

Genetic Programs to Improve Carcass Quality

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Introduction

Cow/calf and feedlot producers and those who provide professional assistance to them are very aware of the need to produce feeder/fed cattle profitability, but often fail to put sufficient emphasis on ensuring consumers a quality and consistent beef product. A heightened awareness of the importance of beef quality and consistency has occurred throughout the beef industry during the 1990's. The first indication on a national scale was the establishment of the Value-Based Marketing Task Force in 1990. This act essentially started the "war on fat" which has really turned into an attempt to assess the overall quality and consistency of beef at the packing plant, in the retail store, and in the eyes of our consumers through various studies (Table 1).

Of course, the real impetus for this interest in the actual product rather than just the production process can be attributed to the significant loss of market share beef has experienced since the 1970s. Quarterly per capita disappearance expressed as shares of the U.S. domestic market in 1979 for beef, poultry, and pork was 51.0, 20.3, and 28.7%, respectively, and in 1993, 38.6, 32.9, and 28.6%, respectively. Note that beef's market share dramatically decreased at the expense of poultry's increased share. The reason was stated very clearly in the opening sentences of the Beef Industry Long Range Task Force Report (1993), **"The U.S. beef industry has, for too long, been focused inwardly-production driven, not consumer driven. We have demonstrated neither the ability nor inclination to respond to consumer signals in the market place."**

The purpose of this paper is to present information that veterinarians and others attending this conference can use to influence cow/calf producers and feedlot operators to be concerned with improving carcass quality at every stage of the production cycle, realizing that genetics play but one role in determining the final product. The paper is organized into four main areas, 1) issues of primary importance, 2) assessing carcass/beef quality in a herd, 3) targets for carcass/beef quality and yield, and 4) methods for improvement.

Issues of Primary Importance

All of us involved in the beef industry need to be aware of the hurdles we are faced with overcoming so as to prevent blindly going in multiple directions, which are likely to lead many further from what is desired rather than toward beef quality and consistency targets. The four primary issues of importance and other contributing factors from a genetic standpoint along with potential industry improvements were recently presented at the Beef Improvement Federation meetings (Woodward, 1994a). A brief review of the primary issues follows.

Table 1. Studies, reports, and demonstrations targeted at evaluating meat quality.

National Beef Market Basket Survey (1990-91) *Savell et al. (1991)*

Objective: To determine the amount of external fat remaining on beef cuts at retail along with dissectable and chemical fat levels found in cuts offered in the retail meat case.

Results: Overall mean fat thickness was .12 inch, and .15 inch for steaks and roasts from the chuck, rib, loin, and round. Steaks and roasts had 27.4% less separable fat and hamburger 10% less fat than USDA Agriculture Handbook 8-13.

National Beef Tenderness Survey (1990-91) *Morgan et al. (1991)*

Objective: To determine and compare average sensory panel tenderness scores and Warner-Bratzler shear force values from a representative cross-section of U.S. retail cuts varying in USDA quality grades and subprimal source.

Results: Percentage of beef cuts rated as "slightly tough" or tougher - - 20% of middle meats,

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40% of chucks, and 50% of round steaks/roasts.

National Beef Quality Audit (1991-92)

NCA (1992); Lorenzen et al. (1993)

Objective: Assess what the beef industry is producing through slaughter floor and cooler surveys.

Results: Cattle are fed to heavier weights with about the same subcutaneous fat, but less marbling and fewer high quality grades than in the 1970's. Significant losses in value for every fed animal primarily due to excess fat and lack of quality and consistency. One out of every four steaks is too tough.

Beef Industry Long Range Plan Task Force Report (1993)

NCA (1993)

Objective: To develop a long range strategic plan for the beef industry that focused on domestic marketing, international marketing, issues management, public relations, efficient and effective use of resources, and industry governance.

Results: Eight "leverage points" to regain market share were cited. Quality and consistency were identified as the most critical and the plan calls for reducing consumer dissatisfaction (related primarily to toughness) by 50% by 1997.

Strategic Alliances Field Study (1992-94)

NCA (1994); Woodward (1994b)

Objective: Conduct a value-based marketing pilot project to answer at least six "big picture" questions on beef uniformity and consistency by doing everything "right" from "gate to plate."

Results: Greater communication across segments and a value-based marketing system are necessary to make positive changes in beef uniformity and consistency.

National Customer Satisfaction Project (1993-94)

Objective: To determine the relationship of beef quality classification -- marbling score -- to satisfactory eating experiences -- customer satisfaction -- in three different retail cuts, prepared and evaluated in the home of moderate to heavy users of beef.

Results: Beef found to be more tender and flavorful was rated higher. Data show a strong inter-

action between quality grade and cut, where the greatest effects of grade are more for lower-quality cuts and less for the best-quality cuts. Price is the most important factor in purchase intent.

National Beef Tenderness Conference Report (1994)

NCA (1994)

Objective: To determine the current state of knowledge about beef tenderness/palatability, review research in process, determine minimum thresholds and develop a plan to address the genetic contribution to beef's inconsistency and lack of tenderness.

Results: The final report gives a broad overview of the genetic, nutrition, management, and processing factors that the industry must confront to improve beef tenderness/palatability.

Excess Fat

Consumers have supposedly wanted leaner red meat for 20 years, but the beef industry has seen little change in fat content of fed steers and heifers. The amount of excess fat produced on U.S. fed cattle is estimated to be over 5 billion pounds annually. Actual cost of this waste fat to the industry was estimated in 1991 to be \$4.4 billion -- \$2.0 billion to produce and another \$2.4 billion to ship and trim (Lambert, 1991).

Variation in Tenderness/Palatability

Perhaps the largest single factor contributing to beef quality and consistency problems is the variation in product tenderness and palatability. The Beef Industry Long Range Plan Task Force Report (1993) cited eight "leverage points" to regain market share. Quality and consistency were identified as the most critical and the plan calls for reducing consumer dissatisfaction (related primarily to toughness) by 50% by 1997. Both the National Beef Quality Audit (1992) and the Strategic Alliances Field Study (1994) indicated that as many as 1 out of every 4 steaks is unacceptably tough. While genetics of fed cattle play a role, there also are numerous management, nutrition, and processing factors that contribute to tenderness and palatability variation.

The industry should not expect a premium for improving tenderness and palatability. It should be considered a minimum requirement for retail beef; the return will come in the form of increased market share.

Variation in Carcass/Retail Cut Size

There has been a long-term trend toward larger frame size cattle, starting with the introduction of Continental European breeds of cattle in the 1960s. Larger

frame size cattle naturally led to larger carcasses and larger retail cuts. While beef consumption initially increased, later during the 1980s the average (and especially urban) consumer began to reduce their preferred portion size due to a more sedentary life style, health concerns (unfounded or not) and America's growing obsession with not being fat and reducing consumption of saturated fats. The introduction of boxed beef for 600 to 800 lb carcasses revolutionized the sale and distribution of beef. The commonly accepted carcass weight range for boxed beef is now 550 to 900 lb.

Outdated Marketing and Quality Grading Systems

Although there have been some changes to the way cattle have been marketed and graded over time, it has become fairly obvious that major changes are yet necessary. The fact that packers still buy the majority of their cattle on averages based on visual assessment of when a pen of cattle is 70% Choice suggests that the beef industry really only talks about change and meeting consumers' preferences. The message sent to feeders and cow/calf producers is that "cattle are cattle" and almost all types will eventually reach the 70% Choice target.

Not only is there a problem with predicting when cattle have enough finish to grade Choice, the subjective nature of evaluating the ribeye for marbling compounds the problem. In addition, we have known for years that marbling accounts for only about 10% of the variation in tenderness. The Strategic Alliances Field Study results clearly showed considerable variation in fat thickness, carcass weight, and yield grade of carcasses grading Select and also for those grading Choice (NCA, 1994; Woodward, 1994b).

If improvements are to occur in the quality and consistency of beef provided to the consumer, a quality assessment and pricing system based on discounts and premiums related to consumer preferences must be implemented. Value-based marketing is being touted as the system that will send the appropriate signals from the consumer all the way through the chain to the cow/calf producer, hence, creating a link from conception of the animal to consumption of the product.

Other Contributing Factors

Although a complete list of factors contributing to beef quality and consistency problems is not possible here, there are several others worth mentioning that have a genetic component.

- Industry structure
- Lack of information flow between segments
- Lack of business approach to cattle production
- Poor/nonexistent crossbreeding programs
- Low selection emphasis on carcass quality and

carcass traits in general

- Breed association spending on shows and promotion much more than research

Assessing Current Carcass Quality in a Herd

A small percentage of livestock producers seriously track the type of carcasses their breeding programs generate because very few carcass data are reported to breed associations. Many of these same producers are interested in carcass quality, but choose not to go to the extra effort and expense required to track contemporary groups through the feedlot and arrange to have qualified people collect the necessary carcass data. Even fewer commercial producers track large numbers of the cattle they produce annually. Prior to developing a genetic selection program that includes carcass characteristics or changing one's crossbreeding system to produce feeder cattle for a specific market, cow/calf producers need to evaluate what their current genetic program is producing in terms of carcass quality and yield. There are several options that range from getting a limited amount of data to a very detailed report of how a group of cattle from an individual operation hang on the rail: 1) sell grade and yield, 2) participate in a carcass merit/steer "feedlot" program, and 3) use a carcass data collection service.

Selling Grade and Yield

Although this should be a last resort on which to base genetic decisions, producers can get an indication of what quality and yield grades their cattle have. On the contrary, if a large producer had this type of information on numerous pens of cattle over time, there might be sufficient information to assess the general changes necessary in genetics, nutrition or management, but probably not any one in particular. There is just not enough information in knowing the breakdown by yield and quality grade to develop a genetic improvement program for carcass quality, assuming value-based marketing becomes reality. If you choose this option, sire groups should be slaughtered in a manner that will result in separate data summaries as a minimum.

Carcass Merit Programs

Many states now have some type of program designed to assist producers in obtaining feedlot performance and carcass data on a sample of calves from any operation. The programs have been known as steer "feedouts" or carcass merit programs. Typically, a producer pays a fee for a single or multiple lots of 5 calves. Note that it is important to collect data on 15 to 20 progeny per sire to get a meaningful indication of his genetics for carcass quality and yield. Generally, all of the cattle are fed and slaughtered at one place. Arrangements are

made to collect the feedlot and carcass data for all cattle. Owners do not have to be present when the cattle are weighed or slaughtered. Although there is a fair amount of labor in running these programs from the standpoint of the organizers, producers stand to learn something about their end-product at a very reasonable price and with little extra effort.

Minnesota's Carcass Merit Program started last year and was well received by most participating producers even though the market had a drastic drop this spring, causing most groups of 5 head to lose money. The 1994 program offers three feeding options: 1) an accelerated finishing program, 2) a growing phase followed by a high-energy finishing diet, and 3) backgrounding at the home operation for 45 days, followed by a high-energy finishing diet. Cattle are weighed initially, and at 45 day intervals. Because of small groups from many producers being commingled, death loss is shared by all owners who, incidentally, are required to follow preconditioning guidelines. In addition to the valuable carcass data, owners are able to evaluate the pros and cons of retained ownership on a small scale. The most profitable group of 5 head in 1993-94 earned a \$921.45 profit while the greatest loss suffered on 5 head was \$613.70. Hopefully, both producers will utilize the information received as a result of their participation to fine-tune their program or make the major changes necessary to produce more efficient cattle that have higher quality carcasses. Keeping everything as is and just selling feeder cattle to a different buyer each year should not be considered an option. Otherwise, we will never be able to make industry-wide improvements in beef quality and consistency.

Carcass Data Collection Services

In order for producers to obtain a complete set of data on cattle from their operation not involved in a state or breed carcass merit program, it is necessary to use a carcass data collection service. The four primary sources offering this type of service are: 1) USDA, 2) National Cattlemen's Association (NCA), 3) breed association programs, and 4) individual packing plants.

The USDA (or orange tag) program has been available for many years; however, it is not widely used because of problems with excessive missing data for groups of fed cattle. It seems a surprising number of the orange tags were lost between arrival at the packing plant holding pens and the slaughter floor! Typical charges for this program are 50 cents for the tags and \$2.50/hd for collecting the data. Similar characteristics are recorded by USDA and NCA (see below).

NCA began the Cattlemen's Carcass Data Service in March, 1992 in an effort to offer U.S. cattle producers a totally reliable method for obtaining carcass data. They achieve that reliability by contracting with uni-

versity and college personnel near major packing plants to personally match ear tags on the live animals with the appropriate carcasses and then return to collect carcass data. The minimum charge (< 50 hd) for this service is \$250 for members and \$300 for non-members. A per head fee of \$5 is charged to members with 50 to 120 hd and \$4.50/hd for groups over 120 hd. Data collected through the USDA and NCA are similar and include at least the following:

Tag number	Fat thickness	Ribeye area	Marbling score
Hide color	Yield grade	Internal fat	Quality grade
Carcass weight	Remarks and abnormalities (dark cutter, bruises, etc.)		

Some breed associations involved in recording carcass data also offer some type of carcass data gathering system. Perhaps the most successful is the Certified Angus Beef program. Other breed associations with the intent of conducting a national cattle evaluation for carcass traits may assist their producers in arranging to have carcass data collected and added to the breed database.

Finally, some packing plants are beginning to offer this service to their customers. As the demand for carcass data continues to increase, as is expected with value-based marketing coming closer to reality, this may become more widespread.

Targets for Beef Quality and Yield

Prior to developing and implementing a plan for improving carcass quality, or more specifically, beef quality and optimum yield, producers and their advisors need to have some specific targets to strive for. Assuming value-based marketing is going to become reality in the next 5 to 10 years, changes in breeding programs to take maximum advantage of that type of marketing need to begin soon. Those producers running "cutting edge" businesses today have probably already found a marketing system that will reward them for the type of end-product their cattle produce. However, under a value-based marketing system and changing consumer preferences, producers will probably want to develop genetic improvement programs that will result in carcasses fitting into one of four categories: 1) "lean" or "lite" beef, 2) "retail" beef, 3) "white tablecloth" beef, or 4) "natural" or "organic" beef. There are programs already which pay premiums for beef fitting into one or more of these categories. Such programs currently in place are either tied to a breed or a packing plant. In addition, there are certainly other niche markets currently in existence or waiting to be developed.

The following paragraphs provide a definition of each of these categories in terms of end-product targets and breed combinations likely to be most successful pro-

ducing cattle that when fed out appropriately should meet the desired end-product targets. End-product targets are adapted from articles by Strohbehn and Gibb (1993), Dikeman (1994), and other carcass extension and research literature. (Note that a general discussion is given based on research results not presented here for the sake of simplicity and brevity.) A review of the Meat Animal Research Center's (MARC) Germplasm Evaluation (GPE) project results are a good starting point for helping interested producers in choosing breeds and a breeding system.

"Lite" or Lean Beef

The number of diet/health conscious consumers has dramatically increased over the past 20 years. However, the common perception of this demand for leaner beef has not translated into volume buying in most markets. Granted, lean or Select graded beef is not commonly found in most retail meat counters. Nevertheless, it is safe to assume this trend for a growing segment of the population to prefer less fat in their diet will continue. As that happens, there will be greater demand for leaner beef and more retail stores will carry USDA Select in their meat counters. Table 2 contains the specification targets producers should use in developing a genetic improvement program aimed at producing beef for the lean beef market.

Table 2. Lean or Lite Beef Specification Targets.

Typical breed type	Continental; 75% Continental, 25% British
Average live weight range	1,200 to 1,300 lb
Average carcass weight range	750 to 850 lb
Average frame score range	6 to 7
Average ribeye area range	13 to 14.5 square inches
Average fat thickness range	.15 to .25 inches
Yield grade mix	1s and 2s
Average age range	13 to 15 months
Quality grade minimum	Low Select

While it is not difficult to produce leaner beef through management and nutrition, i.e., fewer days on feed or lower concentrate diets, there may be ramifications in terms of reduced red meat yield, carcass quality, and profitability. Because of the genetic antagonism between fat and lean accretion, it is possible to genetically select and breed cattle that will have adequate red meat yield with limited amounts of waste fat. Continental breeds are typically known for their ability to have higher lean to fat ratios than British breed cattle because they grow more rapidly and mature later. Therefore, commercial cow/calf producers would find it relatively easy to produce feeder calves for this type of end-product by using a crossbreeding system that results in 75% Continental and 25% British breed calves.

Dams that are a 50:50 mix bred to a Continental breed sire should work well. These half-blood cows mated to a terminal sire avoid dealing with selecting for leanness within the cow herd. Cows need a certain amount of condition (fat cover) to get through winter in many parts of the U.S. and as they prepare for lactation. Having these body reserves then allows them to begin cycling sooner after calving. The trade-offs between lean beef production and its ramifications in the cow herd are still being researched.

Some purebred Continental feeder calves are ideally suited to this market because of their ability to reach market weight with little fat and high meat yield at a young age when weaned at 7 to 8 months and put into the feedlot by about 9 months of age. Although many of these calves will grade at least Select, a small percentage will grade Standard. Pushing these cattle on a high energy finishing diet in the feedlot should allow most of them to be ready for this market within the 1200 to 1300 lb live weight range specified.

Another option for lean beef production includes utilizing cattle with muscle hypertrophy (double-musled). Although more research is needed on raising these cattle in the U.S. and crossing them with our existing breeds, dystocia may not be a major production obstacle in producing F₁ calves (Cundiff *et al.*, 1993). Recent preliminary results from Cycle V of the MARC GPE study indicate that Belgian Blue and Piedmontese sires work well as terminal sires because their progeny have high retail product yield and relatively tender steaks (Cundiff *et al.*, 1994).

Retail Beef

This is the category in which the bulk of the beef from fed cattle produced in the U.S. will fit and the type of beef most consumers buy in retail stores. These consumers are looking for a balance between fat/leanness, price, nutritional value, and overall palatability. Producers who choose not to aim for the smaller niche markets (those listed in this paper or others) need to develop their genetic selection program to at least fit this "retail" or "institutional" beef market (Table 3). Part of the implementation of a value-based marketing system could include new measures of beef quality that are no longer dependent on fat. Therefore, it should be possible for many breed types to fit this market. However, we must keep in mind the beef industry goal of overall increased beef quality and consistency. That means the existence of this broader end-product target market should not be thought of as the catch-all for beef that does not fit anywhere else. That type of beef will and should be discounted.

Because this category is more flexible or easier to fit, producers have more crossbreeding systems and breeds to choose from in designing a breeding program

Table 3. Retail Beef Specification Targets.

Typical breed type	50% Continental, 50% British
Average live weight range	1,100 to 1,300 lb
Average carcass weight range	650 to 850 lb
Average frame score range	5 to 7
average ribeye area range	11 to 13 square inches
Average fat thickness range	.25 to .35 inches
Yield grade mix	Mostly 2s
Average age range	14 to 16 months
Quality grade minimum	High Select

that produces easy-fleshing, good maternal females while also capable of producing feeder calves right for the retail market.

Breeding systems that produce feeder calves with 50% Continental and 50% British breeding will have a high probability of meeting the quality standards required of retail beef even when fed under the multitude of conditions that exist in the feedlot segment. Higher red meat yield and rapid growth come from the Continental breed influence while a greater ability to grade Select and Choice comes from the British breed influence. Taking advantage of breed complementarity in this type of cross makes this an efficient approach to improving carcass quality. An appropriate crossbreeding system can be designed to utilize moderate-size cows adapted to their local environment to help keep feed costs low, yet produce a quality consistent product for the retail market. Depending on the breed combinations used, these calves could be put directly into a feedlot or backgrounded a few months on pasture or confinement growing diet.

Even those tropical and sub-tropical environments can match these targets and generally be sufficiently tender as long as *Bos indicus* influence in the feeder calves is less than $\frac{1}{4}$ to $\frac{3}{8}$. Preliminary results from progeny of Tuli sires used in Cycle V of MARC's GPE study indicate that the calves (50% Tuli, 50% British) have carcass characteristics more similar to British-sired (*Bos taurus*) progeny than other *Bos indicus*-sired progeny (Cundiff *et al.*, 1994). Therefore, because the Tuli breed of cattle evolved in the tropics, they may be an ideal choice for using in southern regions of the U.S. without the usual risk of reduced carcass quality associated with *Bos indicus*-sired progeny.

White Tablecloth Beef

Beef destined for consumption in higher quality restaurants has come to be known in the industry as white tablecloth beef. These types of restaurants typically prefer beef that is at least average Choice and a small percentage of restaurants buy only Prime beef. They have found that consumers who frequent this type of establishment with the intent of eating a steak are not overly concerned with fat and cholesterol intake,

and in many cases price, because they are looking for the "ultimate" eating experience. That is not to say they are not diet-health conscious because fat intake in moderation, i.e., most people don't eat the same foods every night, is necessary for normal body functions. Therefore, restaurants buy beef with higher amounts of marbling to ensure sufficient flavor and juiciness (Table 4). A smaller percentage of these steaks will be found to be tough as well. However, marbling is not the best indicator of tenderness, but it currently defines our measure of quality along with the maturity of the carcass. Without another indicator of quality, i.e., a quantitative measure of tenderness, it is difficult to provide direction to producers aiming for this target market. A reasonable goal for fat thickness is given (but may still result in excessive waste fat) and it is conceivable that the importance of marbling will decrease when a measure of tenderness is developed. The Beef Industry Long Range Plan Task Force Report (1993) and the National Tenderness Conference Report (1994) suggest it is only a matter of time.

Table 4. White Tablecloth Beef Specification Targets.

Typical breed type	British and British crossbreeds
Average live weight range	1,100 to 1,200 lb
Average carcass weight range	650 to 750 lb
Average frame score range	5 to 6
Average ribeye area range	11 to 13 square inches
Average fat thickness range	0.35 to 0.45 inches
Yield grade mix	2s and 3s
Average age range	15 to 17 months
Quality grade minimum	Average Choice

The trade-offs between meat yield and meat quality (under the current market quality definition) play more of a role in trying to produce a product for this target market than probably any other. In order to have sufficient marbling to attain average Choice or better, cattle breed type is fairly limited to British and British-cross cattle. The Strategic Alliances Field Study results indicated that cattle of only British inheritance may be more profitable when put on a cheap growing diet (in confinement or on pasture) before going into the feedlot for 120 to 150 days (Woodward, 1994b). Some success also is possible with cattle that are 25% Continental breeding, provided they are managed appropriately in the feedlot on a high concentrate diet and marketed after reaching about .40 inches of fat cover. Continental breeds best to consider are those moderate-framed, previously dual-purpose type cattle. Research has shown that it is possible to select, breed and feed cattle to grade average Choice and still be yield grade 2s and 3s as indicated in Table 4. Yield grade 4 cattle are discounted now and may receive greater discounts under a value-based marketing system. If yield grades 2 and 3 are split

as proposed by NCA, carcasses in the upper half of yield grade 3 may also be discounted. Finally, white tablecloth establishments do not want **any** unsatisfied customers; therefore, it is not wise to include any or certainly no more than $\frac{1}{8}$ *Bos indicus* breeding in cattle being produced for this market.

"Organic" or "Natural" Beef

These terms are very misleading as they implicate any beef not fitting under this label is either inorganic or unnatural, which is obviously not true. Unfortunately, these terms are used in restaurants and advertising which is sometimes on the borderline of being classified as misleading. Some federal and state government guidelines have been developed (i.e., Organic Foods Production Act of 1990), but it is yet unclear how they can be enforced. It is not possible to detect "chemical" differences between meat taken from an organic carcass and meat from a typical carcass at levels deemed safe for human consumption. The only reason to produce beef for an "organic" market is to receive the typically large price differential that often times comes with any product **perceived** by small segments of a population to be better for them.

It is not really necessary to provide any specification targets for cattle produced for an organic market because one could use those specifications given for any of the other three end-product target markets. The difference is only in the management of the animals and the feed fed. However, there is a high likelihood that a person willing to pay a higher price for a product labeled "organic" probably also prefers lean or "lite" beef. A person who can establish a market for "organic" beef and has "organic" feedstuffs available may want to also consider feeding out intact males if feedlot facilities permit and no discount is given at the packing plant. Another production option is to raise primarily British purebreds or crossbreds on grass to finish. Once again, it is important to have a market outlet prior to having the final product. Americans are used to the taste of grain-fed beef, making this option less likely an easy sell.

Improving Meat Quality

Producers continue to struggle with the question of whether it is economically justified to select for improved meat quality and how to go about doing so. The many popular press articles in magazines recently covering the beef industry and articles like this should make it fairly clear that a lot of people think meat quality is important enough to evaluate in every cow herd. Some of the information for this selection has already

been discussed for each end-product target market and will not be repeated here.

The manner in which actual improvement is undertaken will vary; however there is no doubt it will not be as easy as with growth traits. The first step in improving meat quality after assessing what a particular herd is producing will be to evaluate the feeding, marketing, management, and genetic programs that determine the end-product. The second step will be to determine the primary marketing goal by selecting one of the markets presented in this paper or another niche market. The next step will be the most difficult -- developing a plan to make genetic progress in carcass quality and ensuring the cattle are managed, fed, and marketed accordingly.

The task is somewhat easier for individuals raising Angus, Limousin, Simmental, and Salers cattle (or when using progeny-tested bulls from these breeds) because they have carcass Estimated Progeny Difference (EPDs) for some of the traits discussed in the specification targets given in Tables 2 to 4. These EPDs will allow for directional change the same way growth and milk EPDs do. As other carcass traits become important, additional EPDs will be developed. For example, considerable research efforts are currently underway at several universities to develop EPDs for Warner-Bratzler shear force, "tenderness" and various ultrasound measurements. In addition, other breed associations are working at encouraging their breeders to collect and report carcass records in sufficient numbers to enable them to develop carcass EPDs. In the meantime, those purebred producers will have to evaluate enough progeny from the sires used in their herd to know what sire lines are best.

The best opportunity for commercial producers to improve meat quality of the feeder calves they produce is through the use of a crossbreeding system that takes advantage of breed complementarity. The discussion of each end-product target market included details of the typical breed crosses most suited to meet the goals listed. For example, a producer with a moderate-frame cow herd of primarily British breeding many want to balance the earlier-maturing, higher-marbling British contribution with faster-growing, increased muscling/decreased fatness provided by Continental European breed sires. If a breed without carcass EPDs is chosen, then visual characteristics for muscling, possibly ultrasound data and carcass information potentially collected on progeny of the same sire line by other producers will have to be used.

Use of composite breeds of cattle were not previously discussed because there are enough different ones already in existence to effectively meet the specification targets of the different markets discussed in this paper. A composite breed of cattle may consist of as few

as two breeds, such as all those developed for tropical and sub-tropical U.S. regions using Brahman (i.e., Simbrah, Brangus, Braford, etc.). Development of a composite breed may involve several breeds in an effort to take advantage of breed complementarity to the extent of attempting to use the best of several breeds for growth, maternal, and carcass traits. Composite breeds have received a considerable amount of press, but should not be considered the cure-all nor something that everyone should consider developing. They can help small producers take advantage of the retained heterosis by using a composite bull in their straightbred or two-breed cross cow herd.

Conclusions

The beef industry is entering a period that will most likely involve numerous changes destined to affect all segments of production. Part of this change is guaranteed to be a much greater focus on the end-product and how it is perceived by U.S. consumers (and foreign consumers as exports of higher quality cuts increases). Remember that consumers make the final judgement of the product and the Customer Satisfaction Project results showed that participants (moderate to heavy beef users) think beef tenderness, flavor and appearance are the "main drivers of consumer satisfaction."

Keep in mind that as the industry changes, one of the most often predicted changes will be the adoption of a value-based marketing system and under that system, fat (marbling and otherwise) will most likely play a less significant role, other than result in discounts for excess. Along with quality of product, cow/calf producers need to strive toward a more uniform cow herd that will produce more uniform, moderate-frame calves. Feedlot operators need to fine tune their management and feeding of these calves in an effort to produce a more consistent, higher-quality

ity carcass. Finally, beef processors (and retailers to some extent) must make a much greater effort at adopting proven technology and handling procedures known to influence the quality and consistency of the end-product. In essence, the beef industry must do a much better job of working together to regain market share or the current downward trend will continue.

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