Assuring the Consistency and Competitiveness of Beef by Use of Correct Biological Types of Cattle

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To assure the consistency and competitiveness of beef, the U.S. cattle industry must: (a) use the correct biological types of cattle and (b) design breeding systems to meet both profit and target-market needs. Raw agricultural products, intended for use as human food, are usually sorted/categorized -- prior to marketing -- to facilitate direction of product of a specified size, weight or quality-level to the part of the trade that is most likely to make the most efficient use of such product. Beef, as it is produced and if it were sold without prior sorting, constitutes a "commodity."

Sale of all of a food product as a "commodity" ignores possibilities of selling superior-quality segments of the commodity at substantial premiums to the value needed to offset the penalties assigned to inferior-quality segments, in order to arrive at the average price for the commodity. For example, if the commodity price for beef is $2.00/lb, there would be little incentive to sort beef into segments of 10% "excellent," 60% "average" and 20% "inferior" and then to sell those segments for $3.00, $2.00 and $1.00/lb, respectively, because the proportion x price, net realization, for all of the product is still -- on the average -- $2.00/lb. But what if the "excellent" product merited a premium and could be sold for $4.00/lb. There is well-documented merchandising logic which argues forcefully -- in the words of Kevin Costner in the movie "Field of Dreams" -- IF WE BUILD IT, THEY WILL COME!

Results of the Face-to-Face Interview phase of the National Beef Quality Audit--1991 reveal that "lack of consistency and uniformity of beef" ranks 6th, 6th, 9th and 10th among "concerns about the quality of beef" to purveyors, retailers, packers and restaurateurs, respectively. A primary quality shortfall of beef to those who deal directly with end-users of the beef -- retailers and restaurateurs -- relates to its inadequacies in terms of eating satisfaction and palatability performance; "inadequate flavor" ranked 9th among restaurateurs' concerns, and "inadequate tenderness" ranked 7th and 8th among retailers' and restaurateurs' concerns, respectively, about the quality of beef.

Some restaurateurs, but not all, and some retailers, but not all, buy beef in narrowly defined (in terms of quality-indicating characteristics like maturity and marbling) USDA Quality Grade segments in an attempt to control their own destiny with regard to the palatability-performance of the beef that they sell. The fact that inadequacies in flavor and tenderness remain in the top-10 of concerns about beef quality to either or both of retailers and restaurateurs suggests that either: (a) beef quality-level sorting, as presently practiced, isn't doing enough to standardize palatability-performance, for those who purchase beef in narrowly defined quality segments, or (b) too few retailers and/or restaurateurs are taking advantage of beef quality-level segmentation systems (e.g., U.S.D.A. Quality Grades, U.S.D.A. Quality Certification, Packing Company Branded Beef) and thus experience wide fluctuations and excessive variability in the palatability-performance of the beef they buy and sell. If we could convince more retailers not to buy "No-Roll" beef and more restaurateurs to buy beef in the upper two-thirds of Choice, many of the palatability problems could be solved.

"Quality" in cooked beef is best defined in terms of flavor, juiciness and tenderness (collectively, "overall palatability" or "eating satisfaction") when eaten; "quality" in beef carcasses and cuts is usefully predicted by: (1) marbling and maturity (collectively, U.S.D.A. Quality Grade); (2) knowledge of genetics and feeding-history of the live animal and (3) handling-history of the carcasses/cuts. Categorizing beef, according to its quality level, changes the marketing strategy so that,

rather than selling beef as a single "commodity," the market can then be segmented to allow for direction of beef of different qualities to markets with different end-uses for the product and thus, different capacities to pay for the product.

There are five primary targets for "Qualities" of beef: (a) <u>Exemplary Quality</u> -- Low Prime or higher-grade beef works well in premium-quality, "white tablecloth" dining establishments; (b) <u>Superior Quality</u> -- Average Choice and High Choice beef (e.g., Certified Angus Beef, Chef's Exclusive, Sterling Silver) best fits the need for high and consistent palatability-performance for use in the foodservice trade and for use by supermarkets that wish to feature beef of superior quality; (c) <u>Very High Quality</u> -- Low Choice beef fulfills demands for parts of the foodservice trade and fits almost perfectly the desires of retail supermarket customers who emphasize "taste" over "leanness"; (d) <u>High Quality</u> -- Beef for supermarket and/or foodservice operators who emphasize sale of product that is both "lean and palatable," best comes from Genetic/Treatment/Trait Programs in which cattle of specific gender/breed/type that have been fed/managed in special ways, and from carcasses with specific maturity/marbling/fatness characteristics that have been tenderized/ aged (e.g., electrically stimulated) to ensure "high" palatability; and, (e) <u>Acceptable Quality</u> -- Low Select to High Select beef appeals to retail supermarket customers who emphasize "leanness" over "taste."

During the Face-to-Face Interview phase of the National Beef Quality Audit --1991, members of the National Association of Meat Purveyors agreed that "Restaurateurs and chefs want beef to be popular with their guests because beef can sell at a price high-enough to allow them to make their covers." A "cover" is the minimum ticket-total-charge per customer needed for the restaurateur/chef to break-even on the cost of doing business. For example, if an eating establishment has 120 seats, an occupant-turnover per seat per business day of 2.4, and total operating expenses per business day of $7,200 -- a "cover" is $25.00. To warrant a "cover" of $25.00, beef must be "Exemplary" or "Superior" in palatability-performance.

Consumers have demonstrated willingness to pay substantially higher prices for a more pleasureful eating experience; such hedonism may result from either or both of the food quality or the atmosphere/setting/surroundings in which the food will be consumed. A friend of mine recently dined at one of the top restaurants in the U.S. and had a dinner featuring 12-ounce, top loin, U.S. Prime steak; the ticket for each individual meal (alone, and exclusive of drinks) was nearly $75.00. My friend said "I ate there with five other people, because it was of great importance -- to me, as part of my profession -- to impress those in attendance. I was quite willing to spend that amount of money, as an investment, expecting future good-will and cooperation from those in my party. It was essential to my plan that the beef be of exemplary quality. And....it was." If beef is to assure itself a place in such experiences, its palatability-performance must be exemplary, superior and/or truly unique. I checked with the purveyor who sold the steaks to the restaurateur who sold it to my friend and his party; top loins of the quality sufficient to allow a restaurant to charge $74.00 for a meal, were sold to the restaurant for $30 per pound. <u>Why?</u> I asked, would a restaurateur be willing to pay that much for a product worth -- as a commodity -- $5, maybe $6, per pound? Well....they are willing because they know that....."IF WE BUILD IT, THEY WILL COME" and if the eating satisfaction is exemplary...."THEY WILL COME BACK"....for more.

Of concern to us, at present, is designing cattle breeding systems to meet profit and target-market needs. To do that, we must understand the genetic diversity with which we work in the U.S. beef industry. The U.S. beef cattle genetic-base derives largely from those animals brought to "the colonies" by settlers from Great Britain (after 1783, predominately Shorthorn) and--later--of those animals (of Andalusian breeding, these became Texas Longhorns) brought to the U.S. by Spanish explorers and missionaries, until the British breeds (Hereford in 1817 and Angus in 1873) were imported for use in upgrading the cattle supply. Because heat, the Texas Fever Tick and humidity limited the productivity of beef cattle in the Gulf Coast region of the U.S., *Bos indicus* cattle were imported (in 1849; from India) and used for crossbreeding, particularly in Texas, Louisiana and Florida.

Especially through the period of 1880 through 1950, most of the farmers in the middle portion of the U.S. had

small acreages (40 to 160 acres) on which they raised cash ("row") crops (e.g., cotton, corn, grain sorghum), cereal grains (e.g., wheat, oats, barley) and livestock (usually pigs, sheep, chickens and cattle). The cattle on most of those farms were grazed on pasture and milked (twice daily; usually by hand). The milk was separated into cream and skimmed milk; cream was accumulated in cans and taken to town, for sale, once weekly. The majority of those "milk cows" were half-Jersey, half-Guernsey or half-Durham (Beef or Milking Shorthorn) and the other half was either Angus or Hereford (the latter two breeds because the male offspring of such cattle were more valuable for use as beef). Throughout the U.S. there were dairy farms where Holstein-Friesian or Jersey, primarily, but also Brown Swiss, Ayrshire, Guernsey and Milking Shorthorns were managed as purebred dairy cattle for production of fluid milk. Of Continental European breeds, only the Charolais existed in any real numbers (those had first been imported in 1936; illegally, through Mexico).

Until about 1950, the cattle that were "finished" (fed high levels of concentrates) prior to slaughter were fed corn in farmer-feedlots, largely in the Corn Belt States; the majority of cattle slaughtered for beef consumption in the remainder of the U.S. had grazed on pasture or rangelands, had harvested crop aftermath, or had subsisted on hay, fodder, silage or straw with little or no grain supplementation. When large-scale, grain-finishing of cattle for beef production started in the U.S., in the period between the end of World War II and about 1960, the population of "feeder cattle" available was comprised of the following kinds and breeds: (a) Purebred British beef breeds (majorally Angus, Hereford and Shorthorn); (b) Purebred dairy breeds (primarily Holstein-Friesian); (c) "Okie" cattle (Jersey/Guernsey/Durham crossed with Angus or Hereford); (d) "Crossbred" cattle (*Bos indicus* crossed with Angus, Hereford, Shorthorn or Charolais).

The best of the feeder cattle of that era were those of the purebred British beef breeds (first) and the "Okie" cattle (second); less valuable were the "Crossbred" cattle (third) and the purebred dairy breeds (last). USDA beef carcass grading at that time was based upon (a) maturity (age at slaughter), (b) conformation (plumpness, bulge and thickness), and (c) finish (amount of external--subcutaneous--fat). Purebred British beef-breed cattle were short, deep and thick bodied (desirable in conformation), had extraordinary abilities to deposit external fat, in layers 0.80 to 1.40 inches thick, at liveweights of 800 to 1000 pounds (desirable in finish) and achieved the desired fatness at young ages (desirable in maturity); because of those attributes, Angus, Hereford and Shorthorn were the most valuable of feeder cattle. Holstein-Friesians were the least valuable of feeder cattle because they were long, tall, shallow and thinly muscled ("poor" in conformation) and they deposited external fat in the desired quantities only if fed for long periods ("slow" to finish).

Little about relative carcass merit of cattle changed until the early 1960s, when it was made mandatory that carcasses be ribbed--between the 12th/13th ribs, to expose the ribeye muscle--so "marbling" could be ascertained. When ribbing became the practice, value of "Okie" cattle increased enormously because those cattle (due to their mixed dairy and beef heritage) marbled well and produced very flavorful, juicy and tender meat.

Things changed immensely in 1965 when the U.S.D.A. changed the beef carcass grading standards to create a dual-grading system consisting of Quality Grades--Prime, Choice, Good, Standard and Utility--for palatability prediction, and Yield Grades -- 1,2,3,4 and 5 -- for cutability prediction. Also in the 1960s, "conformation" was dropped as a Quality-Grade determinant. Coinciding closely with those changes in USDA beef carcass grading standards was importation, first to Canada (in about 1965) and subsequently to the U.S. (beginning about 1967), of the Continental European ("Exotic") breeds like, for example, Limousin, Simmental, Maine-Anjou, Gelbvieh, Chianina and Salers. Those breeds of cattle were, in general, larger, more muscular, faster-growing and leaner than then-existing purebred British beef cattle and "Okie" cattle; and, pure or when crossed with purebred British beef-breed cattle or "Okie" cattle, they produced carcasses that were larger, more muscular and higher in cutability (thus more desirable--lower numbered--in USDA Yield Grade) but that had less marbling (thus less desirable in USDA Quality Grade).

Changes in USDA grading standards in the 1960s (creation of Yield Grades; deleting conformation from

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Quality Grades) helped also "Crossbred" cattle, Holstein-Friesians and cattle of the American Breeds. American Breeds are those created (between 1920 and 1950) by crossing *Bos indicus* (majorally those of the American Gray Brahman breed) cattle with those of the purebred British beef breeds and, once the desired proportion of *Bos indicus* (usually 3/8 or 1/2) X *Bos taurus* blood had been attained in the offspring, of pure-breeding the newly created composite-breed cattle. Examples of the American Breeds include Brangus (3/8 Brahman, 5/8 Angus), Braford (3/8 Brahman, 5/8 Hereford), Santa Gertrudis (3/8 Brahman, 5/8 Shorthorn) and Beefmaster (1/2 Brahman, 1/4 Hereford, 1/4 Shorthorn). "Crossbred" cattle, Holstein-Friesians and American Breed cattle are larger, later-maturing and more moderately muscled animals than are those of the purebred British beef breeds; so, they yield carcasses that are leaner (at normal slaughter weights) and merit higher (lower numbered; more desirable) Yield Grades. And, with conformation no longer a Quality Grade determinant, about half of those cattle -- if fed sufficiently -- will marble enough to grade U.S. Choice.

In the 1970s, additional American Breeds were developed that, in this case, resulted from crossing the Continental European breeds with *Bos indicus* cattle; from such efforts originated breeds like Charbray, Simbrah, Brahmousin and Bralers. Cattle of the latter breeds produce carcasses with higher Yield Grades (lower numbered; more desirable) than do cattle of the American Breeds that were developed by crossing British beef breeds with *Bos indicus* cattle but--unfortunately--they have less propensity to deposit marbling and only about 35% of such cattle produce U.S. Choice carcasses even when fed for prolonged periods on high-concentrate diets.

It is very common for U.S. meat scientists, when asked to categorize breeds and crossbreeds of cattle according to carcass desirability, to hide behind that old adage...."There is more difference within breeds, than among breeds"....but that is not correct. That does not mean that there are not individuals within a breed that are very good or very bad...and, so, with selection pressure, strains can be developed within breeds that excel in one or more carcass traits. It is essentially impossible to find Limousin cattle that marble as well as Wagyu, Holstein-Friesians with as high muscle-to-bone ratios as

Limousins, or Brahman cattle that produce meat as flavorful and tender as Jersey cattle. So, there are differences between breeds. Examples of breeds capable of producing carcasses with certain marbling scores and quality levels are presented in Table 1.

Present thinking is that those cattle with muscles comprised of relatively high proportions of "red" vs. "white" muscle fibers have superior propensities to deposit intramuscular fat that is visualized--after carcass chilling--as "marbling" in their carcasses. Of all cattle breeds for which ratios of "red" vs. "white" muscle fibers have been characterized and reported in the scientific literature, the ratio is highest for Japanese Black Wagyu cattle. Other cattle breeds for which proportions of "red" muscle fibers are high include Angus, Jersey and Guernsey; breeds of cattle with high proportions of "white" muscle fibers include Blonde D'Aquitaine, Belgian Blue and Piedmontese. Data for marbling from cattle of Wagyu, Angus and Jersey slaughter steers/heifers reveal that their scores are high (usually in the Shimofuri, U.S. Prime or U.S. Choice grade ranges) while those for Blonde D'Aquitaine, Belgian Blue and Piedmontese are low (often in the U.S. Select and U.S. Standard grade ranges).

The hypothesis is that "red" muscle fibers use fatty acids, extensively, as a source of contraction/relaxation energy--and thus store supplies of that substrate, nearby, in the form of triglycerides (fat), as marbling--while "white" muscle fibers use glucose to a much greater extent than fatty acids as a source of contraction/relaxation energy and thus--not needing ready sources of fatty acids for catabolic purposes--do not store fat nearby. Cattle with muscles comprised largely of "white" muscle fibers do not have extensive intramuscular fat deposits (as "marbling") when the chilled carcass is ribbed to expose the cross-section of the ribeye muscle.

If that logic is correct, attempts to produce beef with high levels of marbling will succeed, not by prolonged feeding of high-concentrate diets alone, but only if genetic propensity to deposit marbling exists in the animals being fed. To produce the highest grading beef, feeder cattle of Wagyu, Jersey, Guernsey, Angus, Red Angus or Galloway breeding are required (not withstanding existence of individual animals with similar capability in

other breeds). Attempts to produce U.S. Prime beef by high-energy feeding of Piedmontese, for example, or Marchigiana or Belgian Blue cattle, even for very long periods of times, will yield very disappointing results. It is for purposes of understanding such relationships that I developed Table 1.

Reasonably educated guesses can similarly be made in an attempt to identify the "Top Ten" breeds or crossbreeds of cattle based on assessments of muscling, marbling, combined Yield and Quality Grades and cooked beef tenderness, as I have done in Table 2. For muscling, the "Top Ten" cattle breeds include Belgian Blue and Piedmontese, both of which are colloquially described as "double muscled" (they do not have more than the conventional number of muscles; instead, they have very high proportions of "white" muscle fibers and the latter are large in diameter). Categorization of cattle breeds according to ability to deposit marbling is related to proportions of "red" vs. "white" muscle fibers; Wagyu, Jersey, Guernsey and Angus are in the "Top Ten" for marbling because of their high average ability to deposit marbling after periods of 120 days or more on high-energy diets.

To optimize both Yield Grade and Quality Grade outcome in slaughter steers and heifers usually requires combining of two breeds or kinds of cattle to create a crossbreed or composite with the ability to achieve, for example, both the U.S. Choice and Yield Grade 1 or 2 designations. Critical to that mix is one parent with sufficient genetic propensity to deposit enough marbling to "carry" the lower-marbling parent "through the cross"; as will be noted in Table 2, the only breed that has proven able to consistently perform that feat in the U.S. cattle population is Angus.

Cooked beef tenderness depends in large part upon marbling level in the meat but that is certainly not the entire story. Hereford cattle produce consistently tender beef yet are in the upper-midrange of breeds in propensity to deposit marbling. Piedmontese cattle are unique; their muscles contain almost no marbling and yet are in the midrange among breeds in cooked beef tenderness. It is thought that both Hereford and, especially, Piedmontese, beef is tender because of comparatively small quantities of connective tissue (i.e., "gristle") present in their muscles. Beef from *Bos indicus* cattle is disportionately tough--partially because it (a) usually has only limited amounts of marbling, (b) often possesses higher than normal quantities of heat-resistant connective tissue, and (c) sometimes contains a de-activator (called calpastatin) of calcium-dependent protease (CDP II and/or calpain) -- an enzyme that tenderizes meat during postmortem carcass storage.

About 12 years ago, I gave a speech at the Beef Improvement Federation meeting that was entitled "Targeted Breeds For Targeted Needs." In that talk, I expressed the opinion that commercial cattlemen should "Choose the cow to fit the environment; choose the bull to fit the marketplace". My logic was, and remains, that -- given the exceptional variation in climate, weather and feed supplies in the U.S. -- there are breeds and crossbreeds of cattle that are uniquely adapted, acclimatized or genetically prepared to perform optimally in given geographic regions. American Breeds of cattle make possible or more profitable the production of beef in hot, humid areas and/or dry, sparsely vegetated regions; Brangus and Braford cattle, for example, perform exceptionally well in areas of the U.S. like South Texas, Arizona and Florida. Without such breeds, beef-production enterprises in those geographic regions would probably not be economically viable. In the high-mountain areas of my home state -- Colorado -- success in beef cattle production demands cows of breeds or crossbreeds that are good rustlers (can travel extensively to find forage), that have strong feet/legs/pasterns/joints to enable them to climb and to traverse steep and rocky terrain, and that have the ability to store ample supplies of body fat so they will give milk, ovulate and get pregnant when it is cold and when feed supplies are short; for us, Angus, Hereford and several other breeds work well.

The second part of my "Targeted Breeds..." logic regards selection of a breed of bulls that will complement the short-comings in performance, productivity or carcass quality/yield of the mother-cow breed or crossbreed when mating decisions are made. For example, if a cow herd consisted of Braford cattle, I could recommend use of Angus bulls to produce terminal-cross offspring (to improve carcass quality); if a cow herd consisted of Angus cattle, I could recommend use of Charolais bulls

to produce feeder cattle offspring (to improve growth rate and carcass cutability); and, if a cow herd was comprised of Simmental cattle, I could recommend use of Shorthorn bulls to generate calves for eventual sale to stockers/feeders (to improve fleshing abilities and carcass quality). It is not necessary to crossbreed cattle to create mating schemes that will result in offspring that are superior to their parents in one or more traits; it is equally plausible to have lines/strains of a given breed with superior maternal traits and lines/strains of that same breed with superior performance or carcass traits. Lessened substantially in purebreeding, as compared to crossbreeding, will be those performance or carcass traits benefitted by heterosis, but the trade-off is appropriate if the endproduct of matings within a breed is uniformity of the calf-crop.

Whatever is the case, whether you desire to purebreed or crossbreed and irrespective of the kind, strain or breed of cattle that comprise your cow herd, if your desire is to improve carcass traits, four items are critical to your success....focus, direction, dedication, and base-line information. "Focus" regards being able to avoid diversions that could cause you lessen the singularity of the goal you seek; "direction" relates to the specific trait or character you have decided to improve. "Base-line information" tells you where your cattle now are, relative to all other cattle, in exact terms--qualitatively or quantitatively--for a specific trait or character;

"dedication" will determine how rapidly you are likely to achieve the desired trait-level, target or goal. Obtaining the base-line information is usually the most difficult step -- requiring collection of carcass data from progeny--and, once that has been done, measurements of progress can be made only by subsequent collections of carcass data from succeeding-generation progeny. The Beef Carcass Data Collection Program of the National Cattlemen's Association, initiated in 1992, can be extremely helpful in identifying superior/average/inferior lines or strains of cattle for seedstock producers, commercial cattlemen and feedlot operators.

Perseverance in setting goals for carcass improvement and in working diligently to progress and succeed, depends most on existence of a value-based marketing system that rewards production of superior cattle or carcasses and/or that punishes production of inferior cattle or carcasses. We do not presently have a value-based marketing system for U.S. beef cattle but we are working very, very hard to put one in place. Only when generation of undesirable product is treated punitively and/or when creation of exemplary product is financially rewarding, will we gain the full attention of our beef producers. It remains for us to include as one of our goals, the production of beef that is consistent in eating satisfaction. To do that will necessitate a belief that "IF WE BUILD IT, THEY WILL COME!"

TABLE 1. **Examples of Breeds Capable of Producing Carcasses With Certain Marbling Scores and/or Quality Levels**

MARBLING SCORE	QUALITY LEVEL	CATTLE BREEDS
Extremely Abundant	Shimofuri	Wagyu
Moderately Abundant	U.S. Prime	Angus, Jersey, Guernsey
Slightly Abundant	U.S. Prime	Angus, Red Angus, Guernsey
Moderate & Modest	Certified Angus Beef; Chef's Exclusive; and Sterling Silver	Angus, Galloway, Red Angus
Small	U.S. Choice "Lean & Palatable"	Hereford, Brangus,Holstein Hereford
Slight	U.S. Select	Charolais, Limousin, Gelbvieh

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 × Angus	Wagyu
Piedmontese	Jersey	Simmental × Angus	Jersey
Limousin	Guernsey	Limousin × Angus	Guernsey
Blonde D'Aquitaine	Angus	Red Angus	Angus
Marchigiana	Red Angus	Hereford × Angus	Red Angus
Romagnola	Galloway	Brangus	Hereford
Charolais	Holstein-Friesian	Holstein × Angus	Galloway
Gelbvieh	Red Poll	Holstein-Friesian	Shorthorn
Simmental	Shorthorn	Angus	South Devon
Braunvieh	South Devon	Hereford	Piedmontese