

National Beef Instrument Assessment Plan (NBIAP) III Meeting: The Next Five Years

Carol Lorenzen, Ph.D.

EXECUTIVE SUMMARY

The ability to assess beef yield and quality consistency is something that the beef industry has been striving to accomplish for a number of years. Assessment consistency will enhance communication between all segments of the beef industry. The Beef Checkoff through the National Cattleman's Beef Association brought together a group of industry professionals that encompassed all segments of the beef chain with representatives from the processing, retail and foodservice segments, as well as university and government personnel, to address the challenges associated with instrument assessment on August 21 and 22, 2007 in Denver, Colorado. This group was assigned the task of developing research and implementation strategies for beef instrumentation technology over the next five years. This summary is a compilation of the reviews provided by meeting attendees. It addresses the current state of technologies related to instrument grading of beef carcasses and ongoing research related to using instruments to predict beef tenderness.

Beef Instrumentation Technology – An Overview

The meeting started with an overview of the current meat grading technologies being implemented by the meat industry from both an industry and government perspective. The participants and speakers then turned their attention to tenderness instrumentation. A general discussion of the principles behind the near infrared (NIR) technology, the technology used most often for tenderness prediction, was followed by the economic importance of tenderness. Finally, the state of research as it relates to managing tenderness both in the live animal and meat was discussed.

What Works Now?

Glen Dolezal, Ph.D., Cargill Meat Solutions

Cargill Meat Solutions has been using vision grading technology for the past 15 years. The E + V Vision Grading System (Erdgasversorgung Oranienburg GmbH, Oranienburg, Germany) has been installed in all of Cargill's steer and heifer processing facilities since May, 2007 gathering over 40,000 images daily. The grading system is being used to assess carcass merit for individuals, serve as a performance score card for cattle buyers, manage fabrication floor yields, and track accuracy, repeatability and sameness of USDA graders. The grading system provides viable images at least 97% of the time in their facilities. The vision grading system is used for collecting measurements related to both USDA yield and quality grades. Cargill Meat Solutions is currently working with the USDA-Agricultural Marketing Service to adopt vision grading technology to sort carcasses for USDA certified programs.

Cargill Meat Solutions fully supports the implementation of instrument-based grading and carcass assessment. In order for this to be successfully utilized by the beef industry, instrument-based grading augmentation must be implemented seamlessly to avoid disrupting trade and producer payments. In addition, there needs to be full participation by all packers for augmenting USDA yield and quality grades and certifying premium programs.

All of the brands of beef produced by Cargill Meat Solutions have a tenderness claim. This tenderness claim is managed through pre-harvest quality control points and multiple post-harvest patented processes. The tenderness claim is verified through random testing using slice shear force after 14 days of aging. Cargill is currently working on the implementation of an on-line tenderness prediction technology and has found positive trends in their data.



Figure 1. E + V Vision Grading System Display (Courtesy of Cargill Meat Solutions)

For any instrument that predicts tenderness to be embraced and utilized by the beef industry, it needs to be an objective, non-invasive system that is as reliable as the existing vision grading instruments. Cargill's goal is to be able to pay for cattle based on tenderness. However, current data shows that 90% of the beef produced by Cargill Meat Solutions is tender so the technology would be used for identifying the other 10%. They will discount beef from the tough carcasses, as opposed to providing a premium for tender beef, since the tough carcasses do not fit their general population.

Implementing Beef Instrument Grading Technology

Martin O'Connor, USDA-Agricultural Marketing Service

The USDA-Agricultural Marketing Service (AMS) is interested in evaluating technology to aid graders because of several challenging factors: increased chain speeds, inconsistent presentation of carcasses because of chain speeds, environmental conditions (e.g. lighting, height of ribeye), and grader to grader subjective evaluation. In the past, AMS has provided graders with tools such as ribeye dot grids, preliminary yield grade rulers, and marbling cards. At current chain speeds, instruments can reduce variation and enhance accuracy and precision of the evaluation of USDA yield and quality grade factors. AMS performance standards were released for using instruments to determine ribeye area in 2003, USDA yield grade in 2005, and marbling score in 2006. For plants adopting instrument grading technology, the AMS is responsible for in-plant monitoring and validation. This is done by providing continuous on-line review of the operation.

The adoption of instrument grading technology has had many positive impacts on the beef industry. Within the AMS, instrument grading has enhanced grading accuracy and consistency, improved producer and packer confidence in the grades, and increased efficiency in the workplace. The beef packing industry has been impacted by increased accuracy and

Table 1. USDA-Agricultural Marketing Service Role in Instrument Grading Application

Operational Procedures	Monitoring Procedures	Verification Procedures
Installation	Sawing/ribbing	Calibration
Training	Over trimming in key areas	Employee training
Calibration	Carcass identification	Equipment operation
Testing	Continuous review of on-line	Operator performance
Maintenance	Operation	Camera accuracy
Traceability	Validation	Process flow
Operation		Presentation of data and carcass to meat grader
		Grade rail-outs
		Schedule rail-outs
		Retention data
		System security and integrity of the data

precision of the instruments, greater uniformity, and stronger basis for portioning value. In addition, greater instrument resolution offers new opportunities for new products and customer offerings. The benefit to beef producers is that instrument grading provides a stronger foundation for value-based marketing grids, provides more accurate market signals throughout the beef chain, and provides a better understanding of the impact of management decisions on animal value.

Introduction to Near Infrared Analysis

Brian Curtiss, Ph.D., Analytical Spectral Devices

Near infrared (NIR) spectroscopy uses a portion of the light spectrum within the visible range. The principle behind this technology is light's interaction with matter. When white light is shone onto an object, some percentage of that light returns so measurements can be made based on differential light absorption of material. The constituents of the material will have different characteristics and the composite spectrum is influenced by all of the materials present. The advantages of near infrared spectroscopy are that it is rapid, non-destructive, accurate and precise, requires little sample preparation, and is easy to operate. The one disadvantage is that it is a secondary measurement technique meaning that initial calibrations must be done against another laboratory method.

The following steps are necessary to apply NIR spectroscopy as an analysis tool:

- 1. Define the material.** The type of material, properties of interest, analysis of properties, and how the materials will be presented to the spectrometer must be defined.
- 2. Collect a spectral library using selected samples, a defined procedure and defined spectrometer settings.** The sample spectra are then matched to a spectral library and tested for outliers.
- 3. Develop the calibration.** To do this, sample spectra are combined with reference analysis to assess the calibration accuracy.

4. Apply the calibration to unknowns.

5. Update the calibration by adding new sample spectra that represent relevant sample attributes.

For near infrared technology to be applied to the meat industry, some adjustments had to be made to bench-top technology because of the harsh environment found in processing facilities. All instrument technologies need to be operable at temperatures near freezing, withstand sanitation procedures, be operated by non-technical operators, have diagnostics that ensure accurate results, and have the ability to integrate with existing in-plant information systems.

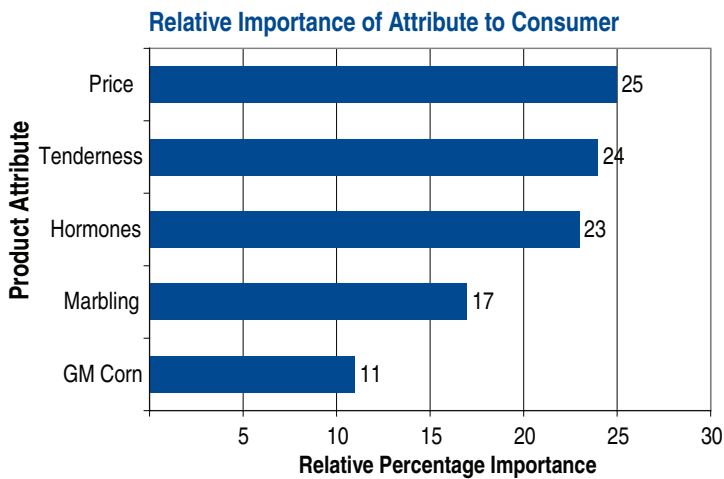
Economics of Beef Tenderness

Ted Schroeder, Ph.D., Kansas State University

Based on scientific literature, the top seven attributes that beef consumers demand are: safety, tenderness, flavor, consistently high quality, convenience of preparation, healthy and nutritious, and competitively priced. Of these, safety, tenderness, flavor, consistently high quality, and healthy and nutritious are attributes that can not be discerned by looking at the raw product when you purchase it. This means that explicit labeling and branding are essential to convey the information to the consumer.

Two willingness-to-pay studies (Gao and Schroeder, 2007; Loureiro and Umberger, 2004) revealed that consumers are willing to pay a premium between \$1.14 and \$2.76 per pound for guaranteed tender beef. Another study (Lusk and Fox, 2000; Figure 2) revealed that tenderness is of equal importance to price and more important than marbling to the consumer.

Figure 2. Relative importance of beef attributes to consumers



Source: Lusk and Fox, 2000

While tenderness continues to rate high on preference ordering and consumers are increasingly willing to pay for guaranteed tender meat, consumers have little to no tolerance for tenderness failures. This means that a meat product that is assured to be tender has more value than one produced to increase the probability for tenderness. Tenderness is an important attribute to consumers and a lack of consistently tender beef will ultimately hurt beef demand.

Pre-Harvest Management of Beef Tenderness

Daryl Tatum, Ph.D., Colorado State University

Managing tenderness creates opportunities to add value to cattle and beef by consistently providing consumers with a pleasurable eating experience. Tenderness can be enhanced by producers through controlling breeds and genetic inputs, using feeding systems that are known to enhance product quality, applying growth enhancement technologies judiciously, and implementing “best management practices” to avoid beef quality and tenderness problems stemming from morbidity and pre-harvest stress.

Managing genetic inputs – Short-term impact is realized by balancing various breed strengths (e.g., environmental adaptability, maternal performance, growth, carcass yield, and carcass/meat quality). Crosses that include 50 to 75% British breed influence and 25 to 50% Continental breed influence are effective for balancing the growth performance and carcass yield advantages of the Continental breeds with the maternal performance and beef quality advantages of the British breeds. In tropical-like U.S. environments, moderating Zebu breed influence (maximum of 25 to 38%) can help avoid tenderness problems without completely sacrificing the adaptability of heat-tolerant breeds. Longer-term impacts may be realized by selection for tenderness within breeds. Tools to assist in selection for improved tenderness include expected progeny differences (EPDs) and commercially available gene markers.

Feeding systems – Cattle finished on grain have been shown to produce brighter colored, finer textured lean, whiter fat, and more marbling than cattle finished on grass. In addition, grain feeding improves tenderness and imparts a characteristic grain-fed flavor to beef. Recent research has also shown that calf-fed (longer-fed) cattle produce more tender beef than yearling-fed (shorter-fed) cattle when both are fed to the same USDA quality grade endpoints (Brewer et al., 2004). Most of the benefits associated with grain feeding occur within the first 80 to 100 days of the finishing period. Finishing periods longer than 100 days for yearling cattle provide little additional benefit.

Growth enhancement – Growth enhancers such as implants and beta (β)-agonists increase weight gain and profitability during the feeding period but also decrease tenderness to varying degrees if used improperly. Tenderness is influenced by both the number and dosages of implants used during finishing. Repetitive implanting can decrease carcass quality and tenderness, particularly when implants containing high doses of androgens and estrogens are used. If the feeder’s goal is to minimize beef toughness problems, aggressive implant programs should be avoided. Single ingredient implants (estradiol for steers; trenbolone acetate (TBA) for heifers) tend to have the mildest effects on carcass quality and tenderness. Additionally, low- to mid-dose combination (estrogen + androgen) implants can be used without severely affecting beef quality; however, high-dose combination implants should be used no more than once during finishing to avoid beef quality problems. Effects of β -agonists on growth and beef quality are additive to the effects elicited by implants. In general, the greater the growth response elicited by combined use of β -agonists and implants, the greater the observed reduction in beef quality and tenderness.

Management practices – Minimizing pre-harvest stress results in calmer cattle that produce more tender beef. In order to reduce stress, producers should avoid aggressive handling, excitement, or physical activity of cattle before, during, or following transportation to the processing facility. During transportation, long transit times or scheduling delays that prevent prompt unloading of cattle should be avoided. In addition, mixing cattle from different pens when they arrive at the processing facility should be avoided.

Post-Harvest Management of Tenderness

Gary Smith, Ph.D., Colorado State University

Post-harvest management of tenderness involves interventions applied before or during chilling, interventions used to categorize beef carcasses in the cooler, and practices that can be applied to primal and subprimal cuts of beef.

Before and during chilling – Interventions applied before and during chilling, while effective, may be preventing toughness as opposed to increasing tenderness. Electrical stimulation applied appropriately on the processing floor can improve tenderness. Suspension of carcasses by the pelvis improves tenderness of major muscles but also changes their shape. In addition, chilling carcasses over 48 hours, rather than 24 hours, can increase tenderness.

Cooler – Sorting cattle based on physical characteristics such as color, marbling, hump height, and skeletal maturity can generate populations of products that are more tender. This sorting can be accomplished using visual appraisal or currently available instruments.

Primals and subprimals – Postmortem aging for the appropriate periods of time at the appropriate storage conditions can improve tenderness in cuts that are low in connective tissue. Mechanical tenderization is effective in improving tenderness in all cuts. The use of marination with tropical-plant enzymes, when applied properly, can also improve tenderness. Moreover, high pressure processing can improve tenderness but there are cost concerns with this process.

Research Overviews: Tenderness Prediction

The Beef Checkoff has provided funding to individual researchers to pursue instrumental prediction of tenderness. Several of these researchers were asked to present their findings to the group and the summary of that discussion follows.

Jeyamkondan Subbiah, Ph.D.

University of Nebraska – Lincoln

Subbiah and his collaborator, Chris Calkins, Ph.D., use hyperspectral imaging to predict beef tenderness. Hyperspectral imaging uses both video image analysis (VIA) and near-infrared (NIR) spectroscopy and can capture both muscle structure and biochemical properties of meat. Hyperspectral imaging provides both the high spatial resolution of VIA and the high spectral resolution of NIR spectroscopy. This method distinguishes between fat and lean through different spectral responses produced at different wavelengths.

Hyperspectral imaging was accurate 96.5% of the time in an initial University of Nebraska study conducted using steaks (n = 111) aged 14 days to predict slice shear force classification into three categories (tender, intermediate and tough). The technology was successful in identifying all of the steaks classified as tough through the slice shear force method.

Next, Subbiah and Calkins used hyperspectral imaging on steaks (n = 314) aged three to four days to predict tenderness at 14 days of aging using slice shear force. Out of the 243 bands

generated, 12 were found to be key bands for use in prediction. When the steaks were classified into tender, intermediate, and tough categories using slice shear force, the technology had a prediction accuracy of 79%. However, when the number of categories was reduced to two, tender and tough, the prediction accuracy increased to 96%. Cross-validation was also done on these same steaks using sensory analysis. Hyperspectral imaging was able to predict trained sensory analysis responses into three categories (tender, intermediate, and tough) with 73% accuracy and into two categories (tender and tough) with 86% accuracy. Prediction accuracy was similar for both re-substitution and cross-validation methods indicating that the hyperspectral imaging system is robust. Therefore, hyperspectral imaging is expected to predict a different carcass population with similar accuracy in an in-plant setting.

J. Brad Morgan, Ph.D.

Oklahoma State University

Morgan and colleagues have conducted research using NIR technology and in-plant VIA systems to predict tenderness of beef. Both near-infrared projects utilized “off-the-shelf” equipment purchased by Oklahoma State University. In the first project, the near-infrared equipment was used to classify steaks (n = 476) as tender, intermediate, or tough using Warner-Bratzler shear force. Morgan and colleagues were able to predict these three classifications with 90% accuracy and were able to accurately classify all of the tough steaks. This technology was capable of using spectral reflectance to segment steaks based on shear force. This technology was also able to predict tender, intermediate, or tough classifications based on Warner-Bratzler shear force with 85% accuracy on 276 steaks. Morgan and colleagues then investigated the technology’s ability to predict slice shear force on low Choice and Select steaks (n = 200) aged 14 days. The technology was able to discriminate between steaks that were certified as tender and those that were not.

Morgan also reported on research conducted using the NIR and VIA technologies to predict slice shear force values on steaks (n = 51) aged for either 7 or 14 days. By combining these technologies, researchers were able to explain 90 and 91% of the variation associated with slice shear force. Morgan and others further divided the tenderness categories into tender, intermediate and tough. They were then able to predict the correct category of tenderness based on 14 day slice shear force values 75% of the time using NIR and VIA technologies.

Keith Belk, Ph.D.

Colorado State University

Belk and his collaborators at Colorado State University evaluated both the Australian VIAScan™ (Sastek PTY LTD, Brisbane QLD Australia) and the Computer Vision System™ (RMS Research Management Systems USA, Inc., Fort Collins, CO) to predict beef carcass yields when fabricated to less than, or equal to, 0.25 inch fat trim. Belk reported that both of the instrument assessment systems were substantially more accurate in predicting carcass yields and had lower absolute errors than USDA yield grades assigned to carcasses on-line at chain speeds. The CSU researchers also investigated using the

two differing VIA systems to augment application of USDA grades. In this case, the online VIA augmentation systems, [Assigning ribeye area and performing calculations of yield grade; on-line graders determined adjusted preliminary yield grades (PYGs) and percent kidney, pelvic and heart fat (%KPH)], approached the accuracy of grade assignment to carcasses by expert graders that were not constrained by time or carcass motion during the evaluation process. This fortifies the concept that instruments would improve grade placement accuracy at chain speeds and allow assignment of yield grades to the tenth of a yield grade unit. Belk provided evidence that augmentation of current USDA yield grade placement with instrumentation could increase the value of carcasses by up to \$115.00 per head if used to sort carcasses to maximize selection of fabrication style. Based on their experience with these machines, Belk and collaborators concluded they were integral in the development of USDA instrument approval standards and the approval of two VIA systems to measure ribeye area and assign yield grades to beef carcasses.

Belk also reported on the performance of BeefCam™ (RMS Research Management Systems USA, Inc., Fort Collins, CO), which uses visible reflectance color measurement in conjunction with evaluation of marbling features and other ribeye attributes to predict beef tenderness. Cattle certified with the BeefCam™ were, on average, more tender ($P < 0.05$) than those that were not certified. Nonetheless, the need exists to continue research efforts to develop and implement instrumentation that accurately and precisely forecasts eating quality attributes of beef. Belk invited Dr. David Goldberg, CEO of Tenera Technologies, to share a new idea of using high-resolution imaging to improve accuracy and precision of tenderness predictions. This technology appeared to merit further investigation.

In addition, during 2005-2006, CSU scientists and graduate students worked closely with USDA-AMS and USDA-ARS to develop instrument approval standards for determination of marbling scores for beef carcasses. In that process, it was determined that regression statistical techniques were not adequate for purposes of measuring the performance of instrument assessments of marbling due to the fact that marbling scores are subjective and also variable when assigned by differing human graders. Likewise, it was determined during this research effort that extractable fat measures also were not suitable for measuring instrument performance when assigning marbling scores. Ultimately, the research collaboration settled on use of a Method Comparability statistical approach to approve instruments for assignment of marbling scores to beef carcasses. In 2006, two instruments were approved by USDA-AMS to officially assign marbling scores in commerce.

Lastly, Belk reported on additional roles and functions for which instrumentation could be used in industry to improve beef value. For example, he described the role that dark-cutting carcasses and carcasses with excessively small or large ribeye areas play in non-conforming discounts in commerce, and how instrumentation could better assess true carcass value when such non-conforming carcasses are encountered.

Carol Lorenzen, Ph.D. **University of Missouri-Columbia**

Lorenzen and her collaborator, Sheila Grant, Ph.D., used the principle of fluorescence resonance energy transfer to develop a biological sensor to detect calpastatin. Calpastatin is the primary component responsible for regulating the tenderness response due to meat aging. Fluorescence resonance energy transfer measures changes in fluorescence when two antibodies labeled with fluorescent dyes come in contact with each other in the presence of calpastatin.

Their first project, using purified calpastatin in a test tube, proved that a biosensor for calpastatin could be developed with a detection limit of 120 ng calpastatin/mL solution and a stable response time could be reached in five minutes. Lorenzen and Grant followed up on these results with a project designed to put the biosensor on an optical fiber and compare the biosensor readings with traditional calpastatin activity assays on calpastatin extracted from beef. This work resulted in strong correlations (0.501 - 0.597) between the biosensor readings and calpastatin assay on steaks aged for two days indicating that this would be the most appropriate time for taking biosensor readings. They reported some inherent variability within and between optical fibers. This makes other sensor platforms desirable for further research in developing an in-plant biological sensor.

The third project Lorenzen reported on used capillary tubes as a platform for the biological sensor. The capillary tube platform was able to increase the correlation between calpastatin assays and biosensor readings to 0.778. When the optical fiber and capillary tube platforms were compared for their variability, the capillary tube platform was found to be less variable ($P < 0.05$) indicating greater precision compared to the optical fiber.

Steve Shackelford, Ph.D. **Roman Hruska U.S. Meat Animal Research Center (MARC), USDA**

USMARC scientists have been using visible and near-infrared reflectance as a non-invasive means to predict beef tenderness. Shackelford reported on research that involved an “off-the-shelf,” portable spectroscopy system which could stand up to the rigors of a processing plant environment. The initial research focused on USDA Select carcasses as these carcasses are discounted but can be as tender as USDA Choice. In two different experiments, the percentage of cattle classified as tender, based on a 25 kg slice shear force, that were, in fact, tender ranged from 94.5 to 93.2% while the cattle that were not classified as tender that were, in fact, tender ranged from 76.8 to 69.9%. This indicated that the system should only be used to certify cattle as tender because the error in predicting tough cattle is too high to be acceptable.

USMARC scientists worked with the instrument vendor to develop a second generation system to facilitate on-line, real-time prediction of tenderness. This system was tested on 575 cattle and the error rate of certifying cattle with the incorrect classification was reduced to 0.9% for cattle classified as tender.

This system was then verified on 2,351 cattle where the error rate of certifying cattle with the incorrect classification was 7.3% for cattle classified as tender. Shackelford then reported on ability of the system to certify USDA Choice and Select cattle. The error rate of 6.5% was the same for both USDA quality grades for cattle classified as tender.

Collectively, these experiments have shown that this system reliably discerned tenderness differences across numerous studies undertaken in several processing plants and a diversity of production systems. Use of this system allows for identification of guaranteed tender beef for branded programs.

Industry Perspectives on Instrumentation

The following companies were represented on a panel that shared industry perspectives on beef instrumentation: Nolan Ryan's Guaranteed Tender Beef, IMI Global, Elanco Animal Health, Certified Angus Beef, and Swift & Co. These companies are currently using instrumentation to segregate carcasses based on tenderness and color, to manage and sort cattle in the feedyard, and to provide a means for conflict elimination. All members of the industry panel expressed a need for uniformity in the execution of types of instrumentation across the industry and uniformity of a value system to communicate information through the entire beef marketing chain. Members also agreed that there is not a current need for development of instrumentation systems at the foodservice or retail levels because these segments of the beef chain want beef sorted before it arrives. The question was raised on whether instrumentation should be utilized as process validation, identification of physical attributes, or a combination of the two. However, they all agreed that the most important issue is raising confidence in the technology in use versus how to use the data.

Summary of Presentations and Industry Panel Discussion

There is a need for multiple technologies to identify tenderness at multiple times during the beef chain. The instruments discussed at this meeting attempt to predict tenderness through the measurement of color, calpastatin, muscle structure and biochemical properties of meat. However, none of these single instruments integrates all of the factors that affect tenderness.

Many questions remain to be answered by the industry and researchers. The questions below were meant to serve as action points for moving the implementation of tenderness prediction technologies forward.

- Can technologies be integrated since one technology does not measure all aspects of tenderness?
- What is the difference between all of the different measurements taken by the current technologies? Can this be explained by a sophisticated data analysis?
- Where is the optimal point for measuring tenderness in the beef chain?
- What is the economic impact of using multiple tools at multiple levels of the beef chain?

- Can technologies be implemented uniformly?
- Should the technologies aim to eliminate a high percentage of tough or identify a high percentage of tender carcasses?

While large meat companies and the USDA have embraced the use of instruments to augment the application of USDA grades and segment carcasses to capture value in processing, not all believe that a tenderness problem exists. However, there is a need to establish the economic value of tenderness. Some of the current issues in beef production, such as the impact of corn production being used for ethanol or existing and new methods of increasing growth rate or efficiency, may negatively impact tenderness. Finally, the use of slice shear force versus Warner-Bratzler shear force was recommended at the National Beef Instrument Assessment Plan II meeting held in 2002 but it has not been universally adopted by researchers in academia and industry indicating an educational need.

- Does the tenderness problem need to be documented?
- What does a standard for tenderness look like?
- Do we need to continue to work on or refine end-product testing?

Finally, next steps for instrumentation and the role of The Beef Checkoff through the National Cattlemen's Beef Association in this process were discussed. Decisions about advancing the technologies that are available today are imperative.

- What types of research are necessary to make these technologies as accurate and precise as possible?
- What is the timeline for getting instrument tenderness assessment implemented?

Breakout Group Reports

The participants at the meeting were broken out into groups according to their interest to discuss, in more detail, industry and research needs for moving tenderness prediction technologies forward. These groups focused on: research for new instrumentation, the role of tenderness in customer satisfaction, and the role of The Beef Checkoff through the National Cattlemen's Beef Association in relation to these technologies.

What should be the focus be for new instrumentation research?

There is a need for a large, collaborative study comparing tenderness instrumentation technologies. This study should be conducted in multiple plants during different times of the year with measurements taken both on- and off-line. The cattle used in this study should be from defined genetics and established pre- and post-harvest management practices.

There is also a need for the integration of technologies with regard to tenderness instrumentation and a standardization of interfaces and reference measures. It was suggested that a task force be formed to direct study parameters and define a population.

Research Needs:

- Application of additional or alternative muscles to the longissimus muscle;
- The use of new technologies to predict tenderness;
- Use of instruments to predict tenderness at multiple points before end-product testing; and
- Basic flavor chemistry research focusing on the absence of beef flavor.

What about customer satisfaction and tenderness?

Customer satisfaction is integral to consumer demand for beef but it is difficult to define in a general term because of the variation between markets. The expectations of the consumer, processor, and producer need to be aligned. Can Customer Satisfaction Audit data be collected on a more ongoing basis? Would this help the industry understand the difference in customer satisfaction at the retail and foodservice levels?

Research Needs:

- Eliminate bad eating experiences by setting a threshold for tenderness;
- Focus on the process of producing tender beef and use instrumentation to increase the likelihood of delivery of a tender product;
- Develop tenderness instrumentation to point where it can play a role in third party verification; and
- Document demand drivers including consumer and marketing channel needs and price potential for certified tender product.

What is the role of The Beef Checkoff through the National Cattlemen's Beef Association for discovery and implementation of instrumentation systems for beef?

The Beef Checkoff through the National Cattlemen's Beef Association plays a role in research discovery and education related to instrumentation systems for beef. They can be instrumental in aiding industry, academic and government researchers in reaching a consensus on tender product claims, defining the parameters for instrument testing in a plant setting, and setting standards for tenderness measurement. The group educates all segments of the beef industry and those who are allied members of the beef industry by providing publications based on research and providing in-person education programs.

Research Needs:

- What can the industry do with tough carcasses or cuts?
- Can tenderness fit into value discovery?
- What are the cookery issues with tough carcasses or cuts?
- Can current instrumentation be used for value discovery in the cow population?

Implementation Needs:

- Determine the data needs of the industry;
- Identify potential grader disadvantages;
- Refine current technologies with respect to USDA yield and quality grades and tenderness;
- Use instrumentation as a sortation system to capture value during processing; and
- Develop color evaluation standard tools for lean and fat.



Summary

The need to establish a uniform tenderness threshold was discussed by each of the breakout groups and seems to be the number one priority. The current state of research indicates that tender meat can be identified more accurately than tough meat. The industry segments should guide researchers in determining if a tender and tough threshold is needed. If carcasses are identified as tough, an industry plan for improving their palatability is also needed.

Next steps include publicizing success stories about instrumentation for the 2008 Cattle Industry Annual Convention. This could ensure the implementation and acceptance of using instrumentation in the USDA yield and quality grading processes. Without the acceptance of the use of instrumentation in augmenting the USDA grades, work on tenderness instrumentation will not be applicable to the industry.

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