New approaches for improving tenderness, quality, and consistency of beef[1]

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Abstract

In an effort to increase U.S. domestic beef demand, beef industry leaders have recommended the development and implementation of Total Quality Management-like systems to enhance product quality and consistency. This review outlines the application of quality management practices and process control to improve tenderness and quality of beef. Adoption of a quality management philosophy for improvement of product quality requires a shift of focus from issues of greatest concern to producers to issues that are of greatest concern to consumers. Development of "alliances" and branded beef programs, in which producers maintain some share of ownership through the entire production/marketing chain helps shift producer focus to issues that are important to consumers, provides a clearer economic signal encouraging improvement of product quality, and provides an opportunity for the application of quality management principles to facilitate the improvement of beef quality. Application of a quality management system for improving beef tenderness and quality requires identification of "control points" and application of process control to prevent quality shortfalls, verification of conformance to specifications for tenderness/quality, and identification of methods for improving tenderness and quality attributes of nonconforming products. A prototype quality management system for ensuring beef tenderness is described. This prototype system involves four "control points" (genetic inputs, preslaughter cattle management, early postmortem management, and postmortem aging) at which inputs/processes are controlled to improve tenderness, a verification step based on a tenderness measurement obtained at 1 to 3 d postmortem, and the use of tenderization technologies to improve tenderness of nonconforming products. Application of the prototype system reduced the expected rate of nonconformance to tenderness specifications from about one in four, for both top sirloin steaks and strip loin steaks, to about 1 in 25 and 1 in 100 for top sirloin steaks and strip loin steaks, respectively. Use of process control in a quality management system may be an effective approach for improving the tenderness and quality of beef.

Key Words: Beef, Management, Tenderness, Quality

Introduction

According to recent estimates reported by the National Cattlemen's Beef Association (**NCBA**, 1999), cumulative U.S. domestic beef demand, as reflected by an index developed for the Joint Industry Evaluation Committee of the Cattlemen's Beef Board and NCBA, declined by more than 48% from 1980 through 1997. During that same time period, market share for poultry products showed a steady increase. Although a number of factors have contributed to the steady erosion of beef's market share, beef industry leaders believe that "meeting and exceeding consumer expectations for quality and consistency" could provide the opportunity to reverse this trend and increase consumer demand for beef (NCBA, 1998b). Correspondingly, a primary goal recently established by the NCBA for improving the eating quality and consistency of beef was to "reduce consumer dissatisfaction due to variability in eating quality (especially tenderness) by fifty percent by the year 2005" (NCBA, 1998b). To accomplish this goal, it was recommended that the beef industry "develop and implement Total Quality Management-like systems to enhance quality and consistency" (NCBA, 1998b).

Discussion

Will Improving Quality And Consistency Increase Consumer Demand for Beef?

Consumer survey results suggest that taste is a primary driver of food purchase decisions. Every year, the Food Marketing Institute conducts a nationwide survey to determine the needs and expectations of supermarket shoppers. Results of each of these surveys are published in an annual report titled *Trends in the United States – Consumer Attitudes and the Supermarket.* For more than a decade, "taste" has topped the list of factors considered "very important" by consumers when making food selection decisions (Food Marketing Institute, 1988, 1998). According to *Trends – 1998*, the second, third, and fourth most important factors affecting consumers' food selection decisions were "nutrition", "product safety", and "price," respectively (Food Marketing Institute, 1998). Feargal Quinn, chief executive of Superquinn Ireland (the second largest supermarket chain in Ireland), recently addressed the 12th World Meat Congress and summarized the overriding importance of "taste" (tenderness, juiciness, and flavor) in consumers' meat purchasing decisions as follows:

> The end-product is not meat, the end-product is taste. . . . Customers won't pay for food to satisfy their nutritional requirements, neither will they pay for it to conform to

> their needs on food safety. These matters are paramount issues for them, certainly. But, they are make-or-break issues. If they are satisfied, they will consider buying; where they are not satisfied, they will increasingly refuse to buy at all. . . . On the other hand, people will pay more for greater satisfaction, and taste is their measure of satisfaction in food. . . . Meat producers who are customer-driven must seek to influence the factors that affect taste, all the way from the field to the table. (Quinn, 1999)

In a recent NCBA marketing study (Moeller and Courington, 1998), consumers were asked to identify factors that would motivate them to purchase more beef. The most powerful incentives to purchase more beef identified by consumers in that study were 1) lower prices, 2) improved quality at the same price, and 3) greater consistency of eating quality (tenderness, flavor, and juiciness).

In another recent study conducted for the NCBA (Talmey-Drake Research & Strategy, Inc., 1998), consumers reviewed a concept card describing "Tender Select" beef (pretested to guarantee tenderness) and were provided with a pair of Select-grade strip loin steaks. Shear force measurements were used to verify that each pair of steaks consisted of one "tender" steak and one "marginally tender" steak. The consumers prepared and evaluated the steaks in their homes and 89% expressed intent to purchase the "Tender Select" product if it was available in their supermarkets. In addition, over one-third of the consumers indicated that they would be willing to pay up to $0.50 more per 454 g for the "Tender Select" product if it was available at their grocery. In a follow-up survey, 32% of consumers said they would eat more beef if "Tender Select" was available, and 34% indicated that they would consider replacing chicken purchases with purchases of "Tender Select" beef. The Talmey-Drake study provides compelling evidence suggesting that improving beef tenderness could have the desired effect of increasing consumer demand for beef and recapturing lost market share from alternative protein sources.

The long-term success of the Certified Angus Beef Program provides additional, empirical evidence supporting the premise that improving beef's quality and consistency could improve demand for beef. Even as domestic beef demand was decreasing from 1980 to 1997, the Certified Angus Beef Program experienced an average annual growth rate of over 40% (Colvin, 1998). During that time period, sales of Certified Angus Beef, positioned in the marketplace as a "premium-quality" product, at a "premium" price, increased from less than 453,592 kg to over 136,077,713 kg. Now, the challenge faced by the Certified Angus Beef Program is supplying the strong demand for their product (Colvin, 1998).

Developing a Consumer Focus

Improving beef's tenderness, quality and consistency will require a shift of focus from the things that matter most to producers to the things that matter most to consumers. Throughout its existence, the U.S. beef industry has been structured to produce and market a commodity (NCBA, 1998a). Today's beef production/marketing chain is segmented into a series of sectors (i.e., cow/calf producers, stockers/backgrounders, feeders, packers, retailers, and restaurateurs), each of which typically operates as an independent business entity (Figure 1). Because the various sectors are not integrated, and in many cases are business competitors, their profit motives usually do not coincide and their production goals are incongruent. The lack of integration and coordination in the beef production/marketing chain not only tends to foster the creation of inconsistencies and quality shortfalls among cattle and beef products, but also impedes efforts to align production goals with consumer expectations. Quinn (1999) remarked: "So long as you see meat as a commodity, you will be driven by quantity – and so long as you do, the overall price trend will inevitably be downward. But if you can get away from the straitjacket of regarding meat as a commodity, you tend to concentrate not on quantity but on how you can best satisfy the needs of the customer."

Even though consumers currently pay different prices for beef products of different quality levels, these price signals are never clearly received by the cattle producer unless ownership of animals and beef products is maintained through the packing-processing sector (Figure 1). Currently, market signals that are transmitted from the retail meat case back through the beef production/marketing chain to the cow-calf sector reward low cost production of kilograms of salable beef (quantity) most often with only minor economic emphasis placed on differences in product quality. As a result, cattle production and management decisions are driven by the primary factors that affect short-term profitability of the individual production unit, where traits such as reproduction rate, maternal ability, and growth performance, traits related to the production of the most total kilograms of beef, are of greatest economic importance (Melton, 1995).

Obviously, producers cannot ignore profitability. So, unless they receive economic signals encouraging improvement of quality and consistency, there will be little change in production/management philosophy and product characteristics will continue to receive secondary emphasis. The question, then, is: How can producers' focus be shifted to address those concerns that are of greatest importance to consumers?

During the 1990s, a number of beef "alliances" were formed in an effort to coordinate the activities of the various beef production/marketing sectors and to develop beef systems that are more responsive to consumer expectations. The key feature of most of these alliances is that they are at least partially integrated via contractual partnerships among the various production/marketing sectors, with producers maintaining some share of ownership through the entire production/marketing chain (Figure 2). By sharing ownership through the entire system, producers also share the economic incentives stemming from satisfaction of the final consumer (i.e., they become more consumer-driven). In addition, many of these beef alliances feature product brands intended to deliver consistency, quality, and value to beef consumers. Keller (1998) noted that "brands are a way of focusing on those things that matter most to consumers. . . . Brands help you keep focused on long-term matters, whereas sales and profits are often concentrated on the short-term."

The development of alliances and branded beef programs not only helps to provide consumer focus and the necessary economic incentives for improving product quality and consistency, but also provides an opportunity for the application of total quality management (**TQM**) principles to facilitate the improvement of beef quality.

Rationale for a TQM Approach

Cattle constituting the U.S. "fed" beef supply are highly variable in biological type, age, and management background; most are grain-finished steers and heifers, but they are started on feed at different ages, given different growth-promoting implants, fed for differing periods of time, and slaughtered at different marketing end-points. Due to the inherent variation in the "fed" cattle population, stemming from both genetic and environmental effects, beef available to U.S. consumers also is quite variable in eating quality, particularly with respect to tenderness (Morgan et al., 1991; George et al., 1999).

The current system for ensuring product quality in the beef industry involves "mass inspection" (i.e., USDA quality grading) of carcasses near the end of the production process. Although this system results in general categorization according to palatability differences, product value is lost due to imprecision of grading methodology and because products with "inferior" quality have been produced and must be merchandised at discounted prices. W. Edwards Deming, often cited as the originator of the "quality revolution" that has swept through American industry, recommended that industries "cease dependence on inspection to achieve quality" and "eliminate the need for inspection on a mass basis by building quality into the product in the first place" (Deming, 1986).

An alternative approach for ensuring beef quality based on TQM principles was proposed at the National Beef Tenderness Conference (NCA, 1994). Application of a TQM system for the assurance of acceptable beef quality requires identification of causes of nonconformance (in this case, "taste") and focuses on prevention of nonconformance through control of inputs and processes.

Defining "Taste"

Quality management focuses on the control of processes to produce a desired outcome. So, a key step in the application of a quality management system is defining, using relatively specific terms, the "desired outcome" expected to result from application of an integrated management system. In the context of our discussion, the objective of quality management is to improve the "taste" or palatability of beef. Research involving frequent beef users (NLSMB, 1995) has shown that consumers' perceptions of "taste" (reflected by overall like/dislike ratings) are associated with differences in juiciness (r = .79), flavor (r = .86), and tenderness (r = .85).

Juiciness of a beef product is determined by the amounts of water and fat remaining in the muscle after the product has been cooked (Smith, 1997) and is strongly influenced by degree of doneness (Lorenzen et al., 1999). Beef cuts with high water-binding ability and(or) with high levels of intramuscular fat are juicier, following cooking, than are cuts that have a low water-binding ability and(or) low levels of intramuscular fat, and such differences in juiciness become more pronounced as degree of doneness increases (Luchak et al., 1998).

Beef flavor desirability is associated both with amount and composition of intramuscular fat (Smith, 1997), which can be affected by forage vs grain feeding (Bowling et al., 1978), and by the number of days cattle are fed a high-concentrate finishing diet (Dolezal et al., 1982). Flavor desirability increases as marbling amount and USDA quality grade increase (Savell et al., 1987; Lorenzen et al., 1999).

Differences in beef tenderness are related to differences in 1) the amount of connective tissue within the muscle, 2) the formation of collagen cross-linkages in the connective tissue component of the muscle, 3) the contractile state of the myofibrils in the muscle when rigor bonds are formed, 4) the amount and distribution of marbling within the muscle, and 5) the extent of postmortem muscle proteolysis that occurs in the muscle during the aging process (Smith, 1997).

Of the three components of beef palatability (tenderness, juiciness, and flavor), tenderness is most amenable to modification via process control. Therefore, subsequent discussion will focus mainly on the application of quality management principles for the assurance of beef tenderness. However, control of processes related to the deposition of intramuscular fat also will be mentioned because of the importance of marbling with respect to cooked beef flavor and juiciness.

Description of a Prototype Quality System for Ensuring Beef Tenderness

"Critical Control Points" and Process Control. In normal systems of beef production, there are several points at which management decisions are made that can have either positive or negative impacts on subsequent product quality. Using TQM terminology, these might be described as "critical control points" (**CCP**), defined for the purposes of our discussion as points at which process control might impart desired product quality characteristics (in this case, acceptable beef tenderness). Figure 3 outlines a prototype quality system that might be used for ensuring beef tenderness. This outline is presented simply to illustrate use of a TQM approach for tenderness assurance and should not be interpreted as a comprehensive list of CCP for the improvement of beef tenderness.

CCP 1 – Genetic Inputs. Previous studies have documented a genetic basis for differences in beef tenderness and intramuscular fat content (Shackelford et al., 1994; Wulf et al., 1996b; O'Connor et al., 1997). Although tenderness differences between breeds (particularly *Bos indicus* vs *Bos taurus* cattle breeds) have been identified (Crouse et al., 1989; Sherbeck et al., 1995; Wheeler et al., 1996), research conducted in the past few years suggests that differences in tenderness among sires within breeds are greater than mean tenderness differences among breeds (Wheeler et al., 1996; Wulf et al., 1996b; O'Connor et al., 1997). Because tenderness and marbling are moderately heritable traits (Koch et al., 1982; Green et al., 2000), sire selection to improve beef palatability should be effective. Yet, the time and expense required to change tenderness via traditional selection methods frequently are cited as impediments to a genetic solution for the beef industry's product quality problems (Koohmaraie et al., 1995; Dikeman, 1996). At the present time, seedstock and commercial cattle breeders must still rely on traditional methods such as progeny testing to obtain meat tenderness and carcass information for selection purposes. However, bovine gene mapping studies have detected DNA markers identifying quantitative trait loci associated with differences in tenderness and marbling (Taylor et al., 1996; Keele et al., 1999; Stone et al., 1999) that soon could facilitate marker-assisted selection of cattle for improved beef palatability (Green et al., 2000). Such advances would greatly enhance the efficacy of producer intervention at CCP 1 to improve beef palatability characteristics.

CCP 2 – Preslaughter Cattle Management. Management practices that alter the endocrine status of the animal are perhaps the most important preslaughter processes that may be controlled to influence beef tenderness and deposition of marbling. The most widely used method of endocrine modification is castration of male cattle (Unruh, 1986). Intact male cattle generally produce less tender beef than do steers (Seideman et al., 1982) because 1) elevated serum testosterone levels, coinciding with sexual development at 8 to 14 mo of age, are associated with a concomitant increase in intramuscular collagen content (Boccard et al., 1979; Cross et al., 1984) and 2) higher calpastatin activity in the musculature of bulls causes their cuts to age more slowly than do cuts from steers (Morgan et al., 1993). In addition, carcasses produced by bulls have less marbling than do carcasses of steers (Seideman et al., 1982).

A growing body of evidence suggests that the use of exogenous hormones (implants) to increase growth rate and efficiency of feed utilization may be detrimental to tenderness and reduce deposition of intramuscular fat, especially when very potent anabolic agents are used repeatedly or when implants are administered too near the date of slaughter (NLSMB, 1995; Morgan, 1997; Roeber et al., 1999). Other preslaughter factors that have been shown to affect tenderness and(or) deposition of intramuscular fat include the number of days the animal is fed a high-energy diet (Tatum et al., 1980; Dolezal et al., 1982; Van Koevering et al., 1995), health status of the animal during the growing and finishing periods (Gardner et al., 1999), age at castration (Martinez-Peraza et al., 1999), intramuscular injection of animal health products (George et al., 1995), temperament and(or) antemortem stress (Voisinet et al., 1997), age (Wulf et al., 1996a), and relative fatness (Dikeman, 1996) of the animal at slaughter.

To encourage U.S. producers to adopt "quality management" practices, the NCBA Beef Palatability Task Force recently established the following preslaughter management recommendations: 1) eliminate aggressive use of anabolic implants; 2) discourage excessive use of biological types with known, wide variability in tenderness; 3) eliminate intramuscular injections; 4) slaughter all cattle prior to 30 mo of age; 5) castrate bull calves as early as possible, and prior to 7 mo of age; and 6) eliminate short (less than 100 d) feeding programs, especially for large biological types of cattle.

CCP 3 – Early Postmortem Management. Two early postmortem rate variables (rate of cooling and rate of postmortem glycolysis) interact to affect beef tenderness (Lee, 1986; Marsh et al., 1987; Geesink et al., 1995), and both are subject to process control. Beef processors can 1) manipulate air temperature and velocity to control chill rates and 2) electrically stimulate carcasses to accelerate the rate of postmortem glycolysis (Marsh et al., 1988; Mallikarjunan and Mittal, 1995). Existing research information suggests that management of early postmortem conditions requires simultaneous consideration of both cooling rate and glycolytic rate to produce desired effects on tenderness. For example, when the cooling rate of a carcass is rapid, acceleration of glycolysis and early rigor development resulting from electrical stimulation (high or low voltage) improves tenderness (Savell et al., 1977b; Marsh et al., 1987), but when carcasses are cooled slowly, accelerated glycolysis (resulting from low frequency or low-voltage stimulation) can result in appreciable toughening (Takahashi et al., 1984; Unruh et al., 1984; Marsh et al., 1987). Delayed chilling or reducing the chill rate of slow glycolysing beef carcasses improves tenderness (Dutson, 1977; Lochner et al., 1980; Lee and Ashmore, 1985) but also can result in more rapid proliferation of microorganisms. Any effort to improve tenderness must be balanced with efforts to maintain and improve product safety. Therefore, use of slower chill routines is not recommended. However, it is noteworthy that chill routines involving extremely rapid chill rates also have been found to produce more tender beef than do conventional chill procedures (Bowling et al., 1987; Joseph, 1996). Koohmaraie (1996) discussed the effects of very rapid chilling on beef tenderness and outlined a hypothetical intervention strategy for the early postmortem period using electrical stimulation, followed by very rapid chilling and conditioning at –5°C to prevent development of toughness in beef carcasses. Other practices that might be considered for intervention at CCP 3 to enhance beef tenderness include, but are not limited to, pelvic suspension of beef carcasses (Hostetler et al., 1972) and skeletal alteration to permit muscle stretching (Wang et al., 1994; Ludwig et al., 1997).

CCP 4 – Postmortem Aging. The length of the postmortem storage/distribution interval for fresh beef cuts affects tenderness and may be considered a CCP for ensuring product quality. In today's beef industry, very few U.S. packers age beef in carcass form. Yet, because of the time required to transport vacuum-packaged, chilled, boxed beef cuts from the point of slaughter and fabrication to the point of purchase, nearly all fresh beef is aged for some period of time before purchase by consumers. However, the time period between packaging and purchase is extremely variable. A recent nationwide survey conducted by George et al. (1999) determined that the time period between fabrication/packaging and retail display for beef strip loins and top sirloins ranged from 2 to 91 d (mean = 20 d). These findings are similar to data for postfabrication aging time (range, 3 to 90 d; mean, 17 d) reported in the National Beef Tenderness Survey (Morgan et al., 1991). At the National Beef Tenderness Conference, it was recommended that beef cuts be aged for at least 10 d to ensure acceptable tenderness (NCA, 1994). Survey results reported by George et al. (1999) suggested that approximately 10% of beef loin steaks were available for purchase in fewer than 10 d from the time of fabrication. Interestingly, nearly 10% of cuts also were offered for sale to consumers more than 35 d after fabrication. Preventing short-aged products from reaching consumers is a readily attainable goal for quality-driven beef suppliers and meat retailers that could contribute to the reduction of toughness problems. Perhaps a "sell-after" date could be placed on packaging to encourage adequate aging of products. Moreover, use of "sell-by" dating on packaging could reduce the incidence of products stored and aged for extremely long periods, and this could improve stability of product quality characteristics.

Verification of Conformance to Specifications. A key element of the quality system outlined in Figure 3 is the verification step. Products must be inspected and tested to verify that they conform to specified requirements (i.e., a specified level of tenderness). Scientists at the U.S. Meat Animal Research Center recently designed a system for measuring shear force at 1 to 3 d postmortem under commercial processing conditions (Shackelford et al., 1999). In this system, a cross-section of the longissimus muscle is obtained from a beef carcass at 1 to 3 d postmortem and cooked using a belt grill. A slice 1 cm thick then is removed from the longissimus sample (parallel to the orientation of the muscle fibers) and used to predict aged longissimus tenderness. Data reported by Shackelford et al. (1997, 1999) suggest that longissimus shear force measured at 1 to 3 d postmortem is a reasonably accurate predictor of longissimus shear force after 14 d of aging. Other noninvasive systems for predicting aged beef tenderness have been investigated and, with further development, also may be useful for tenderness verification (Wulf et al., 1998; Wyle et al., 1999).

In the quality system outlined in Figure 3, measurement of longissimus shear force at 1 to 3 d postmortem has two very important purposes. First, this measurement is used to verify conformance of products to desired tenderness specifications. In our prototype system, the "critical limit" for longissimus Warner-Bratzler shear force measured at 1 to 3 d postmortem (using a conventional 1.3 cm core) was specified as 5 kg. Cuts from carcasses with longissimus Warner-Bratzler shear force values below 5 kg at 1 to 3 d postmortem are classified as "Tender" and are distributed for consumption after a 21-d period. Cuts from carcasses exceeding the "critical limit" for longissimus shear force of 5 kg at 1 to 3 d postmortem are classified as "Tough" and subjected to further processing to improve tenderness (Figure 3). Second, this measurement may be used as a basis for "corrective action" by providing "feedback" of tenderness information (Figure 3) to producers for use in genetic improvement of tenderness (at CCP 1) and for correction of management-related tenderness problems (at CCP 2, CCP 3, and CCP 4). Currently, obtaining tenderness data for selection purposes is difficult and expensive. However, if shear force data were collected routinely for sire-identified cattle using an automated system, producers could have continuous access to tenderness information, allowing them to track genetic progress.

Control of Nonconforming Product. After nonconforming products have been identified (Figure 3), one or more of several different postmortem technologies may be employed to improve their tenderness characteristics. Technologies that could be applied for this purpose include, but are not limited to, 1) calcium-activated tenderization **(CAT)**, which involves injecting beef cuts with a solution containing calcium chloride to increase the rate and extent of muscle proteolysis (Koohmaraie et al., 1995); 2) Hydrodyne (Solomon et al., 1997; Calkins, 1997), which involves the use of an explosion to generate hydrodynamic shock waves in water, causing tenderization of meat cuts submerged in the water; 3) blade or needle tenderization (Savell et al., 1977a), which already is used widely among meat purveyors; 4) injection of cuts with solutions containing sodium phosphate and sodium lactate (Vote et al., 2000), which is used routinely in the pork industry to enhance tenderness and flavor of fresh pork products; 5) use of marinades (Scanga et al., 2000); and 6) further processing, which might involve cubing, cooking, grinding, or flaking.

Performance of the Prototype Quality System. The effectiveness of the prototype quality system for improving beef tenderness was tested in a recent study (Tatum et al., 1999). The test population of cattle was genetically diverse but was constrained to include youthful (14- to 17-mo-old) steers with no more than 3/8 *Bos indicus* inheritance. Feeding and preslaughter management of the cattle were consistent with procedures recommended for production of beef of an acceptable quality level. The steers were slaughtered at an end point of 11 mm of external fat thickness over the longissimus muscle, and 92% of the steers produced carcasses grading Select and low Choice. Application of the prototype quality system, which involved control of genetic inputs as well as preslaughter and postslaughter processes (electrical stimulation, aging, and, in some cases, calcium chloride injection), reduced the expected rate of nonconformance from about 1 in 4 (23% for top sirloin steaks, 26% for strip loin steaks) to 1 in 25 (4%) for top sirloin steaks and 1 in 100 (1%) for strip loin steaks (Tatum et al., 1998). Use of process control in a quality management system may be an effective approach for improving the tenderness, quality, and consistency of beef.

Implications

From 1980 to 1997, U.S. domestic beef demand declined by approximately 48%. Beef industry leaders believe that improving product quality and consistency would reverse this trend and increase consumers' demand for beef. Research has identified a number of factors, including genetic effects, preslaughter management practices, and postslaughter technologies, that could be incorporated into a quality management system for the improvement of tenderness and quality of beef. Research results indicate that the use of process control in a quality management system may be an effective approach for ensuring beef tenderness and quality.

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Notes

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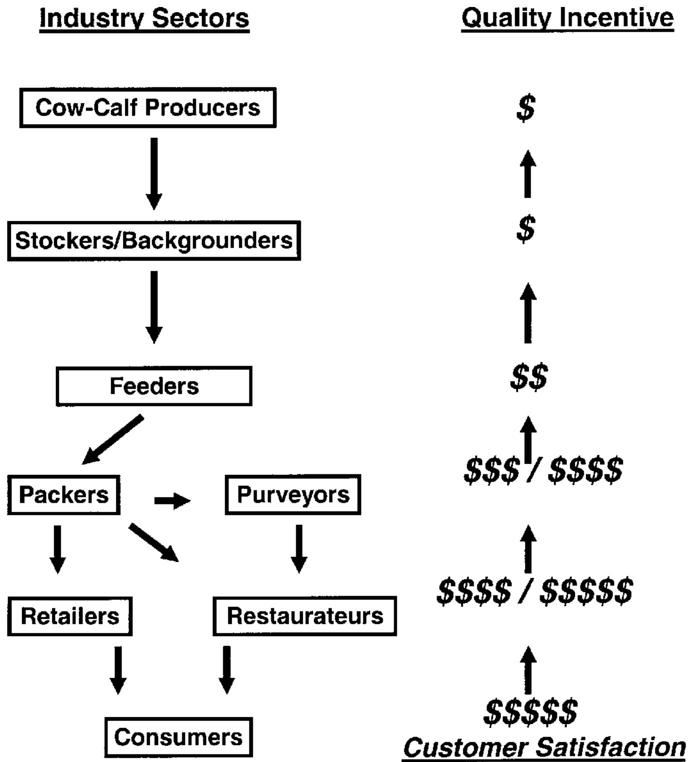

Figure 1. Schematic diagram of a segmented, commodity-driven beef production system showing the lack of economic incentive for producers to improve quality and consistency.

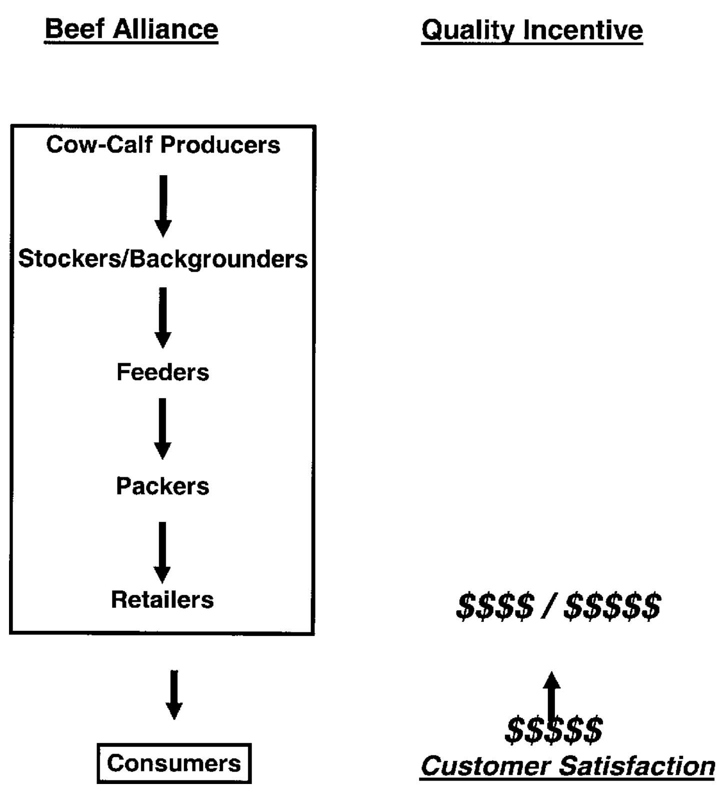

Figure 2. Schematic diagram of a "beef alliance" structure with greater economic incentive for producers to improve quality and consistency.

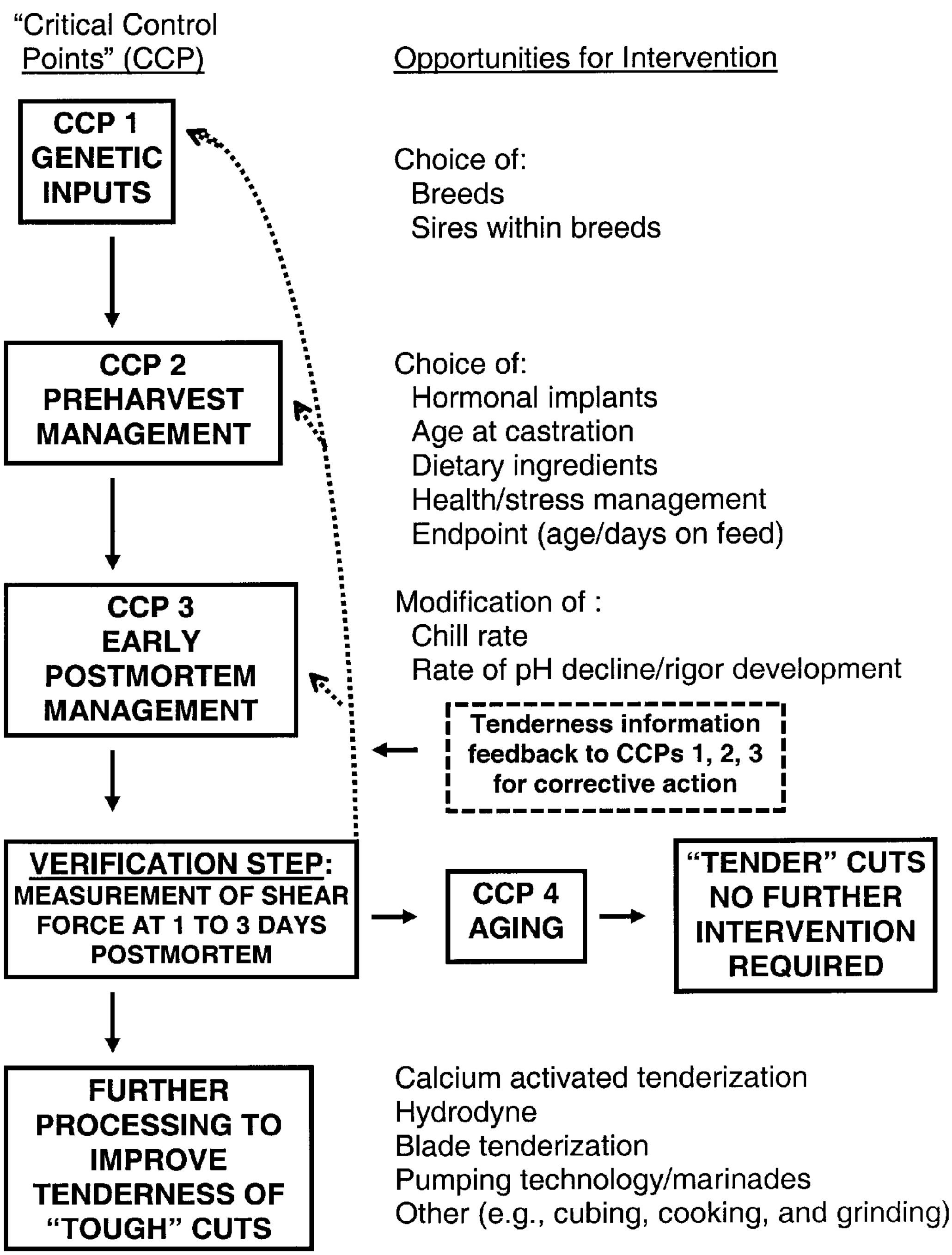

Figure 3. Outline of a prototype quality system that might be used for ensuring beef tenderness.

