# INNOVATIVE WHOLESALE CARCASS FABRICATION AND RETAIL CUTTING TO OPTIMIZE BEEF VALUE

A Thesis

by

KYLE DAVID PFEIFFER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2004

Major Subject: Animal Science

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Approved as to style and content by:

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December 2004

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## ABSTRACT

Innovative Wholesale Carcass Fabrication and Retail

Cutting to Optimize Beef Value. (December 2004)

Kyle David Pfeiffer, B.S., Texas A&M University

Chair of Advisory Committee: Dr. Jeffrey W. Savell

This study evaluated innovations in beef wholesale carcass fabrication that may have potential for improving subprimal yield and overall value of the beef carcass. Thirty beef carcasses, equally representing USDA Choice and Select and USDA yield grade 1 and 2, were selected from a commercial processing facility and transported to Texas A&M University for subsequent fabrication. Beef sides were utilized in comparing a conventional carcass fabrication style to a more innovative method. Innovative forequarter subprimal yields were greater ($P < 0.001$) for the brisket, ribeye roll, blade meat, and back ribs. The innovative method resulted in greater subprimal yield and less lean trim ($P < 0.001$) from the forequarter. Innovative hindquarter subprimal yields were greater ($P < 0.001$) for the tenderloin, top sirloin cap, bottom sirloin tri-tip, and round tip. Hindquarter subprimal yield and lean trim were not affected ($P > 0.05$). Value was greater for the innovative forequarter ($P < 0.001$) and hindquarter ($P < 0.01$); value was increased by more than seven dollars per beef side, thus greater than fourteen dollars per beef carcass. Selected subprimals were evaluated in a retail cutting test. Experienced retail professionals were utilized in fabricating the retail cuts. In general, the innovative retail subprimals performed equally or better than the conventional subprimals. The *M. Serratus ventralis* fabricated from the innovative side, comprising over 4.5% of the innovative forequarter, generated greater than 57% steak yield and 94% saleable yield. Innovative carcass fabrication techniques resulted in greater subprimal yield and increased the value of the entire beef carcass. These results were verified by retail cutting tests conducted on selected subprimals.

## DEDICATION

I dedicate this work and devote my time on Earth to Celeste.

## ACKNOWLEDGEMENTS

This project was funded by beef and veal producers and importers through their $1-per-head check off through the Cattlemen's Beef Board and state beef councils by the National Cattlemen's Beef Association.

In completion of this thesis work I thank the gentlemen of my thesis committee. Dr. John Park began as my professor and was of great support throughout this entire process. Dr. Jimmy Keeton, through his passion as a meat scientist, showed me the many opportunities that lie ahead in this industry. Dr. Davey Griffin's vast knowledge of beef carcass anatomy and fabrication helped make this work a much smoother process. Dr. Jeff Savell has been a teacher, mentor, and role model throughout my years at Texas A&M.

This work could not have been conducted without the hard work of all my fellow graduate students: Kristin Voges, Andy King, John Ellebracht, Celeste Schuehle, Bridget Baird, Stacy Mueller, Carrie Adams, Jason Bagley, Jason Behrends, Betsy Booren, Blaine Jenschke, and numerous student workers.

I thank Dr. Dan Hale and Dr. Davey Griffin for letting me work along side and learn from them. All the experience I have received from their generosity has made me a more complete individual.

I thank two former graduate students that helped me a great deal. Dr. David McKenna led me through a meat judging program, which is the reason I have chosen this route of education. Dr. Patrick Mies always got me involved in functions that helped me progress through my years as a graduate student. Both gentlemen are extremely hard working individuals that showed me the way things should be done.

Lastly, I thank my parents, family, friends, and all of those who have helped get me to this point in my life.

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# CHAPTER I

## INTRODUCTION AND REVIEW OF LITERATURE

The beef industry has built a reputation on taste appeal, the unique flavor that beef presents to the consumer. The unique taste experienced is enjoyed by beef consumers also carries an associated cost. The average cost of beef at the retail counter in 2002 was $3.32/lb., as compared to $2.66/lb. for pork and a mere $1.62/lb. for poultry products (AMI, 2003). With such highly competitive and low cost alternatives, the beef industry must provide customers with a satisfying eating experience with each serving. The beef industry cannot compete with other meat proteins on a price basis, as the economics are different in the beef industry. Beef must continue to provide the consumer with something that cannot be found in alternative meat sources.

Taste is a positive attribute associated with beef, although tenderness and consistency are not. The National Beef Tenderness Surveys (Morgan et al., 1991; Brooks et al., 2000) concluded that increased tenderness was needed in retail cuts from the wholesale beef chuck and round. From that time, much work has been done to enhance the eating quality of cuts from the beef chuck and round. Product consistency is another issue that faces the beef industry. The National Beef Quality Audits (Lorenzen et al., 1993; Boleman et al., 1998, and McKenna et al., 2002) have focused on identifying what the U.S. beef industry is producing.

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This thesis follows the style and format of Journal of Animal Science.

These audits have identified and aided in correcting many particular deficiencies found within management practices and carcass quality evaluations. The beef industry is more variable in its management practices and quality attributes than the more vertically integrated pork and poultry industries.

From 1992 to 1998, beef loin and rib prices increased by 14 and 21%, respectively. Demand, and thus price, of beef "middle meats" were on the rise. However, during the same time period, cuts from the beef chuck and round realized a price decline of 27%. This decrease in value may be linked to the current consumer's lack of time and knowledge of how to prepare beef chuck and round cuts that are typically merchandized in the form of larger roasts. It became apparent to the beef industry that the round and chuck primals that comprise approximately 70% of the beef carcass needed to be reevaluated from a retail cuts standpoint and that these large primals needed an extreme makeover to fit the needs of today's consumer.

Armed with the goal of increasing the overall value of the beef chuck and round and thus the entire beef carcass, the Beef Value Cuts Program (NCBA, 2001) and the Muscle Profiling and Bovine Myology studies (Jones et al., 2001) were launched with support from the nation's cattle producers. The Beef Value Cuts Program focused on the chuck shoulder clod, round tip, and bottom round flat. These subprimals, normally fabricated into large, multi-muscle roasts, were sectioned into individual muscles and portioned into more consistent, greater valued steak cuts. Success stories from the examination of these subprimals include the now popular flat iron steak, shoulder tender petite medallions, ranch cut steak, tip center steak, and the tip side steak. These higher quality steaks can be moderately priced and help in bridging the wide gap between high priced rib and loin cuts and lower valued roasts and ground beef.

The Muscle Profiling and Bovine Myology Study (Jones et al., 2001) went beyond those subprimals and examined 39 muscles of the beef chuck and round for palatability and functionality characteristics. This study defined processing characteristics to help the industry better utilize each muscle individually according to its specific characteristics. The immense knowledge gained from this study will continue to provide the industry with valuable information as individual muscles are merchandised to their highest potential.

Although it is too early to quantify the increase in value obtained for chuck and round cuts due to the knowledge gained from muscle profiling and value cuts studies, it is evident that the knowledge gained has indeed moved the industry one step closer to optimizing the utility and value of individual chuck and round muscles. Chuck and round cut prices have somewhat recovered in the past few years and have begun to narrow the price gap between “middle meats” and “end meats.” Armed with this knowledge, it seems the logical next step is to evaluate alternative wholesale carcass fabrication methods that may increase the utilization of individual beef chuck and round muscles.

The initial cuts on the forequarter and hindquarter that separate the chuck and round from the rib and loin, respectively, needs to be closely examined since these two initial breaks bisect multiple muscles and muscle groups. With the trend moving quickly to the use of individual muscle retail cuts, it seems more advantageous to disassemble the carcass in a layering manner rather than making traditional primal breaks that disrupt many different muscle groups and the associated merchandizing potential of these individual muscles.

Much of the basis for how a carcass is fabricated is based on tradition, rather than optimizing value of the resultant cuts. For example, Reuter et al. (2002a) investigated the efficacy of the traditional rib/chuck separation between the fifth and sixth rib. Their work pinpointed two logical points of separation to optimize value of the primal rib and chuck, depending on the customer base and marketing strategy. These two points were at the fourth/fifth rib interface and the sixth/seventh rib interface, not the conventional fifth/sixth rib separation. Reuter et al. (2002b) mapped intramuscular tenderness variations in four muscles of the beef round. They concluded that the conventional round/loin separation excludes an equally tender portion of the biceps femoris (*M. Gluteobiceps*) from the sirloin. That more tender portion of the *M. Gluteobiceps* then is usually marketed as a portion of the less tender, lower valued bottom round.

Beef cuts in the retail meat case have changed dramatically in the past decades. Starting with more closely trimmed, boneless product and progressing to individual muscle cuts, innovations in retail cutting have changed the face of the industry. However, wholesale fabrication of beef carcasses has remained relatively constant with few major changes employed throughout the industry. Has wholesale beef fabrication advanced as far as possible or has the industry been victim of a lack of imagination?

This study was conducted to examine alternative methods of beef carcass fabrication that may be employed to increase yield and/or value of the beef carcass.

# CHAPTER II

# MATERIALS AND METHODS

## Carcass Selection

Beef carcasses (n = 30) were selected from a commercial packing facility and transported to the Rosenthal Meat Science and Technology Center at Texas A&M University for subsequent fabrication. Carcass selection criteria included: sex (steer), approximate weight range (325 to 390 kg), USDA quality grade (Choice and Select), USDA yield grade (2 and 3) determined by trained evaluators (USDA, 1997), and minimal slaughter/dressing defects (e.g., incorrect splits, major fat tears, large bruises, excess trim). Carcasses were selected to obtain an equal mix of USDA Select and Choice, yield grade 2 and 3. Ten carcasses were selected per week for three consecutive weeks.

## Carcass Fabrication

Carcasses were shipped in the form of beef quarters. Upon arrival at Texas A&M University, quarters were bagged in large polyethylene bags to minimize shrink and ensure freshness, and held at $\pm$ 2$^{o}$ C until cutting time. Comparisons were made by fabricating one side of each carcass in a conventional manner, whereas the opposite side was fabricated by a more innovative method. To avoid any potential biases (e.g., “tight side” vs. “loose side”), sides were alternated so that the same side (right or left) was not fabricated by only one method. Initial quarter weights were obtained before fabrication. Fabrication was performed on a quarter basis and initial weights were taken on each component removed from the carcass. Throughout fabrication, each subprimal and its corresponding lean trim, fat, and bone components were weighed to ensure at least 99% recovery yield of each subprimal and then totaled for the entire quarter. Visual target fat percentage for all lean trimmings was 15%. All subprimals cited using an Institutional Meat Purchase Specification number (IMPS #) were fabricated to comply with those specifications as described by USDA (1996) and NAMP (1997).

**Conventional Style**

*Forequarter Fabrication*

Inside skirt muscles were loosened from the hindquarter before ribbing of the carcass at the packing facility. The inside (*M. Transversus abdominis*) and outside (*M. Diaphragma pars costalis* and *M. Diaphragma pars sternalis*) skirt muscles were removed and all major connective tissue and fat was trimmed in preparing the IMPS #121D Beef Plate, Inside Skirt and the IMPS #121C Beef Plate, Outside Skirt. The rib/chuck separation was made by a saw cut between the fifth and sixth rib, perpendicular to the dorsal edge of the carcass. From the chuck, the brisket portion was separated by an initial saw cut 2.54 cm from the dorsal edge of the *M. Pectoralis profundus.* The cut was completed by following the natural seam on the medial side of the foreshank. Costal and sternal bones and cartilage were removed and the deckle fat was trimmed to expose the lean surface of the *M. Pectoralis profundus*. The hard fat along the ventral edge was trimmed flush with the lean surface and the external fat was trimmed to 1.27 cm to create an IMPS #120 Beef Brisket, Deckle Off, Boneless. The chuck portion then was hung by the foreshank and the IMPS #114 Beef Chuck, Outside Shoulder (Clod) was removed. The medial side of the subprimal was trimmed practically free of fat and the subcutaneous fat was trimmed to 0.32 cm. The scapula was removed from the chuck including the *M. Supraspinatus* and the *M. Subscapularis*. The #116B Beef Chuck, Chuck (Mock) Tender was fabricated by separating and trimming the *M. Supraspinatus*. The dorsal section of the *M. Pectoralis profundus* remaining on the chuck after brisket separation was removed and peeled creating the IMPS #115D Beef Chuck, Square Cut, Pectoral Meat. The remainder of the chuck portion was separated from the foreshank through the natural seam. A saw cut was made to separate the neck from the chuck perpendicular to the dorsal edge of the carcass at a point leaving two cervical vertebrae on the chuck. Chuck short ribs were removed by a saw cut immediately ventral to the vertebral column and perpendicular to the rib end. IMPS #130 Beef Chuck, Short Ribs were fabricated by removing the first rib and trimming the lean surface practically free of fat. From the bone-in chuck, the IMPS #116A Beef Chuck, Chuck Roll was fabricated by removing the vertebrae, dorsal spinous processes (feather bones), *ligamentum nuchae* (backstrap), and any part of the *M. Trapezius* and associated fat that was present. The tail was reduced to 2.54 cm ventral to the *M. Longissimus thoracis* on the posterior end and 2.54 cm ventral to *M. Complexus* on the anterior end. The remaining foreshank and neck were separated into knife separable lean trim, excess fat, and bone components.

The rib/plate separation was made by a saw cut 10.16 cm ventral to the *M. Longissimus thoracis* on the anterior end and 7.62 cm ventral to the *M. Longissimus thoracis* on the posterior end. The plate was separated into lean trim, fat, and bone components. The body of the thoracic vertebrae on the rib were removed and the blade meat (*M. Rhomboideus thoracis, M. Trapezius pars thoracia,* and *M. Latissimus dorsi*) was separated through the natural seam. IMPS #109B Beef Rib, Blade Meat was fabricated by separation of theindividual muscles and trimming each one practically free of fat. IMPS #124 Beef Rib, Back Ribs were fabricated from the rib by separating along the lateral edge of the ribs. IMPS #112A Beef Rib, Ribeye, Lip-On was fabricated by removing the *ligamentum nuchae* (backstrap) and reducing the tail to 2.54 cm ventral to the *M. Longissimus thoracis* on both ends.

*Hindquarter Fabrication*

Kidney and pelvic fat was removed and weighed. The round/loin separation was made by a saw cut 2.54 cm anterior to the aitch bone and between the juncture of the last sacral and first caudal vertebra. The aitch bone was removed from the round before hanging on the rail for further fabrication. Starting at the patella, the round tip was removed by following the natural seams and the IMPS #167A Beef Round, Tip (Knuckle) Peeled was prepared by excluding the patella and the distal tip of the *M. Tensor fasciae latae* and all associated fat. The IMPS #168 Beef Round, Top (Inside) was separated from the femur through the natural seam, the subcutaneous fat was trimmed to 0.32 cm and the medial side was trimmed practically free of fat. The IMPS #170 Beef Round, Bottom (Gooseneck) was separated from the hindshank and subsequently fabricated into an IMPS #171B Beef Round, Outside Round (Flat) and an IMPS #171C Beef Round, Eye of Round. Heavy connective tissue ("silver skin") was removed from the outside round (flat), both cuts were trimmed practically free of fat on the medial surface and to 0.32 cm of subcutaneous fat.

The *M. Rectus abdominis* and associated fat were removed and the IMPS #193 Beef Flank, Flank Steak was fabricated by trimming excess fat and heavy connective tissue. The IMPS #185A Beef Loin Bottom Sirloin Butt, Flap, Boneless (*M. Obliquus abdominis internus*) was separated from the flank through the natural seam and trimmed practically free of fat. The IMPS #189A Beef Loin, Tenderloin, Full was removed from the full loin prior to separation of the sirloin from the shell short loin immediately anterior to the tuber coxae of the ilium and perpendicular to the cut surface of the round/loin break. The top and bottom sirloin were separated by a straight cut along the natural seam at the ventral edge of the *M. Gluteus medius*. The top sirloin was fabricated into an IMPS #184 Beef Loin, Top Sirloin Butt, Boneless and subsequently separated into an IMPS #184B Beef Loin, Top Sirloin Butt, Center-Cut, Boneless, cap off and an IMPS #184D Beef Loin, Top Sirloin, Cap (Coulotte). The center-cut top sirloin was trimmed practically free of fat while the cap portion was completely skinned. The bottom sirloin was separated into an IMPS #185B Beef Loin, Bottom Sirloin Butt, Ball Tip, Boneless and an IMPS #185D Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless, defatted, both of these cuts were trimmed practically free of fat. The flank was separated by a straight cut 7.62 cm from the ventral edge of the *M. Longissimus thoracis* on the anterior end and 5.08 cm from the ventral edge of the *M. Longissimus lumborum* on the posterior end. The *M. Obliquus externus abdominis* (special trim flank muscle) was isolated and trimmed practically free of fat. The bodies of the thoracic and lumbar vertebrae of the 7.62 x 5.08 shell short loin were removed, all remaining portions of bones excluded, subcutaneous fat trimmed to 0.32 cm, and the tail was reduced to 2.54 cm on the anterior end and 0.00 cm on the posterior end in preparing the IMPS #180 Beef Loin, Strip Loin, Boneless.

**Innovative Style**

*Forequarter Fabrication*

The inside (*M. Transversus abdominis*) and outside (*M. Diaphragma pars costalis* and *M. Diaphragma pars sternalis*) skirt muscles were removed and all major connective tissue and fat was excluded in preparing the IMPS #121D Beef Plate, Inside Skirt and the IMPS #121C Beef Plate, Outside Skirt. Beginning at the twelfth rib and progressing cranially, the *M. Rhomboideus thoracis*, *M. Trapezius pars thoracica*, and the *M. Latissimus dorsi* were removed to their points of attachment on the shoulder, leaving the *M. Serratus ventralis thoracis* exposed. The entire shoulder was removed through the natural seam between the *M. Subscapularis* and the *M. Serratus ventralis thoracis*. The *M. Serratus ventralis thoracis* and the *M. Serratus ventralis cervicis* were separated from the points of attachment on the medial side of the dorsal edge of the scapula, loosening the shoulder from the main attachment to the axial skeleton. Ventrally, the natural seam was followed that left only the *M. Pectoralis profundus, M. Pectoralis descendens*, and the *M. Pectoralis transversus* intact, thus removing all of the intrinsic muscles of the thoracic limb. Once removed from the carcass, the *M. Rhomboideus thoracis, M. Trapezius pars thoracica*, and the *M. Latissimus dorsi* were removed at the individual insertion points on the scapula or humerus. These muscles were trimmed practically free of fat and weighed as blade meat. The thoracic limb was hung by the foreshank and a subprimal similar the IMPS #114 Beef Chuck, Outside Shoulder Clod (excluding any part of the *M. Trapezius thoracica* and the *M. Latissimus dorsi*) was removed, subcutaneous fat was trimmed to 0.32 cm, and the medial side of the cut was trimmed practically free of fat. The scapula then was removed including the *M. Subscapularis* and the *M. Supraspinatus* from which the IMPS #116B Beef Chuck, Chuck (Mock) Tender was fabricated. The *M. Pectoralis profundus, M. Pectoralis descendens,* and the *M. Pectoralis tranversus* were removed and the subcutaneous fat covering was trimmed to 1.27 cm. The deckle fat was removed exposing the lean surface of the *M. Pectoralis profundus* and the hard fat along the ventral edge was trimmed flush with the lean surface before weighing as the brisket. The *M. Serratus ventralis thoracis* and *M. Serratus ventralis cervicis* were removed from the attachment points along the lateral edge of the ribs and trimmed practically free of fat, leaving the heavy connective tissue (epimysium) intact. The remainder of the forequarter was fabricated on the cutting table. The rib/chuck separation was made by a saw cut between the fourth and fifth ribs instead of the conventional fifth/sixth rib separation. The rib/plate separation was made by a saw cut 10.16 cm from the ventral edge of the *M. Longissimus thoracis* on the anterior end and 7.62 cm from the ventral edge of the *M Longissimus thoracis* on the posterior end. The bodies of the thoracic vertebrae on the rib were removed, thus facilitating removal of the dorsal spinous processes (feather bones), and *ligamentum nuchae* (backstrap). The back ribs (similar to the IMPS #124 Beef Rib, Back Ribs) were separated, by cutting along the lateral edge of the ribs, and weighed. The tail was reduced to 2.54 cm from the ventral edge of the *M. Longissimus thoracis* on both ends and the resulting subprimal weighed as the ribeye roll. The bone-in chuck was separated from the neck at a point leaving two cervical vertebrae on the chuck and the breast portion was separated from the chuck by a saw cut immediately ventral to the vertebral column. All bones and *ligamentum nuchae* (backstrap) were removed in fabricating the chuck roll, and the tail was reduced to 2.54 cm from the ventral edge of the *M. Longissimus thoracis* on the posterior end and 2.54 cm from the ventral edge of the *M. Complexus* on the anterior end. The remaining neck, plate, foreshank, and breast portions were separated into knife separable lean trim, excess fat, and bone components.

*Hindquarter Fabrication*

The *M. Rectus abdominis* and associated fat were removed and the IMPS #193 Beef Flank, Flank Steak was fabricated by trimming excess fat and heavy connective tissue. All kidney and pelvic fat was removed and weighed. The *M.*

*Tensor fasciae latae* was removed and trimmed practically free of fat to create the IMPS #185C Beef Loin, Bottom Sirloin Butt, Tri-Tip, Boneless, Defatted. The *M. Obliquus internus abdominis* and the *M. Obliquus externus abdominis* were removed by a cut starting at the insertion point of the *M. Obliquus internus abdominis* on the tuber coxae and progressing cranially to the thirteenth rib along a line approximately 2.54 cm ventral to the *M. Longissimus lumborum*. The two muscles were separated through the natural seam and trimmed practically free of fat creating the IMPS #185A Beef Loin, Bottom Sirloin Butt, Flap, Boneless (*M. Obliquus internus abdominis*) and the special trim flank muscle (*M. Obliquus externus abdominis*). Starting at the patella, the entire *M. Quadriceps femoris (M. Rectus femoris, M. Vastus intermedius, M. Vastus lateralis*, and *M. Vastus medialis*) was removed through the natural seam and trimmed of any bone (patella) and fat before weighing as the quadriceps. The entire *M. Gluteobiceps* was removed and the anterior portion was separated at a point immediately proximal to the caudal origin at the lateral tuberosity of the tuber ischiadicum, as suggested by Reuter et al. (2002b), resulting in a subprimal similar to the IMPS #184D Beef Loin, Top Sirloin, Cap. The top sirloin cap was defatted and completely skinned. The remainder of the *M. Gluteobiceps* was trimmed to 0.32 cm of subcutaneous fat, and the heavy connective tissue("silver skin") on the medial side was completely removed creating a subprimal similar to the IMPS #171B Beef Round, Outside Round (Flat). The IMPS #168 Beef Round, Top (Inside) Round was removed through the natural seam, subcutaneous fat was trimmed to 0.32 cm while the medial side of the cut was trimmed practically free of fat. The *M. Iliopsoas* (*M. Psoas major* and *M. Iliacus*) were loosened from the insertion point on the lesser trochanter of the femur and the round/loin separation was made by loosening the femur from the aitch bone. The IMPS #189A Beef Loin, Full Tenderloin (side muscle on, defatted) was fabricated from the full loin. The sirloin/shell short loin separation was made by a saw cut immediately anterior to the tuber coxae (hip bone) and the IMPS #184B Beef Loin, Top Sirloin Butt, Center-Cut, Boneless, Cap Off was fabricated. From the shell short loin, the body of the vertebrae and all other bone was removed, tail reduced to 2.54 cm from the ventral edge of the *M. Longissimus thoracis* on the anterior end and 0.00 cm from the ventral edge of the *M. Longissimus lumborum* on the posterior end, and subcutaneous fat trimmed to 0.32 cm in preparation of the IMPS #180A Beef Loin, Strip Loin. The hindshank (including the aitch bone) was knife-separated into lean trim, excess fat, and bone components.

**Carcass Value**

Data collected during carcass fabrication were used in determination of value differences that may have occurred between cutting styles. Subprimal and component prices used in the analysis were obtained from the United States Department of Agriculture, Agricultural Marketing Service (USDA, 2004). Prices were averaged over a three year period (2001, 2002, and 2003) to minimize any seasonal or annual price biases. Subprimals fabricated from the conventional style correspond with the IMPS numbers and the values that were utilized. Blade meat and the special trim flank muscle were valued using the reported price of Cap & Wedge meat. Reported back rib price is based only on the year 2003 as no other prices were available. Value for the center-cut top sirloin butt and top sirloin cap were analyzed together using the reported price for the IMPS #184E Beef Loin, Top Sirloin Butt, Boneless, 2-piece. Many subprimals generated from the innovative side are not identical to that of the conventional style, thus are not identical in terms of IMPS numbers and would most likely be priced independently. For comparative purposes, the innovative brisket, shoulder clod, chuck roll, ribeye roll, back ribs, blade meat, 2-piece top sirloin butt, round tip, and outside round flat from this study were priced identical to their conventional counterparts. The *M. Serratus ventralis* was priced using the reported prices for Cap & Wedge meat.

**Retail Cutting**

*Product Selection*

All subprimals generated in the carcass fabrication phase that were decidedly different between cutting styles were immediately vacuum packaged, heat shrunk, boxed, and held in refrigerated storage (± 2$^{o}$ C) for retail cutting analysis. Subprimals held for retail cutting included: IMPS #120 Beef Brisket, Deckle Off, Boneless (conventional) and the entire M. *Pectoralis profundus, M. Pectoralis descendens*, and *M. Pectoralis transversus* (innovative); IMPS #116A Beef Chuck, Chuck Roll (conventional) and the chuck eye roll containing four rib sections (similar to the IMPS #116D Beef Chuck, Chuck Eye Roll) from the innovative style; IMPS #112A Beef Rib, Ribeye Roll (conventional) and the ribeye roll containing eight rib sections (innovative); IMPS #185B Beef Loin, Bottom Sirloin Butt, Ball Tip, IMPS #167A Beef Round, Round Tip (conventional) and the entire *M. Quadriceps femoris* (innovative); IMPS #171B Beef Round, Bottom Round (Flat), IMPS #184D Beef Loin, Top Sirloin, Cap (conventional) and the bottom round (flat) and the top sirloin cap separated immediately proximal to the attachment at the tuber ischiadicum (innovative); and the *M. Serratus ventralis thoracis* and *M. Serratus ventralis cervicis* (innovative), which had no comparative subprimal from the conventional style.

*Cutting Tests*

Subprimals were fabricated into retail cuts and component parts by experienced retail industry meat cutters to simulate typical retail practices. Trained technicians recorded the time to the nearest 0.01 s needed to complete each phase of the cutting test. Technicians also were responsible for recording weights of each component (each retail cut, lean trim, and excess fat) and ensuring that the combined total weight accounted for at least 99% of the initial subprimal weight. Subprimal weights were taken before and after removal from the bag. Bags were washed, dried, and weighed so that an accurate measurement of purge loss could be obtained. Time phases recorded during cutting tests included bag opening time (time required for removal of the subprimal from a vacuum package bag) and trimming/cutting time (time required for complete fabrication of the subprimal into specific retail cuts, lean trim, and fat components). Retail cuts were identified by

Universal Product Code numbers (NLSMB, 1995), where numbers have been previously established for those particular retail cuts.

The conventional brisket (IMPS #120) was separated through the natural seam, making an IMPS #120A Beef Brisket, Flat Cut, Boneless (*M. Pectoralis profundus*) and an IMPS 120B Beef Brisket, Point Cut, Boneless (*M. Pectoralis transversus* and *M. Pectoralis descendens*). The innovative brisket was separated in the same manner making an IMPS #120B Beef Brisket, Point Cut, Boneless. The remaining portion (entire *M. Pectoralis profundus*) was separated into two equal size pieces; the thin portion on the caudal end of the *M. Pectoralis profundus* was removed from the posterior flat section. All pieces were trimmed practically free of fat on both surfaces.

The conventional chuck roll (IMPS #116A) was portioned by cutting two to three chuck steaks (approximately 1.9 cm thick) from the rib end before cutting chuck roasts (approximately 5 cm thick) from the remainder of the chuck roll. Where possible, IMPS #135A Beef for Stewing was recovered by dicing meat into approximately 3 cm cubes. The innovative chuck roll (similar to the IMPS #116D Beef Chuck, Chuck Eye Roll) was portioned by cutting IMPS #1116D Beef Chuck, Chuck Eye Role Steaks, Boneless, 2.54 cm thick, from the rib end until deemed no longer appropriate for chuck eye steaks (typically 2 steaks). The remainder of the subprimal was separated into two equal portion chuck eye roasts.

Both the conventional (IMPS #112A) rib eye roll and the innovative (similar to the IMPS #112A except includes the fifth rib section) rib eye roll were fabricated into 2.54 cm thick ribeye steaks.

The conventional (IMPS #171B) and innovative bottom round flat were fabricated in the same manner. Both subprimals were initially fabricated by removing the ishiatic head of the *M. Gluteobiceps* and preparing an IMPS #171E Beef Round, Bottom Round, Side Roast. The remainder of the *M. Gluteobiceps* was portioned into 1.92 cm thick bottom round steaks by cutting perpendicular to the muscle fiber orientation; IMPS #135A Beef for Stewing was recovered when appropriate. The conventional (IMPS #184D) and innovative top sirloin cap were portioned into 2.54 cm steaks by cutting perpendicular to the muscle fiber orientation.

The conventional IMPS #167A Beef Round, Round Tip was fabricated by separating the *M. Rectus femoris* and the *M. Vastus lateralis* into individual muscles by cutting through the natural seam. All visible connective tissue was removed before cutting 2.54 cm steaks from the *M. Rectus femoris* (tip center steaks) and *M. Vastus lateralis* (tip side steaks). The *M. Vastus intermedius, M. Vastus medialis*, and tips from the *M. Rectus femoris* and *M. Vastus lateralis*, where appropriate, were used to create IMPS #135A Beef for Stewing and IMPS #135B Beef for Kabobs. The conventional IMPS #185B Beef Loin, Bottom Sirloin Butt, Ball Tip was fabricated into 2.54 cm steaks by cutting parallel to the cut surface, and IMPS #135B Beef for Kabobs. The innovative entire *M. Quadriceps femoris* was fabricated by separating the *M. Rectus femoris* and the *M. Vastus lateralis* into individual muscles. All visible connective tissue was removed before cutting 2.54 cm steaks from the *M. Rectus femoris* (tip center steaks) and *M. Vastus lateralis* (tip side steaks). The *M. Vastus intermedius*, *M. Vastus medialis*, and tips from the *M. Rectus femoris* and *M. Vastus lateralis*, where appropriate, were used to create IMPS #135A Beef for Stewing and IMPS #135B Beef for Kabobs.

The *M. Serratus ventralis thoracis* and *M. Serratus ventralis cervicis* retrieved from the innovative style were separated into individual muscles before trimming or cutting. The thinner *M. Serratus ventralis thoracis* was trimmed of all heavy connective tissue and portioned into four flat cut, rectangular shaped steaks. The thicker *M. Serratus ventralis cervicis* was trimmed of all heavy connective tissue and cut into 2.54 cm strips, perpendicular to the muscle fiber orientation. The strips then were sectioned into 2 to 3 pieces, creating steaks that were 2.54 cm thick and approximately 12 cm in length (similar to the IMPS #123D Beef Chuck, Boneless Short Ribs).

**Statistical Analysis**

Subprimal and retail cut weights, percentages, and value figures were analyzed using the MIXED procedure of SAS (Version 9, SAS Inst., Inc., Cary, NC). All models included cutting style and quality grade as main effects. Carcass number was included as a randomized effect. Least squares means were generated, and when an alpha-level of $P < 0.05$ was established, least squares means were separated by a pairwise *t*-test (PDIFF option).

# CHAPTER III

# RESULTS AND DISCUSSION

## Carcass Fabrication

Means, standard deviations, minimum and maximum values for carcass traits are reported in Table 1.

Table 1. Means, standard deviations (STDEV), minimum and maximum values for carcass traits

| Variable | Mean | STDEV | Min | Max |
|---|---|---|---|---|
| Actual fat thickness, cm | 1.16 | 0.86 | 0.51 | 1.73 |
| Adjusted fat thickness, cm | 1.43 | 0.69 | 0.71 | 1.83 |
| Hot carcass weight, kg | 349.4 | 16.6 | 325.0 | 387.0 |
| Longissimus muscle area, $cm^2$ | 88.3 | 11.2 | 69.0 | 107.1 |
| Estimated kidney, pelvic, and heart fat, % | 2.0 | 0.53 | 1.5 | 4.0 |
| Lean maturity[a] | 170 | 8.50 | 150 | 190 |
| Skeletal maturity[a] | 180 | 10.66 | 160 | 210 |
| Overall maturity[a] | 176 | 6.66 | 165 | 195 |
| Marbling score[b] | 406.9 | 86.77 | 310 | 620 |
| USDA quality grade[c] | 381.5 | 50.71 | 310 | 473 |
| USDA yield grade | 2.88 | 0.64 | 2.0 | 3.9 |

[a]100= $A^{00}$, 200= $B^{00}$
[b]300= $Slight^{00}$, 400= $Small^{00}$, 500= $Modest^{00}$, 600= $Moderate^{00}$
[c]300= $Select^{00}$, 400= $Choice^{00}$

Table 2. Conventional and innovative forequarter subprimal and component means, standard deviation (STDEV), minimum and maximum values expressed in kg

| | Mean | | STDEV | | Min | | Max | |
|---|---|---|---|---|---|---|---|---|
| Subprimal | Conv | Innov | Conv | Innov | Conv | Innov | Conv | Innov |
| Brisket | 5.22 | 7.63 | 0.82 | 0.62 | 4.22 | 6.33 | 7.44 | 9.31 |
| Shoulder clod | 8.80 | 7.80 | 0.76 | 0.63 | 7.47 | 6.86 | 10.49 | 9.30 |
| Chuck tender | 1.42 | 1.43 | 0.13 | 0.14 | 1.26 | 1.21 | 1.72 | 1.71 |
| *M. Serratus ventralis* | - | 4.25 | - | 0.53 | - | 3.30 | - | 5.47 |
| Pectoral meat | 1.05 | - | 0.21 | - | 0.35 | - | 1.39 | - |
| Chuck roll | 7.27 | 2.74 | 0.95 | 0.40 | 5.76 | 2.15 | 9.35 | 3.57 |
| Chuck short rib | 1.50 | - | 0.25 | - | 1.08 | - | 2.10 | - |
| Inside skirt | 1.11 | 1.13 | 0.15 | 0.18 | 0.81 | 0.83 | 1.36 | 1.62 |
| Outside skirt | 0.62 | 0.62 | 0.12 | 0.10 | 0.41 | 0.27 | 0.85 | 0.85 |
| Ribeye roll | 5.01 | 5.61 | 0.43 | 0.59 | 4.16 | 4.68 | 5.91 | 7.15 |
| Back ribs | 1.59 | 1.78 | 0.16 | 0.19 | 1.30 | 1.46 | 2.03 | 2.48 |
| Blade meat | 1.65 | 3.81 | 0.34 | 0.80 | 1.17 | 2.33 | 2.58 | 6.17 |
| Subprimal total | 35.22 | 36.81 | 3.00 | 2.96 | 29.78 | 31.55 | 41.46 | 41.55 |
| Lean trim | 24.72 | 23.74 | 2.54 | 2.46 | 20.55 | 19.01 | 29.64 | 28.83 |
| Fat | 14.20 | 13.88 | 2.81 | 2.75 | 8.69 | 9.20 | 19.17 | 18.44 |
| Bone | 16.47 | 16.30 | 1.47 | 1.53 | 13.96 | 12.80 | 19.94 | 19.64 |

Table 3. Least squares means for forequarter subprimal and component percentages

| Subprimal | Conv | Innov | SEM | *P* > F |
|---|---|---|---|---|
| Brisket | 5.77 | 8.41 | 0.12 | <0.001 |
| Shoulder clod | 9.70 | 8.60 | 0.08 | <0.001 |
| Chuck tender | 1.57 | 1.57 | 0.02 | 0.81 |
| Pectoral meat | 1.16 | - | 0.04 | - |
| Chuck roll | 8.01 | 3.02 | 0.10 | <0.001 |
| *M. Serratus ventralis* | - | 4.69 | 0.09 | - |
| Chuck short rib | 1.65 | - | 0.04 | - |
| Inside skirt | 1.22 | 1.25 | 0.03 | 0.29 |
| Outside skirt | 0.68 | 0.68 | 0.02 | 1.00 |
| Ribeye roll | 5.53 | 6.19 | 0.08 | <0.001 |
| Back ribs | 1.75 | 1.96 | 0.03 | <0.001 |
| Blade meat | 1.85 | 4.19 | 0.09 | <0.001 |
| Subprimal total | 38.86 | 40.55 | 0.29 | <0.001 |
| Lean Trim | 27.23 | 26.12 | 0.35 | <0.001 |
| Fat | 15.75 | 15.39 | 0.47 | 0.27 |
| Bone | 18.16 | 17.94 | 0.23 | 0.27 |

*Forequarter Fabrication*

Simple statistical analyses of forequarter subprimal and component weights for both cutting styles are presented in Table 2. Forequarter wholesale cuts and carcass component percentages were analyzed by cutting style and are reported in Table 3. The innovative brisket (entire *M. Pectoralis profundus, M. Pectoralis descendens*, and *M. Pectoralis transversus*) comprised a greater ($P < 0.001$) percentage of the beef forequarter than the conventional IMPS #120 Beef Brisket, Deckle Off, Boneless. Inclusion of the IMPS #115D Beef Chuck, Square Cut, Pectoral Meat with the conventional brisket still resulted in a lighter combined subprimal weight than that of the innovative brisket. This was an expected result as the muscles were kept intact within the innovative style, creating a heavier subprimal including portions of the *M. Pectoralis profundus* that would conventionally be excluded from the brisket. The conventional IMPS #114 Beef Chuck, Outside Shoulder (Clod) was significantly ($P < 0.001$) higher yielding than the innovative shoulder clod. Again, this was expected due to the portions of the *M. Trapezius thoracica* and *M. Latissimus dorsi* that remain on the conventional IMPS #114 Beef Chuck, Outside Shoulder (Clod), but were removed from the innovative shoulder clod and included as a portion of the blade meat. The shoulder clod was not evaluated in the retail cutting phase, though it would be expected that less lean trim would be generated in fabrication of the innovative subprimal due to the absence of any portions of the *M. Trapezius thoracica* and *M. Latissimus dorsi.*

The chuck rolls were not comparable in weight, as the fabrication methods generated extreme differences in subprimal weight. Therefore, the IMPS #116A Beef Chuck, Chuck Roll comprised a much greater ($P < 0.001$) percentage of the forequarter than the innovative chuck roll (similar to the IMPS #116D). Based on previous work by Reuter et al. (2002a), the rib/chuck separation was made between the fourth and fifth ribs (instead of the convention fifth/sixth rib separation). Using tenderness ratings and consumer appeal, these authors found that a rib/chuck separation between the fourth and fifth rib was not detrimental in either focus, and could provide for the merchandizing of four extra ribeye steaks per carcass. Thus, the innovative ribeye presented a significantly ($P < 0.001$) greater forequarter percentage than the conventional IMPS #112A. Removing the three extrinsic muscles of the forelimb that comprise the blade meat (*M. Rhomboideus thoracis, M. Trapezius pars thoracia,* and *M. Latissimus dorsi*) in their entirety was a priority. Conventionally, these muscles are not removed initially, causing them to be portioned throughout several subprimals where they are typically merchandized as lean trim. The innovative fabrication style optimized the merchandizing potential of these individual muscles by removing them as whole muscles.

Blade meat recovered from the innovative side was much heavier (3.82 vs. 1.65 kg), comprising a greater ($P < 0.001$) forequarter percentage than the conventional IMPS #109B Beef Rib, Blade Meat. The chuck tender, inside skirt, and outside skirt were not affected ($P > 0.05$) by fabrication style. According to Belew et al. (2003), the *M. Serratus ventralis* was the sixth most tender muscle in the beef carcass with a Warner-Bratzler shear force of 3.00 kg. Within the innovative fabrication style, the entire *M. Serratus ventralis* was removed, and accounted for over 4.5% of the beef forequarter. In the innovative fabrication style, the chuck short ribs were not fabricated due to the removal of the *M. Serratus ventralis*. The combined forequarter subprimal yield of the innovative fabrication style was significantly ($P < 0.001$) greater than the combined yield of the conventional cuts, and thus the amount of lean trim generated by the innovative fabrication style was significantly less ($P < 0.001$). Percentages of fat and bone were not affected ($P > 0.05$) by cutting style.

Table 4. Conventional and innovative hindquarter subprimal and component means, standard deviations (STDEV), minimum and maximum values expressed in kg

| | Mean | | STDEV | | Min | | Max | |
|---|---|---|---|---|---|---|---|---|
| Subprimal | Conv | Innov | Conv | Innov | Conv | Innov | Conv | Innov |
| Flank steak | 0.87 | 0.84 | 0.13 | 0.13 | 0.58 | 0.65 | 1.14 | 1.12 |
| Tenderloin | 2.63 | 2.76 | 0.24 | 0.25 | 2.25 | 2.31 | 3.19 | 3.30 |
| Bottom sirloin flap | 1.55 | 1.65 | 0.20 | 0.24 | 1.20 | 0.89 | 1.85 | 1.98 |
| Strip loin | 4.93 | 4.88 | 0.49 | 0.48 | 3.90 | 3.98 | 5.87 | 5.60 |
| Flank muscle | 0.99 | 0.93 | 0.25 | 0.20 | 0.39 | 0.55 | 1.57 | 1.56 |
| Center-cut top sirloin | 3.77 | 3.71 | 0.44 | 0.47 | 2.69 | 2.80 | 4.53 | 4.68 |
| Top sirloin cap | 0.77 | 1.14 | 0.12 | 0.14 | 0.51 | 0.91 | 1.08 | 1.40 |
| Bottom sirloin ball tip | 0.92 | - | 0.32 | - | 0.38 | - | 1.42 | - |
| Bottom sirloin tri-tip | 1.03 | 1.20 | 0.11 | 0.16 | 0.83 | 0.92 | 1.25 | 1.55 |
| Round tip | 4.52 | 5.34 | 0.60 | 0.47 | 3.46 | 4.62 | 6.05 | 6.28 |
| Top round | 9.38 | 9.48 | 0.91 | 0.98 | 8.15 | 7.60 | 11.37 | 11.16 |
| Eye of round | 2.64 | 2.59 | 0.35 | 0.34 | 1.84 | 1.84 | 3.30 | 3.22 |
| Bottom round flat | 6.15 | 5.56 | 0.56 | 0.59 | 4.93 | 3.96 | 7.01 | 6.80 |
| Subprimal total | 40.16 | 40.08 | 3.26 | 3.40 | 33.42 | 31.92 | 46.42 | 46.64 |
| Lean trim | 8.58 | 8.62 | 0.99 | 1.02 | 7.03 | 6.89 | 10.03 | 10.38 |
| Fat | 19.32 | 19.58 | 2.46 | 2.42 | 15.10 | 14.83 | 24.10 | 24.18 |
| Bone | 11.71 | 11.69 | 1.10 | 1.04 | 10.05 | 10.19 | 13.86 | 14.60 |

Table 5. Least squares means for hindquarter subprimal and component percentages

| Subprimal | Conv | Innov | SEM | *P* > F |
|---|---|---|---|---|
| Flank Steak | 1.08 | 1.06 | 0.02 | 0.34 |
| Tenderloin | 3.30 | 3.46 | 0.04 | <0.001 |
| Bottom sirloin flap | 1.94 | 2.06 | 0.04 | 0.01 |
| Strip loin | 6.19 | 6.10 | 0.09 | 0.34 |
| Flank muscle | 1.24 | 1.17 | 0.05 | 0.15 |
| Center-cut top sirloin | 4.73 | 4.64 | 0.08 | 0.30 |
| Top sirloin cap | 0.96 | 1.43 | 0.03 | <0.001 |
| Bottom sirloin ball tip | 1.15 | - | 0.07 | - |
| Bottom sirloin tri-tip | 2.28 | 2.63 | 0.05 | <0.001 |
| Round tip | 5.67 | 6.68 | 0.09 | <0.001 |
| Top round | 11.75 | 11.83 | 0.12 | 0.46 |
| Eye of round | 3.31 | 3.24 | 0.05 | <0.01 |
| Bottom round flat | 7.70 | 6.94 | 0.09 | <0.001 |
| Subprimal total | 50.32 | 50.10 | 0.34 | 0.38 |
| Lean trim | 10.72 | 10.76 | 0.17 | 0.86 |
| Fat | 24.27 | 24.53 | 0.43 | 0.42 |
| Bone | 14.68 | 14.62 | 0.19 | 0.73 |

*Hindquarter Fabrication*

Simple statistical analyses of hindquarter subprimal and component weights for both cutting styles are presented in Table 4. Hindquarter wholesale cuts and carcass component percentages were analyzed by cutting style and are reported in Table 5. The tenderloin fabricated from the innovative side was heavier ($P < 0.001$) than the conventional tenderloin. This occurred because the innovative tenderloin was retrieved from the insertion point of the *M. Ilopsoas* on the lesser trochanter of the femur. This most posterior portion is typically excluded from the tenderloin by the conventional round/loin break. Statistical significance ($P < 0.01$) was reported between cutting styles for the bottom sirloin flap, though the innovative mean weight was only 0.09 kg heavier than the conventional style. The innovative top sirloin cap (coulotte) was significantly ($P < 0.001$) higher yielding (1.43 vs. 0.96 %) than the conventional cut. This is a function of the method employed to fabricate the *M. Gluteobiceps*. From the conventional side, the round/loin break was made 2.54 cm anterior to the tip of the aitch bone and between the last lumbar and first sacral vertebra, the top sirloin cap was just that portion of the *M. Gluteobiceps* that remained on the sirloin. Employing the innovative fabrication style, the entire *M. Gluteobiceps* was removed before the round/loin separation was made. The top sirloin cap (coulotte) then was separated at a point immediately anterior to its caudal origin at the lateral tuberosity of the tuber ischiadicum. This point of separation was used based on previous work by Reuter et al. (2002b) that quantified Warner-Bratzler shear force differences throughout the entire *M. Gluteobiceps*. The study showed the *M. Gluteobiceps* being most tender at the origin (sirloin section) and toughest 7 to 10 cm posterior to the conventional round/loin break. The authors explained that the conventional round/loin separation left some of the more tender portion of the *M. Gluteobiceps* on the round. The innovative bottom sirloin tri-tip also was higher yielding ($P < 0.001$) than its conventional counterpart, again because the innovative fabrication included removal of the entire *M. Tensor fasciae latae*, including the distal tip of the muscle that is normally excluded by the round/loin separation. The round tip (*M. Quadriceps femoris*) of the innovative style also comprised a greater ($P < 0.001$) percentage of the hindquarter, mainly due to the inclusion of the bottom sirloin ball tip in the innovative round tip. Inclusion of the bottom sirloin ball tip with the conventional round tip resulted in a slightly heavier quadriceps group compared to the innovative side. The conventional eye of round was statistically heavier ($P < 0.01$), although only 0.05 kg heavier than its innovative counterpart. The conventional bottom round flat also was higher yielding ($P < 0.001$) in comparison to the innovative bottom round flat, this due to the separation that was made to create a larger top sirloin cap (coulotte) from the innovative side. The flank steak, strip loin, special trim flank muscle, center-cut top sirloin, top round, lean trim, bone, and fat were not affected ($P > 0.05$) by cutting style.

Carcass fabrication times and labor efforts were not recorded as this would be extremely difficult to accurately quantify. Though it appeared that the innovative style would be more conducive to a high speed, continuous type fabrication floor as a greater portion of the fabrication was accomplished while the carcass was hanging on the rail. This method of fabrication should require less physical exertion from employees as full forequarters and hindquarters would not need to be removed from the rail to facilitate initial breaking (i.e. round/loin, rib/chuck). The innovative fabrication style created smaller, more manageable pieces that would be more worker friendly and would even help create a safer work environment.

**Carcass Value**

Wholesale carcass value also was assessed on a quarter basis. Subprimal prices used to determine fabricated carcass value are reported in Table 6.

Table 6. USDA Choice and USDA Select subprimal price/100 kg averaged over 2001, 2002, and 2003, reported in U.S. dollars

| IMPS # | Subprimal | Choice | Select |
|---|---|---|---|
| 120 | Brisket | 209.45 | 209.52 |
| 114 | Shoulder clod | 276.95 | 278.65 |
| 116B | Chuck tender | 298.53 | 293.93 |
| 115D | Pectoral meat | 357.01 | 357.01 |
| 116A | Chuck roll | 307.55 | 300.32 |
| | *M. Serratus ventralis* | 337.17 | 337.17 |
| 130 | Chuck short rib | 364.33 | 361.09 |
| 121D | Inside skirt | 476.19 | 476.19 |
| 121C | Outside skirt | 476.19 | 476.19 |
| 112A | Ribeye roll | 999.44 | 858.89 |
| 124 | Back ribs | 272.38[a] | 272.38[a] |
| 109B | Blade meat | 337.17 | 337.17 |
| 193 | Flank steak | 718.43 | 672.11 |
| 189A | Tenderloin | 1720.47 | 1529.54 |
| 185A | Bottom sirloin flap | 529.69 | 525.89 |
| 180A | Strip loin | 1001.14 | 774.33 |
| | Flank muscle | 337.17 | 337.17 |
| 184E | 2-piece top sirloin butt | 705.93 | 606.71 |
| 185B | Bottom sirloin ball tip | 378.55 | 370.53 |
| 185D | Bottom sirloin tri-tip | 466.91 | 447.79 |
| 167A | Round tip, peeled | 332.67 | 326.25 |
| 168 | Top (inside) round | 323.80 | 316.29 |
| 171C | Eye of round | 377.32 | 354.78 |
| 171B | Outside round (flat) | 300.59 | 293.53 |
| | Lean trim, 85% lean | 230.97 | 230.97 |
| | Fat | 24.26 | 24.26 |
| | Bone | 11.03 | 11.03 |

[a]2003 price is reported

*Forequarter Value*

Forequarter value comparisons were made between cutting style and are reported in Table 7. Value differences of subprimal cuts parallel weight and percentage yields. Due to the weight differential created by fabricating the entire *M. Pectoralis profundus*, the innovative brisket contributed greater ($P < 0.001$) value than the conventional brisket. The conventional IMPS #114 Beef Chuck, Outside Shoulder (Clod) was more valuable ($P < 0.001$) than the innovative shoulder clod, though due the exclusion of the *M. Trapezius thoracica* and *M. Latissimus dorsi* the innovative shoulder clod should realistically command a higher price per pound. The same scenario is true for the innovative chuck roll that yielded less ($P < 0.001$) value than the conventional IMPS #116A Beef Chuck, Chuck Roll, as these very different cuts also were priced identically. The innovative ribeye roll (containing the fifth rib section) generated significantly ($P < 0.001$) greater value, though in a market setting this cut would most likely not realize the same price per pound as the conventional IMPS #112A Beef Rib, Ribeye Roll, Lip-On. Due to greater fabrication weights, the innovative back ribs and blade meat generated more ($P < 0.001$) value. More lean trim was generated within the conventional style of fabrication, thus also producing greater ($P < 0.001$) value of lean trim. The *M. Serratus ventralis* fabricated from the innovative style, priced as cap & wedge meat, generated $14.36 for the side. Total subprimal, saleable yield, and forequarter values were higher ($P < 0.001$) within the innovative style as compared to the conventional fabrication.

Table 7. Least squares means for forequarter subprimal and component values reported in U.S. dollars

| Subprimal | Conv | Innov | SEM | *P* > F |
|---|---|---|---|---|
| | ——— $ ——— | | | |
| Brisket | 10.97 | 15.97 | 0.25 | <0.001 |
| Shoulder clod | 24.48 | 21.70 | 0.34 | <0.001 |
| Chuck tender | 4.23 | 4.24 | 0.07 | 0.71 |
| Pectoral meat | 3.74 | - | 0.13 | - |
| Chuck roll | 22.13 | 8.34 | 0.37 | <0.001 |
| *M. Serratus ventralis* | - | 14.36 | 0.33 | - |
| Chuck short rib | 5.45 | - | 0.15 | - |
| Inside skirt | 5.28 | 5.39 | 0.14 | 0.25 |
| Outside skirt | 2.93 | 2.93 | 0.09 | 0.99 |
| Ribeye roll | 46.64 | 52.27 | 0.71 | <0.001 |
| Back ribs | 4.32 | 4.85 | 0.08 | <0.001 |
| Blade meat | 5.55 | 12.88 | 0.34 | <0.001 |
| Lean trim | 57.14 | 54.84 | 1.03 | <0.001 |
| Fat | 3.46 | 3.38 | 0.10 | 0.28 |
| Bone | 1.82 | 1.80 | 0.03 | 0.37 |
| Subprimal value | 135.72 | 142.94 | 1.68 | <0.001 |
| Salable yield value | 192.85 | 197.78 | 2.40 | <0.001 |
| Forequarter total value | 198.13 | 202.96 | 2.38 | <0.001 |

*Hindquarter Value*

Hindquarter value comparisons were made between cutting style and are reported in Table 8. The increased weight of the innovative tenderloin, 2-piece top sirloin butt, and bottom sirloin tri-tip resulted in greater ($P < 0.001$) value, as did the innovative bottom sirloin flap ($P < 0.005$). The same scenario was true for the conventional IMPS #171C Beef Round, Eye of Round and the IMPS #171B Beef Round, Outside Round (Flat). The entire *M. Quadriceps femoris* fabricated within the innovative fabrication style was heavier and thus generated greater ($P < 0.001$) value than the conventional IMPS #167A Beef Round, Tip (Knuckle), peeled. Although including the conventional IMPS #185B Beef Loin, Bottom Sirloin Butt, Ball Tip with the round tip results in slightly greater value, it should be noted that the innovative *M. Quadriceps femoris* was priced identical to the conventional round tip and could potentially command a higher price in the market place in its intact form. Total subprimal, saleable yield and hindquarter values were greater ($P < 0.05$) for the innovative fabrication style.

Table 8. Least squares means for hindquarter subprimal and component values reported in U.S. dollars

| Subprimal | Conv | Innov | SEM | *P* > F |
|---|---|---|---|---|
| | ——— $ ——— | | | |
| Flank Steak | 6.02 | 5.88 | 0.16 | 0.37 |
| Tenderloin | 42.77 | 44.93 | 0.66 | <0.001 |
| Bottom sirloin flap | 8.20 | 8.70 | 0.21 | 0.005 |
| Strip loin | 43.80 | 43.27 | 0.71 | 0.39 |
| Flank muscle | 3.34 | 3.15 | 0.13 | 0.15 |
| 2-piece top sirloin butt | 29.83 | 31.82 | 0.55 | <0.001 |
| Bottom sirloin ball tip | 3.44 | - | 0.23 | - |
| Bottom sirloin tri-tip | 4.73 | 5.46 | 0.11 | <0.001 |
| Round tip | 14.91 | 17.61 | 0.30 | <0.001 |
| Top round | 30.02 | 30.31 | 0.44 | 0.28 |
| Eye of round | 9.66 | 9.48 | 0.17 | 0.002 |
| Bottom round flat | 18.27 | 16.50 | 0.27 | <0.001 |
| Lean trim | 19.79 | 19.91 | 0.41 | 0.71 |
| Fat | 4.69 | 4.74 | 0.08 | 0.46 |
| Bone | 1.29 | 1.29 | 0.02 | 0.84 |
| Subprimal value | 214.98 | 217.12 | 2.54 | 0.04 |
| Salable yield value | 234.77 | 237.03 | 2.80 | 0.02 |
| Hindquarter total value | 240.75 | 243.07 | 2.79 | 0.01 |

Table 9. Least squares means of retail yields (%) and processing times (s) for fabrication of the brisket from different cutting styles

| Item | UPC[a] | Conv | Innov | SEM[b] | *P* > F |
| --- | --- | --- | --- | --- | --- |
| Net weight, kg | | 5.05 | 7.67 | 0.15 | <0.001 |
| Retail yield | | ---------- | % | ---------- | |
| Flat front[c] | 1623 | 38.01 | 20.08 | 1.22 | <0.001 |
| Flat back[d] | 1623 | - | 22.47 | 0.64 | - |
| Point[e] | 1628 | 21.99 | 16.53 | 0.83 | <0.001 |
| 90% lean trimmings | 1653 | 14.80 | 16.39 | 1.61 | 0.28 |
| Fat | | 24.50 | 23.50 | 1.40 | 0.37 |
| Purge | | 0.69 | 0.93 | 0.19 | 0.14 |
| Cutting loss | | 0.01 | 0.11 | 0.06 | 0.23 |
| Total saleable yield | | 74.80 | 75.46 | 1.43 | 0.53 |
| Processing time, per subprimal | | ---------- | s | ---------- | |
| Bag opening time | | 8.72 | 13.58 | 1.18 | 0.01 |
| Trimming/cutting time | | 336.08 | 456.79 | 28.09 | 0.01 |
| Total time | | 344.80 | 470.37 | 28.43 | 0.01 |

[a]UPC = Universal product code
[b]SEM is the standard error of the least squares means
[c]Anterior portion of the *M. Pectoralis profundus*
[d]Posterior portion of the *M. Pectoralis profundus*
[e]Includes the *M. Pectoralis transversus* and *M. Pectoralis descendens*

Table 10. Least squares means of retail yields (%) and processing times (s) for fabrication of the chuck roll from different cutting styles

| Item | UPC[a] | Conv | Innov | SEM[b] | $P$ > F |
|---|---|---|---|---|---|
| Net weight, kg | | 7.34 | 2.78 | 0.23 | <0.001 |
| Steak number | | 2.67 | 2.17 | 0.16 | <0.05 |
| Roast number | | 6.00 | 2.00 | 0.13 | <0.001 |
| Retail yield | | ——— | % | ——— | |
| Chuck eye steak | 1102 | 15.65 | 17.10 | 1.13 | 0.31 |
| Chuck roast | 1151 | 72.90 | 77.39 | 0.91 | 0.003 |
| Beef for stewing | 1727 | 3.51 | - | 0.45 | - |
| 90% lean trimmings | 1653 | 4.69 | 2.08 | 0.62 | 0.01 |
| Fat | | 2.24 | 2.39 | 0.53 | 0.71 |
| Purge | | 0.95 | 0.89 | 0.22 | 0.78 |
| Cutting loss | | 0.07 | 0.15 | 0.04 | <0.21 |
| Total saleable yield | | 96.74 | 96.57 | 0.61 | <0.67 |
| Processing time, per subprimal | | ——— | s | ——— | |
| Bag opening time | | 9.54 | 8.09 | 0.89 | 0.08 |
| Trimming/cutting time | | 206.86 | 89.83 | 10.85 | <0.001 |
| Total time | | 216.39 | 97.92 | 11.22 | <0.001 |

[a]UPC = Universal product code

[b]SEM is the standard error of the least squares means

Table 11. Least squares means of retail yields (%) and processing times (s) for fabrication of the top sirloin cap from different cutting styles

| Item | UPC[a] | Conv | Innov | SEM[b] | $P > F$ |
|---|---|---|---|---|---|
| Net weight, kg | | 0.78 | 1.14 | 0.04 | <0.001 |
| Steak number | | 4.50 | 4.58 | 0.16 | 0.34 |
| Retail yield | | ——— | ——— % ——— | ——— | ——— |
| Top sirloin cap steaks | 1421 | 83.92 | 85.75 | 1.38 | 0.25 |
| 90% lean trimmings | 1653 | 12.83 | 11.50 | 1.39 | 0.36 |
| Purge | | 3.10 | 2.62 | 0.31 | 0.20 |
| Cutting loss | | 0.15 | 0.13 | 0.13 | 0.92 |
| Total saleable yield | | 96.75 | 97.25 | 0.34 | <0.001 |
| Processing time, per subprimal | | ——— | ——— s ——— | ——— | ——— |
| Bag opening time | | 5.95 | 6.09 | 0.56 | 0.83 |
| Trimming/cutting time | | 13.49 | 16.51 | 1.76 | 0.08 |
| Total time | | 19.43 | 22.59 | 2.08 | 0.09 |

[a]UPC = Universal product code

[b]SEM is the standard error of the least squares means

Table 12. Least squares means of retail yields (%) and processing times (s) for fabrication of the bottom round flat from different cutting styles

| Item | UPC[a] | Conv | Innov | SEM[b] | $P > F$ |
|---|---|---|---|---|---|
| Net weight, kg | | 6.29 | 5.79 | 0.15 | <0.001 |
| Steak number | | 9.83 | 10.08 | 0.39 | 0.49 |
| Roast number | | 1.00 | 1.00 | 0.00 | 1.00 |
| Retail yield | | ——————— | % | ——————— | |
| Bottom round steak | 1466 | 50.10 | 51.68 | 2.42 | 0.41 |
| Bottom round pot roast | 1464 | 13.15 | 13.80 | 0.52 | 0.04 |
| Beef for stewing | 1727 | 8.84 | 6.43 | 0.99 | 0.03 |
| 90% lean trimmings | 1653 | 17.79 | 18.89 | 1.38 | 0.34 |
| Fat | | 7.28 | 6.65 | 0.70 | 0.37 |
| Purge | | 2.91 | 2.45 | 0.30 | 0.20 |
| Cutting loss | | -0.07 | 0.10 | 0.06 | 0.03 |
| Total saleable yield | | 89.88 | 90.80 | 0.72 | 0.26 |
| Processing time, per subprimal | | ——————— | s | ——————— | |
| Bag opening time | | 12.33 | 11.07 | 1.45 | 0.19 |
| Trimming/cutting time | | 368.01 | 346.12 | 15.26 | 0.20 |
| Total time | | 380.33 | 357.19 | 14.73 | 0.18 |

[a]UPC = Universal product code
[b]SEM is the standard error of the least squares means

Table 13. Least squares means of retail yields (%) and processing times (s) for fabrication of the quadriceps from different cutting styles

| Item | UPC[a] | Conv | Innov | SEM[b] | *P* > F |
|---|---|---|---|---|---|
| Net weight, kg | | 5.47 | 5.42 | 0.15 | 0.28 |
| Side steak number | | 4.33 | 5.67 | 0.17 | <0.001 |
| Center steak number | | 3.83 | 6.17 | 0.25 | <0.001 |
| Ball tip steak number | | 3.50 | - | 0.14 | - |
| Retail yield | | ————— | % | ————— | |
| Tip side steak | 1543 | 18.39 | 24.80 | 0.71 | <0.001 |
| Tip center steak | 1549 | 14.41 | 23.68 | 0.83 | <0.001 |
| Ball tip steak | 1308 | 13.53 | - | 0.99 | - |
| Total steak | | 46.33 | 48.48 | 0.81 | <0.05 |
| Beef for stewing | 1727 | 8.69 | 10.82 | 0.83 | 0.03 |
| Beef for kabobs | 1576 | 11.40 | 8.30 | 0.95 | 0.005 |
| 90% lean trimmings | 1653 | 27.98 | 27.80 | 0.84 | 0.84 |
| Fat | | 2.89 | 2.78 | 0.51 | 0.80 |
| Purge | | 2.72 | 1.73 | 0.32 | 0.02 |
| Cutting loss | | 0.53 | 0.08 | 0.11 | 0.006 |
| Total saleable yield | | 94.40 | 95.40 | 0.67 | 0.09 |
| Processing time, per subprimal | | ————— | s | ————— | |
| Bag opening time | | 14.68 | 7.76 | 0.89 | <0.001 |
| Trimming/cutting time | | 428.30 | 499.53 | 31.48 | 0.06 |
| Total time | | 442.98 | 507.29 | 31.77 | 0.08 |

[a]UPC = Universal product code

[b]SEM is the standard error of the least squares means

Table 14. Least squares means of retail yields (%) and processing times (s) for fabrication of the ribeye roll from different cutting styles

| Item | UPC[a] | Conv | Innov | SEM[b] | *P* > F |
|---|---|---|---|---|---|
| Net weight, kg | | 5.09 | 5.70 | 0.17 | <0.001 |
| Steak number | | 13.42 | 15.42 | 0.46 | <0.001 |
| Retail yield | | ——————— | % | ——————— | |
| Ribeye steak | 1203 | 91.23 | 89.72 | 1.00 | 0.03 |
| 90% lean trimmings | 1653 | 1.36 | 1.68 | 0.56 | 0.32 |
| Fat | | 6.58 | 7.71 | 1.05 | 0.03 |
| Purge | | 0.68 | 0.85 | 0.17 | 0.37 |
| Cutting loss | | 0.15 | 0.04 | 0.07 | 0.26 |
| Total saleable yield | | 92.59 | 91.40 | 1.14 | 0.03 |
| Processing time, per subprimal | | ——————— | s | ——————— | |
| Bag opening time | | 9.88 | 10.15 | 0.80 | 0.71 |
| Trimming/cutting time | | 179.72 | 203.78 | 8.20 | 0.03 |
| Total time | | 189.60 | 213.92 | 8.03 | 0.03 |

[a]UPC = Universal product code
[b]SEM is the standard error of the least squares means

Table 15. Least squares means of retail yields (%) and processing times (s) for fabrication of the *M. Serratus ventralis* from different USDA quality grades

| Item | UPC[a] | Choice | Select | SEM[b] | *P* > F |
|---|---|---|---|---|---|
| Net weight, kg | | 4.37 | 4.23 | 0.13 | 0.48 |
| Flanken Steak number | | 14.50 | 13.17 | 0.61 | 0.15 |
| Serratus steak number | | 4.00 | 4.00 | 0.00 | 1.00 |
| Retail yield | | ———— | ———— % | ———— | ———— |
| Flanken steak[c] | | 42.22 | 45.39 | 1.83 | 0.25 |
| Serratus steak[d] | | 15.20 | 15.90 | 1.15 | 0.68 |
| 90% lean trimmings | 1653 | 36.53 | 34.30 | 2.09 | 0.47 |
| Fat | | 3.19 | 2.08 | 0.49 | 0.14 |
| Purge | | 2.55 | 2.05 | 0.72 | 0.63 |
| Cutting loss | | 0.31 | 0.28 | 0.11 | 0.87 |
| Total saleable yield | | 93.96 | 95.59 | 0.98 | 0.27 |
| Processing time, per subprimal | | ———— | ———— s | ———— | ———— |
| Bag opening time | | 10.39 | 9.33 | 1.17 | 0.54 |
| Trimming/cutting time | | 406.99 | 402.64 | 21.02 | 0.89 |
| Total time | | 417.37 | 411.98 | 21.81 | 0.86 |

[a]UPC = Universal product code
[b]SEM is the standard error of the least squares means
[c]Anterior (thick) portion of the *M. Serratus ventralis*
[d]Posterior (thin) portion of the *M. Serratus ventralis*

**Retail Cutting**

Beef subprimals were evaluated for mean retail yields and processing times, and comparisons were made between cutting style (Tables 9-15) and USDA quality grade. No statistically significant values were found between quality grades (data not reported in tabular form). Retail portioning of the heavier innovative brisket (7.67 vs. 5.05 kg) revealed approximately the same percentage yield of whole muscle retail cuts, although the combined weight of these cuts was greater. This is important because much of the *M. Pectoralis profundus* not included in the conventional IMPS # 120 Beef Brisket, Deckle Off, Boneless would normally be included in lean trimmings. Fabrication of the innovative chuck eye roll as compared to the much heavier chuck roll retrieved from the conventional style produced a greater ($P < 0.001$) saleable yield. In addition, the saleable yield figures for the innovative subprimal included less ($P < 0.01$) lean trim and no beef for stewing. The total fabrication time was greater ($P < 0.001$) for the much heavier conventional chuck roll. Comparison of the top sirloin cap (coulotte) revealed that the heavier (innovative) cut produced a higher saleable yield percentage ($P < 0.001$), though steak and trim yields were not affected ($P > 0.05$). There were no measurable amounts of fat on these cuts as they were completely skinned in the carcass fabrication phase. Processing times were also not affected by cutting style. The bottom round flat was fabricated by first removing the ishiatic head of the *M. Gluteobiceps* and preparing it as a bottom round pot roast. The remainder of the *M. Gluteobiceps* was portioned into bottom round steaks. Neither steak nor trim yields were affected ($P > 0.05$) by cutting style. Roast yield was affected ($P = 0.04$), though roast weight was not affected ($P > 0.05$) by cutting style. McKenna et al. (2003) reported only 48.68% bottom round steak yield for USDA Select subprimals compared to these findings of 50.10% (conv) and 51.68% (innov) for USDA Select and Choice subprimals. Fabrication of the *M. Quadriceps femoris* revealed a greater ($P < 0.05$) total steak yield (48.48%) for the innovative style and total saleable yield also was approaching significance ($P = 0.09$). The 48.48% steak yield is also greater than that reported by McKenna et al. (2003) for the IMPS #167A Beef Round, Tip (Knuckle), Peeled. Due to the reduction in surface area of the cut face, the innovative cut also produced less purge (1.73 vs. 2.72 %). It is also important to note that the innovative side produced only single muscle steaks (*M. Vastus Lateralis* and *M. Rectus femoris*), whereas a portion of the conventional steak yield was comprised of less consistent, multiple muscle ball tip steaks. Fabrication of the ribeye roll was conducted by cutting 2.54 cm steaks and trimming any excess fat. The innovative ribeye roll was heavier ($P < 0.001$) than its counterpart due to the extra rib section that was present. Thus, the steak number also was greater ($P < 0.001$), yielding two more steaks per subprimal. Cutting times also were greater ($P = 0.03$) for the innovative ribeye roll. Fabrication of the *M. Serratus ventralis* from the innovative style yielded flanken style steaks similar to the IMPS #123D Beef Short Ribs, Boneless and Serratus steaks that were similar in appearance to that of the flat iron steak cut from the *M. Infraspinatus* (NCBA Beef Value Cuts). This subprimal could only be analyzed by USDA quality grade as the *M. Serratus ventralis* was only retrieved from the innovative fabrication style. There were no significant ($P > 0.05$) findings between quality grades. The subprimal did reveal a total steak yield of approximately 59%, and total saleable yield of approximately 95%. The innovative fabrication style allows for harvesting, retail merchandizing, and thus greater utilization of this large, high quality muscle from the lower valued chuck.

# CHAPTER IV

## SUMMARY AND CONCLUSIONS

Carcasses are typically fabricated by methods based on tradition. As the beef industry attempts to meet evolving consumer demands, subprimal cuts have been subjected to further fabrication resulting in more consistent, single muscle retail cuts. Conventional carcass fabrication methods have limited the industry's ability to merchandize certain muscles and muscle groups. The priority of this research was to optimize beef carcass value through innovative fabrication styles. Data presented in this study showed that carcass value could be significantly increased by the application of alternative carcass fabrication styles as compared to conventional methods. In this demonstration, the innovative fabrication increased subprimal yield and value of the entire beef carcass. The present data support an approximate increase of fourteen dollars per beef carcass using such innovative carcass fabrication methods. Retail cutting data also were obtained to evaluate any yield differences that may be present between conventional and innovative subprimals. In general, innovative subprimals produced similar steak/roast and saleable yields as compared to conventional subprimals.

## LITERATURE CITED

AMI. 2003. Meat and Poultry Facts. Amer. Meat Inst., Washington, DC.

Belew, J. B., J. C. Brooks, D. R. McKenna, and J. W. Savell. 2003. Warner-Bratzler shear evaluations of 40 bovine muscles. Meat Science. 64:507-512.

Boleman, S. L., S. J. Boleman, W. W. Morgan, D. S. Hale, D. B. Griffin, J. W. Savell, R. P Ames, M. T. Smith, J. D. Tatum, T. G. Field, G. C. Smith, B. A. Gardner, J. B. Morgan, S. L. Northcutt, H. G. Dolezal, D. R. Gill, and F. K. Ray. 1998. National Beef Quality Audit-1995: Survey of producer-related defects and carcass quality and quantity attributes. J. Anim. Sci. 76:96-103.

Brooks, J. C., J. B. Belew, D. B. Griffin, B. L. Gwartney, D. S. Hale, W. R. Henning, D. D. Johnson, J. B. Morgan, F. C. Parrish, Jr., J. O. Reagan, and J. W. Savell. 2000. National Beef Tenderness Survey-1998. J. Anim. Sci. 78:1852-1860.

Jones, S. L., D. E. Burson, and C. R. Calkins. 2001. Muscle profiling and bovine myology. Accessed at: http://bovine.unl.edu. Accessed: August 30, 2004.

Lorenzen, C. L., D. S. Hale, D. B. Griffin, J. W. Savell, K. E. Belk, T. L. Frederick, M. F. Miller, T. H. Montgomery, and G. C. Smith. 1993. National Beef Quality Audit: Survey of producer-related defects and carcass quality and quantity attributes. J. Anim. Sci. 71:1495-1502.

McKenna, D. R., D. L. Roeber, P. K. Bates, T. B. Schmidt, D. S. Hale, D. B. Griffin, J. W. Savell, J. C. Brooks, J. B. Morgan, T. H. Montgomery, K. E. Belk, and G. C. Smith. 2002. National Beef Quality Audit-2000: Survey of targeted cattle and carcass characteristics related to quality, quantity, and value of fed steers and heifers. J. Anim. Sci. 80:1212-1222.

McKenna, D. R., D. B. Griffin, H. K. Johnson, B. R. Covington, and J. W. Savell. 2003. Retail yields from beef chuck and round subprimals from two grade groups when merchandised as single muscle cuts. J. Anim. Sci. 81:1482-1487.

Morgan, J. B., J. W. Savell, D. S. Hale, R. K. Miller, D. B. Griffin, H. R. Cross, and S. D. Shackelford. 1991. National Beef Tenderness Survey. J. Anim. Sci. 69:3274-3283.

NAMP. 1997. Meat Buyers Guide. Natl. Assoc. Meat Purveyors, Reston, VA.

NCBA. 2001. Beef value cuts: New cuts for the new consumer. Natl. Cattlemen's Beef Assoc., Chicago, IL.

NLSMB. 1995. U.P.C. Identification Numbers. Natl. Live Stock and Meat Board, Chicago, IL.

Reuter, B. J., D. M. Wulf, B. C. Shanks, and R. J. Maddock. 2002a. Evaluating the point of separation, during carcass fabrication, between the beef wholesale rib and the beef wholesale chuck. J. Anim. Sci. 80:101-107.

Reuter, B. J., D. M. Wulf, and R. J. Maddock. 2002b. Mapping intramuscular tenderness variation in four major muscles of the beef round. J. Anim. Sci. 80:2594-2599.

USDA. 1996. Institutional meat purchase specifications for fresh beef. Agric. Marketing Serv., USDA, Washington, DC.

USDA. 1997. Official United States standards for grades of carcass beef. Agric. Marketing Serv., USDA, Washington, DC.

USDA. 2004. Agric. Marketing Serv., Accessed at http://ams.usda.gov. Accessed March 30, 2004.

# APPENDIX A

**TABLE A-1**

Least squares means of retail yields (%) and processing times (s) for fabrication of the brisket from different USDA quality grades

| Item | UPC[a] | Choice | Select | SEM[b] | *P* > F |
|---|---|---|---|---|---|
| Net weight, kg | | 6.14 | 6.58 | 0.16 | 0.09 |
| Retail yield | | ——— | % | ——— | |
| Flat front[c] | 1623 | 29.43 | 28.65 | 1.22 | 0.66 |
| Flat back[d] | 1623 | 11.16 | 11.32 | 0.65 | 0.86 |
| Point[e] | 1628 | 18.50 | 20.01 | 0.84 | 0.23 |
| 90% lean trimmings | 1653 | 16.58 | 14.60 | 2.06 | 0.51 |
| Fat | | 23.51 | 24.49 | 1.83 | 0.71 |
| Purge | | 0.78 | 0.84 | 0.24 | 0.85 |
| Cutting loss | | 0.04 | 0.08 | 0.06 | 0.68 |
| Total saleable yield | | 75.68 | 74.59 | 1.89 | 0.69 |
| Processing time, per subprimal | | ——— | s | ——— | |
| Bag opening time | | 11.85 | 10.45 | 1.18 | 0.42 |
| Trimming/cutting time | | 415.87 | 377.00 | 29.79 | 0.38 |
| Total time | | 427.72 | 387.45 | 30.25 | 0.37 |

[a]UPC = Universal product code
[b]SEM is the standard error of the least squares means
[c]Anterior portion of the *M. Pectoralis profundus*
[d]Posterior portion of the *M. Pectoralis profundus*
[e]Includes the *M. Pectoralis transversus* and *M. Pectoralis descendens*

**TABLE A-2**

Least squares means of retail yields (%) and processing times (s) for fabrication of the chuck roll from different USDA quality grades

| Item | UPC[a] | Choice | Select | SEM[b] | *P* > F |
|---|---|---|---|---|---|
| Net weight, kg | | 5.18 | 4.94 | 0.26 | 0.54 |
| Steak number | | 2.42 | 2.42 | 0.16 | 1.00 |
| Roast number | | 4.25 | 3.75 | 0.13 | 0.02 |
| Retail yield | | ——— | ——— % | ——— | ——— |
| Chuck eye steak | 1102 | 15.01 | 17.74 | 1.26 | 0.15 |
| Chuck roast | 1151 | 76.29 | 73.99 | 0.97 | 0.12 |
| Beef for stewing | 1727 | 1.32 | 2.19 | 0.45 | 0.20 |
| 90% lean trimmings | 1653 | 3.64 | 3.13 | 0.62 | 0.58 |
| Fat | | 2.64 | 1.99 | 0.69 | 0.52 |
| Purge | | 0.96 | 0.88 | 0.28 | 0.85 |
| Cutting loss | | 0.15 | 0.08 | 0.04 | 0.31 |
| Total saleable yield | | 96.26 | 97.05 | 0.82 | 0.50 |
| Processing time, per subprimal | | ——— | ——— s | ——— | ——— |
| Bag opening time | | 9.52 | 8.10 | 1.14 | 0.39 |
| Trimming/cutting time | | 163.72 | 132.97 | 10.85 | 0.07 |
| Total time | | 173.24 | 141.07 | 11.22 | 0.07 |

[a]UPC = Universal product code
[b]SEM is the standard error of the least squares means

**TABLE A-3**

Least squares means of retail yields (%) and processing times (s) for fabrication of the top sirloin cap from different USDA quality grades

| Item | UPC[a] | Choice | Select | SEM[b] | *P* > F |
|---|---|---|---|---|---|
| Net weight, kg | | 0.93 | 0.99 | 0.05 | 0.36 |
| Steak number | | 4.58 | 4.50 | 0.21 | 0.79 |
| Retail yield | | ——————— | % | ——————— | |
| Top sirloin cap steaks | 1421 | 85.81 | 83.87 | 1.64 | 0.42 |
| 90% lean trimmings | 1653 | 11.44 | 12.89 | 1.70 | 0.56 |
| Purge | | 2.71 | 3.01 | 0.36 | 0.57 |
| Cutting loss | | 0.04 | 0.24 | 0.12 | 0.28 |
| Total saleable yield | | 97.25 | 96.76 | 0.37 | 0.37 |
| Processing time, per subprimal | | ——————— | s | ——————— | |
| Bag opening time | | 5.53 | 6.51 | 0.63 | 0.30 |
| Trimming/cutting time | | 14.43 | 15.56 | 2.23 | 0.73 |
| Total time | | 19.96 | 22.07 | 2.67 | 0.59 |

[a]UPC = Universal product code

[b]SEM is the standard error of the least squares means

**TABLE A-4**

Least squares means of retail yields (%) and processing times (s) for fabrication of the bottom round flat from different USDA quality grades

| Item | UPC[a] | Choice | Select | SEM[b] | *P* > F |
|---|---|---|---|---|---|
| Net weight, kg | | 5.99 | 6.08 | 0.21 | 0.77 |
| Steak number | | 10.00 | 9.92 | 0.49 | 0.91 |
| Roast number | | 1.00 | 1.00 | 0.00 | 1.00 |
| Retail yield | | ——— | % | ——— | |
| Bottom round steak | 1466 | 51.67 | 50.12 | 3.17 | 0.74 |
| Bottom round pot roast | 1464 | 12.74 | 14.21 | 0.71 | 0.17 |
| Beef for stewing | 1727 | 7.21 | 8.06 | 1.23 | 0.63 |
| 90% lean trimmings | 1653 | 19.15 | 17.53 | 1.79 | 0.54 |
| Fat | | 6.72 | 7.20 | 0.86 | 0.70 |
| Purge | | 2.56 | 2.81 | 0.35 | 0.63 |
| Cutting loss | | -0.05 | 0.08 | 0.05 | 0.12 |
| Total saleable yield | | 90.77 | 89.91 | 0.86 | 0.50 |
| Processing time, per subprimal | | ——— | s | ——— | |
| Bag opening time | | 10.96 | 12.44 | 1.94 | 0.60 |
| Trimming/cutting time | | 349.36 | 364.77 | 18.31 | 0.56 |
| Total time | | 360.32 | 377.21 | 17.45 | 0.51 |

[a]UPC = Universal product code

[b]SEM is the standard error of the least squares means

**TABLE A-5**

Least squares means of retail yields (%) and processing times (s) for fabrication of the quadriceps from different USDA quality grades

| Item | UPC[a] | Choice | Select | SEM[b] | *P* > F |
|---|---|---|---|---|---|
| Net weight, kg | | 5.46 | 5.44 | 0.20 | 0.95 |
| Side steak number | | 4.92 | 5.08 | 0.20 | 0.57 |
| Center steak number | | 5.00 | 5.00 | 0.25 | 1.00 |
| Ball tip steak number | | 1.75 | 1.75 | 0.14 | 1.00 |
| Retail yield | | ——————— | % | ——————— | |
| Tip side steak | 1543 | 21.47 | 21.73 | 0.85 | 0.84 |
| Tip center steak | 1549 | 18.66 | 19.43 | 0.95 | 0.58 |
| Ball tip steak | 1308 | 6.87 | 6.66 | 1.02 | 0.89 |
| Total steak | | 47.00 | 47.81 | 0.92 | 0.55 |
| Beef for stewing | 1727 | 9.81 | 9.70 | 1.01 | 0.93 |
| Beef for kabobs | 1576 | 9.76 | 9.93 | 1.18 | 0.92 |
| 90% lean trimmings | 1653 | 28.38 | 27.40 | 1.01 | 0.51 |
| Fat | | 2.85 | 2.82 | 0.66 | 0.98 |
| Purge | | 2.20 | 2.26 | 0.38 | 0.91 |
| Cutting loss | | 0.27 | 0.35 | 0.11 | 0.63 |
| Total saleable yield | | 94.96 | 94.84 | 0.87 | 0.92 |
| Processing time, per subprimal | | ——————— | s | ——————— | |
| Bag opening time | | 11.74 | 10.70 | 0.89 | 0.43 |
| Trimming/cutting time | | 464.78 | 463.05 | 37.68 | 0.97 |
| Total time | | 476.52 | 473.75 | 38.18 | 0.96 |

[a]UPC = Universal product code
[b]SEM is the standard error of the least squares means

**TABLE A-6**

Least squares means of retail yields (%) and processing times (s) for fabrication of the ribeye roll from different USDA quality grades

| Item | UPC[a] | Choice | Select | SEM[b] | *P* > F |
|---|---|---|---|---|---|
| Net weight, kg | | 5.39 | 5.39 | 0.23 | 0.99 |
| Steak number | | 14.75 | 14.08 | 0.64 | 0.48 |
| Retail yield | | ——————— | % | ——————— | |
| Ribeye steak | 1203 | 89.93 | 91.02 | 1.35 | 0.58 |
| 90% lean trimmings | 1653 | 1.53 | 1.51 | 0.76 | 0.99 |
| Fat | | 7.72 | 6.57 | 1.44 | 0.58 |
| Purge | | 0.73 | 0.80 | 0.21 | 0.82 |
| Cutting loss | | 0.09 | 0.10 | 0.08 | 0.97 |
| Total saleable yield | | 91.45 | 92.54 | 1.58 | 0.64 |
| Processing time, per subprimal | | ——————— | s | ——————— | |
| Bag opening time | | 9.60 | 10.43 | 1.01 | 0.57 |
| Trimming/cutting time | | 206.28 | 177.22 | 9.51 | 0.05 |
| Total time | | 215.87 | 187.65 | 9.03 | <0.05 |

[a]UPC = Universal product code
[b]SEM is the standard error of the least squares means

# APPENDIX B

**FIGURE B-1**

Whole innovative brisket (entire *M. Pectoralis profundus, M. Pectoralis descendens*, and *M. Pectoralis tranversus*)

**FIGURE B-2**

Fabricated innovative brisket (entire *M. Pectoralis profundus, M. Pectoralis descendens*, and *M. Pectoralis tranversus*)

**FIGURE B-3**

Whole innovative chuck roll (similar to the IMPS # 116D beef chuck, chuck eye roll)

**FIGURE B-4**

Fabricated innovative chuck roll (similar to the IMPS # 116D beef chuck, chuck eye roll)

**FIGURE B-5**

Whole innovative top sirloin cap

**FIGURE B-6**

Fabricated innovative top sirloin cap

**FIGURE B-7**

Whole innovative bottom round flat

**FIGURE B-8**

Fabricated innovative bottom round flat

**FIGURE B-9**

Whole innovative quadriceps (entire M. *Rectus femoris, M. Vastus lateralis, Vastus medialis*, and *Vastus intermedius*)

**FIGURE B-10**

Fabricated innovative quadriceps (entire M. *Rectus femoris, M. Vastus lateralis, Vastus medialis*, and *Vastus intermedius*)

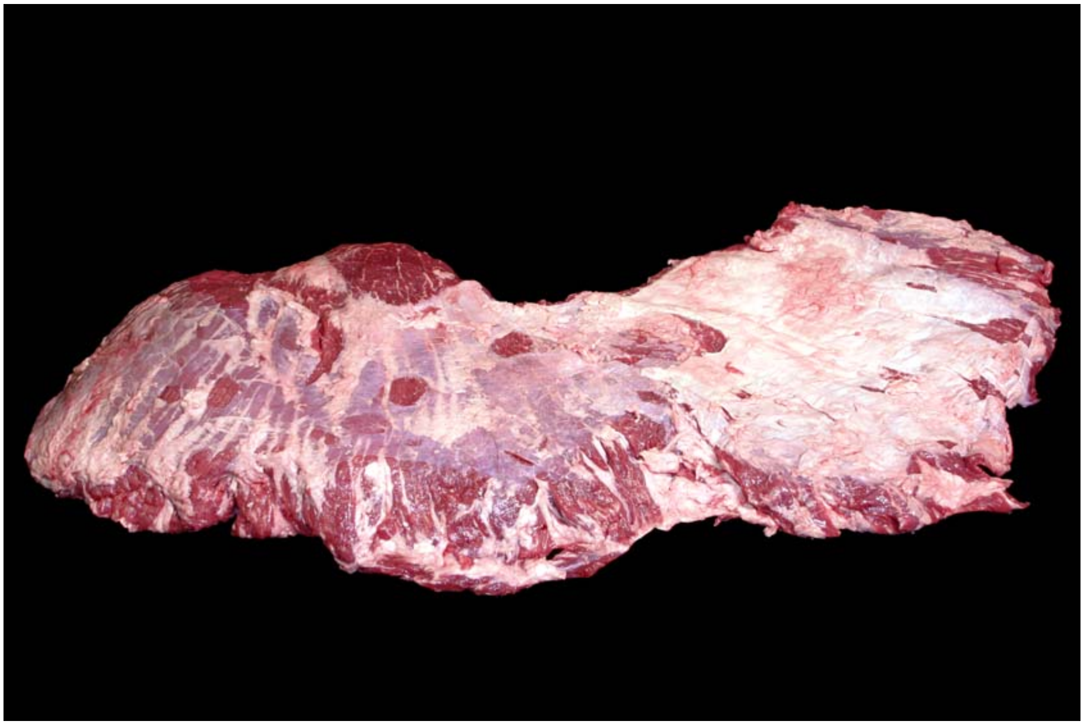
**FIGURE B-11**

Whole innovative ribeye roll (eight rib sections)

**FIGURE B-12**

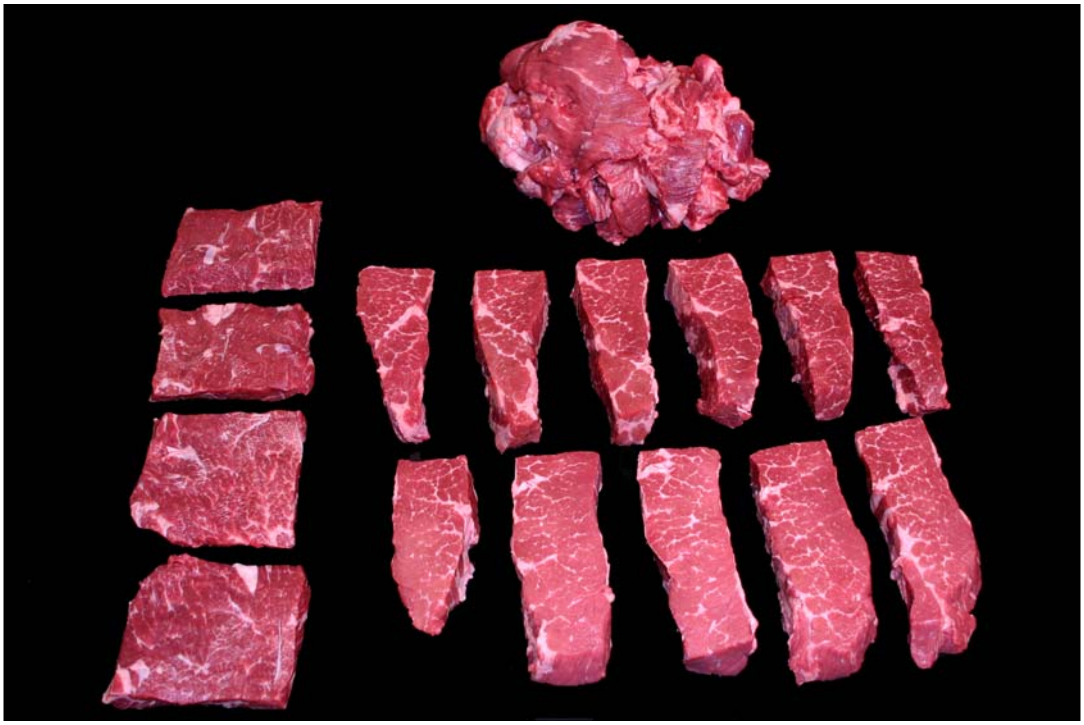
Fabricated innovative ribeye roll (eight rib sections)

**FIGURE B-13**



Whole innovative *M. Serratus ventralis*

**FIGURE B-14**



Fabricated innovative *M. Serratus ventralis*

# VITA

| | |
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