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Considerations in Genetic Selection & What About DNA?

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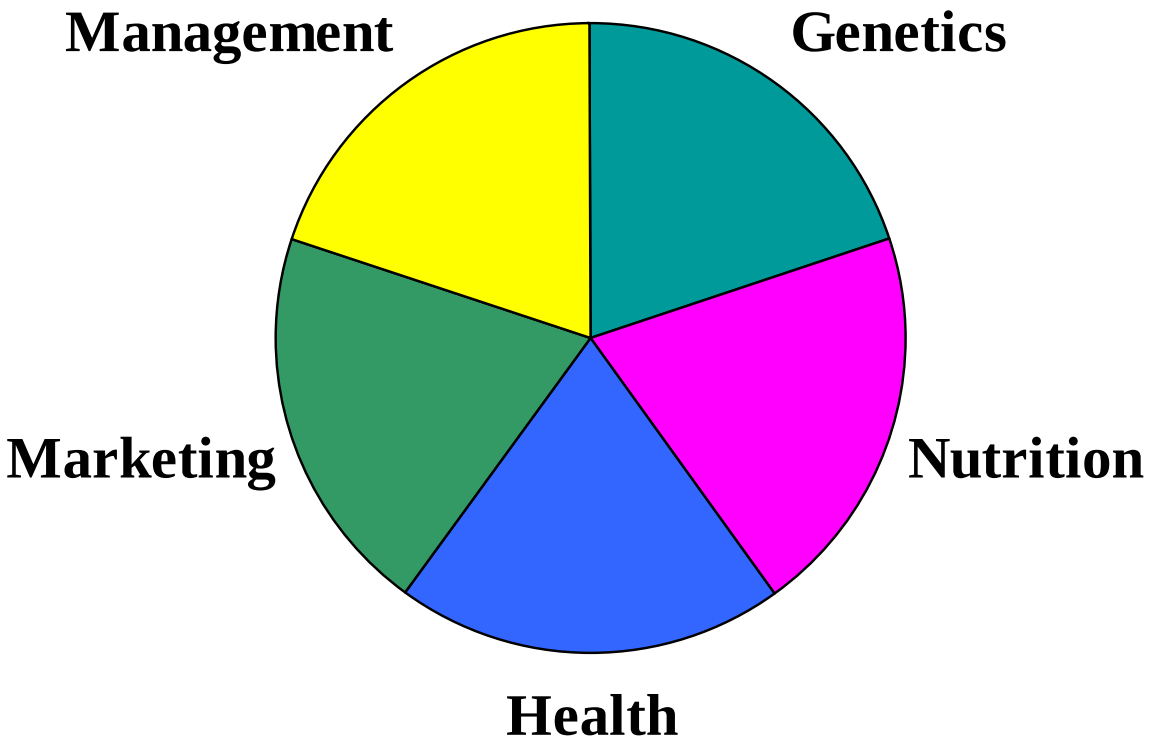
Beef Enterprise Success



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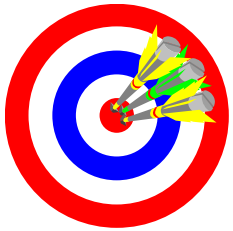
OUR #1 CHALLENGE- BALANCE

- OPTIMIZING PRODUCTIVTY

- Reproduction
- Calving Ease
- Growth
- Maternal Ability
- Carcass Merit



- MANAGE COSTS OF PRODUCTION

- Mature Size
- Milk Production
- Longevity

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Too Many EPDs?

- Calving Ease
- Birth Weight
- Maternal CE
- WW
- YW
- Milk
- Maternal WW
- Scrotal
- Mature Wt.
- Mature Ht.
- Stayability
- Heifer Pregnancy

- Carcass
  - Wt.
  - MB
  - REA
  - FT
  - YG
  - QG

- INDEXES

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EPDs

Export To Excel

Percentile Breakdown
Current Sires

	Production						Maternal					Carcass				$Values					
Top Pct	CED	BW	WW	YW	YH	SC	CEM	Milk	MW	MH	$EN	CW	Marb	RE	Fat	$W	$F	$G	$QG	$YG	$B
1%	+14	-2.7	+66	+117	+1.2	+1.68	+13	+34	+107	+1.7	+29.07	+32	+.83	+.61	-.045	+34.93	+51.69	+38.23	+31.62	+11.67	+64.07
2%	+13	-1.9	+63	+111	+1.1	+1.53	+12	+33	+93	+1.5	+24.08	+29	+.76	+.55	-.038	+33.45	+47.17	+36.65	+30.54	+10.89	+61.11
3%	+12	-1.5	+61	+108	+1.0	+1.40	+12	+32	+87	+1.4	+21.64	+28	+.72	+.51	-.033	+32.60	+44.63	+35.55	+29.58	+10.33	+59.39
4%	+12	-1.2	+60	+106	+1.0	+1.31	+11	+31	+83	+1.3	+19.77	+26	+.68	+.48	-.030	+31.96	+42.55	+34.59	+28.95	+9.90	+58.03
5%	+11	-1.0	+59	+105	+.9	+1.25	+11	+30	+80	+1.2	+18.50	+26	+.65	+.45	-.027	+31.43	+41.29	+33.80	+28.20	+9.57	+56.82
10%	+10	-.2	+55	+99	+.8	+1.04	+10	+28	+68	+1.0	+14.67	+22	+.56	+.37	-.019	+29.80	+36.45	+31.12	+25.88	+8.37	+52.91
15%	+9	+.3	+52	+95	+.7	+.90	+10	+27	+61	+.9	+12.29	+20	+.50	+.33	-.013	+28.72	+33.39	+29.22	+24.20	+7.65	+50.21
20%	+9	+.6	+50	+92	+.7	+.79	+9	+26	+55	+.8	+10.49	+18	+.45	+.28	-.009	+27.85	+30.93	+27.51	+22.66	+7.08	+48.09
25%	+8	+1.0	+49	+89	+.6	+.69	+9	+25	+50	+.7	+9.06	+17	+.41	+.25	-.005	+27.11	+28.93	+25.96	+21.69	+6.53	+46.17
30%	+8	+1.2	+47	+87	+.6	+.61	+8	+24	+46	+.7	+7.70	+16	+.38	+.22	-.002	+26.46	+27.12	+24.40	+20.21	+6.11	+44.52
35%	+7	+1.5	+46	+85	+.5	+.54	+8	+23	+42	+.6	+6.60	+15	+.34	+.19	+.001	+25.86	+25.54	+23.06	+18.85	+5.66	+42.89
40%	+7	+1.7	+45	+83	+.5	+.47	+7	+22	+39	+.6	+5.52	+13	+.31	+.17	+.004	+25.27	+24.03	+21.79	+17.75	+5.19	+41.33
45%	+6	+1.9	+44	+81	+.5	+.41	+7	+22	+36	+.5	+4.55	+12	+.28	+.14	+.006	+24.70	+22.62	+20.55	+17.10	+4.78	+39.85
50%	+6	+2.1	+43	+79	+.4	+.35	+7	+21	+32	+.5	+3.51	+11	+.25	+.12	+.009	+24.09	+21.17	+19.39	+15.84	+4.38	+38.42
55%	+5	+2.3	+41	+77	+.4	+.28	+6	+20	+29	+.4	+2.49	+10	+.23	+.09	+.012	+23.51	+19.75	+18.28	+14.59	+3.90	+36.84
60%	+5	+2.6	+40	+75	+.3	+.22	+6	+19	+25	+.4	+1.53	+9	+.20	+.07	+.015	+22.90	+18.34	+17.18	+13.39	+3.42	+35.25
65%	+4	+2.8	+39	+73	+.3	+.15	+6	+18	+21	+.3	+.57	+8	+.17	+.05	+.017	+22.28	+16.86	+16.08	+12.49	+2.95	+33.62
70%	+4	+3.0	+38	+71	+.3	+.08	+5	+18	+18	+.2	-.52	+7	+.15	+.02	+.020	+21.60	+15.20	+14.92	+11.26	+2.33	+31.77
75%	+3	+3.3	+36	+69	+.2	+.01	+5	+17	+13	+.2	-1.67	+5	+.12	-.01	+.024	+20.84	+13.45	+13.73	+10.49	+1.74	+29.77
80%	+2	+3.6	+35	+66	+.2	-.07	+4	+16	+9	+.1	-2.93	+4	+.09	-.04	+.027	+20.01	+11.46	+12.40	+9.07	+1.01	+27.42
85%	+1	+3.9	+33	+62	+.1	-.17	+3	+14	+2	+0	-4.33	+2	+.06	-.07	+.032	+18.93	+8.95	+10.85	+7.82	+.16	+24.79
90%	+0	+4.4	+30	+58	+0	-.29	+3	+13	-5	-.1	-6.17	+0	+.02	-.12	+.038	+17.53	+5.57	+8.84	+5.93	-1.11	+21.46
95%	-2	+5.1	+26	+50	-.1	-.47	+1	+10	-18	-.4	-8.92	-3	-.04	-.20	+.047	+15.21	+.32	+5.88	+3.05	-3.10	+16.31
Total Animals	23,410	23,620	23,620	23,620	9,138	12,706	23,410	23,620	2,643	2,643	23,628	17,115	17,115	17,115	17,115	23,628	23,628	19,836	19,836	19,836	19,836
Avg	+5	+2.1	+42	+78	+.4	+.36	+6	+21	+32	+.4	+4.02	+11	+.27	+.12	+.009	+23.82	+21.01	+19.69	+15.75	+3.94	+37.59

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Challenges

- Measuring directly the economically relevent trait vs. use of indicator trait
  - EPDs not available for all economically important traits
  - Some EPDs on indicators, not direct measures, of trait of interest
- Genetic antagonisms
- Multiple-trait selection

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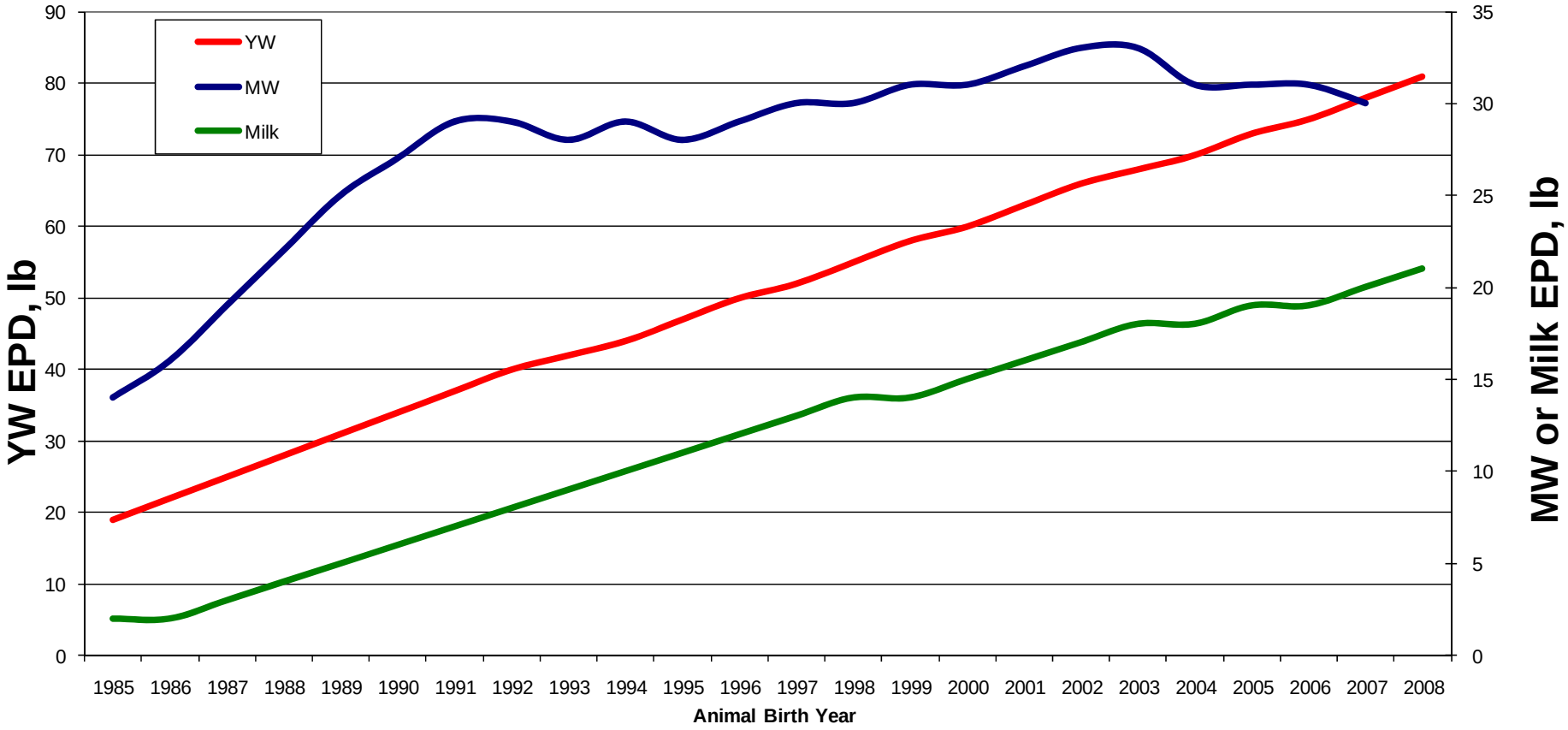
Angus Genetic Trend for Yearling Weight (YW), Mature Weight (MW), and Milk



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"Good" Cows....

- Calves successfully at 2 years, annually thereafter, with minimal calving difficulty
- Weans valuable calf annually that fits demands of marketplace and satisfies consumers
- Highly adapted to environment and managerial resources
- Optimizes revenue vs. costs of production over long life

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Challenges to Selection for Reproduction

- Reproductive efficiency- affected by complex interaction of factors
  - Mature size/Milk/Genetics interactions with environment/nutrition/management
  - Favorable management imperative
- Few genetic tools for direct selection
- Multiple trait selection
  - Antagonisms with production traits

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TOOLS & STRATEGIES TO ENHANCE PROFIT

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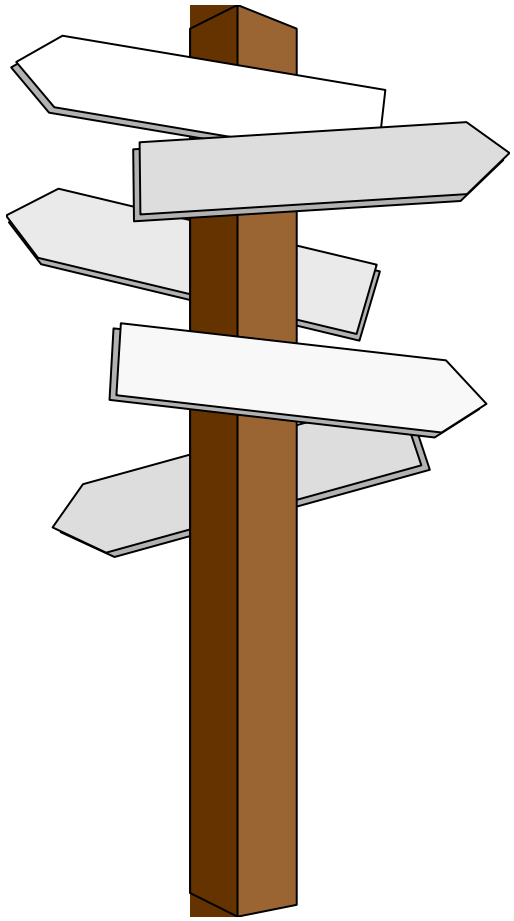
Identify Herd Goals

- **PROFIT!**

- Where have we been?
- Where are we now?
- Where are we going?
- How do we get there?



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Assessing Your Cow Herd

- Pregnancy rate ?
- Weaning % ?
- Sale Wt. ?
- Cow costs ?
- Post-weaning performance ?
- Carcass merit ?

- COSTS OF PRODUCTION ????
- PROFITABILITY ????

- *Calculated on an individual cow basis!*

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Assess Herd Strengths and Weaknesses

- ***STRENGTHS***
- Weaning weight
- Calving ease
- Milk
- Color/type/grade
- Management

- ***WEAKNESSES***
- Cow size
- Uniformity
- Marbling/Quality Grade
- Feed/forage resources

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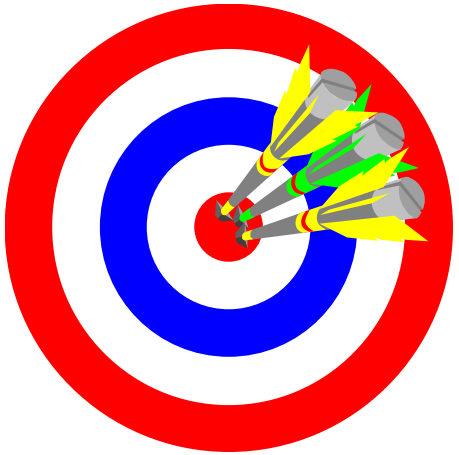
Herd Goals

- Heifer bull? Mature cows? Both?
- Replacement heifers retained?
- Calf crop marketing?
  - Weaning
  - Backgrounded
  - Retained ownership
- Labor and management resources?
- Feed resources?
- How will sire contribute to overall plan?



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Strategies to Making Change

- Management
- Genetics

- Performance = Genetics + Management

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Genetic Traits That Impact the Cost of Production

- Reproduction
- Maintenance costs (mature weight, milk)
- Cow longevity
- Calving difficulty
- Feed efficiency
- Production costs (growth, milk)

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Basic Economics

- **Income**
  - Quantity x Sale weight x price
    - Reproduction, Growth, Quality/Value
- **Costs**
  - Production, Maintenance, Land, Labor, Capitol
- **Profitability = Income - Costs**

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Heritability and Heterosis of Various Traits and Their Impact on Components of Cow-Calf Profitability

Trait	Heritability	Heterosis	Impact on Production Costs	Impact on Production Output
Reproduction	Low	High	Favorable	Positive
Calf Survival	Low	High	Favorable	Positive
Longevity	Low	High	Favorable	Positive
Milk	20%	Mod.	Variable	Positive
Calving Difficulty	15%	Mod.	Unfavorable	Negative
Mature Size	50%	Mod.	Variable	Positive
Calf Weight	40%	Mod.	Variable	Positive

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Maternal Heterosis

Advantage of the Crossbred Cow

- Advantage of crossbred cow vs. straightbred
  - Reproductive efficiency
  - Maternal ability
  - Longevity
- Increased lifetime productivity
- Maternal heterosis accounts for largest portion of total heterosis advantage (60%)

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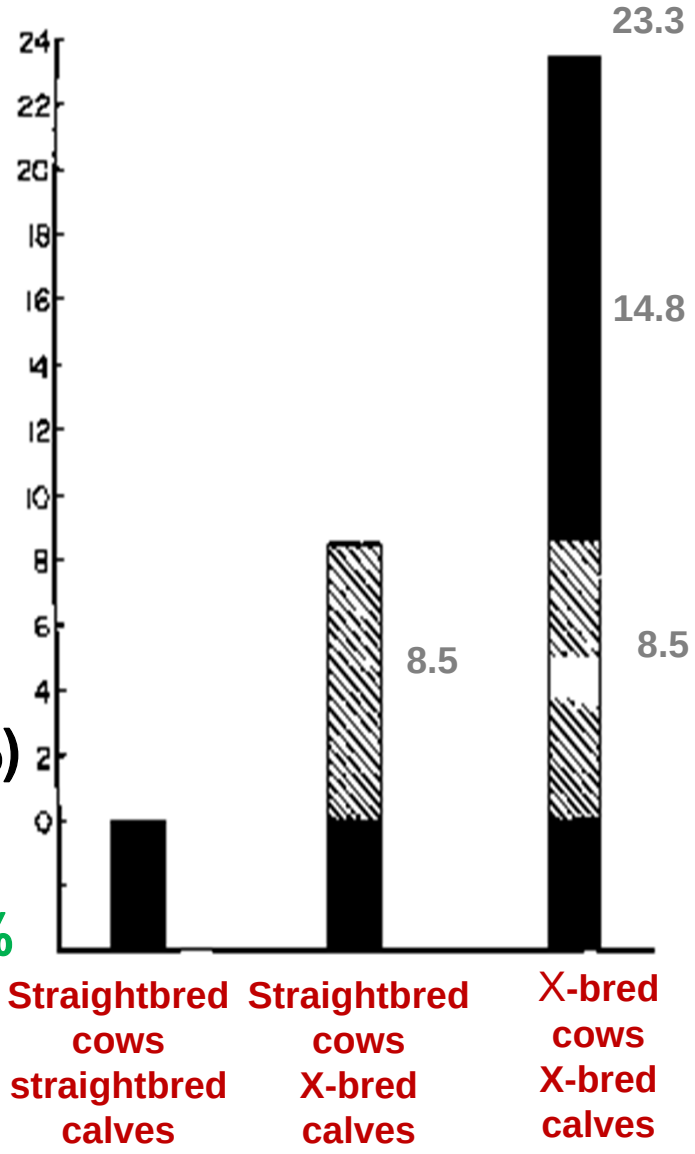
Maternal Heterosis

- Advantage of crossbred cow vs. straightbred
  - Reproductive efficiency
  - Maternal ability
  - Longevity
- Increased lifetime productivity
- Maternal heterosis accounts for largest portion of total heterosis advantage (60%)
- REDUCED BREAK-EVEN COSTS OF ~9.5%

Weight of Calf Weaned Per Cow Exposed To Breeding (%)



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Planned Crossbreeding Program Goals

- Maintain optimum levels of heterosis
- Utilize breeds/genetics that fit-
  - Environment/feed resources
  - Management
  - Marketing system
- Simple, manageable system
- Sustainable system

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Breeds and Breed Combos

Dam	Sire	Resulting Calf
75% Angus x 25% Simm/Gelbvieh	SimmAngus or Gelb Balancer	5/8 Angus x 3/8 Simm/Gelb
50% Angus x 50% Simm/Gelbvieh	Angus	75% Angus x 25% Simm/Gelb
50% Angus x 50% Simm/Gelbvieh	SimmAngus or Gelb Balancer	50% Angus x 50% Simm/Gelb
50% Angus x 50% Hereford	PB Simm or PB Gelbvieh	50% British x 50% Continental
50% Angus x 50% Hereford	SimmAngus or Gelb Balancer	75% British x 25% Continental
Any of above	Charolais terminal sire	50% Charolais x 50% British/Continental

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Establish Selection Priorities

- ***STRENGTHS***
- Weaning weight
- Calving ease
- Milk
- Color/type/grade
- Management

- Maintain growth and maternal ability

- ***WEAKNESSES***
- Cows too big
- Uniformity
- Marbling/Quality Grade
- Feed/forage resources

- Moderate frame size
- Improve marbling

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Establish Benchmarks

Setting EPD Specifications

- Accurate record-keeping is key
- Tracking performance and genetic merit of cow herd
  - Calving ease
  - Milk
  - Growth (including cow size)
  - Carcass Merit
- Optimizing vs. Maximizing

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Establishing Benchmarks

Export To Excel

Percentile Breakdown
Current Sires

	Production						Maternal					Carcass				$Values					
Top Pct	CED	BW	WW	YW	YH	SC	CEM	Milk	MW	MH	$EN	CW	Marb	RE	Fat	$W	$F	$G	$QG	$YG	$B
1%	+14	-2.7	+66	+117	+1.2	+1.68	+13	+34	+107	+1.7	+29.07	+32	+.83	+.61	-.045	+34.93	+51.69	+38.23	+31.62	+11.67	+64.0
2%	+13	-1.9	+63	+111	+1.1	+1.53	+12	+33	+93	+1.5	+24.08	+29	+.76	+.55	-.038	+33.45	+47.17	+36.65	+30.54	+10.89	+61.1
3%	+12	-1.5	+61	+108	+1.0	+1.40	+12	+32	+87	+1.4	+21.64	+28	+.72	+.51	-.033	+32.60	+44.63	+35.55	+29.58	+10.33	+59.3
4%	+12	-1.2	+60	+106	+1.0	+1.31	+11	+31	+83	+1.3	+19.77	+26	+.68	+.48	-.030	+31.96	+42.55	+34.59	+28.95	+9.90	+58.0
5%	+11	-1.0	+59	+105	+.9	+1.25	+11	+30	+80	+1.2	+18.50	+26	+.65	+.45	-.027	+31.43	+41.29	+33.80	+28.20	+9.57	+56.8
10%	+10	-.2	+55	+99	+.8	+1.04	+10	+28	+68	+1.0	+14.67	+22	+.56	+.37	-.019	+29.80	+36.45	+31.12	+25.88	+8.37	+52.9
15%	+9	+.3	+52	+95	+.7	+.90	+10	+27	+61	+.9	+12.29	+20	+.50	+.33	-.013	+28.72	+33.39	+29.22	+24.20	+7.65	+50.2
20%	+9	+.6	+50	+92	+.7	+.79	+9	+26	+55	+.8	+10.49	+18	+.45	+.28	-.009	+27.85	+30.93	+27.51	+22.66	+7.08	+48.0
25%	+8	+1.0	+49	+89	+.6	+.69	+9	+25	+50	+.7	+9.06	+17	+.41	+.25	-.005	+27.11	+28.93	+25.96	+21.69	+6.53	+46.1
30%	+8	+1.2	+47	+87	+.6	+.61	+8	+24	+46	+.7	+7.70	+16	+.38	+.22	-.002	+26.46	+27.12	+24.40	+20.21	+6.11	+44.5
35%	+7	+1.5	+46	+85	+.5	+.54	+8	+23	+42	+.6	+6.60	+15	+.34	+.19	+.001	+25.86	+25.54	+23.06	+18.85	+5.66	+42.8
40%	+7	+1.7	+45	+83	+.5	+.47	+7	+22	+39	+.6	+5.52	+13	+.31	+.17	+.004	+25.27	+24.03	+21.79	+17.75	+5.19	+41.3
45%	+6	+1.9	+44	+81	+.5	+.41	+7	+22	+36	+.5	+4.55	+12	+.28	+.14	+.006	+24.70	+22.62	+20.55	+17.10	+4.78	+39.8
50%	+6	+2.1	+43	+79	+.4	+.35	+7	+21	+32	+.5	+3.51	+11	+.25	+.12	+.009	+24.09	+21.17	+19.39	+15.84	+4.38	+38.4
55%	+5	+2.3	+41	+77	+.4	+.28	+6	+20	+29	+.4	+2.49	+10	+.23	+.09	+.012	+23.51	+19.75	+18.28	+14.59	+3.90	+36.8
60%	+5	+2.6	+40	+75	+.3	+.22	+6	+19	+25	+.4	+1.53	+9	+.20	+.07	+.015	+22.90	+18.34	+17.18	+13.39	+3.42	+35.2
65%	+4	+2.8	+39	+73	+.3	+.15	+6	+18	+21	+.3	+.57	+8	+.17	+.05	+.017	+22.28	+16.86	+16.08	+12.49	+2.95	+33.6
70%	+4	+3.0	+38	+71	+.3	+.08	+5	+18	+18	+.2	-.52	+7	+.15	+.02	+.020	+21.60	+15.20	+14.92	+11.26	+2.33	+31.7
75%	+3	+3.3	+36	+69	+.2	+.01	+5	+17	+13	+.2	-1.67	+5	+.12	-.01	+.024	+20.84	+13.45	+13.73	+10.49	+1.74	+29.7
80%	+2	+3.6	+35	+66	+.2	-.07	+4	+16	+9	+.1	-2.93	+4	+.09	-.04	+.027	+20.01	+11.46	+12.40	+9.07	+1.01	+27.42
85%	+1	+3.9	+33	+62	+.1	-.17	+3	+14	+2	+0	-4.33	+2	+.06	-.07	+.032	+18.93	+8.95	+10.85	+7.82	+.16	+24.79
90%	+0	+4.4	+30	+58	+0	-.29	+3	+13	-5	-.1	-6.17	+0	+.02	-.12	+.038	+17.53	+5.57	+8.84	+5.93	-1.11	+21.46
95%	-2	+5.1	+26	+50	-.1	-.47	+1	+10	-18	-.4	-8.92	-3	-.04	-.20	+.047	+15.21	+.32	+5.88	+3.05	-3.10	+16.31
Total Animals	23,410	23,620	23,620	23,620	9,138	12,706	23,410	23,620	2,643	2,643	23,628	17,115	17,115	17,115	17,115	23,628	23,628	19,836	19,836	19,836	19,836
Avg	+5	+2.1	+42	+78	+.4	+.36	+6	+21	+32	+.4	+4.02	+11	+.27	+.12	+.009	+23.82	+21.01	+19.69	+15.75	+3.94	+37.59

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Economically Relevant Traits

- Reproductive Efficiency
- Calving Ease
- Growth
- Maternal Ability
- Mature Size
- Adaptability/Longevity
- End Product Merit

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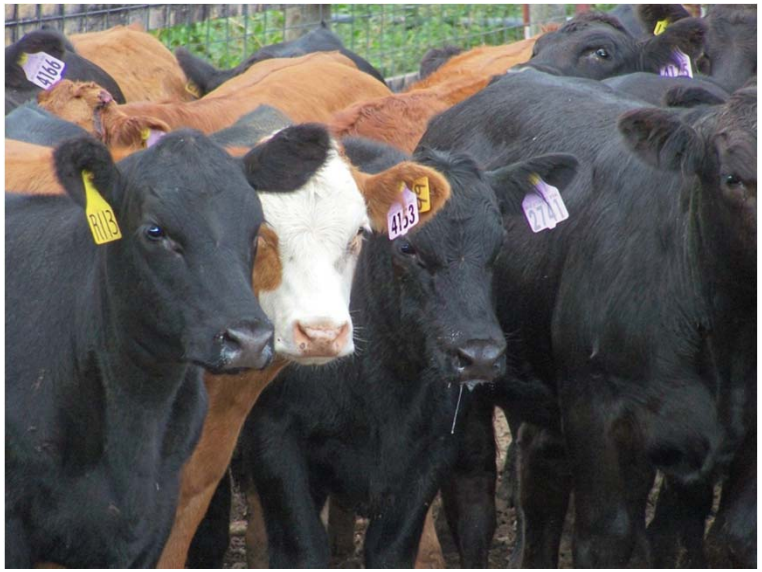
Genetic Traits That Impact the Gross Revenue

- Growth
- Maternal ability/milk
- Carcass merit
- Grade/type
- Coat color



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Challenges with EPDs

- **Balanced trait selection**
  - Which traits??
  - Proper weighting

- **Economic value of each EPD**
  - Relative to a unit change
  - Relative to its importance in selection

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Index EPDs

- Index = a combination and weighting of multiple traits, and their relative economic impact, into one value that can be used to rank animals
  - Challenging to develop
  - Simple to use
  - Result in directional change in multiple traits

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Interpreting EPDs
Which is the better bull?

Bull	CW EPD	MB EPD	RE EPD	Fat EPD	YW EPD
20X	+11	+.77	+.52	+.008	+84
30T	+20	+.37	+.64	-.018	+98
Diff.	-9	+.40	-.12	+.026	-14

How do they translate to $$$$?

How do we weight each EPD?

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Angus $Beef Example

Bull	$B Value
A	$40
B	$30
Diff.	$10

Progeny of Bull A would be expected to be $10 per head more profitable post-weaning, as a result of advantages in feedlot performance efficiency and carcass merit.

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Interpreting EPDs
Which is the better bull?

Bull	CW EPD	MB EPD	RE EPD	Fat EPD	YW EPD
20X	+11	+.77	+.52	+.008	+84
30T	+20	+.37	+.64	-.018	+98
Diff.	-9	+.40	-.12	+.026	-14

Both bulls are +60 $Beef!

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Tools:
$W (Weaned Calf Value)

Bull	$W Value
A	$30
B	$20
Diff.	$10

Progeny of Bull A would have $10 per head advantage in preweaning value, as a result of advantages in birth weight, weaning weight, maternal milk, and mature cow size.

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$EN (Cow Energy Value)

Bull	$W Value
117	$10
118	$0
Diff.	$10

Daughters of Bull A would have $10 per head savings in cow energy costs per year due to advantages in energy costs associated with mature size and lactation.

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AAA Sire Sort: $EN = +$10-11 (top 20%)

Expected Progeny Differences Sires found: 11

Registration Name	Tattoo Birth Date	Production						Maternal					
		CED Acc	BW Acc	WW Acc	YW Acc	YH Acc	SC Acc	CEM Acc	Milk Acc	MkH MkD	MW Acc	MH Acc	$EN
12548426(AMF-NHF)	5365	-5	+2.4	+46	+85	-.2	-.39	+7	+17	58	+32	+0	+10.98
G A R Enhancer 5365	08/31/1995	.76	.89	.84	.81	.84	.82	.61	.72	167	.72	.72	
12530601(AMF-NHF)	6I6	+11	-.4	+41	+84	-.1	-.29	+6	+17	1,862	+34	+.2	+10.97
Rito 6I6 of 4B20 6807	01/04/1996	.96	.98	.97	.96	.96	.96	.92	.95	6,470	.93	.93	
12813196	6106	+8	-.2	+50	+88	+0	-.13	+9	+22	189	+12	+.3	+10.94
Wulffs Ext 6106	09/04/1996	.80	.92	.88	.86	.88	.89	.74	.82	622	.80	.81	
10705768(AMF-NHF)	5204	+11	-2.1	+22	+49	+.4	+1.11	+7	+24	1,652	+4	+.3	+10.76
R R Traveler 5204	02/04/1985	.94	.97	.96	.95	.94	.94	.91	.95	3,674	.89	.89	
14230973(NHC-AMF)	2824	+11	+.8	+28	+51	+.2	+.30	+13	+23	155	+4	+.3	+10.68
KG Dakota	02/27/2002	.71	.92	.88	.84	.75	.86	.66	.78	417	.52	.52	
12309326	216D	+6	+4.3	+50	+94	+.8	-.36	+2	+10	550	+61	+.7	+10.61
SVF Gdar 216 LTD	08/29/1994	.75	.93	.90	.85	.87	.89	.82	.90	1,131	.73	.73	
13456210	9121	+7	+1.3	+50	+90	-.1	+.54	+10	+12	128	+41	+.3	+10.48
Connealy Timeline	01/26/1999	.81	.93	.90	.87	.83	.86	.69	.82	443	.57	.57	
12923633	745	+3	+4.2	+51	+78	+.4	+1.03	+4	+14	110	+44	+.7	+10.33
Mc Bee WMR Super X 745	02/05/1997	.78	.93	.90	.88	.75	.81	.72	.83	427	.56	.56	
13254554(AMF-NHF)	6578	+4	+5.9	+68	+120	+.6	+.46	+8	+10	972	+64	+.8	+10.20
G A R Grid Maker	08/21/1998	.83	.97	.96	.94	.95	.94	.88	.92	2,963	.86	.86	
10776479(AMF-NHF)	U23	+6	+1.9	+43	+79	+.2	-.36	+11	+18	4,412	+34	+.2	+10.09
N Bar Emulation EXT	02/01/1986	.96	.99	.98	.98	.97	.97	.95	.97	17,109	.95	.95	
12223857(AMF-NHF)	4100	+2	+3.7	+45	+81	+.4	+.30	+1	+17	412	+34	+.7	+10.07
L F New Trend 4100	01/29/1994	.79	.95	.93	.90	.91	.89	.81	.89	1,036	.74	.73	

- Minimum Milk ACC .7
- Minimum MW ACC .5
- $EN only estimates cost (no revenue component)

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Successful Sire Selection: Keys

- Define herd goals and objectives
  - What needs improvement?
  - What needs to stay same?
- Define strategy to make change
- Understand and effectively utilize tools for selection (EPDs, performance data, etc.)
- Do your homework (establish benchmarks), prepare to prioritize
- Balance traits impacting revenue and production costs- optimize vs. maximize

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Fundamentals of Selection Success

- Define herd goals, identify strengths and weaknesses
- Identify Priorities and Opportunities for Improvement
- Effectively Utilize Selection Tools
- Track Performance and Know Your Customer

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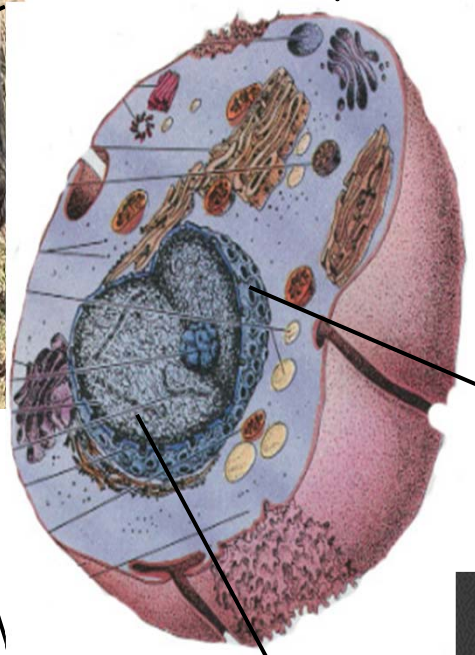
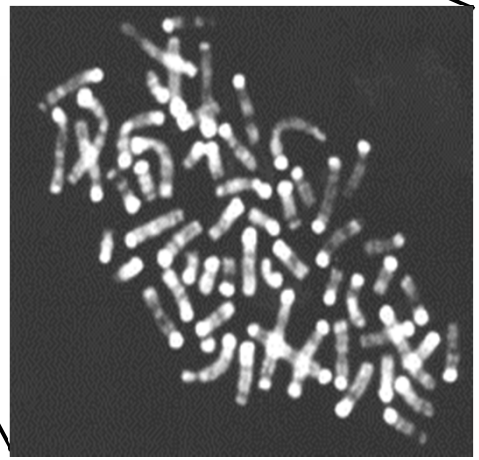
Genomics & Beef Selection

Marker Assisted Selection

10-30μm





Selection of specific DNA variations that are associated with an effect on particular trait.

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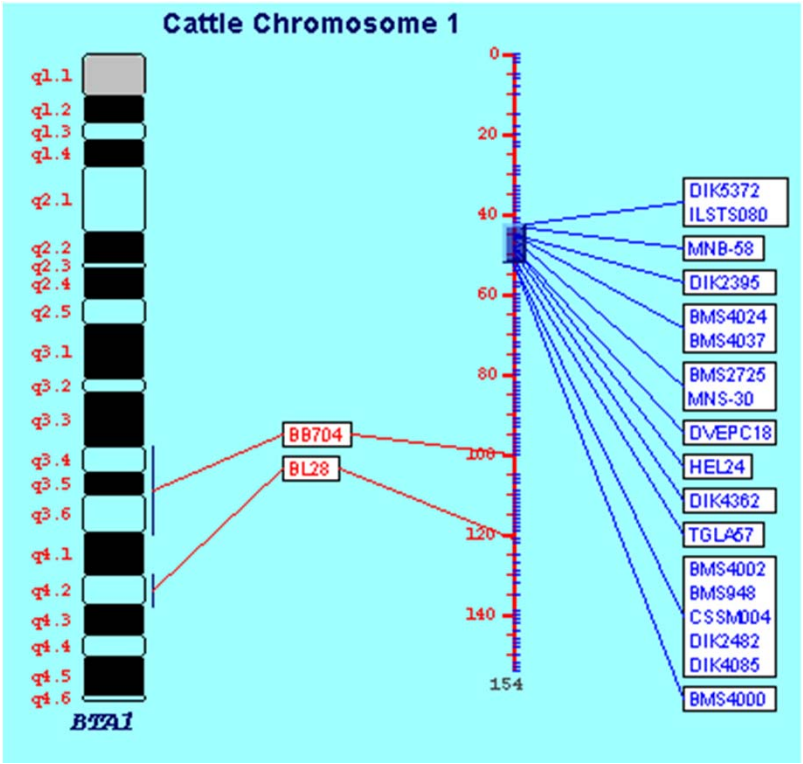
DNA Markers

- Locations along bovine genome where animal differ in genotype
- Most are just "markers" as opposed to "functional mutations"



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DNA Marker Application

- Major Genes
  - Horned vs polled
  - Coat Color
  - Genetic Diseases
- Parentage Verification
- Marker Assisted Selection

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Marker Assisted Selection

- Prediction of genetic merit utilizing association of genotype (marker) with phenotype
- Science rapidly evolving
- Considerations
  - EPDs vs. markers/genotypes
  - Marketing vs. genetic improvement

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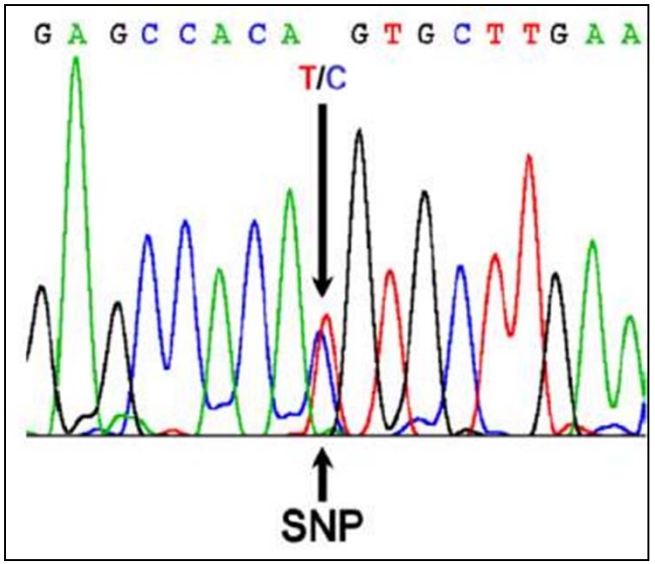
Single Nucleotide Polymorphisms (SNPs)

- SNPs are the most common and stable type of DNA marker in cattle
- Ideally suited for automated, economical genetic testing
- SNPs associated with various biological processes involved in relevant production traits



Early Markers

- **GeneSTAR Quality Grade**
  - Two markers (TG5 and M2) associated with increased quality grade
  - Associated with variation of thyroglobulin gene
  - Results reported as 0 to 4 “stars”
  - Average effect of associated with 6.2% increase in % Choice or better
- **GeneSTAR Tenderness**
  - Three markers
  - Markers associated with calpastatin and calpain, enzymes involved in normal tenderizing of meat post-mortem
  - 2.2 pound difference in shear force between 0-star and 6-star genotype
- **Ignenity TenderGENE**
  - Three markers associated with calpain and calpastatin
  - 2.3 pound difference in shear force between best and worst genotypes

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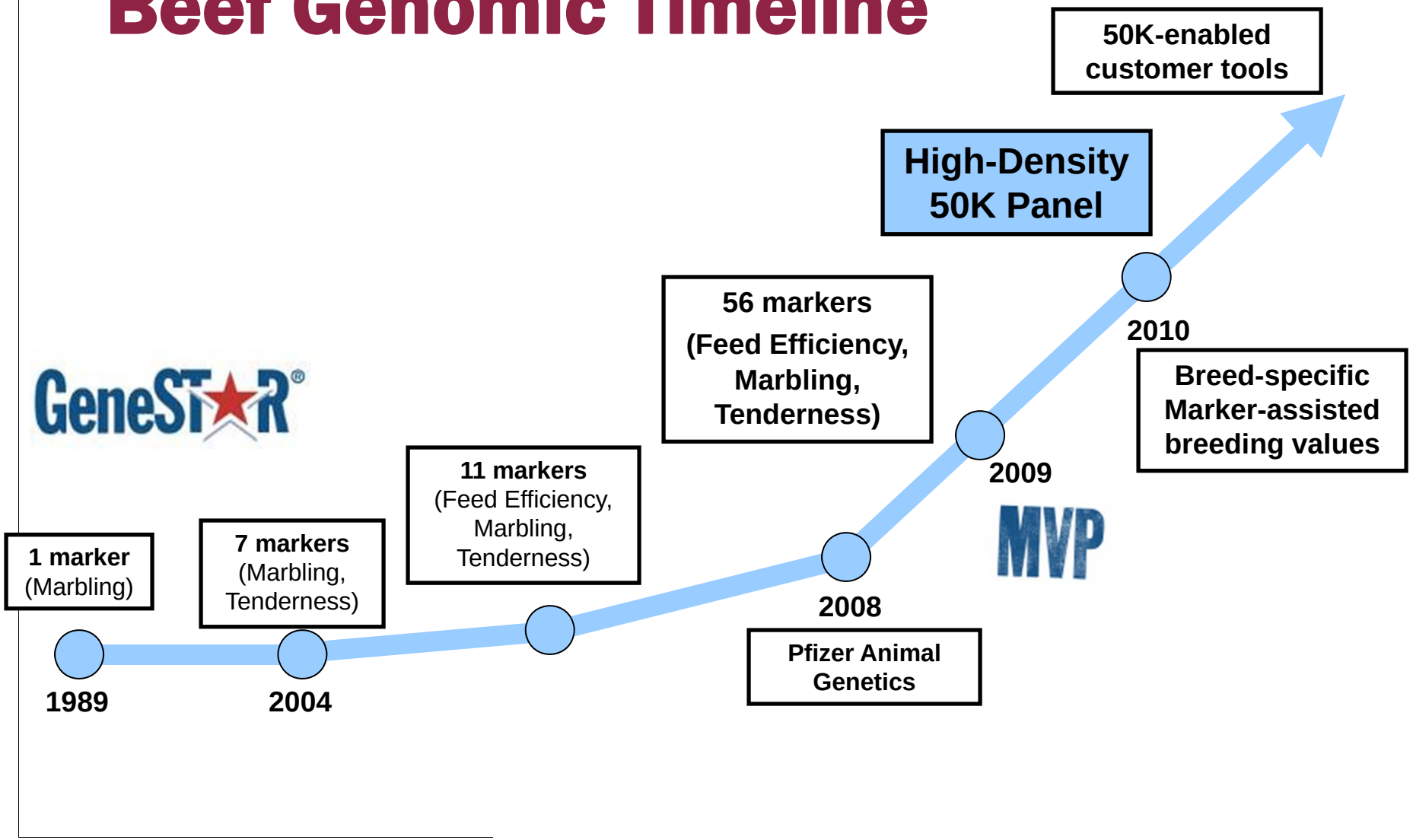
Beef Genomic Timeline



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DNA Revolution

- SNP 50 chip
- Broad scan of genome- cumulative effect of genes (higher proportion of genetic merit explained)
- Incorporation of genomic information ("molecular breeding values") with EPDs
- Application underway in beef (Angus), currently used in dairy

BovineSNP50 Genotyping BeadChip

Developed in collaboration with leading bovine researchers, the BovineSNP50 BeadChip features more than 54,000 evenly spaced SNP probes that span the bovine genome. This 12-sample BeadChip presents a cost-effective and high-quality solution for cattle researchers interested in genome-wide genotyping applications.

ILLUMINA® SNP GENOTYPING

INTRODUCTION

Illumina, in collaboration with the USDA ARS, University of Missouri, and the University of Alberta, has developed the first high-density, genome-wide genotyping array for the interrogation of genetic variation in cattle. The BovineSNP50 BeadChip features more than 54,000 highly informative SNP probes that uniformly span the entire bovine genome, empowering applications such as genome-wide enabled selection, identification of quantitative trait loci, evaluation of genetic merit of individuals, and comparative genetic studies.

More than half of the probes on this Genome Analyzer, a next-generation sequencing system. Additional high-value content is derived from publicly available sources such as the bovine reference genome, Btau[1], and the Bovine HapMap Consortium data set[2].

The BovineSNP50 BeadChip covers common SNPs validated in economically important beef and dairy cattle breed types and presents an average minor allele frequency (MAF) of 0.25 across all loci. Importantly, this BeadChip offers uniform coverage with an average probe spacing of 51.5kb to provide more than sufficient SNP density for robust genome-association studies in cattle.

FIGURE 1: BOVINESNP50 BEADCHIP

The BovineSNP50 BeadChip features more than 54,000 evenly-spaced SNPs across the entire bovine genome.

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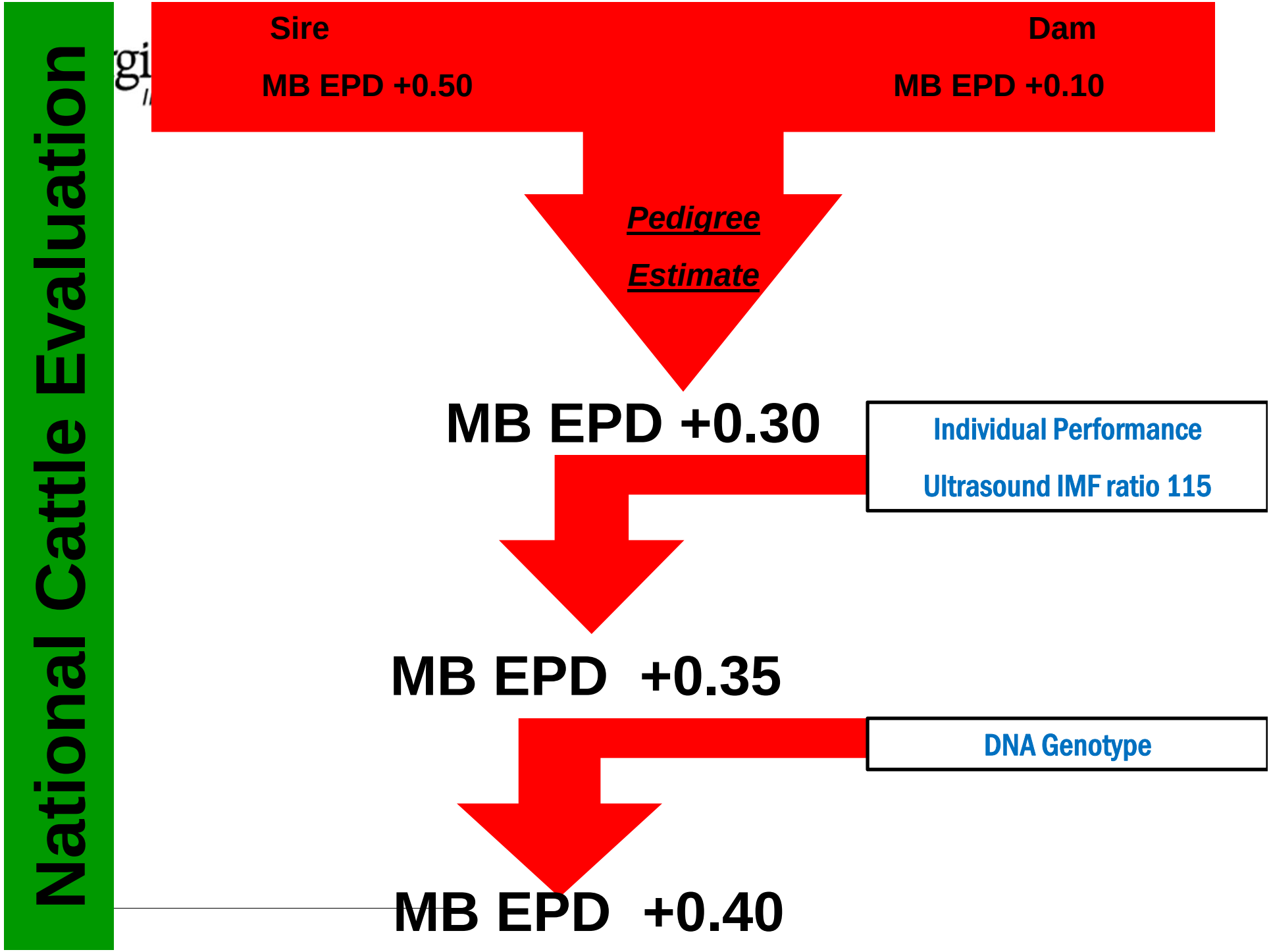
IGENITY for Beef

- Genetic profiling for multiple traits
- Results expressed on 10 point scale
- Pricing: Profile $38

IGENITY profile results and associated effects*

IGENITY Result	Residual Feed Intake (Indicus)**	Residual Feed Intake (Taurus)**	Average Daily Gain***	Tenderness in lbs. of WBSF	USDA Marbling Score	% Choice & higher	Yield Grade	Back Fat Thickness (in)	Ribeye Area (in²)	Heifer Pregnancy Rate (%)	Stayability (%)	Maternal Calving Ease (%)	Docility (%)
10	5.5	4.2	0.81	-2.3	161.4	64.4	1.35	.37	2.56	19.8	16.7	9.5	45.4
9	5.0	3.6	0.72	-2.0	141.3	57.2	1.21	.32	2.22	16.2	14.7	8.4	39.6
8	4.2	3.1	0.64	-1.9	123.6	50.1	1.07	.28	1.93	14.2	12.9	7.3	34.7
7	3.6	2.7	0.54	-1.5	106.4	42.9	0.92	.24	1.64	12.1	11.2	6.2	30.0
6	3.0	2.2	0.44	-1.2	88.4	35.8	0.76	.21	1.35	10.0	9.5	5.1	25.3
5	2.4	1.8	0.34	-1.1	70.6	28.6	0.61	.17	1.07	8.1	7.6	4.1	20.5
4	1.9	1.3	0.24	-0.8	53.3	21.5	0.46	.13	0.80	6.0	5.8	3.1	15.7
3	1.2	0.9	0.14	-0.4	35.5	14.3	0.31	.09	0.53	4.0	3.9	2.0	10.7
2	0.6	0.4	0.05	-0.2	17.7	7.2	0.15	.06	0.24	1.9	2.5	1.0	5.8
1	0	0	0	0	0	0	0	0	0	0	0	0	0
P-value	5.7E-13	8.04E-08	2.4E-19	19E-08	3.8E-18	1.0E-20	1.6E-16	3.9E-20	1.8E-14	2.6E-30	1.1E-34	4.2E-32	3.1E-19

*Data on file at Weald. Results expressed represent differences expected in animals compared to counterparts scoring with IGENITY Profile score of 1.
**Lower feed per day.
***Lbs of gain per day.
WBSF = Warner-Bratzler shear force


National Cattle Evaluation
Sire
MB EPD +0.50
Dam
MB EPD +0.10
Pedigree
Estimate
MB EPD +0.30
Individual Performance
Ultrasound IMF ratio 115
MB EPD +0.35
DNA Genotype
MB EPD +0.40

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EPDs Enhanced with Genomics

As of 08/12/2011

Production								Maternal						
CED Acc	BW Acc	WW Acc	YW Acc	RADG Acc	YH Acc	SC Acc	Doc Acc	HP Acc	CEM Acc	Milk Acc	MkH MkD	MW Acc	MH Acc	$EN
+4 .90	+4.0 .98	+52 .97	+98 .96	+0 .80	-.1 .97	+.29 .96	+13 .94	+10.8 .80	+9 .89	+29 .93	897 4319	-5 .90	+0 .91	+8.21

Carcass					
CW Acc	Marb Acc	RE Acc	Fat Acc	Carc Grp Carc Pg	Usnd Grp Usnd Pg
+31 .87	+1.24 .89	+.61 .88	+.042 .88	126 474	6550 18484

$Values					
$W	$F	$G	$QG	$YG	$B
+40.96	+36.45	+39.38	+36.47	+2.91	+73.32

*EPDs are enhanced by **genomic** results generated by:* igenity. Pfizer

192604 BO 11091999; 504288 12052000

American Angus Association® 3201 Frederick Ave. St. Joseph, MO 64506
Contact us: phone 816.383.5100 fax 816.233.9703 **e-mail**

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Pfizer Animal Genetics HD 50K

- First genetic predictions based solely on markers
- Applicable to Angus
- Molecular Value Predictions (MVPs) for 14 traits
  - Unique: ADG, DMI, Net Feed Intake, Tenderness
  - Others: CED, BW, WW, CEM, MM, CW, REA, FT, MB
- Genomics derived Economic Index - $MVP^{FL}

- Results reported to breed association
  - Incorporated into Angus EPD calculations
  - Angus HD50K test $139

EPDs vs. MVPs

G A R Predestined															13395344
	CED	BW	WW	YW	ADG	DMI	NFI	CEM	MA	CW	FAT	REA	MS	TND	$B/$MVP™
EPD	7	4.1	53	99	-	-	-	6	28	26	0.046	0.59	1.07	-	69.78
ACC	0.84	0.97	0.96	0.94	-	-	-	0.8	0.85	0.82	0.81	0.82	0.84	-	-
EPD % Rank	30	85	15	15	-	-	-	55	10	4	90	2	1	-	1
MVP	13	1.0	37	-	0.45	0.97	0.04	8	33	55	0.07	0.92	1.52	-0.43	243
MVP % Rank	3	70	10	-	30	90	90	4	1	1	90	1	1	80	1

G A R Retail Product															13395329
	CED	BW	WW	YW	ADG	DMI	NR	CEM	MA	CW	FAT	REA	MS	TND	$B/$MVP™
EPD	6	2.6	47	93	-	-	-	7	25	16	0.003	0.47	0.42	-	55.08
ACC	0.92	0.98	0.96	0.95	-	-	-	0.87	0.91	0.7	0.7	0.73	0.74	-	-
EPD % Rank	45	60	35	20	-	-	-	40	25	30	35	5	30	-	10
MVP	8	1.1	26	-	0.43	0.44	-0.37	4	25	34	0.02	0.54	0.71	-0.43	167
MVP % Rank	20	70	40	-	40	80	10	20	9	6	80	2	10	80	15

Source: www.pfizeranimalgenetics.com

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Status of Genomics

- Rapidly evolving science
- Opportunities
  - Efficiency, reproduction, health traits
- Phenotypes remain critical (and limiting factor)
- Incorporation of genomic information into traditional genetic evaluations (EPDs) is key for genetic progress
- Genetic improvement vs. marketing

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Applications

- **Beef Selection**
  - Enhanced EPD accuracy (inclusion into existing performance databases)
    - Carcass traits, growth, calving ease, milk, residual ADG
  - EPDs for new traits
- **Challenges**
  - Validation in non-Angus populations
  - Selection via DNA result vs. EPD