Improvement in Calf Predictability Through Genetics

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INTRODUCTION

The beef cattle industry is currently undergoing dynamic change from an animal oriented emphasis based on production traits to one of beef product evaluation. All cattlemen must now become better informed on beef carcass and product traits and consider them in the herd management and production plan. This change represents an expanded role for cattlemen that forces a balanced selection emphasis both among and within breeds and crosses for reproductive, maternal, growth and carcass traits. The attention afforded the National Beef Quality Audit (NBQA) focussed management emphasis on genetics. However, cattlemen must seek germplasm that represents a balance or optimum across production and beef quality product traits to be reflected in profit. Beef product quality and consistency have become the buzzwords in cattle genetics.

GENETIC MANAGEMENT CONCEPTS

Cundiff et al., (1994), Field (1994), and Smith (1993) have addressed the issues relative to breeding cattle for product consistency with major emphasis on breed selection and utilization of breeds in well-defined crossbreeding schemes. Selection within breeds is deemed feasible but the needed carcass traits are expensive and costly in terms of time to measure. This results in a relatively low predicted rate of change as compared to production traits measured directly on animals at relatively young ages. The heritability estimates for beef carcass and product traits are certainly high enough to expect good response to individual selection. Also, there is no question that observed variation in beef carcass and product traits is larger than most realize (Table 1, Lorenzen et al., 1993). It is common to see the coefficient of variation (CV) exceed 20% for traits associated with fat thickness (Figure 1). This normally compares to 10% to 15% values for production traits. This observed variation (differences) in carcass and product traits has been identified as the problem in industry acceptance (Figure 2). The National Beef Quality Audit (Lorenzen et al., 1993) concluded that both genetic and management decisions should be made to improve the quality and consistency of beef.

Given that direct selection of individuals is limited due to our inability to measure carcass traits directly or with indicator traits at young ages, we are forced to consider selection via EPD calculations or carcass progeny tests where carcass traits are directly measured. This is both difficult and costly at best. Some breed associations are currently working toward this objective. However, the more obvious concept to use is selection among breeds for carcass aspects. Smith (1993) identified the "top ten" breeds and crossbreeds for muscling, marbling, combined yield and quality grades and cooked beef tenderness (Table 2). The muscling breeds were all high lean, exotic breeds with some double muscling aspects. The marbling "top ten" breeds were largely Waygu, dairy and small, early maturing British breeds. The combined beef quality and yield "top ten" were identified within Exotic X British crosses or basic British-breed crosses. The cooked beef tenderness "top ten" paralleled the marbling "top ten" with the exception of the Piedmontese. Cundiff et al., (1994) emphasized that the potential for growth and carcass aspects are more nearly optimized with cattle containing 50% Continental and 50% British inheritance (Tables 3 and 4). Gregory et al., (1992) documented that composite breeds are not more variable than purebred breeds in production traits and evidence indicates that carcass traits are predictable by simple knowledge of breed composition since such traits are highly heritable and not influenced by heterosis (Table 5).

Collectively, the genetic concepts that will surface are either: 1) select an adapted breed that excels and use within breed selection to promote predicted quality and consistency or 2) design a crossbreeding plan that utilizes heterosis in reproductive, maternal, and growth traits and use breed composition to influence carcass and product traits. The emphasis on "branded" programs like Certified Angus Beef are surely to expand with a product-oriented industry. The American Hereford Association has assumed a breed promotion strategy to position Herefords as a product-oriented breed--"frankly he fits." Other "breed" oriented aspects have come from the National Beef Quality Audit and the Strategic Alliances Field Study (SAFS). While neither were designed to compare breeds, the *Bos indicus* and dairy breeds were identified in the NBQA while the SAFS separated British and Continental breeds by quality grades into groups that differed in beef product traits (Tables 6 and 7). These broad "breed" designations are intended to focus attention on product aspects yet not dictate a "culling" of breeds or breed types.

INDUSTRY PROBLEMS

The addition of beef product traits to the required traits for selection emphasis does create some real herd management problems. First, and foremost, producers must recognize that singular emphasis on any trait is not recommended or viable. Beef cattle must meet acceptance (target trait values) for several economically important traits. In the beef females, reproductive, maternal and growth traits are an absolute necessity while maintaining an adaptable cow for the production environment that is convenient to manage. No one breed or crossbreed will achieve this success across our nation. It is more likely that a single breed will excel in the more temperate regions with less stressful environments and superior feed resources. In Southern areas, either arid or humid, crossbred cows will be required. Evidence to date indicates that *Bos indicus* inheritance greater than 50% will be unacceptable for beef product predictability or acceptance. Cattle less than 50% *Bos indicus* are identified as acceptable but this generalization is subject to error since no reference is made to the other parental breed. It is safe to suggest that British breed inheritance is best recommended for the crossbred cow for Southern regions. The choice of bull breed will depend upon additive breed effects and the target product traits. I prefer three-breed composition in most crossbreeding plans and feel two British breeds using a half-blood *Bos indicus* crossbred cow still represents the "best" optimum.

The other industry problem is to project genetic value in the calf at marketing time. The industry has attempted to achieve a perception of product value by promoting a more uniform calf crop by color. Hence, we see several black breeds coming into play with the theory if they are black they will excel in the carcass. This is false. A black exotic breed will perform like the original color exotic breed. However, color uniformity is promoted as a marketing tool. This implies that reputation cattle must be created based on objective records of performance. This essentially reduces market outlets and takes away from public auction marketing. Also, larger herds will be favored in crossbred marketing while small herd size owners will not be as effective in merchandising their cattle. Comingled feeding pens and partnerships are likely to develop. To select for and promote carcass and product traits essentially forces the producer to consider selling at the carcass level or use a reputation or retained ownership management plan.

NEW TECHNOLOGY

With no easy and direct carcass and beef product trait measurements or indicator traits, selection for carcass traits will be restricted to only the elite larger purebred herds. Breed EPD calculations will help but will develop slowly due to required data. The use of DNA profile or gene marker and gene probe assisted selection affords the opportunity to select young cattle for carcass trait genotypes. It most likely will involve elimination of "unacceptable" cattle. Current research at Texas A&M University is directed at use of marker-assisted selection for carcass merit traits in

Bos indicus-based beef cattle. Preliminary indications reflect a large amount of variation (genetic and environmental) that hopefully will identify some major genes or markers. The research will not be completed until 1996; however, it affords a major potential change and utility for the beef industry should accurate carcass merit genotypes be identified.

IMPLICATIONS

Genetic control of beef cattle and product consistency and quality will largely depend upon breed genetics. Crossbreeding schemes are expected to be more effective and applicable to optimize profit potential. However, some breeds will be competitive and used commercially as a straightbred. Environmental restrictions force consideration of crossbreds and/or composite populations. Within breed selection for quality and product traits will continue to be stressed; however, results will be realized slowly. New technology offers an exciting and effective potential to create major changes in individual selection methodology. If successful, elimination of unacceptable cattle could afford a faster rate of change in breeds and greater predictability.

REFERENCES

Cundiff, Larry V., Keith E. Gregory and Robert M. Koch. 1994. Breeding cattle for improved product consistency. 1994 Cattlemen's College, Pfizer Animal Health and National Cattlemen's Association. Reno, Nevada. January 26-29, 1994.

Field, Tom. 1994. What will happen to production traits if we select for carcass traits? 1994 Cattlemen's College. Pfizer Animal Health and National Cattlemen's Association. Reno, Nevada. January 26-29, 1994.

Gregory, K.E., L.V. Cundiff and R.M. Koch. 1992. Composite breeds to use heterosis and breed differences to improve efflciency of beef production. Roman L. Hruska U.S. Meat Animal Research Center, Agricultural Research Service, USDA in Cooperation with the Institute of Agriculture and Natural Resources, University of Nebraska. Lincoln. pp. 1-53.

Lorenzen, C.L, D.S. Hale, D.B. Griffin, J.W. Savell, K.E. Belk, T.L. Frederick, M.F. Miller, T.H. Montgomery and G.C. Smith. 1993. National beef quality audit: Survey of producer-related defects and carcass quality and quantity attributes. J. Anim. Sci. 71:1495-1502.

Smith, Gary C. 1993. Assuring the consistency and competitiveness of beef by use of correct biological types of cattle. Proceedings 42nd Annual Florida Beef Cattle Short Course, University of Florida. Gainesville, Florida. pp. 16-22.

Strategic Alliances Field Study. 1993. Executive summary. National Cattlemen's Association. Englewood, Colorado. pp. 1-28.

Table 1. Means, Standard Deviations, and Minimum and Maximum Values for USDA Carcass Grade Traits					
Trait	Mean	SD	CV	Minimum	Maximum
USDA Yield Grade	3.2	.9	28.8	-.8	7.2
USDA Quality Grade[a]	686.0	60.0	8.8	213.0	900.0
Adjusted fat thickness, cm	1.5	.6	40.7	.0	4.6
Carcass wt, kg	345.0	42.8	12.4	173.4	542.5
Longissimus muscle area, cm	83.4	10.5	12.6	47.1	146.5
Kidney, pelvic, and heart fat,	2.2	.7	29.7	.0	6.0
%	424.0	106.0	11.7	140.0	1,000.0
Marbling score[b]	163.0	19.0	17.0	110.0	330.0
Lean maturity[c]	175.0	29.0	12.5	100.0	470.0
Skeletal maturity[c]	169.0	21.0	25.1	110.0	430.0
Overall maturity[c]					

[a]100 = Canner^{oo} and 800 = Prime^{oo}.

[b]100 = Practically devoid^{oo} and 900 = Abundant^{oo}.

[c]100 = A^{oo} and 400 = D^{00}.

Source: Lorenzen et al., (1993).

Table 2. The "Top Ten" of the Cattle Breeds and Crossbreds for Certain Carcass/Meat Traits.

MUSCLING	MARBLING	COMBINED YIELD & QUALITY GRADES	COOKED BEEF TENDERNESS
Belgian Blue	Wagyu	Charolais x Angus	Waygu
Piedmontese	Jersey	Simmental x Angus	Jersey
Limousin	Guernsey	Limousin x Angus	Guernsey
Blonde D'Aquitaine	Angus	Red Angus	Angus
Marchigiana	Red Angus	Hereford x Angus	Red Angus
Romagnola	Galloway	Brangus	Hereford
Charolais	Hollstein-Friesian	Holstein x Angus	Galloway
Gelbvieh	Red Poll	Holstein-Friesian	Shorthorn
Simmental	Shorthorn	Angus	South Devon
Braunvieh	South Devon	Hereford	Piedmontese

Source: Smith (1993).

Table 3. Breed Group Averages For Factors Identified With Meat Quality.

Breed group	Marbling score[a]	Percent USDA Choice	Warner-Bratzler shear[b] lb	Sensory panel scores[c]		
				Tenderness	Flavor	Juiciness
Chianina-X	8.3	24	7.9	6.9	7.3	7.2
Limousin-X	9.0	37	7.7	6.9	7.4	7.3
Brahman-X	9.3	40	8.4	6.5	7.2	6.9
Gelbvieh-X	9.6	43	7.8	6.9	7.4	7.2
Sahiwal-X	9.7	44	9.1	5.8	7.1	7.0
Simmental-X	9.9	60	7.8	6.8	7.3	7.3
Maine-Anjou-X	10.1	54	7.5	7.1	7.3	7.2
Tarentaise-X	10.2	60	8.1	6.7	7.3	7.0
Charolais-X	10.3	63	7.2	7.3	7.4	7.3
Braunvieh-X	10.4	61	7.7	7.2	7.4	7.2
Pinzgauer-X	10.8	60	7.4	7.1	7.4	7.2
South Devon-X	11.3	76	6.8	7.4	7.3	7.4
Hereford-Angus-X	11.3	76	7.3	7.3	7.3	7.3
Red Poll-X	11.5	68	7.4	7.3	7.4	7.1
Jersey-X	13.2	85	6.8	7.4	7.5	7.5

[a]Marbling: 8 = slight, 11 = small, 14 = modest, 17 = moderate.
[b]Shear force required for a 1.27 cm core of cooked steak.
[c]Scores: 2 = undesirable, 5 = acceptable, 7 = moderately desirable.

Source: Cundiff et al., (1194).

Table 4. Means for Pure Breeds and Composite Populations in Germplasm Utilization Program at MARC Growth and Carcass Traits of Steers.							
Breed group	Number	Average daily gain lb	Final weight lb	Dress. pct. %	Marbling[a] sc	USDA Choice or higher %	USDA Select or higher %
Pure breeds:							
Red Poll	114	2.5	1157	60.	530	71	10
Hereford	146	2.7	1118	60.	521	60	10
Angus	118	2.6	1135	61.	541	77	10
Limousin	142	2.6	1144	63.	443	14	8
Braunvieh	139	2.7	1250	59.	484	42	9
Pinzgauer	118	2.6	1228	59.	516	55	9
Gelbvieh	150	2.7	1250	59.	453	15	8
Simmental	127	2.9	1281	59.	480	34	9
Charolais	126	2.8	1263	60.	471	24	9
Composite populations:							
MARC I	178	2.8	1241	61.	479	42	9
MARC II	148	2.8	1263	61.	513	57	10
MARC III	155	2.7	1226	59.	531	65	10

[a]Slight = 400 to 499, small = 500 to 599, etc.

[b]MARC I = 1/4 Charolais, 1/4 Limousin, 1/4 Braunvieh, 1/8 Hereford, and 1/8 Angus; MARC II = 1/4 Gelbvieh, 1/4 Simmental, 1/4 Angus, and 1/4 Hereford; MARC III = 1/4 Pinzgauer, 1/4 Red Poll, 1/4 Hereford, and 1/4 Angus.

Source: Cundiff et al., (1994).

Table 5.	**Heritability and Phenotypic Standard Deviations for Traits of Economic Importance to Beef Production in Composite and Contributing Purebred Populations.**			
	Heritability		Phenotypic standard deviation	
Trait	Composite	Purebreds	Composite	Purebreds
Birth weight, lb	.3	.4	11.	10.
200-day weaning weight, lb	.2	.3	47.	45.
368-day weight, females, lb	.3	.3	66.	63.
368-day weight, males, lb	.2	.4	82.	76.
Age at puberty, females	.2	.3	25.	28.
Scrotal circumference	.4	.5	2.	2.
Gestation length of dam, days	.7	.5	4.	4.
200-day wean. wt (Maternal), lb	.3	.3	57.	51.
Cow weight (2-7 years), lb	.6	.6	11.	10.
Cow hip height (2-7 years), in	.5	.6	1.	1.
Cow condition score (2-7 years)	.2	.3	.	.
12-hr milk yield, lb	.4	.6	2.	2.

Source: Gregory et al., (1992).

Table 6. Sensory Panel Ratings, Shear Force Values.

Breed Type X Quality Grade	Flavor Rating	Tenderness Rating	Overall Palatability Rating	Shear Force Value (lbs).
British Choice	4.58[a]	5.07[a]	4.73 [a]	6.89[a]
British Select	4.57[a]	5.17[a]	4.76[a]	7.68[bc]
Continental Choice	4.46[a]b	5.11[a]	4.67[ab]	7.45[b]
Continental Select	4.31[b]	4.85[b]	4.51[b]	8.04[c]

[abc]Mean values in same column followed by same superscript letter indicate no statistically significant difference.

Critical score greater than 4.5 for acceptable beef quality rating.

Source: Strategic Alliances Field Study (1993).

Table 7. Shear Force Values.

Breed Type X Quality Grade	8.5 lbs. or less	More than 8.5 lbs.	More than 10.0 lbs.
British Choice	91.2%	8.8%	2.9%
British Select	78.0%	22.0%	8.5%
Continental Choice	76.6%	23.4%	1.6%
Continental Select	65.7%	34.3%	11.0%

Source: Strategic Alliances Field Study (1993)