EFFECT OF MUD, MANURE AND OTHER ADHERING MATERIAL ON SLAUGHTER CATTLE SHRINKAGE

By

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INTRODUCTION

A recurring economic problem in the marketing of fat cattle is shrinkage loss due to mud, manure and other adhering material. No reports of any work on this problem in marketing fat cattle can be found in the literature and the industry currently has no guidelines to use when selling or purchasing cattle that have quantities of mud on them. A problem is readily apparent when visiting with either buyers or sellers of fat cattle.

During wet seasons, feedlot cattle can become quite muddy especially during periods when temperatures are above freezing during the day and then drop below freezing at night. Mud accumulates on the hair coat of animals during periods of thaw and freezes to the hair when the temperature drops below freezing. Over a period of time, mud will accumulate in balls on the underline, sides and tail. Cattle that are slaughtered while in this muddy condition have an additional amount of shrinkage due to the weight of adhering mud.

This project was undertaken in an effort to determine amounts of mud, manure and other adhering material on fat cattle at the time of slaughter and its effect on live weight shrinkage. It is hoped that subjective visual scores can be established by which approximate degrees of muddiness of slaughter cattle can be determined.

LITERATURE REVIEW

Shrinkage in Slaughter Cattle

Traditionally, shrinkage in beef cattle has been of two types. Excretory shrink or loss of belly fill is one type. It involves passage of the digestive tract contents which is intensified during periods of stress. The second type is tissue shrink which results in actual loss of body tissue. These types of shrinkage probably do not occur as two distinct phases of the shrinkage process. Rather, excretory shrink occurs during the early part of shipment, then at an undefined point both excretory and tissue shrink occur simultaneously. Toward the latter part of prolonged stress only tissue shrink is relatively important. Shrinkage involved in this study would necessitate the establishment of a third type of shrinkage, that caused by adhering exogenous material.

Transportation Shrinkage

Transportation shrinkage had not been investigated extensively until the last twenty years chiefly because of the difficulty in obtaining farm weights. Since then, various experiment stations have investigated transportation shrinkage. In transporting livestock, external influence as well as various animal factors affect the amount of shrinkage. The external factors include time, distance, method of transportation, and season of the year. The animal factors involved are animal weight and condition, breed, sex, and individual variation.

Effects of Time and Distance in Transit

Time and distance are both important factors in considering transportation shrink. Henning and Thomas (1962) studied shrinkage losses on 72 lots totaling 944 head with trucking distances mostly under 100 miles (161 km). They found 0.259% shrink in every 100 minutes of transit time and 0.881% shrink per 100 miles (161 km). They concluded that time in transit was slightly more important than distance hauled and that the two factors accounted for about one-third of the transit shrinkage.

Tippets et al. (1957) considered 242 shipments of 48,757 head with an average shrink of 6.66%. Shrinkage based on gross weight occurred at the rate of 1% per hour for the first 3 to 4 hours, then about 0.15% for the next 8 to 10 hours and 0.085% per hour for the remainder of the journey. Fat cattle enroute from 10 to 17 hours shrank 57% as much as other cattle in transit 84 hours or more. Bronson (1970) found fat cattle to shrink about 5% during the first 5 hours of transit, then 0.17% per hour for the next 25 to 30 hours. Self (1967) observed eight shipments with shrinkage ranging from 1.2% to 5.2%. He suggested from the data that slaughter cattle be shipped to market with as little time lapse as possible.

Wyckoff (1962) studied in transit shrinkage of slaughter steers finding that steers lost almost 3% for each additional 100 miles (161 km) hauled for distances between 100 (161 km) and 300 (463 km) miles.

Method of Transportation

Harston (1959) reported there is not much difference between trucking and shipping by rail. Cattle moved by rail shrank slightly more than those moved by truck for short hauls but less on longer hauls.

Season and Temperature Effects

Self (1972) collected data on 4,685 feeder cattle and found the following seasonal trend. Cattle purchased directly from ranches had the greatest percentage shrink during the summer (June, July, August) months (8.3%) and the least in the fall (October, November, December) months (6.4%). The shrink for cattle purchased at markets was quite uniform among the three seasons (9.1, 8.9, and 9.2%, respectively, for spring, summer and fall). Wyckoff (1962) found that time of year had an effect on shrinkage of slaughter steers. Steers in transit from 100 (161 km) to 150 (241 km) miles shrunk an average of 1% more from April through August than in other months.

Henning et al. (1962) divided 944 head of slaughter cattle into two temperature classes, below 75°F and over 75°F. The resulting regression coefficients indicated for every 10 degree increase in temperature, there is a 0.181% decrease in shrinkage. These workers suggested that temperature is not as large a factor as once was thought.

Tippets et al. (1957) studied the effect of season on shrinkage with two groups. The first group were all fat cattle including 1,243 shipments having 48,584 head. The highest shrinkage occurred during the summer months with an average of 7.32%. There was very little difference between the winter and spring shipments, which averaged 6.43 and 6.46%, respectively. The lowest total shrinkage occurred in shipments made during the fall months with an average of 6.07%. The second group represented records of a large packing company and involved 1,254 shipments and 49,686 head. These shipments originated from a particular region and were exposed to less extremes in climatic conditions. Analysis indicated little difference in the average percent shrinkage by seasons. Winter showed 5.22%,

spring, 5.25%, summer, 5.24%, and fall, 5.36%.

Tippets et al. (1957) considered the effect of temperature on transportation shrinkage. In an Arizona trial including 734 head, it was found that warmer days were associated with greater shrinkage. The regression value of shrinkage on temperature was found to be, b = .075 during the summer. This means that for each degree rise in temperature above the mean of 87.8°F, shrinkage rose 0.75%. A Colorado study involving 348 head showed no effect of temperature on shrinkage in either the winter or spring seasons, but summer and fall provided significant relationships. It was concluded that extreme temperatures such as occur during the summer season in the southern states do increase cattle shrinkage. But in the northern areas, the effect of high and low temperatures on shrinkage tend to cancel each other when studied by seasons. Bronson (1970) found temperature extremes can effect shrinkage to a large extent but other factors such as wind, rain, snow, humidity, and other wet weather conditions have more effect than temperature alone.

Effect of Weight and Condition on Shrinkage

Tippets et al. (1957) indicated that the percentage of shrinkage for fat cattle was greater during the first 9 hours in transit than for feeder cattle. However, from 10 hours and longer the percentage was greater in feeder cattle. Fat cattle in transit for 3 hours shrank 45% as much as fat cattle enroute 84 hours, while for feeder cattle, those shipped 3 hours shrank only 30% as much as feeder cattle shipped 84 hours or more. Roberts (1961) also reported that fat cattle shrank more than feeder cattle during the first few hours in transit. However, after the first few hours, feeders shrank more. The previous experimenters showed the

following results: hours in transit were 6, 15, 60 and 80; fat cattle shrinkage percentages were 5.4, 6.2, 8.2 and 10.8; and feeder cattle shrinkage percentages were 3.8, 8.2, 9.5 and 12.4, respectively.

Brotherton and Tippets (1957) reported that weight and finish of the animals appear to have little bearing on shrinkage rates, either for stocker-feeders or for fat animals. Conversely, Tippets et al. (1957) showed a low but positive correlation between shrinkage and carcass grade. Those steers with the highest dressing percentage shrank less. They concluded that fat animals shrank less than thinner animals but there is little evidence to support the assertation that heavier animals shrink less than lighter slaughter animals.

Breed Effects

Tippets et al. (1957) looked at 58 shipments of Herefords and Brahmas in an Arizona study. For the whole group, there was no significant difference between the breeds. For the 28 shipments made during the summer, a significant difference was found with the average shrinkage being 7.56% for Brahmas and 7.01% for Herefords with standard deviations of 1.25 and .74, respectively. They concluded that Brahmas shrink more during hot weather, but this is offset by slightly lower shrinks during the cooler months. In contrast Brotherton et al. (1957) found that Brahmas and Brahma crossbreeds shrank at almost the same rates as the English breeds.

Sex Effects

Tippets et al. (1957) looked at 215 and 575 lots of heifers and steers, respectively, during the various seasons of the year. The

distribution curve for both heifers and steers was very similar, with relatively little variation from the average. These workers found that heifers shrank more than steers, but there was no great difference except during the summer season when heifers shrank 7.38% as compared to 6.22% for steers. These workers reported a significant ($P < .05$) difference between seasons and between sexes. Roberts (1961) reported bulls generally shrank more than steers or heifers because of the disturbing influence of strange animals nearby.

Animal Variation

Self (1967) found on eight shipments of slaughter cattle extreme variation in the transfer and sale of finished cattle of similar weight, quality and history. Henning et al. (1962) agreed that considerable shrinkage variation existed between lots of livestock hauled the same distance or having equal time in transit. Tippets et al. (1957) explained daily changes in weight of cattle, resulting from hour to hour fill differences, are important factors to consider when calculating shrinkage. In any period throughout the day, some animals will have heavier fill than others, thus causing some of the wide variations in shrinkage of individual animals.

Unusual Conditions Affecting Shrinkage

There are a variety of unusual conditions in transportation shrinkage that are uncontrollable. Tippets et al. (1957) found that feeder cattle subjected to muddy and wet conditions had the highest shrinkage (16.26%).

There is no literature available on effect of mud, manure and other adhering material on fat cattle shrinkage.

Agitated Brine Curing Method

The hides studied in this project were cured using the agitated brine curing method. Biedermann et al. (1962) analyzed this method on an industry wide basis. They found that the raceways have 4 (1.81 kg) to 5 (2.27 kg) pounds of brine per pound of hide with a 95^{o} salinometer reading. Usually a bactericide was included to retard bacterial growth and the curing time is normally 24 hours. After curing, the hides were pulled from the raceway and allowed to drain for 48 hours. Hides were then salted and folded to be sent to the tannery. They found the weight loss in the brine raceway to be as follows: 3% loss due to trimming; 2% loss from blood and manure; 15 to 17% loss equalized by a 20 (9.09 kg) to 25 (11.36 kg) pound loss of water and an 8 (3.64 kg) to 12 (5.45 kg) pound uptake of salt. This adds up to 20 to 22% of the green hide weight. Since the 3% trimming loss and 2% blood and manure loss were not a factor in this experiment, we could anticipate a weight loss of somewhat less than 15% from the brine raceway.

EXPERIMENTAL PROCEDURE

Source of Material

This study involved 6 trials of slaughter steers and heifers and was conducted at Thies Packing Company, Great Bend, Kansas. Trial 1 through 5, involving 77 heifers and 60 steers occurred in the winter and spring of 1973 (trial 1 through 4 in February and trial 5 in April). Trial 6 with 30 heifers was completed in November, 1973. These slaughter cattle were individually identified and photographed for reference purposes and notes recorded on any abnormalities in mud deposition. The following information was also recorded: sex, apparent breed and live weight (Table 1). During the slaughter process, the complete hide was recovered and ear tagged to maintain individual identity. The hides were immediately trucked from Thies Packing Company 8 miles (12.9 km) to the Heizer By-Products Company, Great Bend, Kansas. At this point, a green hide weight was obtained. The unfleshed green hides were then placed in an agitated brine curing raceway for approximately 18 hours or until 7 a.m. the next morning. At this time, the hides were pulled from the raceway; placed on wooden stands and mud was completely removed manually; excess water stripped off; hide thickness measured at withers; and hair length recorded at withers and right flank. The hides were then allowed to dry 48 hours, and a cured hide weight was recorded.

TABLE 1. EXPERIMENTAL DISTRIBUTION

Day	Steer	Heifers	Herefords	Angus	Hereford x Angus	Charolais & Charolais x	Dairy Cross
1	---	20	12	2	1	3	2
2	30	---	29	---	---	1	---
3	---	30	20	3	4	2	1
4	---	27	11	8	7	---	1
5	30	---	8	14	3	4	1
6	---	30	10	12	4	3	1

Hide Weight Loss Determination

The amount of hide weight loss was determined by subtracting the dry cured hide weight from the green hide weight.

Muddiness Rating Determination

At the end of the experiment, using the photographs and notes recording any abnormalities in mud deposition, the cattle were sorted into four groups: Group 1 (clean) were cattle with no adhering mud; Group 2 (slightly muddy) had slightly muddy underline; Group 3 (muddy) were cattle with muddy hips and underline; and Group 4 (very muddy) had definitely muddy hips, sides and underline (Table 2).

TABLE 2. EXPERIMENTAL DESIGN

	Muddiness Rating[a]			
	1	2	3	4
Number of Observations	42	64	54	7

[a]1 (clean), 2 (slightly muddy), 3 (muddy), 4 (very muddy)

Pounds of Mud Determination

The pounds of mud were determined by assuming the group 1 cattle had no weight loss due to mud and that the hide weight loss was due to shrinkage during the curing process and this shrinkage was uniform among the other 3 groups. Thus, the pounds of mud were calculated by subtracting the hide weight loss of group 1 from hide weight loss of the other cattle.

Determination of Hide Thickness

Hide thickness was determined measuring the double thickness of the hide at the withers using a set of calipers. This measurement included hair, hide and underlying fleshing. Three measurements were taken: over the midline and 2 inches (5.0 cm) on both sides of the midline at the withers. These 3 measurements were averaged to obtain final hide thickness.

Determination of Hair Length

Hair length was measured at two locations, the withers and right flank. The hair in these areas was combed out then measured using a steel ruler.

Statistical Analyses

The statistical procedures followed were least squares analysis of variance, Kemp (1972). Significant mean differences were computed using Duncan's New Multiple Range Test according to Harvey (1960).

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Chapter 1

THE EFFECT OF MUD, MANURE AND OTHER ADHERING MATERIAL ON SLAUGHTER CATTLE SHRINKAGE

A recurring economic problem in the marketing of fat cattle is shrinkage loss due to mud, manure and other adhering material. No reports of any work on this problem can be found in the literature and the industry currently has no guidelines to use in the marketing of cattle that have quantities of mud on them.

Traditionally, shrinkage in beef cattle has been classified as two types: excretory shrink or loss of belly fill being one and tissue shrink which results in actual loss of body tissue being the second. Shrinkage involved in this study would by necessity be classified as a third type, that of adhering material. In transporting livestock, external influences as well as various animal factors affect the amount of shrinkage. The external factors include time, distance, method of transportation and season of the year. The animal factors involved are animal weight and condition, breed, sex and individual variation.

Tippets et al. (1957) found that shrinkage based on gross weight occurred at the rate of 1% per hour for the first 3 to 4 hours, then 0.15% for the next 8 to 10 hours and for the remainder of the journey, 0.085% per hour. Wyckoff (1962) showed slaughter steers lost almost 3% of their body weight during the first 100 miles (161 km) and about 1.03% for each additional 100 miles (161 km) hauled for distances between 100 (161 km) and 300 miles (483 km).

Wycoff (1962) reported that slaughter steers in transit from 100 (161 km) to 150 (241 km) miles shrank an average of 1% more from April through August than in other months.

Roberts (1961) found that fat cattle shrank more than feeder cattle during the first few hours in transit. However, after the first few hours, feeders shrank more.

Tippets et al. (1957) revealed that Brahmas shrank more during hot weather, but this is offset by slightly lower shrinks during the cooler months. These workers also found that heifers shrank more than steers, but there is no great difference except during the summer season when heifers shrank 7.38% as compared to 6.22% for steers.

Self (1967) encountered extreme variation in transfer and sale of finished cattle of similar weight, quality and history.

Experimental Procedure

This study involved 6 trials of slaughter steers and heifers and was conducted at Thies Packing Company, Great Bend, Kansas. Trial 1 through 5, involving 77 heifers and 60 steers, occurred in the winter and spring of 1973 (trial 1 through 4 in February and trial 5 in April). Trial 6, with 30 heifers, was completed in November, 1973. These slaughter cattle were individually identified and photographed for reference purposes and notes recorded on any abnormalities in mud deposition. The following information was also recorded: sex, apparent breed and live weight (Table 1). During the slaughter process, the complete hide was recovered and ear tagged to maintain individual identity. The hides were immediately trucked from Thies Packing Company 8 miles (12.9 km) to the Heizer By-Products Company, Great Bend, Kansas. At this point, a green

hide weight was obtained. The unfleshed green hides were then placed in an agitated brine curing raceway for approximately 18 hours or until 7 a.m. the next morning. At this time, the hides were pulled from the raceway; placed on wooden stands and mud was completely removed manually; excess water stripped off; hide thickness measured at withers; and hair length recorded at withers and right flank. The hides were then allowed to dry for 48 hours, and a cured hide weight was recorded. After trial 6, the cattle were sorted into muddiness groups (Table 2). Mud samples were collected during the experiment and oven dried for 2 weeks. The mud balls were found to have a moisture content of 18%.

TABLE 1. EXPERIMENTAL DISTRIBUTION

Day	Steer	Heifers	Herefords	Angus	Hereford x Angus	Charolais & Charolais x	Dairy Cross
1	---	20	12	2	1	3	2
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4	---	27	11	8	7	---	1
5	30	---	8	14	3	4	1
6	---	30	10	12	4	3	1

TABLE 2. EXPERIMENTAL DESIGN

	Muddiness Rating[a]			
	1	2	3	4
Number of Observations	42	64	54	7

[a]1 (clean), 2 (slightly muddy), 3 (muddy), 4 (very muddy)

The statistical procedures followed were least squares analysis of variance, Kemp (1972).

Results and Discussion

Experimental Means

The average live weight of the cattle in this study was 1006 pounds (457 kg) (Table 3). This represented a cross section of 107 heifers that averaged 942 pounds (428 kg) and 60 steers with an average live weight of 1134 pounds (516 kg) (Table 8). These animals were typical of the current weights of slaughter cattle. Mean surface area was 5.93 square meters. Surface area was calculated by taking weight in kilograms to the two-thirds power, Kleiber (1961). Thus, surface area was directly related to live weight. Green hide weight averaged 90.97 pounds (41.35 kg) (Table 3). This weight included any adhering mud that the live cattle were carrying and represented 9.04% of live weight. The mean cured hide weight was 77.94 pounds (35.43 kg) (Table 3). This represented 7.74% of live weight. Average weight of mud for the study was 8.58 pounds (3.90 kg) (Table 3) and represented 0.85% of live weight. The mean weight of mud was arrived by averaging 42 cattle from group 1, 64 from group 2, 54 from group 3, and 7 head from group 4. The distribution was heavily skewed toward the lower groups and explains the relatively low mean for mud weight.

Factors Effecting Weight of Adhering Material

Day had a highly significant ($P < .01$) effect on the weight of mud, manure, and other adhering material (Table 4). This effect can be explained through several factors. First, the degree of muddiness of

TABLE 3. EXPERIMENTAL MEANS FOR LIVE WEIGHT, SURFACE AREA, GREEN HIDE WEIGHT, CURED HIDE WEIGHT, AND WEIGHT OF MUD

	Experimental Means	
Live Weight	1006 (lb)	457 (kg)
Surface Area	7.18 (yd^2)	5.93 (m^2)
Green Hide Weight	90.97 (lb)	41.35 (kg)
Cured Hide Weight	77.94 (lb)	34.53 (kg)
Weight of Mud	8.58 (lb)	3.90 (kg)

TABLE 4. ANALYSIS OF VARIANCE FOR WEIGHT OF MUD, MANURE AND OTHER ADHERING MATERIAL

Source of Variation	d.f.	Mean Square
Day	5	101.33**
Breed	4	64.85*
Muddiness Rating	3	1022.08**
Flank Hair Length	1	7.68
Surface Area	1	48.21
Error	152	23.89

* ($P < .05$)

** ($P < .01$)

cattle was not constant from day to day, the cattle varied from very muddy on day 2 to clean on day 6. Secondly, day included a sex effect with heifers being used on day 1, 3, 4 and 6, while steers were studied on day 2 and 5. Also, weather conditions were variable over the six days and this affected hide weight loss during the 48 hour hide drying period. The February days (trial 1 through 4) were cooler than April and November days (trial 5 and 6, respectively). Finally, differences in brine concentration from one trial to the next could increase the significance of day effect.

Rating the cattle on muddiness was obviously successful since muddiness rating had a highly significant ($P < .01$) effect on weight of mud. Significant mean differences (Table 5) for hide weight loss with the muddiness ratings were computed using Duncan's New Multiple Range Test at the .05 level according to Harvey (1960). The mean hide weight losses were 4.44 (2.02 kg), 10.12 (4.60 kg), 17.26 (7.85 kg) and 27.65 (12.57 kg) pounds, respectively, for groups 1, 2, 3 and 4 as rated for muddiness (Table 5). To convert hide weight loss to weight of mud, the mean hide weight loss of group 1 [4.44 pounds (2.0 kg)] was subtracted from hide weight loss of the other groups. It can be concluded that the weight loss of group 1 was due only to hide shrinkage during the curing process as these cattle were clean. The 4.44 (2.0 kg) hide weight loss represented 4.88% shrink during the curing process. This shrinkage loss was considerably lower than 15% reported by Biederman *et al.* (1962). This difference is possibly due to shorter curing time (18 vs. 24 hours) and the addition of Syntalazene. Syntalazene is a hide curing agent which accelerates curing and assists moisture retention. Finally, no additional salt was added during the curing process as was done in the work reported by the

previous workers. In all probability, these three conditions all contributed to a lower shrinkage rate. The weight of mud was 0.00 (0.00 kg), 5.68 (2.58 kg), 12.82 (5.83 kg) and 23.32 (10.55 kg) pounds of mud for groups 1, 2, 3 and 4, respectively (Table 5).

These results indicate that cattle can be subjectively grouped by visual observation and certain assumptions can be made regarding the amount of mud being carried. When studying Table 5 and seeing the percent of live weight represented by mud of the various groups, the economic importance of being able to estimate the amount of mud on an animal becomes apparent. Groups 1 through 4 had an average shrinkage loss due to mud of 0.00, 0.56, 1.27 and 4.31%, respectively, [or 0.00 (0.00 kg), 5.68 (2.58 kg), 12.82 (5.83 kg) and 23.21 (10.55 kg) pounds of mud, respectively]. At a slaughter price of $45.00 per hundred weight, group 1 had a $0.00 shrinkage loss, group 2 lost $2.56 in mud shrinkage, group 3 lost $5.77 and group 4 showed a shrinkage loss of $10.44. The above price differences demonstrate the potential economic importance of muddiness as a bargaining point in the marketing of slaughter cattle. Figures 1 through 4 show a representative animal of each of the muddiness groups.

Breed had a significant effect ($P < .05$) on the weight of mud, manure and other adhering material (Table 4). Herefords had a significantly ($P < .05$) higher mean hide weight loss than the Angus or Charolais and Charolais crosses (Table 6). This relationship is unexplainable.

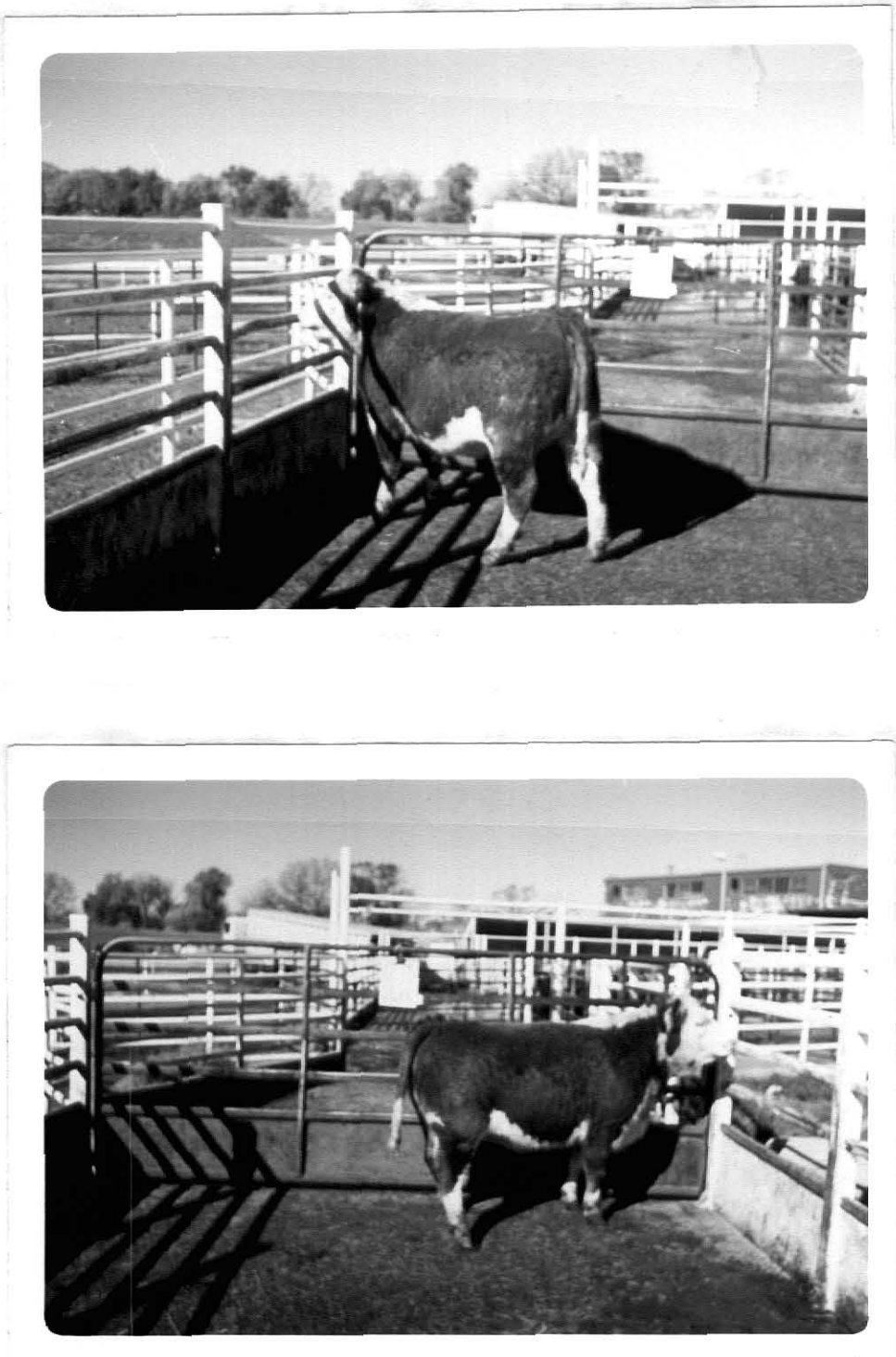
Flank hair length and hide surface area showed no significant effects in this study. However, surface area approached significance and had a probability of .16. For each 1.1 square yard (1.0 m^2) increase in surface area, the weight of mud, manure and other adhering material increases 1.48 pounds (0.67 kg).

TABLE 5. ADJUSTED MEANS FOR MUDDINESS RATING WITH HIDE WEIGHT LOSS, MUD WEIGHT, PERCENT SHRINK AND COST

Muddiness Rating	Hide Weight Loss lb.	Hide Weight Loss (kg.)	Weight of Mud lb.	Weight of Mud (kg.)	Percent Shrink of Live Weight	Cost at $45.00/cwt
1	4.44 ± 1.23^{a}	2.20 ± 0.56	0.00	0.00	0.00	$ 0.00
2	10.12 ± 0.86^{b}	4.60 ± 0.39	5.68	2.58	0.56	2.56
3	17.26 ± 0.99^{c}	7.85 ± 0.45	12.82	5.83	1.27	5.77
4	27.65 ± 2.09^{d}	12.57 ± 0.95	23.21	10.55	2.31	10.44

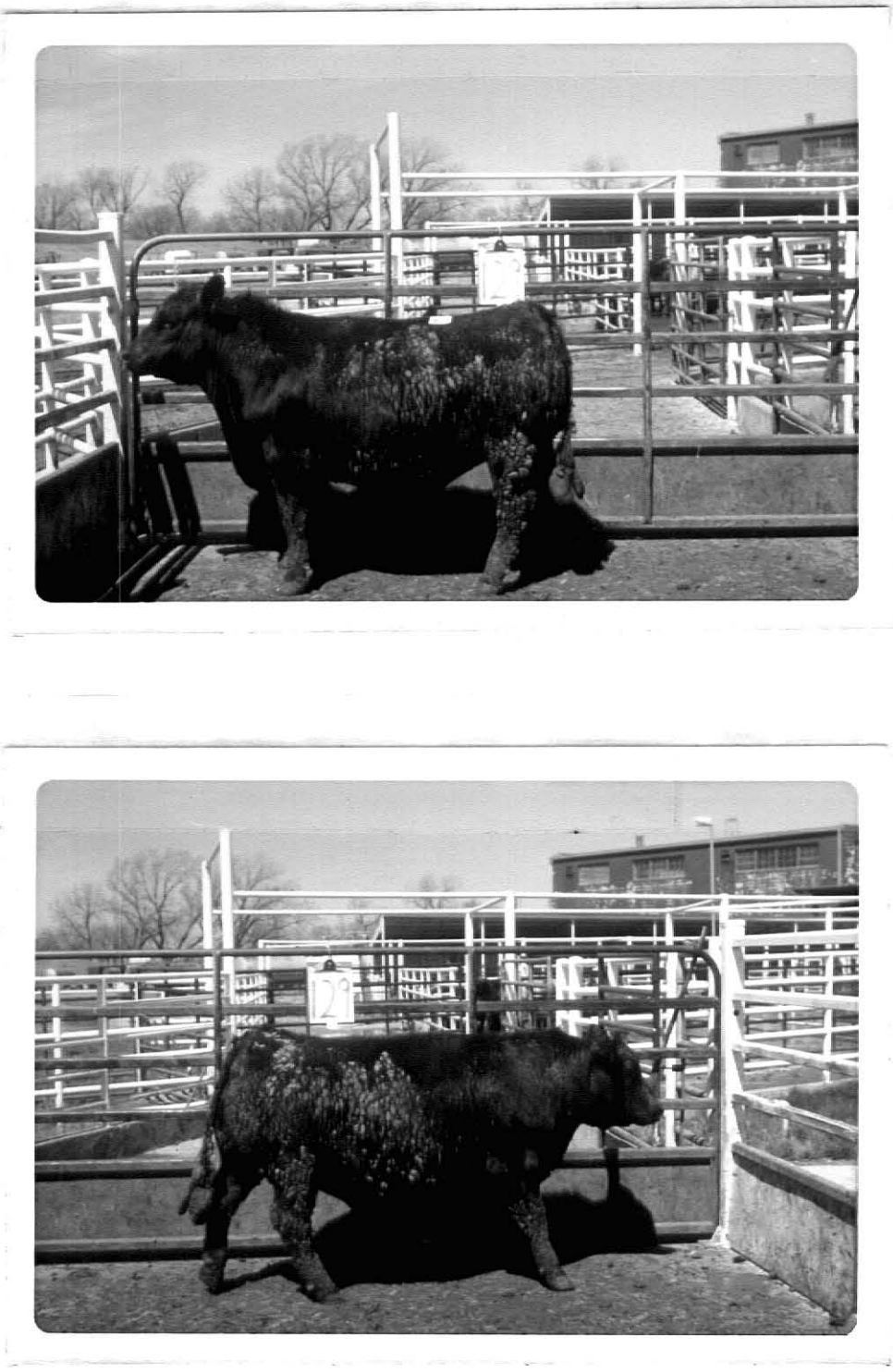
^{a,b,c,d} Means bearing a different superscript are significantly ($P < .05$) different.

Figure 1
Muddiness Group 1 (Clean)



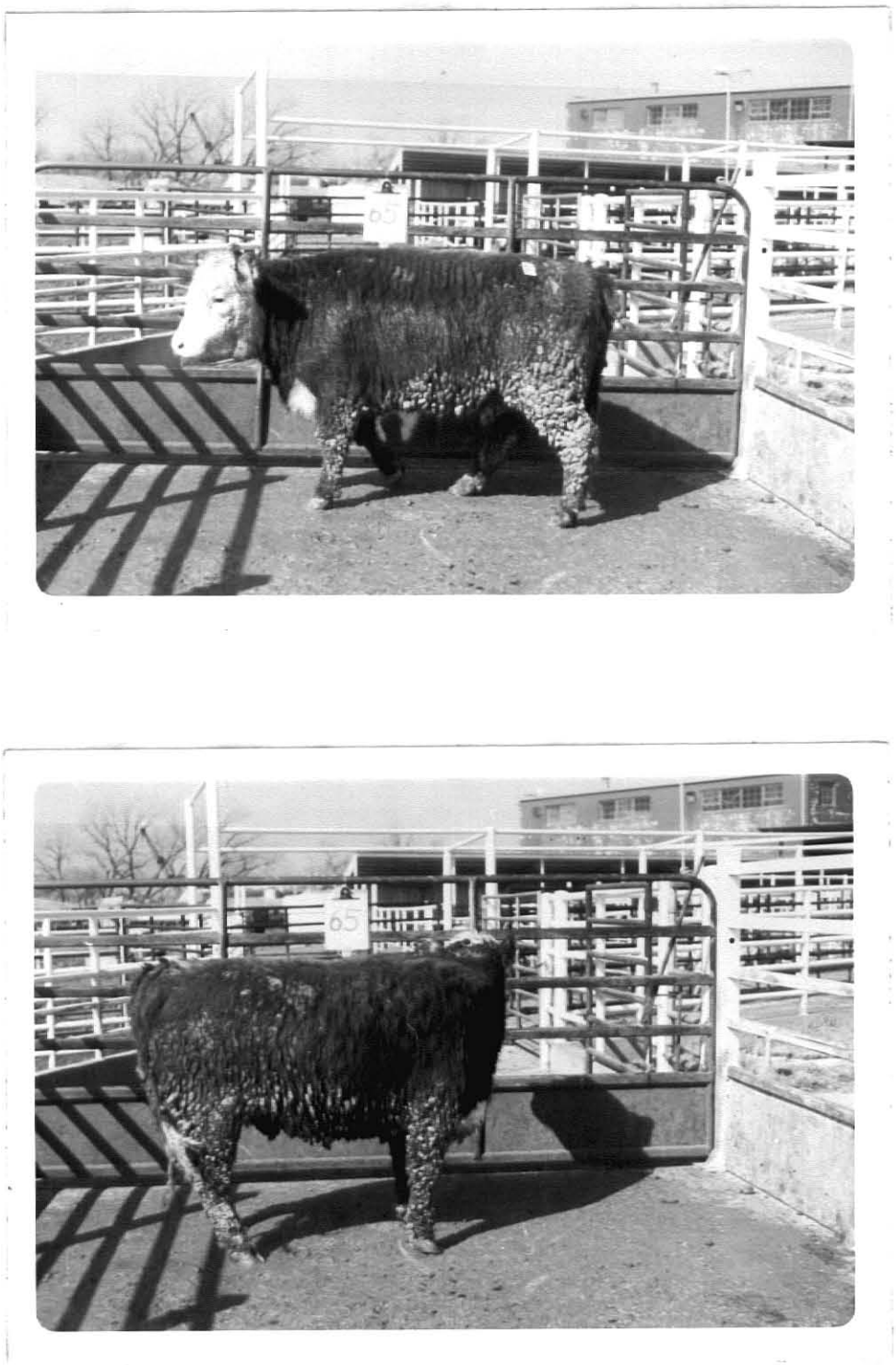
0.00 Pounds of Mud (0.00 kg)
0.00% Shrink
$0.00 @ $45.00/cwt

Figure 2
Muddiness Group 2 (Slightly Muddy)



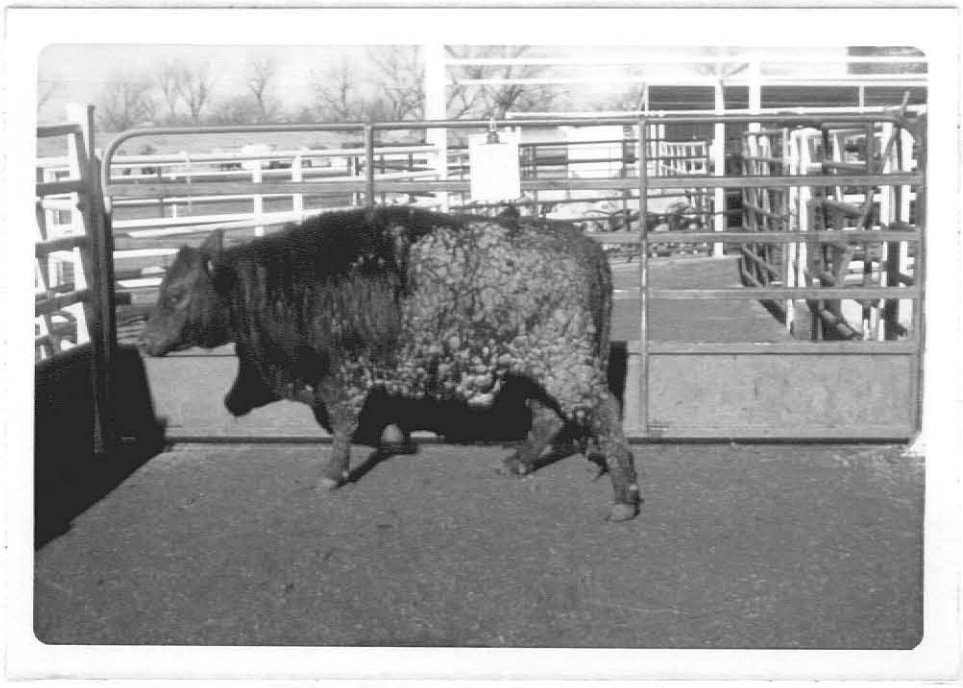
5.68 Pounds of Mud (2.58 kg)
0.56% Shrink
$2.56 @ $45.00/cwt

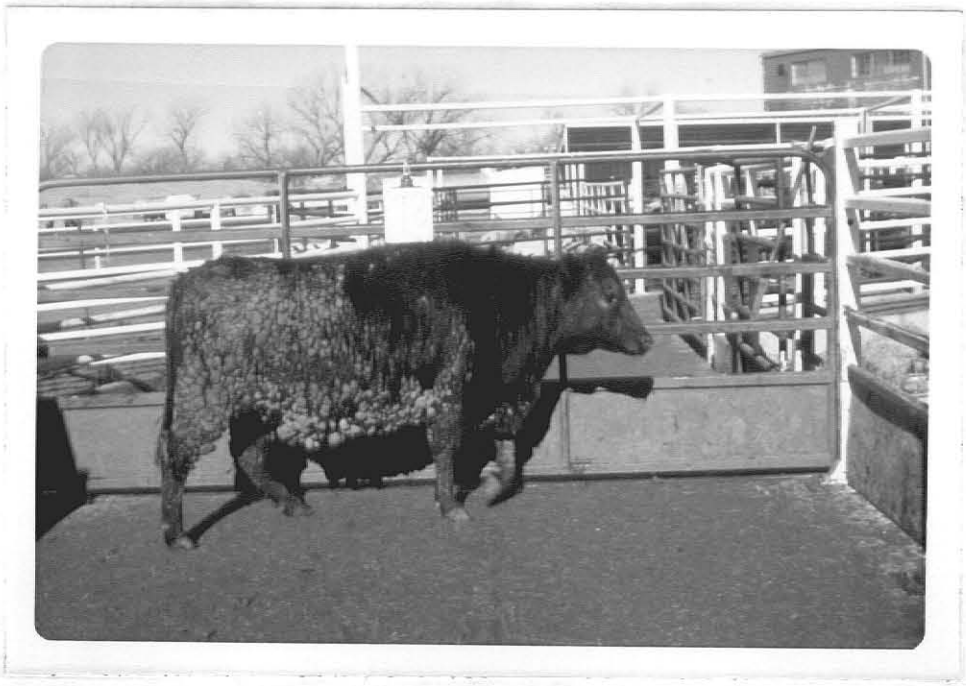
Figure 3
Muddiness Group 3 (Muddy)



12.82 Pounds of Mud (5.83 kg)
1.27% Shrink
$5.77 @ $45.00/cwt

Figure 4
Muddiness Group 4 (Very Muddy)





23.21 Pounds of Mud (10.55 kg)
2.31% Shrink
$10.44 @ $45.00/cwt

TABLE 6. ADJUSTED BREED MEANS AND STANDARD ERROR FOR LIVE WEIGHT, HIDE WEIGHT LOSS, HIDE THICKNESS, GREEN HIDE WEIGHT, CURED HIDE WEIGHT, FLANK HAIR LENGTH AND WITHER HAIR LENGTH

Breed	No. of Observations		Live Wt.	Hide Wt. Loss	Green Hide Wt.	Cured Hide Wt.
Herefords	90	lb.	1041 ± 11^{b}	17.27 ± 0.69^{ac}	98.55 ± 0.84^{c}	85.53 ± 0.84^{c}
		kg	473 ± 5	7.89 ± 0.31	44.80 ± 0.38	38.88 ± 0.38
Angus	39	lb.	989 ± 16^{a}	14.06 ± 0.96^{b}	81.32 ± 1.22^{a}	68.29 ± 1.22^{a}
		kg	450 ± 7	6.39 ± 0.44	36.96 ± 0.55	31.04 ± 0.55
Hereford-Angus	19	lb.	1066 ± 24^{b}	15.32 ± 1.27^{ab}	88.06 ± 1.79^{b}	75.03 ± 1.79^{b}
		kg	485 ± 11	6.96 ± 0.58	40.03 ± 0.81	34.10 ± 0.81
Charolais & Charolais X	13	lb.	1065 ± 28^{b}	14.13 ± 1.52^{b}	91.58 ± 2.18^{b}	78.56 ± 2.18^{b}
		kg	484 ± 13	6.42 ± 0.69	41.63 ± 0.99	35.71 ± 0.99
Dairy & Dairy X	6	lb.	1028 ± 42^{ab}	13.56 ± 2.12^{bc}	92.50 ± 3.11^{bc}	79.48 ± 3.11^{bc}
		kg	467 ± 19	6.16 ± 0.96	42.05 ± 1.41	36.13 ± 1.41

^{a,b,c}Means bearing a different superscript are significantly ($P < .05$) different.

TABLE 6 (Cont.). ADJUSTED BREED MEANS AND STANDARD ERROR FOR LIVE WEIGHT, HIDE WEIGHT LOSS, HIDE THICKNESS, GREEN HIDE WEIGHT, CURED HIDE WEIGHT, FLANK HAIR LENGTH AND WITHER HAIR LENGTH

Breed	No. of Observations		Hide Thickness	Flank Hair Length	Wither Hair Length
Herefords	90	in.	0.80 ± 0.02^{b}	0.93 ± 0.04	2.69 ± 0.09
		cm	2.04 ± 0.06	2.35 ± 0.11	6.82 ± 0.23
Angus	39	in.	0.70 ± 0.03^{a}	1.04 ± 0.06	2.58 ± 0.13
		cm	1.77 ± 0.08	2.63 ± 0.15	6.55 ± 0.32
Hereford-Angus	19	in.	0.75 ± 0.04^{b}	0.97 ± 0.08	2.62 ± 0.16
		cm	1.90 ± 0.11	2.45 ± 0.19	6.65 ± 0.40
Charolais & Charolais X	13	in.	0.87 ± 0.05^{b}	0.85 ± 0.09	2.40 ± 0.19
		cm	2.21 ± 0.13	2.15 ± 0.23	6.10 ± 0.48
Dairy & Dairy X	6	in.	0.77 ± 0.08^{bc}	0.95 ± 0.13	3.05 ± 0.27
		cm	1.95 ± 0.19	2.42 ± 0.33	7.74 ± 0.68

^{a,b,c}Means bearing a different superscript are significantly ($P < .05$) different.

Effect of Sex and Breed on Live Weight, Hide Thickness, Green Hide Weight, Cured Hide Weight, Flank Hair Length and Wither Hair Length

Sex effect was highly significant ($P < .01$) for live weight (Table 7) with heifers being significantly ($P < .05$) lighter than steers, 942 pounds (428 kg) as compared to 1134 (515 kg) (Table 8). Breed had an effect on live weight ($P < .05$) (Table 7). The adjusted breed means showed the Hereford-Angus crossbreds were the heaviest [1066 pounds (485 kg)] and the Angus the lightest [989 pounds (450 kg)]. Angus weighed significantly ($P < .05$) less than all other breeds, with the exception of the dairy and dairy crossbreds (Table 6). This demonstrates the heterosis advantage of the Hereford-Angus cross over straight bred Angus for slaughter weight.

TABLE 7. ANALYSIS OF VARIANCE FOR LIVE WEIGHT

Source of Variation	d.f.	Mean Squares
Sex	1	1368777.00**
Breed	4	28719.08*
Error	161	10242.63

** ($P < .01$)

* ($P < .05$)

Sex had a significant effect ($P < .01$) on hide thickness (Table 9). The sex means were significantly different ($P < .05$), with the heifers having a thickness of .70 inch (1.77 cm) and steers .87 inch (2.17 cm) (Table 8). Some of the difference could be explained by the heifers live weight being considerably lower than that of the steers. Breed also had

TABLE 8. ADJUSTED SEX MEANS AND STANDARD ERROR FOR HIDE THICKNESS, GREEN HIDE WEIGHT, CURED HIDE WEIGHT, FLANK HAIR LENGTH, WITHER HAIR LENGTH

Sex	No. of Observations		Live Weight	Green Hide Weight	Curing Hide Weight
Steers	60	lb.	1134 ± 17^{a}	96.10 ± 1.45^{a}	83.07 ± 1.45^{a}
		kg	516 ± 8	43.68 ± 0.66	37.76 ± 0.66
Heifers	107	lb.	942 ± 13^{b}	84.71 ± 1.02^{b}	71.68 ± 1.02^{b}
		kg	428 ± 6	38.50 ± 0.46	32.58 ± 0.46

[a,b]Means bearing a different superscript are significantly ($P < .05$) different.

TABLE 8 (Cont.). ADJUSTED SEX MEANS AND STANDARD ERROR FOR HIDE THICKNESS, GREEN HIDE WEIGHT, CURED HIDE WEIGHT, FLANK HAIR LENGTH, WITHER HAIR LENGTH

Sex	No. of Observations		Hide Thickness	Flank Hair Length	Wither Hair Length
Steers	60	in.	0.87 ± 0.04^{a}	0.75 ± 0.06^{a}	2.57 ± 0.13
		cm	2.17 ± 0.09	1.90 ± 0.16	6.53 ± 0.33
Heifers	107	in.	0.70 ± 0.03^{b}	1.14 ± 0.05^{b}	2.76 ± 0.10
		cm	1.77 ± 0.07	2.90 ± 0.12	7.01 ± 0.25

^{a,b}Means bearing a different superscript are significantly ($P < .05$) different.

an effect ($P < .05$) on hide thickness (Table 9). These data suggested that Angus cattle have significantly ($P < .05$) the thinnest hides of the traditional breeds of cattle but indicates that the other breeds involved in this study show no difference in hide thickness, but does not substantiate the idea that Herefords have the thickest hides. Flank hair length also showed a significant ($P < .01$) relationship with hide thickness (Table 9). Every .40 inch (1.00 cm) increase in flank hair length results in a .08 inch (0.20 cm) increase in hide thickness.

TABLE 9. ANALYSIS OF VARIANCE FOR HIDE THICKNESS

Source of Variation	d.f.	Mean Square
Sex	1	2.34**
Breed	4	0.47*
Live Weight	1	0.60
Green Hide	1	0.20
Cured Hide	1	2.05**
Wither Hair Length	1	0.26
Flank Hair Length	1	4.19**
Surface	1	0.55
Error	155	0.19

** ($P < .01$)

* ($P < .05$)

Sex, breed, live weight, hide thickness and weight of mud all were highly significant ($P < .01$) on green cured hide weight (Table 10). The adjusted sex means were significantly different with steer hides weighing

96.10 pounds (43.68 kg) and heifers 84.71 pounds (38.50 kg) (Table 8). Adjusted breed means showed the Angus to have the lightest green hide weight of 81.32 pounds (36.96 kg) that is significantly ($P < .05$) lighter than the other breeds. Herefords had the heaviest green hide weight of 98.55 pounds (44.80 kg) and were significantly different from the other breeds except the dairy and dairy crossbreds. As live weight and weight of mud increased by one pound (.45 kg) so did the green hide weight by .04 (0.02 kg) and 1.24 (0.56 kg) pounds, respectively. Hide thickness had a highly significant ($P < .01$) negative effect, with each .40 inch (1.00 cm) increased hide thickness resulting in a decrease of 3.53 pounds (1.06 kg) in green hide weight.

Cured hide weight showed the same relationships with sex, breed, live weight and hide thickness as green hide weight (Table 10). One unexplainable exception was that the weight of mud had a significant effect on cured hide weight. For every pound (.45 kg) increase in pounds of mud there was a .24 pound (0.11 kg) increase in cured hide weight.

Sex effect was significant ($P < .01$) for flank hair length (Table 11). The adjusted sex means were significantly different ($P < .05$) with steers having a shorter hair length of .75 inch (1.90 cm) and heifers 1.15 inches (2.90 cm) (Table 8). Green hide weight caused a .02 inch (.04 cm) increase in flank hair length for every pound (0.45 kg) increase. With every increase of .40 inch (1.00 cm) in hide thickness there was a .25 inch (.62 cm) increase in flank hair length. A pound (0.45 kg) increase in the weight of mud resulted in a decrease of .02 inch (.04 cm) in flank hair length. This could result from the fact that the more pounds of mud would require more manual scrapping and remove some of the flank hair.

TABLE 10. ANALYSIS OF VARIANCE FOR GREEN AND CURED HIDE WEIGHT

Source of Variation	d.f.	Mean Squares	
		Green Hide Weight	Cured Hide Weight
Sex	1	2621.65**	2621.67**
Breed	4	1950.47**	1950.48**
Live Weight	1	3061.96**	3061.98**
Hide Thickness	1	452.51	452.51**
Weight of Mud	1	11800.00**	428.85**
Error	158	55.36	55.35

** ($P < .01$)

TABLE 11. ANALYSIS OF VARIANCE FOR FLANK AND WITHER HAIR LENGTH

Source of Variation	d.f.	Mean Squares	
		Flank Hair Length	Wither Hair Length
Sex	1	15.37**	3.68
Breed	4	0.52	2.94
Live Weight	1	1.12	4.82
Green Hide Weight	1	14.18**	54.46**
Hide Thickness	1	13.12**	1.31
Weight of Mud	1	4.82**	1.62
Surface Area	1	1.04	3.52
Error	156	0.62	2.66

** ($P < .01$)

Sex and breed effect were not significant for wither hair length (Table 11). Green hide weight did have a significant ($P < .01$) effect for wither hair length. With every pound (0.45 kg) increase in green hide weight there was a .04 inch (.08 cm) increase in wither hair length.

Summary

It can be concluded from these findings that adhering material represents a third type of shrinkage and slaughter cattle can be grouped visually according to amounts of exogenous material with assumptions made based on this grouping about the number of pounds of mud, percent shrinkage and resulting price adjustments. The muddiness groupings rated in this study were: Group 1, clean; group 2, slightly muddy; group 3, muddy and group 4, very muddy with 0.00 (0.00 kg), 5.68 (2.58 kg), 12.82 (5.83 kg) and 23.21 (10.55 kg) pounds of adhering mud, respectively. The weight of mud constitutes a 0.00, 0.56, 1.27 and 2.31% shrink on a live weight basis for groups 1, 2, 3 and 4, respectively; and at a $45.00 per hundred weight cost represents $0.00, $2.56, $5.77 and $10.44 shrinkage loss due to mud. The economic importance of the above groupings should have a definite effect on the buying and selling of slaughter cattle.

Sex had a significant effect on live weight, hide thickness, green hide weight, cured hide weight and flank hair length. Breed was significant for live weight, hide thickness, green hide weight and cured hide weight.

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EFFECT OF MUD, MANURE AND OTHER ADHERING MATERIAL ON SLAUGHTER CATTLE SHRINKAGE

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ABSTRACT

This experiment was undertaken in an effort to determine amounts of mud, manure and other adhering material on fat cattle at the time of slaughter and its effect on live weight shrinkage. It was hoped that subjective visual scores could be established by which approximate degrees of muddiness of slaughter cattle could be determined. The project included 6 trials involving 107 heifers and 60 steers. Cattle were studied at Thies Packing Company, Great Bend, Kansas, and hide data collected at Heizer By-Products Company, Great Bend, Kansas.

The study indicates the necessity for the establishment of a third type of live animal shrinkage due to adhering exogenous material. It can also be concluded from these findings that slaughter cattle can be grouped visually according to amounts of adhering material and assumptions made based on the grouping about the number of pounds of mud, percent shrinkage and resulting price adjustments. The muddiness groupings are Group 1, clean; group 2, slightly muddy; group 3, muddy; and group 4, very muddy with 0.00 (0.00 kg), 5.68 (2.58 kg), 12.82 (5.83 kg), and 23.21 (10.55 kg) pounds of adhering mud, respectively. The weight of mud constitutes a 0.00, 0.56, 1.27 and 2.31% shrink on a live weight basis for groups 1, 2, 3 and 4, respectively. At $45.00 per hundred weight cost, the mud weight represents a $0.00, $2.56, $5.77 and $10.44 shrinkage loss, respectively, for the above groupings. The economic importance of the above groupings should be of obvious value for use when buying or selling slaughter cattle.