Meat and Muscle Biology™

Carcass Yield and Subprimal Cutout Value of Beef, High- and Low-Yielding Beef × Dairy, and Dairy Steers

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Abstract: This study compared carcass yield and cutout value of conventional beef and dairy cattle to high-yielding (HY) and low-yielding (LY) crossbred beef × dairy cattle and identified the contribution of carcass regions to carcass yield and cutout value among beef × dairy crossbreds. Carcasses of conventional beef, beef × dairy crossbred, and dairy cattle were selected according to industry-average slaughter endpoints for their cattle type. Carcasses were fabricated at a commercial processing facility, and weights of carcass components were obtained. *Post hoc* subsampling was used to segregate HY and LY beef × dairy crossbreds based on subprimal yield. Multiple linear regression was used to assess carcass yield and subprimal cutout value between the 4 cattle types ($n = 21$ to 26 per cattle type). Beef cattle and HY crossbreds produced 1.59 to 3.04 percentage units greater ($P < 0.05$) subprimal yield than LY crossbreds and dairy cattle. Dairy cattle produced at least 1.16 percentage units more ($P < 0.05$) bone than any other cattle type. Subprimal to bone was not different ($P > 0.05$) between HY crossbreds and beef cattle, and subprimal to fat was lesser ($P < 0.05$) in HY crossbreds than beef cattle. Subprimal cutout value was more than 5 US dollars (USD)/45.4 kg different ($P < 0.05$) between cattle types, which were ranked HY crossbreds > beef cattle > LY crossbreds > dairy cattle. In beef × dairy cattle, subprimal to bone in the round contributed most greatly to an increase ($P = 0.02$), by 3.79 USD/45.4 kg, in subprimal cutout value. Together, these results suggested carcass value of beef × dairy cattle may be maximized when cattle are harvested at a lesser overall fatness than conventional beef cattle and when considerable muscling, especially in the round, is achieved.

Key words: beef-on-dairy, yield, fabrication, muscle, fat, bone
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Introduction

Large differences in carcass tissue proportions have been attributed to biological cattle type, specifically that associated with cattle of beef versus dairy breeds (Callow, 1961; Berg and Butterfield, 1976; Griffin et al., 1992). Because they have not been selected for beef production traits, cattle of dairy breeds generally convert less body weight into carcass weight and contain a lesser ratio of muscle to bone compared to conventional beef cattle. Some of the most recent evaluations of carcass tissue proportions, measured using fabrication yields, in the United States (US) production system have occurred in conventional beef or dairy (primarily Holstein) cattle, but these studies focused on the effect of beta-agonist usage and were not designed to evaluate cattle type (Arp et al., 2014; Howard et al., 2014; Schmitz et al., 2018). Most, if not all, studies evaluating the effect of cattle type, specifically between beef and dairy breeds, on carcass yield were conducted more than 10 years ago, when the cattle population was presumably very different from that of today because of appreciable advancements in genetics and feeding practices.

The number of crossbred beef × dairy cattle produced and slaughtered in the US has grown considerably in recent years (Baisel and Felix, 2022; Foraker et al., 2022; Pereira et al., 2022). The only known study published in the last 10 years to evaluate carcass yield of beef × dairy crossbreds in the US was conducted by Jaborek et al. (2019), which evaluated Jersey crossbreds. Large differences in carcass conformation, fatness, and value have been noted among Holstein and Jersey cattle in Ireland (Berry et al., 2018). Because Holstein constitutes the predominant breed makeup of dairy cows in the US (USDA, 2014), results of Jaborek et al. (2019) may not be directly applicable to most beef × dairy crossbreds in the US. Moreover, within the population of beef × dairy crossbreds, even those with equal breed composition, industry leaders and experts have reported concerns of considerable variation in live expression of beef versus dairy type. This variability may hold implications for carcass yield and value, although no published research has reported on this topic.

We hypothesized that carcass yield and cutout value would differ among conventional beef, high-yielding (HY) and low-yielding (LY) beef × dairy, and dairy cattle, and we aimed to understand what carcass regions and traits were most responsible for these differences, specifically in the beef × dairy population. This study addressed objectives (1) to compare carcass yield and cutout value of unsegregated (i.e., average-yielding) conventional beef and dairy cattle to HY and LY crossbred beef × dairy cattle and (2) to identify which carcass regions and characteristics of these regions most greatly differentiated carcass yield and cutout value among HY and LY beef × dairy crossbreds.

Materials and Methods

This study evaluated carcasses in a federally inspected beef production facility, where humane slaughter practices were followed according to USDA guidelines. Thus, institutional animal care and use committee approval was not obtained.

Harvest and carcass selection

Carcasses in this study were selected over a 3-day period in July 2021 from harvest lots that contained exclusively steers. Information provided by cattle procurement leadership for the production facility was used to identify 3 cattle types (conventional beef, crossbred beef × dairy, or dairy) on a harvest lot basis. For brevity, conventional beef is referred to as "beef" in the remainder of this manuscript. Cattle of each type were sourced from multiple feedlots.

Two days before carcass fabrication, steers were harvested using standard procedures for the facility. Carcasses were split longitudinally through the vertebral column into 2 sides, and each hot side weight (HSW) was obtained using a certified scale (to the nearest 0.454 kg). Carcass HSW were summed to obtain a hot carcass weight (HCW). Some fat was removed from each carcass on the harvest floor, including kidney, pelvic, and heart fat, which was a standard and consistent procedure for processing all carcasses at the facility. After the removal of this fat, a hot fat trimmed side weight (HFTSW) was obtained using a certified scale (to the nearest 0.454 kg). Normal spray chilling procedures for the facility were applied (mean: 29 h, SD: 0.8 h) to carcasses before grading.

Because they represent different maturing rates and growth patterns, different cattle types are typically marketed at different slaughter endpoints by feeders to maximize efficiency and profitability (Dolezal et al., 1993; Tatum et al., 2012). These slaughter endpoints generally correlate with body composition and, indirectly, carcass yield (McEvers et al., 2012). In the present study, criteria for industry-average slaughter endpoints of 12th rib fat thickness and HCW were used to select cattle of each cattle type. Using all data points collected from January to June 2021 at all US facilities for the company of the production facility, mean 12th rib fat thickness was calculated for each of the 3 cattle types. Only cattle within a range of one negative to 1 positive standard deviation (SD; beef: 0.76 cm; beef × dairy: 0.76 cm; dairy: 0.64 cm) from mean 12th rib fat thickness (beef: 1.47 cm; beef × dairy: 1.27 cm; dairy: 0.89 cm) for their respective cattle type and between 364 and 455 kg HCW were selected. By selecting cattle under these constrained parameters, the influence of feeding practices and/or cattle source inherent to the geographical region of the production facility were minimized, such that cattle more nearly represented a US average for their cattle type. Only cattle with carcasses free from trim damage and defects (e.g., bruising) were selected. All other carcass traits, including marbling, were ignored as selection criteria. A minimum of 10 beef × dairy crossbreds were selected within each beef × dairy harvest lot to provide enough numbers for an approximately normal distribution of carcass yield for segregation into HY and LY groups.

Carcasses were separated between the 12th and 13th ribs, and USDA yield grade data were obtained using a portable video image analysis system (VBG 2000, e+v Technology GmbH & Co. KG, Oranienburg, Germany; USDA, 2017). USDA yield grade was calculated using the average values for 12th rib fat thickness and ribeye area from both carcass sides. Because a direct kidney, pelvic, and heart fat weight (FW) was not obtained, calculation of USDA yield grade included a standard kidney, pelvic, and heart fat percentage of 2.0 (average for native beef cattle in the most recent National Beef Quality Audit; Boykin et al., 2017). Left carcass sides were selected, according to the outlined criteria, at their time of grading and during the day before their fabrication.

The number of selected carcasses, grouped by 12th rib fat thickness and HCW ranges, is presented in Table 1. In total, 26 beef, 106 beef × dairy, and 21 dairy steers were sampled across 7, 8, and 3 harvest lots, respectively. The disproportionately large sample size of beef × dairy steers was later subdivided and sampled, after fabrication, into HY and LY groups more nearly equal in sample size to beef and dairy steers (see the following section) before data analysis. Selected carcass sides were grouped by their marketing type (e.g., USDA quality grade or company-specific program) and held overnight before their fabrication on the next day. The proportion of carcass sides fabricated on each day within each cattle type was approximately equal.

Carcass fabrication

Selected carcass sides were interspersed and fabricated in line with nonstudy carcasses at normal facility processing speeds as part of standard production for the processing facility. Thus, the fabrication make sheet for the facility's daily production dictated the number of carcasses representing a particular marketing type that were processed in the day. Marketing type was largely dictated by quality grade. While all efforts were made to fabricate an equal proportion of carcasses from each cattle type in a random order alongside nonstudy carcasses of the same marketing type, this was not always attainable, particularly because of the disproportionate sample sizes between cattle types. Hence, because carcass quality was not a focus of this study, marbling score and quality grade information were not reported.

Immediately before fabrication, facility designated identity and study assigned sequence were recorded for each carcass side, and chilled side weight (CSW) was obtained using a certified scale (to the nearest 0.454 kg). Fabrication personnel and technicians were blinded to the identity of cattle type. Carcass sides were separated at standard carcass breaks for the facility into wholesale cuts: (1) round, (2) loin, (3) rib, (4) chuck, (5) flank, (6) plate, and (7) brisket. Wholesale cuts were removed from the production line, identified by their study assigned sequence, and transported within the facility to their appropriate fabrication location (near their respective production line for ease of returning product to commerce).

Trained production facility personnel were designated to fabricate specific wholesale cuts and remained at that designation for all 3 days of the study. Each wholesale cut was fabricated into components: (1) subprimal(s); (2) trimmings (trim); (3) fat; and (4) bone. Subprimals produced in this study are detailed in Table 3 according to Institutional Meat Purchasing Specifications (NAMP, 2010). Trim, fat, and bone were produced and classified according to standard practices for the production facility.

Table 1. Number of carcasses from each cattle type stratified by hot carcass weight and 12th rib fat thickness ranges

		12th Rib Fat Thickness, cm							
Cattle Type	Hot Carcass Weight, kg	0.23–0.51	0.53–0.76	0.79–1.02	1.04–1.27	1.30–1.52	1.55–1.78	1.80–2.03	2.06–2.29
Beef	364–386		1	1	2	2			
	387–409				1	4	1		
	410–431				4	2	3		
	432–455		1		1		1	1	1
Beef × dairy	364–386		5	4	3				
	387–409		6	13	7	5	3	1	
	410–431	1	5	9	11	6	1	2	
	432–455		2	6	5	6	4		1
Dairy	364–386	1	5	2	1		1		
	387–409		3		2	1			
	410–431		2	1		1			
	432–455		1						

Table 2. Number of carcasses from each cattle type classified by percentage of breed composition. Each row (breed) is independent within each cattle type, such that the sum of counts within a row equals the number of carcasses fabricated within that cattle type

Cattle Type	Breed[1]	≤10%	11%–20%	21%–30%	31%–40%	41%–50%	51%–60%	61%–70%	71%–80%	81%–90%	≥91%
Beef	AN	5	2	3	4	2	2	6	2		
	AR	20	3	1	2						
	BN	20	1	3	2						
	BR	23	2	1							
	CH	21	1	2	2						
	GV	25	1								
	HE	19	6		1						
	LM	25		1							
	SM	24	2								
	JE	25	1								
Beef × dairy[2]	AN	27	37	26	4	9					
	BN	102	1								
	LM	76	2	12	13						
	SM	41	12	30	19	1					
	HO	16	8	28	16	34	1				
	JE	43	8	30	8	11	3				
Dairy	HO								1	9	11

[1]AN = Angus; AR = Red Angus; BN = Brangus; BR = Brahman; CH = Charolais; GV = Gelbvieh; HE = Hereford; LM = Limousin; SM = Simmental; HO = Holstein; JE = Jersey.

[2]Data missing from 3 carcasses.

Technicians electronically recorded initial weights of wholesale cuts (to the nearest 0.454 kg) or untrimmed subprimals (to the nearest 0.227 kg, when breaks were made on a wholesale cut before fabrication) and fabricated components (to the nearest 0.227 kg) into Microsoft Excel worksheets with precalculated formulas to ensure quality data capture in real time. To obtain weights, products were placed on a sanitary food tray atop a certified scale (for wholesale cuts: Model D32XW150VL, Ohaus Corp., Parsippany, NJ; for components and untrimmed subprimals: Model SD35, Ohaus Corp.). Components were reweighed once only if, after the first weighing event, the sum of their weights recovered was not 99% to 101% of their respective wholesale cut or untrimmed subprimal total weight. After weighing, all pieces were returned to commerce and not retained for further analysis.

Data management

Carcasses with missing data for any subprimal listed in Table 3 were removed from the study. Weight calculations were computed separately for each carcass. Weights of pieces within each component (subprimals, trim, fat, and bone) of each wholesale cut (round, loin, rib, chuck, flank, plate, and brisket) were summed to produce within-wholesale cut component weights (WCCW). The sum of WCCW for each component across all wholesale cuts was calculated to produce carcass component weights (subprimal weight [SPW]; trim weight [TW]; FW; bone weight [BW]). The sum of SPW, TW, FW, and BW was deemed fabricated side weight (FSW). Fabricated side weight recovery (FSWR) was determined as FSW divided by CSW. All carcasses were retained for further data processing because FSWR acceptably ranged from 97.9% to 101.0%.

Designation of HY and LY beef × dairy crossbreds

Data from all carcasses of beef steers ($n = 26$) and dairy steers ($n = 21$) were retained for analysis. The disproportionate sample size of beef × dairy ($n = 106$) violated an assumption of randomness between the treatment groups such that, because of a larger sample size, beef × dairy was more random than beef and dairy. This difference in randomness between the cattle types could, in theory, result in a difference in variance between the groups because it could be expected that a more random sample would provide a more accurate representation of all statistical measures. But, also, variance could inherently differ between the cattle types if it is inherent to the population.

Table 3. Subprimals fabricated from each wholesale cut and their annual weighted average value (US dollars [USD], per 45.4 kg) in 2021

Item	IMPS[1]	Fat Limitation[2]	USD per 45.4 kg	Value Source[3]
Round				
Eye of round	171C	3	323.61	USDA
Knuckle, peeled	167A	4	308.48	USDA
Outside round	171B	3	290.73	USDA
Top inside, cap off	169A	5	424.02	USDA
Superficial digital flexor muscle	–	–	259.87	Company
Loin				
Ball-tip, boneless, heavy	185B	1	330.78	USDA
Bottom sirloin, flap	185A	4	674.88	USDA
Sirloin, tri-tip, peeled	185D	4	574.75	USDA
Strip, boneless, 0 × 1	180	3	743.91	USDA
Tenderloin, trimmed, heavy	189A	4	1,313.28	USDA
Top sirloin butt, center-cut, boneless, cap off	184B	5	426.99	Company
Top sirloin, cap	184D	3	494.29	Company
Steak tail	176	6	266.25	Company
Rib				
Ribeye, boneless, heavy	112A	3	1,050.28	USDA
Cap and wedge meat[4]	–	4	340.87	USDA
Back ribs	124	–	285.97	Company
Chuck				
Chuck tender	116B	1	301.86	USDA
Clod tender	114F	5	599.62	USDA
Clod, arm roast	114E	3	415.93	USDA
Clod, top blade	114D	3	516.00	USDA
Flap	116G	4	734.58	USDA
Chuck roll, retail ready	916A	3	415.28	USDA
Chuck short rib	130	4	494.44	USDA
Pectoral meat[4]	–	4	352.42	USDA
Flank				
Flank steak	193	4	580.05	USDA
Plate				
Short rib	123A	3	574.06	USDA
Short rib cap, boneless (candy stripe)	–	–	141.04	Company
Short plate, short ribs removed, boneless	121G	–	193.17	Company
Inside skirt[4]	121D	4	585.81	USDA
Outside skirt, peeled[4]	121E	6	1,187.98	USDA
Brisket				
Brisket, deckle-off, boneless	120	1	342.10	USDA

[1]Institutional Meat Purchasing Specifications (IMPS).

[2]Maximum average fat thickness: 1 = 19 mm; 3 = 3 mm; 4 = practically free (75% surface lean exposed); 5 = peeled/denuded; 6 = peeled/denuded, surface membrane removed. Maximum fat at any point: 1 = 25 mm; 3 = 6 mm; 4, 5, and 6 = 3 mm.

[3]USDA: values were sourced from the National Weekly Boxed Beef Cutout and Boxed Beef Cuts - Negotiated Sales reports (LM_XB459) between 1/01/2021 and 12/31/2021 for Choice, 273 to 409 kg carcasses. Company: values were not available from USDA reporting and thus were provided by the company for certain cuts for 1/01/2021 to 12/31/2021.

[4]Subprimal values were sourced from cuts of Choice and Select carcasses combined.

Variance measures for percentage subprimal yield (the primary trait of interest in the study) were evaluated by breed type: beef (SD: 1.06, coefficient of variation: 1.98%, $n = 26$), beef × dairy (SD: 1.48, CV: 2.78%, $n = 106$), and dairy (SD: 1.25, CV: 2.43%, $n = 21$). Levene's test to test for homogeneity of variance between these groups indicated that variance tended to differ between cattle types ($P = 0.097$). Speculation by some in the industry, combined with theory of combining the genetic profiles of 2 highly divergent cattle populations into a hybrid, has suggested that beef × dairy is a more variable population for many metrics than beef and dairy. We did not design this study to answer that question, as we would have needed a sample of beef and dairy that was equal in size to our sample of beef × dairy and much larger samples for all cattle types than what was feasible for fabrication in a commercial facility. Our objective was to assess carcass yield between the cattle types, and we believed the difference in variance demonstrated between the 3 cattle types would influence the interpretation of these results. Hence, we *post hoc* subdivided our large beef × dairy sample to equalize variance among the treatment groups so that statistical assumptions were met more adequately to solve our questions regarding yield differences between the cattle types.

Preliminary subprimal yield (SPW divided by FSW) was used in a *post hoc* sampling technique to establish HY and LY groups of beef × dairy crossbreds (Figure 1). Mean and SD of preliminary subprimal yield were calculated within each harvest lot, and carcasses were categorized (by harvest lot) into sampling groups: (1) preliminary subprimal yield less than 1 negative SD from the mean; (2) preliminary subprimal yield greater than 1 negative SD from the mean but less than the mean; (3) preliminary subprimal yield greater than the mean but less than 1 positive SD from the mean; and (4) preliminary subprimal yield greater than 1 positive SD from the mean. All carcasses from the sampling group within a harvest lot that contained the least number were retained for analysis, and an equal number of carcasses was randomly selected from each of the remaining 3 sampling groups in that harvest lot. Selected beef × dairy crossbreds from sampling groups 1 and 2 were combined to represent LY beef × dairy steers ($n = 26$), and selected beef × dairy carcasses from sampling groups 3 and 4 were combined to represent HY beef × dairy steers ($n = 26$).

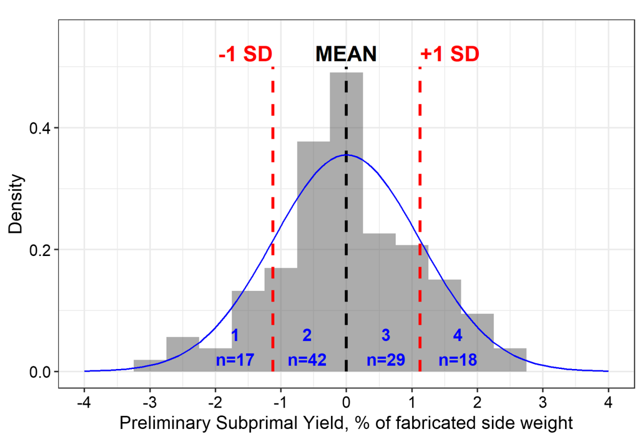

Figure 1. Distribution of preliminary subprimal yield, adjusted for harvest lot effects, of all beef × dairy cattle fabricated in the study. Within each harvest lot, an equal number of carcasses was randomly selected from each group (established using mean and SD) to constitute low-yielding (LY; groups 1 and 2) and high-yielding (HY; groups 3 and 4) categories of beef × dairy crossbreds.

Random selection of crossbreds within each of the HY and LY groups resulted in the exclusion of data obtained for 54 crossbreds from statistical analyses. However, these excluded cattle established a normal distribution and the parameters for random sampling of HY and LY groups which, correspondingly, provided validity to the comparison of these groups. After we subset the beef × dairy sample into HY and LY groups, variance for percentage subprimal yield became much more equal (Levene's test; $P = 0.729$) between cattle types: beef (SD: 1.06, CV: 1.98%, $n = 26$), HY beef × dairy (SD: 1.32, CV: 2.43%, $n = 26$), LY beef × dairy (SD: 1.21, CV: 2.32%, $n = 26$), and dairy (SD: 1.25, CV: 2.43%, $n = 21$).

Carcass yield calculations

All yields were expressed as a percentage of HSW. Disappearance of HSW was allocated to fat trimmed at harvest (difference between HFTSW and HSW, divided by HSW), chilling shrink (difference between CSW and HFTSW, divided by HSW), fabrication shrink (difference between FSW and CSW, divided by HSW), and sum of fabrication components (FSW divided by HSW). Component yields were calculated within carcass (SPW, TW, FW, or BW divided by HSW), and subprimal yield was calculated within wholesale cuts (subprimal WCCW divided by HSW). Ratios of subprimal to bone and subprimal to fat were calculated within carcass and within wholesale cuts (subprimal yield divided by bone yield and subprimal yield divided by fat yield, respectively). Collectively, subprimal to bone and subprimal to fat were termed component ratios. Distribution of wholesale cut within carcass was calculated as the sum of WCCW for a wholesale cut divided by HSW. Distribution of subprimal yield within wholesale cut of the carcass subprimal portion was calculated as subprimal WCCW divided by SPW.

Subprimal cutout value calculations

When available, weighted average cutout value corresponding to each subprimal listed in Table 3 was calculated from all reports in 2021 of National Weekly Boxed Beef Cutout and Boxed Beef Cuts – Negotiated Sales (LM_XB459) for Choice, 273 to 409 kg carcasses (USDA-AMS, 2021). Cutout values for cap and wedge meat, pectoral meat, inside skirt, and outside skirt (peeled) were representative of Choice and Select carcasses because values for these cuts were not reported for Choice carcasses alone. For subprimals not included in USDA reporting, the company of the production facility provided an average weighted cutout value based on company sales for Choice product in 2021. Whole carcass cutout value was not calculated in this study because components of trim, fat, and bone were not produced in an entirely equivalent specification (e.g., lean percentage) to those for which cutout values were reported by USDA (2021).

Computation of subprimal cutout value was equivalent to that of value represented by the subprimal portion in the carcass cutout value, which was expressed on an HCW basis. Individual SPWs within a carcass were multiplied by their corresponding subprimal cutout value to generate a subprimal value. The sum of subprimal values within a wholesale cut and within a carcass were divided by HSW to produce subprimal cutout values within wholesale cut and within carcass, respectively. Subprimal cutout values were expressed in US dollars (USD) per 45.4 kg of HSW. Distribution of subprimal cutout value within wholesale cut of the carcass subprimal portion was calculated as subprimal cutout value within wholesale cut divided by carcass subprimal cutout value.

Breed prediction

Because samples were collected postmortem and cattle type was designated only from information provided by the cattle procurement leadership team for the production facility, a secondary analysis was conducted to validate cattle type designation and provide information about the sample pertaining to breed composition. From each carcass, approximately 1 g of *longissimus* muscle was collected at the time of fabrication, placed in a 1.5 mL microcentrifuge tube, and stored at −80°C. Frozen samples were shipped, on ice, to a third-party genetic company for genotyping using the Illumina BovineSNP100 assay (Illumina Inc., San Diego, CA). Breed prediction was determined similar to Kuehn et al. (2011). Breed composition for all fabricated carcasses is presented in Table 2. Based on these breed predictions, all carcasses were correctly classified into their designated cattle type. Generally, beef cattle were influenced by some portion of Angus. Beef × dairy crossbreds were composed of beef breeds Angus, Simmental, and/or Limousin and dairy breeds Holstein or seemingly Holstein × Jersey. Dairy cattle were primarily Holstein.

Statistical analyses

Data were analyzed using R statistical software, version 3.6.0 (R Core Team, 2021). Carcass traits were summarized by their mean for each cattle type but not statistically tested because they were used as selection criteria.

To address the first objective, statistical analyses evaluated effect of cattle type, which was represented by 4 treatment groups: (1) beef; (2) HY beef × dairy; (3) LY beef × dairy; and (4) dairy. Yields and cutout values for each animal (experimental unit; $n = 21$ to 26 per cattle type) were analyzed in a completely randomized design using linear models. Models for HSW disappearance included the fixed effect of cattle type. Models for carcass yields (subprimal, trim, fat, and bone), carcass subprimal cutout value, subprimal yield by wholesale cut, and subprimal cutout value by wholesale cut included cattle type and covariates of chilling shrink and fabrication shrink. Models for distribution of subprimal yield and cutout value into wholesale cuts included cattle type and covariates chilling shrink and fabrication shrink.

To address the second objective, cattle type (HY and LY beef × dairy only), component ratios, and their interactions were used to explain carcass subprimal yield and cutout value. Residuals were obtained from linear models fit to predict carcass subprimal yield and cutout value, separately, from continuous predictors chilling shrink and fabrication shrink; these residuals represented the dependent variates for modeling. Similarly, residuals were extracted from linear models fit to predict each wholesale cut component ratio, separately, from continuous predictors chilling shrink, fabrication shrink, and respective trim yield for that wholesale cut; these residuals represented the independent variates. These models adjusted out slight variations attributable to shrink that were not a primary interest. A linear model was fit to predict each of carcass subprimal yield residuals and carcass subprimal cutout value residuals using cattle type, wholesale cut component ratio residuals (scaled to a mean of 0 and SD of 1), and their interaction. Separate linear models were fit to predict (1) carcass subprimal yield residuals using cattle type, distribution of SPW into wholesale cuts, and their interaction and (2) carcass subprimal cutout value using cattle type, distribution of subprimal cutout value into wholesale cuts, and their interaction. For all models, intercepts and slopes were tested for their difference from 0 (no difference on outcome).

Significance of effects, intercepts, slopes, and pairwise comparisons was established at $P \leq 0.05$, and a tendency of an effect was established at $0.10 \leq P \leq 0.05$. Residuals and fitted values of each model were plotted to assess model assumptions for linearity and homogeneity of variance. Effect of cattle type was tested with an analysis of variance. When effect of cattle type was significant, means were separated with Tukey adjusted pairwise comparisons using the emmeans package (Lenth, 2018). Means of carcass and wholesale cut yields, carcass and wholesale cut cutout values, and wholesale cut component ratios were reported as the difference from their arithmetic mean across all cattle types (i.e., reported means sum to 0 across all cattle types for a variable) to not disclose fabrication yields of the production facility.

Results and Discussion

Carcass traits

Because they were used as selection criteria and, consequently, not a study objective, carcass traits were only presented to provide context for the cattle representing each cattle type (Table 4). Given the growth pattern of muscle, fat, and bone and their part-whole relationship to HCW, fat-free lean percentage has been reported to decrease as carcass weight increases (Berg et al., 1978a). To address this phenomenon, studies evaluating cattle slaughtered at serial timepoints have used allometric growth models to analyze carcass component weight with carcass weight as a covariate (Kempster et al., 1976; Berg et al., 1978a; Tatum et al., 1986). A more recent serial slaughter study (May et al., 2017) evaluated linear and quadratic effects of components yields as a percentage of side weight. Still, other studies without a serial slaughter component have evaluated component weights as a percentage of side weight (Rathmann et al., 2009; Arp et al., 2014; Howard et al., 2014). It seems that statistical techniques to account for the biological confoundment of composition and carcass weight are imperfect, especially when serial slaughter is not conducted. In this study, because HCW was used to select industry-average cattle within each cattle type, fabrication yields were not adjusted for an overall effect of HSW other than computing yields as a percentage of HSW.

HSW disappearance

An appreciably greater (0.75 units; $P < 0.05$) percentage of fat was trimmed at harvest from dairy cattle than beef cattle (Table 5). It has been well reported that dairy cattle deposit a greater proportion of carcass fat toward internal depots (like kidney, pelvic, and heart fat) than beef cattle, perhaps because of differences in fat partitioning between cattle types as a result of divergent selection over time for different production systems (Callow, 1961; Kempster et al., 1976; Tatum et al., 1986). Given that fat trimmed at harvest was primarily composed of kidney, pelvic, and heart fat in this study, our results would support these reports. Differences in fat trimmed at harvest seemed to directly correspond to a difference in sum of fabrication components, which was less ($P < 0.05$; data not reported tabularly) in dairy cattle than beef cattle. An approximately 20% coefficient of variation suggested considerable variability in percentage of fat trimmed at harvest across all cattle types.

Percentage of HSW disappearance attributed to carcass shrink during chilling (e.g., evaporation of

Table 4. Summary statistics of carcass traits for beef cattle, high- and low-yielding (HY, LY) beef × dairy crossbreds,[1] and dairy cattle

		Beef × Dairy			
Item	Beef	HY	LY	Dairy	SEM[2]
Number of cattle	26	26	26	21	
Hot carcass weight (HCW), kg	409	407	411	393	4.9
12th rib fat thickness, cm	1.34	0.97	1.17	0.85	0.073
Ribeye area (REA), square cm	90.0	98.5	92.3	85.4	1.80
REA:HCW, square cm/kg	0.221	0.242	0.225	0.218	0.0049
USDA yield grade[3]	3.18	2.38	2.92	2.80	0.136
Fabricated hot side weight, kg	206.8	205.8	207.9	198.3	2.44

[1]*Post hoc* subsampling of 106 crossbreds was used to differentiate HY and LY groups based on preliminary subprimal yield.

[2]Standard error of the means (SEM), pooled.

[3]Yield grade was calculated using a standard kidney, pelvic, and heart fat percentage of 2.0.

Table 5. Carcass yield and subprimal cutout value (US dollars [USD], per 45.4 kg hot side weight [HSW]) of beef cattle, high- and low-yielding (HY, LY) beef × dairy crossbreds[1], and dairy cattle

Item	Beef	Beef × Dairy		Dairy	SEM[2]	*P* Value
		HY	LY			
Number of cattle	26	26	26	21		
HSW disappearance, % of HSW[3]						
Fat trimmed at harvest (includes kidney, pelvic, and heart fat)	−0.34[b]	−0.33[b]	0.28[ab]	0.40[a]	0.200	<0.01
Carcass yield,[3] % of HSW						
Subprimals	0.76[a]	1.55[a]	−0.83[b]	−1.49[b]	0.252	<0.01
Trimmings	0.06	−0.02	0.04	−0.07	0.140	0.94
Fat	0.50[a]	−0.81[b]	0.54[a]	−0.23[ab]	0.224	<0.01
Bone	−0.98[c]	−0.38[bc]	0.10[b]	1.26[a]	0.220	<0.01
Subprimal to bone ratio (constant trim)	3.15[a]	3.07[a]	2.85[b]	2.62[c]	0.043	<0.01
Subprimal to fat ratio (constant trim)	4.41[b]	5.11[a]	4.29[b]	4.55[b]	0.113	<0.01
Subprimal cutout value,[3,4] USD/45.4 kg	3.03[b]	8.29[a]	−2.60[c]	−8.72[d]	1.312	<0.01

[1]*Post hoc* subsampling of 106 crossbreds was used to differentiate HY and LY groups based on preliminary subprimal yield.

[2]Standard error of the means (SEM), pooled.

[3]Group means are reported as the difference from their arithmetic mean (means within a row sum to 0) to not disclose confidentiality of beef processor yields.

[4]Subprimal values were sourced from all National Weekly Boxed Beef Cutout and Boxed Beef Cuts - Negotiated Sales reports (LM_XB459) in 2021 for Choice, 273 to 409 kg carcasses.

[a–c]Estimated marginal means within a row without a common superscript are different ($P < 0.05$).

surface water) and fabrication (e.g., purge and unaccounted trivial pieces produced during cutting) was not different ($P \geq 0.11$) between cattle types (data not reported in tabular form). Because they were computed on an HSW basis, carcass yields could be influenced by even trivial differences in chilling and fabrication shrink. Differences in chilling and fabrication shrink were likely attributable to fabrication day and/or time, and evaluating these effects was not an objective of this study. Therefore, chilling and fabrication shrink (expressed as percentage of HSW) were included as covariates in subsequent analyses, when applicable.

Carcass yields

Cattle types were largely different from each other in subprimal and bone yields (Table 5). Beef cattle and HY crossbreds produced 1.59 to 3.04 percentage units greater ($P < 0.05$) subprimal yield than LY crossbreds and dairy cattle, and bone yield was greatest ($P < 0.05$) in dairy cattle (1.26 percentage units). Correspondingly, subprimal to bone ratio was greatest ($P < 0.05$) in beef cattle (3.15) and HY crossbreds (3.07), which were not different ($P > 0.05$) from each other, intermediate ($P < 0.05$) in LY crossbreds (2.85), and least ($P < 0.05$) in dairy cattle (2.62). These results aligned with other reports of greater bone yield in dairy cattle than beef cattle (Callow, 1961; Nour et al., 1983; Griffin et al., 1992).

Fat yield differences across breed types were not as prevalent as differences in subprimal and bone yields across breed types. Beef cattle, LY crossbreds, and dairy cattle were not different ($P > 0.05$) from each other in fat yield (−0.23 to 0.54 percentage units) or subprimal to fat ratio (4.29 to 4.55). HY crossbreds produced the greatest ($P < 0.05$) subprimal to fat ratio (5.11) and 1.31 to 1.35 percentage units lesser ($P < 0.05$) fat yield than beef cattle and LY crossbreds.

Carcass trim yield was not different ($P = 0.94$) between cattle types, and it did not logically trend in a direction between beef cattle, crossbreds, and dairy cattle. Hence, it seems that only large differences in fat percentage of trimmings could overcome the seemingly negligible difference in trim yield to contribute to meaningful trim value differences between cattle types. A difference in fat percentage of trimmings between cattle types could exist, especially if cuts from leaner cattle types, like dairy cattle, experienced more overtrimming than cuts from fatter cattle. Fat percentage of all trimmings generated from each carcass was not directly measured in this study. Consequently, because of its seemingly negligible contribution to study variation and a lack of information about its composition, trimmings yield was used as a covariate in assessment of carcass and within-wholesale cut component ratios to minimize its influence on yield of the more interesting, meaningful, and variable carcass yield components of subprimals, fat, and bone. This provided for a clearer discussion on relationships between subprimal, fat, and bone yields without concern of trimmings yield influencing these relationships.

Subprimal cutout value

Cutout values presented in this study only represent those of the subprimal portion and do not reflect the contribution of value from trim, fat, and bone to carcass cutout value. Using weighted average cutout values during 2021 and standardized yields provided by USDA-AMS (2022) for subprimals similar to those in this study, greater than 80% of the weighted average carcass cutout value was accounted in the subprimal portion alone (USDA-AMS, 2021). The large proportion of carcass cutout value represented in the subprimal portion underpins the relevancy in using subprimal cutout value to determine value differences among cattle with different subprimal yields. Products from dairy-type cattle are not represented in the cutout values reported by USDA (USDA-AMS, 2010). Separate from yield, if an inherent value difference existed between beef- versus dairy-type products, it was not reflected in the subprimal cutout values of this study.

All cattle types were different ($P < 0.05$; Table 5) from each other in subprimal cutout value, which decreased in a sequence (interval differences in parentheses): HY crossbreds (+5.26 USD/45.4 kg) > beef cattle (+5.63 USD/45.4 kg) > LY crossbreds (+6.12 USD/45.4 kg) > dairy cattle. These differences must be interpreted within the constraints of this study, as a distribution sampling technique, like that applied to crossbreds, could have been utilized in both beef and dairy cattle. The difference in value between beef and dairy cattle has been well established and likely represents one of the most important value distinctions in the fed cattle market:– the dairy discount (McKendree et al., 2020). Here, subprimal cutout value difference ($P < 0.05$) between beef and dairy cattle was 11.75 USD/45.4 kg, which was only 8% greater than the difference ($P < 0.05$) between HY and LY crossbreds (10.89 USD/45.4 kg). Crossbreds of HY and LY groups were differentially selected to center each group at 1 SD from the overall mean subprimal yield of all crossbreds. Naturally, some crossbreds within each of the HY and LY groups exhibited a subprimal yield greater than 2 SD away from the overall mean. Because these crossbreds were not removed, the cutout value difference between HY and LY crossbreds could be exaggerated to a degree. Even so, this result demonstrated considerable differences in cutout value within the beef × dairy crossbred population.

Subprimal yield and cutout value by wholesale cut

Subprimal yield and cutout value in each wholesale cut were assessed between cattle types (Figures 2 and 3, respectively). Beef cattle demonstrated the greatest ($P < 0.05$) yield and cutout value in the brisket, and dairy cattle exhibited the least ($P < 0.05$) yield and cutout value in the rib and brisket. Crossbreds of the HY type contained the greatest ($P < 0.05$) yield and cutout value in the round compared to the other 3 cattle types, which were not different ($P > 0.05$) in the yield and cutout value of the round. HY crossbreds also produced an especially greater ($P < 0.05$) yield and cutout value in the chuck when compared to LY crossbreds.

Distribution of subprimal yield and cutout value into wholesale cuts

Distribution of subprimal yield and cutout value into wholesale cuts differed among cattle types (Table 6). For both percentage subprimal yield and cutout value, dairy cattle had a greater ($P < 0.05$) distribution into the round than beef cattle and LY crossbreds, lesser ($P < 0.05$) distribution into the rib than HY and LY crossbreds, and the least ($P < 0.05$) distribution into the brisket. These results suggested that, even if carcass subprimal yield was the same between cattle types, dairy cattle more inefficiently distributed their SPW toward subprimals of lower value than any other cattle type. Thus, the disparity in carcass subprimal yield and cutout value between dairy cattle and other cattle types occurred in more than one way. Dairy cattle partitioned a greater amount of their subprimal yield toward low-value wholesale cuts, like the round, where they were least efficient in a relatively important component ratio for carcass subprimal yield, namely subprimal to bone.

Distribution of carcass subprimal yield and cutout value into the brisket was greatest ($P < 0.05$) in beef cattle. At a constant age, this might support a shift in carcass weight of earlier maturing cattle toward anterior carcass regions, especially in cuts that contain an appreciable proportion of inter- and intra-muscular fat depots, like the brisket. Crossbreds of the HY type distributed greater ($P < 0.05$) subprimal yield and value into the round than beef cattle or LY crossbreds.

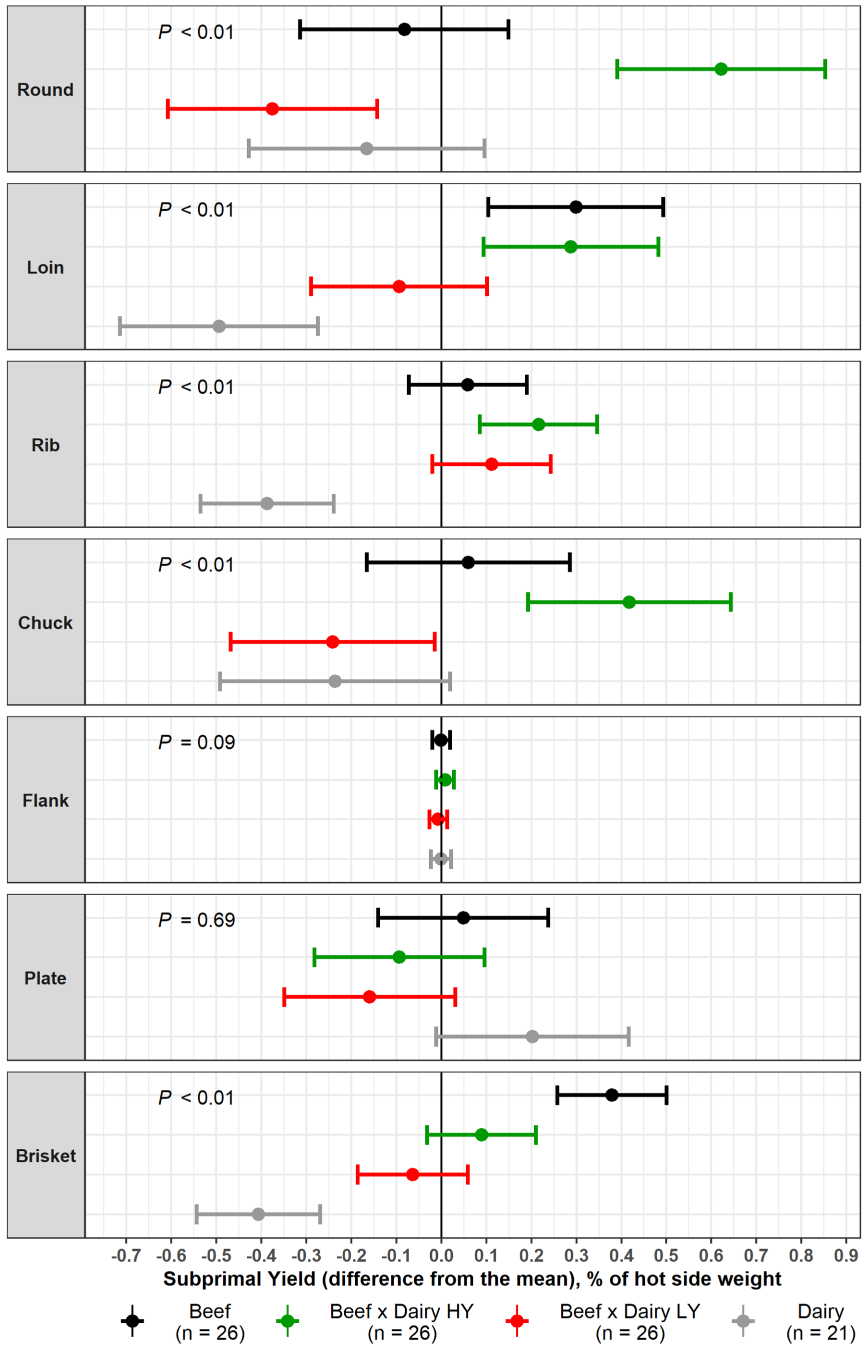

Figure 2. Subprimal yield (mean and 95% confidence interval) in wholesale cuts from beef cattle, high- and low-yielding (HY, LY) beef × dairy crossbreds, and dairy cattle. *Post hoc* subsampling of 106 crossbreds was used to differentiate HY and LY groups based on preliminary subprimal yield.

Berg et al. (1978b) suggested that relative development of muscles could be an indicator of maturity. Hence, at a constant age, comparatively earlier maturing breeds, like Hereford, had a greater proportion of muscle distributed toward muscles of lower growth impetus, like the round, compared to later maturing breeds, like Chianina. The authors suggested a need to evaluate muscle weight distribution in mature, rather than young, cattle of different breeds. If the cattle in our study were harvested at similar points of maturity, the literature generally does not support differences in subprimal distribution between cattle types, although no known studies within the last 20 years have evaluated these concepts. Berg and Walters (1983) reaffirmed the accounts from many studies where differences in muscle distribution among cattle, if existent, were generally small and not commercially relevant. These authors were firmly positioned that any selection or

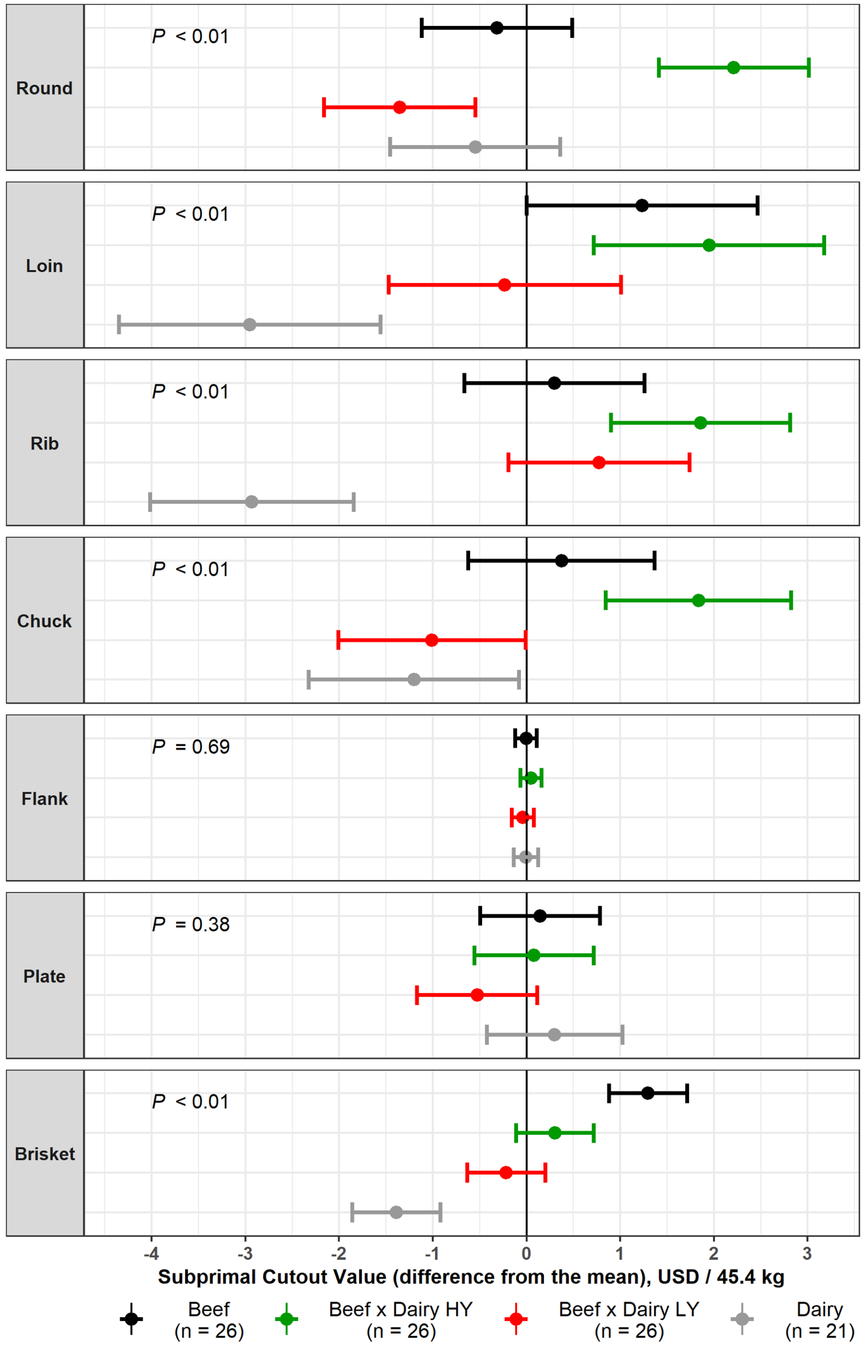

Figure 3. Subprimal cutout value (US dollars [USD], per 45.4 kg; mean and 95% confidence interval) in wholesale cuts from beef cattle, high- and low-yielding (HY, LY) beef × dairy crossbreds, and dairy cattle. *Post hoc* subsampling of 106 crossbreds was used to differentiate HY and LY groups based on preliminary subprimal yield.

crossbreeding practice outside of using extremes, such as double-muscled cattle breeds, would have minimal impact on muscling distribution. Their understanding was founded from many studies on dissected carcass tissue. Here, distribution of weight between cattle types was not determined on dissected carcass tissue. Thus, distribution differences between cattle types might be attributed to variables associated with producing tissues in saleable form that are not present in dissectible tissue. Nonetheless, industry carcass value is determined from these tissues in saleable form. So, if carcass distribution into saleable cuts truly differs between certain types of cattle, implications on profitability, cattle selection, and cattle management could exist. Further research is needed to investigate muscle distribution.

Table 6. Distribution of subprimal yield and value across wholesale cuts of beef cattle, high- and low-yielding (HY, LY) beef × dairy crossbreds,[1] and dairy cattle

		Beef × Dairy				
Item	Beef	HY	LY	Dairy	SEM[2]	P Value
Number of carcasses	26	26	26	21		
Distribution, % of carcass subprimal yield						
Round	22.96[b]	24.00[a]	23.11[b]	23.88[a]	0.210	<0.01
Loin	20.55[a]	20.20[ab]	20.40[ab]	19.85[b]	0.193	0.03
Rib	11.07[ab]	11.22[a]	11.56[a]	10.65[b]	0.159	<0.01
Chuck	23.33	23.68	23.47	23.81	0.217	0.19
Flank	1.05	1.05	1.07	1.10	0.024	0.29
Plate	13.94[b]	13.44[b]	13.97[b]	14.95[a]	0.230	<0.01
Brisket	7.10[a]	6.42[b]	6.41[b]	5.77[c]	0.139	<0.01
Distribution, % of carcass subprimal value						
Round	16.08[b]	16.75[a]	16.02[b]	16.79[a]	0.152	<0.01
Loin	28.27	27.95	28.31	27.90	0.217	0.29
Rib	17.71[ab]	17.97[a]	18.34[a]	17.21[b]	0.213	<0.01
Chuck	21.12	21.27	21.04	21.51	0.197	0.17
Flank	1.24	1.23	1.25	1.30	0.027	0.19
Plate	10.65[b]	10.40[b]	10.62[b]	11.27[a]	0.162	<0.01
Brisket	4.94[a]	4.44[b]	4.42[b]	4.03[c]	0.099	<0.01

[1]*Post hoc* subsampling of 106 crossbreds was used to differentiate HY and LY groups based on preliminary subprimal yield.

[2]Standard error of the means (SEM), pooled.

[a,b]Estimated marginal means within a row without a common superscript are different ($P < 0.05$).

Carcass regions in predicting subprimal yield and value among HY and LY crossbreds

The second objective of this study was to determine which carcass regions and associated traits (i.e., subprimal to bone and subprimal to fat) most differentiated carcass subprimal yield and cutout value among HY and LY beef × dairy crossbreds. Linear combinations of cattle type (HY and LY beef × dairy), component ratios within each wholesale cut, and the interaction of cattle type and component ratios was used to predict carcass subprimal yield and cutout value, separately. Component ratios represented all unique part-whole relationships (i.e., bone to fat yield not included because it was redundant) of HSW, except for weight trimmed at harvest. Slopes (or coefficients) of each component ratio or interaction characterized the contribution of that ratio or interaction in predicting the outcome.

The combination of beef × dairy cattle type, component ratios, and their interactions explained much of the variability ($R^2 = 0.85$; $P < 0.01$) in carcass subprimal yield (Table 7). Averaging over HY and LY beef × dairy cattle type, subprimal to bone of the round and plate were the most predictive of subprimal yield (0.59 percentage units or greater; $P \leq 0.05$). The only interaction between a component ratio and cattle type was subprimal to bone of the chuck for LY beef × dairy, which resulted in a greater (0.84 percentage units; $P = 0.05$) subprimal yield than an increase in subprimal to bone of the chuck for HY beef × dairy. Subprimal to bone of the rib ($P = 0.06$) and subprimal to fat of the loin ($P = 0.09$) tended to predict total carcass subprimal yield. Even at constant component ratios and interactions, LY beef × dairy were 2.53 percentage units lower ($P < 0.01$) in carcass subprimal yield than HY beef × dairy, which might be related to differences between the cattle types in subprimal distribution, specifically in the round.

Carcass subprimal cutout values were also well characterized ($R^2 = 0.83$, $P < 0.01$) by the linear combination beef × dairy cattle type, component ratios, and their interactions (Table 7). A one-unit increase in subprimal to bone of the round, averaging over HY and LY beef × dairy, contributed to a 3.79 USD/45.4 kg increase ($P = 0.02$) in subprimal cutout value. The interaction of subprimal to bone of the chuck in LY beef × dairy also contributed to a greater ($P = 0.03$) subprimal cutout value. Subprimal to bone of the brisket ($P = 0.08$) and subprimal to fat of the rib ($P = 0.06$) tended to predict carcass subprimal cutout value. The main effect of LY beef × dairy on carcass subprimal cutout value tended ($P = 0.08$) to be 8.57 USD/45.4 kg less than HY beef × dairy, which substantiates the importance of component ratios and their interaction

Table 7. Estimations of subprimal yield and subprimal cutout value[1] (US dollars [USD], per 45.4 kg) from ratios[2] of subprimal to bone yield and subprimal to fat yield in wholesale cuts of high- and low-yielding (HY, LY) beef × dairy crossbreds[3] ($n = 26$ per group)

			Subprimal Yield, % of Hot Side Weight Residual SE: 0.65 Adjusted $R^2 = 0.85$ $P < 0.01$			Subprimal Cutout Value, USD/45.4 kg Residual SE: 3.21 $R^2 = 0.83$ $P < 0.01$		
Independent Variate			Standardized β	SE	P Value[4]	Standardized β	SE	P Value[4]
Intercept (Beef × dairy HY)			1.18	0.35	<0.01	4.89	1.73	0.01
Beef × dairy LY			−1.35	0.40	<0.01	−3.68	1.99	0.08
Subprimal to bone	Round		0.65	0.31	0.05	3.79	1.52	0.02
	Loin		0.06	0.25	0.81	−0.75	1.23	0.55
	Rib		−0.38	0.19	0.06	−0.69	0.94	0.47
	Chuck		−0.18	0.28	0.52	−0.81	1.39	0.56
	Plate		0.59	0.22	0.01	1.97	1.08	0.08
	Brisket		−0.27	0.25	0.31	−0.82	1.26	0.52
Subprimal to fat	Round		0.01	0.16	0.95	0.28	0.79	0.72
	Loin		0.30	0.17	0.09	1.27	0.85	0.15
	Rib		0.41	0.29	0.17	2.86	1.43	0.06
	Chuck		0.00	0.24	1.00	−0.57	1.19	0.64
	Flank		−0.45	0.26	0.10	−1.15	1.28	0.38
	Plate		−0.08	0.22	0.72	−0.98	1.10	0.38
	Brisket		0.15	0.18	0.39	−0.07	0.87	0.94
Subprimal to bone	Round:	Beef × dairy LY	−0.51	0.46	0.28	−3.8	2.28	0.11
	Loin:	Beef × dairy LY	−0.18	0.38	0.64	0.94	1.89	0.63
	Rib:	Beef × dairy LY	0.27	0.36	0.46	1.08	1.78	0.55
	Chuck:	Beef × dairy LY	0.84	0.41	0.05	4.89	2.05	0.03
	Plate:	Beef × dairy LY	−0.08	0.33	0.82	−0.61	1.61	0.71
	Brisket:	Beef × dairy LY	0.11	0.43	0.80	−0.31	2.12	0.89
Subprimal to fat	Round:	Beef × dairy LY	0.08	0.24	0.75	−0.83	1.21	0.50
	Loin:	Beef × dairy LY	−0.05	0.34	0.88	0.4	1.68	0.81
	Rib:	Beef × dairy LY	0.51	0.62	0.42	−0.92	3.10	0.77
	Chuck:	Beef × dairy LY	0.19	0.38	0.62	2.54	1.86	0.19
	Flank:	Beef × dairy LY	0.21	0.37	0.58	1.66	1.83	0.37
	Plate:	Beef × dairy LY	0.44	0.28	0.14	1.78	1.41	0.22
	Brisket:	Beef × dairy LY	0.15	0.27	0.59	1.05	1.33	0.44

[1]Subprimal cutout values were sourced from all National Weekly Boxed Beef Cutout and Boxed Beef Cuts - Negotiated Sales reports (LM_XB459) in 2021 for Choice, 273 to 409 kg carcasses.

[2]Ratios were adjusted to constant trimmings yield within each respective wholesale cut.

[3]*Post hoc* subsampling of 106 crossbreds was used to differentiate HY and LY groups based on preliminary subprimal yield.

with cattle type to driving differences in value between these cattle types.

Cattle type (HY and LY beef × dairy), distribution of subprimal yield into wholesale cuts, and their interactions predicted 66% of the variability in carcass subprimal yield ($P < 0.01$; data not reported tabularly). Averaging over HY and LY crossbreds, the distribution of subprimal yield into the round portion tended to be predictive ($P = 0.07$) of carcass subprimal yield. Similarly, cattle type, distribution of subprimal value into wholesale cuts, and their interaction was used to predict carcass subprimal cutout value. This model was predictive of carcass subprimal cutout value ($R^2 = 0.63$, $P < 0.01$), and distribution of value into the round ($P = 0.10$) and loin ($P = 0.07$), averaged over HY and LY crossbreds, tended to influence subprimal cutout value.

Together, the use of component ratios within wholesale cuts demonstrated the importance of muscling in the hindquarter, specifically that of the round, to differentiating carcass yield and cutout value among beef × dairy crossbreds. Although to a lesser degree, these findings also demonstrated that the distribution of weight and value into the hindquarter also could influence carcass yield and cutout value of beef × dairy crossbreds. The contribution of subprimal to bone of the chuck to increase carcass yield and cutout value more greatly in LY beef × dairy crossbreds than HY beef × dairy crossbreds cannot be entirely explained but may pertain to a greater amount of fat remaining on the boneless short plate (the largest subprimal of the plate) of LY crossbreds than HY crossbreds.

Conclusions

At industry-average slaughter endpoints for their cattle type, HY beef × dairy cattle produced more than 3.0 percentage units greater subprimal yield than dairy cattle. And, both HY and LY beef × dairy cattle produced markedly greater subprimal cutout value than dairy cattle. Hence, the recent increase in beef × dairy cattle to US annual fed cattle slaughter has positive implications on pounds of saleable beef and value in the supply chain over straightbred dairy cattle.

When equivalent in subprimal to bone to beef cattle, HY beef × dairy crossbreds had a greater subprimal to fat and a greater subprimal cutout value than beef cattle. Conversely, when equivalent in subprimal to fat to beef cattle, LY crossbreds produced lesser subprimal to bone and a lower subprimal cutout value than beef cattle. Increases in subprimal to bone of the round were most responsible for increasing subprimal cutout value among beef × dairy crossbreds, irrespective of HY or LY designation.

Dairies adopting a beef × dairy crossbreeding system may consider retained ownership of beef × dairy calves through the finishing phase. Producers marketing beef × dairy cattle may be able to avoid packer discounts founded on inferior carcass yield traditionally associated with cattle of dairy breeding by selecting for considerable muscling, especially in the round, in relation to bone and by harvesting cattle at a lesser overall fatness than conventional beef cattle.

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