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Description of feedlot animals culled for slaughter, revenue received, and associations with reported US beef market prices

Lucas M. Horton,[1] MS; **Brandon E. Depenbusch,**[2] MS, PhD; **Dustin L. Pendell,**[1,3] MS, PhD; **David G. Renter,**[1] DVM, PhD
[1] Center for Outcomes Research and Epidemiology and the Department of Diagnostic Medicine and Pathobiology, College of Veterinary Medicine, Kansas State University, Manhattan, KS 66506
[2] Innovative Livestock Services, Inc., Great Bend, KS 67530
[3] Department of Agricultural Economics, College of Agriculture, Kansas State University, Manhattan, KS 66506
Corresponding author: Dr. David Renter; drenter@vet.k-state.edu

Abstract

Our objectives were to describe revenue received for feedlot cattle culled for slaughter and associations with reported weekly prices from US beef markets. Observational data on feedlot culls (N = 2,992) were collected from 4 Kansas feedlots over 2 years (2018 to 2020). Weekly prices from various US beef markets were used to evaluate correlations with prices received for culled animals. Descriptive statistics, and linear and generalized linear mixed models, were used to evaluate characteristics of feedlot culls. Musculoskeletal/trauma (49.7%) and respiratory disease (40.9%) were the most common reasons for culling. Culls returned revenue 98.1% of the time; those culled for respiratory disease or "other" reasons returned revenue significantly less frequently (96.7 or 96.3%, respectively) than those culled for musculoskeletal/trauma (99.1%). Mean revenue received [± 95% CI] was 434.81 [427.22 to 442.40] $/animal (culls returning no revenue included); and mean carcass price was 87.40 [86.70 to 88.10] $/hundredweight. Revenue was significantly correlated with several market indices, but most correlations were relatively weak. In this population, national cull cow (Breaker [75% lean]; over 500 lb [227 kg]) prices appeared to be the overall best indicator of feedlot cull prices, with feedlot cull carcasses averaging 74.6% of the weekly cull cow carcass price.

Key words: beef markets, cattle, cull, feedlot, revenue

Introduction

Cattle are culled from feedlots when they are no longer able to perform along with pen-mates, and it is expected that they will be unable to be harvested at a reasonable endpoint. Common ailments that may lead to culling a feedlot animal include respiratory disease, lameness/injury, digestive, and metabolic disorders.[14,6] This decision is made when producers feel the risk of death, or costs associated with feeding, housing, and treating, outweigh the potential benefits of feeding an animal until it reaches an ideal harvest weight. It is assumed that some amount of economic loss (e.g. purchase price, feed, processing costs) will be recovered, or "salvaged," by culling these types of animals. Verbiage of feedlot culls varies, but common terms include "railer" (referring to a light carcass hanging on a packing plant rail), "realizer" (i.e., one can "realize" some revenue returned), or "chronic" (an animal treated multiple times that has failed to recover).[6] There are a few common market pathways used for feedlot culls; animals can be slaughtered (generally at a small scale abattoir), sold at an auction market (with buyers aware of additional risk), sold to a "railer buyer" (a person who purchases the animal at a reduced price [typically 0.15 to 0.35 $/lb live weight[6]] and attempts to rehabilitate the animal), or placed in a "re-start" program, where the animal would be allotted to pasture or a grass-trap for recovery.[6]

There are limited publicly available data or literature on feedlot animals culled for slaughter and the associated revenues (or costs). While on a much smaller scale compared to fat cattle sales, feedlot culls still represent a proportion of feedlot revenue. A comprehensive assessment of costs and revenues associated with culls may not be fully quantified for management decisions. In addition, economic assessments can be an important component of feedlot research trials, but there is a lack of methodological consistency with how revenue from feedlot culls is estimated. United States Department of Agriculture (USDA) Agricultural Marketing Service (AMS) reports live cattle and beef carcass price indices, but none for culled feedlot animals. Tennant et al used USDA AMS weekly cow and boneless beef summary for 80 to 95% lean, 600 to 900 lb (272 to 408 kg) cows from 4 states to estimate revenue for feedlot culls in a randomized controlled finishing trial.[18] An observational study on feedlot lameness assumed prices received for culls to be 54% of fat cattle market value.[19] Valencia et al estimated revenue from removed animals in a

growing calf study as 70% of the standardized purchase price of feeder calves,[25] and referenced an observational study of feeder cattle prices.[2] The last example was a study evaluating stocker calves whereas the previous examples were for finishing cattle. Without a standardized reporting system or published research on methods for price evaluation, there remains a lack of an evidence-based resource for estimating revenue of culled feedlot cattle.

The primary objective of our retrospective observational study was to describe revenue received for feedlot cattle culled for slaughter from Central Kansas commercial feedlots, and evaluate associations with US beef cattle markets. Our secondary objective was to describe factors that characterize this population of feedlot culls.

Materials and Methods

Data Sources

Four commercial feedlots in Central Kansas were used to collect data on culled feedlot cattle. Feedlot data were from 2 sources; 1) manual entry of "receipts," which contained individual animal level data, and 2) operational database records, which contained lot level (where "lot" is defined as a group of cattle purchased, received, housed, and marketed together) and animal level data. Culled animals were harvested for "salvage" value (i.e., an attempt to recover some revenue and mitigate risk of a total loss), and each of the 4 feedlots shipped culls to a small, specialized abattoir, which provided the feedlots with hot carcass weight (HCW), $/lb HCW, and total $/animal. Data were collected on animals culled between the weeks of December 24, 2018 and November 23, 2020.

Data entered manually from culled animal receipts included: feedlot name, lot number, animal-ID (unique identification ear-tag), date culled, sale weight (HCW), price received ($/cwt), total value/animal, and reason for culling (variable by feedlot if reported here or in operational database). Lot level data from the operational database included: in-date(s) for lot, number of animals, average in-weight, sex, and processing charges. Animal level data from the operational database consisted of reasons for culling, and treatment history records which included: reason for each pull, date of each pull, product(s) administered at each pull, and cost/product ($).

Pricing data from US beef markets (fed cattle, feeder cattle, cull cow, and boxed beef) were sourced to compare possible associations with revenue from feedlot culls. Historic fat cattle prices in KS were sourced from the USDA AMS as a weekly report (LM_CT140[22] and LM_CT157[20]). The sale/purchase bases of fat cattle were both live or dressed, and included: formula net, forward contract net, negotiated grid net, negotiated grid base (delivered or "free on board"; FOB), and negotiated cash (delivered or FOB). Historic national cull cow prices were also obtained from USDA AMS as a weekly report (LM_CT168).[23] Sale/purchase of cull cows on a dressed basis are classified as "Breaker" (75% lean; above or below 500 lb [227 kg]), "Boner" (85% lean; above or below 500 lb [227 kg]), "Cutter" (90% lean; under 400 lb [181 kg], 400 to 500 lb [181 to 227 kg], or above 500 lb [227 kg]), and "Premium White" (all weights). If sold live, cull cows are categorized the same as above, but are not categorized into weight groups (only "all weights" reported). Feeder cattle sale/purchase prices were sourced from the Livestock Marketing Information Center (LMIC)[9] which uses USDA AMS data. An average sale price per week was calculated from 100 lb [45 kg] weight ranges for medium and large frame #1 steers and heifers by averaging price across all ranges. Additionally, weekly averages of boneless cow and beef trimmings in the Central US were sourced from USDA AMS (report LM_XB460)[24] to compare possible associations.

Inclusion Criteria

Feedlot culls included in the final dataset were of beef lineage (i.e., dairy-bred cattle excluded), classified as steers or heifers (cattle from "mixed" lots excluded), met conditions of being normal feedlot inhabitants (e.g., culls from pasture excluded), and were harvested for salvage (i.e., animals re-sold live at auction market excluded). Cull data that did not link with a lot number within the feedlot operational database were excluded from the final dataset.

Data Management

Data were managed and formatted for analyses using a combination of R[a], Access 2016[b], and Excel 2016[b]. Manual entry data from Excel were uploaded in R. Two operational database spreadsheets were then uploaded in R, one of which contained lot level data, and the other contained animal level data for each cull. Manual entry and operational lot level data were linked using lot (within feedlot) as a unique identifier; variables linked from lot level data included: number of animals received, initial weight, first in-date, last in-date, and sex. Manual entry and operational animal level data were linked using animal-ID (within lot and feedlot) as a unique identifier; and the variable linked from operational data was reason for culling. Days-on-feed at culling (DOF) for each cull was calculated as the number of days between the date culled and first in-date for its respective lot. Sex could only be determined for individual culls using the sex assigned to each lot in operational lot level data; culls from a lot classified as "mixed" or "dairy-bred" were then removed so only steers and heifers remained.

To assess animal health history, pulls and antimicrobial treatments were separated into 2 categories; a "pull" was any time an animal was removed from its home pen for further evaluation of health concerns, and includes any/all products administered and procedures performed; an "antimicrobial treatment" was any time an animal was pulled and administered an injectable antimicrobial compound (i.e., all antimicrobial treatments are pulls, but not all pulls are antimicrobial treatments). Pull and treatment history were

animal level data, and were linked with individual culls using animal-ID (within lot and feedlot). If a cull did not link with any pull/treatment data, it was assumed that the animal was never pulled or treated. Variables linked from pull/treatment data included: date, reason, products used, and total cost of products used. Processing costs were lot level, and included the cost of products used and operational charges. Estimated processing cost per culled animal was calculated as the total lot processing cost divided by the number of animals received in the lot. Average processing cost per animal was then linked with individual culls using lot (within feedlot) as a unique identifier.

Reasons for culling were categorized into musculoskeletal/trauma, respiratory, or "other." Common culling reasons classified as "other" included: bloat, hardware, unknown, poor performance, and abscess. Depending on the feedlot, culling reasons were either listed on receipts (and entered manually), or in the operational database. To determine a consensus for each cull, these 2 sources were merged into a single column. In cases where reasons were non-specific (i.e., not clear which culling category to use) or unknown, the pull/treatment history of individual culls was used to determine the final category (reason for culling). Cases that were still unclear or unknown were classified as "other."

There were 2 reasons in which culls that were shipped for harvest did not return revenue to the feedlot; 1) cattle were either not harvested (e.g., died between shipping and harvest or were non-ambulatory) or were condemned post-harvest, or 2) the packer was instructed to harvest the animal and return product (meat) back to the owner. In both cases, no values for HCW or revenue were provided, although, other data from the animals were still used in other analyses (e.g., DOF, cause of cull, times pulled). For case 1, revenue received for each animal was included as $0.00 and still used in descriptive and inferential statistical analyses. For case 2, no value for revenue was included in any analyses (i.e., observations for price/revenue received excluded).

Historic beef market data were linked with individual feedlot cull receipts to assess possible associations between beef market prices and prices received for culls. These were week-level data, and were matched with the week culled for each animal. Weekly average fat cattle and feeder cattle prices in KS were linked with individual feedlot culls based on week and sex. Weekly average national cull cow and Central US boneless cow and beef trimmings prices were linked with individual culls based on week.

As cattle market prices are largely driven by weight, feedlot culls were categorized into weight groups to describe and characterize potential differences by weight. These categories were culls with HCW over 600 lb (272 kg), between 400 and 599 lb (181 to 271 kg), and below 400 lb (181 kg). Categories were chosen relative to weight-based discounts as reported by the USDA AMS for fat cattle, where: carcasses over 600 lb (272 kg) receive no discounted price, carcasses between 400 and 599 lb (181 to 271 kg) are discounted, and carcasses below 400 lb (181 kg) are not reported.[21] As HCW of individual culls could only be obtained from those that received revenue, those that did not return revenue and those that were harvested and returned meat to the owner were excluded (n = 66) from this categorization and statistical analyses.

Statistical Analyses

Descriptive statistics including means, standard errors of the means (SEM), medians, interquartile ranges (IQR), ranges, and 95% confidence intervals (CI) were calculated in Excel. Spearman's correlation coefficients between prices received for feedlot culls and US beef markets were determined using Proc CORR in SAS[c]. Only feedlot culls that returned revenue were included in correlation analyses. While many beef markets were used for correlations (see "*Data Sources*"), only the most relevant results are provided. Interpretation of correlation coefficients varies, is not always consistent across disciplines, and may change based on research objectives and precision/accuracy of measurements.[10,13] We considered (in absolute value) $r < 0.20$ as a negligible/very weak relationship; $0.20 \leq r < 0.40$ as a small/weak relationship; $0.40 \leq r < 0.70$ as a moderate relationship; $0.70 \leq r < 0.90$ as a strong relationship; and $r \geq 0.90$ as a very strong/highly correlated relationship. R^2 values, which indicate the percentage of the variation explained by the correlation, are also reported.

We used general and generalized linear mixed models (LMM and GLMM, respectively; Proc GLIMMIX, SAS[c]) for all analyses with significance declared at $\alpha \leq 0.05$. Individual feedlot culls were the unit of analysis. All models included "feedlot" as a random intercept to account for lack of independence between culls within a feedlot.

Continuous outcomes (e.g., DOF, HCW, metrics of price/cost) were modeled using LMM assuming a normal distribution. For variables with a price ($) component, a random residual term for "month culled" with a first-order autoregressive covariance structure was used to account for correlations of prices over time. Generalized linear mixed models were used to fit revenue returned (yes or no) using a binomial distribution, and count distributions for times pulled and antimicrobial treatments were specified with a Poisson distribution. A Tukey-Kramer adjustment was used for pairwise comparisons of fixed effects in all LMM and GLMM models, and model adjusted means and SEM are reported.

Multinomial variables (e.g., culling reason category), when fit as a response, were fit with a generalized logit link function for non-ordered categories. A likelihood ratio test was used to assess whether the distribution of nominal outcomes differed significantly between independent variables, and the resulting *P*-value is reported along with frequency statistics (percent and count).

Results

The initial population contained 4,135 observations (culled animals). Observations excluded from final dataset

included: n = 135 from dairy-bred lots, n = 332 from "mixed" lots, n = 608 marketed at auction, and n = 6 for failure to link with a lot within feedlot from the operational database. Additionally, n = 62 animals were removed as they could not be classified as a feedlot cull. Thus, the final population of feedlot culls meeting inclusion criteria contained 2,992 total animals, with 1,322 steers (44.2%), and 1,670 heifers (55.8%). Of all animals culled and shipped from feedlots for salvage value, 98.1% returned revenue while 1.9% did not.

Descriptive Statistics

Descriptive statistics of continuous variables of feedlot culls, overall and by reason for cull are in Table 1. Descriptive statistics of continuous variables grouped by HCW ranges are in Table 2. In the entire population, the number of animals received in lots with feedlot culls had a median of 150 animals/lot, and a mean [± 95% CI] of 153 [151 to 155] animals/lot. Average arrival weight of all cattle per lot had a median of 743 lb (337 kg), and a mean [± 95% CI] of 745 lb [741 to 749 lb] (338 kg [336 to 340 kg]). Days-on-feed at culling (measured as difference in days between the date culled and initial lot in-date) for the entire population had a median of 111 days, and a mean [± 95% CI] of 111 [109 to 113] days. Hot carcass weight had a median of 473 lb (215 kg), and a mean [± 95% CI] of 483 lb [478 to 488 lb] (219 kg [217 to 221 kg]). For the entire population, prices received on a HCW basis had a median of 87.00 $/cwt, and a mean [± 95% CI] of 87.40 [86.70 to 88.10] $/cwt. Hot carcass weight, and HCW price excluded culls that returned no revenue (n = 57) and those harvested which returned meat to the owner (n = 9). Total revenue received resulted in a median of 405.02 $/animal, and a mean [± 95% CI] of 434.81 [427.22 to 442.40] $/animal. Total revenue received includes culls that returned no revenue ($0.00; n = 57), but excludes those that were harvested and returned meat to the owner (n = 9). The number of times animals were pulled from home pens for further evaluation of health concerns ranged from 0 to 10 pulls/animal, with a median of 2 pulls/animal, and a mean [± 95% CI] of 2.39 [2.34 to 2.44] pulls/animal. The number of antimicrobial treatments ranged from 0 to 8 treatments/animal, with a median of 2 treatments/animal, and a mean [± 95% CI] of 1.73 [1.69 to 1.77] treatments/animal. Total treatment costs (all pulls/treatments) had a median of 42.88 $/animal, and a mean [± 95% CI] of 45.09 [43.91 to 46.27] $/animal. Costs associated with processing lots with feedlot culls had a median of 15.73 $/animal, and a mean [± 95% CI] of 18.72 [18.37 to 19.07] $/animal.

Sex Comparisons

Table 3 depicts outcomes from statistical models testing for potential differences between steers and heifers. There was no difference between steers and heifers for the proportion of culls that returned revenue ($P = 0.86$). Frequencies of removal reasons did not appear to be impacted by sex as there was no evidence for a difference when comparing their distributions ($P = 0.55$). Weight ranges were used to examine if prices received for culls differed between sexes when HCW was similar. There was a sex by HCW range interaction ($P < 0.01$), thus, comparisons between sexes were only made within HCW ranges. Evidence for a difference between sexes occurred only for culls with carcasses weighing over 800 lb (363 kg), where heifers received higher prices on average compared to steers ($P < 0.01$).

Removal Reason Comparisons

Results of analyses of factors associated with categories for removal reasons are in Table 4. Animals culled for musculoskeletal/trauma reasons were from larger lots than respiratory culls ($P < 0.01$), but mean lot size for musculoskeletal/trauma culls was not significantly different ($P = 0.07$) than for "other" culls. Average arrival weight (per animal) was approximately 30 lb (14 kg) greater for musculoskeletal/trauma culls when compared to both respiratory and "other" culls (P-values < 0.01). Days-on-feed at culling was smallest for respiratory culls, which differed from both musculoskeletal/trauma and "other" culls (P-values < 0.01). The proportion of animals that returned revenue was greatest for musculoskeletal/trauma culls, differing significantly from respiratory and "other" culls (P-values < 0.01). There were heavier HCW for musculoskeletal/trauma culls, versus for respiratory and "other" culls; respiratory culls had the smallest mean HCW, which also differed from "other" culls (P-values < 0.05). With price partially being a function of HCW, musculoskeletal/trauma culls on average received the greatest $/cwt, and the greatest total revenue per animal compared to respiratory and "other" culls (P-values < 0.01). Respiratory culls were pulled from their home pen, and administered injectable antimicrobial treatments, significantly more often than musculoskeletal/trauma or "other" culls (P-values < 0.01). Musculoskeletal/trauma culls received antimicrobial treatments more often than "other" culls ($P < 0.01$). Total costs associated with pulling and treating were highest for respiratory culls, approximately twice as much as costs associated with "other" and musculoskeletal/trauma culls (P-values < 0.01). Processing costs were significantly greater for lots with respiratory culls when compared to musculoskeletal/trauma culls ($P < 0.01$). There was no evidence for a difference in processing costs for "other" culls compared to respiratory or musculoskeletal/trauma culls (Table 4).

Weight Range Comparisons

Table 5 contains results from statistical models evaluating effects of HCW, grouped by ranges (under 400 lb [light; 181 kg], 400 to 599 lb [middle; 181 to 271 kg], and over 600 lb [heavy; 272 kg]). Distributions of animals in the removal reasons categories differed between the 3 weight categories ($P < 0.01$); in particular, the number of respiratory culls decreased and musculoskeletal/trauma increased with increasing weight categories. Mean number of animals received per lot was smallest for the light HCW group, which differed from middle and heavy groups (P-values < 0.01). Average lot ar-

Table 1. Descriptive statistics of continuous variables for feedlot culls that were harvested for salvage overall and by reason for culling category.

Item	n*	Mean	95% CI†	Median	IQR‡	Range
Animals received per lot, n						
All cattle	2,992	153	151 to 155	150	101 to 192	28 to 506
Musculoskeletal/trauma	1,488	159	155 to 163	154	109 to 201	40 to 448
Respiratory	1,223	148	144 to 152	146	92 to 186	28 to 506
Other	281	146	139 to 153	150	102 to 179	31 to 353
Average lot arrival weight, lb/animal						
All cattle	2,992	745	741 to 749	743	677 to 810	339 to 1,203
Musculoskeletal/trauma	1,488	762	757 to 767	763	701 to 824	411 to 1,203
Respiratory	1,223	727	721 to 733	724	663 to 789	399 to 1,182
Other	281	730	716 to 744	726	652 to 803	339 to 1,096
Days-on-feed at culling						
All cattle	2,992	111	109 to 113	111	69 to 146	1 to 331
Musculoskeletal/trauma	1,488	113	111 to 116	116	68 to 147	1 to 331
Respiratory	1,223	107	105 to 110	102	68 to 139	30 to 317
Other	281	118	112 to 124	118	75 to 153	7 to 315
Hot carcass weight§, lb						
All cattle	2,926	483	478 to 488	473	380 to 583	129 to 919
Musculoskeletal/trauma	1,468	516	509 to 523	520	410 to 618	169 to 899
Respiratory	1,187	445	438 to 453	429	349 to 526	163 to 919
Other	271	472	455 to 489	462	381 to 553	129 to 898
Carcass weight price§, $/cwt						
All cattle	2,926	87.40	86.70 to 88.10	87.00	74.00 to 101.00	21.00 to 155.00
Musculoskeletal/trauma	1,468	91.12	90.19 to 92.05	93.00	79.00 to 105.00	32.00 to 155.00
Respiratory	1,187	83.20	82.08 to 84.32	82.00	69.00 to 98.00	25.00 to 155.00
Other	271	85.61	83.28 to 87.94	85.00	73.00 to 100.00	21.00 to 125.00
Total revenue‖, $/animal						
All cattle	2,983	434.81	427.22 to 442.40	405.02	280.96 to 585.96	0.00 to 1,378.50
Musculoskeletal/trauma	1,480	485.22	474.70 to 495.74	480.69	326.26 to 640.04	0.00 to 1,278.75
Respiratory	1,223	379.30	367.88 to 390.72	343.50	242.00 to 497.20	0.00 to 1,378.50
Other	280	410.79	386.34 to 435.24	393.69	277.41 to 552.86	0.00 to 942.90
Times pulled, n/animal						
All cattle	2,992	2.39	2.34 to 2.44	2	1 to 3	0 to 10
Musculoskeletal/trauma	1,488	2.11	2.05 to 2.17	2	1 to 3	0 to 10
Respiratory	1,223	2.82	2.75 to 2.89	3	2 to 3	0 to 10
Other	281	1.96	1.78 to 2.14	2	1 to 3	0 to 10
Antimicrobial treatments, n/animal						
All cattle	2,992	1.73	1.69 to 1.77	2	1 to 3	0 to 8
Musculoskeletal/trauma	1,488	1.42	1.36 to 1.48	1	0 to 2	0 to 6
Respiratory	1,223	2.26	2.20 to 2.32	2	1 to 3	0 to 7
Other	281	1.13	0.98 to 1.28	1	0 to 2	0 to 8
Total treatment costs, $/animal						
All cattle	2,992	45.09	43.91 to 46.27	42.88	18.94 to 68.05	0.00 to 185.43
Musculoskeletal/trauma	1,488	32.51	31.00 to 34.02	26.98	4.54 to 50.11	0.00 to 185.43
Respiratory	1,223	63.34	61.78 to 64.90	58.50	43.54 to 81.80	0.00 to 185.43
Other	281	32.30	28.34 to 36.26	27.10	2.10 to 56.09	0.00 to 150.96
Processing cost, $/animal						
All cattle	2,992	18.72	18.37 to 19.07	15.73	14.04 to 18.43	4.98 to 71.36
Musculoskeletal/trauma	1,488	17.32	16.93 to 17.71	15.42	13.93 to 17.67	7.56 to 64.09
Respiratory	1,223	20.21	19.56 to 20.86	16.06	14.23 to 19.68	4.98 to 71.36
Other	281	19.68	18.41 to 20.95	15.75	13.97 to 18.99	9.03 to 69.60

* n = number of observations (animals) used for descriptive statistics

† 95% confidence interval of the mean

‡ IQR (interquartile range: quartiles 1 to 3)

§ Animals that returned no revenue had no carcass weight or price recorded and were excluded (n = 57 total [n = 12 musculoskeletal/trauma, n = 36 respiratory, n = 9 other]), those which returned harvested meat back to the owner were excluded (n = 9 total [n = 8 musculoskeletal/trauma, n = 1 other])

‖ Animals that returned no revenue ($0.00) were included in total revenue (n = 57 total [n = 12 musculoskeletal/trauma, n = 36 respiratory, n = 9 other]), but those that returned harvested meat back to the owner were excluded (n = 9 total [n = 8 musculoskeletal/trauma, n = 1 other])

Table 2. Descriptive statistics of continuous variables for feedlot culls that were harvested for salvage by carcass weight categories.

Item	n*	Mean	95% CI†	Median	IQR‡	Range
Animals received per lot, n						
Over 600 lb	639	159	154 to 164	156	115 to 200	45 to 488
400 to 599 lb	1,394	154	150 to 158	149	102 to 194	28 to 470
Under 400 lb	893	148	144 to 152	147	90 to 180	31 to 506
Average lot arrival weight, lb/animal						
Over 600 lb	639	795	786 to 804	789	728 to 874	399 to 1,203
400 to 599 lb	1,394	751	746 to 757	753	691 to 813	406 to 1,182
Under 400 lb	893	699	693 to 705	701	630 to 760	339 to 1,096
Days-on-feed at culling						
Over 600 lb	639	143	140 to 146	144	123 to 165	39 to 331
400 to 599 lb	1,394	114	112 to 117	113	75 to 146	1 to 317
Under 400 lb	893	82	79 to 85	70	55 to 101	1 to 315
Hot carcass weight, lb						
Over 600 lb	639	684	679 to 689	668	630 to 725	600 to 919
400 to 599 lb	1,394	493	490 to 496	489	446 to 539	400 to 599
Under 400 lb	893	324	320 to 328	335	287 to 371	129 to 399
Carcass weight price, $/cwt						
Over 600 lb	639	107.18	106.30 to 108.06	105.00	100.00 to 115.00	65.00 to 155.00
400 to 599 lb	1,394	89.74	89.02 to 90.46	87.00	79.00 to 100.00	55.00 to 122.00
Under 400 lb	893	69.58	68.59 to 70.57	69.00	59.00 to 81.00	21.00 to 110.00
Total revenue, $/animal						
Over 600 lb	639	734.23	725.16 to 743.30	718.30	657.30 to 787.20	419.25 to 1,378.50
400 to 599 lb	1,394	446.10	440.79 to 451.41	439.13	365.75 to 521.53	237.60 to 701.50
Under 400 lb	893	230.69	225.79 to 235.59	231.88	180.96 to 283.91	43.25 to 392.70
Times pulled, n/animal						
Over 600 lb	639	1.74	1.66 to 1.82	2	1 to 2	0 to 8
400 to 599 lb	1,394	2.35	2.28 to 2.42	2	1 to 3	0 to 10
Under 400 lb	893	2.91	2.83 to 2.99	3	2 to 4	0 to 8
Antimicrobial treatments, n/animal						
Over 600 lb	639	1.05	0.98 to 1.12	1	0 to 2	0 to 5
400 to 599 lb	1,394	1.69	1.63 to 1.75	2	1 to 3	0 to 8
Under 400 lb	893	2.29	2.22 to 2.36	2	2 to 3	0 to 7
Total treatment costs, $/animal						
Over 600 lb	639	36.24	33.61 to 38.87	35.56	2.53 to 55.47	0.00 to 168.30
400 to 599 lb	1,394	46.43	44.64 to 48.22	41.28	19.06 to 71.11	0.00 to 185.43
Under 400 lb	893	49.54	47.61 to 51.48	48.68	28.15 to 69.07	0.00 to 185.43
Processing cost, $/animal						
Over 600 lb	639	16.63	16.15 to 17.11	15.36	14.00 to 16.79	8.53 to 62.72
400 to 599 lb	1,394	18.31	17.84 to 18.78	15.73	14.03 to 18.31	4.98 to 69.60
Under 400 lb	893	20.84	20.03 to 21.65	15.90	14.11 to 20.12	6.34 to 71.36

* n = number of observations (animals) used for descriptive statistics; only animals that had a recorded carcass weight were included (57 excluded that returned no revenue [n = 12 musculoskeletal/trauma, n = 36 respiratory, n = 9 other], and 9 excluded that returned harvested meat back to the owner [n = 8 musculoskeletal/trauma, n = 1 other])

† 95% confidence interval of the mean

‡ IQR (interquartile range: quartiles 1 to 3)

rival weight, DOF, $/cwt, and total revenue per animal were all smallest for light culls, and greatest for heavy culls (with middleweight culls intermediate). The mean number of times pulled and antimicrobial treatments were both greatest for light culls and smallest for heavy culls; thus, total treatment costs were greatest for light culls, and smallest for heavy culls (Table 5). Processing costs were also highest for light culls and lowest for heavy culls.

Beef Market Associations

Spearman's correlation coefficients between prices received for individual feedlot culls and weekly beef market

Table 3. Results from analyses of potential differences between culled steers and culled heifers.

Item	Steers	Heifers	*P*-value
Revenue returned*, % (SEM)	97.80 (0.733)	97.90 (0.662)	0.86
Culling reason category†, % of sex (n)			0.55
Musculoskeletal/trauma	50.08 (662)	49.46 (826)	
Respiratory	41.15 (544)	40.66 (679)	
Other	8.77 (116)	9.88 (165)	
Price received‡, $/cwt HCW (SEM)			
Sex*HCW range	--	--	< 0.01
100 to 199 lb	47.06 (2.193)	44.44 (1.409)	0.26
200 to 299 lb	56.01 (0.977)	55.09 (0.878)	0.17
300 to 399 lb	74.38 (0.859)	74.09 (0.836)	0.46
400 to 499 lb	83.98 (0.841)	83.46 (0.830)	0.13
500 to 599 lb	97.56 (0.850)	97.49 (0.838)	0.85
600 to 699 lb	107.22 (0.866)	106.42 (0.872)	0.08
700 to 799 lb	109.47 (0.906)	110.12 (1.019)	0.39
Over 800 lb	114.83 (1.107)	122.59 (2.182)	< 0.01

* Percent of feedlot culls that returned revenue; values are model mean percentages

† Comparison of the distribution steers or heifers across categories; values are frequency statistics

‡ Price received ($/cwt [hundredweight] HCW [hot carcass weight]); 57 animals that returned no revenue and thus had no price were excluded (n = 25 steers, n = 32 heifers) and 9 animals that returned harvested meat back to the owner were excluded (n = 2 steers, n = 7 heifers); values are model adjusted means for sex within HCW range and used an adjustment for multiple comparisons for determination of *P*-values

Table 4. Model adjusted means and standard errors of the means (SEM) from analyses of factors associated with reasons for culling.

	Reason for culling			Overall
Item*, (SEM)	Musculoskeletal/trauma	Respiratory	Other	*P*-value
Animals received per lot, n	162 (8.1)[a]	152 (8.2)[b]	152 (8.9)[ab]	< 0.01
Average lot arrival weight, lb/animal	752 (9.1)[a]	720 (9.2)[b]	721 (10.8)[b]	< 0.01
Days-on-feed at culling, mean	115 (9.0)[a]	110 (9.0)[b]	120 (9.3)[a]	< 0.01
Revenue returned†,‡, %	99.14 (0.359)[a]	96.73 (1.081)[b]	96.30 (1.612)[b]	< 0.01
Hot carcass weight‡,§, lb	505 (17.0)[a]	435 (17.0)[b]	457 (18.5)[c]	< 0.01
Carcass weight price‡,§, $/cwt	89.10 (2.635)[a]	82.73 (2.638)[b]	83.49 (2.762)[b]	< 0.01
Total revenue‖, $/animal	463.85 (26.098)[a]	369.68 (26.142)[b]	385.83 (27.955)[b]	< 0.01
Times pulled, mean	2.26 (0.209)[a]	3.03 (0.278)[b]	2.15 (0.214)[a]	< 0.01
Antimicrobial treatments, mean	1.51 (0.119)[a]	2.40 (0.185)[b]	1.20 (0.112)[c]	< 0.01
Total treatment costs, $/animal	33.99 (5.204)[a]	62.68 (5.210)[b]	30.61 (5.421)[a]	< 0.01
Processing cost, $/animal	17.74 (2.292)[a]	19.49 (2.293)[b]	18.60 (2.339)[ab]	< 0.01

[a,b] Different superscripts within a row indicate a difference between culling reason categories ($P < 0.05$) after adjustment for multiple comparisons

* N = 2,992 total animals unless otherwise specified (n = 1,488 musculoskeletal/trauma, n = 1,223 respiratory, n = 281 other)

† Percent of feedlot culls that returned revenue; values are model adjusted mean percentages

‡ N = 9 animals excluded that returned harvested meat back to the owner (n = 8 musculoskeletal/trauma, n = 1 other)

§ N = 57 animals that returned no revenue had no carcass weight or price recorded and were excluded (n = 12 musculoskeletal/trauma, n = 36 respiratory, n = 9 other)

‖ Animals that returned no revenue ($0.00) were included in total revenue (n = 57 total [n = 12 musculoskeletal/trauma, n = 36 respiratory, n = 9 other]), but those that returned harvested meat back to the owner were excluded (n = 9 total [n = 8 musculoskeletal/trauma, n = 1 other])

averages are in Table 6. Generally speaking, price correlations tended to be significant, but were weak to negligible ($r < 0.40$) when culls were grouped by all weights, 400 to 599 lb (181 to 271 kg) HCW, or below 400 lb (181 kg) HCW. Evidence of strong correlations was observed when comparing feedlot culls weighing over 600 lb (272 kg) HCW with cull cow (Breaker [75% lean]) and boneless beef trimmings (85% lean) markets. The strongest correlation was observed between prices received for feedlot culls over 600 lb (272 kg) when compared with prices of dressed cull cows over 500 lb (227 kg) HCW ($r = 0.77$). Cull cows sold on a live basis (all weights) compared to actual prices for feedlot culls over

Table 5. Model adjusted means and standard errors of the means (SEM) from analyses of factors associated with carcass weight categories of feedlot culls.

Item*	Weight group, lb hot carcass weight			Overall *P*-value
	Under 400	400 to 599	Over 600	
Culling reason category†, % of column total (n)				< 0.01
Musculoskeletal/trauma	37.51 (335)	50.22 (700)	67.76 (433)	
Respiratory	53.08 (474)	39.60 (552)	25.20 (161)	
Other	9.41 (84)	10.19 (142)	7.04 (45)	
Animals received per lot, n (SEM)	151 (8.9)[a]	158 (8.8)[b]	165 (9.0)[b]	< 0.01
Average lot arrival weight, lb/animal (SEM)	693 (8.3)[a]	745 (8.1)[b]	788 (8.7)[c]	< 0.01
Days-on-feed at culling, mean (SEM)	87 (8.0)[a]	118 (8.0)[b]	147 (8.1)[c]	< 0.01
Carcass weight price, $/cwt	69.14 (1.169)[a]	89.18 (1.151)[b]	106.37 (1.191)[c]	< 0.01
Total revenue, $/animal	232.68 (7.748)[a]	440.91 (7.528)[b]	721.61 (8.087)[c]	< 0.01
Times pulled, mean (SEM)	3.05 (0.263)[a]	2.53 (0.217)[b]	1.92 (0.172)[c]	< 0.01
Antimicrobial treatments, mean (SEM)	2.41 (0.185)[a]	1.79 (0.137)[b]	1.12 (0.094)[c]	< 0.01
Total treatment costs, $/animal (SEM)	50.71 (6.402)[a]	46.73 (6.373)[b]	36.27 (6.449)[c]	< 0.01
Processing cost, $/animal (SEM)	20.30 (2.294)[a]	18.11 (2.287)[b]	16.46 (2.304)[c]	< 0.01

[abc]Different superscripts within a row indicate a difference between weight groups ($P < 0.05$) after adjustment for multiple comparisons

* N = 2,926 total animals (n = 893 under 400 lb, n = 1,394 between 400 and 599 lb, and n = 639 over 600 lb carcass weight); only animals that had a recorded carcass weight were included (57 excluded that returned no revenue [n = 12 musculoskeletal/trauma, n = 36 respiratory, n = 9 other], and 9 excluded that returned harvested meat back to the owner [n = 8 musculoskeletal/trauma, n = 1 other])

† Comparison of the distribution of animals across culling reason categories; values are frequency statistics

600 lb (272 kg) indicated a moderate relationship ($r = 0.55$). Additionally, a moderate relationship was observed between actual price of feedlot culls over 600 lb (272 kg) and boneless beef trimmings ($r = 0.49$). Prices received for feedlot culls over 600 lb (272 kg) HCW were significantly correlated with feeder cattle prices, but the correlation was weak and negative ($r = -0.16$), and the feedlot cull prices received were not correlated with fat cattle markets (Table 6).

Prices received for feedlot culls expressed as a percent of dressed cull cow (Breaker [75% lean]) pricing for each weight category are in Figure 1. On average [with 95% CI], prices received for feedlot culls of all weights were 74.6% [74.1 to 75.2%] of weekly dressed cull cow (over 500 lb [227 kg] HCW) prices; and when categorized by weight, culls weighing below 400 lb (181 kg) HCW, between 400 and 599 lb (181 to 271 kg) HCW, and over 600 lb (272 kg) HCW received 59.5% [58.7 to 60.3%], 76.3% [75.8 to 76.9%], and 92.0% [91.5 to 92.5%] of cull cow prices, respectively.

Discussion

This is the first known published paper reporting the actual revenue returned from feedlot animals culled for slaughter and evaluating relationships between revenue received and reported US beef market prices. While the majority of price relationships were weak to negligible, the correlations were stronger when cattle were categorized by weight groups. The vast majority of culls returned at least some revenue (98.1% of total population). However, it is important to consider that this only accounts for animals that were actually shipped as culls; there was likely a population of animals that were intended to be culled from the feedlot, but were unable to ship (e.g., death at feedlot) and thus were not measured herein. Since there was no evidence that populations of culls that returned revenue differed compared to those that did not return revenue with respect to any of the characteristics reported in descriptive statistics, those results were not provided.

Overall, comparisons of data between culled steers and heifers were not meaningfully different (Table 3). Proportions of culls between sex that returned revenue were similar, and there was no evidence for a difference in reasons for culling between sexes. Hot carcass weight could be considered a potential confounder when comparing carcass price/value as steers on average weigh more than heifers. However, when HCW is controlled for by categorizing steers and heifers into weight groups, prices received between sexes were similar (within weight groups), with the lone exception being when HCW was greater than 800 lb (363 kg). While this indicated heifers received 7.76 $/cwt more than steers when carcasses were over 800 lb (363 kg), there were few carcasses in this weight group category with only 5 heifers and 39 steers with HCW over 800 lb. Although this mean price difference could be due to heifers and steers having differences in carcass composition (fat/meat/yield), those data were not available. Generally speaking, the results indicate that steers and heifers of the same weight receive a similar price when culled, and since the proportion of animals that return revenue and reasons for culling were not significantly different, both sexes were combined for subsequent analyses.

Table 6. Correlation coefficients comparing price received for individual feedlot culls to weekly average reported prices of different US beef markets.

Feedlot cull weight group, HCW*	Spearman's correlation†		
Beef market, $/cwt	***r*-value**	***R*²**	***P*-value**
All weights, n = 2,926			
Fat cattle‡, formula net (dressed)	0.07	< 0.01	< 0.01
Fat cattle‡, formula net (live)	0.05	< 0.01	< 0.01
Cull cow§, (Breaker, over 500 lb; dressed)	0.26	0.07	< 0.01
Cull cow§, (Breaker, all weights; live)	0.26	0.07	< 0.01
Feeder cattle‖	0.06	< 0.01	< 0.01
Boneless beef trimmings (85% lean)¶	0.15	0.02	< 0.01
Over 600 lb, n = 639			
Fat cattle‡, formula net (dressed)	0.02	< 0.01	0.56
Fat cattle‡, formula net (live)	0.03	< 0.01	0.48
Cull cow§, (Breaker, over 500 lb; dressed)	0.77	0.59	< 0.01
Cull cow§, (Breaker, all weights; live)	0.55	0.30	< 0.01
Feeder cattle‖	-0.16	0.03	< 0.01
Boneless beef trimmings (85% lean)¶	0.49	0.24	< 0.01
400 to 599 lb, n = 1,394			
Fat cattle‡, formula net (dressed)	0.30	0.09	< 0.01
Fat cattle‡, formula net (live)	0.30	0.09	< 0.01
Cull cow§, (Breaker, over 500 lb; dressed)	0.34	0.12	< 0.01
Cull cow§, (Breaker, all weights; live)	0.39	0.15	< 0.01
Feeder cattle‖	0.03	< 0.01	0.21
Boneless beef trimmings (85% lean)¶	0.19	0.04	< 0.01
Under 400 lb, n = 893			
Fat cattle‡, formula net (dressed)	0.31	0.10	< 0.01
Fat cattle‡, formula net (live)	0.25	0.06	< 0.01
Cull cow§, (Breaker, over 500 lb; dressed)	0.23	0.05	< 0.01
Cull cow§, (Breaker, all weights; live)	0.39	0.15	< 0.01
Feeder cattle‖	0.08	0.01	0.02
Boneless beef trimmings (85% lean)¶	0.13	0.02	< 0.01

* HCW (hot carcass weight); only animals that had a recorded HCW and price were included (57 excluded that returned no revenue [n = 12 musculoskeletal/trauma, n = 36 respiratory, n = 9 other], and 9 excluded that returned harvested meat back to the owner [n = 8 musculoskeletal/trauma, n = 1 other])

† Spearman's R^2 is the squared correlation coefficient (*r*-value) and indicates the proportion of variation for which received feedlot cull prices can be explained by beef market indices; *P*-value is a measure of significance for the correlation

‡ Weekly average of historical fat cattle pricing in KS using formula net pricing (dressed or live) for all quality grades[22]

§ Weekly average of historical US national cull cow (Breaker [75% lean]) pricing (dressed or live)[23]

‖ Weekly average of historical 85% lean boneless cow and beef trimmings (Central US region)[24]

¶ A mean price per week was calculated for heifers and steers (separately) by averaging across all 100 lb weight ranges for medium and large frame #1 cattle; reported values are for combined KS auctions[9]

Historically, respiratory disease has accounted for the greatest proportions of morbidity (70 to 80%) and mortality (40 to 50%) in US beef feedlots.[14] More recently, evidence of respiratory disease contributing to 65 to 75% of feedlot deaths has been reported.[5] However, in the population of feedlot culls used in this study, there was a greater proportion of animals culled due to musculoskeletal/trauma reasons (approximately 50%), followed by respiratory (approximately 41%). Although literature on feedlot culls is limited, a past report attributed 70% of non-performing cattle sales to those with lameness.[7] Our results demonstrating differences in culled cattle populations when grouped by removal reason categories (Table 4) tend to agree with previous literature. It is generally well accepted that risk of respiratory disease in feedlot cattle is associated with arrival weight, and risk decreases in heavier cattle;[12,3,15] this is similar to our observations comparing mean lot arrival weight between animals culled for respiratory vs musculoskeletal/trauma reasons. The greatest proportion of respiratory disease incidence typically occurs early in the feeding period,[12,4,17,14] and in this population, animals culled for respiratory reasons had the smallest mean DOF compared to other reasons for culling. Feedlot cattle treated for respiratory disease multiple times (0, 1, 2, or over 3 times) have decreased total value

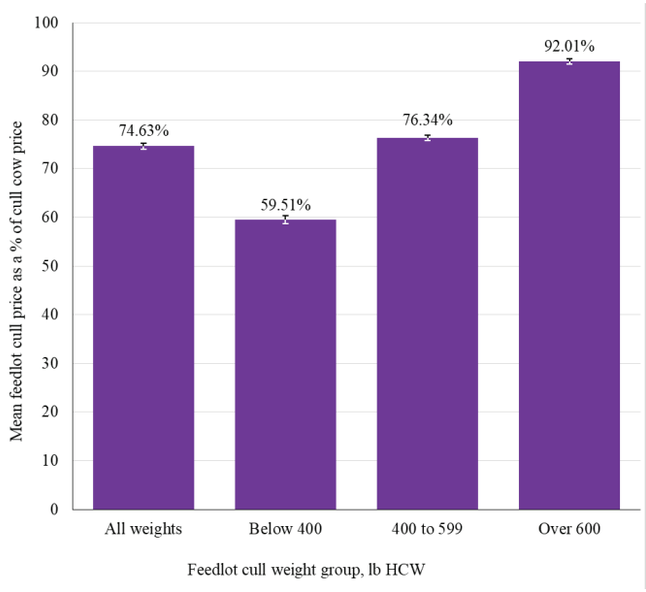

Figure 1. Mean price received for feedlot culls by weight group (HCW; hot carcass weight) as a percent of national dressed cull cow prices (Breaker [75% lean]; over 500 lb HCW).[23] Error bars represent 95% confidence intervals for estimates of mean feedlot cull price received (as a percent of mean cull cow price).

($/animal) as the number of treatments increase;[16] notably, growth performance indicators like average daily gain as well as carcass quality measurements (quality grade, marbling score) also have been shown to decrease as the number of respiratory treatments increased.[8,16] Cattle culled for respiratory reasons in our study were pulled and administered antimicrobial treatments more often, and had reduced carcass value compared to musculoskeletal/trauma culls. Additionally, respiratory culls originated from lots with higher processing costs compared to musculoskeletal/trauma culls, possibly due to increased use of antimicrobial metaphylaxis in lots presumably at greater risk of respiratory disease.

When feedlot culls were categorized by weight groups, changes in the distributions of animals by removal reasons were observed (Table 5). Light weight cattle were primarily culled for respiratory reasons, and as weight increased to middle and heavy weight groups, the distribution shifted in a likewise manner towards a greater proportion of musculoskeletal/trauma culls. A majority of observed differences between weight groups may be explained by the shift of respiratory to musculoskeletal/trauma culls as weight increased.

As this is the first known published paper describing actual revenue returned from feedlot culls and relationships with reported US beef market prices, available literature for comparison is minimal. As noted previously, the strength of correlations increased with weight group categorizations. Some important observations to note were that prices received for the heaviest culls were not significantly correlated with fat cattle prices (Table 6); and that prices received for heavy culls had the strongest correlation with 85% lean boneless cow and beef trimmings. Overall, cull cow prices had the highest correlation coefficients with received feedlot cull prices; thus, it appears that use of cull cow prices may provide the best estimate of feedlot cull prices. We described this relationship for each weight group of feedlot culls using dressed cull cow (Breaker [75% lean]) prices from cows weighing over 500 lb (227 kg) HCW in Figure 1. If estimating feedlot cull prices for individual animals, estimating the animals HCW would enable a more accurate approximation of potential revenue. If not, the percent of dressed cull cow price received for all weights of feedlot culls may still provide an adequate estimate for economic analyses.

This study was limited to 4 commercial feedlots, all located in a similar geographic region, and studied during a limited time frame. Additionally, all feedlots used the same specialized abattoir to harvest feedlot culls. This scope may be an adequate representation for Central KS, but broadening inference to other states or other regions of the US would rely on the tenuous assumptions that our data are representative. In addition, US beef markets are prone to volatility, especially over multiple years.[1,11] This must be taken into consideration when making conclusions, or using these outcomes to estimate feedlot cull revenue. Future research in a greater variety of regions and larger populations of cattle would be beneficial to improve the validity of using US beef market pricing to estimate revenue generated from feedlot culls.

Conclusions

In this study of commercial feedlot animals culled for slaughter, the vast majority returned revenue to the feedlot, but the amount of revenue varied significantly depending on the reason for culling and carcass weight. Cattle culled for musculoskeletal/trauma reasons were heaviest, and returned the most revenue compared to respiratory and "other" culls. While respiratory disease typically has the greatest health impact in beef feedlots, we observed a greater proportion of feedlot animals that were culled for slaughter, were culled for musculoskeletal/trauma reasons. Prices received for feedlot culls were significantly correlated with several reported US beef market price indices; most were weak to negligible, but improved when categorizing culls by carcass weight. Overall, the strongest relationships occurred when correlating received feedlot cull prices with dressed cull cow prices. Reported dressed cull cow prices may provide an adequate estimation of revenue from harvested feedlot culls in economic assessments.

Endnotes

[a] R Core Team, Vienna, Austria; Version 4.0.2
[b] Microsoft, Redmond, WA
[c] SAS Institute Inc., Cary, NC; Version 9.4

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APPENDIX

Appendix Table A. Descriptive statistics of continuous variables for feedlot culls that were harvested for salvage overall and categorized by sex.

Item	n*	Mean	95% CI†	Median	IQR‡	Range
Animals received per lot, n						
All cattle	2,992	153	151 to 155	150	101 to 192	28 to 506
Steers	1,322	148	144 to 152	146	87 to 190	31 to 448
Heifers	1,670	157	154 to 160	152	111 to 195	28 to 506
Average lot arrival weight, lb/animal						
All cattle	2,992	745	741 to 749	743	677 to 810	339 to 1203
Steers	1,322	777	771 to 783	777	107 to 858	339 to 1203
Heifers	1,670	719	714 to 724	726	657 to 779	399 to 1182
Days-on-feed at culling						
All cattle	2,992	111	109 to 113	111	69 to 146	1 to 331
Steers	1,322	111	108 to 114	109	68 to 146	5 to 331
Heifers	1,670	111	109 to 113	111	69 to 145	1 to 317
Carcass weight§, lb						
All cattle	2,926	483	478 to 488	473	380 to 583	129 to 919
Steers	1,295	513	505 to 521	500	399 to 618	129 to 919
Heifers	1,631	460	454 to 466	455	363 to 553	163 to 869
Carcass weight price§, $/cwt						
All cattle	2,926	87.40	86.7 to 88.1	87.00	74.00 to 101.00	21.00 to 155.00
Steers	1,295	90.14	89.11 to 91.17	92.00	76.00 to 105.00	21.00 to 150.00
Heifers	1,631	85.21	84.28 to 86.14	85.00	72.00 to 100.00	25.00 to 155.00
Value returned‖, $/animal						
All cattle	2,983	434.81	427.22 to 442.4	405.02	280.96 to 585.96	0.00 to 1378.50
Steers	1,320	474.81	462.71 to 486.91	454.19	303.59 to 641.30	0.00 to 1378.50
Heifers	1,663	403.06	393.67 to 412.45	380.78	266.22 to 543.15	0.00 to 1278.75
Times pulled, n/animal						
All cattle	2,992	2.39	2.34 to 2.44	2	1 to 3	0 to 10
Steers	1,322	2.36	2.29 to 2.43	2	1 to 3	0 to 10
Heifers	1,670	2.41	2.35 to 2.47	2	1 to 3	0 to 10
Antimicrobial treatments, n/animal						
All cattle	2,992	1.73	1.69 to 1.77	2	1 to 3	0 to 8
Steers	1,322	1.69	1.63 to 1.75	2	1 to 3	0 to 7
Heifers	1,670	1.77	1.71 to 1.83	2	1 to 3	0 to 8
Total treatment costs, $/animal						
All cattle	2,992	45.09	43.91 to 46.27	42.88	18.94 to 68.05	0.00 to 185.43
Steers	1,322	46.00	44.17 to 47.83	44.90	15.83 to 70.08	0.00 to 168.30
Heifers	1,670	44.37	42.82 to 45.92	41.33	20.13 to 66.12	0.00 to 185.43
Processing cost, $/animal						
All cattle	2,992	18.72	18.37 to 19.07	15.73	14.04 to 18.43	4.98 to 71.36
Steers	1,322	18.24	17.75 to 18.73	15.49	14.11 to 17.28	7.56 to 65.15
Heifers	1,670	19.10	18.61 to 19.59	15.95	14.00 to 19.32	4.98 to 71.36

* n = number of observations (animals) used for descriptive statistics

† 95% confidence interval of the mean

‡ IQR (interquartile range: quartiles 1 to 3)

§ Carcass weight and price excludes 57 animals that returned no revenue (n = 25 steers, n = 32 heifers) and 9 animals returned harvested meat back to the owner (n = 2 steers, n = 7 heifers)

‖ Animals that returned no revenue ($0.00) were included in total revenue (n = 57 total [n = 25 steers, n = 32 heifers]), but those that returned harvested meat back to the owner were excluded (n = 9 total [n = 2 steers, n = 7 heifers])

Appendix Table B. Model adjusted means and standard errors of the means (SEM) from analyses of factors comparing feedlot culls that did or did not return revenue.

	Revenue returned		
Item*	**Yes**	**No**	**P-value**
Animals received per lot, n (SEM)	157 (8.6)	149 (12.1)	0.40
Average lot arrival weight, lb/animal (SEM)	735 (9.9)	725 (17.4)	0.49
Days-on-feed at culling, mean (SEM)	113 (9.0)	116 (10.8)	0.68
Times pulled, mean (SEM)	2.59 (0.240)	2.33 (0.294)	0.23
Antimicrobial treatments, mean (SEM)	1.87 (0.158)	1.79 (0.233)	0.66
Total treatment costs, $/animal (SEM)	46.00 (6.468)	49.38 (7.676)	0.43
Processing cost, $/animal (SEM)	18.53 (2.392)	20.38 (2.647)	0.11

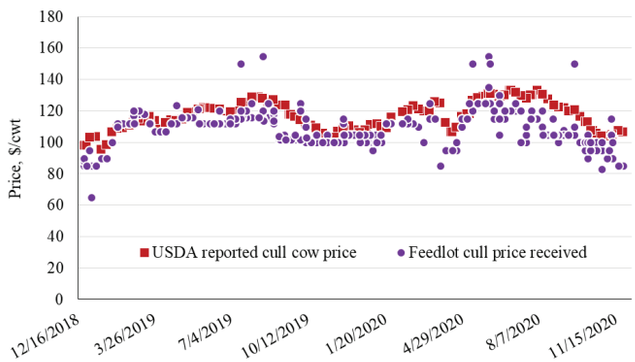
*N = 2,926 animals that returned revenue, n = 57 animals that did not return revenue, n = 9 animals excluded that returned harvested meat back to the owner

Appendix Table C. Description of feedlot culls separated by hot carcass weight (HCW) group.

Weight group, lb HCW	n	Percent	Estimated live weight*, lb	Estimated dressing percent†
Over 600	639	21.84	Over 995	Over 60.33
400 to 599	1394	47.64	696 to 993	57.44 to 60.32
Under 400	893	30.52	Under 696	Under 57.42

*Live weight of harvested culls was estimated from individual HCW using the inverse of regression equation described by Tatum et al (2012); live weight = $(HCW/0.2598)^{(1/1.1378)}$

†Hot carcass weight group/estimated live weight



Appendix Figure 1. Description of changes in sale prices over time between individual feedlot culls weighing over 600 lb (272 kg) HCW and weekly average US national dressed cull cow (Breaker [75% lean]) price for carcasses greater than 500 lb (227 kg).

Notes