Evaluation Of High Moisture And Dry Feed Both With And Without Hay Fed To Feeder Calves Subjected To Transportation Shrink.

by

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Abstract

Two backgrounding trials were carried out to evaluate the effects of diet on shrink both with and without hay offering 48-h prior to shipment, as well as subsequent weight recovery post-shipment. In trial 1, forty-eight British x Continental steers (initial BW 351 kg) were assigned randomly to one of two diets and fed for a 45-d period (four steers/pen; three pens/diet). Diets, on a dry matter basis, were as follows: 1) 82% corn silage and 18% pelleted corn gluten feed (HM), 2) 20% pelleted corn gluten feed, 40% pelleted peanut hulls, and 40% soybean hull pellets (DF). On day 45 half of the steers from each pen were shipped, while their pen mates remained in their respective pen of origin (24 shipped; 24 unshipped). Steers remained on the trailers for twenty-one hours to simulate transport from the southeastern stocker operation to a great plains feedlot. Shipped calves were returned to their pen of origin, weighed immediately upon arrival, 30-h post-shipment, then at 24-h increments throughout day 6 to monitor diet effects on weight recovery. Trial 2 was identical to the previous trial, in terms of experimental design, with the exception of the number of calves used and the length of the backgrounding period. One hundred eighteen calves were used (54 heifers; 64 steers; initial BW 297 kg; 320kg, respectively). Diets were fed for 49 d as opposed to 45 d the previous year. A total of 59 calves shipped, while the other 59 remained in their pen of origin. Shipped calves were returned to their pen of origin, weighed immediately upon arrival, 30-h post-shipment, then twice daily the following 7 d, on day 11 and day 15 recording an average weight for those days. For trial 1, shipped calves shrank 7.1%, and body weights remained different throughout the recovey period ($P < 0.01$). In experiment 2, shipped calves shrank 8.4% and body weights remained different ($P < 0.01$) for shipped calves vs unshipped calves throughout the recovery weigh period. HM, DF, or hay offering had no effect on shrink in either year, yet hay offering prior to shipment did effect post transit weight recovery in trial 2 ($P < 0.05$). In summary, feeding HM or DF had no effect on shrink or subsequent BW gain after transportation. Offering hay 48 h prior to shipment had no effect on shrink but did alter BW gain following 21 h of transportation.

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INTRODUCTION

The southeastern United States provides many opportunities to the stocker producer. One of the biggest advantages that exists in this region is the ability to produce large quantities of high quality cool-season forages. Another is the historical availability of by-product feedstuffs, that can be utilized as a supplement to winter grazing, or used solely fed in a dry-lot system. The goal in either scenario is to obtain BW gains of 0.68 to 1.13 kg/d with minimal input costs. A variety of feedstuffs have been used to put inexpensive gains on cattle; however, with feed prices rising, producing inexpensive gain is quite challenging. Feeder cattle market trends also are in favor of southeastern stocker producers that utilize cool-season forages. Historically, the Alabama price cycle shows that October is often the purchasing month, with the highest price index being in August. Most stocker calves are maintained until forage is depleted, which is typically April or May then sold, though this is not the peak price index for this class of cattle, the price index is in the upswing (Prevatt et al., 2010). Since United States feedlots are geographically concentrated in the great plains states (Minert, 2003), southeastern stocker cattle must undergo lenghty transport. Grandin (1997) stated that both transportation-related handling and travel have been identified as potentially stressful events for cattle, and can be detrimental to BW gain and subsequent BW recovery (Crookshank et al., 1979). While it is known that transport stress induces many physiological changes, the one that is still a complex puzzle is transportation shrink.

Shrink is a major factor in the marketing of feeder cattle. Shrink represents a cost to both the buyer and seller of cattle through lost BW, and is especially important for longhauls (20+ h) from southeastern backgrounders to midwestern feedlots. Shrink occurs in two forms: 1) loss of body fill and 2) loss of tissue fluids, which is observed during longer periods of transport. Fill shrink is recovered in a fairly rapid manner, while tissue shrink can take days, maybe weeks to recover lost BW. Shrink is effected by numerous factors; which include, but are not limited to, time of gathering, handling procedures, climate, and diet. In many instances it is estimated that shrink can lead to a loss in calf value exceeding $10/hd, and in some instances, it may exceed $25/hd (Coffey et al., 2001). Some conditions remain beyond human control in effecting shrink such as a bad storm, unusually hot day, and bad road conditions; however, Barnes et al. (2007) stated that careful planning and management can provide some control over other unusual conditions that affect shrink. Most research evaluating shrink has been conducted with stocker cattle coming off of wheat pasture. Few studies have evaluated shrink following a drylot-backgrounding type scenario. There are data stating the implications of implementing backgrounding in a preconditioning program; however, the scientists were interested in morbidity and mortality and how backgrounding in a preconditioning program may help reduce these instances (Swanson and Morrow-Tesch, 2001; Prichard and Mendez, 1990).

REVIEW OF LITERATURE

Shrink

The majority of beef cattle raised in the United States will undergo transportation at least once in their lifetime, which is considered one of the most stressful events that cattle will undergo during their lives (Swanson and Morrow-Tesh 2001). Many factors are involved in the complex issue that is termed “transport stress.” Included in this list of factors is pre-transport management, noise, crowding, climatic factors (temperature, humidity) loading and unloading, time of transit, types of feed, and time of gathering (Barnes et al., 2007; Swanson et al., 2001). These factors lead to a loss of bodyweight during transportation, which is termed shrink. Shrink is usually considered as loss of fill and excretions of feces and urine, but loss of fluid from animal tissue also may occur (tissue shrink) (Barnes et al., 2007; Coffey et al., 2001). Fill shrink is recovered in a short period of time after feed and water intake returns to normal. Warriss (1990) and Barnes et al. (2007) stated the main factors which influence gut fill associated with shrink, and therefore initial liveweight loss, were recent water consumption and the amount and quality of feed consumed, with animals on high-roughage pasture having larger weights of gut contents than those fed grain diets. Tissue shrink is a decrease in the weight of the carcass and other body tissues, which can exceed 60% of the total BW loss (Coffey et al., 2001). This type of shrink is primarily the result of extra-cellular fluid loss. Tissue shrink is generally associated with long haul periods without feed and water (Barnes et al., 2007). The time for which cattle are transported, rather than distance appears to be the important factor (Warriss 1990). Self and Gay (1972) studied a large number of feeder cattle transported over a range of distances from 240 to 1800 km. The regression coefficient indicated that percent shrink had a positive regression of 0.38 percentage points per 100 km deviation from the mean shipping distance of 1,023 km. From a separate experiment, they estimated that slightly less than one-half (46.7%) of total shrink was caused by loss of gut contents, leaving the remaining shrink (53.3%) in the form of actual body tissue (carcass, hide). Length of time cattle are fasted has an impact on both amount and type of shrink. Cattle begin to lose BW at the time they are moved. An often overlooked phenomenon is the time cattle are gathered and sorted. Cattle, gathered at first daylight, have had little or no time to graze, whereas animals gathered mid-morning have finished their major grazing period of the d and have watered. Shrink occurs rapidly during the early part of transport, plateaus, then gradually increases. Cattle will lose approximately 1% BW/h for the first 3 to 4 h (Barnes et al., 2007). Coffey et al (2001) showed similarities with Barnes et al., (2007) and stated that shrink can range from approximately 0.75% to 1.25% of BW/h during the first 3 to 4 h. Rate of shrink during later or longer periods of feed and water deprivation is much more variable, but is generally lower than during initial hours. Environmental conditions impact cattle shrink as well, and as temperatures rise, rate of shrink tends to hasten as well. Self and Gay (1972) reported a tendency for stocker calves to shrink more when shipped in summer compared with those shipped in fall or spring if calves were shipped directly from the ranch to feedlots. Interestingly, they found the trends negated if calves were transported to a sale yard prior to shipping them to the feedlot. In a study conducted by Phillips et. al (1991), steers transported when ambient temperature was 18 to 34°C lost 15.8% more BW relative to their initial BW than steers transported when ambient temperature was -16 to -6°C. Both fecal and urine output (kg and % of initial BW) were less when ambient temperature was greater; therefore, the increased BW lost during higher ambient temperatures is a result of a greater proportion of respiratory loss, probably at the expense of fluid from body tissue. It has long been known that the way cattle are handled also influences the amount of shrink. Self and Gay (1972) indicated that cattle shrank less when they were handled as quietly as possible upon removal from pen, or pasture, and transported directly to their final destination. Although data concerning the effects of cattle disposition on shrink and BW recovery have been inconclusive, Voisinet et. al (1997) concluded cattle with a quieter and calmer temperament had higher feedlot gains. It is logical to believe that the type of diet cattle are consuming pre-transport would have a significant impact on shrink due to the variability in nutrient content, rate and extent of digestion, which may lead to a variability in feed intake. However, results have been inconsistent. Phillips et al. (1985) reported that steers fed hay had greater BW loss during both 13- and 46-h trucking than steers fed a 50% concentrate diet. Subsequently, Cravey et al. (1991) stated that cattle on lush green grass will shrink more than if they were consuming a less digestible dried grass hay. Hutcheson et al. (1984) fed steers diets of hay or 55% concentrate prior to shipment from east Tennessee to the Texas panhandle in two trials. Results varied between the two trials. In Trial 1, little difference in shrink was observed as a result of pre-shipment diet; however, in Trial 2, steers fed hay had less shrink than those fed the 55% concentrate diet. Cole and Hutcheson (1985; 1987) fed diets varying in roughage concentration or fed different amounts of a 35% roughage diet before fasting and surmised that cattle fed a 35% roughage diet tended to shrink less than those fed a higher roughage diet, but allowing ad libitum access to the roughage diet resulted in greater shrink than feeding restricted levels of the diet. Definitive research evaluating pre-shipment diets and management has produced variable results (Coffey et al., 2001). Little research has been conducted to evaluate diet effects on shrink especially in drylot conditions. Most research conducted on this topic deals with wheat pasture grazing, and/or a backgrounding system where the same base diet exists, but they either alter the amount of feed offered (limit vs. ad libitum) or try to manage shrink with implementation of some type of high roughage/fiber component before the onset of transportation. Similar to dietary effects across trials, preconditioning effects on shrink also have produced variable results. Preconditioning (vaccination, castration, dehorning, and weaning) programs have been developed to increase health of calves sent to feedlots and decrease the effect of transport stress. Preconditioning was not found to reduce weight loss following transport in several studies (Cole and Hutcheson, 1985; Pritchard and Mendes, 1990). Woods et al. (1973) reported 22.8% less shrink in calves that were preconditioned compared with those removed directly from their dams before shipment. Similar to Cole and Hutcheson (1985), Prichard and Mendes (1990) showed no difference in BW loss following transport; however, in a second trial they reported that preconditioned calves displayed a tendency for greater shrink (8.8%). With that, one could also conclude that preconditioning effects on shrink have varied in results, and proves that shrink is a much more complex physiological change that one can not simply answer, at this time, by encouraging producers to precondition, background, or to follow a specific diet regime. Although preconditioning did not reduce BW loss post-transport, Swanson and Morrow-Tesh (2001) showed backgrounding (with vaccinations) for 30 to 45 d after weaning was effective for reducing mortality in calves arriving at feedyards. While many consequences of transport stress have been reviewed, they have not thoroughly addressed the factors that affect the magnitude of BW loss from stressed cattle during transport. Numerous trials have been conducted evaluating various factors associated with shrink; however, few data exist that evaluated recovery time or subsequent BW gain in calves following transportation. Many factors influence the time required for cattle to regain gut fill and tissue shrink. A few of these factors include; amount of shrink and type of shrink, cattle health, type of diet, and weather conditions (Barnes et al., 2007). Cravey et at. (1991) stated that cattle consuming a high moisture diet and experiencing primarily fill shrink had a minimal recovery time. Cattle that are subjected to conditions producing considerable tissue shrink may require several days, even weeks, to regain their pre-market weight. Hale et al. (1967) shipped a load of 72 steers approximately 1,500 km where the steers shrank 10.8%. They reported steers that received no medication in feed or water post arrival required 23 d to regain shipping shrink. Lalman et al. (1994) indicated considerable variation in BW loss as well as rate of BW recovery within a pen or load of cattle. These workers reported BW loss ranging from 17.7 to 22.7 kg. However, the range in BW change increased over time periods of 24 and 72 h. These findings imply that some cattle began consuming feed or water or both much quicker than others, or perhaps some cattle experienced a greater degree of stress probably due to individual variation. In this study, on average, the group of cattle had regained their pre-shipment weight by d 7, while one steer was still 22 kg lighter and one steer was 25 kg heavier.

Summary

Shrink is a loss of BW during periods of feed and water deprivation and represents losses not only from excretion of feces and urine, but also from other body tissue. Shrink begins at the time feed and water are withdrawn and is much more rapid during the early h of shrink. Therefore, practices aimed at reducing early shrink could have the biggest impact on total BW loss, but more information is needed to determine the relationship between early shrink and long term shrink. Shrink is affected by a number of factors and is highly variable, which makes it difficult to predict with any degree of accuracy. Stressors involved with shrink also impact the proportion of BW lost from gut full vs tissue losses. Preconditioning programs have had varied results with regards to shrink.

RESEARCH PROBLEM STATEMENT

Shrink in cattle is a complex issue caused by and affected by numerous factors. Some factors remain out of control to both the buyer and seller, yet others prove to be a very important decision to both the buyer and seller in terms of shrink. In many transactions a "pencil shrink" is applied to the live BW of the cattle sold (Coffey et al., 2001). Much research has been conducted to elucidate the numerous factors that effect shrink in feeder cattle. Results have been quite variable; however, some observations are consistent. Research indicates that most shrink occurs early at a very rapid pace, 0.75% to 1.25% BW/h during the first 3 to 4 h (Barnes et al., 2007). This fill shrink is no more than a loss of rumen contents either from urination or defecation. It would seem plausible and practical to find a way to reduce shrink that occurs early and rapidly. Tissue shrink occurs at a much slower pace and is generally observed in transport situations greater than 8 h in length. This is the most difficult BW to recover because the animal lost tissue mass. Subsequent weight recovery of transported animals has not been studied thoroughly. While it is not common practice to monitor weight recovery of freshly shipped calves, it is common to monitor health status. If all calves are healthy, they are left alone, provided a receiving diet and allowed to rest and eat. However, focusing on weight recovery in freshly shipped calves may reveal valuable information to researchers. Which diet is recovering weight the quickest? Is there any difference in weight recovery across diets? Does offering hay have any effect on post-transport weight recovery? Does hay allowance affect shrink? All of these questions may be answered in monitoring weight recovery of shipped calves, and more research is needed to determine weight recovery implications.

Either a high-moisture or dry feed diet was fed both with or without hay to 1) examine the effects of pre-shipment feeding regimens on shrink and subsequent BW recovery in feeder calves subjected to transport shrink, and 2) determine the effects of pre-shipment hay offering on shrink and subsequent BW gains throughout the recovery period. Weights were recorded at the beginning, mid-trial, shipment, arrival, 30-h post-shipment, and every subsequent day throughout the recovery period in two 45- to 50-d backgrounding studies.

MATERIALS AND METHODS

Two trials were conducted at the EV Smith Beef Cattle Research Center in Shorter, Alabama. All procedures were previously reviewed and approved by the Auburn University Institutional Animal Care and Use Committee.

Data Collection

Experiment 1

Fourty-Eight British x Continental steers (initial BW 351 kg) were assigned randomly to one of two diets and fed for a 45-day period (four steers/pen; three pens/diet). Total pen space in each pen was 286-m^2, containing a 72-m^2 concrete covered loafing area, and inline feed bunks 6.7 meters in length. Diets, on a dry matter basis, were as follows: 1) 82% corn silage and 18% pelleted corn gluten feed (HM), 2) 40% pelleted peanut hulls, 40% soybean hull pellets, and 20% pelleted corn gluten feed (DF). Both diets were fortified with a mineral-vitamin supplement (manufactured by Sweetlix; Kowpoke-4). Monensin was added to each diet to provide 200mg/hd/d. Bunk management was used in order to determine the amount of feed to add each day. Steers were weighed initially, on d 21, prior to loading, and after shipment throughout the next 6 d. Forty-eight hours prior to shipment, d 43, half of the pens within each diet were either offered hay or no hay at a rate of 10.7 kg/hd. The hay was offered as square bales fed in the bunk. On d 45, half of the steers shipped while half of the steers remained in their respective pen of origin (24 shipped; 24 unshipped). Steers were assigned randomly to one of two trailers.

Steers were loaded on two trailers (11.3 m^2; 12 steers/trailer; one from each pen) with an average stocking density of 413 kg BW/m^2. Average shipping BW was 393 kg. Transported calves remained on the trailer for approximately 21 h, then unloaded and returned to their pen of origin. No further hay was offered and both pre- and post-transport diets were the same. BW were recorded immediately upon arrival, 30-h post-transport, and at 24-h increments throughout the following 6 d to monitor subsequent BW gain.

Experiment 2

Everything was the same as *Experiment 1*, in regards to diet and hay offering; however, one-hundred eighteen calves representing both genders were used (54 heifers; 64 steers), with an initial BW of 297 and 320 kg, respectively. Calves were sorted by gender, then randomly assigned to one of two diets fed for 49 d opposed to 45 d in *Experiment 1*. Calves were weaned over a 2-d period and received soybean hull pellets at a rate of 2.7 kg/hd throughout the first 7 d, which included the weaning period. Shipped calves were loaded on a semi, double decker pot trailer, in cuts of 4, 25, 26, and 4 (59 shipped; 59 unshipped). Stocking densities reported for each cut were as follows: 187 kg BW/m^2, 421 kg BW/m^2, 438 kg BW/m^2, and 129 kg BW/m^2. Stocking densities reported agree with the Farm Animal Welfare Council (FAWC) space guideline of $0.021BW^{0.67}$ (FAWC, 1991). Following a 21-h transport period, shipped calves returned to their pen of origin. BW were recorded immediately upon arrival, 30-h post transport, and twice daily the following 7 d, using an average BW for those d. BW were also recorded both 11 and 15 d post-transport to monitor BW gains.

Chemical Analysis

Feed samples were ground using a Wiley Mill to pass a 2-mm screen. Duplicates from each sample were used for chemical analysis to have a repeatable, and accurate sample. Dry matter, CP, NDF, and ADF were analyzed for each sample. Crude protein was determined using the Kjeldahl nitrogen determination method (AOAC, 1995). NDF and ADF for all samples were analyzed sequentially using the Van Soest Fiber Analysis procedure (Van Soest et al., 1991). Fiber concentrations were determined using an ANKOM $^{200/220}$ Fiber analyzer and filter bags with a pore size of 57 microns.

Statistical Analysis

Experiment 1 and Experiment 2

Data from Experiments 1 and 2 were analyzed as a completely randomized design using the Proc GLM procedure of SAS. A (2 x 2 x 2) factorial arrangement of treatments was used where the factors imposed were; HM or DF, hay or no hay, ship or not shipped. Pen was used as the experimental unit. Test of significance was determined at $\alpha < 0.05$.

RESULTS

Diet analysis and nutrient composition for year 1 are shown in Table 1. Year 2 analyses and nutrient composition are shown in Table 2. Diets fed were the exact same both years, but due to variation of by-product feedstuffs chemical analysis showed some differences between the two trials.

Experiment 1

Initial BW was not different ($P > 0.05$) across treatments (Table 3). ADG was not different ($P > 0.10$) during the backgrounding period and averaged 0.94 kg/day. Shipping/final BW was not different ($P > 0.05$) across treatments and averaged 393 kg. Following a 21-h transport period, BW were decreased ($P < 0.05$) for shipped calves (28.0 kg) versus their unshipped pen mates (1.5 kg; Table 4). Neither HM or DF (Table 5) or hay (Table 6) affected shrink ($P > 0.10$). Throughout 6 d post-shipment BW differences between shipped calves and unshipped calves remained different ($P < 0.05$; 9.40 kg vs 0.0 kg). Pre-shipment diets or 48-h hay offering did not affect BW post shipment ($P > 0.10$).

Experiment 2

Initial BW was not different ($P > 0.10$) and averaged 309 kg. Shipping/final BW was not different ($P > 0.10$) across treatments and averaged 346 kg (Table 7). Upon arrival, BW were decreased ($P < 0.05$) for transported calves (29.0 kg) versus their unshipped pen mates (0.0 kg; Table 8). Neither HM or DF (Table 9) or hay (Table 10) affected shrink ($P > 0.10$). Following transport, 5 d post-shipment DMI was not different between diets (Table 11). Throughout 15 d post-shipment BW differences between shipped calves and unshipped calves remained different ($P < 0.05$; 4.5 kg vs. 10.8 kg). Post-shipment weight recovery was faster for the pens that received hay 48 h prior to shipment ($P < 0.05$; Table 10).

Table 1: Average nutrient composition of diets fed in experiment 1.

	Feed Mixture	
Nutrient [a]	High Moisture [bd]	Dry Feed [cd]
DM, %	44.4	91.0
NDF, %	39.7	64.7
ADF, %	17.7	48.9
CP, %	13.4	11.6

[a] Dry-matter basis
[b] 82 % corn silage : 18 % corn gluten feed pellets
[c] 40 % soyhull pellets : 40 % peanut hull pellets : 20 % corn gluten feed pellets
[d] diets fortified with a mineral-vitamin supplement (manufactured by Sweetlix; Kowpoke-4). monensin was added to each diet to provide 200mg/hd/d.

Table 2: Average nutrient composition of diets fed in experiment 2.

	Feed Mixture	
Nutrient [a]	High Moisture [bd]	Dry Feed [cd]
DM, %	47.5	91.5
NDF, %	32.7	57.6
ADF, %	15.6	43.5
CP, %	10.5	12.4

[a] Dry-matter basis
[b] 82 % corn silage : 18 % corn gluten feed pellets
[c] 40 % soyhull pellets : 40 % peanut hull pellets : 20 % corn gluten feed pellets
[d] diets fortified with a mineral-vitamin supplement (manufactured by Sweetlix; Kowpoke-4). monensin was added to each diet to provide 200mg/hd/d.

Table 3: Body weights, ADG, and daily DMI for steers prior to shipment. (Experiment 1)

	Feed Mixture		
	High Moisture	Dry Feed	SE
Initial BW, kg	350	352	5.9
Final BW, kg	390	396	6.0
ADG, kg/d	0.90	0.97	0.05
Feed intake, kg/hd/d	9.7[a]	12.0[b]	0.06

[ab] values differ ($P < 0.05$)

Table 4: Effect of 21-h transport on BW loss and subsequent BW recovery in calves backgrounded for 45 d [a] (Experiment 1)

	Treatment		
	Home	Shipped	SE
Initial, kg	350	352	5.9
Final, kg	393	393	6.0
Arrival [b]	-1.50 [c]	-28.3 [d]	1.3
30 h	-1.40 [c]	-22.2 [d]	1.3
Day 2	-3.60 [c]	-15.8 [d]	1.0
Day 3	-3.06 [c]	-15.7 [d]	1.4
Day 4	-2.80 [c]	-11.80 [d]	1.4
Day 5	-3.60 [c]	-9.40 [d]	1.4
Day 6	0.0 [c]	-9.40 [d]	1.5

[a] ANOVA showed no two- or three-way interactions ($P > 0.10$); therefore main effect means are shown

[b] value is the difference, in kg, between that particular day weight-final weight for arrival through Day 6

[cd] values within a row significantly different ($P < 0.05$)

Table 5: Effects of diet on BW loss and subsequent BW recovery in calves backgrounded for 45 d [a] (Experiment 1)

	Treatment		
	High Moisture	Dry Feed	SE
Initial, kg	350	352	5.9
Final, kg	390	396	6.0
Arrival [b]	-16.0	-13.7	1.3
30 h	-12.3	-11.4	1.3
Day 2	-11.3 [c]	-8.1 [d]	1.0
Day 3	-11.2 [e]	-7.6 [f]	1.4
Day 4	-6.9	-7.7	1.4
Day 5	-5.9	-7.1	1.4
Day 6	-6.3 [e]	-2.6 [f]	1.5

[a] ANOVA showed no two- or three-way interactions ($P > 0.10$); therefore main effect means are shown
[b] value is the difference, in kg, between that particular day weight-final weight for arrival through Day 6
[cd] values within a row differ ($P < 0.05$)
[ef] values within a row differ ($P < 0.10$)

Table 6: Effects of 48-h pre-shipment hay offering or no 48-h pre-shipment hay offering on BW loss and subsequent BW recovery in calves backgrounded for 45 d [a] (Experiment 1)

	Treatment		
	Hay	No Hay	SE
Initial, kg	352	350	5.9
Final, kg	390	396	6.0
Arrival [b]	-13.7	-16.0	1.3
30 h	-10.0 [e]	-13.5 [f]	1.3
Day 2	-8.7	-10.7	1.0
Day 3	-6.4 [c]	-12.4 [d]	1.4
Day 4	-6.0	-8.6	1.4
Day 5	-7.6	-5.4	1.4
Day 6	-3.7	-5.3	1.5

[a] ANOVA showed no two- or three-way interactions ($P > 0.10$); therefore main effect means are shown
[b] value is the difference, in kg, between that particular day weight-final weight for arrival through Day 6
[cd] values within a row differ ($P < 0.05$)
[ef] values within a row differ ($P < 0.10$)

Table 7: Body weights, ADG, and daily DMI for calves prior to shipment. (Experiment 2)

	Feed Mixture		
	High Moisture	Dry Feed	SE
Initial, kg	306	311	4.6
Final, kg	351	341	5.0
ADG, kg/d	0.81[a]	0.53[b]	0.04
Feed intake, kg/hd/d	7.0[a]	7.9[b]	0.12

[ab] values within a row differ (P < 0.05)

Table 8: Effects of 21-h transport on BW loss and subsequent BW recovery in calves backgrounded for 49 d [a] (Experiment 2)

	Treatment		
	Home	Shipped	SE
Initial Weight, kg	311	305	4.7
Final, kg	346	345	5.0
Arrival [b]	0 [c]	-29.0 [d]	1.3
30 h	2.9 [c]	-14.0 [d]	0.8
Day 2	-1.0 [c]	-10.0 [d]	0.9
Day 3	-1.7 [c]	-11.3 [d]	1.0
Day 4	1.0 [c]	-9.2 [d]	1.1
Day 5	-2.6 [c]	-12.3 [d]	1.1
Day 6	-2.4 [c]	-10.1 [d]	1.4
Day 7	-2.5 [c]	-10.1 [d]	1.3
Day 11	5.7 [c]	-1.0 [d]	1.4
Day 15	10.8 [c]	4.5 [d]	1.3

[a] ANOVA showed no two- or three-way interactions ($P > 0.10$); therefore main effect means are shown
[b] value is the difference, in kg, between that particular day weight-final weight for arrival through Day 15
[cd] values within a row differ ($P < 0.05$)

Table 9: Effects of diet on BW loss and subsequent BW recovery in calves backgrounded for 49 d [a] (Experiment 2)

	Treatment		
	High Moisture	Dry Feed	SE
Initial Weight, kg	306	311	4.6
Final, kg	351	341	5.0
Arrival	-14.5	-14.6	1.3
30 h [b]	-3.8 [c]	-7.3 [d]	0.8
Day 2	-5.5	-5.9	0.9
Day 3	-6.9	-6.1	1.0
Day 4	-5.1	-3.4	1.1
Day 5	-7.3	-7.6	1.1
Day 6	-7.5	-5.0	1.4
Day 7	-8.4 [c]	-4.3 [d]	1.3
Day 11	0.0 [c]	4.6 [d]	1.4
Day 15	6.9	8.5	1.3

[a] ANOVA showed no two- or three-way interactions ($P > 0.10$); therefore main effect means are shown

[b] value is the difference, in kg, between that particular day weight-final weight for arrival through Day 15

[cd] values within a row differ ($P < 0.05$)

Table 10: Effects of 48-h pre-shipment hay offering or no 48-h pre-shipment hay offering on BW loss and subsequent BW recovery in calves backgrounded for 49 d [a] (Experiment 2)

	Treatment		
	Hay	No Hay	SE
Initial Weight, kg	307	310	4.7
Final, kg	344	347	5.0
Arrival [b]	-13.6	-15.5	1.3
30 h	-5.7	-5.4	0.8
Day 2	-4.2 [c]	-7.2 [d]	0.9
Day 3	-5.4	-7.6	1.0
Day 4	-2.6 [c]	-5.9 [d]	1.1
Day 5	-5.4 [c]	-9.5 [d]	1.1
Day 6	-3.8 [c]	-8.7 [d]	1.4
Day 7	-4.8	-7.9	1.3
Day 11	3.4	1.3	1.4
Day 15	9.5	5.9	1.3

[a] ANOVA showed no two- or three-way interactions ($P > 0.10$); therefore main effect means are shown
[b] value is the difference, in kg, between that particular day weight-final weight for arrival through Day 15
[cd] values within a row differ ($P < 0.05$)

Table 11: Effects of diet on DMI 5 d post-shipment [a] (Experiment 2)

	Treatment		
	High Moisture	Dry Feed	SE
Arrival, kg/hd	8.33	8.88	0.64
Day 2, kg/hd	8.31	8.88	0.37
Day 3, kg/hd	7.68	8.03	0.20
Day 4, kg/hd	7.68	7.38	0.33
Day 5, kg/hd	7.68 [b]	8.88 [c]	0.15

[a] ANOVA showed no two- or three-way interactions ($P > 0.10$); therefore main effect means are shown

[bc] values within a row differ ($P < 0.05$)

DISCUSSION

Shipped calves shrank 7.1% during trial 1 and 8.4% during trial 2. Self and Gay (1972) reported similar values where they noted shipped calves in their study shrank in a range of 7.2 to 9.1% of their pre-haul weight. In both experiments 1 and 2 calves fed the HM diet consumed less feed than calves on the DF diet ($P < 0.01$). Both diets were fed one time per day. Twice per day feeding may have improved intake of the HM diet. In both studies, offering hay prior to shipment did not reduce shrink compared to calves who received no supplemental hay. Hutcheson et al. (1984) showed that steers fed hay exhibited less shrink than those fed a 55% concentrate diet. Cattle off of dry pasture shrank 3.5% after a two-hour haul compared to 5.3% for animals off of lush, green forage (Barnes et al., 2007). Furthermore, Cravey et al. (1991) stated cattle conditioned with grass hay before hauling were found to shrink less than if removed directly from wheat pasture prior to shipment and found a 24% decrease in shrink following a four hour shipment period for the grass hay vs wheat pasture treatments. No incidences of morbidity or mortality, at the expense of shrink, was observed post-transport during either of the two trials. Ribble et al. (1995) reported stress of transportation may make feeder cattle more susceptible to bovine respiratory disease (BRD) thus increasing morbidity and mortality rates. In a model produced by Cernicchiaro et al. (2012) there was linear relationship between BW loss during transit and BRD morbidity risk in excess of 5% shrink but levels out shortly thereafter. The lack of morbidity and mortality seen in our trials may be attributed to the fact that the cattle did undergo backgrounding and preconditioning period during the feeding trial portion of this study. Preconditioning is a management practice that not only helps during pre-shipment, but also aids calves during the post-shipment phase as seen with reduced morbidity and mortality. Preconditioning results in more calves on feed quicker post-shipment. Hutcheson and Cole (1986) found that upon arrival, calves that were naive to bunks only ate 0.5% of BW the first seven days, whereas the calves that were from a backgrounding lot and knew how to eat from a bunk averaged eating 1.5% of BW. However, preconditioning was not found to reduce weight loss following transportation in several studies (Cole and Hutcheson, 1985; Prichard and Mendez, 1990). With this study all calves used underwent the same preconditioning strategies.

While diet had no effect on shrink, the calves receiving the DF diet had a much more consistent weight recovery than the calves on the HM diet. In trial 2, calves receiving hay prior to shipment recovered lost BW much more rapidly, day two through day six, than those not receiving hay during that same time period. Post-shipment DMI was not different across diets. Calves that received hay may have started consuming water at a quicker rate post-shipping; however, water consumption was not measured for this particular trial. Further research is needed on the effects of offering hay prior to shipment on post-shipment BW recovery. Previous research concerned with weight recovery post-shipment shows wide ranges in the number of days needed to recover BW loss due to shrink. Cravey et al. (1991) revealed that in cattle that are consuming a high moisture diet and experience primarily fill shrink, recovery time will be minimal. Barnes et al. (2007) stated cattle that are subjected to considerable tissue shrink, due to long hauls, coupled with continuing sources of stress will require several d, even wk to regain their pre-market weight. Transport time in our studies was 21-h, which far exceeds the limits of only fill shrink which is seen in the onset of handling and occurs very rapid the first three to four hours of transport (Coffey et al., 2001). While we did observe immediate weight gain, in neither trail were the calves able to reach pre-transport weight. The immediate weight gain is the equivalent of the calves being able to recover fill shrink. That aspect of the study agrees with Barnes et al. (2007) stating that fill shrink is recovered in a short period of time after feed and water intake returns to normal.

IMPLICATIONS

Experiments 1 and 2 revealed there is a wide range of variation with shrink and subsequent weight recovery in feeder calves. With two very different diets, in terms of composition, we were unable to manipulate shrink. The inability to manipulate shrink may be due to the fact that all cattle used during the study were preconditioned and backgrounded for 45-d in trial 1 and 49-d in trial 2. That may also lead to the reason that no morbidity or mortality was observed throughout the two trials.

Hay offering prior to shipment did not effect shrink, but did improve post-transport BW recovery during year two of the study and tended to improve BW recovery during year one. Further research is needed to pinpoint the reason this occured, and how to minimize shrink that is lost early during the fasting period. It is the quickest lost; therefore, if there’s a way to minimize this shrink we could possibly decrease the total percent shrink. Hutcheson and Cole (1986) found it to be more beneficial that feeder calves have access to feed and water all times possible during marketing.

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Appendix: Internal dimensions of a standard Wilson 53’ double decker cattle trailer used to calculate stocking density