

Tools for Making Genetic Change

Tom Field, PhD



Overview of the U.S. Beef Industry

Segment	Participants	Inventory/Products
Seedstock	120,000 breeders plus a handful of AI studs	Approx. 80 breeds with 10 breeds most critical & 5 providing about 60% of the genetics, yearling bulls, semen, some females



Field, 2004

Overview of the U.S. Beef Industry

Segment	Participants	Inventory/Products
Cow-calf	<ul style="list-style-type: none"> • 796,000 beef herds • 92,000 dairy herds • 90% of beef cow herds with <100 head but controlling only 50% of inventory 	<ul style="list-style-type: none"> • 32.9 million beef cows • 9.0 million dairy cows • 29 million feeder calves



Field, 2004

Overview of the U.S. Beef Industry

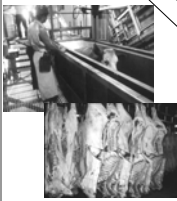
Segment	Participants	Inventory/Products
Feedlot	1,781 feeding companies with >1000 hd capacity	<ul style="list-style-type: none"> • 14 million head bunk capacity • 23.5 million fed cattle marketings



Field, 2004

Overview of the U.S. Beef Industry

Segment	Participants	Inventory/Products
Packer	<ul style="list-style-type: none"> • 706 plants harvest steers & heifers • 97% of production is boxed beef, 81% of harvest by top 4 firms, & almost 50% of purchases on a carcass basis 	<ul style="list-style-type: none"> • 28.2 million head harvested • 26.2 billion pounds of beef • 758 lb avg. carcass weight



Field, 2004

Characteristics of U.S. Beef Cattle Enterprises

- ❖ 69% of cow-calf enterprises are in place as secondary income sources.
- ❖ 49.1% of individual beef cattle enterprises utilize individual calf identification (64.7% of the calves).
- ❖ 53.2% of enterprises record individual cow identification (69.8% of the cows).

NAHMS, 1997 & 1998

Characteristics of U.S. Beef Cattle Enterprises

- ❖ No form of identification is applied to 35% and 30% of the total calves and cows, respectively.
- ❖ 34% of beef cattle herds are routinely pregnancy checked.
- ❖ 23% of beef cattle managers observe and record body condition scores.

NAHMS, 1997 & 1998

Characteristics of U.S. Beef Cattle Enterprises

- ❖ Approx. 1/5 of the cowherd is straight bred, 45% are F1s, and about a third result from a three-breed cross.
- ❖ Just over 10% of beef cattle enterprises utilize artificial insemination on any part of their herd.



NAHMS, 1997 & 1998

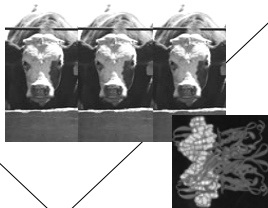
Characteristics of U.S. Beef Cattle Enterprises

- ❖ Only about one-half of producers report establishing a breeding season of specific duration.
- ❖ Nearly 80% of cattle enterprises rely on handwritten record keeping systems.



NAHMS, 1997 & 1998

Any discussion of genetic tools must be assessed with an awareness of the resistance to adoption that will likely be encountered.



The Key to Widespread Adoption of New Technologies is Two-fold:

1. The technology must be **cost effective** by returning clearly identified benefits beyond direct and indirect costs.
2. The technology must be **user friendly**.



Cost Effectiveness

Barry Dunn (2002) made a strong case for evaluating profitability as a series of relationships:

- ❖ productivity levels
- ❖ market value of production
- ❖ annual costs associated with production
- ❖ investment required to maintain productive capacity

Cost Effectiveness

Most, if not all, of these relationships are either directly or indirectly affected by genetic influence. Yet, almost none of the current genetic tools available in the industry are reported in terms directly related to profitability.

The technologies used currently to estimate carcass traits in live animals have a high cost:

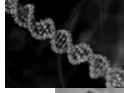
- Approx. \$15 per head for ultrasound
- \$80 for a two-marker test.

Simplicity Has a High Value on Most Cow-Calf Enterprises



❖ Any technology that betrays the premise of simplicity must have an easily recognizable high net value to the enterprise if it is to be integrated into the business.

Three Primary Genetic Tools Available to the Cow-Calf Producer



- ❖ Selection Pressure
- ❖ Breed Differences
- ❖ Mating Systems

Five Undeniable Truths of the Beef Business

1. The success of commercial cow-calf producers is the foundation of any breed's longevity.
2. One breed cannot do it all.
3. Crossbred cows are essential for maximum financial success (longevity alone is worth the effort of creating them).



Don Scheifelbein (2003)

Five Undeniable Truths of the Beef Business

4. Uniformity and consistency drives producer success (manage breed composition to achieve this goal).
5. Simplicity is the key to success.

Don Scheifelbein (2003)

Measuring Return on Assets as a Function of the Interaction of Several Factors...

- ❖ Leads to the notion that genetic influences should be evaluated in terms of:
 - how much is produced
 - what it costs to produce it
 - the market value of what is produced

Dunn (2002)

Volume of Production (per animal):

- ❖ Market weight (offspring plus culled breeding animals)



Units of Production (per enterprise):

- ❖ Reproductive rate
- ❖ Calf survival
- ❖ Cow survival



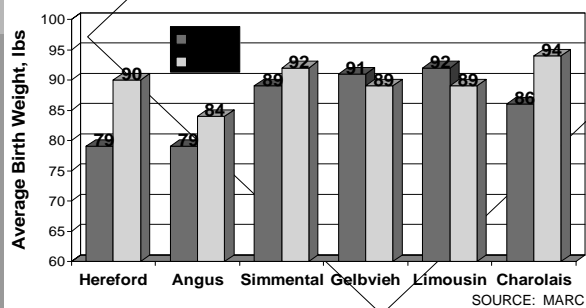
While the advent of grid pricing has been a useful way of communicating desired carcass trait specifications throughout the industry, weight still drives the gross value of a carcass.

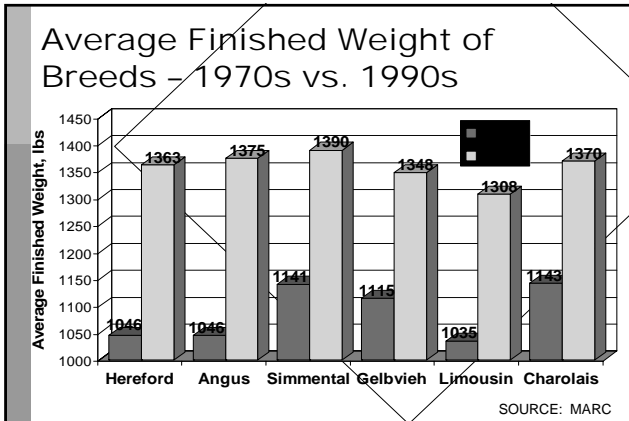


Gross Revenue for Various Carcass Weights at Differing Prices

	\$106/ cwt	\$104/ cwt	\$102/ cwt	\$100/ cwt	\$98/ cwt	\$96/ cwt
650 lb	\$689	\$676	\$663	\$650	\$637	\$624
700 lb	\$742	\$728	\$714	\$700	\$686	\$672
750 lb	\$795	\$780	\$765	\$750	\$735	\$720
800 lb	\$848	\$832	\$816	\$800	\$784	\$768
850 lb	\$901	\$884	\$867	\$850	\$833	\$816
900 lb	\$954	\$936	\$918	\$900	\$882	\$864


Average Birth Weight of Breeds - 1970s vs. 1990s






Traits That Impact the Cost of Production

- ❖ Maintenance costs (mature weight, milk production)
- ❖ Cow longevity
- ❖ Calving difficulty
- ❖ Flething ability
- ❖ Feed efficiency
- ❖ Convenience traits
 - disposition
 - pigmentation
 - horned vs. polled



Traits That Impact the Market Value of Production

- ❖ Retail yield
- ❖ Marbling
- ❖ Conformance to specifications, such as carcass weight (avoidance of outliers)



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

Traits/ Trait Classes	Herit- ability	Heter- osis	↑ Impact on Cost	↑ Impact on Production	↑ Impact on Mkt. Value
Mkt wt, offspring	40%	Mod.	Var.	Pos.	Neut.
Mkt wt, culled breeders (mature sz)	50%	Mod.	Var.	Pos.	Neut.
Reproductive rate	<20%	High	Var.	Pos.	Neut.
Survival rate, offspring	20%	High	Favorable	Pos.	Neut.
Survival rate, parents	20%	High	Favorable	Pos.	Neut.

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

Traits/ Trait Classes	Herit- ability	Heter- osis	↑ Impact on Cost	↑ Impact on Production	↑ Impact on Mkt. Value
Milk production	20%	Mod.	Var.	Pos.	Neut.
Calving difficulty	15%	Mod.	Unfavorable	Neg.	Neut.
Fleshing ability	40%	Mod.	Favorable	Var.	Var.
Feed efficiency	45%	Mod.	Favorable	Pos.	Neut.
Convenience traits	Var.	Var.	Var.	Var.	Var.

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

Traits/ Trait Classes	Herit- ability	Heter- osis	↑ Impact on Cost	↑ Impact on Production	↑ Impact on Mkt. Value
Marbling	35%	Low	Neut.	Neut.	Pos.
Retail yield	25%	Low	Neut.	Var.	Pos.
Degree of conformance to specifications	Var.	Var.	Neut.	Neut.	Pos.

Adapted from Field and Taylor, 2002

Two Challenges Facing Producers

1. Measuring directly for the economically relevant trait vs. having to rely on indicator traits



2. Antagonisms between traits

Producers Have Partially Complete Set of Tools to Assist Making Effective Within-Breed Selection Decisions

- ❖ The current list of EPDs provides a basis for making selection decisions but EPDs are lacking for many traits
- ❖ Too many of the current EPD traits are indicators of economically important traits as opposed to being direct measures



Ultimately, Selection Must be Based on a Multiple-Trait Strategy

- ❖ There is a growing need for:
 - more effective multiple trait selection strategies that encompass lifetime productivity.
 - balancing selection for traits that are important at the ranch, the feedlot, and the packing plant.

Tess, 2002

While Within-Breed Selection is a Useful Tool...



❖ Maximum genetic benefit is typically obtained via the exploitation of breed differences and the creation of heterosis as a result of planned crossbreeding systems.

Crossbreeding Systems Reminders

- ❖ No one breed does all things well and no one breed is without weaknesses.
- ❖ Careful matching of breed strengths and weaknesses can yield optimal trait combinations.
- ❖ Hybrid vigor (heterosis) provides a buffer against environmental stress that allows crossbred animals to be more productive in some traits than the average of the parental breeds that originated the cross.

Crossbreeding Systems Reminders

- ❖ Greatest advantage of heterosis is in reproductive performance, calf survival, and cow longevity. The advantage increases as the environmental conditions become harsher.
- ❖ Implementing an effective crossbreeding system requires thoughtful planning, may increase the intensity of management, and must account for the resource limitations of a particular farm or ranch.
- ❖ Crossbreeding is not a silver bullet and a poorly designed program may yield less than desirable results.

Reasons Why a Crossbreeding System Fails

1. Over-use of individual cattle breeds that have too much in them – too much milk, mature size, growth, or birth weight.



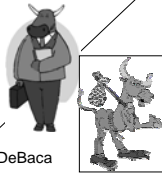
2. The mating system was too complicated or wasn't implemented in a systematic manner.

Bob DeBaca

Reasons Why a Crossbreeding System Fails

3. Seedstock providers failed to develop the expertise and service orientation to assist their clients in the development of effective crossing systems.

4. The use of poor quality bulls in a crossing system will not yield desirable results. The use of objective selection criteria is critical to the success of the mating system.



Bob DeBaca

The Choice of a Mating System Depends On....

❖ Assessment of environmental considerations associated with a particular ranch



- forage availability
- regularity of precipitation
- feed costs
- grazing system design that best utilizes and conserves the forage resources

The Choice of a Mating System Depends On....

- ❖ Assessment of market constraints associated with a particular ranch



- progeny performance should be appropriate for desired market outlet
- Emphasize cutability, marbling and growth rate (retained ownership setting)

Benefits and Drawbacks Associated With Crossing Systems

Mating System	Benefits	Requirements/Drawbacks
2-Breed Rotational	Weaning wt./cow exposed 16%	Minimum of 2 breeding pastures. Herd size of 50 or greater. Replacement heifers identified by sire breed. Generation-to-generation variation may be large. Management intensity—moderate.
3-Breed Rotational	Weaning wt./cow exposed 20%	Minimum of 3 breeding pastures. Herd size of 75 or greater. Replacement heifers identified by sire breed. Generation-to-generation variation may be larger. Management intensity—high.

Benefits and Drawbacks Associated With Crossing Systems

Mating System	Benefits	Requirements/Drawbacks
Rotation Terminal Sire (2-breed)	Weaning wt./cow exposed 21%. Target specific marketing goals.	Minimum of 3 breeding pastures. Herd size of 100 or greater. Replacement heifers identified by sire bred and year of birth. Management intensity—high.
Terminal SireX Purchased F1 Females	Weaning wt./cow exposed 21%. Avg herd size. Target specific marketing goals.	Purchased females. Replacement heifers identified by source. Increased risk of disease. Management intensity—moderate.

Benefits and Drawbacks Associated With Crossing Systems

Mating System	Benefits	Requirements/Drawbacks
4-Breed Composite	Weaning wt./cow exposed 17.5%. Min. of 1 breeding pasture. Any herd size. Reduce inter-generational variation.	Availability may be limited. Genetic information (EPD) may be limited or lower in accuracy than from traditional bulls due to population size. Management intensity—low (after composite formation).
Composite-Terminal Sire	Weaning wt./cow exposed 21%. Min. of 1 breeding pasture. Any herd size.	Availability of composite may be limited. Management intensity—moderate.

SOURCE: Bourdon

General Targets for Carcass Traits



70% or better Choice



70% Yield Grade 1 and 2



0% discounts for outliers

For Most Commercial Cattle Producers, the Use of Multiple Breeds in a Planned Crossing System Will be Required to Hit These Targets



Cattle that are 50% British and 50% Continental breed are recommended to provide optimal levels of marbling and retail yield.



75% British and 25% Continental may be desirable when the target is weighted towards rewarding higher levels of marbling.

Conformance of Various Breed Crosses and Composites to Yield and Quality Grade Targets in Steers Produced at the U.S. Meat Animal Research Center

	MARC I ^a	MARC II ^b	British	Continental	MARC III ^c
≥ 70% YG 1 & 2	83.1	56.1	37.6	89.3	52.5
≥ 70% QG Ch & up	43.1	54.7	69.6	30.4	66.0
% Non-conform YG	16.9	33.9	62.4	10.7	47.5
% Non-conform QG	56.9	45.3	30.4	69.6	34.0

Conformance of Various Breed Crosses and Composites to Yield and Quality Grade Targets in Steers Produced at the U.S. Meat Animal Research Center

	MARC I ^a	MARC II ^b	British	Continental	MARC III ^c
Deviation from acceptance					
Non-conform (30%)					
YG	0	3.9	32.4	0	17.5
QG	26.9	15.3	0.4	39.6	4.9
TOTAL	26.9	19.2	32.8	39.6	21.5

^a MARC I = ¼ Charolais, ¼ Limousin, ¼ Braunvieh, ¼ Angus, ¼ Hereford.
^b MARC II = ¼ Gelbvieh, ¼ Simmental, ¼ Hereford, ¼ Angus.
^c MARC III = ¼ Pinzgauer, ¼ Red Poll, ¼ Hereford, ¼ Angus.

Performance of cattle of varying degree of Angus and Gelbvieh influence

	USDA Choice %	USDA YG 1 & 2 %
100% Angus	76	49
75:25 Angus/Gelbvieh	69	55
50:50 Angus/Gelbvieh	57	68
25:75 Angus/Gelbvieh	49	82
100% Gelbvieh	41	85

Beneficial Tools for Managers of Commercial Cow-Calf Enterprises

- ❖ Selection
- ❖ Breed Differences
- ❖ Mating Systems



Not using these tools should only be undertaken with a detailed assessment of the value of lost opportunities. New approaches will be developed to enhance our ability to utilize these tools. However, they will only be implemented if they are cost effective and user friendly.
