Harvest co-product, primal, and subprimal yields of Angus compared to Angus × Holstein crossbred steers.

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OBJECTIVES:

Purebred dairy cattle are typically discounted when marketed to beef processors, due to unfavorable carcass muscling attributes, ergonomic carcass length complications, and marketing limitations. Dairy-crossbred cattle allow producers to add value to the dairy industry by providing a product that reduces discounts and improves marketability. Angus and Angus × Holstein cattle differ in genetic composition, thus potentially impacting the yield outcomes of co-products at harvest, and yield outcomes for primal and subprimal cuts during carcass fabrication. Our objectives were to quantify absolute weight and percentage yield similarities and differences for harvest co-products between purebred black Angus and black Angus × Holstein steers, and determine primal and subprimal yield similarities and differences between Angus and Angus × Holstein steers.

MATERIALS AND METHODS:

Harvest

Cattle (n = 60), consisting of black Angus (AU) steers (n = 30), and black Angus × Holstein (AH) steers (n = 30) originating from 6 different feedlots, were harvested on 6 different days at the Caviness Meat Science & Innovation Center. All cattle were immobilized via a captive bolt stunner and were weighed before and after exsanguination. Hides were removed from carcasses with the aid of pneumatic dehiders, and hide thickness was measured at the midline of the hide (mm) and 30 mm proximal left and right of the initial measurement. The gastrointestinal tract and internal organs were removed from the carcass; the four-compartment stomach and small and large intestines were separated, washed clean, and weighed. Omental and mesenteric fat were removed from the gastrointestinal tract and weighed. Absolute weights of all harvest co-products removed from the carcass, throughout the harvest process, were recorded. Hot carcass weights were observed and recorded to calculate the dressing percentage of each animal. Empty body weight (EBW) was calculated by adding all carcass components plus the empty gastrointestinal tract. Yield of each co-product was also calculated as a percentage of empty body weight (EBW %).

Grading

Carcasses were allowed a 48-hour chill and all right sides were ribbed at the 12^{th} and 13^{th} rib interface, prior to fabrication, and evaluated for yield and quality outcomes after a fifteen-minute bloom time. All right sides were evaluated by three trained personnel throughout the duration of the study, whom measured fat thickness opposite the ribeye with a fat ruler, ribeye area with a dot grid, and subjectively determined marbling scores using official marbling cards as a reference. Averages of each outcome were determined to provide a uniform assessment of these

outcomes. Lean and bone maturity scores were evaluated by a separate trained faculty member prior to fabrication. Yield grade of each animal was calculated using the equation YG = 2.5 + (2.5 × FT) + (0.0038 × HCW) + (0.2 × KPH %) - (0.32 × REA).

Fabrication

After grading, sides were weighed and then separated into primals (Chuck, Rib, Loin, Round, Brisket, Plate, Flank). Primals were weighed and fabricated into subprimals according to USDA IMPS specifications. Subprimal cuts from the brisket included the brisket, deckle off, boneless (IMPS #120). Chuck and foreshank subprimal cuts included the shoulder clod, arm roast (IMPS #114E), top blade, roast (IMPS #114D), shoulder tender (IMPS #114F), chuck tender (IMPS #116B), chuck roll (IMPS #116A), chuck flap (IMPS #116G, PSO 1), short ribs, boneless (IMPS #130A), and pectoral meat (IMPS #115D). Rib subprimal cuts included ribeye roll, lip-on (IMPS #112A), back ribs (IMPS #124), and blade meat (IMPS #109B). Subprimals for the plate were inside skirt (IMPS #121D), outside skirt (IMPS #121C), and plate short ribs, trimmed (IMPS #123A). Loin and sirloin subprimals were strip loin, boneless (IMPS #180), tenderloin, full, side muscle on, defatted (IMPS #189A), top sirloin butt, boneless (IMPS #184), bottom sirloin butt, tri-tip, boneless, defatted (IMPS #185D), hanging tender (IMPS #140), and the bottom sirloin butt, ball tip, boneless (IMPS 185B). Subprimal cuts from the flank included flank steak (IMPS #193) and bottom sirloin butt, flap, boneless (IMPS #185A). Round subprimal cuts included knuckle, peeled (IMPS #167A), top (inside) (IMPS #169), outside round (IMPS #171B), eye of round (IMPS #171C), and heel meat (IMPS #171F). Weights of all subprimal cuts, trimmings, fat, and bones were recorded for each primal. All, trimmings, fat, and bone from all primals were combined to calculate total weights for each category. Yield weights were converted to percentage of chilled carcass weight and percentage of primal weight for analysis.

Statistical Analysis

All statistical analyses were completed via the SAS System version 9.4. Demographic information of the AU and AH cattle consisted of days on feed (DOF) and initial weight (INWT). These data were analyzed using PROC MEANS with class statement including cattle type and the variable of interest being DOF or INWT. Results of these analyses reported the mean, standard deviation, maximum, and minimum for each cattle type for both variables. All harvest yields, quality and yield grade, and fabrication yields were analyzed using mixed models via PROC GLIMMIX with an alpha level of 0.05. Data were analyzed via mixed models using a completely randomized design; breed type was the main effect and feedyard source was the random effect. Means of each variable for each breed type were reported along with the standard error of the mean and the statistical significance level (*P* – value).

RESULTS AND DISCUSSION:

Harvest Outcomes

Demographic information (Table 1) of AU and AH cattle revealed AU cattle had heavier initial weight (763.8 lbs. vs 619.3 lbs.) than AH cattle. As a result of AH being brought into the

feedlot at a lower initial weight, AH cattle were on feed for a longer duration (271 days vs 192 days) than AU steers.

At harvest, stun weights, empty body weights (EBW), intestinal fill, and carcass weights with and without KPH were heavier ($P \leq 0.0077$) than those reported by AU steers (Table 2). However, dressed yield percentages, and EBW percentages for carcass weight with and without KPH were higher ($P < 0.0001$) for AU steers than AH steers.

Hides (Table 3) of AH steers were 7.5 lbs. heavier ($P = 0.0066$) than AU steers, but no difference was detected for total hide weight as a percentage of EBW ($P = 0.4044$) between cattle types. Midline hide thickness measurements indicated that AU steers had thicker hides (6.20 mm vs. 5.53 mm; $P = 0.0532$) than AH steers. There was no difference ($P \geq 0.5014$) detected for hide thickness proximal to the midline measurement.

Yield outcomes for products sourced from the head (Table 4) indicated that AH steers yielded heavier weights for the initial head weight, head without tongue, untrimmed tongue, trimmed tongue, tongue root, salivary glands and associated fat, head meat, trimmed head, and pituitary gland ($P \leq 0.0332$) than those from AU steers. A tendency occurred in which AH steers had heavier weights for cheek meat ($P = 0.0718$) than AU steers. No difference was observed for *M. sternomandibularis* or oxlips ($P \geq 0.2418$) between AU and AH steers. No difference existed ($P \geq 0.1085$) between cattle type for any of the products sourced from the head as a percentage of EBW.

Harvest co-product components (Table 5) indicated AH steers had heavier weights ($P \leq 0.0240$) for tendons, oxtail, thymus and blood than those from AU steers. Additionally, EBW percentages of thymus, and blood were higher ($P \leq 0.0155$) for AH steers than AU steers. No difference was observed ($P \geq 0.2407$) for percentage EBW for tendons and oxtail between cattle types.

Digestive tract yields (Table 6) revealed heavier weights ($P \leq 0.0199$) for the esophagus, reticulum, omasum, abomasum, and small intestine of AH steers. No differences were detected ($P \geq 0.6681$) for rumen, and large intestine weights between AH and AU steers. However, percentage EBW for the rumen of AU steers was higher (1.83% vs 1.65%; $P = 0.0021$), whereas percentage EBW for abomasum tended to be higher ($P = 0.0640$) for AH steers. No differences ($P \geq 0.2018$) were observed for percentage EBW of esophagus, reticulum, omasum, small intestine, and large intestine, between AU and AH steers.

Organ weights (Table 7) indicated that AH steers had heavier ($P \leq 0.0023$) heart, aorta, lung, trachea, liver, spleen, and kidney weights than AU steers. No difference in weight was detected for pericardium, bile, or pancreas ($P \geq 0.1565$). The heart, spleen, and kidneys of AH steers accounted for a larger percentage ($P \leq 0.0419$) of EBW than AU steers. No differences occurred for aorta, pericardium, lungs, trachea, liver, bile, or pancreas ($P \geq 0.1027$) as a percentage of EBW were detected between cattle types.

Carcass components utilized for meat and bone meal (Table 8) revealed that AH steers yielded heavier weights ($P \leq 0.0185$) for metacarpals, metatarsals, ears, muzzle, and

bladder/contents. The larynx (P = 0.0625) and hyoid bone (P = 0.0878) also tended to be heavier for AH steers than AU steers. No differences in weight were observed for switch, weasand, penis, and total muscle trim ($P \geq 0.2764$) between cattle types. Overall the heavier weights of the AH components reported in this table resulted in AH steers yielding more raw material for meat and bone meal weight (35.08 vs. 32.13 lbs.; P = 0.0003) than AU steers. Metatarsals of AH steers accounted for a larger percentage of EBW (P = 0.0176) than AU metatarsals. In addition, bladder and contents tended to account for a higher EBW percentage (P = 0.0745) for AH than AU steers. No differences occurred ($P \geq 0.1127$) for metacarpals, muzzle, weasand, larynx, hyoid bone, penis, and total muscle trim between cattle types. This resulted in no difference for meat and bone meal (P = 0.9644) as a percentage of EBW between cattle types.

Specified risk materials (Table 9) sourced from AU and AH steers demonstrated no differences for weights ($P \geq 0.3237$) of tonsils, spinal cord, or total specified risk material. This resulted in no differences for EBW percentages ($P \geq 0.3087$) for tonsils, spinal cord, or total specified risk material between cattle types. The distal ileum (last 80 inches of small intestine) was included as part of the small intestine weight and yield and thus not separated as an SRM for this yield test.

Weights of inedible tallow components (Table 10) yielded by AH steers were heavier ($P \leq 0.0092$) for removed KPH, omental fat, mesenteric fat, and lung fat. However, no difference was observed ($P \geq 0.1693$) for fat trim removed during harvest, and heart fat between cattle types. This permitted AH steers to yield a greater total quantity of inedible tallow weight than AU steers (159.52 lbs. vs 125.32 lbs.; $P < 0.0001$). In addition to weight differences, AH steers had higher EBW percentages ($P \leq 0.0025$) for removed KPH, omental fat, and mesenteric fat. A tendency occurred for AH steers to have higher EBW percentages for lung fat (P = 0.0632). No differences were observed ($P \geq 0.3413$) for carcass fat trim removed during harvest or heart fat between AU and AH steers. AH steers also yielded a higher EBW percentage (10.30%) for total inedible tallow than AU steers (8.83%; $P < 0.0001$).

Grading Outcomes

Carcass grading outcomes (Table 11) demonstrated heavier hot carcass weights (P = 0.0001) and higher KPH percentages (P = 0.0010) for AH carcasses at grading. However, lean maturity scores indicated AU carcasses had lighter colored lean at the 12th and 13th rib interface than AH steers (A^{66} vs A^{74}; P = 0.0151). No differences ($P \geq 0.1205$) were observed for fat thickness, ribeye area, yield grade, marbling score, or bone maturity between AU and AH carcasses.

Fabrication Outcomes

At fabrication, AH carcasses had heavier side weights than AU carcasses (508.80 lbs. vs 476.71 lbs.; P = 0.0006; Table 12). Moreover, primal weights of these carcasses revealed that AH carcasses had heavier chuck and foreshank, rib, plate, flank, and round weights ($P \leq 0.0222$) than AU carcasses. No difference was observed for the brisket (P = 0.2705) and loin (P = 0.1164) primal weights between cattle types. Primal weights as a percentage of the carcass indicated the loin represented a greater percentage of AU carcasses than AH carcasses (15.81% vs 15.36%; P =

0.0390). The chuck and foreshank of AH carcasses tended to represent a greater percentage of the carcass ($P = 0.0787$) when compared to AU carcasses. No difference was detected ($P \geq 0.2736$) for brisket, rib, plate, flank, and round primals as a percentage of the fabricated carcass between cattle types.

Results from the brisket primal (Table 13) indicate AH carcasses yielded more 80/20 trim ($P = 0.0408$) and bone ($P = 0.0272$) than AU carcasses. No difference was detected for brisket subprimal, 50/50 trim and fat trim ($P \geq 0.3554$) weights between cattle types. However, AU brisket subprimals tended to represent a greater percentage ($P = 0.0677$) of the fabricated carcass. In terms of the brisket primal itself, the brisket subprimal of AU carcasses represented a greater percentage of the primal ($P = 0.0320$) than AH carcasses. Primal percentages for 80/20 trim ($P = 0.0959$) and bones ($P = 0.0841$) tended to be higher for AH carcasses. No difference occurred for primal percentages of 50/50 trim ($P = 0.4138$) and fat trim ($P = 0.7472$) between cattle types.

Weights of the cut primal plate (Table 14) indicated heavier weights for bone-in plate short ribs ($P = 0.0041$) and bones ($P = 0.0110$) of AH carcasses. A tendency occurred for 50/50 trim of AH carcasses to be heavier ($P = 0.0646$) than AU carcasses. No difference was detected for inside skirt, outside skirt, boneless plate short ribs, 80/20 trim, and fat trim ($P \geq 0.1181$) weights of fabricated plate. Bone-in plate short ribs tended to account for a larger percentage of AH carcasses ($P = 0.0805$) than AU carcasses. Additionally, outside skirt of AU carcasses accounted for a higher percentage of the plate primal than AH carcasses (3.76% vs 3.45%; $P = 0.0459$). No differences were observed for inside skirt, outside skirt, or boneless plate short ribs ($P \geq 0.1159$) as a percentage of carcass. Moreover, no differences existed for inside skirt, bone-in plate short ribs, boneless plate short ribs, 80/20 trim, 50/50 trim, fat trim, and bones ($P \geq 0.1412$) as a percentage of the plate primal.

Flank steak and 80/20 trim (Table 15) weights were heavier from flank primals of AH carcasses ($P \leq 0.0107$) than AU carcasses. Sirloin flap weights for AH carcasses tended to be heavier ($P = 0.0701$) than AU carcasses. No difference was observed for fat trim ($P = 0.1402$) or bone ($P = 0.5227$) weights between AU and AH carcasses. As a percentage of carcass, the flank steak of AH carcasses represented more of the carcass ($P = 0.0025$) whereas no difference was observed for sirloin flap as a percentage of carcass ($P = 0.3418$) between cattle types. No differences were observed for flank steak, sirloin flap, 80/20 trim, fat trim, and bones ($P \geq 0.1995$) as a percentage of the flank primal.

Weights of products from the chuck and foreshank primals (Table 16) for mock tender, rope meat, 80/20 trim, fat trim and bones ($P \leq 0.0350$) were heavier for AH carcasses than AU carcasses. Additionally, the top blade subprimal of AH carcasses tended to weigh more ($P = 0.0801$). No differences were detected for the weights of shoulder clod, shoulder tender, chuck eye roll, chuck flap, chuck short ribs boneless, pectoral meat, and 50/50 trim ($P \geq 0.1596$) between AU or AH carcasses. Mock tender as a percentage of the carcass was higher for AH carcasses than AU carcasses (0.70% vs 0.66%; $P = 0.0232$). No differences were observed for shoulder clod, top blade, shoulder tender, chuck eye roll, chuck flap, chuck short rib boneless, pectoral meat, and rope meat ($P \geq 0.1135$) as a percentage of carcass between cattle types. However, the shoulder clod of AU carcasses represented a greater percentage of the primal (5.34%; $P = 0.0140$), whereas

the bones from AH carcasses represented a greater percentage of the primal (18.72% vs 17.28%; $P < 0.0001$). Primal percentages of shoulder tender, chuck flap, and chuck boneless short ribs tended to be higher ($P \leq 0.0842$) for AU carcasses, whereas the mock tender of AH carcasses tended to represent a greater percentage ($P = 0.0812$) of the primal. No differences were observed for top blade, chuck eye roll, pectoral meat, rope meat, 80/20 trim, 50/50 trim, or fat trim between cattle types.

Weights reported in Table 17 for the rib primal revealed AH carcasses had heavier ribeye roll, back ribs, and bone weights ($P \leq 0.0336$) than AU carcasses. No differences were evident for back rib trim, blade meat, 80/20 trim, 50/50 trim, and fat trim ($P \geq 0.2004$) between cattle types. Back ribs of AH carcasses accounted for a higher percentage of the carcass ($P = 0.0137$) than AU carcasses. No differences were observed for ribeye roll, back rib trim, or blade meat ($P \geq 0.5334$) as a percentage of the carcass between cattle types. Back ribs and bones of AH carcasses accounted for a higher percentage ($P \leq 0.0438$) of the rib primal when compared to AU carcasses. No differences occurred for ribeye roll, back rib trim, blade meat, 80/20 trim, 50/50 trim, and fat trim ($P \geq 0.3494$) between cattle types as a percentage of the rib primal.

Weights from the primal loin (Table 18) indicated that AH carcasses had heavier weights for the tenderloin, tri-tip, and bones ($P \leq 0.0131$) than AU carcasses. No differences occurred for the striploin, top butt, hanging tender, bottom sirloin ball tip, 80/20 trim, 50/50 trim, or fat trim ($P \geq 0.1764$) weights between cattle types. Striploin of AU carcasses accounted for a greater percentage of the fabricated carcass when compared with AH carcasses (2.61% vs 2.46%; $P = 0.0061$). No differences occurred for tenderloin, top butt, tri-tip, hanging tender, or bottom sirloin ball tip ($P \geq 0.1611$) when represented as a percentage of the carcass. Bones of AH carcasses represented a greater percentage ($P < 0.0001$) of the loin primal when compared to AU carcasses. No differences were detected from the striploin, tenderloin, top butt, tri-tip, hanging tender, bottom sirloin ball tip, 80/20 trim, 50/50 trim, and fat trim ($P \geq 0.1234$) as a percentage of the loin primal between cattle types.

Weights reported from the round primal (Table 19) indicated that the knuckle ($P = 0.0051$) and bones ($P < 0.0001$) of AH carcasses were heavier than those observed for AU carcasses. A tendency occurred for AH carcasses to have heavier top rounds ($P = 0.0589$) than AU carcasses. No weight differences were observed for the bottom round, eye of round, heel, 80/20 trim, or fat trim ($P \geq 0.1060$) between cattle types. Bottom round, eye of round, and the heel of AU carcasses represented a higher percentage ($P \leq 0.0373$) of the carcass when compared to AH carcasses. No differences occurred for the knuckle ($P = 0.5130$) and top round ($P = 0.4522$) when expressed as a percentage of the fabricated carcass. Also, bottom round, eye of round, and heel of AU carcasses accounted for a higher percentage ($P \leq 0.0179$) of the round primal when compared to AH carcasses. However, bones as a percentage of the round primal was higher ($P < 0.0001$) for AH carcasses than AU carcasses. No difference was observed for knuckle, top round, 80/20 trim, or fat trim ($P \geq 0.1385$) as a percentage of the round primal between cattle types.

Total trim weights from all primals (Table 20) indicated that AH carcasses yielded heavier weights in terms of 80/20 trim ($P = 0.0066$) and bones ($P < 0.0001$) when compared to AU carcasses. No weight differences were observed for 50/50 trim or fat trim ($P \geq 0.2233$) sourced

from all primals of either cattle type. Additionally, bones of AH carcasses represented a higher percentage of carcass weight than bones from AU carcasses (13.98% vs 12.89%; $P = 0.0001$). No differences were detected for 80/20 trim, 50/50 trim, and fat trim ($P \geq 0.6432$) as a percentage of the fabricated carcass between cattle types.

CONCLUSION:

This study demonstrates that at current market weights, Angus × Holstein steers generally produce heavier carcasses and associated components compared to Angus steers. While AH carcasses yielded greater absolute weights for several harvest co-products, internal fat depots, and bone-in components, empty body percentage-based comparisons revealed fewer differences between the two breed types. The most notable distinctions were observed in internal fat distribution, with AH steers exhibiting significantly higher mesenteric, omental, and KPH fat weights and percentages. Fabrication outcomes showed minimal variation in primal and subprimal muscle yields, indicating that crossbreeding Angus with Holstein genetics does not substantially alter the proportion of high-value cuts. These findings suggest that while AH steers offer advantages in total weight yielded, their proportional carcass composition remains largely comparable to AU steers, supporting the viability of dairy-beef crossbreeding as a strategy to enhance carcass value without compromising beef processing yields.

Table 1. Demographic information of Angus and Angus x Holstein cattle.				
Breed	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Angus				
Initial Weight (lbs.)	763.8	202.7	519.0	1140.0
Days on Feed	192	29	164	237
Angus x Holstein				
Initial Weight (lbs.)	619.3	127.4	497.0	739.0
Days on Feed	271	41	190	315

Table 2. Live, empty, and carcass weights of Angus and Angus x Holstein cattle.				
	Angus	**Angus x Holstein**	**SEM**	***P* - Value**
Number (*n*)	30	30		
Stun Weight (Live Weight) (lbs.)	1494.0	1633.9	43.5	< 0.0001
EBW (lbs.)[1]	1414.4	1542.8	44.4	< 0.0001
Dressed Yield (%)	66.14	64.80	0.49	< 0.0001
Fill (lbs.)[2]	79.6	91.1	3.9	0.0077
Carcass Weight with KPH (lbs.)	988.8	1059.3	32.6	0.0001
EBW %[3]	69.86	68.65	0.35	< 0.0001
Carcass Weight without KPH (lbs.)	956.2	1017.3	31.6	0.0005
EBW %[3]	67.57	65.93	0.40	< 0.0001

[1]Empty Body Weight (EBW) = Sum of all carcass components and internal organs with digesta removed from the digestive tract

[2]Fill= Difference between stun weight and empty body weight.

[3]Percent Empty Body Weight (EBW %) = Percentage of the empty body weight that a given factor composes.

Table 3. Outcomes of hide yield and thickness from Angus and Angus x Holstein carcasses.

	Angus	**Angus x Holstein**	**SEM**	***P* – Value**
Number (*n*)	30	30		
Hide (lbs.)	105.5	113.0	3.7	0.0066
EBW %[1]	7.47	7.33	0.13	0.4044
Hide Thickness (mm)[2]				
Middle	6.20	5.53	0.29	0.0532
Right	6.50	6.40	0.28	0.7314
Left	6.77	6.57	0.27	0.5014

[1]Percent Empty Body Weight (EBW %) = Percentage of the empty body weight that a given factor composes.
[2]Hide Thickness (mm) = The initial measurement for the hide was taken after removal at the midline, then a second measurement was taken 30 cm to the right of the initial measurement and a third measurement was taken 30 cm to the left of the initial measurement.

Table 4. Outcomes of head product yields of Angus and Angus x Holstein carcasses.				
	Angus	**Angus x Holstein**	**SEM**	***P* - Value**
Number (*n*)	30	30		
Initial Head Weight (lbs.)	41.65	45.82	0.90	< 0.0001
EBW %[1]	2.96	2.98	0.07	0.5465
Head Without Tongue (lbs.)	30.15	33.29	0.63	< 0.0001
EBW %[1]	2.14	2.17	0.05	0.4019
Sternomandibularis (lbs.)	0.54	0.45	0.09	0.5124
EBW %[1]	0.04	0.03	0.01	0.3594
Cheek Meat (lbs.)	3.44	3.63	0.16	0.0718
EBW %[1]	0.24	0.24	0.02	0.2095
Tongue (Untrimmed) (lbs.)	10.81	11.77	0.28	0.0006
EBW %[1]	0.77	0.77	0.02	0.9231
Trimmed Tongue (lbs.)	2.54	2.72	0.11	0.0134
EBW %[1]	0.18	0.18	0.01	0.3403
Oxlips (lbs.)	1.82	1.89	0.11	0.2418
EBW %[1]	0.13	0.12	0.01	0.1085
Tongue Root (lbs.)	2.46	2.73	0.11	0.0046
EBW %[1]	0.17	0.18	0.004	0.5546
Salivary Glands and Associated Fat (lbs.)	2.79	3.19	0.11	0.0121
EBW %[1]	0.20	0.21	0.01	0.3935
Head Meat (lbs.)	1.46	1.59	0.09	0.0332
EBW %[1]	0.10	0.10	0.01	0.8411
Trimmed Head (lbs.)	23.02	25.66	0.54	<0.0001
EBW %[1]	1.64	1.67	0.04	0.1687
Brain (lbs.)	0.89	1.31	0.22	0.1925
EBW %[1]	0.06	0.09	0.02	0.2952
Pituitary Gland (grams)	2.18	2.51	0.13	0.0292
EBW %[1]	---	---	---	---

[1]Percent Empty Body Weight (EBW %) = Percentage of the empty body weight that a given factor composes.

Table 5. Yields of harvest co-products of Angus and Angus Holstein carcasses.				
	Angus	**Angus x Holstein**	**SEM**	***P* - Value**
Number (*n*)	30	30		
Metacarpal Tendons (lbs.)	0.87	0.96	0.05	0.0240
EBW %[1]	0.06	0.06	0.004	0.6415
Oxtail (lbs.)	3.13	3.55	0.12	0.0006
EBW %[1]	0.22	0.23	0.01	0.2407
Thymus (lbs.)	0.72	1.09	0.10	0.0019
EBW %[1]	0.05	0.07	0.01	0.0155
Blood (lbs.)	51.02	59.35	1.86	< 0.0001
EBW %[1]	3.60	3.85	0.07	0.0146
[1]Percent Empty Body Weight (EBW %) = Percentage of the empty body weight that a given factor composes.				

Table 6. Digestive tract component yields of Angus and Angus x Holstein carcasses.

	Angus	**Angus x Holstein**	**SEM**	***P* – Value**
Number (*n*)	30	30		
Esophagus (lbs.)	1.12	1.28	0.04	0.0007
EBW %[1]	0.08	0.08	0.002	0.3198
Rumen (lbs.)	25.69	25.32	1.68	0.6681
EBW %[1]	1.83	1.65	0.15	0.0021
Reticulum (lbs.)	2.44	2.67	0.09	0.0199
EBW %[1]	0.17	0.17	0.01	0.8711
Omasum (lbs.)	7.01	8.03	0.36	0.0009
EBW %[1]	0.50	0.52	0.02	0.2759
Abomasum (lbs.)	3.82	4.43	0.10	< 0.0001
EBW %[1]	0.27	0.29	0.01	0.0640
Small Intestine (lbs.)	11.35	12.70	0.44	0.0009
EBW %[1]	0.81	0.83	0.03	0.5115
Large Intestine (lbs.)	6.05	5.89	0.56	0.7622
EBW %[1]	0.43	0.38	0.04	0.2018

[1]Percent Empty Body Weight (EBW %) = Percentage of the empty body weight that a given factor composes.

Table 7. Organ yields of Angus and Angus x Holstein carcasses.				
	Angus	**Angus x Holstein**	**SEM**	***P* – Value**
Number (*n*)	30	30		
Heart (lbs.)	6.31	7.17	0.12	< 0.0001
EBW %[1]	0.45	0.47	0.01	0.0419
Aorta (lbs.)	0.38	0.43	0.02	0.0022
EBW %[1]	0.03	0.03	0.001	0.2993
Pericardium (lbs.)	5.30	5.90	0.40	0.1565
EBW %[1]	0.37	0.38	0.02	0.7329
Lungs (lbs.)	6.84	7.90	0.18	0.0001
EBW %[1]	0.48	0.51	0.02	0.1027
Trachea (lbs.)	1.06	1.17	0.04	0.0003
EBW %[1]	0.07	0.08	0.001	0.5084
Liver (without Gallbladder) (lbs.)	17.17	19.75	0.72	0.0023
EBW %[1]	1.22	1.29	0.05	0.2563
Bile (lbs.)	0.63	0.57	0.06	0.4530
EBW %[1]	0.04	0.04	0.003	0.1704
Pancreas (lbs.)	1.19	1.26	0.07	0.2171
EBW %[1]	0.08	0.08	0.004	0.5791
Spleen (lbs.)	2.24	2.78	0.08	< 0.0001
EBW %[1]	0.16	0.18	0.01	0.0007
Kidneys (lbs.)	2.66	3.14	0.08	< 0.0001
EBW %[1]	0.19	0.20	0.003	0.0025
[1]Percent Empty Body Weight (EBW %) = Percentage of the empty body weight that a given factor composes.				

Table 8. Carcass yields of components used for meat and bone meal from Angus and Angus x Holstein carcasses.

	Angus	Angus x Holstein	SEM	*P* – Value
Number (*n*)	30	30		
Switch (lbs.)	0.34	0.30	0.035	0.2764
EBW %[1]	0.02	0.02	0.0028	0.0694
Metacarpals (lbs.)	11.15	11.95	0.28	0.0044
EBW %[1]	0.79	0.78	0.02	0.4478
Metatarsals (lbs.)	9.85	11.33	0.22	< 0.0001
EBW %[1]	0.70	0.74	0.01	0.0176
Ears (lbs.)	1.21	1.43	0.09	< 0.0001
EBW %[1]	0.09	0.09	0.004	0.0595
Muzzle (lbs.)	1.95	2.09	0.12	0.0163
EBW %[1]	0.14	0.14	0.01	0.5231
Weasand (Esophagus) Trim (lbs.)	0.17	0.19	0.02	0.3756
EBW %[1]	0.01	0.01	0.001	0.7680
Larynx (lbs.)	0.75	0.82	0.03	0.0625
EBW %[1]	0.05	0.05	0.003	0.9943
Hyoid Bone (lbs.)	0.40	0.44	0.02	0.0878
EBW %[1]	0.03	0.03	0.001	0.7992
Penis (lbs.)	3.56	3.51	0.25	0.8398
EBW %[1]	0.25	0.23	0.02	0.1127
Total Muscle Trim (lbs.)	1.69	1.51	0.20	0.4529
EBW %[1]	0.12	0.10	0.01	0.1784
Bladder and Contents (lbs.)	1.06	1.52	0.16	0.0185
EBW %[1]	0.08	0.10	0.01	0.0745
Meat and Bone Meal (lbs.)[2]	32.13	35.08	0.91	0.0003
EBW %[1]	2.28	2.28	0.05	0.9644

[1]Percent Empty Body Weight (EBW %) = Percentage of the empty body weight that a given factor composes.
[2]Meat and Bone Meal= Calculated by summing all components in the table.

Table 9. Yield of specified risk materials from Angus and Angus x Holstein carcasses.				
	Angus	**Angus x Holstein**	**SEM**	***P* – Value**
Number (*n*)	30	30		
Tonsils (lbs.)	0.65	0.68	0.03	0.3237
EBW %[1]	0.05	0.04	0.0023	0.4479
Spinal Cord (lbs.)	0.47	0.47	0.10	0.9510
EBW %[1]	0.03	0.03	0.01	0.3976
Specified Risk Materials (lbs.)[2]	1.11	1.14	0.12	0.6593
EBW %[1]	0.08	0.07	0.01	0.3087

[1]Percent Empty Body Weight (EBW %) = Percentage of the empty body weight that a given factor composes.
[2]Specified Risk Material= Calculated by summing all components in the table.

Table 10. Harvest yields for inedible tallow from Angus and Angus x Holstein carcasses.

	Angus	**Angus x Holstein**	**SEM**	***P* – Value**
Number (*n*)	30	30		
Carcass Fat Trim (lbs.)	9.89	11.24	1.50	0.1693
EBW %[1]	0.69	0.72	0.09	0.6851
Removed KPH (lbs.)	30.40	40.57	2.11	< 0.0001
EBW %[1]	2.23	2.61	0.12	0.0025
Omental Fat (lbs.)	44.14	58.44	2.46	< 0.0001
EBW %[1]	3.18	3.78	0.13	< 0.0001
Mesenteric Fat (lbs.)	38.07	47.75	2.98	< 0.0001
EBW %[1]	2.68	3.08	0.16	0.0015
Heart Fat (lbs.)	0.37	0.10	0.21	0.3625
EBW %[1]	0.03	0.01	0.02	0.3413
Lung Fat (lbs.)	1.16	1.63	0.54	0.0092
EBW %[1]	0.08	0.11	0.04	0.0632
Inedible Tallow (lbs.)[2]	125.32	159.52	8.42	< 0.0001
EBW %[1]	8.83	10.30	0.43	< 0.0001

[1]Percent Empty Body Weight (EBW %) = Percentage of the empty body weight that a given factor composes.
[2]Inedible Tallow= Calculated by summing all components in the table.

Table 11. Yield and quality grading outcomes of Angus and Angus x Holstein carcasses.

	Angus	Angus x Holstein	SEM	*P* - Value
Number (*n*)	30	30		
Hot Carcass Weight (lbs.)	988.77	1059.27	32.55	0.0001
Fat Thickness (in.)	0.75	0.69	0.05	0.2986
Ribeye Area (in^2)	14.62	14.40	0.39	0.5440
KPH (%)[1]	3.19	3.81	0.17	0.0010
Yield Grade	4.09	4.40	0.21	0.1205
Marbling Score[2]	513	496	21	0.4939
Lean Maturity[3]	166	174	2	0.0151
Bone Maturity[4]	181	181	5	0.9920

[1]Kidney-Pelvic-Heart Fat Percentage = Percent of the carcass composed of kidney, pelvic, and heart fat.
[2]Marbling Scores = Scale ranges from 100-1000; 400 = $Small^{00}$; 500 = $Modest^{00}$
[3]Lean and Bone Maturity = Scale ranges from 100-600; 100 = A^{00}; 200 = B^{00}

Table 12. Primal weight outcomes of Angus and Angus x Holstein carcasses.				
	Angus	**Angus x Holstein**	**SEM**	***P* - Value**
Number (*n*)	30	30		
Carcass Side Weight (lbs.)	476.71	508.80	14.25	0.0006
Brisket Primal (lbs.)	26.54	27.55	0.84	0.2705
Carcass %	5.57	5.41	0.10	0.2779
Chuck and Foreshank Primals (lbs.)	143.40	155.34	3.97	<0.0001
Carcass %	30.11	30.54	0.21	0.0787
Rib Primal (lbs.)	34.55	37.26	1.29	0.0033
Carcass %	7.26	7.31	0.12	0.6940
Plate Primal (lbs.)	57.58	62.54	2.55	0.0037
Carcass %	12.04	12.27	0.20	0.2736
Loin Primal (lbs.)	75.38	78.11	2.24	0.1164
Carcass %	15.81	15.36	0.21	0.0390
Flank Primal (lbs.)	35.76	38.81	1.18	0.0222
Carcass %	7.52	7.62	0.15	0.6442
Round Primal (lbs.)	103.01	108.64	3.2260	0.0099
Carcass %	21.60	21.38	0.22	0.4076

Table 13. Subprimal yields from the brisket primal of Angus and Angus x Holstein carcasses.

	Angus	**Angus x Holstein**	**SEM**	***P* - Value**
Number (*n*)	30	30		
Brisket (lbs.)	18.10	18.36	0.57	0.6873
Carcass %	3.79	3.61	0.07	0.0677
Primal %	68.22	66.64	0.51	0.0320
80/20 Trim (lbs.)	1.67	1.91	0.09	0.0408
Primal %	6.30	6.97	0.28	0.0959
50/50 Trim (lbs.)	0.08	0.02	0.04	0.3554
Primal %	0.26	0.08	0.16	0.4138
Fat Trim (lbs.)	3.75	3.94	0.22	0.3742
Primal %	14.04	14.21	0.54	0.7472
Bones (lbs.)	2.87	3.25	0.12	0.0272
Primal %	10.90	11.84	0.47	0.0841

Table 14. Subprimal yields from the plate primal of Angus and Angus x Holstein carcasses.

	Angus	Angus x Holstein	SEM	*P* - Value
Number (*n*)	30	30		
Inside Skirt (lbs.)	3.80	3.88	0.15	0.6376
Carcass %	0.80	0.76	0.02	0.2980
Primal %	6.65	6.23	0.20	0.1412
Outside Skirt (lbs.)	2.17	2.15	0.10	0.8698
Carcass %	0.45	0.42	0.01	0.1159
Primal %	3.76	3.45	0.14	0.0459
Bone-in Plate Short Ribs (lbs.)	5.48	6.31	0.26	0.0041
Carcass %	1.15	1.25	0.06	0.0805
Primal %	9.60	10.22	0.51	0.1828
Boneless Plate Short Ribs (lbs.)	3.94	4.31	0.21	0.1181
Carcass %	0.83	0.85	0.05	0.5686
Primal %	6.89	6.99	0.44	0.7726
80/20 Trim (lbs.)	7.50	8.33	1.46	0.4540
Primal %	12.66	13.40	2.28	0.6832
50/50 Trim (lbs.)	27.10	30.12	1.65	0.0646
Primal %	47.55	48.02	2.54	0.8367
Fat Trim (lbs.)	5.90	5.52	0.80	0.5816
Primal %	9.94	8.63	0.94	0.1540
Bones (lbs.)	5.39	5.90	0.29	0.0110
Primal %	9.44	9.56	0.54	0.7252

Table 15. Subprimal yields from the flank primal of Angus and Angus x Holstein carcasses.				
	Angus	**Angus x Holstein**	**SEM**	***P* - Value**
Number (*n*)	30	30		
Flank Steak (lbs.)	2.26	2.60	0.13	< 0.0001
Carcass %	0.47	0.51	0.02	0.0025
Primal %	6.41	6.76	0.25	0.1995
Sirloin Flap (lbs.)	4.75	4.97	0.16	0.0701
Carcass %	1.00	0.98	0.01	0.3418
Primal %	13.43	12.96	0.33	0.3053
80/20 Trim (lbs.)	8.78	9.77	0.29	0.0107
Primal %	24.71	25.24	0.56	0.4726
50/50 Trim (lbs.)	---	---	---	---
Primal %	---	---	---	---
Fat Trim (lbs.)	19.65	21.17	0.79	0.1402
Primal %	54.54	54.25	0.81	0.7932
Bones (lbs.)	0.27	0.28	0.02	0.5227
Primal %	0.76	0.73	0.06	0.6152

Table 16. Subprimal yields from the chuck primal of Angus and Angus x Holstein carcasses.

	Angus	Angus x Holstein	SEM	*P* - Value
Number (*n*)	30	30		
Shoulder Clod (lbs.)	7.68	7.94	0.33	0.1596
Carcass %	1.61	1.56	0.04	0.1135
Primal %	5.34	5.11	0.12	0.0140
Top Blade (lbs.)	5.91	6.22	0.13	0.0801
Carcass %	1.24	1.23	0.03	0.6002
Primal %	4.13	4.02	0.11	0.2512
Shoulder Tender (lbs.)	1.09	1.12	0.05	0.3514
Carcass %	0.23	0.22	0.01	0.2166
Primal %	0.76	0.72	0.02	0.0842
Mock Tender (lbs.)	3.14	3.56	0.14	<0.0001
Carcass %	0.66	0.70	0.02	0.0232
Primal %	2.19	2.29	0.06	0.0812
Chuck Eye Roll (lbs.)	6.68	6.93	0.30	0.3190
Carcass %	1.40	1.37	0.03	0.5177
Primal %	4.63	4.47	0.12	0.2460
Chuck Flap (lbs.)	3.47	3.52	0.12	0.6591
Carcass %	0.73	0.69	0.03	0.1570
Primal %	2.42	2.28	0.09	0.0671
Chuck Short Ribs Boneless (lbs.)	3.89	3.95	0.23	0.7178
Carcass %	0.81	0.77	0.03	0.1961
Primal %	2.70	2.53	0.09	0.0830
Pectoral Meat (lbs.)	2.38	2.47	0.17	0.4080
Carcass %	0.50	0.49	0.03	0.6105
Primal %	1.65	1.59	0.08	0.3799
Rope Meat (lbs.)	2.46	2.68	0.15	0.0350
Carcass %	0.52	0.53	0.03	0.6156
Primal %	1.72	1.72	0.08	0.9307
80/20 Trim (lbs.)	58.58	62.32	3.61	0.0218
Primal %	40.67	40.00	1.65	0.4002
50/50 Trim (lbs.)	10.54	10.29	1.84	0.7942
Primal %	7.54	6.72	1.46	0.2388
Fat Trim (lbs.)	12.61	14.99	0.65	0.0082
Primal %	8.80	9.59	0.35	0.1111
Bones (lbs.)	24.73	28.97	0.51	< 0.0001
Primal %	17.28	18.72	0.52	< 0.0001

Table 17. Subprimal yields from the rib primal of Angus and Angus x Holstein carcasses.

	Angus	Angus x Holstein	SEM	*P* – Value
Number (*n*)	30	30		
Ribeye Roll (lbs.)	13.71	14.45	0.42	0.0336
Carcass %	2.88	2.85	0.06	0.5334
Primal %	39.76	39.08	0.93	0.4167
Back Ribs (lbs.)	4.08	4.64	0.16	< 0.0001
Carcass %	0.86	0.91	0.02	0.0137
Primal %	11.86	12.57	0.37	0.0390
Back Rib Trim (lbs.)	2.20	2.31	0.11	0.4212
Carcass %	0.46	0.46	0.02	0.9553
Primal %	6.37	6.34	0.31	0.9321
Blade Meat (lbs.)	3.19	3.37	0.21	0.2427
Carcass %	0.67	0.66	0.03	0.7595
Primal %	9.19	8.98	0.36	0.5299
80/20 Trim (lbs.)	1.12	1.27	0.15	0.2004
Primal %	3.20	3.36	0.37	0.5909
50/50 Trim (lbs.)	2.37	2.44	0.24	0.6099
Primal %	6.82	6.45	0.57	0.3494
Fat Trim (lbs.)	6.41	6.83	0.46	0.3473
Primal %	18.50	18.10	0.82	0.6726
Bones (lbs.)	3.57	4.17	0.20	0.0012
Primal %	10.35	11.25	0.64	0.0438

Table 18. Subprimal yields from the loin primal of Angus and Angus x Holstein carcasses.

	Angus	Angus x Holstein	SEM	*P* - Value
Number (*n*)	30	30		
Striploin (lbs.)	12.45	12.49	0.33	0.9085
Carcass %	2.61	2.46	0.07	0.0061
Primal %	16.51	16.05	0.36	0.1234
Tenderloin (PSMO) (lbs.)	6.67	7.15	0.28	0.0064
Carcass %	1.40	1.41	0.03	0.7351
Primal %	8.87	9.17	0.24	0.1346
Top Butt (lbs.)	16.45	17.03	0.42	0.1764
Carcass %	3.45	3.36	0.06	0.1611
Primal %	21.87	21.85	0.37	0.9502
Tri-tip (lbs.)	3.30	3.54	0.16	0.0131
Carcass %	0.69	0.69	0.02	0.8894
Primal %	4.40	4.54	0.14	0.2391
Hanging Tender (lbs.)	2.33	2.34	0.11	0.8781
Carcass %	0.49	0.46	0.02	0.1815
Primal %	3.09	3.01	0.11	0.5268
Bottom Sirloin Ball Tip (lbs.)	1.64	1.46	0.23	0.3789
Carcass %	0.34	0.28	0.04	0.1828
Primal %	2.11	1.83	0.24	0.2606
80/20 Trim (lbs.)	3.24	3.45	0.17	0.3636
Primal %	4.27	4.41	0.23	0.5455
50/50 Trim (lbs.)	3.12	3.02	0.16	0.6285
Primal %	4.16	3.85	0.19	0.2443
Fat Trim (lbs.)	15.35	15.17	1.13	0.8177
Primal %	20.22	19.27	0.91	0.2439
Bones (lbs.)	10.59	12.24	0.36	< 0.0001
Primal %	14.18	15.74	0.74	< 0.0001

Table 19. Subprimal yields from the round primal of Angus and Angus x Holstein carcasses.

	Angus	Angus x Holstein	SEM	*P* – Value
Number (*n*)	30	30		
Knuckle (lbs.)	12.74	13.78	0.45	0.0051
Carcass %	2.67	2.71	0.06	0.5130
Primal %	12.37	12.69	0.22	0.1385
Top Round (lbs.)	24.47	25.68	0.69	0.0586
Carcass %	5.14	5.06	0.08	0.4522
Primal %	23.77	23.66	0.27	0.7430
Bottom Round (lbs.)	14.62	14.84	0.63	0.5940
Carcass %	3.06	2.92	0.08	0.0373
Primal %	14.14	13.64	0.27	0.0179
Eye of Round (lbs.)	7.01	6.95	0.28	0.7920
Carcass %	1.47	1.37	0.03	0.0155
Primal %	6.78	6.39	0.11	0.0060
Heel (lbs.)	5.58	5.54	0.17	0.8097
Carcass %	1.17	1.09	0.02	0.0022
Primal %	5.41	5.11	0.05	0.0001
80/20 Trim (lbs.)	10.09	10.65	0.52	0.1060
Primal %	9.79	9.79	0.29	0.9804
50/50 Trim (lbs.)	---	---	---	---
Primal %	---	---	---	---
Fat Trim (lbs.)	13.03	13.50	0.53	0.4096
Primal %	12.73	12.41	0.37	0.5502
Bones (lbs.)	14.97	17.37	0.38	< 0.0001
Primal %	14.57	16.02	0.35	< 0.0001

Table 20. Trim yields of Angus and Angus x Holstein carcasses.				
	Angus	**Angus x Holstein**	**SEM**	***P* - Value**
Number (*n*)	30	30		
80/20 Trim (lbs.)	90.98	97.69	5.42	0.0066
Carcass %	19.00	19.18	0.73	0.6432
50/50 Trim (lbs.)	43.21	45.89	2.37	0.2461
Carcass %	9.16	9.02	0.59	0.7547
Fat Trim (lbs.)	76.69	81.13	3.84	0.2233
Carcass %	16.07	15.85	0.41	0.7073
Bones (lbs.)	61.21	70.83	1.12	< 0.0001
Carcass %	12.89	13.98	0.40	0.0001