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Development of Multibred Genetic Evaluation

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DEVELOPMENT OF MULTIBREED GENETIC EVALUATION

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There are several important reasons the beef industry needed to develop multibreed genetic evaluation capabilities:

- Multibreed analyses procedures do a better job of evaluating breeding values of individuals with two or more breeds in their pedigree.
- This new technology provides information that more closely matches the potential genetics in current and future beef production systems.
- U.S. Beef Producers want to alternate breeds to take advantage of crossbreeding and biological type complementarity.
- The beef industry wants to utilize composite seedstock that benefit from seedstock production heterosis and provide heterosis in commercial production systems.
- The long term impact will be our ability to rank and evaluate the potential genetic value of any animal regardless of breed composition.

These reasons hinge on the premise that beef production is enhanced by heterosis. Agriculture has "harnessed" heterosis in plant production (especially grains), poultry and pork. For several reasons, crossbreeding has been more difficult for beef producers to use in a sustainable way; however, producers who employ heterosis know the benefits of reproduction, growth and efficiency traits.

The Evolution of U.S. Beef Production

Reading the history and development of livestock breeds is a favorite pastime for many. The glorious accounts of thoughtful selection for traits is intriguing, but certainly, nothing has had a greater effect on trait selection (mostly color has been the basis for breeds) than geographical isolation and technology (lack of).

Few argue that neonatal and long-life survival have been major factors in any animal's potential to contribute genes to future generations. We know gentle disposition, milk production and draft potential were important traits in the longevity of cattle. Meat production was mostly an afterthought, and the slow development of organized meat and food industries had little impact on cattle selection until recently.

After the settlement of the West, cattle were no longer used for draft, and we turned our attention to production of milk and meat. However, specific widespread selection for important

traits which we now value, didn't come into focus until the 1960s. Three important factors pressing cattle producers into focused selection were:

- IBP was established and positioned to market beef in a much broader geographic region than previous packers. They would set the standard for marketing beef in a box.

- Food retailers became more "chain" based and began purchasing product by specifications.

- Development of feedyards on the High Plains provided detailed information on the value of growth, efficiency and carcass worth.

From the "Art" to the "Science" of Producing Beef

Agriculture and Animal Husbandry technology "exploded" during the Post WWII years. Both cattlemen and beef production specialists knew systems would develop to identify superior genetics. In 1955, the American Beef Cattle Performance Registry Association (ABC-PRA) was formed in an effort to focus on improving cattle by capture and application of performance records. Canadian seedstock producers objected to using the term "American", and the name was changed to Performance Registry International (PRI) in 1958. By 1964, the American Polled Hereford and Angus Associations had established performance programs, and by 1968, the Beef Improvement Federation (BIF) was established.

Besides our focus on performance records (primarily weights), the greatest impact of fledgling efforts to identify superior parent stock, was the establishment of databases. The key to useful genetic evaluations are detailed, organized, fast growing databases. By the 1990s, all of the successful beef breeds had valuable databases, and until 1997, all breed databases were analyzed on a single breed basis. In the fall of 1997, the American Simmental Association and Cornell University previewed the first American multibreed genetic analyses in history.

Seedstock from Different Databases (Breeds)

One primary reason multibreed genetic evaluation is important is that it clarifies the differences in breeding values between seedstock sources. Remember, breed associations maintain and fund the databases that are analyzed for calculations of breeding values, specifically, EPDs. In most cases, we only have detailed records and scientific programming for the single breed we register and promote. For example, producers interested in using both Hereford and Angus seedstock are not sure how they are modifying traits with their selections, because the American Angus Association and American Hereford Association do not compare each other's gene pool.

MARC ABCs

Commercial producers could only be sure of the percentile ranks of their choices (how they compared to other individuals in the same breed), as displayed by each breed's sire

summary. Research at the U.S. Meat Animal Research Center (MARC), although not designed to clarify individual animal breeding values, captured data that allowed comparisons among the breeds sampled there.

In fact, in 1989, the Beef Improvement Federation passed a resolution to investigate methodology to compare the mean performance traits of breeds. By 1990, Dr. Larry Cundiff at MARC published a table (see Table 1) that estimated the average trait effects of most of the breeds they had sampled at the USDA Research Unit. This "MARC Across Breeds Comparison" (ABC) Table was the first tool available for our industry to put EPDs on a "level playing field".

Table 1. 1999 MARC Adjustment factors to add to within breed EPD to calculate across breed EPD.

Breed	Birth Wt	Weaning Wt	Yearling Wt	Milk
Hereford	4.0	3.3	-4.4	-9.6
Angus	0.0	0.0	0.0	0.0
Simmental	7.1	18.0	50.0	18.0

For example, we can use this table to determine the breeding values of Simmental or Angus bulls we may wish to sample. Let's assume a herd has sampled the Angus bull **Alberda Traveler 416**, from Alta Genetics, Inc. (current EPDs are 2.4, 39, 88, and 16 (milk)) and wanted to sample a Simmental bull with similar breeding values.

This would require identifying a Simmental bull with the following EPDs:

Simmental EPDs = Angus EPDs – MARC Adjustment factors

BW = 2.4 – 7.1 = -4.7
WW = 39 – 18 = 21
YW = 88 – 50 = 38
Milk = 16 – 18 = -2.0

In another example, what if a herd had sampled the Simmental bull **Nichols Black Destiny D12** (also from Alta with current EPDs of 2.2, 44, 64, and 7) and wanted to identify an Angus bull to provide similar performance? This would require an Angus bull with the following EPDs:

Angus EPDs = Simmental EPDs + MARC Adjustment factors

BW = 2.2 + 7.1 = 9.3
WW = 44.3 + 18 = 62.3
YW = 64.4 + 50 = 114.4
Milk = 6.7 + 18 = 24.7

American Simmental Association's Database

In the early 1990s, leaders of the American Simmental Association (ASA) recognized the value of non-Simmental records contained in the ASA database. Breeds with open herdbooks (Simmental, Limousin, Gelbvieh, Chianina, Maine Anjou, etc.) often capture data from other seedstock sources. Although much of this data stems from purebred British females that are bred to one of the continental breeds to get F1s, it is not uncommon for members of the continental breed associations to own and record more than one breed and rear them in the same contemporary group.

Fortunately for many years, ASA had not only recorded the many breeds reared in comparable groups (contemporaries), but we also recorded the pedigrees of non-Simmental parents. This was one of the keys that allowed us to develop a multibreed genetic analyses.

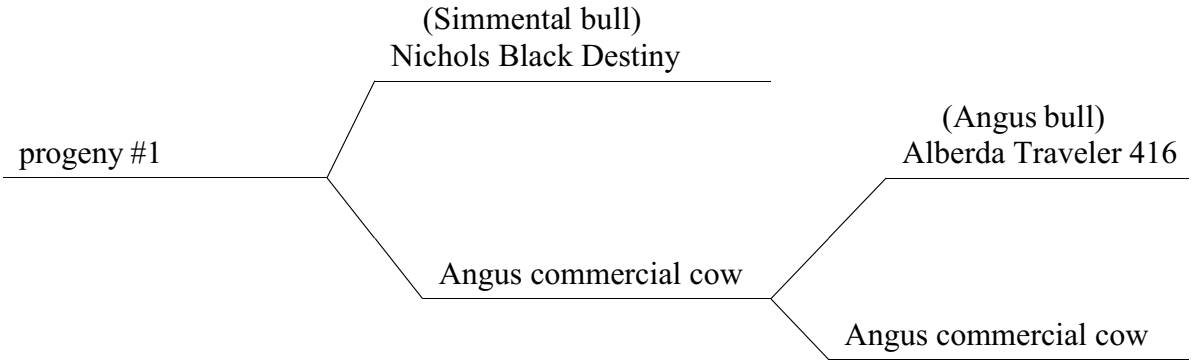
The keys to effectively defining multibreed breeding values are:

1. detailed ancestral maps (pedigrees) of individuals (all breeds) contributing records to the database
2. performance records comparing all birth contemporaries regardless of breed percentage or make-up
3. effective adjustment factors for direct and maternal heterosis
4. estimates of average breed/type effects
5. genetic trends for all breeds/types

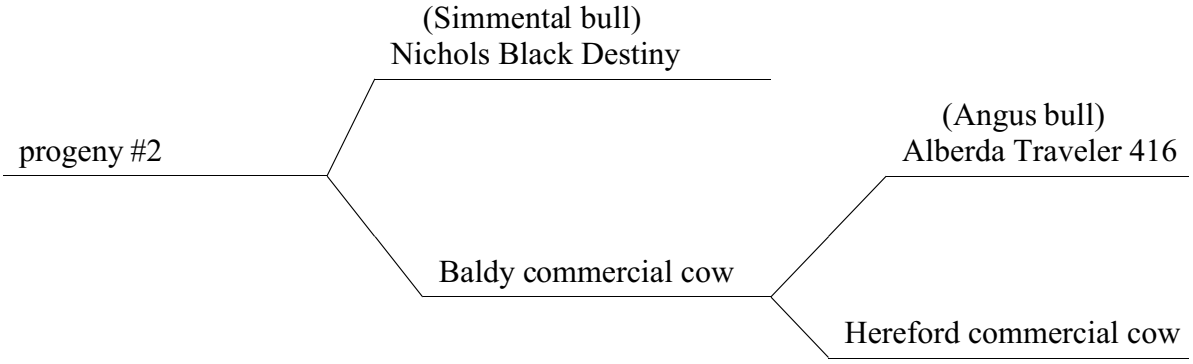
So, what has the American Simmental Association developed for producers interested in employing heterosis?

- multibreed EPDs on every animal in the ASA database regardless of breed or breed make-up
- the most technologically advanced system of comparing popular sires of many breeds
- the most accurate system of evaluating breeding values of sires that have progeny from crossbred cows or cows of other breeds
- all calves in the same birth/management groups are contemporaries (make very large contemporary groups)
- scientific literature provided breed/type effects and updated by ASA database analyses
- a system to add influential databases to ASA's database
    1. MARC GPU
    2. Maine Anjou, and perhaps other breeds and seedstock sources

Examples of how the system works:



EPDs for progeny #1 are determined by performance adjusted for direct (progeny #1 is 1/2 Simmental 1/2 Angus) heterosis, and breeding values for all ancestors where the Angus granddam receives average Angus EPDs.



EPDs for progeny #2 are determined by performance adjusted for both direct (progeny #2 is 1/2 Simmental 1/4 Angus and 1/2 Hereford) and maternal (the dam is 1/2 Angus and 1/2 Hereford) heterosis, and breeding values for all ancestors where the Hereford granddam receives average Hereford EPDs.

Will Beef Cattle Seedstock Become "Composited" Like Hogs and Chickens?

A huge number of scientific research papers substantiate the value of crossbred parents. British x Continental cows mated to Continental x British sires may optimize many traits including profit potential. For example, Shorthorn x Simmental cows mated to Charolais x Red Angus sires might be highly productive in excellent forage producing systems. Obviously, heat tolerant composited breeds have become very popular in our Southern Regions.

Research centers have developed practical methods of using composite seedstock. It is just a matter of time until U.S. cattle producers embrace the opportunities of combining heterosis and complimentary traits in production systems that provide more profit and/or lower costs. The breeding values of composite seedstock will have similar importance to current "purebred" seedstock.

To date, several leading composite cattle producers subscribe to ASA's multibreed database and genetic evaluation services. We suspect an intensified effort by many breeders to combine breeds/types to develop the most useful composite maternal and sire lines for their environment.

The Future of Multibreed Genetic Analyses

We believe the future of multibreed genetic evaluation is very bright. The obvious next step is more detailed trait analyses (to date, we have completed the programming for the growth traits, including maternal milk). Great opportunities to develop multibreed calving ease (CE) EPDs exist. The relationship of dystocia and birth weight is about the same as the relationship between marbling and tenderness. If we can unlock the breeding values for both direct and maternal dystocia, selection for several traits associated with profit can be pursued with less resistance from restricted birth weights.

Multibreed calving ease EPD are just one of our future projects. We are very interested in multibreed carcass trait EPDs. The opportunity to select sires from many breeds by their carcass merit defined on the same basis should excite anyone. All breeds have sires that are exceptional, and the mechanism to compare them directly in the same database would put our commercial producers in a much better position to satisfy the growing intensity of value based marketing.

The potential of multibreed genetic analyses isn't even close to full value. Could you imagine if all or most breeds decided to commit their databases to a single analyses system? The beef industry would have more genetic information by that single factor than anytime in the history of food production.

Improving Beef as Food

In our systems of producing and marketing cattle for food, the ultimate question posed by the end-user is: "How much do you have and how good is it?" I guess this is applicable to many if not most commodities. The beef industry has used the USDA Beef Grading Standards and Grading Service as the primary decision maker to place value on our products.

Beef cutability, defined in our industry by USDA Yield Grades is a relatively effective "signal" to all segments of production. From a genetic improvement standpoint, breed association EPDs for backfat, REA and carcass weight are easy to implement. Our industry has demonstrated we can modify meat yield by selecting seedstock with EPDs that favor higher cutability. The question that continually arises is, can we improve end- user satisfaction by selecting for enhanced breeding values for USDA Quality Grade?

This issue is clouded by masses of research which infers traditional visual evaluation techniques for meat quality are at best, mildly related to end user eating satisfaction.

We know our biggest challenge is meat tenderness. Research during the past two decades has defined the primary factor as the rate and extent of post mortem aging of muscle (tenderization). Since variation in beef tenderness is not visually apparent, is our industry forever shackled to the fact that a proportion of all beef we produce will be less than satisfactory to consumers?

Experimentally, we have measured beef tenderness for years. Environmental and managemental factors have been identified, but what role do animal genetics play in tenderness? The following table are means from several breeds evaluated at MARC.

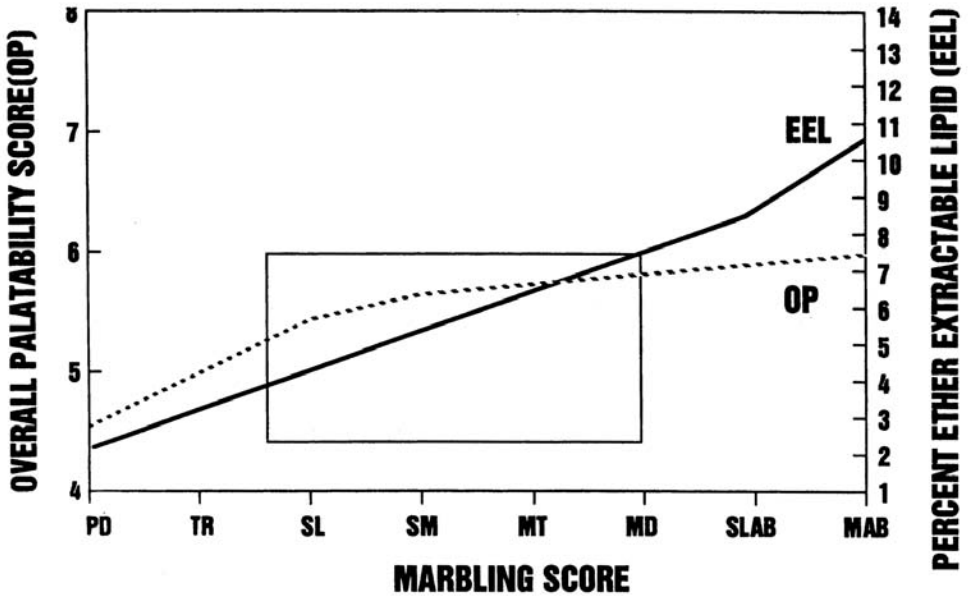
Table 2. Adapted from Several U.S. MARC Reports 1973-1995.

Breed	Shear, lbs.	% Choice	BF
S Devon	-0.5	-10	-.17
Jersey	-0.4	+15	-.19
Angus	base	base	base
AXH, HXA	+0.4	-7	-.01
Hereford	+0.5	-20	-.15
Simmental	+0.5	-28	-.26
Shorthorn	+0.6	+15	-.12
Piedmontese	+1.0	-50	-.34
Brahman	+4.0	-50	-.08

Since several of these breed averages are statistically different, it is a logical proof there is genetic control over tenderness. To date, tenderness is not a trait the beef industry can measure economically either for seedstock selection or market cattle value determination. So, a USDA Quality Grades Factor (specifically marbling) has become the single and only trait for which we have formulated breeding values, i.e. marbling EPDs, in an effort to improve beef tenderness.

There are literally hundreds, if not thousands, of well-documented scientific papers that consider the potential for USDA grades to describe and potentially separate beef products into eating satisfaction categories. One of the most referenced depictions is Figure 1, that Drs. Savell and Cross (Texas A&M University) published in 1988.

Figure 1. Relationship of marbling to overall palatability.



These data imply there is a "law of diminishing returns" relative to the contribution intramuscular lipid (marbling) makes to beef palatability scores. This situation is like the relationship between frame score and yearling weight. Our industry has decided to directly select for yearling weight. In a similar manner, could we select seedstock for meat tenderness?

This question led several segments of our industry to focus on potential techniques to identify genetic breeding values for superior meat tenderness. If on-line tenderness evaluation technology develops (as researchers at MARC have tested), the seedstock industry could performance test for tenderness similar to data collection for other traits. Correlated traits such as ultrasound, colorimetry and DNA markers could impact selection for tenderness.

Our National Cattlemen's Beef Association (NCBA) in cooperation with approximately sixteen U.S. Beef Breed Associations have planned perhaps the most comprehensive project in history to evaluate the potential to modify beef tenderness by genetic selection. Each Association will submit several sires to both DNA marker evaluation and progeny testing. This is a landmark experiment to investigate both the biological and economic potential of identifying genetic variation in these sires.

The future of rural families and businesses across this country depends on our industry's ability to produce one of the most desired foods in the world at a price and consistency everyone appreciates. We must solve the genetic riddle of beef tenderness and eliminate the cattle that produce unacceptable eating experiences.