.com/Genotype/cur_density.html (August, 2018)

HOARD'S DAIRYMAN BULL LIST

Holstein Top Bulls — August 2018 Sire Summaries

Top 50 Ranked by Net Merit $

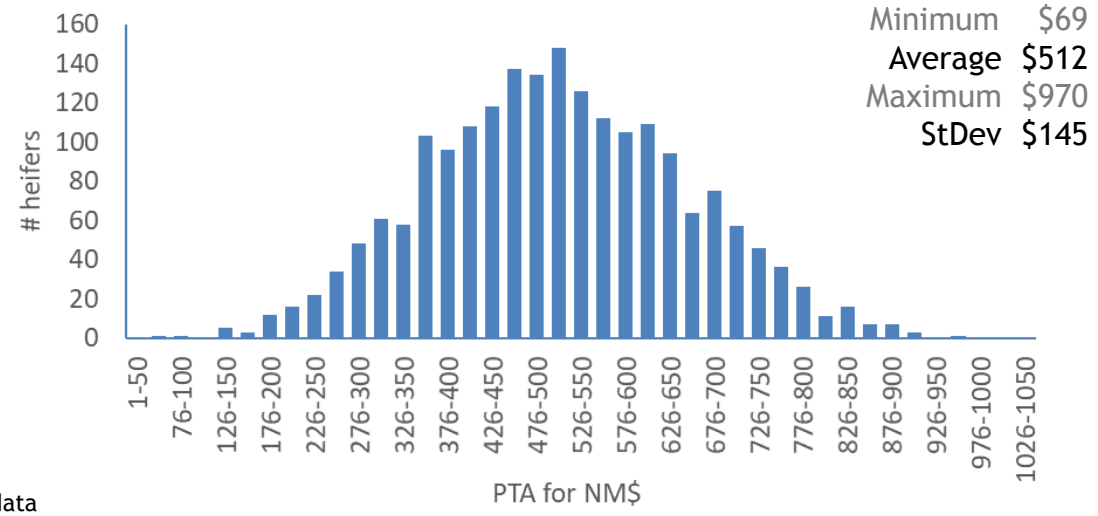
NAAB	Name	NM$	Rel.
29H017553	JOSUPER	999 G	96
151H0681	RUBICON	953 G	95
203H01468	DELTA	928 G	96
1H010396	CABRIOLET	917 G	98
7H012266	YODER	904 G	96
203H01513	DANTE	875 G	91

Top 50 Genomic-only, Net Merit $

	NAAB	Name	NM$	Rel.
99-I	551H03529	CHARL	1107 G	73
99-I	29H018906	BILLY	1061 G	73
99-I	29H018693	CRIMSON	1060 G	73
99-I	551H03600	NASHVILLE	1056 G	74
99-I	11H012157	LAWSON	1040 G	73
99-N	29H018296	ACHIEVER	1037 G	78

Net Merit $ = Predicted transmitting ability (PTA) of lifetime profit compared to profit of base cow

gPTA Net Merit Dollars for 2000 heifers

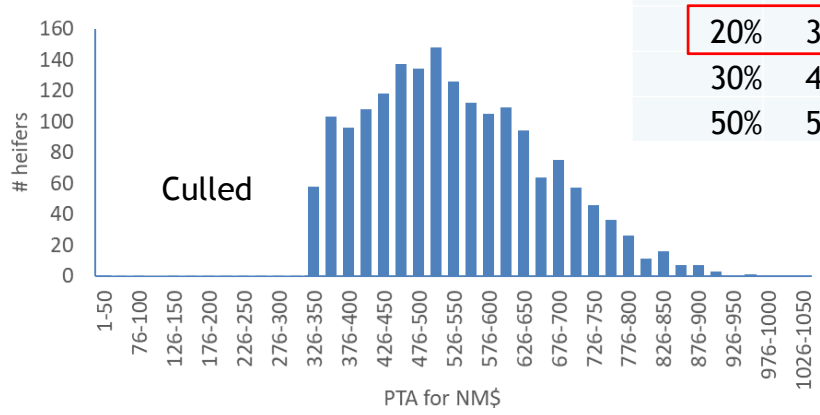


Minimum $69
Average $512
Maximum $970
StDev $145

2013 data

gPTA Net Merit Dollars for 2000 heifers

Culled	Min	Average	Gain	StDev
0%	69	512	**0**	145
10%	318	537	**25**	126
20%	391	564	**52**	112
30%	436	585	**73**	103
50%	510	631	**119**	88



How much is +$52 PTA NM$ worth?

+$52 predicted transmitting ability / life time

= +$104 estimated breeding value / life time (= 3 years)

= +$34 estimated breeding value / year

Keeping the best 80% of heifers increases the genetic level of the herd by $34/cow/year

(but culling, discounting makes final value a little lower)

Genetic progress in the population

Breeders equation

Natural genetic differences

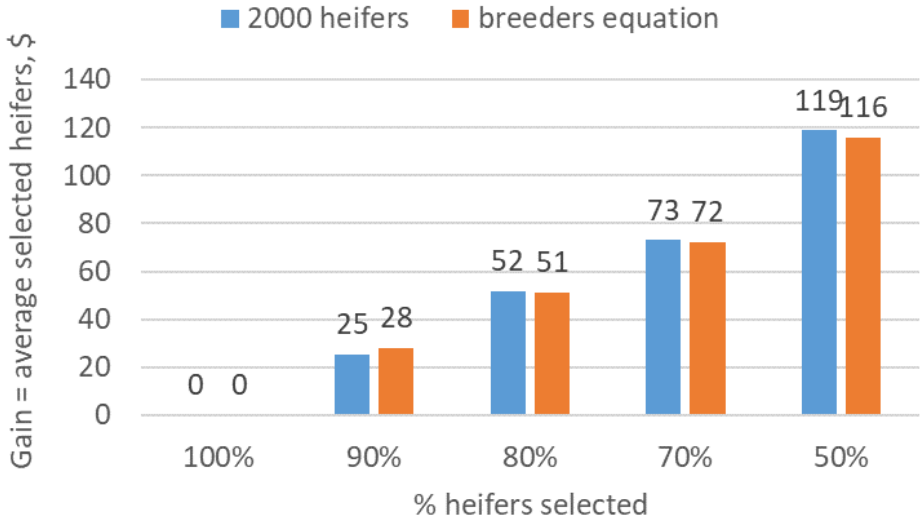
- Genetic progress = genetic variation x
  selection intensity x √(reliability of info)

How picky we can be

How good the ranking is:
- Pedigree info.
- Genomic test info.

- Genetic progress *per year* = genetic progress between generations / generation interval

Comparison: gain in selected heifers vs. breeders equation



Reliability = 70%, phenotypic standard deviation = 145, genetic standard deviation = 173

Assumed reliability values for predictions of Lifetime Net Merit based on pedigree, performance, and low-density genotyping data ("Traditional" = no DNA testing, "Genomic" = DNA testing with 3K chip) for simulated animals in each age group.

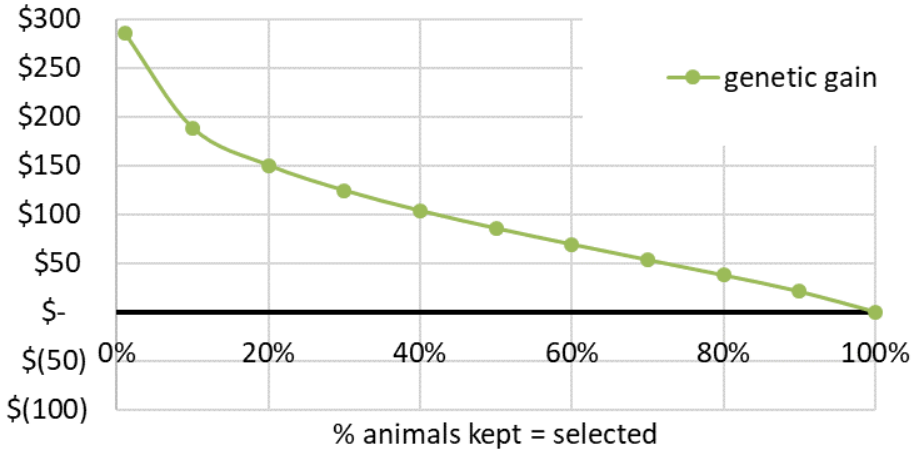
	Ancestry Unknown		Sire-Identified		Full Pedigree	
Age Group	Traditional	Genomic	Traditional	Genomic	Traditional	Genomic
Heifer calves	0.00	0.50	0.20	0.57	0.34	0.67
Yearling Heifers	0.00	0.52	0.21	0.59	0.35	0.68
1st Lactation Cows	0.18	0.56	0.40	0.63	0.52	0.71
2nd Lactation Cows	0.22	0.59	0.44	0.66	0.55	0.73
3rd Lactation Cows	0.25	0.62	0.46	0.68	0.57	0.74
4th Lactation Cows	0.27	0.64	0.48	0.69	0.58	0.74
5th Lactation Cows	0.29	0.65	0.49	0.70	0.59	0.75
6th Lactation Cows	0.30	0.65	0.50	0.70	0.60	0.75

Reliabilities based on unselected population

Dr. Kent Weigel UW (2011)

Simple math: value per kept animal

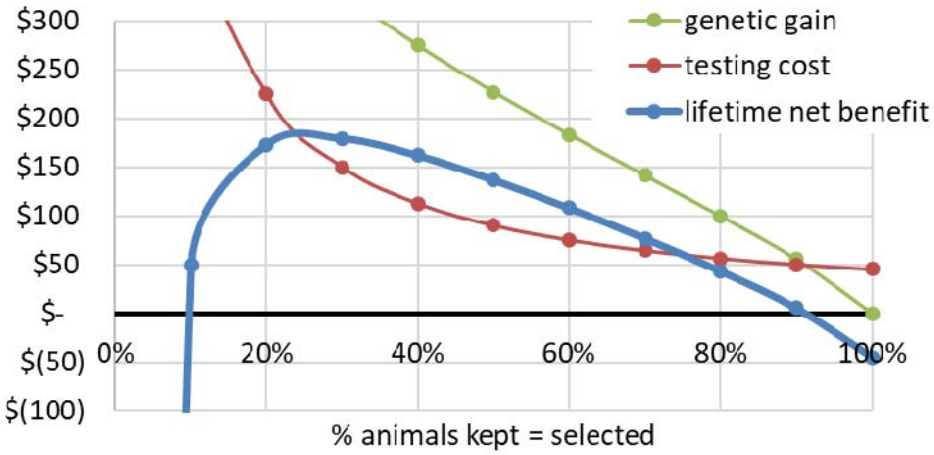
Parent Average "equilibrium" reliability



$340 genetic standard deviation breeding value, 10% equilibrium reliability

Simple math: value per kept animal

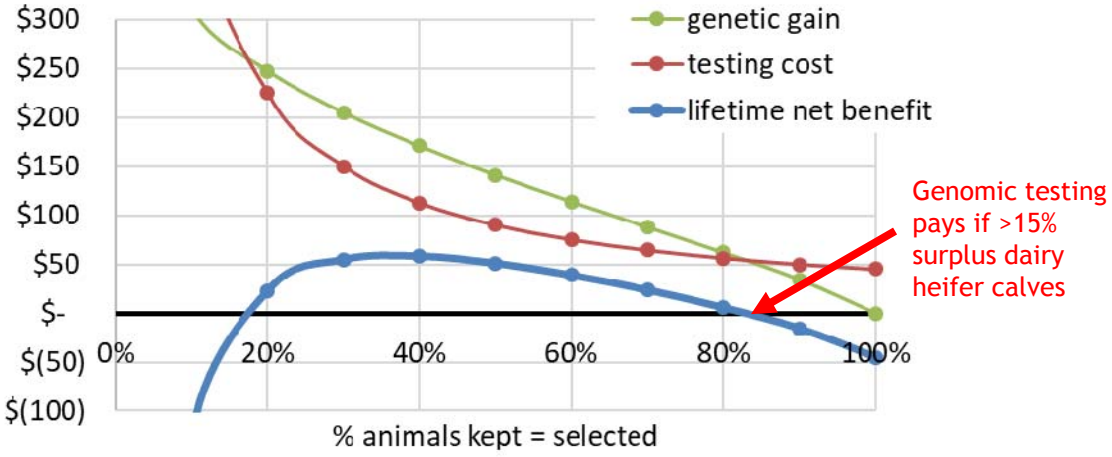
Genomic reliability



$340 genetic standard deviation breeding value, 70% reliability, $45 testing cost

Simple math: value per kept animal

Genomic minus Parent Average = net gain



$340 genetic standard deviation breeding value, 70% vs 10% equilibrium PA reliability, $45 testing cost

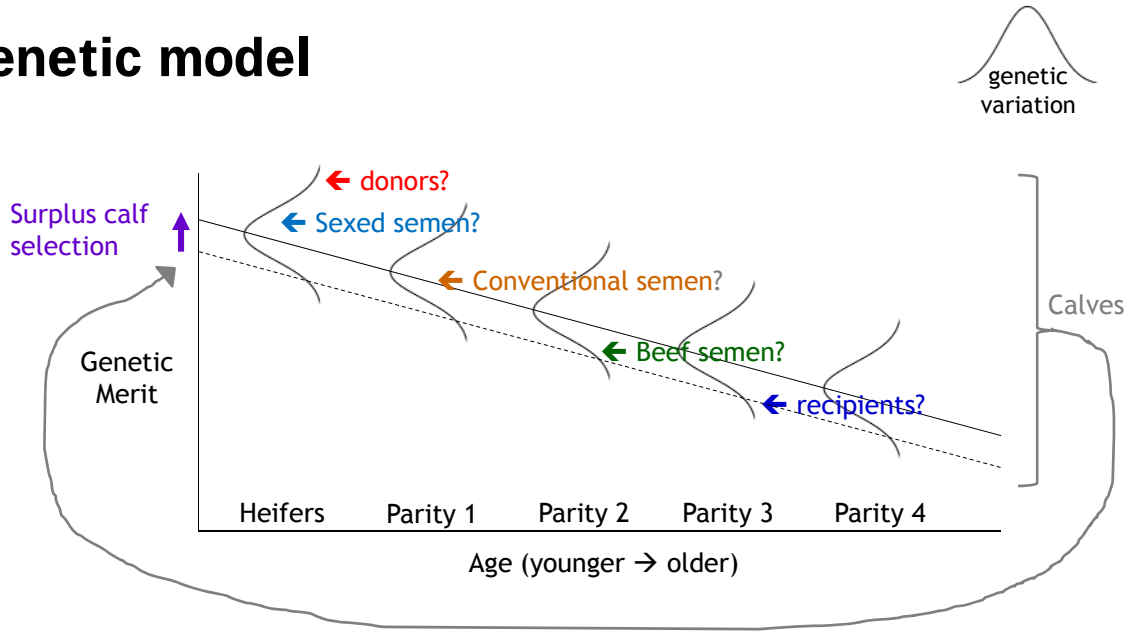
2. Make more dairy heifer calves than needed?

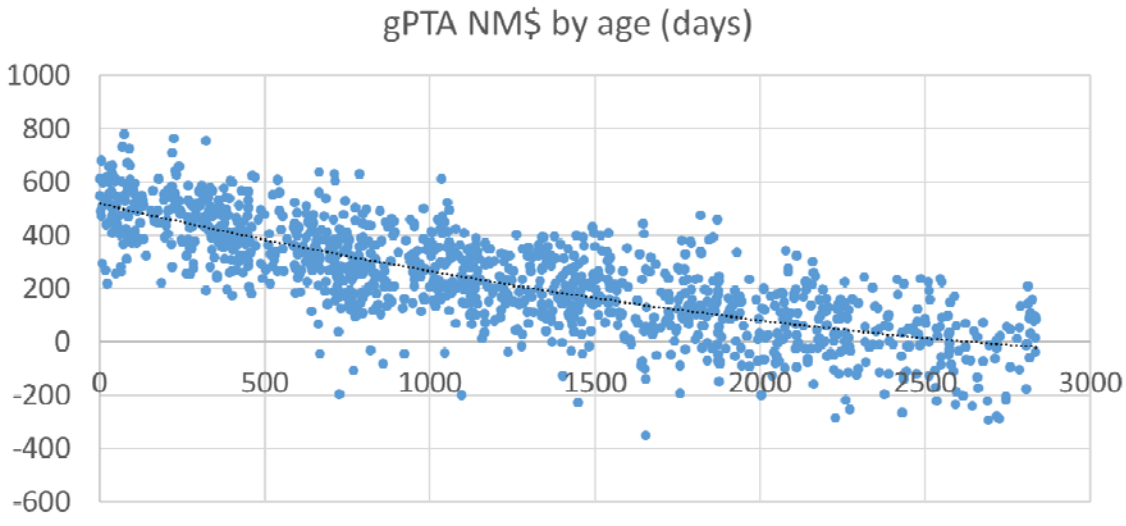
- Use sexed semen
- Higher selection intensity
- Greater selection gain
- Other advantages dairy calves

Which animals benefit from genomic testing?

- Selected animal (calf) herself
- Daughters, due to animal selection
- Daughters, due to animal's selective mating
- (Future generations)

Genetic model

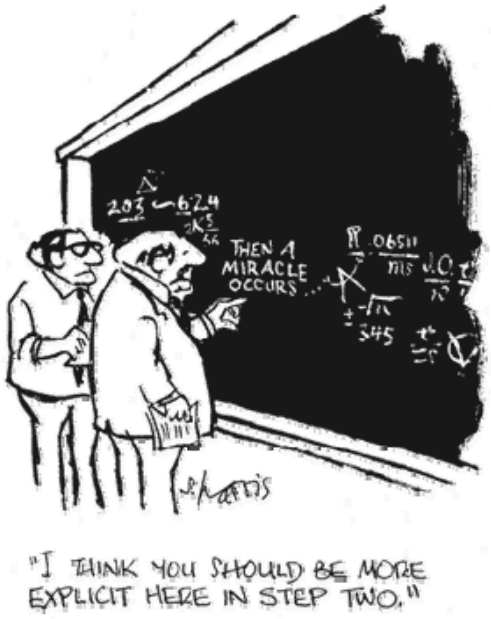




1,247 animals genomic tested at the UF Dairy Unit

Herd budget model

Genetics, phenotype, prices, …



Bottom line:
Profit per milking cow per year

0% → sexed semen use → a lot

5 breeding policies

No selective mating

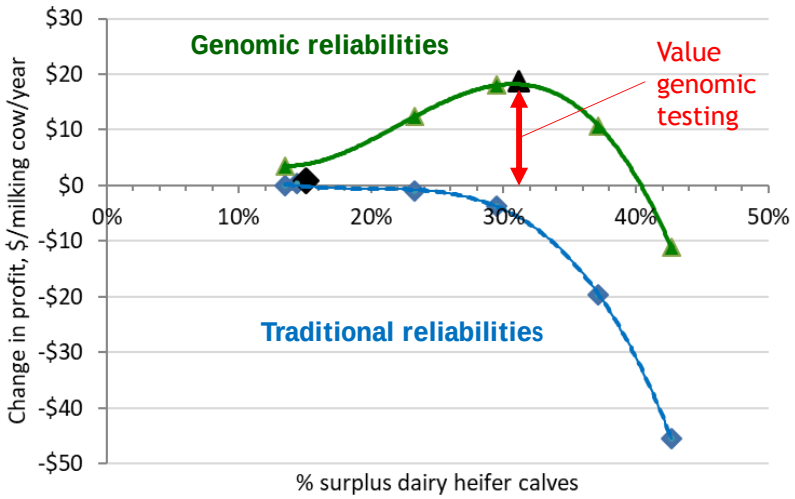
35% cow cull rate
Many other inputs
➔ surplus calves

breeding type	Be|Co|Se	Be|Co|Se	Be|Co|Se	Be|Co|Se	Be|Co|Se
heifers, 1					
heifers, 2					
heifers, 3					
heifers, 4+					
cows 1, 1					
cows 1, 2					
cows 1, 3					
cows 1, 4+					
cows 2, 1					
cows 2, 2					
cows 2, 3					
cows 2, 4+					
cows 3, 1					
cows 3, 2					
cows 3, 3					
cows 3, 4+					
cows 4+, 1					
cows 4+, 2					
cows 4+, 3					
cows 4+, 4+					
surplus dairy calves (%)	13%	23%	29%	37%	43%

Default = base line inputs

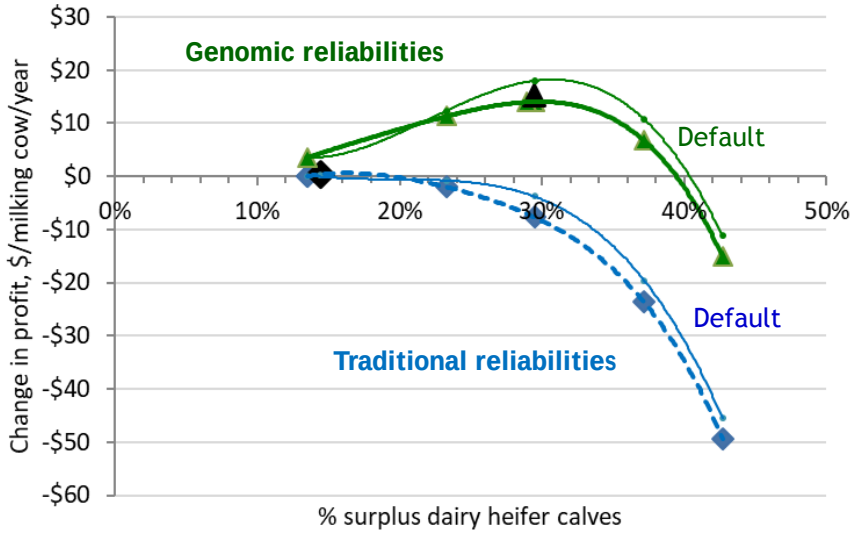
- 35% cull rate
- Vary use of sexed semen
- Complete budget of revenues and costs

- Conclusion: genomic testing pays if willing to make surplus heifers with lots of sexed semen



0% → sexed semen use → a lot

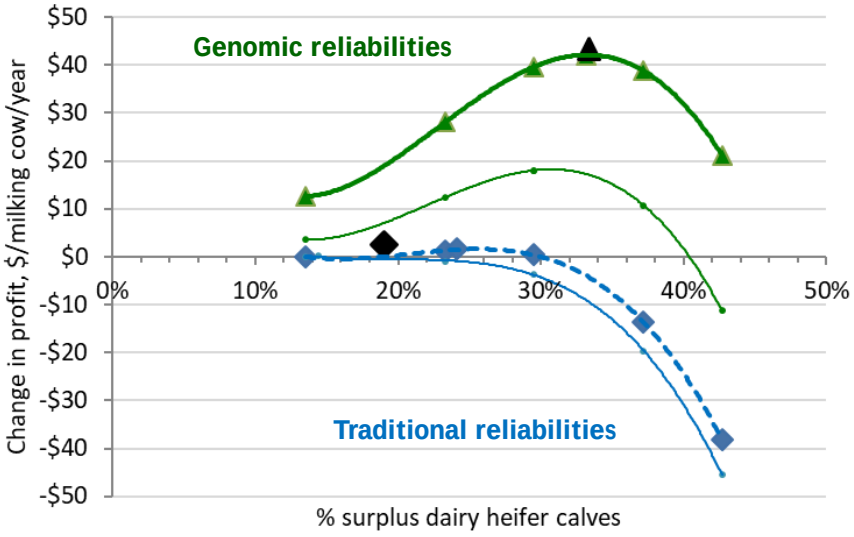
Worse sires: $200 PTA of NM$ lower than default



- 35% cull rate

0% → sexed semen use → a lot

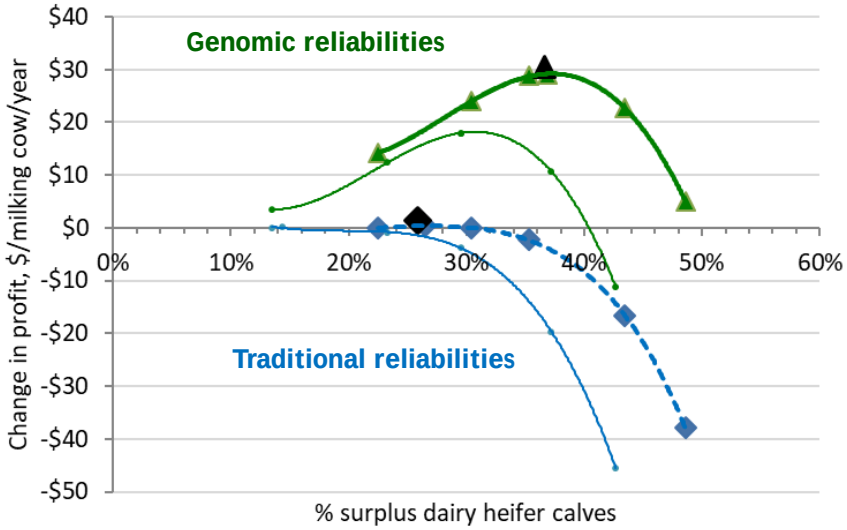
35% greater genetic variation (a different selection index)



- 35% cull rate

0% → sexed semen use → a lot

+10 percentage points greater conception rate cows

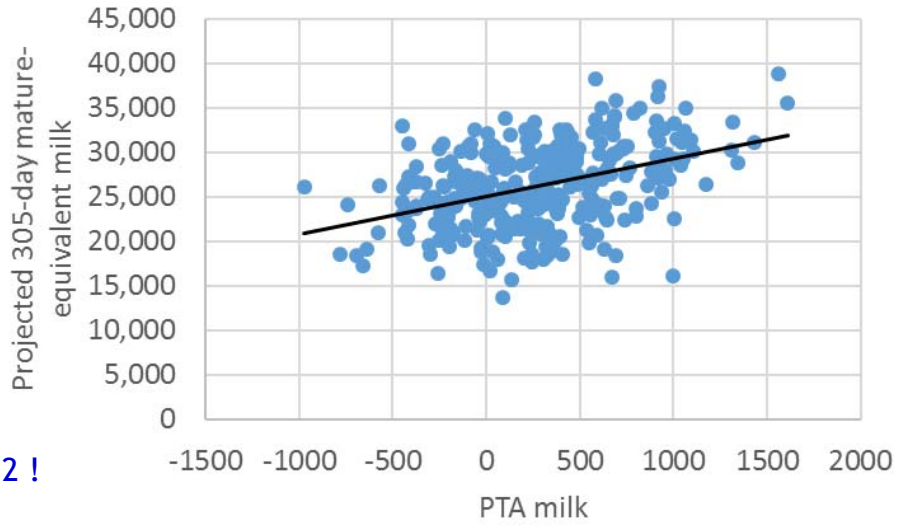


- 35% cull rate

0% → sexed semen use → a lot

Response to selection:

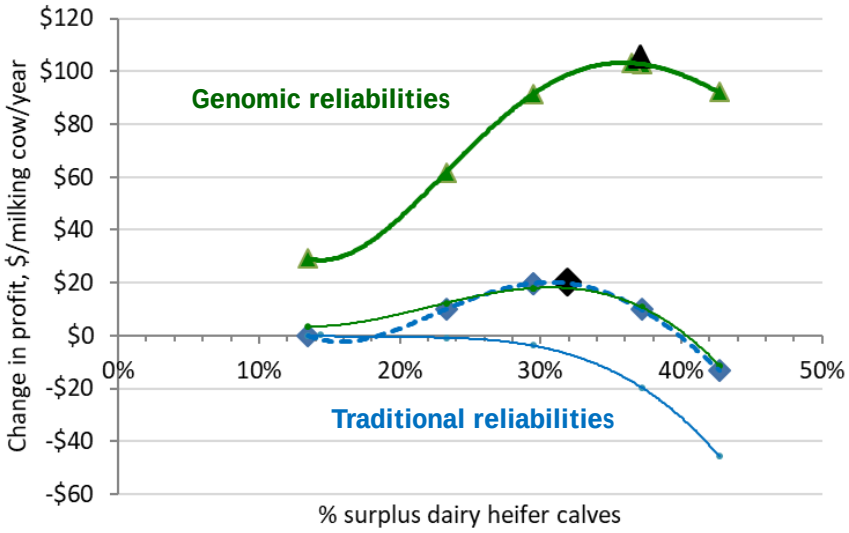
"Traditional" PTA milk vs. phenotype mature equivalent milk
University of Florida Dairy Unit



Response to selection =

$$\frac{32{,}000 - 21{,}000}{2*(1{,}500 - -1{,}000)} = 2.2\ !$$

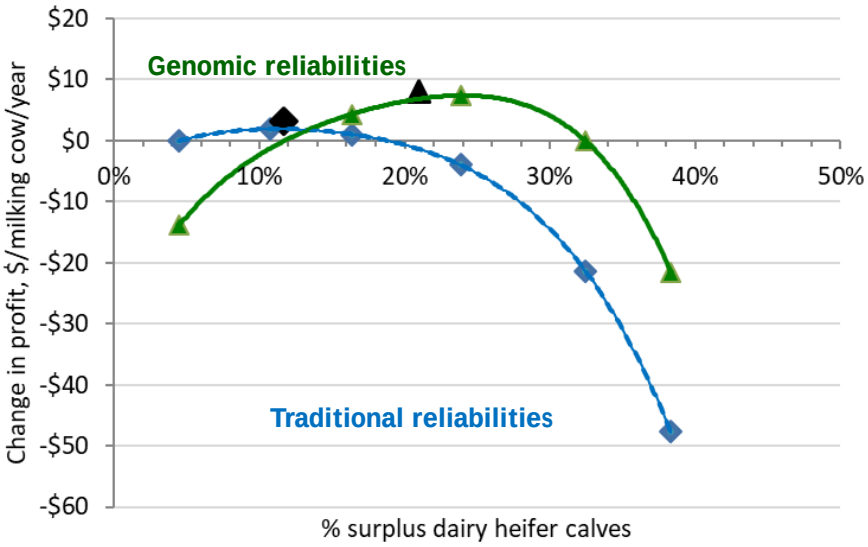
2 x Response to selection



- 35% cull rate

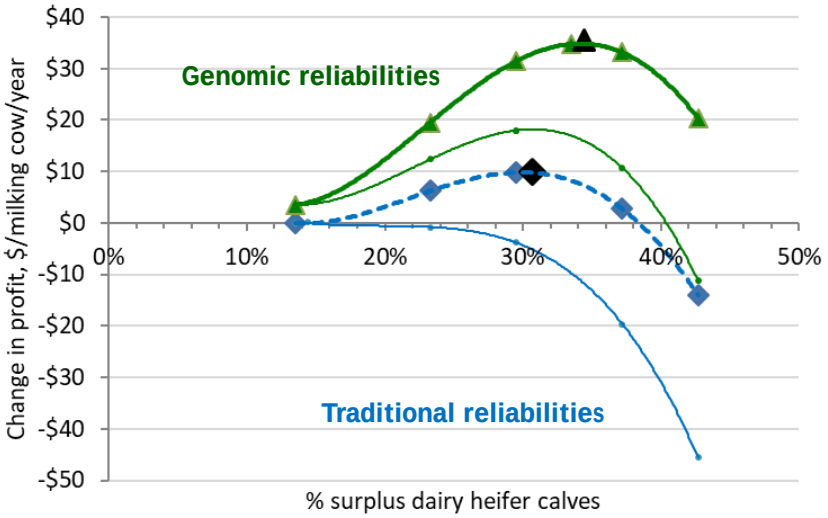
0% → sexed semen use → a lot

45% cow cull rate



0% → sexed semen use → a lot

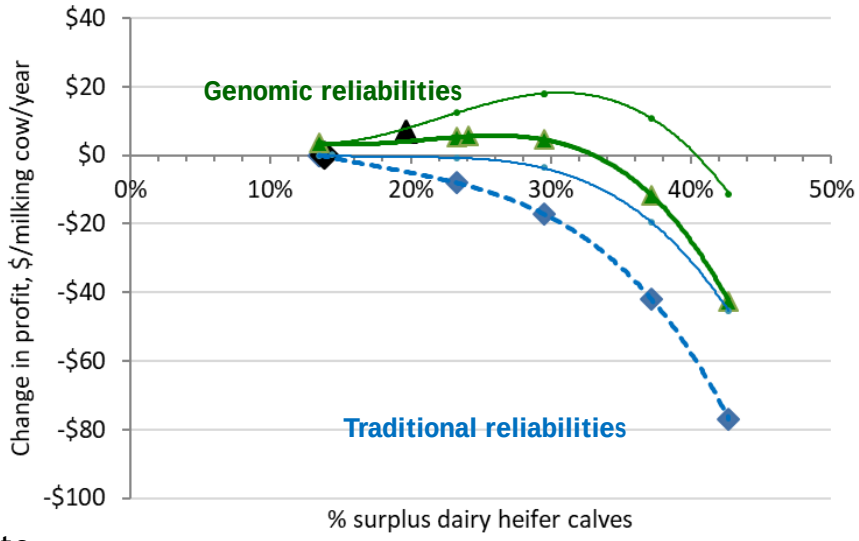
$100 greater dairy calf sale price compared to dairy bull calf



- 35% cull rate

0% → sexed semen use → a lot

$100 lower dairy calf sale price compared to dairy bull calf



- 35% cull rate

0% → sexed semen use → a lot

3. Use beef semen to sell crossbred calves?

- Sell crossbred calves at a premium
- Use low genetic dams with beef semen
- Use high genetic dams to make dairy heifer calves
- Reduces selection intensity of dairy heifer calves

"Simple" math: all sexed vs. some beef semen

100% sexed dairy semen				70% sexed semen and 30% beef semen			
total	per calf	#calves		#calves	per calf	total
		159	total calves born	159		
$2,400	$24	100	Δ genetics kept heifers	100	$0	$0
		30%	surplus heifer calves	0%		
$2,143	$50	43	sold heifer calves	0	$50	$0
		143	total heifer calves	100		
$794	$50	16	sold dairy bull calves	11	$50	$556
$0	$125	0	sold crossbred calves	48	$125	$5,952
$5,337	$34				$41	$6,508

Optimal breeding policy, surplus allowed

beef premium	cross: +$0		cross+$75		cross: +150	
reliablity	traditional	genomic	traditional	genomic	traditional	genomic
breedings type	Be|Co|Se	Be|Co|Se	Be|Co|Se	Be|Co|Se	Be|Co|Se	Be|Co|Se
heifers						
cows 1						
cows 2						
cows 3						
cows 4+						
surplus dairy calves (%)	10%	29%	2%	13%	2%	10%
#dairy bull calves sold	367	425	200	257	73	150
#crossbred calves sold	242	24	441	320	558	436
#dairy heifer calves sold	53	205	10	74	10	58
#dairy calves kept	493	499	501	500	507	502
profit(/milkingcow/yr)	Refr = $0	$ 11	$ 27	$ 26	$ 66	$ 57
Advantage genomic testing		$ 11		$ (1)		$ (9)

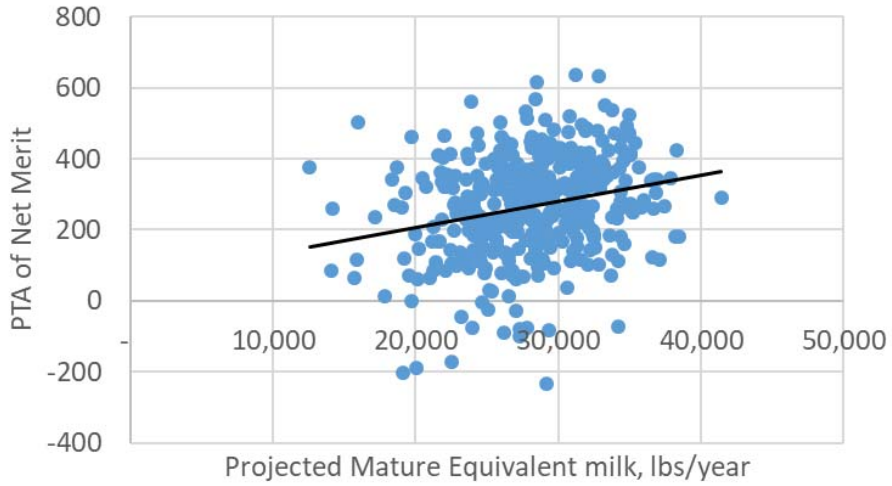
Crossbred premium could reduce the value of genomic testing

4. Other considerations

- Cow cull rate
- Sire selection
- Embryo transfer
- Misidentification
- Recessives
- Timing of return on investment
- Partial genomic testing
- Other ways to rank animals

gNet Merit $ vs. Mature equivalent milk

533 cows at University of Florida Dairy Unit



0.24 Correlation
0.06 "Reliability"

5. Take home messages

1. Genomic testing is profitable when at least:
   - Have surplus dairy heifer calves (good reproduction, sexed semen)
   - Good response to genetics
   - Embryo transfer
2. Crossbred calf premiums reduce the value of genomic testing
   - Genomics for selective mating decisions less valuable than for culling decisions
3. Finding greatest value is complicated; you need a good plan

Thank you

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