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Managing Genetic Defects and Enhancing End Product

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Arthrogryposis Multiplex (AM) a.k.a. "Curly Calf Syndrome"

- Lethal condition characterized by lightweight calves with curved spine, extended and contracted limbs, thin appearance

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What causes AM?

- Genetic abnormality (lethal recessive)
- Research has identified mutation in gene which impairs function of nerve and muscle tissue development
- AM manifests itself when calf inherits one copy of recessive gene from ***both*** parents- simple recessive
- Traced from the most recent common ancestor, Rito 9J9 of B156 7T26 and distributed widely through the popular Angus sire GAR Precision 1680

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Neuropathic Hydrocephalus (NH)

- Lethal condition characterized by absence of CNS tissue, hydrocephalus (water on brain), skull malformation, arthrogryposis (joint fixation)
- Mutation traces to GAR Precision 1680

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NH

- First appeared in conjunction with investigations related to Curly Calf
- AM and NH are independent (different genes)
- NH also a simple recessive
- Causative gene isolated and DNA test has been developed
- Trace to GAR Precision 1680
- Preliminary list of affected/carrier sires released by American Angus Association on April 13
- Commercial DNA test became available in June

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Qualitative Traits- Controlled by One Gene
Coat Color (black vs. red)

- B – Black (dominant)
- b – Red (recessive)

- Genotypes (phenotypes)
- BB – homozygous (black)
- Bb – heterozygous (black)
- bb – homozygous (red)

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Qualitative Traits- Controlled by One Gene
Coat Color (black vs. red)

- Mating of heterzygous black parents

		Red Carrier Bull: B	Red Carrier Bull: b
Red Carrier Cow	B	BB	Bb
	b	Bb	bb

- 1 BB –black
- 2 Bb – black (red carrier)
- 1 bb –red

3:1 black:red (75%)
50% red carriers
25% red

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Qualitative Traits- Controlled by One Gene
Arthrogryposis Multiplex

- A – normal (dominant)
- a – arthrogryposis (recessive)

- Genotypes (phenotypes)
- AA – homozygous (normal)
- Aa – heterozygous (normal)
- aa – homozygous (AM)

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AM

- Mating of heterozygous parents

		Carrier Bull (AMC)	
		A	a
Carrier Cow (AMC)	A	AA	Aa
	a	Aa	aa

- 1 AA –normal (AMF)
- 2 Aa – normal (AM carrier)
- 1 AA –AM

75% normal calves
50% carriers
25% AM calves

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AM

		"free" Bull (AMF)	
		A	A
Carrier Cow (AMC)	A	AA	AA
	a	Aa	Aa

- 2 AA –normal (AMF)
- 2 Aa – normal (AM carrier)
- (no aa genotypes)

100% normal calves
50% carriers
0% AM calves

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DNA Genotyping

- Commercial DNA genotyping test became available in late 2008
- Test provides genotype of individual animals
  - Absence of gene: AM or NH “free” (AMF, NHF)
  - Presence of gene: AM or NH “carrier” (AMC, NHC)
- DNA samples
  - Hair root
  - Blood

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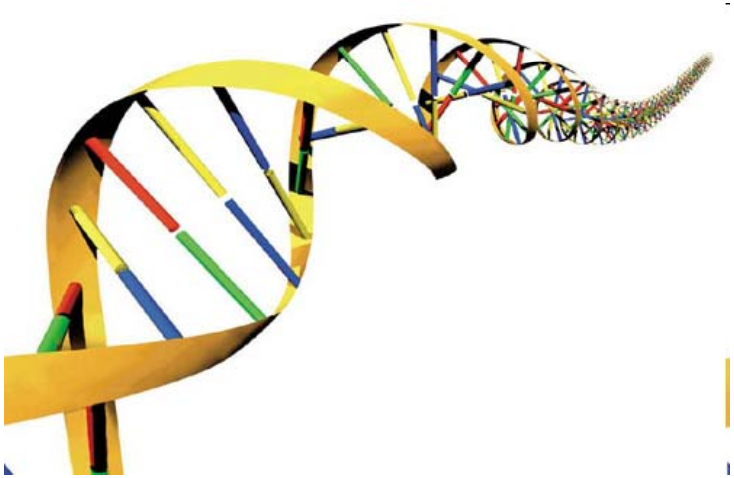
Genetic Test Labs & Cost

- Laboratories:
  - MMI Genomics
  - AgriGenomics
  - Pfizer Animal Genetics
  - IGENITY
  - GeneSeek



- Test cost ~$20 per animal (plus sample collection and shipping)
  - Can use archived DNA (from AM test)
  - ~$36 for both AM and NH tests

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Populations Concerned

- Angus
- Angus-influenced
  - SimmAngus
  - Gelbvieh Balancer
  - LimFlex

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Implications for Cow-Calf Producers

- Probability of animal itself being carrier when..
  - Sire is carrier = 50%
  - Grandsire is carrier = 25%
  - Great-grandsire is carrier =12.5%
  - Great, Great- grandsire is carrier = 6.25%
- Probability of animal's progeny being carrier is ½ that of parent probability (probability decreases by ½ each generation)
- Probability of having AM calf is product of probability of inheriting gene from sire x probability of inheriting gene from dam

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Scenario: Daughters or Grandaughters of AMC Bulls

- These daughters bred to AMF bull = 0 affected calves
- Daughters of carrier bulls- 50% will be carriers
  - 12.5% chance of getting AM calf if bred to carrier bull
- Granddaughters of carrier bulls- 25% will be carriers
  - 6.25% chance of getting AM calf if bred to carrier bull

**Same principles apply to NH (independent of AM)*

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Commercial Producers

- Use AM and NH free bulls = never have an AM or NH calf
- Assess herd risk (cows) based on known AM/NH status of popular sires and their impact through their sons in herd
- Potentially test current herd sires which are at-risk of being carriers (based on pedigree)

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Seedstock Producers

- Assess herd risk through pedigree analysis (AAA tools)
- Move towards AM and NH free genetics
- Genotyping
  - Cows (likely at least portion)
  - Replacement heifers
  - Bulls sold (and females)

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American Angus Assoc. updated policy

- Registration of potential and known AM and/or NH carrier animals
  - Currently registered animals remain registered
  - Progeny of carriers or potential carriers
    - Bull calves: born before 12/31/09 (AM) or 6/14/10 (NH) must tested and result reported, animals born after these dates must test free to be registered
    - Heifer calves: born before 12/31/11 (AM) or 6/14/12 (NH) must tested and result reported, animals born after these dates must test free to be registered
  - AI Sires
    - Calves sired by known carrier AI sires ineligible for registration if conceived > 60 d following announcement that AI sire is carrier
- Test results to be published on registration certificates

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Genetic Testing

reported to AAA as of 9/15/09

- AM tested bulls and females
  - AMF 69,877 (78%)
  - AMC 19,376 (22%)
- NH tested bulls and females
  - NHF 24,505 (74%)
  - NHC 8730 (26%)
- 122,488 animals tested
- Cost $2.5 million +

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Tools and Resources

- www.angus.org
- Details on AM and NH
- Complete list of genotyping results for all animals which have been tested
- Links to authorized testing labs
- Policy details

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Our Biggest Challenge…
Can We Have It All???

Profitable & Sustainable

- Reproductively efficient cow herd
- Cows that are low-cost, adaptable to feed and environmental resources
- Optimum growth/feed efficiency
- End product merit

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....producing the right kind of animal for the consumer.

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Beef: Consumer Desires

- Quality/Taste/Freshness
- Safety
- Convenience
- Diet/Health/Nutrition
- Production Practices
- Price/Value

Great taste is primary reason beef is at center of plate as food of choice

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Carcass Value Determinates

$$ Economic Signals $$

- Carcass Weight
- Cutability - Red Meat Yield (Yield Grade)
- Quality (Marbling)

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IBP-Tyson Grid

	YG 1	YG 2	YG 3	YG 4
Prime	**+$14.50**	**+$10.50**	**+$8.00**	**(-$15.00)**
Pr. Choice	**+$9.50**	**+$5.50**	**+$3.00**	**(-$15.00)**
Low Choice	**+$6.50**	**+$2.50**	**Base**	**(-$15.00)**
Select	**(-$3.50)**	**(-$7.50)**	**(-$10.00)**	**(-$25.00)**

Carcass Weight < 550 or > 950 (-$10.00)

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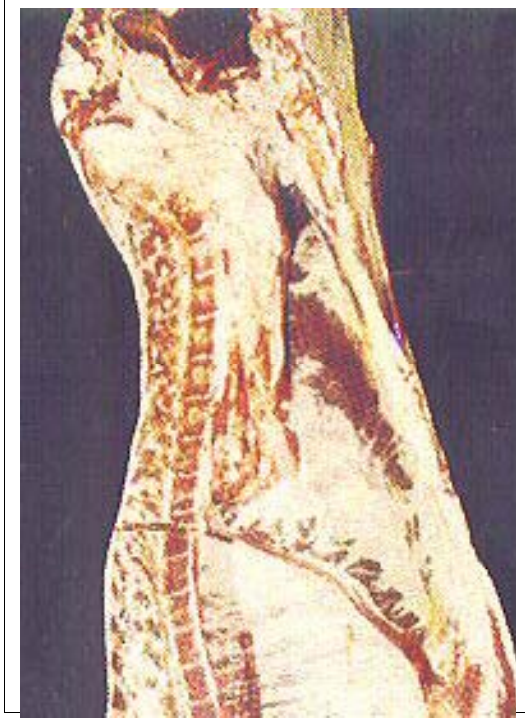
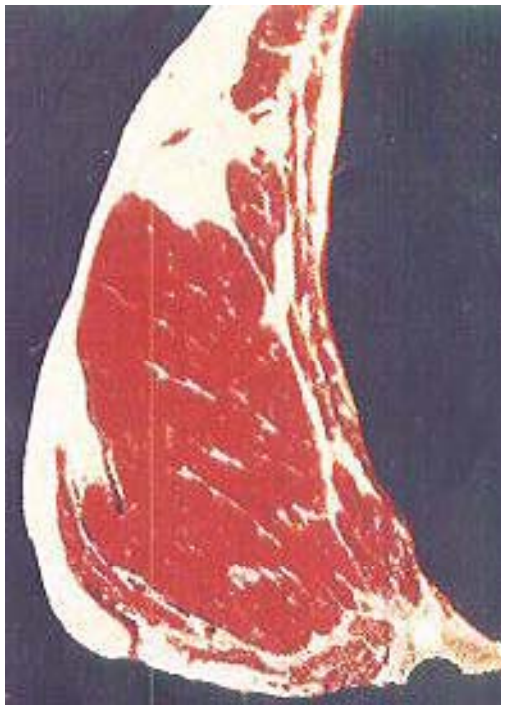
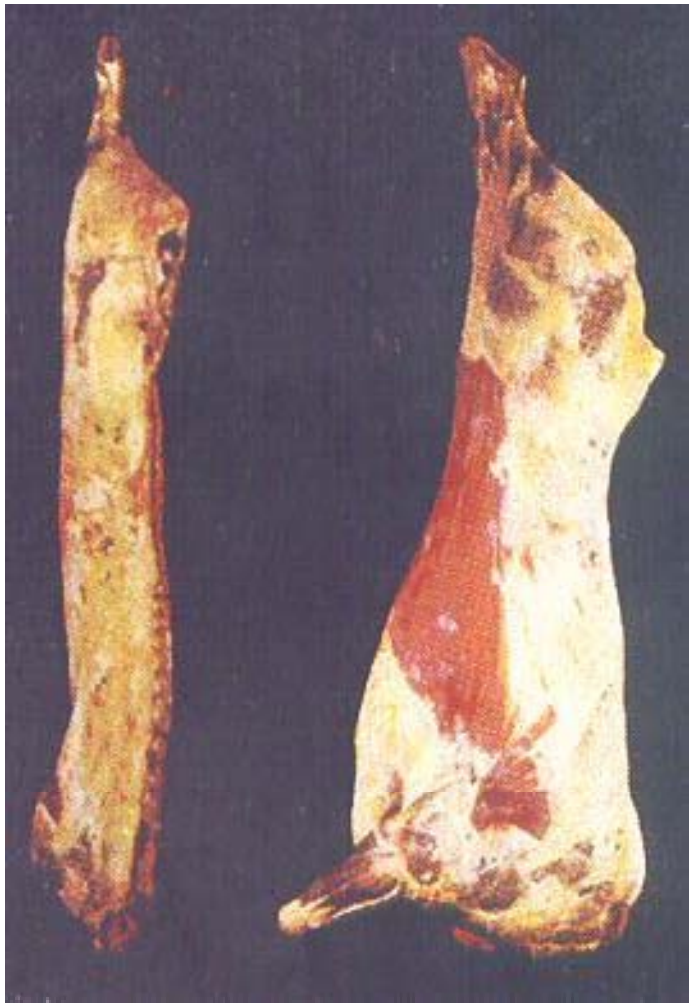
Yield Grade 2 Beef Carcass

Carcass weight	**750 pounds**
External fat	**0.3 inches**
Ribeye area	**13.9 sq. in.**
KPH	**2.0 %**
Yield grade	**2.0**
Retail Product	**67.3%**







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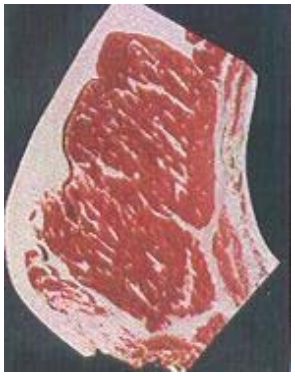
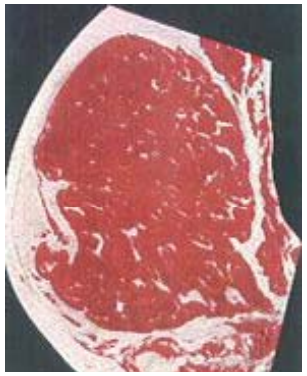
Marbling & Quality Grade



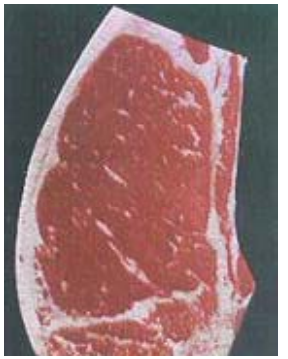
Abundant

(Prime)



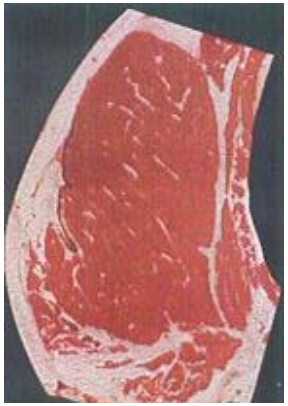
Slightly Abundant

(Prime -)



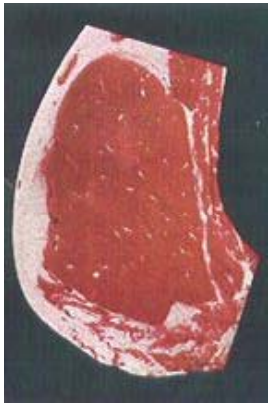
Moderate

(Choice +)



Modest

(Choice)



Small

(Choice -)

Slight

(Select)

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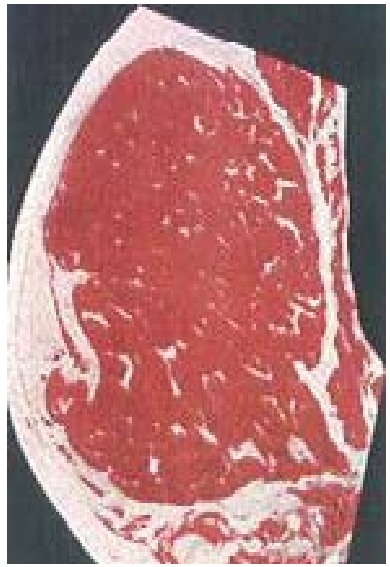
Pre-Harvest Factors Influencing Carcass Merit

- Breed/Genetics
- Energy density of diet
- Feeds
- Age
- Management factors
  - Stress
  - Disposition



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SIRE BREED MEANS FOR FINAL WEIGHT AND CARCASS TRAITS OF F1 STEERS (445 DAYS)

Sire Breed	N	Final wt lb	Retail product %	Retail product lb	Marb-ling sc	USDA Choice %	WB shear lb
Hereford	97	1322	60.7	480	526	70	9.1
Angus	98	1365	59.2	488	584	95	8.9
Red Angus	93	1333	59.1	474	590	93	9.2
Simmental	92	1363	63.0	522	528	66	9.5
Gelbvieh	90	1312	63.8	509	506	58	9.9
Limousin	84	1286	63.7	504	504	57	9.5
Charolais	95	1349	63.7	523	517	62	9.6
LSD ≤ .05		40	1.3	16	17	0.7	0.6

source: Cundiff et al., 2005, Germplasm Evaluation Program

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Marbling EPD Example

	Marbling EPD		Progeny Carcasses
Bull A	**+0.20**	**5.90**	**Small 90 (Low Choice)**
Bull B	**+0.50**	**6.20**	**Modest 20 (Avg. Choice)**

Difference 0.30

30 Marbling Points

30% of a Quality Grade

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Quality Grades

Degree of Marbling	USDA Quality Grade "A" Maturity	
Very Abundant	High Prime	
Abundant	Average Prime	"Prime"
Slightly Abundant	Low Prime	
Moderate (7.0 –7.99)	High Choice	"Premium
Modest (6.00 – 6.99)	Average Choice	Choice"
Small (5.00 – 5.99)	Low Choice	"Choice"
Slight (4.00 – 4.99)	Select	"Select"
Traces	Standard	"No
Practically Devoid	Standard	Roll"
Devoid	Utility	

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Factors Influencing Profitability Post-weaning (Feedyard)

- Feeder Cattle Price
- Fed Cattle Value
  - Carcass Value (Wt., QG & YG)
- Cost of Gain
  - Feed Costs
  - Health Costs
  - Growth Performance
  - Feed Efficiency
  - Yardage
- Trucking Costs
- Interest

...several factors influence each of these

- **Genetics**
- **Health**
- **Management**

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Interpreting EPDs
Which is the better bull?

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

Both bulls are +60 $Beef!

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What about Carcass Traits?

- Are you receiving value for carcass merit today?
- Important considerations:
  - Our genetics and management impact consumer acceptability
  - Progress in carcass traits requires time
  - Need to establish where we are
- Bottom Line-
  - Selection Today Affects Tomorrow
  - Avoid Major Pitfalls

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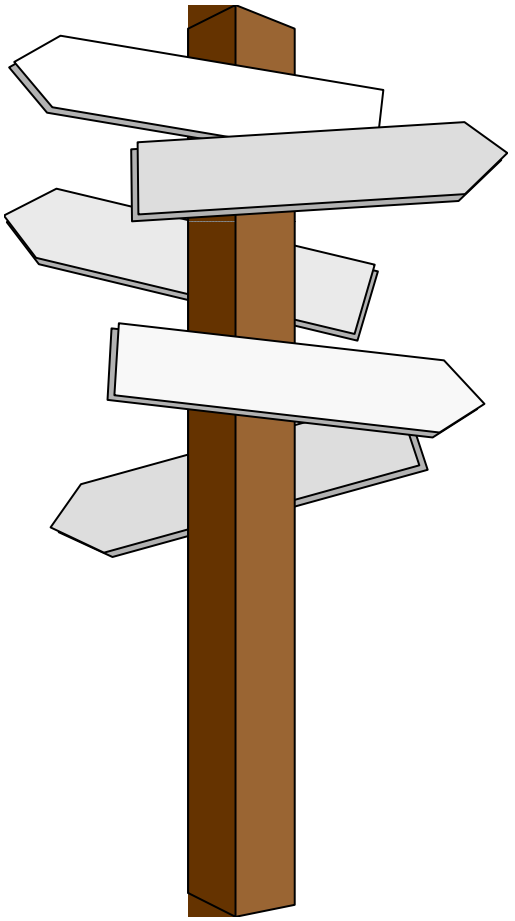
Positioning for the Future

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



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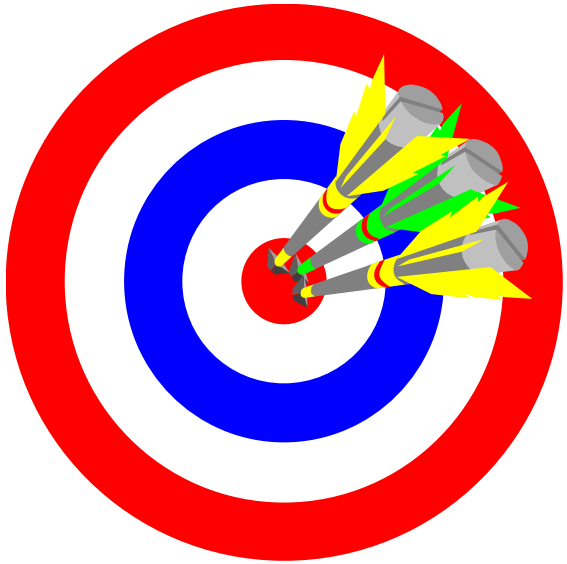
Carcass Targets

- 70 % Low Choice or better
- 70% YG 1's and 2's
- 0% Standards, YG 4's and 5's, Light or Heavyweights



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Are you producing "Reputation" feeder cattle?

WITHOUT QUESTION

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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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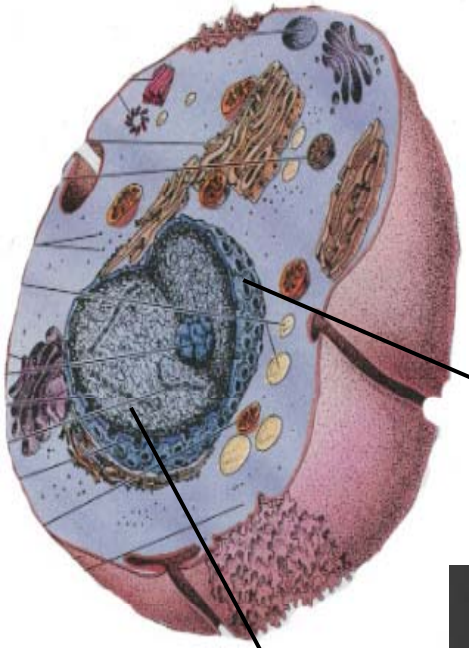
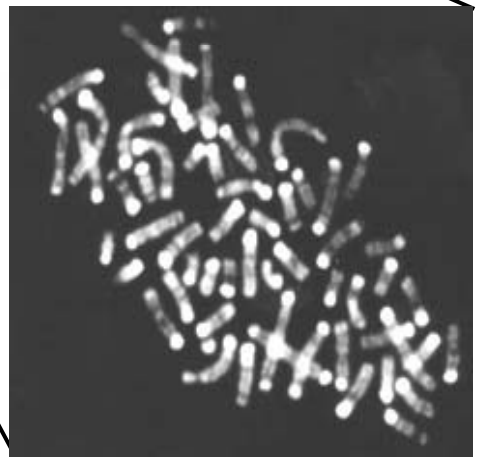
Producer Control of Beef Quality

- Utilize proper breeds and genetics
- Impose proper feeding system
- Judiciously utilize growth promoting technologies
- Apply established Best Management Practices/Beef Quality Assurance

Marker Assisted Selection

10-30μm





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

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Genomic Information

- Commercial DNA Markers
  - Marbling, Tenderness, Feed Efficiency
- Sound science
- Considerations
  - EPDs vs. markers/genotypes
  - Marketing vs. genetic improvement

Pfizer Animal Health
Animal Genetics

MMI Genomics, Inc.
BREED-TRU
DNA VERIFIED

igenity

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Invent the Future

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 in next year in beef (Angus), currently used in dairy

Tri-State Cow/Calf Conference

The conference is presented under a grant from the Southern Region Risk Management Education Center with additional support from the University of Tennessee Extension, Virginia Cooperative Extension and North Carolina Cooperative Extension.

UT Extension

VirginiaTech Invent the Future

NC State University A&T State University Cooperative Extension Helping People Put Knowledge to Work

Tennessee State University

Virginia State University

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