

Final Program Evaluation for Work Completed in Fiscal Year 2011 Beef Safety Research

See www.beefresearch.org for more information on checkoff research.

Contractor: National Cattlemen's Beef Association (Mandy Carr Johnson, Ph.D and Michelle Rossman M.S., program managers)

Note: Checkoff beef safety research projects (and the budgets approved for them) span multi-fiscal-year periods; therefore, reporting on specific efforts is grouped by the following areas:

- *Outcome summaries of research projects completed in a fiscal year*
- *Table of ongoing research in the fiscal year*
- *Summary of dissemination of research efforts*
- *Report on other AR tactics*

Outcomes of Projects Completed in Fiscal Year 2011

Methods for Effectively Controlling *E. coli* O157:H7, non-O157 *E. coli* and *Salmonella* during the Production of Non-Intact Beef Products

Subcontractor: Texas A&M University, Texas Tech University

Expected Outcome: This research was conducted to determine the efficacy of spray interventions on the reduction of *E. coli* O157:H7 and non-O157 STEC on the surface and interior of beef subprimals prior to and after needle tenderization (non-intact product) and cooking to rare and medium degrees of doneness.

Objective Achieved: The reduction in prevalence of each bacterium was evaluated after inoculation (10^6 or 10^2 cfu/cm²) and spray treatment with water, 2.5% and 5% lactic acid, 2% hypobromous acid, 1200 ppm acidified sodium chlorate, or 2% peroxyacetic acid prior to vacuumed storage for 14 d to simulate possible industry conditions. After 14 d, subprimals were needle tenderized and the presence of pathogens on steak surfaces (prior to cooking) and internal samples (from raw and cooked samples) was evaluated. Results suggest spray treatments of 2.5 or 5% lactic acid or 1200 ppm acidified sodium chlorate were most effective followed by 2% hypobromous acid, 2% peroxyacetic acid, or water at reducing the target pathogens on subprimal surfaces and in steak cores when followed by packaging and storage. These data also suggest non-O157 STECs, compared to *E. coli* O157:H7 strains, exhibited greater acid and heat tolerance throughout the study.

Identification and Characterization of Population(s) at greatest Risk for Presences of *Salmonella* Within Lymph Nodes

Subcontractor: Texas Tech University

Expected Outcome: Though cattle feces and hides can harbor *Salmonella* originating from the GI tract, the organism can also be sequestered within cattle lymph nodes. Oftentimes, these lymph nodes are present in the fat that is incorporated into ground beef. Therefore, the objectives of this project were to quantify prevalence of *Salmonella* in lymph nodes of fed and cull dairy cattle, and to determine whether a commercially available *Salmonella* vaccine protects calves from lymph-node colonization following significant oral challenge with *Salmonella*.

Objective Achieved: *Salmonella* was readily recovered from subiliac lymph nodes; however, regional and seasonal differences were observed. Prevalence was highest in fed cattle from the Southern High Plains, averaging 15.9%, and ranged from 29.5% positive in the fall of 2010 to 2.4% in the winter of 2011. Prevalence in lymph nodes of cull cattle from the High Southern Plains and the West Coast was generally low, on average 0.65% and 2.0%, respectively. *Salmonella* prevalence in lymph nodes of cull cattle from the Midwest was lowest, as none of the lymph nodes collected from cull cattle in this region were found to be contaminated with *Salmonella*. While results are geographically limited, some evidence suggests that a commercial vaccine may reduce the duration of infection in the lymph nodes of cattle and may reduce the likelihood *Salmonella* would thus contaminate ground beef, but more work is needed to evaluate the full potential.

Evaluation of Single-Dose *E. coli* O157 Bacterial Extract Vaccine

Subcontractor: Texas Tech University

Expected Outcome: The objective of this project is to evaluate the efficacy of whole-feedlot vaccination (single-dose regimen) on fecal and hide prevalence and levels of the target pathogens compared to non-vaccinates.

Objective Achieved: For the one-dose regimen, more than 200,000 animals were administered the vaccine with an equal number of cattle not given the vaccine to serve as controls in whole feedlot treatments (more than 400,000 total cattle evaluated). Fecal samples were collected by pen, and hide swabs for 20 animals/pen were collected. A beneficial association of vaccine with reduced prevalence of *E. coli* O157 in feces and on hides was seen in vaccinated animals, but varied across sample collection time. Fecal prevalence in July was reduced compared to controls, but no difference was seen in October. Hide prevalence was reduced on three sample days; an inverse relationship was detected on one day, but across time, hide prevalence was reduced 50% among vaccinates relative to controls.

Effects of Two-Dose *E. coli* O157:H7 Vaccination on the Prevalence and Load of *E. coli* O157:H7 and Non-O157 STEC on the Hides of Beef Cattle at Harvest

Subcontractor: USDA-Meat Animal Research Center

Expected Outcome: The objectives for this work were to evaluate efficacy of whole-feedlot vaccination (two-dose regimen) on in-plant hide prevalence and levels of *E. coli* O157:H7 and non-O157 STEC from vaccinates vs. non-vaccinates as well as determine relatedness of *E. coli* O157:H7 isolates obtained from hide and fecal samples.

Objective Achieved: For the two-dose regimen, more than 400,000 cattle were evaluated and 4,000 total hide samples were collected from both vaccinated and non-vaccinated animals to determine the vaccine's effect. *E. coli* O157:H7 was not found to be less prevalent on cattle hides of vaccinated animals. Further analysis indicated that the results obtained in this study may not have been an accurate measure of the vaccine's effects on cattle hides due to the acquisition of additional hide contamination at the processing plant animal holding area. This additional contamination likely masked any effect of the vaccine, making conclusions based on this data set less reliable.

Evaluating the Efficacy Inclusion of Bromine in Drinking Water on the Prevalence of Pathogenic Shiga Toxin Producing *E. coli* in Feedlot Cattle

Subcontractor: USDA-Meat Animal Research Center

Expected Outcome: The beef industry continues to seek a broad spectrum of effective pre-harvest interventions. Bromine has been approved for use in a wash for poultry carcass to effectively reduce microbial contamination. According to U.S. Patent number 6,919,364 B2, including bromine in drinking water is effective in reducing the bacterial load in cattle feces. The objective of this study was to determine if the inclusion of 20-25 ppm bromine in drinking water is an effective pre-harvest control for pathogenic shiga-toxin producing *E. coli* in feedlot cattle.

Objective Achieved: Though FDA was expected to approve the use of the product in water for cattle early in 2010, by spring 2011, the approval had not been granted. Though it was approved as a carcass spray, that application was not within the scope of the project. Therefore, the funds were returned because the project, as written, could not be completed.

Evaluation of the Appropriateness of Previously Developed *Escherichia coli* Biotype I Surrogates as Predictors of Non-O157 Shiga-toxin Producing *E. coli* (STEC) in Beef

Subcontractor: Texas A&M University

Expected Outcome: Three *E. coli* biotype I strains previously isolated from cattle hides and determined to be appropriate for use as surrogates for *E. coli* O157:H7 based on collaborative studies conducted by Texas A&M University and Iowa State University were to be evaluated. Six non-O157 STEC serotypes (identified as O26, O111, O121, O145, O103 and O45) were selected as target pathogens for comparison against the known surrogate bacteria. Ideally, growth characteristics of surrogate organisms should be equivalent or greater, but not less than, target pathogens. Growth characteristics for O26, O111, and O103 were compared to determine if the previously identified *E. coli* O157:H7 surrogates can also be used for non-O157 STECs. Therefore, the objective of this project was to compare the growth, resistance, and survival properties of non-O157 STECs to those of *E. coli* biotype I microorganisms previously identified as *E. coli* O157:H7 surrogates.

Objective Achieved: These data demonstrated the overall growth characteristics for the *E. coli* biotype I surrogates and the three non-O157 STECs are similar. These results will allow previously identified surrogate microorganisms to be used by the beef industry to conduct in-plant validation studies, to determine the efficacy of antimicrobial interventions on both *E. coli* O157:H7 and non-O157 STECs. These data will also assist the beef industry in fulfilling regulatory

expectations because USDA’s Food Safety and Inspection Service requires scientific validation on interventions and has published draft guidelines for in-plant validations.

Evaluating the Impact of Pre- and Post-Harvest Process Controls and Intervention Strategies Used to Reduce *Escherichia coli* O157:H7

Subcontractor: Texas A&M University

Expected Outcome: Researchers often focus on a single sector, such as harvest, rather than looking at the total system from pre-harvest through harvest and beyond, to further-processing establishments. Multiple variables (e.g., incoming microbial load, dressing procedures, types of interventions being applied, processing and sanitation practices) may have an impact on contamination levels of finished products. Although the efficacy of most antimicrobial interventions has been demonstrated in a laboratory setting, the results in-plant vary, and are sometimes less effective than expected. Therefore, this multi-phase project was designed to evaluate existing pre- and post-harvest process controls and intervention strategies as prescribed and when modified to reduce *E. coli* O157:H7.

Objective Achieved: Data from the present study support the concept that pre- and post-harvest practices may influence pathogen contamination on beef carcasses. Data from both establishments demonstrated detectable incoming bacterial loads; however, the resulting carcass surface levels were below detection in only one of the establishments. Differences in sanitary dressing practices and the in-plant interventions contribute to these differences. The process identified in this study can be used by facilities to determine interventions and processes that make the most significant reductions in contamination.

Investigation of Molecular Targets that Identify the Presence of Pathogenic Non-O157 STEC

Subcontractor: USDA-Meat Animal Research Center

Expected Outcome: The current Shiga toxin producing *E. coli* (STEC) detection method described by FSIS will identify an unacceptably high number of suspect positive samples that will either require a lengthy confirmation (culture isolation) or more likely the thermal treatment/cooking of beef at a loss of value to the processor. The objective of this project was to determine the combination of molecular markers that best indicates the presence of pathogenic non-O157 STEC in beef culture enrichment and reduce the likelihood of false positive samples.

Objective Achieved: It was determined by testing enrichments for additional virulence factors, fewer samples will be identified as suspect for STEC. The virulence genes *nleB*, *nleC*, *subA* and *espK* correlated with samples that contained Shiga toxin genes. Culture confirmation performed on Shiga-toxin positive enrichments showed as the number of virulence gene markers detected increased, the proportion of pathogenic STEC isolates recovered increased while the proportion of non-pathogenic STEC isolates recovered decreased (false positives). This information can be utilized by FSIS, the beef industry, and the rapid-testing kit manufacturers to develop screening procedures to more accurately identify beef products containing viable bacterial cells that have true ability to cause human illness, and reduce the number of false positive samples, and thus the number of beef products removed from commerce, that do not have the potential to cause human illness.

Ongoing Research in Fiscal Year 2011

Project Title	Contracting Institution	Tactic #
Strategies to reduce super-shedding and the bioburden of <i>E. coli</i> O157:H7 in feedlots	University of California-Davis	1A
Using critical parameters to ensure efficacy of selected harvest and fabrication intervention strategies used to control <i>Escherichia coli</i> O157:H7 and <i>Salmonella</i>	Texas A&M University	1A
Providing solutions for the food safety threat posed by <i>Salmonella</i> in the lymph nodes of cattle presented for harvest	Texas Tech University, USDA-ARS College Station, USDA-MARC Clay Center	1A

Summary of Beef Safety Research Dissemination

Dissemination of research results and issues papers on key beef safety issues is a continuous process. Materials are developed for specific audiences and strategically disseminated to ensure utilization by multiple stakeholders. The following information summarizes the diverse efforts to spread beef safety research information to the appropriate audiences.

Internal Audiences

Beef safety research data play a key role in developing beef safety messages for consumers. This foundation of science allows communication professionals to develop supportable messages that will resonate with consumers and enforce their confidence in the safety of beef products. New information is shared with industry spokespeople to ensure they're armed with the latest data when contacted by the media for interviews. In addition, pro-active beef safety research monitors emerging issues and assists Issues Management staff in targeting key threats and preparing for them.

External Audiences

Results from safety research projects funded by checkoff are presented by scientists at multiple scientific meetings including International Association for Food Protection, Institute of Food Technologists, Reciprocal Meat Conference, American Society for Microbiology, and the Beef Industry Safety Summit. These presentations reach thousands of scientists from around the world.

Project executive summaries are posted on www.beefresearch.org for utilization by the beef industry and other external audiences.

Additionally, investigators use these data to write scientific articles published in peer-reviewed scientific journals.

Report on Other Measurable Objectives

Tactic 3A: Essential Safety Science Advancement

All tactic objectives achieved.

- *Development of a Request for Proposals to facilitate research project ideas and/or think tank meetings (3 meetings held) to formulate subsequent focused collaborative projects.*
- *Contract and complete 4 to 6 research projects (8 projects)*

Tactic 3B: Science Application

All tactic objectives achieved.

- *Development and publication of an Executive Summary (Beef Industry Safety Summit Executive Summary and 2 session inserts completed) and 4 to 6 Project Summaries (8 completed) and 2 fact sheets (4 completed). Additionally, 4 Topic Briefs per State Beef Council request and 3 videos about the program were completed.*
- *Maintenance of Beef Safety sections of www.beefresearch.org website and the extranet to include current and relevant information to support stakeholders. (2 sections updated on website and new pages added to Extranet)*

Tactic 3C: Beef Industry Food Safety Council (BIFSCo)

All tactic objectives achieved.

- *Host at least three BIFSCo meetings during FY 2010 (Beef Industry Safety Summit with record attendance and regional meetings noted below).*
- *Develop and execute educational tools and regional meetings (6 regional BIFSCo meetings held and a pre-harvest literature review written)*
- *Printed material dissemination will occur through cooperation with other organizations (4 organizations, various producer/board meetings, and collaborative research forums utilized)*

Final Program Evaluation for Work Completed in Fiscal Year 2011

Nutrition Research

Contractor: National Cattlemen's Beef Association (Shalene McNeill, Ph.D, R.D., and Clara Lau, Ph.D, program managers)

See www.beefresearch.org for more information on checkoff research.

Note: Checkoff nutrition research projects (and the budgets approved for them) span multi-fiscal-year periods; therefore, reporting on specific efforts is grouped by the following areas:

1. Outcome summaries of research projects completed in the 2011 fiscal year
2. Table of ongoing research in the fiscal year
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Outcomes of Projects Completed in Fiscal Year 2011

The following projects were completed in Fiscal Year 2011, but may have been funded out of previous years' authorization requests.

Comparison of Complementary Feeding Strategies Supplement: Evaluating Biomarkers of Iron, Zinc & Vitamin B12 Status

Subcontractor: University of Colorado School of Medicine

Expected Outcome: The objective of this study was to partner with a National Institute of Health (NIH) funded, multi-country project to test the efficacy of meat (beef) as a first food for breastfed infants in areas with high rates of growth stunting (Guatemala, Pakistan, Zambia, and Democratic Republic of Congo). The study evaluated linear growth and reduction of stunting; neurodevelopment, and illness causing infections. Checkoff funding supplemented the study to analyze iron, zinc and B12 status at the end of the intervention, when the infants were 18 months of age. It was expected that daily feeding meat to children from 6-18 months of age would result in significantly greater linear growth compared to daily feeding of a micronutrient fortified cereal supplement. Daily feeding of meat to children was also predicted to result in improved zinc and iron status, improved brain growth and neurocognitive development, and reduced illness causing infections.

Objective Achieved: Partially. The supplemental funding was applied to the analysis of beef related nutrients noted above. However, because this is part of a large NIH funded study, data for this project are still being evaluated and interpreted. Initial data indicate that vitamin B12 and zinc concentrations were low in these subjects. The complete data interpretation is expected when the NIH portion of the project is complete in December 2011. The results of this project, combined with Dr. Krebs' earlier work, is expected to provide further documentation of the effectiveness of beef in the diet of breast-fed infants as a first complementary food that improves growth, micronutrient status and overall development.

Optimizing choline status during pregnancy

Subcontractor: Cornell University

Partially funded by Egg Nutrition Center (separate contract) and the Nebraska Beef Council

Expected Outcome: This study measured the effects of pregnancy and differing levels of maternal choline intake on maternal and fetal choline status. Researchers tested the hypothesis that choline consumption at intakes higher than the current recommended amounts (450mg/d) will improve choline status of the mother and the fetus and that pregnancy increases choline requirement/status.

Objectives Achieved: The choline Adequate Intakes (AI's) for non-pregnant and pregnant women, 425mg and 450mg/d respectively, were extrapolated from a study conducted in men and based on the level of intake needed to prevent liver dysfunction. Therefore this study sought to quantify the effects of pregnancy on choline metabolism and to determine the effects of varied maternal choline intake on maternal and fetal status indicators. Pregnant and non-pregnant women were randomized to intake 480mg or 930mg/d choline during the third trimester. The main findings were that pregnancy increased choline metabolism and that higher choline intake increased the use of choline in mother and child. The majority of U.S. women consume choline intakes well below the AI's and increased consumption of choline

rich foods, such as beef, can increase choline intake during pregnancy and may improve maternal/fetal pregnancy outcomes.

Role of Dietary Beef in the Preservation of Muscle Mass and Hematologic Status in Older Americans

Subcontractor: Jean Mayer Human Nutrition Research Center on Aging at Tufts University

Fully funded by Nebraska Beef Council

Expected Outcome: This study evaluated the association between beef consumption and its protection against sarcopenia (loss of skeletal muscle mass and strength associated with aging) and red blood cell mass in older Americans. In addition, it analyzed the interaction between beef consumption and exercise level in relation to protection against sarcopenia.

Objective Achieved: Using cross-sectional, population-based data, the researchers found that eating beef can be of value to older Americans (aged ≥ 50) in the prevention of sarcopenia and anemia. Higher beef and protein intakes were related to more skeletal muscle where the high-protein content helps preserve lean body mass and prevent anemia in these individuals. Those who both exercised vigorously and ate high amounts of beef were reported with the greatest skeletal muscle. Results may promote beef consumption by older Americans and foster the idea that beef is a healthy food in later in life.

Protein needs for optimal meal response

Subcontractor: University of Texas Medical Branch at Galveston

Partially funded by Canadian Beef Information Center (\$20,000)

Expected Outcome: The project determined the amount of protein at individual meals required to maximize muscle protein synthesis and satiety for adults. It was hypothesized that the consumption of 65% of daily protein in a single large dinner meal compared with protein distributed across multiple meals will have poorer satiety and reduced efficiency of protein synthesis. Lean beef was the primary nutrient-dense source of protein and leucine for each meal.

Objective Achieved: Despite the same absolute amount of protein in subjects, muscle protein synthesis was ~25% greater in the evenly distributed protein group compared to the skewed diet (over a 24 hr. period). Similarly, satiety improved following the evenly distributed protein diet. Contrary to the common practice of consuming a large protein meal in the evening, evenly distributing a moderate amount of high quality protein over three meals each day increases the utilization of dietary protein and promotes satiety in adults.

A Meta-Analysis to Assess the Associations between Beef Consumption and Blood Lipoprotein Lipids

Subcontractor: Provident Clinical Research

Expected Outcome: It is a common misperception that cutting out red meat and beef from the diet will reduce the risk for coronary heart disease. However a causal relationship between red meat, beef intake and heart disease remains unclear. The researchers of this meta-analysis reviewed randomized, controlled clinical human studies that have already been completed by other researchers and evaluated the associations between the consumption of beef and blood lipoprotein lipid concentrations (total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol and triglycerides) compared with poultry and/or fish consumption. The results of the meta-analysis will help provide a larger picture of the relationship between beef consumption and lipoprotein concentrations.

Objectives Achieved: A total of 124 studies were identified in this review of the science. Eight studies involving 406 subjects met the criteria for the full evaluation. Changes in blood lipids were not significantly different following beef consumption in comparison to poultry and/or fish consumption. The inclusion of lean beef in the diet increases the variety of food choices, which may improve long-term adherence with dietary recommendations for lipid management.

Health Outcomes associated with Beef-Based Dietary Patterns among Adolescent Girls

Subcontractor: Boston University School of Medicine

Expected Outcomes: The study examined the effects of lean beef in context of diet quality in adolescent girls and their body composition (lean and fat body mass), lipid profile and blood pressure using data collected from the National Growth and Health Study.

Objectives Achieved: The results demonstrated that girls who consumed more lean red meat, who also consumed more fruit and non-starchy vegetables, gained less body fat during adolescence and had lower blood pressures and better

lipid profiles at the end of adolescence, than girls who consumed less red meat. These effects were stronger among girls consuming leaner cuts of beef. Red meat when consumed in a low-fat form was associated with positive effects on body fat, body composition, lipid levels and blood pressure.

Nutrient Database Improvement Research – Phase 2B: Nutrient Analysis of Beef Rib and Plate Cuts

Subcontractors: Texas Tech University, Colorado State University, Texas A&M University

Expected Outcomes: The study determined the nutritional composition of the beef rib and plate retail cuts collected in Phase 2A of the Nutrient Database Improvement Research project for inclusion in the USDA National Nutrient Database for Standard Reference (SR).

Objectives Achieved: Laboratory analyses for fatty acids, cholesterol, conjugated linoleic acid (CLA), amino acids, choline, retinol, B Vitamins, Vitamin D, Vitamin E, Selenium, and numerous minerals were completed according to USDA standards. The results were published in the annually updated release of the SR (SR 24) in September 2011.

- Rib and Plate Cuts to be published in SR 24
- Beef Ribeye Bone-in Lip On Steak, 1/8th, Raw and Cooked
- Beef Ribeye Bone-in Lip On Roast, 1/8th, Raw and Cooked
- Beef Ribeye Boneless Lip On Steak 1/8th, Raw and Cooked
- Beef Ribeye Boneless Lip On Roast 1/8th, Raw and Cooked
- Beef Rib Back Ribs, 0", Raw and Cooked
- Beef Plate, Inside Skirt Steak, 0", Raw and Cooked
- Beef Plate, Outside Skirt Steak, 0", Raw and Cooked
- Beef Ribeye Boneless Lip Off Steak, 0", Raw and Cooked

Nutrient Database Improvement Research – Beef Alternative Merchandising (BAM) Cuts

Subcontractor: Colorado State University

Expected Outcomes: To determine the nutritional composition of the beef alternative merchandising (BAM) cuts, collected as an off-shoot of the Nutrient Database Improvement Research project for inclusion in the USDA National Nutrient Database for Standard Reference (SR).

Objectives Achieved: Researchers collected and analyzed nutrients of the beef alternative merchandising (BAM) cuts. Laboratory analyses for fatty acids, cholesterol, conjugated linoleic acid (CLA), B vitamins, and Selenium were completed according to USDA standards. The results were published in the annually updated release of the SR (SR 24) in September 2011.

BAM cuts to be published in SR 24 (7 of the 8 cuts met USDA guidelines for lean)

- Beef Ribeye Cap Steak Boneless, 0", Raw and Cooked
- Beef Ribeye Petite Roast Boneless, 0", Raw and Cooked
- Beef Ribeye Filet Boneless, 0", Raw and Cooked
- Beef, Top Loin, Petite Roast Boneless, 1/8th, Raw and Cooked
- Beef, Top Loin, Filet Boneless, 1/8th, Raw and Cooked
- Beef, Loin Top Sirloin, Petite Roast Boneless, 0", Raw and Cooked
- Beef, Loin Top Sirloin, Filet Boneless, 0", Raw and Cooked
- Beef, Loin Top Sirloin, Cap Steak Boneless, 0", Raw and Cooked

Continuing Research in Fiscal Year 2011

Project	Contracting Institution
Increased protein intakes from predominately meat-versus soy protein/pulses-based foods: Effects on daily and postprandial appetite during energy restriction-induced weight loss	Purdue University
The beneficial effects of a protein-rich breakfast on appetite control and cognition in overweight and obese adolescents	University of Missouri
BOLD (Beef in an Optimal Lean Diet) effects on Metabolic Syndrome, Phase 2: A 12-month follow-up trial	Pennsylvania State University
Assessment of the scientific evidence and recommendations for future research on the effects of red meat and beef consumption on cardiovascular and metabolic disease risk factors	Provident Clinical Research

During Fiscal Year 2011, the following new nutrition research projects were initiated.

Project	Contracting Institution
Nutrient synergy in beef and muscle protein synthesis and breakdown in elderly	University of Arkansas Medical Sciences
Beef jerky as a novel recovery nutrition snack for endurance athletes: Effects on whole body protein utilization and markers of hydration status	University of Connecticut
Effect of incremental increases in dietary carbohydrate on saturated fat levels and blood borne risk markers for cardiovascular disease	University of Connecticut
Nutrient Database Improvement Research – Phase 3A: Collection – Proximate analysis of beef loin and round cuts	Texas Tech University*
Nutrient Database Improvement Research – Phase 3A: Collection – Proximate analysis of beef loin and round cuts	Colorado State University*
Nutrient Database Improvement Research – Phase 3A: Collection – Proximate analysis of beef loin and round cuts	Texas A&M University*

**** This is a three-way collaboration on this project with each university collecting samples in its particular region; the universities work together in performing the various nutrient analyses.***

Summary of Nutrition Research Dissemination

Dissemination of research results and topic papers on key nutrition research issues is a continuous process. Materials are developed for specific audiences and strategically disseminated to ensure utilization by multiple stakeholders. The following information summarizes the diverse efforts to spread beef nutrition research information to the appropriate audiences.

Nutrition research data play a key role in developing the checkoff's nutrition education and communication messages for consumers. This foundation of science allows the communication team to develop supportable messages that will resonate with consumers and enforce their confidence in the nutritional value and health benefits of beef products. New information is shared with industry spokespeople to ensure they're equipped with the latest data when contacted by the media for interviews. In addition, pro-active beef nutrition research monitors emerging nutrition and health issues and assists issues management staff in targeting key concerns, misinterpretations and controversies and preparing for them.

Results from nutrition research projects funded by the beef checkoff are presented by scientists at multiple scientific meetings including American Society for Nutrition, Experimental Biology, American Dietetic Association, and the Institute of Food Technologists. These presentations reach thousands of scientists worldwide. Additionally, investigators use the data to write scientific articles that are published in peer-reviewed scientific journals.

**Final Program Evaluation for Work Completed in Fiscal Year 2011
Product Enhancement Research**
See www.beefresearch.org for more information on checkoff research.

Contractor: National Cattlemen's Beef Association (Bridget Wasser, M.S., program manager)

Note: Checkoff product enhancement research projects (and the budgets approved for them) span multi-fiscal-year periods; therefore, reporting on specific efforts is grouped by the following areas:

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Outcomes of Projects Completed in Fiscal Year 2011

The following projects were completed in Fiscal Year 2011, but may have been funded out of previous years' authorization request.

Relationships of USDA Camera-Based Quality Grades to Beef Palatability Attributes

Subcontractor: Colorado State University

Expected Outcome: To quantify relationships of the recently adopted camera-based USDA quality grades to sensory attributes (tenderness, flavor, juiciness) of fed-steer and fed-heifer beef.

Objective Achieved: Increased marbling resulted in steaks having greater juiciness, tenderness, meaty/brothy flavor intensity and buttery/beef fat flavor intensity. As a result, the likelihood of a steak delivering a positive sensory experience became greater as degree of marbling increased. Nearly all (98 to 99%) of the steaks with Moderately Abundant (Prime) and Slightly Abundant (Prime) marbling, and most (between 80 and 90%) of the steaks with Moderate (Premium Choice) and Modest (Premium Choice) marbling provided a positive overall sensory experience compared with 62% of the Small (Choice) steaks, 29% of the Slight (Select) steaks and 15% of the Traces (Standard) steaks. Comparison of two methods for determining camera-based quality grades (i.e., use of original camera grade lines, based on marbling assessments of USDA grading experts vs. use of adopted camera grade lines, based on marbling assessments of field graders) showed that both methods of grade placement effectively stratified carcasses into grades that differed with respect to steak juiciness, tenderness, and flavor, with little discernible difference between methods. Results of this study provide strong support for continued use of instrument-assisted quality grading as implemented in 2009.

Evaluating Quality and Palatability Characteristics of Beef Carcasses Treated with Low-Dose Surface Irradiation

Subcontractor: Texas A&M University

Expected Outcomes: To determine the impact of low-dose carcass irradiation on the quality characteristics (color and shelf-life) on beef subprimals and trimmings (fat & lean); to determine the impact of low-dose carcass irradiation on palatability characteristics of steaks and ground beef produced from treated subprimals and trimmings.

Objectives Achieved: Raw color differences were seen between treated and control samples on day 0, but minimal differences were exhibited from day 2 to day 4. Differences in Thiobarbituric acid (TBA; oxidation or rancidity) values were seen, but were too inconsistent to attribute to a certain variable. When comparing irradiated and non-irradiated cuts, it was apparent that some differences do exist. Overall, the oxidation values are lower for steaks in comparison to matching patties. Additionally, as the age day increased, the oxidation values increased. Although it was not consistent, some irradiated products produced elevated oxidation values in comparison to the controls. Oxidation values generally increased between shelf-life day 2 and shelf-life day 4. Additionally, the patty oxidation values were higher than their steak counterparts. This would be expected due to the added fat component of the ground beef. Also, the surface area of the lean and fat would increase with the grinding process and would allow for a greater amount of oxygen to interact with the product. Overall, there were minimal differences between irradiated and non-irradiated steaks or patties in color and oxidation values signifying a minimal impact of low-dose carcass irradiation on beef quality.

The Role of Fatty Acids at Enhancing Marbling Development through Bovine G Coupled-Protein Receptors (GPR)

Subcontractor: Texas Tech University

Subcontractor: Texas A&M University

Expected Outcomes: To utilize both a cell culture and adipose tissue model to investigate the effect of specific fatty acids on differentiation of muscle-derived and intramuscular and subcutaneous preadipocytes; to determine if an important membrane bound receptor, GPR43, may be critical in regulating marbling development in beef cattle. This project was a collaborative effort between Texas Tech University and Texas A&M University.

Objectives Achieved: Researchers proposed that oleic acid, naturally produced by adipose tissues in beef cattle, is a potent regulator of marbling fat development via its effects on G-coupled protein receptor 43 (GPR43), and that oleic acid and alpha-linolenic acid may have additive effects in stimulating adipogenesis (marbling development). Results indicated that a primary fatty acid from pasture (alpha-linolenic acid) strongly depresses marbling development, but only in immature marbling adipocytes. Researchers predicted that backgrounding calves on pasture causes a reduction in marbling due to the ingestion of alpha-linolenic acid. By increasing marbling, important palatability factors, such as flavor and juiciness, will be enhanced. This represents phase II of this effort; phase III is ongoing in FY 2011.

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Subcontractor: Texas A&M University

Subcontractor: Texas Tech University

Expected Outcomes: To utilize both a cell culture and adipose tissue model to investigate the effect of specific fatty acids on differentiation of muscle-derived and intramuscular and subcutaneous preadipocytes, in order to determine if an important membrane bound receptor, GPR43, may be critical in regulating marbling development in beef cattle.

Objectives Achieved: Researchers proposed that oleic acid, naturally produced by adipose tissues in beef cattle, is a potent regulator of marbling fat development via its effect on G-coupled protein receptor 43 (GPR43), and further, that oleic acid and alpha-linolenic acid may have additive effects in stimulating adipogenesis (marbling development). Results indicated that a primary fatty acid (alpha-linolenic acid) strongly depresses marbling development, but only in immature marbling adipocytes. Researchers predicted that backgrounding calves on pasture causes a reduction in marbling due to the ingestion of alpha-linolenic acid. By increasing marbling, important palatability factors, such as flavor and juiciness, will be enhanced. This represents phase II of this effort; phase III is ongoing in FY 2011.

Physiological Mechanisms Regulating the Coordinated Development of Marbling and Muscle in Stocker Cattle

Subcontractor: Oklahoma State University

Expected Outcomes: To determine changes in muscle growth and adipose tissue development in cattle from different stocker production systems; further, to identify important physiological mechanisms influencing the coordinated development of marbling and muscle.

Objectives Achieved: Fall-weaned steers that underwent a season-long summer grazing program tended to have greater marbling scores (442 vs. 413) and significantly lower yield grades (3.2 vs. 4.0) compared to steers with rapid rates of gain on wheat pasture. Gene expression results indicate that season-long cattle had a lower level of new adipocyte recruitment in rib fat, but a similar level of marbling compared with steers grazing wheat pasture at the end of the stocker phase. Also, there tended to be an increase in Type I muscle fibers and capillary density in *longissimus* (ribeye) muscle of season-long cattle at the end of the finishing phase, which would be conducive to promoting development of new marbling deposits. Thus, stocker production systems that promote slower rates of gain will not negatively affect carcass quality, and may even enhance marbling development through changes in muscle metabolism. By increasing marbling, important palatability factors, such as flavor and juiciness, will be enhanced.

Novel Markers to Identify Tenderness in Early Postmortem Beef

Subcontractor: Iowa State University

Expected Outcome: To determine the effect of postmortem electrical stimulation on changes in insoluble and soluble protein fractions of bovine *longissimus dorsi* (ribeye) muscle.

Objective Achieved: Electrical stimulation resulted in an accelerated pH decline of *longissimus dorsi* (ribeye) during a 24-hour postmortem chilling period. Electrical stimulation had an apparent effect on protein solubility; fructose-

bisphosphate aldolase A, glyceraldehyde-3-phosphate dehydrogenase, phosphoglycerate kinase 1 and pyruvate kinase isozyme M1 all were less soluble in response to electrical stimulation. However, annexin, pyruvate hydrogenase and creatine kinase all were more abundant in the soluble fraction in response to electrical stimulation. At one day postmortem, electrical stimulation had a notable effect on the abundance of two isoforms of myosin light chain 2 (MLC2). In the insoluble fraction, one MLC2 spot increased while a separate MLC2 spot decreased in response to electrical stimulation. Results demonstrate a clear effect on the apparent solubility of proteins; six proteins showed great promise in aiding in the prediction of beef tenderness.

New Beef Tenderness Theory

Subcontractor: Texas A&M University

Expected Outcomes: To determine the role of sarcoplasmic calcium levels on beef aging and improvements in beef tenderness; to examine the interaction of sarcoplasmic calcium and the calpain system during post-harvest beef aging.

Objectives Achieved: Tender steaks selected from a population of almost 2,000 steers and heifers had higher sarcoplasmic calcium and lower desmin levels. These results showed that beef tenderness is not only regulated by the level of calpastatin and the calpain system, but how much calcium is released early post-harvest within the muscle. This means that the sarcoplasmic reticulum, the organ responsible for regulating calcium levels in the sarcoplasm, plays a significant role in beef tenderness. Current commercial genetic markers have relied heavily on the genetic relationships between calpastatin level and beef tenderness for selection of cattle for beef tenderness. These data strongly support the role of this system for selection of tender beef. This research also revealed genetic differences between factors affecting calcium flux from the sarcoplasmic reticulum in meat in the sarcoplasm. The study provided further insight into factors and potential genetic regulation of beef tenderness.

Tracking Individual Animal Responses to Pre-Conditioning Vaccines, is there a Correlation between Management Strategies or Individual Response to Vaccination and Carcass Quality

Subcontractor: Iowa State University

Expected Outcome: To evaluate the effect of vaccination-weaning management on carcass quality and the impact of an animal's response to vaccination on carcass and meat-quality traits.

Objective Achieved: In this study, 48% of the included cattle were observed to have responded to the vaccine given, with a response defined as a positive difference between antibody level at final observation and at initial vaccination. Increased final antibody level significantly increased yearling weight and subcutaneous fat over the rump. In order to achieve the greatest antibody response, animals weaned at the initial vaccination performed significantly better compared to animals weaned at the booster vaccination with increased performance, harvest weight, and hot carcass weight at harvest. Increased antibody response did not significantly decrease performance or carcass quality in finished cattle. Therefore, increased antibody response should not negatively impact performance or carcass quality traits.

Quantifying the Aging Response for Muscles of the Beef Round

Subcontractor: Colorado State University

Expected Outcome: To develop shear-force aging curves for estimation of improvement in beef muscle tenderness during postmortem aging, for five beef muscles (*Adductor*, *Gracilis*, *Pectineus*, *Gastrocnemius*--medial portion only, *Superficial digital flexor*) obtained from USDA Select and "Upper two-thirds" Choice beef carcasses, without freezing and thawing muscles prior to collection of shear-force values; to rank individual muscles according to (a) initial tenderness, (b) aging response, and (c) rate of tenderization as determined via shear-force evaluation, following multiple lengths of postmortem aging time.

Objective Achieved: Tenderness of cooked beef was affected by individual muscle and length of postmortem aging time. The *Gracilis* (Top Round) was the only muscle tested that showed a significant difference between USDA Select and USDA Premium Choice samples. All muscles required 14 to 25 days of postmortem aging to complete a majority of the aging response. The *Adductor* (Top Round), *Gastrocnemius* (Heel), Select *Gracilis* (Top Round), Premium Choice *Gracilis* (Top Round), and *Pectineus* (Top Round) required 21, 14, 23, 23, and 25 days to complete a majority of the aging response, respectively. Upon completion of the individual optimal aging periods, all muscles fell below the threshold of what most consumers would consider "slightly tender," using previously-defined Warner-Bratzler shear force threshold values. This illustrates the potential for these round muscles to be sold in foodservice operations and retail stores with

marketing emphasis being placed on the acceptable tenderness and exceptional leanness of these cuts. This research has been published as the *Industry Guide for Beef Aging: Round Muscle Addendum*.

National Beef Tenderness Survey-2010

Subcontractor: Texas A&M University

Expected Outcomes: To determine the current tenderness rating of U.S. beef retail and foodservice steaks using Warner-Bratzler shear force and consumer sensory panels; to create a snapshot of marketing techniques and steak characteristics for the current U.S. beef retail and foodservice industry.

Objectives Achieved: Postmortem aging times for retail establishments ranged from one to 358 days with a mean of 20.5 days, and foodservice establishments ranged from nine to 67 days, with an average of 15.9 days. For retail, non-enhanced and enhanced Top Blade had the lowest Warner-Bratzler shear-force values while non-enhanced cuts from the Top and Bottom Round had the highest shear-force values. Top Loin Steaks had the lowest shear-force values, compared to Ribeye and Top Sirloin foodservice steaks. Retail Top Blade Steaks received the highest ratings by consumers for most palatability attributes, and foodservice Top Loin Steaks received the highest ratings. USDA quality grade did have an effect on foodservice Ribeye and Top Sirloin steaks for sensory panels. This research allows all sectors of the beef industry to track advancements made in beef tenderness and consumer trends since the last survey was conducted in 2005/2006.

Interaction of VISNIR Predicted Tenderness Class, Aging Time, and Blade Tenderization on Slice Shear Force on *Longissimus* (loineye) and *Gluteus Medius* (top sirloin)

Subcontractor: USDA-ARS US Meat Animal Research Center

Expected Outcomes: To determine if visible and near-infrared (VISNIR) spectroscopy can be used to optimize aging time and identify cuts that would meet tenderness expectations without blade tenderization; to field test the potential for VISNIR sorting during commercial steak cutting.

Objectives Achieved: Optimal aging times of strip loins and top sirloins differ greatly among predicted tenderness classes based on noninvasive tenderness prediction using VISNIR spectroscopy. Cuts from carcasses in the least tender VISNIR-predicted tenderness quartile require much more aging to reach acceptable tenderness than cuts from the other quartiles. Although the tenderness of cuts from carcasses in the least tender VISNIR-predicted tenderness quartile was improved with blade tenderization, those cuts still require extensive aging. It was determined that optimal aging times differ greatly among VISNIR-predicted tenderness (slice shear force) classes and are influenced strongly by blade tenderization. Cuts from carcasses in the least tender VISNIR-predicted tenderness quartile require much more aging to reach acceptable tenderness than cuts from the other quartiles. This study will allow the beef industry to more effectively control variation in tenderness.

Can DNA Marker Technology Improve Feedlot Growth Promotion Management Decisions to Ultimately Improve the Consumer's Beef Eating Experience?

Subcontractor: Colorado State University

Expected Outcomes: To evaluate the effectiveness of sorting feedlot cattle into tenderness and marbling outcome groups based on DNA marker technology; to determine if interactions related to end-product quality and palatability exist between predicted marbling and tenderness outcome group and growth promotion management strategy.

Objectives Achieved: Yearling steers were sorted into marbling or tenderness outcome groups using DNA marker technology. Steers sorted into high-tenderness genotypes had reduced Warner-Bratzler shear force values as compared with steers sorted into low tenderness genotypes. Steers sorted into high-marbling groups demonstrated greater marbling scores upon harvest than steers sorted into low-marbling groups. Tenderness was improved by using moderate growth promotion programs as compared with aggressive growth promotion programs; however, growth promotion strategy did not impact marbling or USDA quality grade distribution and few interactions related to end-

product quality were found. Furthermore, no interactions for shear force existed between predicted outcome group and growth promotion management strategy, indicating that the degree that end-product quality is impacted by growth promotion strategy is largely independent of marbling and tenderness genotype. This study provides valuable pre-harvest beef quality information regarding growth promotion.

Prediction and Assessment of Genomic Breeding Values for Measures of Tenderness and Temperament in *Bos indicus*-*Bos Taurus* Crossbreds

Subcontractor: Texas A&M University

Expected Outcomes: To predict genomic breeding values for shear force and overall temperament for individuals in *Bos indicus*-*Bos taurus* crossbred cattle groups; to compare those with conventional breeding values.

Objectives Achieved: Genomic breeding values for overall temperament of the best calves (calves with the most favorable breeding values) ranked similarly regardless of whether they were assigned to sets for prediction or validation of genomic breeding values; this suggests that any partitioning of the animals into training and validation groups will not prevent identification of the animals with the best breeding values. However, different animals were identified as the best potential parents by genomic selection than would have been identified by traditional prediction. These results will serve as foundational investigations for the improvement of beef tenderness in *Bos indicus* steaks, and may result in implementation of a new selective tool utilizing whole genome association and high-density marker arrays.

FY 2011 Continuing Checkoff-Funded Product Enhancement Research

Project Title	Contracting Institution	AR Tactic #
Effects of post-mortem aging on sensory characteristics, color, and shelf-life stability in low marbling beef loins	North Dakota State University	1A
An analysis of quality of non-traditional beef grind material versus traditional beef grind material for ground beef products	Auburn University	1A
Prediction of beef flavor by precursor and volatile compounds	Texas Tech University	1A
Management factors affecting inherent beef flavor	University of Nebraska	1A
Physical, chemical, and sensory evaluation of ground beef quality from commodity and premium quality trimmings and a traditional and non-traditional fat source	University of Florida	1A
Effect of packaging type and storage temperature on the quality characteristics of beef longissimus lumborum, gluteus medius and triceps brachii muscles aged for extended storage postmortem	University of Florida	1A
Long postmortem aging effects on tenderness, flavor, lean color, and color stability of beef top loin and top sirloin steaks	USDA-ARS US Meat Animal Research Center	1A
Phase II - Physiological mechanisms regulating the coordinated development of marbling and muscle in stocker cattle	Oklahoma State University	1A
Effects of aging on the color intensity and stability of beef	University of Connecticut	1A
Identification of compounds responsible for positive beef flavor	Texas A&M University	1A
Collaborator 1 - Increasing marbling gene expression in beef cattle with dietary lipids	Texas A&M University	1A
Collaborator 2 - Increasing marbling gene expression in beef cattle with dietary lipids	Texas Tech University	1A
Identifying consumer preferences for specific beef flavor characteristics	Colorado State University	1A

Beef maturity white paper	Colorado State University	1B
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Summary of Product Enhancement Research Dissemination

Research funding return on investment is maximized when research results are thoroughly disseminated to the appropriate audiences. Dissemination is a foundation area of the checkoff-funded product enhancement research program and the beef quality message is spread through research that is shared online, in print and through face-to-face meetings.

Checkoff-funded research information generated through the product enhancement program is shared with other beef checkoff programs to extend project results and provide a science-based foundation for marketing and promotion activities. For example, muscle attribute information is generated from checkoff-funded research projects and leveraged in the development of new beef cuts. In FY 2011, the checkoff's product enhancement program created a new web-based educational tool that animates the processes of muscle contraction and relaxation, rigor mortis, proteolysis and myoglobin oxidation. Animation of these processes will help educate industry participants by illustrating the technical processes involved in beef quality development. In addition, the checkoff's product enhancement program manager conducted numerous cutting demonstrations and research presentations throughout the year. Audiences included the American Culinary Federation, the 2011 North American Meat Processors Association Meat Industry Management Conference, national and regional processor and channel partners, and State Beef Council boards and channel partners. Product enhancement research continues to provide the knowledge base to support product innovations and improvements in beef product quality.

In addition, results from product enhancement research projects funded by The Beef Checkoff are presented annually by scientists at multiple scientific meetings including the American Meat Science Association's Reciprocal Meats Conference and the American Society of Animal Science Annual Meeting. Additionally, researchers utilize data to author scientific articles published in peer-reviewed journals. Research project summaries are posted on www.beefresearch.org for utilization by all.

Report on Other Measurable Objectives

Tactic 1A: Beef Quality Improvement Research

All tactic objectives achieved.

- *Wrote and issued an RFP to solicit novel research ideas that address established focus areas and aim to improve beef quality and consistency.*
- *Facilitated industry review of proposals received.*
- *Selected and funded at least four research projects that receive the highest reviews and have the greatest potential to improve quality and demand.*

Tactic 1B: Targeted Cut Solutions Research

All tactic objectives achieved.

- *Worked with the checkoff-funded Beef Innovations Group to identify specific research needs.*
- *Contracted with qualified researchers to fund at least three projects with the greatest potential to address critical needs for new cut and new product development.*

Tactic 1C: Beef Quality Benchmarking

All tactic objectives achieved.

- *Developed plan and outline for 2010 National Beef Tenderness Survey that takes into account stakeholder feedback on previous surveys.*
- *Contracted with qualified research team to conduct industry stakeholder interviews and regional, on-site auditing of retail stores and foodservice processing facilities.*

Tactic 1D: Spreading the Beef Quality Message

All tactic objectives achieved.

- *Maintained and improved Product Enhancement sections of www.beefresearch.org and the Extranet to ensure research results reach the right audiences.*
- *Completed three to four new informational documents (i.e., fact sheets, executive summaries, etc.) to address critical beef quality questions and make these documents available to stakeholders via online posting and hard-copy printing.*
- *Developed and posted online project summaries for all completed research projects.*

Final Program Evaluation for Work Completed in Fiscal Year 2011 Market Research

Contractor: National Cattlemen's Beef Association

(John Lundeen, MBA; Rick McCarty, M.A.; Wendy Jenkins, M.A.; Rick Husted, MBA, program managers)

See www.beefresearch.org for more information on checkoff research.

Note: Checkoff research projects (and the budgets approved for them) span multi-fiscal-year periods.

In-Home Fresh Beef Usage – Consumer Diary Panel Analysis

Subcontractor: NPD/NET

Expected Outcome: Consumers in the NPD/NET diary panel journal in-home food usage over a two-week period, and also note whether other adults and children in the household had a serving (“eating”) of each item. This database can be used to determine how beef usage is changing – by end-dish, income, age, life stage and gender, and is useful to analyze how beef is performing relative to other proteins, as well as whether beef is capturing a share of important end-dishes that are growing in popularity. The information in this study benefits the nutrition, channel marketing and culinary teams.

Outcome Achieved: Overall, 21.2 billion beef “eatings” are estimated in-home per year. Average annual “eatings” per person have been stable for the last five years, an improvement since the early 2000s, when average eatings per person were declining. Important long-term shifts are seen in the data. In-home eatings of steaks as a center of plate item are still very important, but have declined slightly, with use of beef as an ingredient increasing. Insights from this study help in improving beef checkoff communication and culinary efforts, by providing a thorough understanding of consumer expectations in regards to the type of dishes they want to make in their homes.

Foodservice Beef Purchases – Foodservice Volumetric

Subcontractor: Technomic

Expected Outcome: Each year, nearly 1000 procurement executives across a range of foodservice operations (from limited service to full service, chains and independents, commercial and non-commercial outlets such as cafeterias) provide key details on the beef they are buying for their operations. These data can be extrapolated for the entire foodservice sector to get a year's read on the volume and wholesale value of the cuts being purchased.

Outcome Achieved: Beef volume sales to the foodservice channel bounced back by nearly 1% in 2010, and wholesale dollar sales were up almost 10%. With overall restaurant traffic down slightly, this uptick for beef was a significant win for the industry. The biggest sales gains in 2010 were for sirloin steaks, up by 22 million pounds. New opportunity cuts developed based on checkoff-funded carcass profiling work, including the Delmonico, Flatiron, Denver steak, Ranch Cut and Petite Tender, now represent 170 million pounds of volume sold, and garner wholesale prices comparable to sirloin. Foodservice operators also answered questions about future buying intentions, with a majority indicating a desire to buy leaner beef in smaller portions. In the important hotel and full service segments, this interest was combined with an ongoing interest in offering premium steaks.

Advertising Effectiveness – Ad and Brand Tracker

Subcontractor: Hall and Partners

Expected Outcome: This study was conducted to continue tracking consumer's awareness and response to the print and radio advertising campaigns. The study was conducted with 300 Food and Health Involved (FHI) target consumers, and 300 smaller, but important, Food and Health Involved Influencer (FHII) consumers. Attitudes towards beef were contrasted between those “recognizing” the campaign versus “non-recognizers”. In addition, a host of questions were asked about attitudes about beef versus other major proteins.

Objective Achieved: Overall, consumers rated the new advertising very favorably in awareness, believability, appeal and persuasion (specific results can be found in the Advertising evaluation section). When compared to other advertising campaigns tested by Hall and Partners, the beef campaign scores are significantly higher. The FHI and FHII targets understand that message a bit differently, though – Food and Health Involved consumers are picking up the lean

message, while Influencers still respond primarily to the “enjoyment” side of the messaging. This research helps the advertising team fine-tune the campaign over time to keep it as effective as possible.

Restaurant Steak and Burger Purchases – NPD/CREST

Subcontractor: NPD/CREST

Expected Outcome: CREST determines what dishes consumers are buying in the foodservice segment by conducting interviews with 500,000 consumers a year. Each respondent is queried about their previous day’s restaurant purchases. CREST interviewers also gather important strategic information, including how many beverages and side dishes accompanied the entrée order, price paid, and satisfaction with the meal.

Outcome Achieved: Beef’s contribution to the menu is evident, with 25 - 28% of dinner entrée reported as a beef item, depending on whether the restaurant is a mid-scale, casual or fine dining restaurant. When beef is ordered, patrons also are more likely to order complementary items, such as side dishes, desserts and all types of beverages. As a consequence, steak drives a higher check dollar amount. Patron satisfaction with a beef meal is strong on important measures such as taste and flavor, quality and being “food prepared the way I like it”. The helps the industry tell an important story about beef’s topline financial impact for restaurants, and ability to garner satisfied customers.

National Meat Case Study – Nationwide Audit of Meat Case Practices

Subcontractor: Texas Tech through Cryovac

Expected Outcome: In 2010, the fourth wave of the National Meat Case Study was completed (the previous wave was conducted in 2007). Trained auditors completed a comprehensive audit of the full and self-service meat cases in 133 grocery and club stores, and noted all of the label information on the package or in the surrounding department. This project was an FY 2010 effort that was completed after October 1, 2010 so results are provided here.

Outcome Achieved: The pounds of beef carried in an average meat case is relatively stable at more than 670 pounds per store, but the percent of total pounds represented by ground beef has gained slightly since the first study was conducted in 2002, at the expense of steaks and roasts (whole muscle cuts). The biggest change seen in the audit was to the percent of beef sold using a “store brand”, increasing from 31% of beef packages audited in 2007 to 51% in 2010. As many grocery chains sell beef with their own unique brand, one can expect to see further product differentiation over time. In addition, the percentage of case ready whole muscle cuts in the case increased from 27% to 31% from 2007 to 2010. Cooking instructions are now found on 36% of the packages (up 4% since 2007) and nutritional information was in place for 29% of whole muscle cut packages. Retailers across the nation find this study to be of interest because it allows them to determine how their merchandising efforts compare with national practices.

Nutrition Lean Labeling

Subcontractor: IPSOS

Expected Outcome: This study was conducted to help the Channel Marketing team evaluate the impact of nutritional and lean-beef labels on products. The study used an Omnibus online panel of 1600 consumers who provided feedback on reactions to three package-label examples (approximately 500 consumers viewed each label). The first example contained the “beef-scale” label, the second included the “beef-scale” label as well as the “nutrition” label and the third included the “beef-scale” label, the “nutrition” label and an additional “lean call-out” label.

Outcome Achieved: The results from the study provided feedback from consumers who viewed the nutrition and lean labels. The third, comprehensive example, which contained all three individual labels, provided the most important information to consumers. It was viewed as having the right amount of information, and 60% said they would definitely or probably buy the product. The example with only the “beef-scale” label ranked significantly lower than the example with either the “beef-scale” and “nutrition” labels or with all three labels. The results also indicate that the “lean call out” did not significantly increase the likelihood to purchase the product over the package with just the scale and nutrition labels.

In-home Meal Expectations – Convenience Framework

Subcontractor: Pelegrin Research

Expected Outcome: This study was conducted to help the Beef Innovations team better understand the barriers to convenience and how they relate to beef products. The expected outcome was to drill down further than the word

'convenience' to determine what exactly makes beef convenient or not convenient in the minds of the consumer, all in an effort to help develop products that will increase beef consumption.

Objective Achieved: Qualitative focus groups, ethnographic interviews and an online survey were conducted for this study. The qualitative studies demonstrated the language consumers use with regard to convenience, and the online survey quantified the findings with statistically valid data. The data revealed specific areas where beef is lacking in convenience and also provided detail regarding how the products need to perform or be developed in order to be deemed convenient and therefore increase beef consumption. One primary finding from this research is that defrosting beef is a very big barrier for consumers, and if this was solved their beef consumption would increase. This research was shared with the Beef Innovation Group and Culinary teams.

5 Proto-type Convenience Product Study

Subcontractor: CORE Insights

Expected Outcome: In an effort to meet the changing needs of consumers, and a desire for more convenient foods, the beef industry has worked with several food manufacturers to develop beef concepts and products offering quick, easy handling and cooking. The expected outcome of this research was to understand consumer reaction to five new beef product prototypes after initial exposure followed by an in-home usage test. The project sought to confirm that consumers would find at least some of the new products appealing enough to encourage further refinement and development by the manufacturers.

Objective Achieved: Seventy-three consumers in Denver received samples of all five new beef products and after an in-home trial, respondents were invited to provide direct feedback about the products. The response was positive for some products while other products did not perform as well. Even in cases of poorer performance, the manufacturer received important insight on how to enhance the product. The products that were deemed to have the most potential included a beef stew and a microwave beef dinner. Consumers provided feedback to help the manufacturers make beef products more appealing to consumers.

Convenient Fresh Beef – Phase 2 (Federation Funding)

Subcontractor: Turover Straus

Expected Outcome: In the first phase of work on Convenient Fresh Beef, several beef starter kits were developed and placed with consumers to evaluate whether the market for beef could be expanded by offering under-30-minute beef options. Phase 1 focused on development of beef entrees – roasts and skillet steaks are examples. In phase 2, the portfolio was expanded to include items that included other ingredients, but still met the need for an under-30-minute meal. Examples were beef strips that could be combined with vegetables to make a skillet meal, or with a hoagie/cheese/veggies to make sandwiches, and cube steaks that could be easily used as an ingredient. In all cases, a spice kit, and easy-to-follow instructions were provided.

Objective Achieved: Sandwich kits were very favorably received, as were skillet meals based on beef strips or cubes. A thinner London Broil was a popular family solution. The cube steak solutions also tested well. More than 20 prototype products were developed that the Beef Innovations Group will now present to grocers and manufacturers.

Bell Knuckle (Full Sirloin Tip) Chef Research

Subcontractor: Performed by staff.

Expected Outcome: The objective of this product development research project was to evaluate the foodservice response to four new cuts for fabrication from the full sirloin tip – the tip center steak, tip side steak, tip center medallions and tip center, butterflied. The research was designed to gather input from large operators, mid-scale restaurant chains and independent breakfast and lunch establishments. A two-pronged research approach was used, including focus groups among independent and / or mid-level chain chefs in Denver followed by telephone interviews among high-volume chefs across the USA.

Objective Achieved: Chefs provided valuable feedback on the four proposed cuts from the full sirloin tip. In general, chefs are interested in exploring new cuts and recognize the need to look for lower-priced alternatives as a way to offer value to customers in difficult economic times. Potential exists especially for the center medallions. The results of the other cuts reveal that further refinement is needed to increase value for chefs. From these results the BIG team is better able to determine if any of these cuts should be tested among processors.

Beef Omnibar Protein Bar

Subcontractor: Product Dynamics, Division of RQA, Inc.

Expected Outcome: In an effort to increase the use of beef in convenient products similar to protein bars this study was developed to test consumer acceptability and reactions to three different beef-based protein prototype bars. The research provided the product team with guidance about how a new beef protein bar could be improved and provide development direction on key product characteristics.

Objective Achieved: Three protein bars were tested among consumers in addition to an in-market competitive protein bar. Results were conclusive in that the beef-based protein bars require more refinements and development to be acceptable against competitive products in the market today.

Conversations with Millennials Using Facebook

Subcontractor: TripleScoop

Expected Outcome: This study examined a different research methodology in order to reach out to millennials to understand attitudes and habits toward beef and the beef industry. The research was conducted using a Facebook 'Friend' group where people were invited to participate in a six-week dialogue about beef.

Objective Achieved: An engaged dialog was established in the test group, and participants were engaged for the entire six weeks. Responses to the questions were thorough. More than 60 respondents participated and gave views on all things beef – a key finding was that this generation knows they eat less beef than past generations but they love beef. They would eat it more often if reasons such as 'looking for a balanced diet' or 'it isn't good for me to eat so much' didn't bias their buying decisions. This generation wants to be educated on "how much is too much beef", "how to cook beef besides a steak or ground beef" and finally, "how to shop for beef." The new methodology proved to be a successful way to reach this generation of consumers on their use and attitudes towards beef. The results have been widely shared with checkoff staff, states, and key channel members who attend beef industry conventions.

Key Influencer Identification and Summary

Subcontractors: Golin Harris/Nuffer, Smith, Tucker

Expected Outcome: One goal of the long-range plan was to establish a platform and mechanism for pursuing closer relationships with influencers and beef decision makers across multiple categories (safety, nutrition, culinary, media, etc.), and work to enhance beef-friendly interactions with these groups. The initial phase of this effort was a research project designed to identify a list of the top influencers. The second phase drilled deeper with the top 50 of these influencers and uncovered more insight into their positions relative to beef and the beef industry as well as understanding their openness to engage in open dialogue and information sharing.

Objective Achieved: The study resulted in a list of top influencers with additional perspective drawn from nearly 50 one-on-one interviews. This information will now support relationship development and tracking among respective program areas.

I Heart Beef – Year 2 – Underlying Consumer Statistics on America's Love Affair with Beef

Subcontractor: Pelegrin Research Group

Expected Outcome: This is the second year of an online study on consumer "top picks" when offered a range of proteins for important celebratory events in their lives. The results provide the PR team with statistics they can present to the media to highlight how Americans fit beef into their lives. In addition, this year, the relationship between beef and healthier lifestyle desires was probed.

Outcome Achieved: A wide range of strong beef preferences was documented, providing the PR team with data to integrate into media releases throughout the winter, spring and summer months of the year.

Brand Enhancement 2 - Listening Sessions (Supplemental Federation Funding)

Subcontractor: Strategic Intent

Expected Outcome: Focus groups were held in three cities to begin a comprehensive beef brand enhancement effort to test the consumer potential for a new brand platform.

Outcome Achieved: This first round of focus groups provided the team with consumer insight to define what drives increased or decreased beef consumption. Beef equities were also contrasted to other major proteins. Consumers continue to easily express their strong craving for the taste of beef. They also recognize how beef satisfies important nutritional needs, enriching lives. Downsides to beef that were verbalized included nutritional concerns. While not top-

of-mind, when the discussion eventually wove its way around to production, unease with modern technologies employed by the industry was evident. The results from these focus groups helped to start define a brand platform for the future.

Brand Enhancement 2 – 2nd Round Qualitative (Supplemental Federation Funding)

Subcontractor: Strategic Intent

Expected Outcome: Using results from the first round of focus groups, perform consumer testing on six brand platforms, focusing on lighter consumption consumers within bucket 1 (positives of beef strongly outweigh the negatives) or bucket 2 (positives of beef somewhat outweigh the negatives). A group of beef loyalists was also recruited to make sure the brand platforms being tested did not decrease their beef preference.

Objective Achieved: Two weaker platforms were discarded as a result of this research. This allowed the team to focus on the four strongest beef brand platforms in the following quantitative test described below. The need for third party endorsement (AHA, FDA, USDA) became evident; endorsement options were subsequently tested. In addition to discussing communication that could heighten demand, language that could defend beef and beef production was also explored in these focus groups.

Brand Enhancement 2 – Quantitative Concept Test (Split Between CBB Funding and Federation Funding)

Subcontractor: Hall & Partners

Expected Outcome: Four best brand platforms were taken forward into a large scale online study of 3,200 consumers (800 saw each of the four platforms). After seeing the concepts, consumers were queried on believability, relevance (“it matters”), importance and persuasion (potential to increase frequency of eating beef). Four sources for endorsement statements concerning nutrition were tested (American Heart Association, American Dietetic Association, USDA and FDA). Consumers were asked a bank of questions about attributes of beef before and after the brand platform was exposed to see if there was a shift in their attitudes (example – “beef is healthy”). Individual ways to discuss the vitamins and nutrients in beef were tested so that language could be perfected post-test.

Objective Achieved: Results of the quantitative survey informed the development of a brand platform entitled “Memorably Delicious. Surprisingly Nutritious.” This brand platform will be integrated into the full range of beef messaging. In addition, this research established the soundness of focusing on the food and health involved consumer (individuals who love good food, but are making healthy changes), with special attention on those who are eating beef once or twice a week.

Consumer Beef Index (CBI) – February and July, 2011 Waves

Subcontractor: Pelegrin Research

Expected Outcome: An online survey of 1000 consumers was completed in February; another was completed in July of 2011. This consumer tracker has been run since early 2007, and has become the means for answering a range of questions. These include:

What matters the most in picking a protein for dinner, and how well is beef performing against these same variables. How is beef performing against key high level measurements? For example, as called for in the new Beef Industry Long Range plan, are we succeeding in moving 3% more consumers into Bucket 1 (the benefits of beef strongly outweigh the negatives)? A measurement of image has also been established (to help track progress against another core strategy in the Beef Industry Long Range plan.

Key outcomes of this tracking study are to measure consumer preference for beef and the key drivers of those preferences.

Objective Achieved: Overall, impressions of beef are improving steadily, with important improvements in attitudes about beef nutrition, taste and safety. Overall, most consumers see beef as healthy, but less healthy than other protein options, especially chicken. Compared to previous CBI measures, a much lower percentage of consumers report hearing about issues related to beef in the media. On a negative note, the study is showing erosion in the number of beef meals being consumed every week since 2007, with the most significant reason being nutrition (note earlier point about beef nutrition relative to other choices). The recession has also negatively impacted demand, especially in the foodservice industry.

Consumer Beef Index – Bucket 1 and 2 Light Analysis

Subcontractor: Pelegrin Research

Expected Outcome: Using the last four waves of consumer responses in the Consumer Beef Index (4,000 completed online surveys), the market research team took a deep dive into the responses from moderate consumption beef consumers within Bucket 1 (the benefits of beef strongly outweigh the negatives) and Bucket 2 (the benefits of beef somewhat outweigh the negatives) to see how they differ from the population at large.

Objective Achieved: The study reinforces the power of taste as an important drawing card for beef, but not as a variable that would increase consumption if made the focus of communications. Instead, lighter consumption consumers tend to underscore beef on a range of meal decision variables, which include convenience, nutrition and safety. While a focus on nutrition is warranted, Beef Checkoff efforts cannot ignore the need to educate consumers on all the factors that impact choosing a protein to put on the plate.

Ground Beef Cooking Methods

Subcontractor: IPSOS Public Affairs

Expected Outcome: This study was conducted to help the beef nutrition and food communication teams better understand consumer perspectives on ground beef in terms of nutrition, fat, affordability, convenience, type of ground beef preferred and most frequently used methods of cooking.

Objective Achieved: The study found that the most frequent use of ground beef is as an ingredient and the most frequently used method of cooking is browning ground beef crumbles in a skillet. Significant findings included the fact that most consumers would not buy precooked crumbles – only 20% say they would use crumbles more if they could buy them pre-cooked. In addition, a majority of consumers now see ground beef as a nutritious, low-fat and affordable meal and half view it as a good special-occasion meal because of new recipes and menu ideas.

Consumer Confidence in Beef Safety - Tracker

Subcontractor: IPSOS Public Affairs

Expected Outcome: To measure consumer confidence in beef safety, foods of highest supermarket and restaurant safety concerns, foodborne illness concerns and most concerning food safety issues.

Objective Achieved: This safety tracker online survey found increased confidence in the safety of ground beef compared to a year earlier, with 80% of consumers giving it an A or B for safety compared to 76% the previous year. Ground beef's safety confidence score is up 17% since 2000. Steak confidence remained statistically unchanged with 87% A & B scores in November 2010 compared to 88% a year earlier. Beef continues to be a food of low concern at the supermarket with only 11% of consumers rating it their food of highest safety concern – identical to the score a year – and much less than the 22% that named chicken as their highest concern food. Beef also has low safety concerns at restaurants, with 11% of consumers saying it is their food of greatest concern compared to 22% rating chicken this way at restaurants. Food safety issues consumers rate of highest concern have changed little in the past year. Bacteria, as in past surveys, topped the list of extremely concerning issues followed by pesticides and chemical additives. Less than 30 percent of consumers say they are highly concerned about hormones, antibiotics and irradiated foods. The safety tracker data is used by issues management and communications, as well as SBCs, to communicate about safety confidence and issues.

Modern Beef Production Messaging – Foundation Qualitative

Subcontractor: Tango Strategy

Expected Outcome: This was the first step in a three-phase research program to address the objective of reconnecting consumers with modern beef production. This foundational phase consisted of an immersion process using food and health influencer consumers and including chefs and food writer influencers, and exposing them to a feed yard in order to: identify the positive and emotional benefits consumers and influencers ascribe to modern beef technology, especially the feeding sector; determine if feeding sector messages can be included within the industry holistic message strategy; and identify the most effective communication approach for these important messages.

Objective Achieved: The foundational immersion step showed that feedlot messages do have a place in the holistic message strategy. Seeing the feedlot operation, in person, creates a dramatic shift to the positive for consumers and influencers. Additional research will focus on creating the same response through words and pictures. In addition, it was found that consumers and influencers realize not all aspects of raising cattle are pleasant or “PC”, but would rather have honest, open access to the entire process and the information about the process, than be shielded from it. Knowledge is

power – full exposure to feedlot operations may help people make their own informed choices about beef or help validate their consumption of beef. Industry avoidance of showing or openly discussing all aspects of the feeding sector helps perpetuate consumer misperceptions. The immersion research provided initial holistic themes and messages to be tested and refined in the next research phase.

Modern Beef Production Messaging – Advanced Qualitative Message Testing

Subcontractor: Heart & Mind Strategies

Expected Outcome: This phase of the study used three sessions of an Advanced Strategy Online process (ASO) which is an interactive, online discussion involving approximately 30 specially recruited consumers in each session. The focus of the project was to test messages and themes identified in the foundational phase and test and refine general strategies and messages. The project also was designed to identify images that consumers associated with positive elements of feedlots.

Objective Achieved: This phase determined the most effective approach and messages for communicating to consumers about the role of cattle feeding in modern beef production in a way that can neutralize current negative images of the feeding sector. The research also identified key thematic elements to be included in messaging - such as humane treatment of animals, environmental responsibility, family farms, and a blend of tradition with innovation – and images positively associated with those themes. The message refinement achieved through this phase provides a foundation for a final quantitative message testing step which now is being developed.

Modern Beef Production Messaging – Quantitative Message Testing

Subcontractor: Heart & Mind Strategies

Expected Outcome: The final phase of the study used messaging developed through the immersion phase and refined by the advanced strategy online phase. The objective of the quantitative study was to determine the effectiveness of messages designed to connect consumers with the feeding sector of the beef production chain; determine how to handle information about antibiotics and hormones; determine if consumers equate feedyards and “factory farms”; and establish a hierarchy of positive messages that consumers find important.

Objective Achieved: The analysis found that humanizing the feeding sector and showing how cattlemen care for their animals generates a powerfully favorable view of how beef is raised and improves the benefits of beef over its perceived weaknesses. The analysis also identified images of cattle feeding that supported the messages and resonated most strongly with consumers and concluded that positive images are a vital part of messaging about cattle feeding. However, the analysis also found that messaging about antibiotics and hormones is counter-productive and those issues must be dealt with outside of an overall holistic messaging strategy. The message hierarchy that emerged from the study showed that message areas, from most to least relevant and positive, are: 1) cattle care; 2) cattle diet; 3) human involvement; 4) feedyard benefits; 5) environmental practices; and 6) hormone usage.

Consumer Grilling Behavior

Subcontractor: IPOS Public Affairs

Expected Outcome: The intent of the consumer grilling survey was to develop interesting news hooks and data on consumer grilling behavior and preferences to support food communications team media pitches and communications promoting summer grilling. The 2011 grilling survey added questions specific to planned media pitches which will be conducted at intervals throughout the summer.

Objective Achieved: The online consumer study provided rich data for support of summer grilling media pitches and product public relations activities. Some data highlights included: 90% of consumers who grill plan to grill on the Fourth of July; 69% say beef is the meat they most often grill; 84% prefer to cook steaks on a grill over any other method; the Ribeye is the champ on the grill with 21% of consumers choosing it as their favorite steak; 45% of consumers cook out on the grill year-round; and 85% of married couples said they would have been happy to receive a grill as a wedding present.

Economics and Food Choices: Consumer Response to Food Price Inflation

Subcontractor: IPSOS Public Affairs

Expected Outcome: Food inflation has led a large number of consumers to adjust how they budget for food. Research conducted in 2008 and, now again, in 2011, demonstrates that frugal shopping behaviors have been widely adopted and

are affecting beef purchasing decisions. Consumers are reacting to the pressures of high prices at the pump, economic uncertainty and escalating food costs and one of the most common methods to cut household expenses is to reduce food expenses.

Objective Achieved: The study focused on the food purchasing behaviors of beef and chicken eaters who are involved in household food decisions, are price sensitive and have made changes in food purchasing habits because of economic pressures. The analysis revealed that price sensitive consumers view steak as an expensive food and it often is at the top of their list for cutbacks to reduce food expenses. The study also showed that leveraging consumers' love of steak, its great taste and superior nutrition profile using recipes and information about how it can be affordable and a great value may resonate with price sensitive consumers as a means to increase beef purchases.

Nutrition Messaging

Subcontractor: Strategic Intent

Expected Outcome: Previous qualitative research was conducted with RDs and a follow-on phase of research among consumers was desired to gauge consumer's understanding of protein based foods, as well as determine what nutrition messages would resonate with consumers.

Objective Achieved: Five hundred consumers, nationally representative, completed an online nutrition study and provided feedback on 16 different nutrition messages. Results indicated consumers believe "energy" is a key contributing factor to overall health. This is followed by weight control and feeling sharp and focused. The areas that consumer's attribute to health that is associated with beef includes, taste, satisfaction, enjoyment and easy preparation. Although 16 messages were ranked by respondents no clear winner emerged. These findings will help further refine and build nutrition messages that resonate with consumers.

Consumer Nutrient Information Preference – Beef Labels

Subcontractor: IPSOS Public Affairs

Expected Outcome: This study was undertaken to assess consumers' preferences for nutrition information on package labels.

Objective Achieved: A set of 16 nutrient labels were mocked up, eight with raw product information and a corresponding eight with *cooked* product information. Labels were designated as: Short – *only macronutrients displayed*; Short Lean – *macronutrients along with a lean designation*; Long – *macro and micro nutrients displayed*; Long Lean – *macronutrients along with a lean designation*; Dual Declaration – *displaying information for both Raw and Cooked product* (DD short, DD long, DD short lean, DD long lean). Labels were presented in a choice modeling format to a sample of consumers in an online survey. Consumers overwhelmingly preferred the dual-declaration, long label with a lean designation (showing macro and micro nutrients in both raw and cooked product with a lean designation).

Producer Profile Study – U.S. Cattlemen

Subcontractor: Aspen Media & Market Research

Expected Outcome: To support development of a beef industry social responsibility report by the checkoff Issues Management team, a national survey took a broad and thorough look at American cattlemen to assess not only their basic demographics, but also their values, community engagement, leadership activities and their management practices.

Objective Achieved: The study found that America's cattle farmers and ranchers differ widely in terms of age, size of operations, acres managed and other variables, but they share some important commonalities: Strong family and religious values, a commitment to community, support for the democratic process and a generous spirit of giving – of their time and of their money – to important causes. Most prominently, their love of their land and their animals translates into a dedication to producing safe and affordable beef, providing good care for their animals, making production of safe food a high priority in their management systems and emphasizing environmental stewardship to ensure their operations are sustainable and the land can remain their livelihood and legacy for generations to come.