Hide Defects of Feedlot Cattle: Assessment of Cattle Management, Breed Type, Sex, Live Market Weight, and Source Factors on Hide Quality

by

W.T. Wright,[1] C. R. Richardson,[1,2*] M.A. Bonds,[1] G.V. Pollard,[1,3] P.O Sudhakaran,[2] A.M. Gonzalez[2] and S.P. Martinez[2]

[1]*Department of Animal Science and Food Technology, Texas Tech University,*
Lubbock, Texas 70409

[2]*Department of Agricultural Sciences, Texas State University,*
San Marcos, Texas 78666

[3]*Formerly with Department of Agriculture, Texas State University,*
San Marcos, Texas 78666

Abstract

Twenty groups of finished feedlot cattle (thirteen steer groups, seven heifer groups) of known origin, breed type, sex and implant status were studied after marketing to determine the type and extent of hide defects as related to days on feed, live market weight, and hot carcass weight. Origin of cattle did not significantly influence the five hide characteristics evaluated (hide defects score, hide vein score, healed scratches, ringworm, and warts). Live weight and sex influenced the weight of the hides ($P < 0.05$), with steers being heavier and having heavier hides. Days on feed increased ($P = 0.06$) the amount of vein damage observed on the hides but was not sex related. Results from this study indicate that under typical commercial cattle feeding practices in Texas, hide defects differ among cattle under the same management and are related to the days on feed in the feedlot, which influences final market weight and degree of finish.

Introduction

The beef cattle industry is the largest single sector of agriculture in the U.S. However, it is not realizing potential profits from feedlot cattle by accepting lower quality hides resulting from routine management and nutrition related factors. Reduction in hide quality decreases the net value of hides which is a silent factor that is involved in arriving at the overall worth of live finished steers and heifers. Live cattle are bought and sold as individual packages without consideration of the type of "wrapper" they may have for use in making different leather products. Furthermore, beef cattle are produced under drastically different management conditions across the nation, that result in the use of different practices which are usually beneficial for the primary purpose intended, but which may negatively influence hide quality. Some of these practices that cause preventable hide defects are branding methods, raising and feeding of un-dehorned cattle, using poor quality and improperly designed fencing and handling equipment, parasite control methods, disease, and days on high concentrate feed in feedlots.

Hides with more defects have greater wastage of leather when fabricated into different products, and also require more labor in cutting and processing. This is a double negative situation which reduces the overall value of finished steers and heifers for producers and increases the cost of leather products. Renewed awareness and attention by cattle owners and managers in improving management and nutrition will impact cattle from the time calves are weaned until they are sold as finished beef. Recognition of these variables will help correct economic inefficiencies that have existed for decades. Benefits to the beef cattle industry would come from higher overall net value of live feedlot cattle per kilogram as compared to other animal species produced for food in the United States.

In an attempt to identify the major concerns of all segments of beef cattle production in the U.S. as related to beef quality, National Beef Audits (NBQA) that were conducted in 1991, 1993, 1995, and 2016 included producers, packers, purveyors, retailers, and restaurateurs.[4,1,3,5,11] These audits found that hide defects was the number one concern for beef packers, and identified excessive fat as the number one concern for beef purveyors, retailers, and restaurateurs. A follow-up NBQA in 2000 collected information to compare the top 10 changes since 1991 for the same segments of the beef industry. In this audit, the producer segment was divided into categories of cow-calf producers, stockers/ backgrounders, and feedlot operators. Results of the 2000 audit showed all categories of producers identified location of injection site as the number one change and identified improved handling as number three to number five. Packers also identified presence of injection site lesions as the number one change but identified hide damage by brands as number ten of the top ten changes. As related to hide quality, purveyors, retailers, and restaurateurs were consistent and identified presence of bruises, and injection site lesions in the top three changes since 1991. These national audit data point to the interest and importance of hide defects and support objectives of this study.

*Corresponding author email: cr36@txstate.edu
Technical Note received December 3, 2020, accepted for publication January 10, 2021.

The value of hides to the U.S. beef industry represents 60% of the total by-product sales from cattle and amounts to nearly a billion dollars annually.[2] Thus, reduction in hide defects from better management and nutrition related practices is economically important and improvement appears achievable. Objectives of this study were to determine the type and extent of hide defects in finished steers and heifers as related to source (origin), breed type, sex, days on feed, live market weight, and hot carcass weight.

Experimental

Materials and Methods

Cooperative agreements were arranged with Cactus Feeders, Amarillo, Texas to collect information about groups (pens) of finished steers and heifers marketed from two of their commercial feedlots in the Texas High Plains, and with Tyson / IBP, Amarillo Texas to obtain data on carcass weights, carcass grade and yield, and hide defects of the cattle. A total of 1,844 steers and heifers, representing twenty pens, were involved in this study from March through October 2001. All cattle were fed under the same corporate management and feeding regimen. Carcass information and hide evaluations were collected by qualified personnel at Tyson/ IBP with the assistance of Texas Tech University. Data were then compiled and analyzed by co-authors.

Table I

Information collected about feeder cattle/ feedlot cattle groups used in this study

Source (origin): location within states, or country
Transportation time to feedlots
Breed types within source: domestic;
Brahman influenced; Holsteins
Sex
Number in groups
Feedlot location
Medications administered
Parasite control methods
Vitamins administered
Implant types
Average dry matter intake per day
Average daily gain
Live market weight
Hot carcass weight
Dressing percentage
Quality grade
Yield grade
Type and number of hide defects

Feeder cattle comprised in these twenty pens of finished steers and heifer originated from seven different sources (six states and Mexico). Percentages of the total number of cattle represented by different sources were: Texas - 44%, Mexico – 14%, Oklahoma – 14%, Arkansas – 9%, Mississippi – 8%, Alabama – 7%, and Kentucky – 4%. The length of time in transporting feeder cattle from sources to the feedlots was tabulated using mapquest.com for use in correlating transit time with hide healed scratches and scars.

From the twenty groups of cattle, there were 13 pens of steers (1,174 steers, 64% of total) and 7 pens of heifers (670 heifers, 36% of total). All cattle in all pens were implanted, but the type of implants differed among pens. Three breed types were represented among the twenty pens and types were designated as English and continental crossbred cattle, Brahman influenced, or Holsteins.

All truckloads of finished cattle originating at the two feedlots were met at the packing plant where average live weight was calculated from total pen weight, number of animals in each pen, and individual carcass weights were obtained. Hides were marked with ink at the down-puller in the packing plant and matched with ear tag numbers to correlate hides with the animals they originated from, then hides were followed to the hides department.

Information obtained from the twenty groups of hides consisted of weight score, grade score, vein sore, healed scratches, ringworm, warts, mechanical damage, grub damage, scud damage, light hair stubble, and light draw. Grub damage, scud damage, light hair stubble, and light draw were not statistically analyzed due to their low prevalence in the cattle groups studied. Feedlot derived information about breed type, source of feeder cattle, sex, days on feed, and live weight was used in analysis of hide defect variables, to determine relationships.

Table II

Example of comparative monetary values of main constituent parts of finished cattle[a]

Item	Dollar value, $	Live animal value, %
Live animal value	960.00	–
Carcass value (CV)	903.09	94.1
Carcass parts value[1]		
Loin and ribs (55% of CV)	496.70	51.7
Round (27% of CV)	243.83	25.4
Chuck (14% of CV)	126.43	13.2
Flank and plate (4% of CV)	36.12	3.8
Hide value estimates	40.00/70.00	4.2/7.3

[a]Estimates are based on 545kg (1,200lb) steers, prices for June 9, 2003

[1]Percentages of CV are estimates for medium frame steers, with select quality grade and yield grade of 2.

Table I provides a summary of information collected about the cattle from the originating location of feeder cattle, through their duration in the feedlots, and carcass and hide information at the packaging/hide plant. Some of this information is descriptive in nature and did not offer the opportunity for statistical analysis, while other types of information were analyzed to address objectives of the study. Table II illustrates the comparative dollar value of retail carcass parts from steers and heifers and the dollar spread in hide value. Because carcass values of finished steers and heifers are not related to hide quality, the value for hides may be more or less stable at times when carcass value is fluctuating. Thus, as carcass value decreases, the hide value, as a percentage of live animal value, usually increases. Information presented in Table III describes cattle source, number in groups, breeding, transit time from origin to the feedlots, sex, implant types, medications, injectable vitamins, and feedlot site.

Results and Discussions

Regression analysis was conducted on five categories of data (hide weight score, hide vein score, healed scratches, ringworm, and warts) to develop prediction equations related to cattle source and sex. Grub damage, scud damage, light hair stubble, and light draw were not statistically analyzed due to their low level of prevalence in the cattle.

Twenty pens of steers and heifers were studied for a total of 1,844 animals. Of this total number of cattle, 46% had butt brands, 26% had side brands, 24% were not branded, and 4% were not graded. (Table IV). Cattle came from seven different sources (six states and Mexico) but source did not affect hide quality variables measured. Likewise,

Table III

Descriptive information about groups of cattle

Group No.	Origin	No. in group	Feed-lot No	Breed type	Travel time, h	Sex	Medications[1]	Injectable vitamins	Parasite contol[2]	Implant type[3]
1	McMahan, TX	107	1	Crossbred	15.23	F	1,2,3,4	A, D	1	1
2	Carthage, TX	104	1	Crossbred	12.67	M	2,3,4,6	None	2	2,3
3	Carnegie, OK	89	1	Okies	8.03	M	3,4,5	A, D	1	–
4	Searcy, AR	80	1	Brangus	13.18	M	2,3,4,5	None	1	–
5	Mexico	82	2	Exotics	–	F	2,3,8	None	1	4,5,6
6	Mexico	87	1	Charolais/Angus	15.38	M	3,4,5	A, D	1	2,3
7	Searcy, AR	87	1	Brangus	13.18	M	3,4,8	A, D	1	2
8	Nazareth, TX	70	1	Holsteins	2.48	M	3,4,8	A, D	1	2,3
9	Lawton, OK	81	1	Okies	4.72	M	3,4,5	A, D	1	2,3
10	Culman, AL	131	1	Charolais/Exotics	20.35	M	3,4,5	A, D	1	2,3
11	Elk City, OK	74	1	Okies	4.72	M	3,4,5	A, D	1	2,3
12	Meridan, MS	70	1	Crossbred	17.70	F	2,3,4,5,6	A, D, E	2	1,4
13	Rosebud, TX	110	1	Okies/Crossbred	11.37	F	3,4,8	A, D	1	1,4
14	Fountain Run, KY	80	1	Okies	19.77	M	3,4	A, D	1	2
15	Howe, TX	91	2	Crossbred	10.82	F	2,3,4,8	None	1	4,6
16	Mexico	92	2	Exotic/Okies	19.77	F	2,3,4	None	1	6
17	Sentobia, MS	82	2	Crossbred	14.02	M	2,3,4	None	1	2,3
18	Lamesa, TX	137	1	Exotics/Okies	–	M	3,4	A, D	1	2
19	Tulia, TX	118	1	Exotics/Okies	–	F	3,4	A, D	1	1
20	Gainesville, TX	72	1	Okies	–	M	2,3,4	None	1	2

[1]Medications administered: 1- Lutalase: 2- Bacterin Pasturella: 3- Vision 7 way; 4- IBRP/Fusion; 5- IBRP/Boost; 6- Micotil; 7- IBRP; 8- IBRP; 9- Covexin 8

[2]Parasite control: 1- Dectomax (injectable); 2- Cydectin (pour on).

[3]Implant type: 1- Tulia, TX; 2- Hereford, TX.

Table IV

Frequency of brands across groups of cattle[a]

Type/ not graded	No. of cattle	Percentage of total cattle
Butt (hip)	854	46%
Side (Colorado)	486	26%
Native (no brand)	434	24%
Hides not graded	70	4%

[a]Multiple brands were found on all cattle from Mexico

breed type was not related to hide quality across twenty pens of cattle. Sex affected hide weight score (P < 0.01) with steers having heavier hides. No other hide quality variables were affected by sex.

Performance data as related to days on feed, live market weight, and hot carcass weight are presented in Table IV. Data were collected from cattle fed under the same management, and nutritional regimen. The results indicate duration of time in the feedlot (days on feed) increases vein damage (P < 0.06). Live market weight data show that heavier cattle had heavier hides (P < 0.01); and that heavier hides had increased amount of healed scratches (P = 0.04) (Table V).

Hot carcass weight affected hide weight hide score (P < 0.01). Feed intake, daily gain, and feed efficiency are all related to hot carcass weight, and an increase in feed intake results in increased daily gain which improves feed efficiency and increases hot carcass weight. Summaries of carcass data, and hide defects data are presented in Tables VI and VII, respectively.

Table V

Summary of feedlot data

Group No.	Origin	Breed Type	Sex	Live weight, kg	Days on feed	DMI[1], kg	ADG[1], kg	F:G[3], kg
1	McMahan, TX	Crossbred	F	464.40	153	6.86	0.90	3.45
2	Carthage, TX	Crossbred	M	487.98	189	6.07	1.04	2.49
3	Carnegie, OK	Okies	M	490.70	189	6.29	1.15	2.49
4	Searcy, AR	Brangus	M	529.71	176	8.04	1.41	2.59
5	Mexico	Exotics	F	434.01	231	6.28	0.94	3.03
6	Mexico	Charolais/ Angus	M	502.49	214	6.70	1.17	2.59
7	Searcy, AR	Brangus	M	568.71	212	7.76	1.50	2.34
8	Nazareth, TX	Holsteins	M	604.08	184	8.99	1.40	2.91
9	Lawton, OK	Okies	M	551.02	186	7.49	1.40	2.44
10	Cullman, AL	Charolais/ Exotics	M	564.63	162	9.04	1.44	2.85
11	Elk City, AL	Okies	M	542.86	173	8.00	1.46	2.49
12	Meridan, MS	Crossbred	F	515.65	215	6.71	0.93	3.25
13	Rosebud, TX	Okies/ Crossbred	F	480.27	215	6.35	0.99	3.25
14	Fountain Run, KY	Okies	M	578.68	127	8.65	1.37	2.87
15	Howe, TX	Crossbred	F	532.43	133	6.05	1.02	2.70
16	Mexico	Exotics/ Okies	F	468.48	261	8.34	1.59	2.38
17	Senatobia, MS	Crossbred	M	535.60	236	7.19	1.31	2.49
18	Lamesa, TX	Exotics/ Okies	M	614.06	134	1.68	1.68	2.58
19	Tulia, TX	Exotics/ Okies	F	520.63	142	1.49	1.49	2.66
20	Gainesville, TX	Okies	M	592.29	161	1.50	1.50	2.56

[1]DMI: dry matter intake

[2]ADG: average daily gain

[3]F:G = total group DMI ÷ total group gain.

Conclusion

The hides of finished feedlot cattle in the U.S. comprise from 4% to 8% of their market value at live price of $80 per 45.45 kg (Table II). However, producers do not realize a higher value for cattle with higher quality hides. Probable solutions to hide quality concerns of finished feedlot cattle are related to management practices from weaning to final marketing, source of cattle, and type of branding, days on feed in feedlots, and hide processing procedures-and will require input and cooperative efforts of all segments of the beef industry. Data presented in this study provide information that indicate attention is needed to address specific critical points in the overall beef industry and if accomplished, hide quality of finished feedlot cattle can be improved. Furthermore, improvement in hide quality must have a paycheck and/or benefit to all segments of the cattle and leather industries involved. Thus, hide quality should be considered in arriving at the price paid for finished cattle by packers involved and higher quality hides will then enable packers to offer better products to meet demands for selected markets.

Table VI

Summary of carcass data[1]

Group No.	Hot carcass weight, kg	Dressing, %	Prime	Choice	Select	No rolls, %	1	2	3	4
1	292.01	62.88	2	62	33	3	22	60	18	0
2	314.75	64.50	0	24	26	30	39	54	7	0
3	317.24	64.65	0	51	48	1	11	69	20	0
4	338.38	63.88	0	39	52	9	23	50	24	3
5	277.64	63.97	6	68	22	4	21	73	6	0
6	323.91	64.46	2	51	44	3	37	52	11	0
7	397.04	64.54	0	49	46	5	5	34	59	2
8	371.27	61.46	1	70	29	0	28	77	3	0
9	353.98	64.24	2	25	62	14	28	43	26	3
10	355.09	62.89	0	25	61	14	26	43	26	3
11	350.41	64.55	0	20	49	31	30	51	23	0
12	331.41	64.27	4	51	39	6	30	26	41	3
13	313.90	65.36	0	31	63	6	35	50	35	1
14	368.45	63.67	2	37	55	6	41	32	28	5
15	353.90	66.47	2	63	32	2	15	32	26	1
16	299.78	63.99	0	62	36	2	16	47	36	2
17	337.48	63.01	0	39	51	13	16	54	30	0
18	390.05	63.52	1	39	56	4	18	28	50	14
19	329.98	63.38	5	73	22	0	6	30	50	14
20	376.76	63.31	0	54	43	3	14	50	35	1

[1]To read: Quality grades are Prime, Choice, and Select. Yield grades are 1, 2, 3, and 4.

Table VII

Summary of hide defects data

	Hide weight[1]					Veins[2]				
Group No.	BH	HTS	XHTS	Healed scratches	Ringworm	G1	G2	G3	G4	Warts
1	68	23	0	68	13	0	11	14	66	0
2	12	90	0	75	14	27	40	15	20	0
3	31	45	11	49	10	18	25	13	31	0
4	15	50	12	67	14	2	9	19	47	4
5	67	10	0	51	1	0	11	6	60	0
6	11	76	0	51	1	0	11	6	60	0
7	10	77	0	49	7	11	16	19	41	1
8	16	52	0	12	7	0	14	2	52	1
9	12	61	0	13	3	0	9	12	52	1
10	8	102	21	32	6	19	76	13	23	2
11	12	57	0	19	2	0	11	14	44	0
12	47	20	0	34	5	0	7	13	47	2
13	74	36	0	35	4	9	12	23	66	1
14	0	56	0	9	1	25	4	12	15	0
15	65	26	0	33	2	21	34	17	19	1
16	60	32	0	55	3	0	4	26	62	1
17	17	49	16	42	1	0	0	21	61	2
18	0	97	72	97	1	19	32	35	51	1
19	79	47	0	47	2	30	57	15	16	1
20	0	24	26	24	1	5	12	19	36	0

[1]BH = branded heifers; HTS = heavy Texas steers; XHTS = extra heavy Texas steers

[2]G1 = no visible veins; G2 = visible veins over 1 to 10% of hide; G3 = visible veins over 10 to 25% of hide; G4 = visible veins over 25% of hide

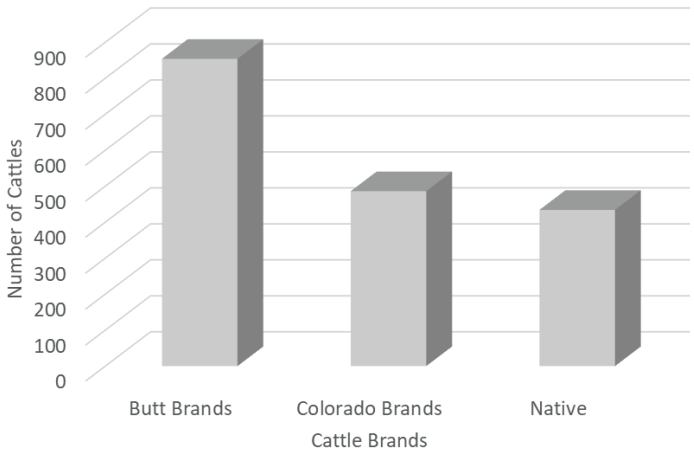

Figure 1. Total Distribution of Brands.

Butt Brands = Hip Brands
Colorado Brands = Side Brands
Native = No Brands

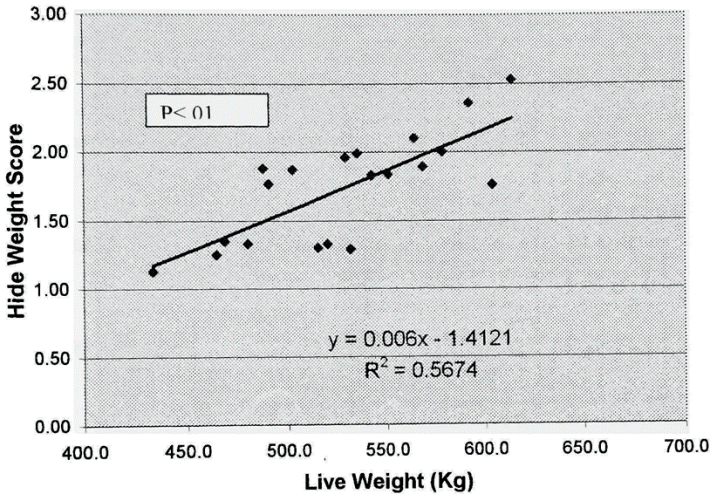

Figure 2. Effect of Live Weight on Hide Weight Score.

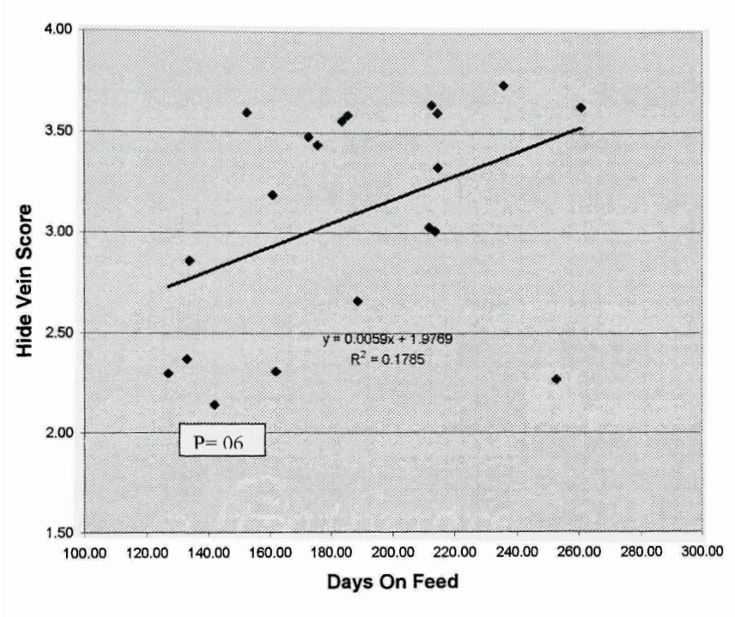

Figure 3. Effect of Days on Feed on Hide Vein Score.

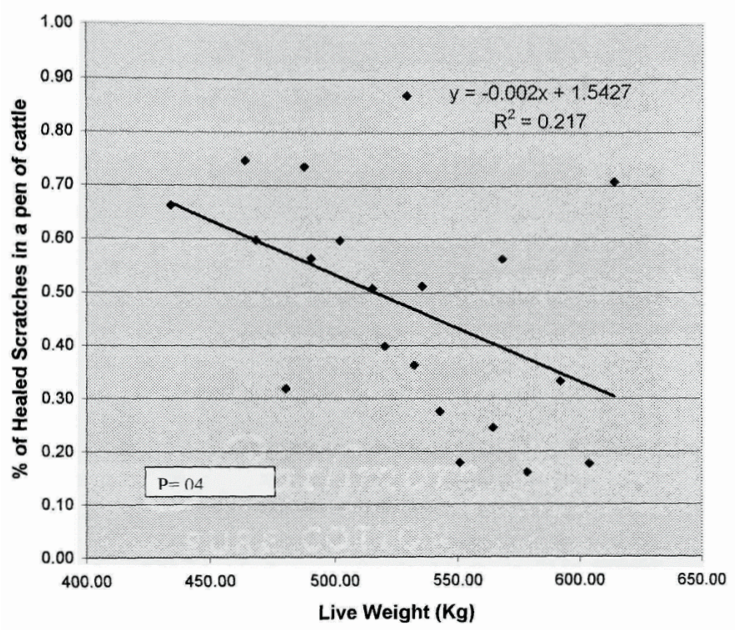

Figure 4. Effect of Live Weight on Healed Scratches.

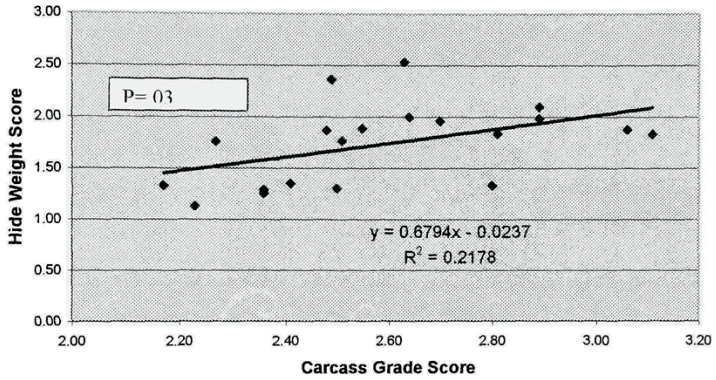

Figure 5. Effect of Carcass Grade Score on Hide Weight Score.

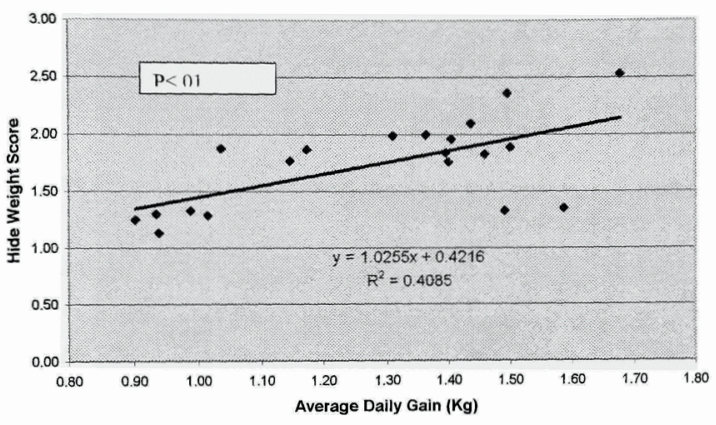

Figure 6. Effect of Average Daily Gain on Hide Weight Score.

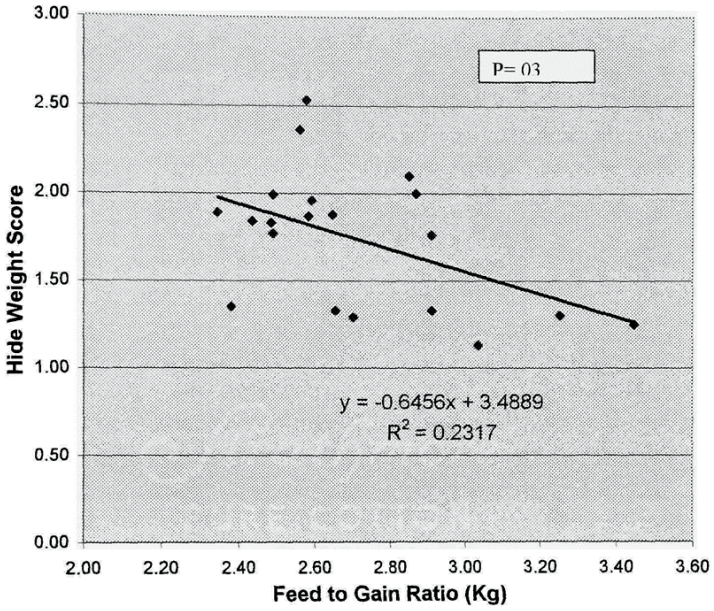

Figure 7. Effect of Feed-to-Gain Ratio on Hide Weight Score.

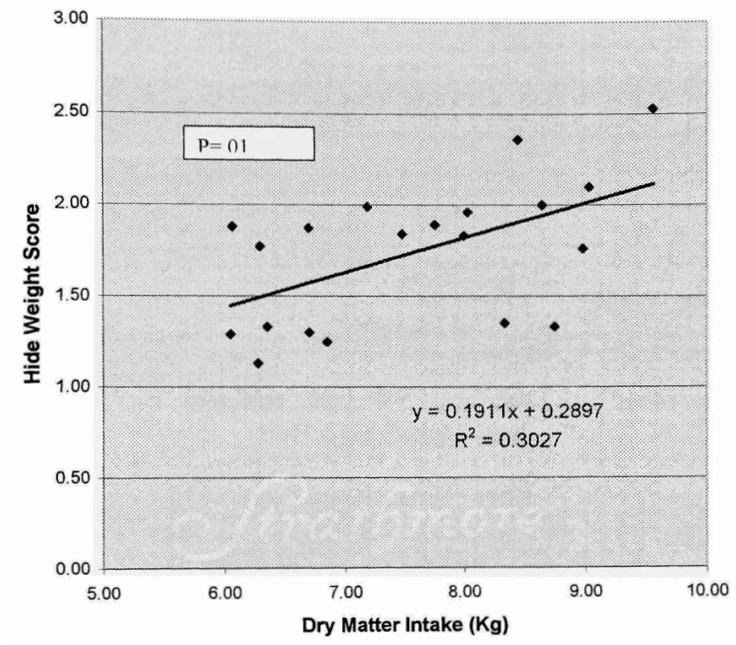

Figure 8. Effect of Dry Matter Intake on Hide Weight Score.

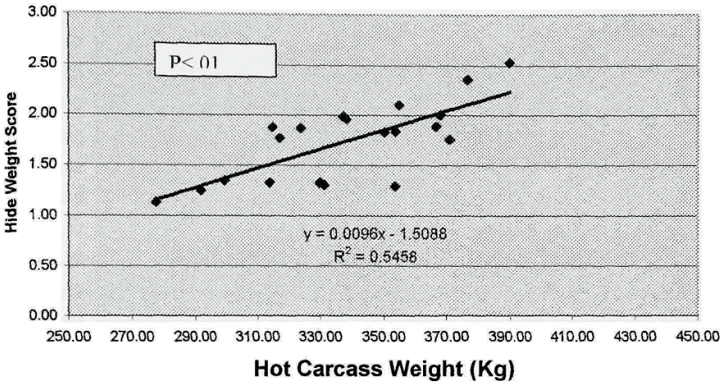

Figure 9. Effect of Hot Carcass Weight on Hide Weight.

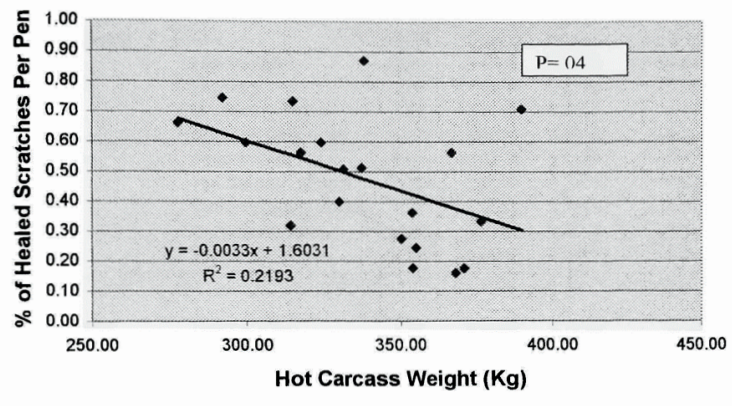

Figure 10. Effect of Hot Carcass Weight on the Amount of Healed Scratches.

Acknowledgments

This study was conducted in cooperation with Cactus Feeders, Amarillo, Texas and Tyson / IBP, Amarillo, Texas. We would like to thank them for providing access to their facilities for acquiring data. Dr. D.C. Shelly at the Texas Tech Leather Institute for his inspiring creative thought and industry application discussions.

References

1. U.S. Leather Industry Statistics, 2000, Leather Industries of America, Washington, D.C.
2. Lorenzen, C.L., D. S. Hale, D. B. Griffin, J. W. Savell, K. E. Belk, T. L. Fredrick, M. F. Miller, T. H. Montgomery, and G.C. Smith. 1993 National Beef Quality Audit: Survey of Producer-Related Defects and Carcass Quality and Quantity Attributes. *J. Anim. Sci* **71**, 1495- 1502.
3. Boleman, S. L., S. J. Boleman, W. W. Morgan, D. S. Hale, D. B. Griffin, J. W. Savell, R. P. Ames, M. T. Smith, J. D. Tatum, T. G. Field, G. C. Smith, B. A. Gardner J. B. Morgan, S. L. Northcutt, H. G. Dolezal, D. R. Grill, and F. K. Ray. National Beef Quality Audit-1995: survey of producer-related defects and carcass quality and quantity attributes. *J. Anim. Sci.* **76**, 96-103, 1998.
4. Smith, G. C., J.W. Savell, R. P. Clayton, T.G. Field, D. B. Griffin, D. S. Hale, M. F. Miller, T. H. Montgomery, J. B. Morgan, J. D. Tatum, and J. W. Wise. Improving the consistency and competitiveness of beef: a blueprint for total quality management in the fed beef industry. The final report of the National Beef Quality Audit-1991. National Cattlemen's Association, Englewood, CO, 1992.
5. Boykin, C. A., L. C. Eastwood, M. K. Harris, D. S. Hale, C. R. Kerth, D. B. Griffin, A. N. Arnold, J. D. Hasty, K. E. Belk, D. R. Woerner, R. J. Delmore, Jr., J. N. Martin, D. L. VanOverbeke, G. G. Maffi, M. M. Pfeiffer, T. E. Lawrence, T. J. McEvers, T. B. Schmidt, R. J. Maddock, D. D. Johnson, C. C. Carr, J. M. Scheffler, T. D. Pringle, A. M. Stelzleni, J. Gottlieb, and J. W. Savell. 2017. National Beef Quality Audit-2016: In-plant survey of carcass characteristics related to quality, quantity, and value of fed steers and heifers. J. Anim. Sci. **95**:2993-3002. doi:10.2527/jas2017.1543 [*PubMed*] [*Journal of Animal Science* link]
6. Harris, M. K., L. C. Eastwood, C. A. Boykin, A. N. Arnold, K. B. Gehring, D. S. Hale, C. R. Kerth, D. B. Griffin, J. W. Savell, K. E. Belk, D. R. Woerner, J. D. Hasty, R. J. Delmore, Jr., J. N. Martin, T. E. Lawrence, T. J. McEvers, D. L. VanOverbeke, G.G. Mafi, M. M. Pfeiffer, T. B. Schmidt, R. J. Maddock, D. D. Johnson, C. C. Carr, J. M. Scheffler, T. D. Pringle, and A. M. Stelzleni. 2018. National Beef Quality Audit – 2016: assessment of cattle hide characteristics, offal condemnations, and carcass traits to determine the quality status of the market cow and bull beef industry. Transl. Anim. Sci. **2**:37-49. doi:10.1093/tas/txx002 [*Translational Animal Science* link]
7. Hasty, J. D., M. M. Pfeiffer, L. C. Eastwood, D. A. Gredell, C. L. Gifford, J. R. Levey, C. M. Cashman, D. R. Woerner, J. N. Martin, R. J. Delmore, W. B. Griffin, D. L. VanOverbeke, G. G. Mafi, C. A. Boykin, D. S. Hale, C. R. Kerth, D. B. Griffin, A. N. Arnold, J. W. Savell, D. L. Pendell, and K. E. Belk. 2017. National Beef Quality Audit 2016: Phase I, face-to-face interviews. Transl. Anim. Sci. **1**:320-332. doi:10.2527/tas2017/.0039 [*Translational Animal Science* link]
8. Harris, M. K., L. C. Eastwood, C. A. Boykin, A. N. Arnold, K. B. Gehring, D. S. Hale, C. R. Kerth, D. B. Griffin, J. W. Savell, K. E. Belk, D. R. Woerner, J. D. Hasty, R. J. Delmore, Jr., J. N. Martin, T. E. Lawrence, T. J. McEvers, D. L. VanOverbeke, G. G. Mafi, M. M. Pfeiffer, T. B. Schmidt, R. J. Maddock, D. D. Johnson, C. C. Carr, J. M. Scheffler, T. D. Pringle, and A. M. Stelzleni. 2017. National Beef Quality Audit- 2016: Transportation, mobility, live cattle, and carcass, assessment of targeted producer-related characteristics that affect value of market cows and bulls, their carcasses, and associated by-products. Transl. Anim. Sci. **1**:570-584. doi:10.2527/tas2017.0063 [*Translational Animal Science* link]
9. Richardson, C. R., M. A. Bonds, D. C. Shelly, W. T. Wright, and G. A. Nunnery. 2003. Measurement of cattle management, nutrition, breed, and source factors that reduce hide quality. 99th annual meeting of the American Leather Chemists Association, Greensboro, NC, June 19-22, 2003.
10. Mies, W. L., J. J. Harris, R. H. Knapp, J. W. Edwards, C. A. Terry, D. W. Savell, and H. R. Cross, 1992. Live and carcass values from different cattle types. J. Anim. Sci. **70**: 1314-1325.
11. Roeber, D. L, P. D. Mies, C. D. Smith, K. E. Belk, T. G. Field, J. D. Tatum, J. A. Scanga, and G. C. Smith, 2001. National market cow and bull beef quality audit – 1999 : a survey of producer-related defects in market cows and bulls. J. Anim. Sci. **79**: 658- 665.
12. Stellar, Nina. 1995. Feedlot quality assurance. National Veterinary Services Laboratory, Ames, Iowa.
13. Skyes, R. L. 1971 Factors affecting the regularity of leather made from cattle hide. J Soc. of Leather Trades' Chemists. **55**:300-301.
14. Terry, C. A., R. H. Knapp, J. W. Edwards, J. W. Meis, W. L. Savell, J. W. Cross, and H. R. Cross, 1990. Yields of by-products from different cattle types. J. Anim. Sci. **68**: 4200-4205.