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Effects of Transportation, Handling and Environment on Slaughter Cattle. I. Weight Loss and Carcass Yield

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Weight loss or shrink in slaughter-weight cattle has long been recognized as an economic fact. However, there have been few systematic studies of the phenomenon. Data on weight loss during different transportation times and conditions have been reported (Abbenhaus and Penney, 1951; Harston, 1959). The influences of withdrawal of feed and water in connection with transportation were examined by Henning and Thomas (1962) and Talkes and Tilley (1975).

It is recognized that both fasting and transportation stress are usually imposed upon cattle being sent to market. The effects of these influences need to be studied separately. Self and Gay (1972) examined the location of shrink in the parts of the animal body and found that all parts lost weight during transportation. They also observed that weight recovery was much slower than weight loss.

This study was initiated to observe in detail the shrink in live slaughter-weight steers to determine the influence of time in transportation, withdrawal of feed and water, and climatic differences on the weight losses.

Materials and Methods

Trial 1. Twenty-four slaughter steers were purchased at a local feedlot. They were penned together without regrouping and had access to feed and water in feedlot conditions for three days. They were then weighed, blood sampled, loaded onto trucks and taken 83 km (52 miles) to

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the University of Missouri Beef Farm near Columbia, Missouri, where they were again weighed.

One-half of the animals were then taken on a trip of 1,419 km (882 miles) and the remaining animals were divided into four groups of three steers each. One group was slaughtered immediately. Another group was held for two days with access to feed and water in outside pens adjacent to the abattoir, then slaughtered. Two groups were held for seven days with access to feed and water in environmentally-controlled chambers at the Missouri Climatic Laboratory; one group at 20°C (64°F) and 75 percent relative humidity and the other at 32°C (85°F) and 50 percent relative humidity. Both groups were slaughtered following the holding period.

The lot of cattle that was transported the longer distance, upon return, was subdivided into the same groups as described above.

Trial 2. This trial involved three experiments of essentially the same design, but carried out under widely different environmental conditions. Experiment 1 was conducted in October, 1978, Experiment 2 in February, 1979 and Experiment 3 in August, 1979. Environmental conditions at these times were considered thermoneutral, stressfully cold and stressfully hot, respectively. In each experiment, 42 head of slaughter steers were selected and held for three days in feedlot conditions (as in Trial 1). They were weighed, blood sampled and transported by truck to the University Beef Farm, a trip of 83 km (52 miles). This facility was 10 km (6 miles) from the abattoir. Here they were again weighed and subdivided into seven groups as follows:

SHIS—Short haul (83 km), immediate slaughter.

SH2DH—Short haul, two day hold. The animals were held two days without feed and water, then slaughtered.

IHIS—Intermediate haul, immediate slaughter. The animals were transported an additional 600 km (373 miles), held overnight and slaughtered immediately the following morning.

IH2DH—Intermediate haul, two day hold. The animals were transported as above, but allowed one drink at unloading and held for two more days without feed and water, then slaughtered.

IH7DH—Intermediate haul, seven day hold. The animals were transported as above, but held for seven days with access to feed and water, then slaughtered.

LHIS—Long haul, immediate slaughter. The animals were transported 1265 km (788 miles) and then taken directly to slaughter.

LH2DH—Long haul, two day hold. These animals were hauled as above, allowed one drink upon unloading and held for two days without feed and water, then slaughtered.

The intermediate-haul groups returned to the abattoir in the evening of the day they were obtained from the feedlot and held overnight before slaughter. The long-haul groups returned the following morning, so both groups were slaughtered at the same time. Hence, the holding time for both groups was identical and they differed only in the proportion of that time that was spent in transportation.

Trial 3. Thirty-six head of steers were purchased commercially and placed on feed at the University Beef Farm. They received a standard finishing ration for six weeks. During that time, 30 of the steers were weighed individually twice a week to condition them to sorting and weighing operations. One group of six was not handled during this period. Six groups of six animals each were treated as follows:

(a) Control I. Conditioned animals taken directly to slaughter at the beginning of the experiment.
(b) Fasted. Conditioned animals held off feed and water for 22 hours, then taken directly to slaughter.
(c) Control II. Conditioned animals taken directly to slaughter at the same time as groups fasted and fasted-hauled.
(d) Fasted-Hauled. Conditioned animals held 17 hours without feed and water, hauled 80 km (50 miles) and taken directly to slaughter.
(e) Hauled. Conditioned cattle, transported 80 km (50 miles) directly from the feedlot to slaughter.
(f) NPC. Non-conditioned animals taken directly from their pens to slaughter.

In all trials, transportation conditions were as close as possible to those normally used in industry. When compartmentalized trailers were used, the animals were allotted to compartments to avoid possible positional biases for treatment groups. All animals were individually weighed at each loading point and immediately before slaughter. At slaughter, hot carcass weights were determined and yield was calculated on the basis of feedlot weight.

Results and Discussion

Trial 1. Cattle transported 83 km direct to slaughter lost 10.9 kg (24 lbs.), or 2.3% of body weight (table 1). When they were held for two days in an open lot with feed and water, they lost an additional 6.5 kg (14 lbs.) However, those held in the closer confinement of the environmental chambers for seven days lost an additional 20 kg (44 lbs.). Those held under high environmental temperatures lost no more than those held under thermoneutral conditions.

The steers that were transported 1,419 km directly to slaughter lost 32.4 kg (71 lbs.), or 6.6% of their body weight. Animals held for two days in open pens with access to feed and water regained almost nine kg of the lost

TABLE 1. WEIGHT LOSSES OF CATTLE IN TRIAL 1[a]

Treatment	Feedlot wt, kg	Shrink from feedlot to abattoir kg	Shrink from feedlot to abattoir %	Carcass yield based on feedlot wt, %
Short Haul				
Direct to slaughter	485.9	10.9	2.3	64.1
Held 2 days, open pen	459.5	17.4	3.7	63.5
Held 7 days, thermoneutral	472.8	33.9	7.2	62.1
Held 7 days, hot environment	474.0	26.0	5.6	62.1
Long Haul				
Direct to slaughter	489.1	32.4	6.6	61.2
Held 2 days, open pen	464.6	23.5	5.0	61.4
Held 7 days, thermoneutral	472.6	26.5	5.6	62.0
Held 7 days, hot environment	483.1	30.0	6.2	61.8

[a]Statistical analysis not performed.

weight, but those held for seven days in the environmental chambers did not signficantly regain weight. They did not, however, lose more weight as was observed in the short-haul group. Again, there was no difference in weight loss between cattle held at the high *vs* thermoneutral environmental temperatures.

It could not be determined whether the additional weight losses in cattle transported for the longer distance resulted from the handling and confinement of transportation or the withholding of feed and water for 24 hours.

Based on feedlot weights, carcass yields were lower for the short-haul cattle held in environmental chambers and for all cattle in the long-haul group than those for cattle slaughtered immediately after the short haul.

Because of small subset numbers, the data were not tested statistically.

Trial 2. Weight losses of as much as 45 kg (100 lbs.) occurred during the course of these experiments. However, up to 50% of the maximum shrink occurred during the first 50 km of transportation and the first four to five hours of holding (table 2).

In each distance group, animals that were held lost more weight than those sent directly to slaughter. This difference was greatest for the short-haul group. However, the intermediate and long-haul groups had access to water when they were unloaded. When the shrink data were corrected for water intake, the influence of holding animals for two days was similar, regardless of distance of transport (figure 1). The magnitude of shrink was also greatly increased when water consumption was

TABLE 2. WEIGHT LOSSES BY EXPERIMENT (TRIAL 2)

	Initial wt, (kg)				*Wt loss (kg)*				*Wt loss (%)*				*Carcass Yield (%)*			
Group	*Oct.*	*Feb.*	*Aug.*	*Mean*	*Oct.*	*Feb.*	*Aug.*	*Mean*	*Oct.*	*Feb.*	*Aug.*	*Mean*	*Oct.*	*Feb.*	*Aug.*	*Mean*
SHIS	503.4	519.5	509.5	511.8	23.2^{b}	23.7^{ab}	3.2^{a}	16.7^{b}	4.61^{b}	4.52^{ab}	0.63^{a}	3.25^{a}	59.7^{ab}	61.8^{a}	61.1^{b}	60.8^{b}
SH2DH	490.7	503.2	505.1	500.7	45.9^{d}	28.0^{ab}	45.9^{d}	40.0^{d}	9.35^{d}	5.54^{ab}	9.06^{d}	7.98^{c}	55.7^{c}	60.6^{ab}	57.1^{d}	57.8^{d}
IHIS	483.8	496.8	512.5	498.7	37.3^{c}	25.8^{ab}	34.9^{c}	32.7^{cd}	7.70^{c}	5.20^{ab}	6.81^{c}	6.57^{bc}	57.7^{b}	60.0^{b}	58.0^{d}	58.7^{d}
IH2DH	480.5	494.7	495.6	491.3	45.0^{cd}	30.2^{b}	42.1^{cd}	39.2^{d}	9.34^{d}	6.09^{b}	8.52^{d}	7.98^{c}	57.1^{b}	59.3^{b}	58.1^{d}	58.3^{d}
IH7DH	487.4	496.5	483.6	490.2	9.3^{a}	17.9^{a}	0.2^{a}	9.2^{a}	1.96^{a}	3.65^{a}	0.05^{a}	2.08^{a}	61.9^{a}	61.2^{a}	62.9^{a}	62.1^{a}
LHIS	496.7	480.9	499.8	493.5	38.2^{cd}	20.9^{ab}	34.8^{c}	31.4^{c}	7.69^{c}	4.26^{ab}	6.97^{c}	6.31^{b}	57.6^{b}	60.3^{ab}	58.2^{d}	58.7^{d}
LH2DH	510.4	514.7	505.6	511.5	44.8^{cd}	31.3^{b}	25.0^{b}	34.0^{cd}	8.81^{cd}	6.05^{b}	4.94^{b}	6.60^{bc}	58.1^{b}	59.9^{b}	60.9^{c}	59.7^{c}

^{a,b,c,d}Means in the same column with the same superscript do not differ (P>0.05).

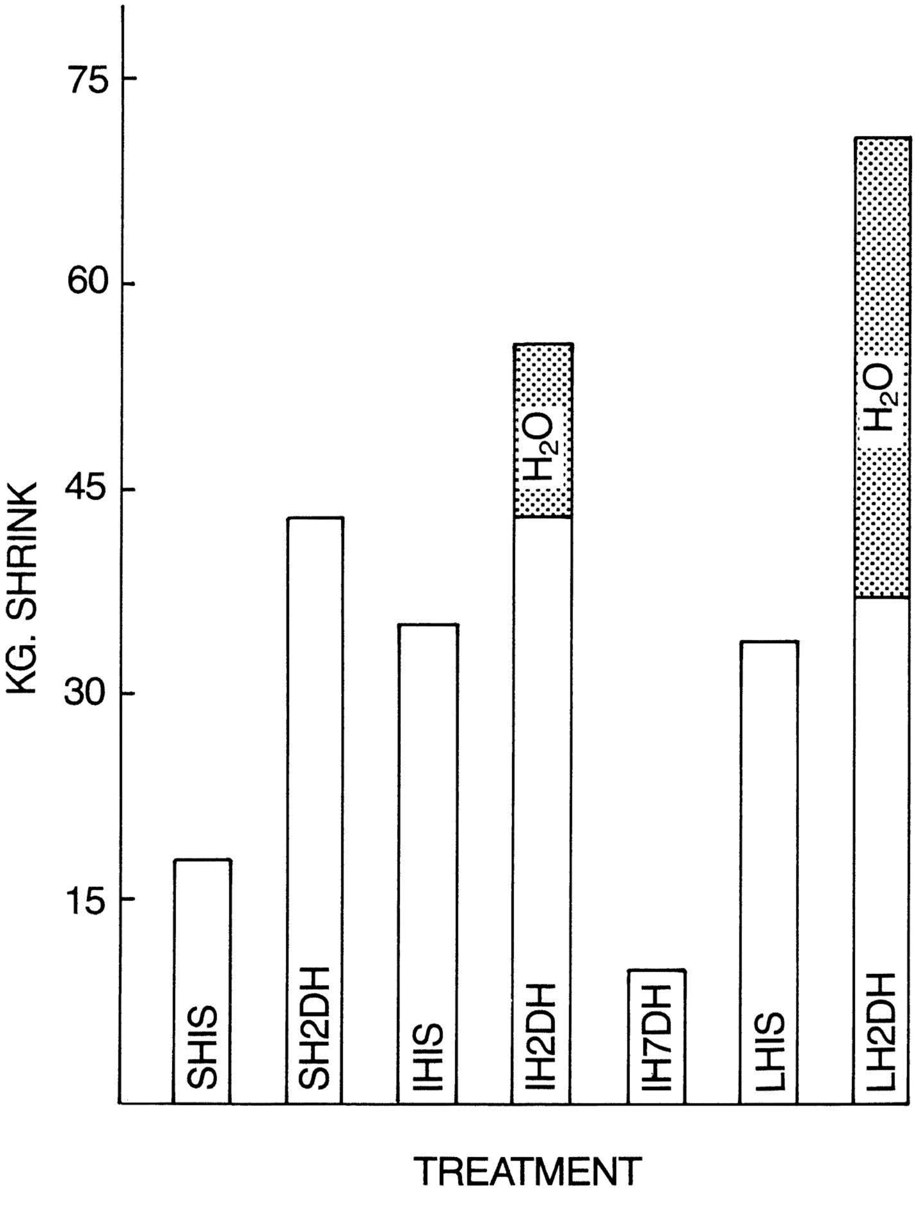

Figure 1. Weight loss by treatment in Trial 2. The dappled areas represent the water intake following transportation.

included in initial weight. Data that include water consumption are theoretically more correct than those based on feedlot weight. However, water intake data were obtained on a group basis and could not be treated statistically.

Differences between the intermediate-haul and long-haul groups were very slight. This suggests that transportation of animals causes essentially no increase in shrink when compared with holding animals in confinement without feed or water.

Animals that had access to feed and water for seven days lost the least amount of weight. In fact, many individuals regained their original weight and even more. This is in contrast with the results in Trial 1 where feed and water did not prevent further losses. However, in Trial 1, the animals were confined indoors in close quarters, whereas, in Trial 2 the steers were in an outside feedlot under conditions more similar to their origin. In spite of this, they still did not regain, on the average, their original weight.

Carcass yield on the basis of feedlot weight for all groups except IH7DH and SHIS averaged over 2% less than for the SHIS group (table 2). This represents approximately a 10 kg (22 lbs.) decrease in carcass weight associated with holding and transport and is consistent with the results from Trial 1. This represents over 50% of the incremental loss of gross live weight compared with the SHIS animals. This observation, coupled with the difficulty with which the original weight loss was regained, suggests that weight losses experienced during the handling and transport involved physiological changes more substantial than temporary loss in gut fill or superficial dehydration. The rapid early loss of weight indicates that the stress of handling may initiate these physiological processes.

The three experiments were conducted under as similar conditions as possible so that the main difference between experiments would be to climatic conditions. During the October trial, the mean daily temperature in Columbia, Missouri was 9°C (44°F) and the extremes for the trial period were 2°C(27°F) and 20°C(64°F). For the February trial, the corresponding values were -12°C(15°F), -26°C(-15°F) and -1°C(30°F), and for the August trial they were 28°C(82°F), 19°C(63°F) and 35.5°C(95°F).

Weight losses in the October trial were significantly greater than in either of the other trials (figure 2). This was true whether or not correction was made for water consumption.

The design of the trial was such that it was not possible to determine with any confidence that the increase in weight loss was associated with the climatic conditions. However, the difference was so striking and the environmental temperatures for each experiment were so dissimilar that possible biological mechanisms ought to be considered. If stress is a determining factor in weight losses during handling and transportation, then it is possible that the animal responds to incremental stressors. It can be assumed that abnormally high or low environmental temperatures by

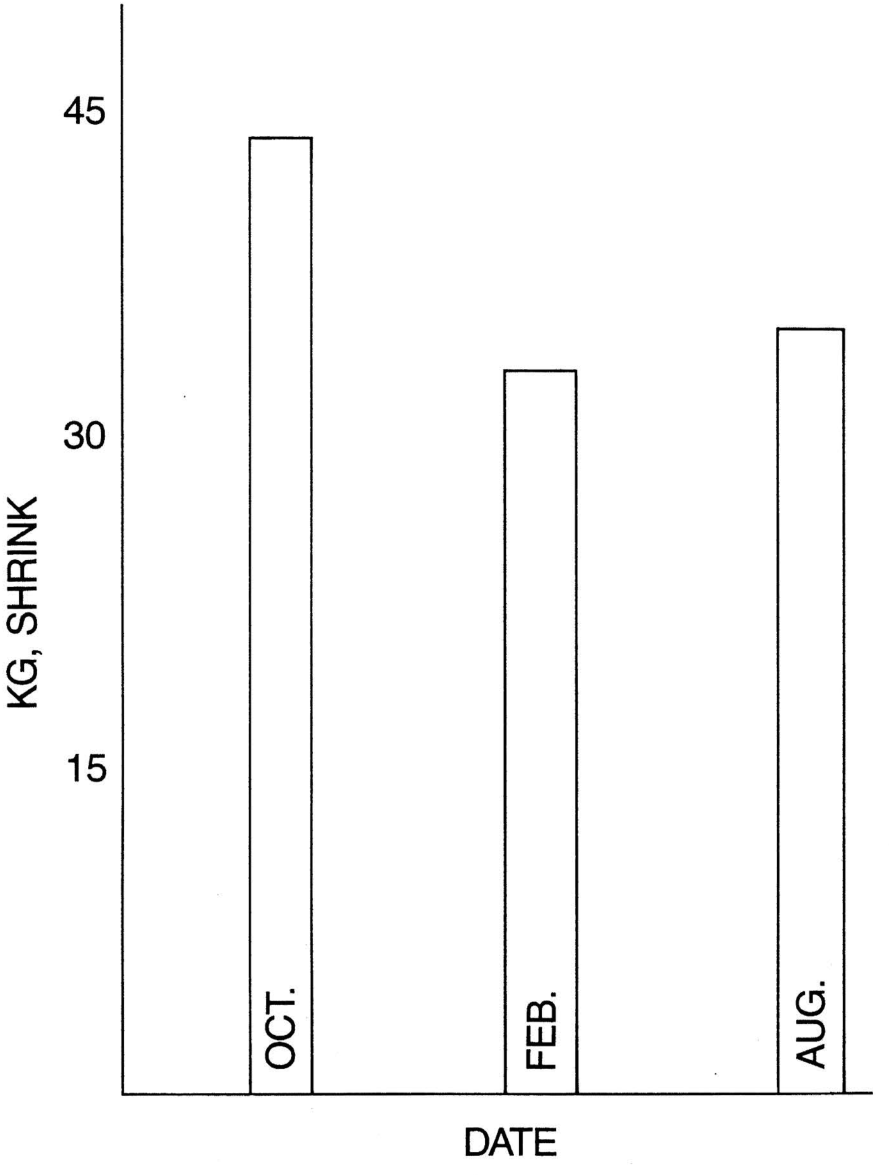

Figure 2. Weight loss by season in Trial 2. Average overall treatments.

themselves were stressful. The animals under the cold and hot conditions would, therefore, be already subject to stress so that the increment of stress during handling and holding would be less for such animals. It is also possible that the temperature-stressed animals had undergone some adaption to stress before the additional stress of handling. It might also be postulated that the handling and transportation conditions may mitigate some of the stress of the feedlot environmental temperatures. None of these hypotheses can be tested with the current data, but they should provide fruitful areas of future research.

It can be seen with some clarity that at least stressful environmental temperatures did not increase weight loss during handling and transportation. This is at variance with the data reported by Harston (1959), but exact details of the experimental conditions for those data were not reported. Hahn *et al.*, 1978, observed a slight increase in weight loss with increasing environmental temperature in animals held in environmentally controlled chambers, but the environmental extremes obtained did not correspond to the conditions of the present experiment. It would be logical to assume greater water losses by animals at high temperatures with low relative humidities, but the present experiment did not include such conditions.

Trial 3. There were smaller weight losses among animals in Trial 3 than among animals of the other trials, but the longest time between withdrawal of feed and slaughter was 22 hours (table 3). There was no difference in shrink between animals transported and fasted and those that were simply held for the same length of time. This suggests that the emotional and environmental insults connected specifically with transportation are not a significant factor in weight loss. It appears that withholding of feed and water from an animal otherwise environmentally disturbed by handling and confinement is the major influence on weight

TABLE 3. WEIGHT LOSS (TRIAL 3)

Treatment	*Feedlot wt*	*Abattoir wt*	*Shrink*	*Shrink*	*Carcass yield*
	kg			%	
Control 1	473.5	469.8	3.7[a]	.8[a]	60.8
Fasted	474.7	450.9	21.8[b]	4.6[b]	62.3
Control 2	490.8	486.1	4.7[a]	1.1[a]	61.5
Fasted-Hauled	481.7	460.9	20.8[b]	4.3[b]	62.9
Hauled	466.3	462.4	3.9[a]	.8[a]	61.2
NPC	495.6	490.8	4.8[a]	1.0[a]	61.6

[ab]Means in the same column with a different superscript differ (P>.05).

loss. The influence of handling, confinement, etc., as opposed to the simple withholding of feed and water could not be determined in this experiment. It would be extremely difficult to isolate the influence of handling, confinement, etc. because the experimental observations such as identification, weighing and sorting are major disturbances in themselves. In this trial they were as minimal as possible.

There was no significant influence of conditioning by regular handling. Empirical observations seemed also to indicate that behavorial stress was no greater for animals that had not been handled regularly before the slaughter date. A longer and more intensive conditioning treatment may have shown some advantage, but such treatment could very conceivably influence feedlot performance.

The findings emphasize the substantial nature of weight loss during transportation of slaughter cattle. Although this is recognized by the marketing system, the actual extent of losses may be greater than generally presumed.

Two aspects of these data appear to be significant in a more realistic understanding of the nature and extent of shrink. The first is that weight losses appear to occur in body tissue and the proportion of weight lost as gut fill is smaller than had previously been assumed. This fact has serious implications upon the methods by which animals are handled subsequent to sale but before slaughter. Not only quantity, but quality of product may be affected by this tissue weight loss.

The second aspect that needs to be considered is the difficulty with which lost weight is regained. Perfunctory feed and water offerings to cattle under the stress and disruption of handling and transportation is likely to be even less effective than the realimentation regimens used in this experiment which took at least seven days to restore the weight losses occasioned by 48 hours of fasting and handling.

Animals in this trial were weighed, but not bled at the feedlot. The hauled and faster-hauled groups were loaded into a low goose-neck trailor and hauled about 80 km. Thus, they were exposed to no more stress than those that went directly to slaughter. The hauled group was slaughtered the same day as Control 1. This brief, mild stress did not result in shrink greater than that observed for the controls. This indicates that handling and hauling conditions can be manipulated to reduce weight losses, at least in certain circumstances.

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