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EFFECT OF PRE-MARKETING MANAGEMENT PRACTICES  
ON SHRINK LOSS IN LAMBS

BY

ANN RUTH KOLTHOFF

A thesis submitted in partial fulfillment of the requirements for the

Master of Science

Major in Animal Science

South Dakota State University

2017

EFFECT OF PRE-MARKETING MANAGEMENT PRACTICES  
ON SHRINK LOSS IN LAMBS

Ann Ruth Kolthoff

This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science degree and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

~~Jeffrey E. Held~~, Ph.D  
Thesis Advisor

Date

~~Cody Wright~~, Ph.D  
Major Advisor

Date

~~Joseph Cassady~~, Ph.D  
Head, Animal Science

Date

~~Dean~~, Graduate School

Date

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## LIST OF ABBREVIATIONS

ADF	acid detergent fiber
ASI	American Sheep Industry
BW	body weight
°C	degrees Celsius
Ca	calcium
cm	centimeter
CP	crude protein
d	day
DIP	degradable intake protein
DM	dry matter
DMI	dry matter intake
E	energy
Exp	experiment
FWD	feed and water deprivation
GM	gluteus medius muscle
h	hour
kg	kilograms
km	kilometer
L	liter
LM	longissimus
LSMEANS	least square means
m	meter

m <sup>2</sup>	square meter
ME	metabolizable energy
mg	milligrams
min	minutes
mL	milliliters
n	number
NDF	neutral detergent fiber
ng	nanogram
ORG	original pen
ONS	overnight stand
P	phosphorus
PDIFF	piecewise differentiable
ppm	parts per million
RFV	relative feed value
SAS	statistical analysis system
SEM	standard error of the mean
TRANS	transition holding pen
US	United States
USDA	United States Department of Agriculture
wt	weight

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## ABSTRACT

EFFECT OF PRE-MARKETING MANAGEMENT PRACTICES  
ON SHRINK LOSS IN LAMBS

ANN KOLTHOFF

2017

Two experiments were conducted to evaluate the effects of three common lamb pre-marketing management practices on live weight shrink loss. Additionally a producer survey was conducted to assess current marketing practices in the North Central region of the US. In these experiments, Exp. 1 (feeder lambs) and 2 (finished lambs), 60 commercial Polypay lambs (Exp. 1:  $37.65 \pm 0.30$  kg of BW; Exp. 2:  $52.56 \pm 0.14$  kg of BW) were allocated for each experiment to 3 treatment groups (n=20 lambs) in a 3 x 3 Latin square design. Treatments were the pre-marketing practices: original pen (ORG), transition pen (TRANS), and overnight stand pen (ONS). During the study, lambs had *ad libitum* access to a lamb diet (ORG and TRANS) or hay (ONS) and fresh water. Overnight stand lambs experienced greater overall shrink loss for both feeder ( $P \leq 0.05$ ) and finished ( $P \leq 0.05$ ) lambs compared to the other treatments, ORG and TRANS. During the management phase in both experiments, dietary intake for ONS was lower ( $P \leq 0.05$ ) than both ORG and TRANS treatment lambs. Water intake was lower for ONS (Exp. 1 = 0.70 L,  $P \leq 0.05$ ; Exp. 2 = 1.42 L,  $P = 0.154$ ) while TRANS lambs recorded the numerical greater water intake for both experiments (Exp. 1 = 1.36 L,  $P \leq 0.05$ ; Exp. 2 = 2.18 L,  $P = 0.154$ ). A 16 question sheep producer survey was conducted electronically to

gain knowledge of the demographics associated with pre-marketing practices in lambs from a 12-state area in the North Central Region of the US. The survey yielded responses from 165 producers. Only 50% of producers indicated that a public auction was their primary marketing choice with the balance of the producers using other available marketing options such as a buying station, direct to packer, or direct to consumer. Over 80% of producers indicated they had no data or knowledge of the degree of lamb shrink loss through the marketing phase. The survey results show that 45% of producers utilize pre-marketing practices including sorting and change of diet.

Keywords: shrink loss, lamb, marketing, overnight stand

## CHAPTER 1

### REVIEW OF LITERATURE

#### INTRODUCTION

##### *US lamb production system demographics*

Most sheep operations within the US are categorized into one of two production systems: range or farm flock. Range operations are traditionally larger flocks, with hundreds to thousands of ewes, which graze native or unimproved pastureland located in the western half of the US. Farm flocks, the typical management system in the Midwest and eastern part of the US, are comprised of smaller flock numbers and raise sheep on improved pastures and in dry-lot conditions (NRC, 2008). According to the USDA (2001), 86% of all sheep operations in the US are operated as farm flock operations. However, farm flock operations only make up of about 30% of the total sheep inventory in the US, while range flock operations make up about only 15% of all the operations in the country but raise around 50% of the sheep (NRC, 2008). A survey conducted by the American Sheep Industry (ASI) (2010b) evaluating individual sheep production information reported that over 30% of operations in the US are located in the North Central region being comprised of the Great Lakes sub-region (OH, MI, IN, IL, WI, and MN) and Midwest sub-region (ND, SD, NE, IA, MO, and OK). Of these operations, over 70 % in the Great Lakes have less than 100 ewes while in the Midwest, about 56 % of the operations have less than 100 ewes. Additionally, ASI reported that 23% of operations in

the Great Lakes region had a flock size of 100-500 while 34% of operations in the Midwest region have flocks from 100-500 ewes in size (ASI, 2010b).

### *Lamb marketing practices by production system-range and farm flock*

#### *Feeder lambs*

Feeder lambs that are marketed from range flocks are older, typically 5 to 7 months of age, and heavier at time of marketing compared to the 2 to 3 month old feeder lambs marketed from farm flock operations (USDA, 2001). The older age is usually attributed to most range ewes having a longer lactation period compared to ewes raised in farm flock operations. While it is common for farm flocks to maintain a 60-d lactation period and then move weaned lambs (22.7 to 31.8 kg) into a growing or finishing phase, lambs in range flock systems commonly experience a 135 to 150-d lactation period with pairs grazing together until fall months when lambs will be weaned (34 to 43 kg) and then marketed to a custom or commercial lamb feeder.

Producers have many different types of marketing options for feeder lambs. Auction barns, buying stations, brokers, electronic markets and direct sales to end-users including commercial feedlot operations. Generally the pricing mechanism for these marketing choices is based on a live weight based bid. Other marketing methods for feeder lambs include contract delivery to a commercial or packer owned feedlot, (NRC, 2007; Viatator et al., 2007). Alternatively, producers can retain ownership of feeder lambs through the finishing phase at a custom feedlot or on the farm or ranch (Bastian and Whipple, 1998; NRC, 2007; Shiflett and Jones, 2002; Viatator et al., 2007). In farm flock production systems less than half of the lamb crop is sold as feeders with the majority finished on the farm or ranch (USDA, 2010a).



USDA (2001) reported that nearly half of all range operations either moved or sold feeder lambs to a commercial/retained ownership feedlot in 2000. Over 75% of these operations changed ownership when lambs were moved into the feedlot. Only about 8% of farm flock operations moved their lambs into a commercial/retained ownership feedlot in 2000. Similarly to the range operations, most farm flock operations did not retain ownership through the feedlot phase. USDA also reported that 15% of range operations sold 22% of the total US feeder lamb population direct to the packer while auction barns and lamb buyers handled the majority of the feeder lamb population.

#### Finished lambs

Most farm flock producers choose to finish their lambs and market either directly to the packer, through an auction barn, or buying station where they will then be transported to a slaughter facility (NRC, 2008; Shiflett and Jones, 2002). According to a recent ASI survey 56% of producers in the United States feed out their own lambs (2010a). When examined regionally, the percent of producers who feed out their lambs in the Great Lakes and Midwest (North Central region) region jumps to 76 and 70%, respectively (2010b). While most feeder lambs were sold through an auction barn, around 95% of the finished lamb population are sold directly to the packer company. However, over 50% of operations sell finished lambs through auction barns and buying stations, yet they only make up around 3% of the total US finished lamb population (USDA, 2001). While the target weight of finished lambs can depend on location, they expected range is 60 to 70 kg (ASI, 2010c; Viatator et al., 2007).

Non-traditional lamb marketing is a rapidly growing sector of the sheep industry resulting in demand for lambs from 25 to 35 kg for immediate harvest (ASI, 2010c;

Viatator et al., 2007). Smaller non-traditional packing plants, or local community lockers, often times slaughter lighter lambs weighing 13 to 18 kg (ASI, 2010c). Currently in the US lambs entering harvest channels through non-traditional markets (ethnic, custom, or 'natural' product) are estimated at 12,000 weekly. Therefore at least one in every five lambs harvested can be classified under the non-traditional trade (ASI, 2010c).

When 302 producers were surveyed to compare the use of traditional live weight based marketing methods (auction barns, buying stations) with alternative marketing options (forward contracts, marketing agreements, packer owned, custom feeding, custom slaughter), Viatator and others (2007) found that small flocks sold primarily finished lambs versus selling feeder lambs. The survey also showed that 83% of lambs, both feeder and finished, sold by producers were sold via cash marketing while about 15% were sold through a form of alternative marketing such as forward contracts, marketing agreements, packer owned, custom feeding, and custom slaughter. Viatator and others (2007) found that the data was analyzed based on region of the United States, that Eastern and Western producers used cash markets similarly. When comparing marketing options of small operations to large operations, the smaller operations tended to use more auction barns and direct trading while large operations used more forward contracts as well as direct trades. However, survey respondents noted that the two most common pricing structures in their lamb sales were public auction bids (57%) and individually negotiated pricing (51%). Both large and small operations cited that price discovery for finished lambs in their market choices were based on live weight rather than carcass weight and a grid system (Viatator et al., 2007).

*Environmental and biological factors affecting live weight of lambs during marketing*

*Shrink loss*

It is a common for livestock to experience body weight changes regularly due to physical and biological factors; a decrease in live body weight is often referred to as shrink loss. Shrink loss, or live BW loss, is most common during periods of stress or when homeostasis has been disrupted (Grandin, 1997; Stott, 1981). These periods can range from an increase or decrease of ambient temperature, parturition, sickness, to everyday industry practices such as sorting, transportation, and feed and water deprivation.

Feeder lambs commonly experience shrink loss due to environmental factors throughout their life. Most events that result in shrink loss result in temporary shrink loss. While weaning and weighing can often be disturbing for them at times, the concern of shrink loss comes at times of shipping. Similar to feeder cattle, many feeder lambs are transported to off-site destinations, often times many miles away from their origin of birth. The management practices (sorting, feed and water deprivation, and transportation) leading up to their arrival at the feedlot is very likely results in shrink loss (Hafez, 1968; Stott, 1981). Shrink loss experienced in feeder lambs prior to arrival to the feedlot may affect their performance (Hogan et al., 2007) once they are received and as a result have an economic impact. (Coffey et al., 2001). The effect of environmental factors resulting in shrink loss, although expected to be a temporary weight loss, can be minimized with management decisions and actions.

Similar to feeder lambs the finished lamb will undergo stress during the shipping phase prior to slaughter that can result in shrink loss (Hafez, 1968; Stott, 1981). However, instead of impacting performance of the lambs after arrival to a feed yard, shrink loss in finished lambs not only has the potential to affect the producers return (Coffey et al., 2001) but has the potential to affect meat quality of the lambs to be harvested (Hogan et al., 2007; Kirton et al., 1971; Thompson et al., 1987; Wythes et al., 1980).

Shrink loss can be best described as live BW change that is commonly associated with marketing management practices. Shrink loss is comprised of both extracellular and intracellular losses (Hogan et al., 2007). Extracellular loss includes losses from the gastrointestinal tract such as gut fill, urine, and feces. Intracellular losses reflect losses at the cellular level, tissue catabolism and fluid losses (Coffey et al., 2001). Self and Gay (1972) report that when feeder steers were transported about 1,000 km, less than half (46.6%) of the live BW lost as gastrointestinal tract contents while 53% of the live weight loss was due to tissue loss. Ambient temperature can also have an effect on the extracellular to intracellular proportion. A study by Phillips and others (1985) found that when ambient temperatures were  $-6^{\circ}\text{C}$  or lower, over 65% of the live BW loss was due to gastrointestinal tract loss with the remaining losses classified as other or respiratory losses. When the temperature was  $18^{\circ}\text{C}$  and higher, gastrointestinal losses only accounted for less than 40% of total shrink loss and other and respiratory accounted for the remaining 60% of shrink loss.

Several factors can be attributed to live BW loss during the pre-marketing phase. These factors or stressors can be classified as either psychological stress or physical stress (Grandin, 1997). Psychological stressors include novelty to environment, isolation

or co-mingling, and handling (Camp et al., 1981; Grandin 1997; Zhong et al., 2011). Indicators of physiological stress are measured in the concentrations of different blood constituents such as glucose, cortisol, plasma urea nitrogen, and creatine kinase (Zhong et al., 2011). Physical stressors include feed and water deprivation (Grandin, 1997; Marques et al., 2012; Swanson and Morrow-Tesch, 2001), ambient temperature, and injury (Camp et al., 1981; Grandin, 1997). The factors that are most common with pre-marketing management of feeder and finished lambs are handling practices, feed and water availability or deprivation, and transportation.

Pencil shrink is commonly applied to animals that are sold on a live weight basis. Pencil shrink, the percentage of animal weight that is subtracted from the actual scale weight, is sometimes used in the livestock industry as a marketing specification to standardize pricing variables that include degree of gut fill, pre-marketing feeding practices, and muddy hides or pelts. In the sheep industry pencil shrink is common with electronic marketing and direct sales to a feedlot or packer whereas it is uncommon for public auctions or buying stations. Pencil shrinks commonly range anywhere from 3 to 6% of body weight. The degree of pencil shrink can vary on a case by case basis. However, animals that have experienced a long transport period should not be applied a pencil shrink (Blue et al., 2000).

#### *Economic importance of shrink loss in marketing lambs on a live weight basis*

Shrink loss becomes an economic consideration for producers who sell livestock on a live weight basis. For example, whether it is an auction barn or direct to a packer, there is an expectation of shrink loss and compensation for both the buyer/packer and seller. Although live price is a reflection of the carcass value of the lamb, the translation

of carcass price to a live weight basis, the price is dependent on the weigh conditions and expectation of shrink loss from the point of sale to the plant. Producers who sell livestock on a live basis and unaware of the relationship between pre-marketing management practices and changes in live body weight at the point of sale can sharply reduce net returns. For those animals sold on a carcass weight basis there too are factors increasing shrink loss of the carcass tissue that can become costly (Blue et al., 2000). In the live weight price bid at a public auction or buying state it is assumed that some degree of shrink loss has been accounted for in the bid price. The source of variable shrink losses occurring between the scale weight at the point of sale and delivery to a packing plant includes gut fill and pelt condition (dry, wet, muddy) (Coffey et al., 2001; Shroeder et al., 1988). However, when the shrink loss percentage increases, even after price adjustment for a lower body weight, producers many time will lose \$10-25 in calf values (Coffey et al., 2001). It is common for animals that experience an excess shrink do not receive full financial compensation even when the bid price is adjusted higher (Blue et al., 2000). Livestock sold on a carcass weight basis yet have experienced excessive shrink loss prior to harvest often incur an economic loss due to tissue shrink (Holmes et al., 1982).

#### *Sources and effects of environmental variables on shrink loss*

##### Stress

According to Stott (1981) stress in livestock can best be described by physiologists as external forces that can displace homeostasis. These external forces are commonly referred to as environmental conditions including severe cold or heat, feed and water deprivation, handling and sorting of animals, or health issues (Hafez, 1968; Stott, 1981). Measuring the magnitude of these environmental conditions often requires

determining the adaptation to specific stressors. The adaptation to the environmental conditions or stressors can be positive or negative for not only producers but also the animals. Negative adaptations are most noticed when the more common production indices are affected such as BW, milk and egg production, and reproduction (Stott, 1981). During periods of stress, greatest shrink loss in lambs has been found to occur within the first 12 h of stress induction and usually levels off to after 36 h (Meyer et al., 1995)

During the pre-marketing phase for feeder and finished lambs, they can encounter many different stressors that are reflective of management practices and production systems. The primary sources of stress due to environmental conditions that feeder and finished lambs can encounter in the pre-marketing period include feed and water deprivation, handling and sorting, co-mingling, and transportation. All of these have the potential to exert a negative effect on homeostasis resulting in reduced live body weight and increase tissue dehydration. Other responses include elevated cortisol level and a potential to compromise immune function.

#### *Sorting and handling*

Sorting, mixing of groups and isolation of animals are normal animal husbandry practices in livestock production. These are normal components of the pre-marketing shipment period for livestock. Due to these environmental conditions there is a potential to induce psychological stressors that negatively impact homeostasis, and result in greater live body weight shrink loss. Lambs are frequently co-mingled, including at the time of weaning, in the feedlot phase, and prior to slaughter. In addition to the effect of co-mingling prior to sale, other environmental stressors including transportation and feed and water deprivation can contribute to pre-marketing shrink loss.

Evaluating the impact of shrink loss on individually housed goats, Kannan et al. (2002) found that does that were individually isolated and kept off feed, steadily increased their shrink loss to 7% after 21 h of isolation. In that same study, does that were isolated from others but kept on feed, did not lose weight until after 14 h of isolation. After 21 h, they had a shrink loss of 6%. Similar data has been reported in cattle. A study by Holmes and others (1982) that transportation has less of an effect than sorting and commingling. Steers that were subject to 5 different treatments prior to slaughter showed an increase in shrink loss as a function of time post sorting ( $P < 0.05$ ). Shrink losses ranged from 5.8% for steers slaughtered a 3-d post sorting to 10.1% for steers slaughtered at 11-d.

Domestic livestock are gregarious animals that when isolated or separated from their contemporaries, can become agitated and stressed. These stressors can be measured not only by live BW loss, but also blood constituents and behavioral measurements. In a study performed by Mounier et al. (2005), they evaluated the social buffering in bulls during the fattening phase. When comparing a pen of mixed bulls to un-mixed bulls, the un-mixed bulls had less non-agonistic interactions with each other. They also spent more time eating instead of fighting and overall were less stressed during the pre-slaughter handling. In contrast to the unmixed bulls, mixed bulls spent less time eating when access to the feed trough had been limited. This behavior indicates that mixed bulls are less tolerant of each other at feeding time. When bulls were put through a separation test where they were isolated and separated from their pen mates, mixed bulls were visually startled more easily ( $P = 0.009$ ) than when compared to unmixed bulls. When the



treatments were applied to the cattle, an increase in urination and defecation was observed during the first period of this study.

One of the most common ways to measure the effect of stress during a sorting or handling procedure is to measure plasma cortisol. In the study by Mounier et al. (2005), when blood components were measured, the pen of mixed bulls had significantly higher blood cortisol levels,  $> 30.6 \text{ ng/mL}$  ( $P < 0.05$ ). A study by Hargreaves and Hutson (1990a) found that sheep that were subject to a drafting (sorting) exercise had significantly higher plasma cortisol levels when compared to control lambs that remained in the sampling pen ( $P < 0.05$ ). The peak was found to occur at 10 min after the exercise began. Similar hormonal response results were found during this study for other handling practices such as drenching, dipping, crutching, and shearing.

#### *Feed and water deprivation*

During the pre-marketing and shipping phase, there are times that lambs will experience a period of feed and water deprivation (FWD). This is considered an accepted husbandry practice to reduce stress during marketing phases; however, extended deprivation has the potential to negatively affect shrink loss. The livestock industry practice of feed and water deprivation prior to transport, referred to as “curfew” by Wythes (1982) helps to reduce the amount of digesta in the gastrointestinal tract. There are two main goals in utilizing a curfew. First, that by reducing the amount of digesta, there would be less contamination of other animals, and less feces and urine output on public roadways. The other goal is to help establish an empty body weight basis to improved prediction of dressing percentage (Hogan et al., 2007; Wythes, 1982). Traditionally there are two kinds of curfew, dry and wet. Dry curfews are when livestock

are kept off both feed and water entirely. Wet curfews allow animals to have access to water. From an animal welfare standpoint, wet curfews are more satisfactory. Wet curfews are more beneficial as when livestock have access to water, they are easier to handle, are more content, and are more hydrated making them more attractive to buyers (Wythes, 1982).

Shrink loss is an expected biological outcome for lambs that undergo a period of feed and water deprivation. Sheep lose the most live weight during their first 12 h of deprivation (Hogan et al., 2007; Wythes, 1982). Cockram and others (1999) have found that sheep lost 5.5 kg over a 12 h period when compared to control sheep. While the data found by Knowles and others (1995) supports other investigations, they also found that significant shrink loss occurs whether or not the effects of transportation are assessed. A metabolism study by Cole (1995) looking at composition of shrink loss due to feed and water deprivation found that wethers that underwent a 3-d feed and water deprivation experienced 7.1 kg of shrink or 9.9% of pre-deprivation BW ( $P < 0.05$ ) when compared to wethers that had access to feed and water. In a study on slaughter hogs performed by Mayes and others (1988) shrink loss following a 24, 48, and 72 h fast were measured at 3.19, 5.97, and 7.68% of BW, respectively. After the hogs were transported, the shrink loss continued to increase. In a study comparing shrink loss between weaned and unweaned lambs during a 96 h fast prior to slaughter, the unweaned lambs had a lower rate of shrink loss in comparison to their counterparts (Thompson et al., 1987). A similar conclusion was found by Kirton et al. (1971) after comparing multiple experiments. It was found that weaned lambs had a greater amount of rumen contents when compared to unweaned lambs resulting in a greater degree of shrink loss.

Source of shrink loss due to FWD is similar to the shrink loss due to handling and transportation. As previously discussed, a large portion of shrink loss is made up of contents from the gastrointestinal tract and potentially over 50% of the total shrink loss may come from other tissue loss (Cole, 1995; Phillips et al., 1985; Self and Gay, 1972). In contrast to data reported by Self and Gray (1972) and Phillips et al. (1985), data shown by Cole (1995) when evaluating the composition of shrink loss, he computed that 28% of the total live BW lost by wethers that underwent a 3-d feed and water deprivation was attributed to gastrointestinal contents. Yet in this study he concluded that 65% of the total shrink loss was presumably found in adipose and tissue losses. While water makes up a majority of the weight loss animals experience, the rumen doesn't appear to serve as a net reserve for any water losses occurring at the tissues (Cole and Hutcheson, 1985a, b, 1987; Cole, 1995). In the study performed by Cole (1995), while still in an acceptable range, 47% of BW in fed and 43% of BW in feed and water deprivation wethers was composed of total body water ( $P < 0.01$ ). Of the total water lost, about 57% was intracellular, 29% was lost through the gastrointestinal digesta, and 14% came from the extracellular fluids (Cole, 1995).

Feed and water deprivation can also cause interruptions with the homeostasis of the animal. This includes metabolic processes, associated stressors that affect meat quality, and an increase in blood constituents. During periods of feed and water deprivation, rumen function has the potential to be slowed down or stopped altogether if the deprivation is long enough. This can cause microbial bacterial populations located in the rumen to be compromised. Once feed has been offered after a fast, there can be

several days before current intake levels return to that of pre-fast or maximum intake (Hogan et al., 2007).

Periods of feed and water deprivation have the ability to decrease meat quality. Sorting and transportation has the greater effect on raising cortisol levels and as a result has more of an impact on glycogen depletion due to the added stress (Eicher, 2001; Hogan et al., 2007). Feed and water deprivation adds to the effects shown from sorting and transportation as most livestock also become dehydrated during the pre-marketing process (Hogan et al., 2007; Wythes et al., 1980). In a study performed by Wythes and others (1980), transported cattle had a shrink loss of 10%. After gaining access of water, shrink loss had improved to a 6% decrease after 3.5 h. When looking at the carcass composition, the access for rehydration increased the water content in the muscle from 76 to 78%. This simultaneously increased carcass weight of the cattle from 369 to 383 kg.

Thompson et al. (1987) reported that when lambs were deprived of feed prior to slaughter for 24, 48, 72, or 96 h the hot carcass weight shrink loss increased linearly with time, 3.5, 5.9, 7.3, and 7.7%, respectively. These findings were greater than reported by Kirton and others (1971). They found lambs that weighed 27 to 32 kg to have a hot carcass weight loss of 2% and 4% after 24 and 48 h fast periods, yet the shrink loss increased with period of deprivation period. This is lower than the reported carcass weight loss of Thompson and others (1987) of 4% and 6 % for 35 kg lambs. Thompson et al. (1987) also reported that similar to live BW loss, the rate or pattern of hot carcass weight loss was curvilinear or greatest during the initial period of the fast.

Livestock that experience a period of feed and water deprivation need time to recover once they reach the feedlot or slaughter facility. Lambs entering a feedlot require

time to not only adjust to new surroundings and possibly pen mates, but require management practices that allow animals to quickly rehydrate and access to diets that support comprised microbial populations in the rumen environment. In extremely warm environments, electrolytes maybe prudent to help restore homeostasis. The amount of time that an animal requires to recover from such stressors is largely dependent on not only the length and severity of the stressors, but also the type of feed that is offered during the recovery process (Hogan et al., 2007).

### Transportation

Transportation is an integral step in marketing livestock and it is widely regarded as a primary source of shrink loss due to the physical, behavioral and biological factors associated with stress. Related to the potential shrink loss, animals experience an increase in heart rate and body temperature (Whickham et al., 2012), influences on blood chemistry (Zhong et al., 2011), and effects to meat quality (Fuente et al., 2010; Miranda-de la Lama, et al 2012; Zhong, et al., 2011).

Zhong and others (2011) found that older sheep had greater shrink loss during transport than younger sheep ( $P = 0.018$ ). In a study monitoring the effect of transportation on BW and blood chemistry, Fischer and others (2010) discovered that as transportation duration increased, there was a decrease in BW of the sheep. The sheep experienced a shrink loss of 4.9, 9.8, and 12.1% following 12, 30, and 48 h of transportation. However, with a 72 h recovery period they reached 91-96% of their pre-transport weight.

A study by Kannan and others (2000) discovered that when goats were transported in high animal density and low animal density situations, the animal density

did not have an effect on the amount of shrink loss the goats experienced. However, the goats did have a mean shrink loss percentage of  $10.0 \pm 0.68$ . Camp and others (1981) found similar results when researching shrink loss in feeder cattle. They determined that the average shrink loss due to transport stress in feeder cattle was 8.2% with a range of 6.5-10% of BW lost. This is also supported by Tippetts et al. (1957), and Self and Gay (1972), a study by Marques and others (2012) also reported a similar degree of shrink loss. However when comparing the three treatments in the Marques et al (2012) study (transported, fasted, and non-transport/non-fasted), transported steers resulted in a significant difference ( $P < 0.01$ ) in shrink loss at 9.6% compared to 8.1% and 0.7%, respectively.

Self and Gay (1972) discovered in their investigations that feeder cattle shrink was in the same range reported by others, 7-10%, however they showed significant difference ( $P < 0.05$ ) between calves that were shipped directly to the feed yard (7.2%) from either the ranch or pasture when compared to cattle that were put through a sale facility (9.1%). In the study conducted by Camp and others (1981), when assessing the shrink loss that occurred at various stages of marketing feeder cattle, transit from the farm to auction barn then transit to a commercial feedlot, they reported that shrink loss was additive with the final average value of 11.9%.

A study performed by Thompson and others (1987) in Australia evaluating transportation and fasting and the effect on live weight and carcass characteristics found that lambs that experienced both transportation and a fasted period, had a greater rate of shrink loss compared to lambs that experienced only a fasting period (0.196 vs 0.096 %

live weight/h.). This data supports the scientific findings that the greatest amount of shrink loss occurs in the first 12 h of stress application.

Studies also shows that shrink loss during transport might be more involved than an emptying of the gastrointestinal tract (Self and Gay, 1972). In the study performed by Self and Gay (1972), steers were slaughtered before transport and after arrival at the feed yard. The shrink loss difference between pre-haul and post-haul calves was 6% of BW. While half of the 6% was made up of a difference in gastrointestinal weight, the remaining significant ( $P < 0.01$ ) shrink loss came from other sources such as carcass weight, hide, pluck, and liver. As a result, the practice of offering *ad libitum* feed and water after arrival to the feed yard to refill the gastrointestinal tract partially resolves the weight lost during transport.

In a study performed by Whickham (2012) and others, transport naive and transport habituated Merino wethers were transported 65 km and evaluated for increase in heart rate. During the transport, the naive wethers heart rate increased by 40% compared to 6% for habituated wethers ( $P = 0.008$ ). Core body temperature was also significantly higher ( $P < 0.001$ ) in naive sheep compared to those that had been habituated to transport (Whickham et al., 2012).

Transportation stress also has the ability to lower the meat quality (color, water holding capacity, pH, tenderness, meat texture) in lambs (Fuente et al., 2010). The reduction in physical and chemical properties of meat quality can be due to a number of factors; however water loss, bruising of meat and glycogen depletion is the most common (Jarvis and Cockram, 1994; Knowles et al., 1994, 1998). Jarvis and Cockram (1994) and Knowles and others (1994, 1998) also found significant differences in the pH of the LM

at 24 hours post mortem ( $P = 0.003$ ) and a decrease in the cooking loss of both the LM and GM of six month old transported sheep ( $P = 0.002$ ). While this did result in a darker color, the shear force values, an index of meat tenderness, were not changed.

### Behavior

Sheep are known for their gregariousness and demonstrated by a strong flocking behavior. They are known to form strong bonds with other sheep and will maintain these bonds upon entering larger groups for 9 or more days (Hulet, 1989; Winfield and Mullaney, 1973). Disrupting the social bond in among a group of sheep can be quantified as a stressor. An example is during the pre-marketing phase of lamb production. This stress not only has a psychological impact on the animal, but also can have a negative physiological impact as well (Grandin, 1997). Similar to cows, the leader of the flock of sheep is usually the eldest or the most aggressive ewe in the flock (Hulet, 1989). Flock leadership or social ranking is known to be a source of stress at times within the less dominant sheep within a group (Grandin, 1997). Social rank within a group of lambs during sorting and handling, and transport can increase animal stress subsequently increase shrink loss. Using the gregarious nature of sheep during handling and shipment activities can reduce stress and animal well-being (Hulet, 1989).

The temperament of sheep and other livestock play an important role in how the individual animal responds to sources of stress. Wild animals that have little human contact are more often to be surprised to new stimuli whereas animals that are domesticated might balk at new stimuli (Grandin, 1997). This is explained best as domesticated animals have been picked for their calm demeanor towards humans (Grandin, 1997; Price, 1984). According to Lanier and others (1995), individuals who are



calmer tempered are able to adapt to their surroundings more easily and as a result are less stressed during handling process while the livestock that become very excited are more prone to increase stress levels as handling is repeated. Common physical signs of uncomfortable behavior are vocalization, looking for an escape route or attempting to escape from their pen, and kicking or fighting back. Physiological signals of discomfort or stress is increase in heart rate, cortisol level, as well as beta endorphins (Grandin, 1997). Therefore livestock handlers should be trained on proper animal handling, facilities design and animal behavioral characteristics to minimize stress during routine production practices.

Following repeated handling procedures, response habituation can occur resulting in lower levels of biologically measured stress (Fox, 1994; Hargreaves and Hutson, 1990b). Rubio and others (1998) found that cattle that were exposed to repeated handling procedures experienced a decrease in cortisol. However, a study by Hargreaves and Hutson (1990b) demonstrated that ewes that were repeated exposed to sham shearing showed a spike in plasma cortisol after each exposure compared to basal levels. When comparing exposure one to exposure four, there was only a slight reduction due to repeated exposure resulting in a slight indication to adaptation and lower stress.

### *Conclusion*

Shrink loss in feeder and finished lambs is a natural phenomenon that can be attributed to many different pre-marketing conditions and practices. The most common causes of shrink loss during pre-marketing practices include sorting and handling, a change in feed or the deprivation of feed and water, and the distance lambs are transported. However, being able to control or predict the shrink loss lambs will incur

during the pre-marketing phase based on the various weight conditions for each marketing option leads not only to improved animal well-being, but also to price discovery for the producer at the point of sale.

## **CHAPTER 2**

### **EFFECT OF PRE-MARKETING MANAGEMENT PRACTICES OF LAMBS ON SHRINK LOSS**

#### **INTRODUCTION**

Shrink loss, or live body weight loss, is a common occurrence during the marketing phase for many livestock (Stott, 1981). Most often, it is thought to be caused by transportation and removing feed and water. However, other environmental influences also disrupt homeostasis in the animals such as change in ambient temperature, new environments, sickness and behavioral traits (Grandin, 1997; Stott, 1981).

During the pre-marketing process there are many sources of stressors for lambs that can result in shrink loss including sorting and handling, co-mingling, transportation, and feeding management practices. As time after sorting and co-mingling increases, shrink loss has also been shown to increase (Holmes et al., 1982; Kannan et al., 2002). Shrink loss due to transport also results in an increase as trip duration increases (Camp et al., 1981; Self and Gay, 1972; Tippets et al., 1957), with livestock that have been through sale facilities having increase transport shrink compared to livestock shipped directly from the farm or ranch (Self and Gay, 1972). Feed and water deprivation is a common practice to help decrease the amount of fecal and urine output there is during the marketing phase (Hogan et al., 2007; Wythes, 1982); however, other research suggests that feed and water deprivation results in shrink loss that is more than just gastrointestinal output, such as intracellular and extracellular losses in adipose and muscle tissue (Cole

and Hutcheson, 1985a, 1985b, 1987; Cole 1995). These previous studies demonstrate that various management practices can influence on farm or ranch shrink loss. Our study was designed to compare the effect of three common pre-marketing management practices on shrink loss in both feeder and finished lambs.

## MATERIALS AND METHODS

All protocols used in this experiment were approved by South Dakota State University Institutional Animal Care and Use Committee (IACUC No. 14-077E). This study was conducted at the South Dakota State University Sheep Unit in Brookings, SD.

### *Animals and experimental design for experiment 1 and 2*

Sixty Polypay sired lambs were used in a 3 x 3 Latin square design (Fig. 2.1) to evaluate the effects of pre-marketing management practices on shrink loss in feeder (Exp. 1) and finished lambs (Exp. 2). Before each trial, lambs were stratified by BW and gender then randomly assigned to one of three treatment groups (trt group n = 20 lambs) (Exp. 1 initial BW =  $37.65 \pm 0.30$  kg and Exp. 2 BW =  $52.56 \pm 0.14$  kg).

Treatments were as follows for both trials: original pen (**ORG**; n = 20 lambs), lambs were weighed and returned to original pen with *ad libitum* access to a 16% CP lamb diet and water; transition pen (**TRANS**; n = 20 lambs), lambs were moved to a non-adjacent pen with *ad libitum* access to the same 16% CP lamb diet and water; overnight stand (**ONS**; n = 20 lambs), lambs were moved to a non-adjacent pen with *ad libitum* access to low quality long-stemmed grass hay and water. Prior to the start of each trial, lambs were housed as a group in the original pen for a 14-d adaptation period and offered

*ad libitum* to the finishing lamb diet consisting of whole corn, soy hulls, and a pelletized lamb protein supplement (Table 2).

Timeline for animal handling steps and data collection are showed in Fig. 2.2. During each trial there were three 7-d periods where lambs were comingled in the original pen, on d 6 at 1600 h lambs were weighed, then sorted into allotted groups and moved to assigned treatment pens ORG, TRANS and ONS. At 0800 h on d 7 all lambs were weighed to determine the shrink loss associated with management practice treatment. Immediately after lambs were weighed they were loaded onto a 7.32 m by 2.13 m livestock trailer (0.26 m<sup>2</sup> per lamb) and transported for 80.5 km. Lambs were returned to the South Dakota State University Sheep Unit, they were off loaded and a final individual weight recorded. Shrink loss during the trial was partitioned into two components, management practice (shrink loss = post-sort weight at 0800h d 7 – initial weight at 1600h d 6) and transportation shrink loss (transportation shrink loss = final individual weight – post-sort weight). Overall shrink loss is the difference between the final individual weight and initial weight.

Dry-lot pens were used for each treatment group with a minimum of 6.30 m<sup>2</sup> per lamb and a minimum distance of 30.5 m between pens. Lambs were monitored twice daily for signs of illness or injury. If needed, treatment of sick animals was prescribed by attending veterinarian. Three animals (1 feeder and 2 finished lambs) were removed from the trial during adaption periods due to health status. Reduction in treatment group populations were accounted for in data collection procedures, no data collection was affected by animal health related topics.

### *Diets*

Diet composition and nutrient analysis for both experiments are provided in Tables 2.1 and 2.2. The lamb diet consisted of whole corn, pelleted soyhulls and a pelleted lamb protein supplement containing soybean meal, urea, limestone, ammonium chloride, fat-soluble vitamins, macro- and microminerals and decoquinate. The dietary ingredients were formulated and mixed at South Dakota State University. The lamb diet for ORG and TRANS trt were offered at *ad libitum* in 2 commercial poly feeders. Feed trays were 33.0 cm off the ground and provided 20.3 cm of tray space per lamb. Mature, long-stemmed grass hay (CP = 6.48%, NDF = 66.93%, and ADF = 43.35%) sourced from South Dakota State University farm department was utilized as the single dietary ingredient in the ONS treatment and was offered at *ad libitum* from 1600 h on d 6 until 0800 h on d 7 in a concrete fence line bunk providing 72.80 cm of bunk space per lamb. Feed samples were collected at the conclusion of every research period and frozen at -20°C until analysis. Samples were later dried in a forced air oven at 60°C for 24 h to determine DM (AOAC, 1990) and ground using a Wiley Mill (Arthur H. Thomas, Philadelphia, PA) through a 1 mm screen. All samples were analyzed for ADF and NDF (Goering and Van Soest, 1970), CP (Kjeldahl procedure; AOAC, 1990) and ash (AOAC, 1990). Water was provided *ad libitum* via automatic waterers during the adaptation period. During the treatment evaluation period (1600 on d 6 through 0800 on d 7), 6 water pails were utilized to provide 5.50 L of water per lamb. Water disappearance was measured and recorded; pails were cleaned before and after every period. Water pails were located near (within 3 m) disabled automatic water units in each treatment pen and

secured to prevent spillage. Water refusal was weighed and recorded at completion of each trial period.

### *Statistical Analysis*

Shrink loss and DM and water intake data was analyzed as a 3x3 Latin square in a completely randomized design with treatment group as the experimental unit. Pre-marketing management practice treatment was considered fixed, and period and animal were considered random variables. Animal shrink loss, diet intake and water consumption resulting from treatment were evaluated using the MIXED procedure of SAS (SAS, 2002). Significant treatment effects were separated using the LSMEANS statement with the PDIFF option. Differences between means were considered significant at  $P \leq 0.05$ , and a tendency considered at  $0.05 < P \leq 0.10$ .

## **RESULTS AND DISCUSSION**

### Experiment 1

#### *Shrink loss*

The effect of management practice and transportation on shrink loss in feeder lambs is reported in Table 2.3. Management treatment had a significant effect on overall shrink loss expressed as a percent of body weight ( $P = 0.017$ ), transport shrink ( $P = 0.023$ ), and management shrink ( $P = 0.027$ ), and resulted in a tendency on post-sort weight ( $P = 0.063$ ) and final weight ( $P = 0.083$ ). Overall shrink percentage was greater ( $P \leq 0.05$ ) for ONS lambs (1.77% of BW) than both ORG and TRANS treatment lambs, which were similar (1.36% and 1.14% of BW, respectively). Overall shrink weight was greater ( $P \leq 0.05$ ) for the ONS lambs (1.56 kg) than ORG lambs (0.35 kg); TRANS was

intermediate (0.93 kg) and not different than either ONS or ORG lambs. Final weight tended to be less ( $P \leq 0.10$ ) for ONS (38.48 kg) lambs than ORG lambs (39.96 kg); TRANS lambs (39.35) were intermediate and not different than either ORG or ONS lambs. Both Kannan et al. (2000) and Knowles (1999) reported that overall shrink loss was at 10% of live body weight when combining transportation and feed and water deprivation. These differ from our study in that ONS resulted in overall shrink loss less than 2% of live body weight despite the diets being similar to those of the previous research. Our study did expose the lambs to less transport time and they had *ad libitum* access to long-stemmed hay and water. The TRANS treatment resulted in less ( $P \leq 0.05$ ) percent overall shrink loss than ONS, 1.14 compared to 1.77%, although the final weight and overall shrink weight were similar despite substantially less diet intake ( $P \leq 0.05$ , Table 2.4) and water consumption ( $P \leq 0.05$ , Table 2.4) for the ONS compared to TRANS lambs. The TRANS treatment in our study mimics a common pre-marketing lamb management practice in the North Central Region with lambs segregated and housed in a new environment with continued access to a familiar high energy diet for a period of time prior to shipment. Overnight stand treatment is a common pre-marketing management practice most often associated with public auction barn sale specifications. Based on data from this study the pre-marketing practices for feeder lambs that resulted in the least overall shrink following transportation was ORG and TRANS.

Overall shrink loss, expressed as a percentage or weight, was less than previously reported data. The total time duration of the present study totaled 18 h, while most studies reported data collected over of range of 12 to 72 h. The management activity of sorting and isolation with livestock has been reported to increase shrink loss as a function of time



(Holmes et al., 1985; Kannan et al., 2002). While not significantly different, the ORG treatment lambs gained 0.30 kg through the sorting phase while the TRANS lambs reported a loss of 0.26 kg. Housing the ORG lambs in their original environment with the same source of feed most likely resulted in the weight gain during this period of time; while the act of moving the TRANS to a new pen resulted in the weight loss even though they had access to the same diet. Kannan and others (2002) reported similar results in goats when does were isolated from contemporaries. Does continued to consume feed even though they were separated and in a new environment, yet reported shrink loss after 14 h of isolation.

There was an effect of management practices on transport shrink percent and weight ( $P = 0.025$  and  $0.023$ , respectively). Transportation shrink due to management practices was greater ( $P \leq 0.05$ ) for ORG (0.73% of BW, 0.65 kg) and TRANS lambs (0.77% of BW, 0.67 kg), which were not different from each other. Lambs on the ONS treatment resulted in the least amount shrink loss (0.55% of BW, 0.47 kg) during the transport phase. This was most likely due to ONS lambs having less content in their gastrointestinal tract, from decreased intake or from being shrunk during the sorting phase, compared with the other treatments resulting in less excretion during the transport phase. Reported transport shrink loss from previous studies in cattle and sheep range from 5 to 12% of BW (Camp et al., 1981; Fischer et al., 2010; Kannan et al., 2000; Self and Gray, 1972; Tippets et al., 1957). The transport shrink loss for lambs reported in the literature was more than 5 times greater than the shrink loss reported in the present study. However, most of the previous studies reported shrink loss figures due to sorting,

transport, and feeding differences together and looked at shrink loss over a longer period of time and distance than in the present study.

Self and Gay (1972) reported that feeder cattle with extensive shrink loss due to transport struggled to recover weight loss on arrival to a feed lot. Hogan et al. (2007) also reported that it takes several days for current intake levels to return of pre-fast or maximum intake after an exposure to pre-marketing stress. In contrast to these findings, Fischer et al. (2010) reported that sheep recover 91 to 96% of pre-transport weight after 72 h. Post study body weight recovery was not monitored for the lambs in the current study.

#### Feed and water intake

Feed and water intake for feeder lambs is reported in Table 2.4. Management treatment had an effect on feed ( $P = 0.001$ ) and water intake ( $P = 0.002$ ). Lambs subject to ONS treatment lambs consumed less feed ( $P \leq 0.05$ ) and water ( $P \leq 0.05$ ) than ORG or TRANS lambs. TRANS lambs consumed similar amounts of feed to the ORG lambs; however, water consumption was higher ( $P \leq 0.05$ ; 1.36 L/animal) compared to 1.11 L/animal. The feed intake depression demonstrated by the ONS lambs is not surprising since they were abruptly switched from a high energy starch based diet with excellent palatability to low quality roughage. The type of diet selected for the ONS treatment reflects a typical management treatment used in the North Central Region for an overnight stand.

Water intake was affected by management treatment ( $P = 0.002$ ; Table 2.4). Water intake was different between all of the treatments ( $P \leq 0.05$ ). Water intake was lowest for the ONS lambs (0.70 L/animal), ORG lambs were intermediate (1.11

L/animal), and TRANS lambs had the highest water intake (1.36 L/animal). With low feed intake for the ONS treatment lambs (0.26 kg/animal), it was expected that water intake would also be lower for this management treatment. For lambs consuming an *ad libitum* high-energy starch-based diet the expected ratio of quantity of water to dry matter intake is expected to be approximately 1:1 (NRC, 2007), for the ORG and TRANS lambs this ratio was 0.84 and 1.20, respectively; whereas for the ONS treatment the ratio is 2.72 ( $P = 0.03$ ). Therefore, the ONS lambs, they consumed more water per unit of DMI presumably to maintain homeostasis. Perhaps more interesting is that the TRANS lambs consumed the most water yet had similar feed intake as the ORG lambs. The increase in water intake could be attributed to the behavioral differences with the TRANS lambs being in a new environment and separated from pen mates resulting in shrink in the form of respiratory loss (Phillips et al., 1985). This loss could come from lambs bleating for their pen mates or exerting more physical activity while exploring their new environment (Grandin, 1997).

## Experiment 2

### Shrink loss

The effect of management practices and transportation on shrink loss in finished lambs is reported in Table 2.5. Management treatment had a significant effect on overall shrink ( $P = 0.015$ ), management shrink ( $P = 0.017$ ), and resulted in a tendency on post-sort weight ( $P = 0.085$ ). Lambs in the ONS treatment had greater ( $P \leq 0.05$ ) overall shrink loss as a percent (1.58% of BW) and weight (1.91 kg) than lambs in either the ORG (-0.20% of BW, -0.24 kg) or TRANS (0.27% of BW, 0.33 kg) treatments. Lambs in the ORG treatment experienced a net gain of BW while TRANS and ONS lambs lost

weight during the trial. The overall shrink weight between ORG and TRANS differed by 2.14 kg. Knowles (1999) and Kannan et al. (2000) have both reported that when in combination, transportation (12+ h) and feed and water deprivation (12+ h) can increase shrink loss to around 10% of live body weight. Results from our study with ONS treatment resulted in shrink loss of less than 2%, however lambs on our study also incurred a shorter transport time and had *ad libitum* access to long-stemmed hay and water.

Similar to experiment 1, weight loss due to management practices on the ONS lambs is most likely due to being in a new environment, being sorted away from pen mates, and being offered a new diet. Many studies have reported sorting increases shrink loss as isolation time increases (Holmes et al., 1985; Kannan et al., 2002). Additionally, Mounier and others (2005) found that isolation and mixing of livestock resulted in more agitation and fighting and less eating during the pre-marketing phase.

Weight gain experienced by the ORG treatment was similar to Exp. 1. This could be due to the lambs having a change in feeding patterns due to the summer heat and lambs reducing their heat load. Most likely, the ORG and TRANS lambs consumed both their night and morning feedings after the initial sort on d 6 and before the post-sort weigh on d 7 resulting in a net gain during the sort phase. Studies performed by Hoffman and Self (1973) and Ray and Roubicek (1971) found that feedlot steers in both Iowa and Arizona spend the most time eating at dusk and dawn, the coolest part of the day, during the warmer summer months. Livestock adjusting their eating patterns to the cooler hours of the day help them to reduce their heat load and prevent heat stress (Mader and Davis, 2004). The weight gain overnight could also be due to being offered the same previous

diet. Kannan and others (2002) found similar results when goats were isolated but kept on a similar diet during the isolation phase. Does that were kept on feed during isolation did not lose weight in comparison to their counterparts who were subject to isolation and a feed and water deprivation until after 14-h of isolation.

Post-sort weight showed a tendency to be different between ONS and ORG and TRANS treatments ( $P \leq 0.10$ ). In contrast to Exp. 1, there was no difference between treatments due to transportation ( $P = 0.25$  and  $0.32$ , respectively). The lack of difference in transport shrink could be due to previous acclimation due to repeated transportation from Exp. 1 (Rubio et al., 1998). Shrink loss due to transportation has been largely researched for transportation durations of 12 h or more. Reported shrink loss in cattle have ranged from 6.5% to 11.9% (Camp et al., 1981; Maruques, 2012; Self and Gay, 1972; Tippets et al., 1957). Shrink in sheep due to transportation had a greater range of shrink loss from 1.4 to 12.1% (Fischer et al., 2010; Thompson et al., 1987). Thompson and others (2010) reported transport shrink figures in sheep that were subject to transportation and a fast of around 0.73%. These shrink figures support the findings in Exp. 2 where transport shrink ranged from 0.54 to 0.73% of BW.

#### Feed and water intake

Feed and water intake for finished lambs is reported in Table 2.6. Management treatment had a significant effect on feed intake ( $P < 0.001$ ). Feed intake for ONS lambs was less ( $P \leq 0.05$ ; 0.30 kg/animal) compared to ORG (1.85 kg/animal) and TRANS (1.60 kg/animal). These results are in agreement with data recorded in Exp. 1. Similar to the ONS lambs from the previous study, DMI was most likely lower due to lambs being in a new environment and being offered poor quality forage. The poor quality, lack of

palatability of the offered diet would lead to a decrease in intake. This setting would be similar to what lambs might encounter in an auction barn setting.

Water intake did not differ ( $P = 0.15$ ) between treatments (Table 2.6). This is in contrast to Exp. 1 where all three treatments were different from each other. However, similar to Exp. 1, TRANS lambs numerically had the greater intake of water across treatments (2.18 L/animal). Using the water intake rule of 1kg (L) of water to 1 kg of DM intake (NRC, 2007), ORG and TRANS lambs (0.94 L/kg and 1.36 L/kg, respectively) recorded lower intakes compared to ONS lambs (4.97 L/kg;  $P = 0.02$ ). The greater intake suggests that the consumption of water increased due to lambs trying to maintain some level of homeostasis as a result of the ONS treatment being moved away from their original pen. The combination of increased water intake and DMI intake most likely compensated for any shrink loss due to defecation and excretion resulting in a weight gain for TRANS lambs during the management phase. In contrast, the combination of feed and water intake did not compensate for any gastrointestinal losses in the ONS group as they recorded a shrink loss during the management phase of 1.27 kg. This suggests that the shrink loss that occurred during this time could be more intracellular than intercellular (Self and Gay, 1972; Phillips et al., 1985; Cole, 1995).

### Conclusion

Management practices prior to marketing that involve handling and sorting, separating contemporaries, changing the penning environment and/or shift in plane of nutrition can impact the live body weight of feeder and finished lambs. For lambs marketed on a live weight basis the degree of shrink loss can impact the gross dollar return. Minimizing pre-marketing shrink loss with appropriate management practices can

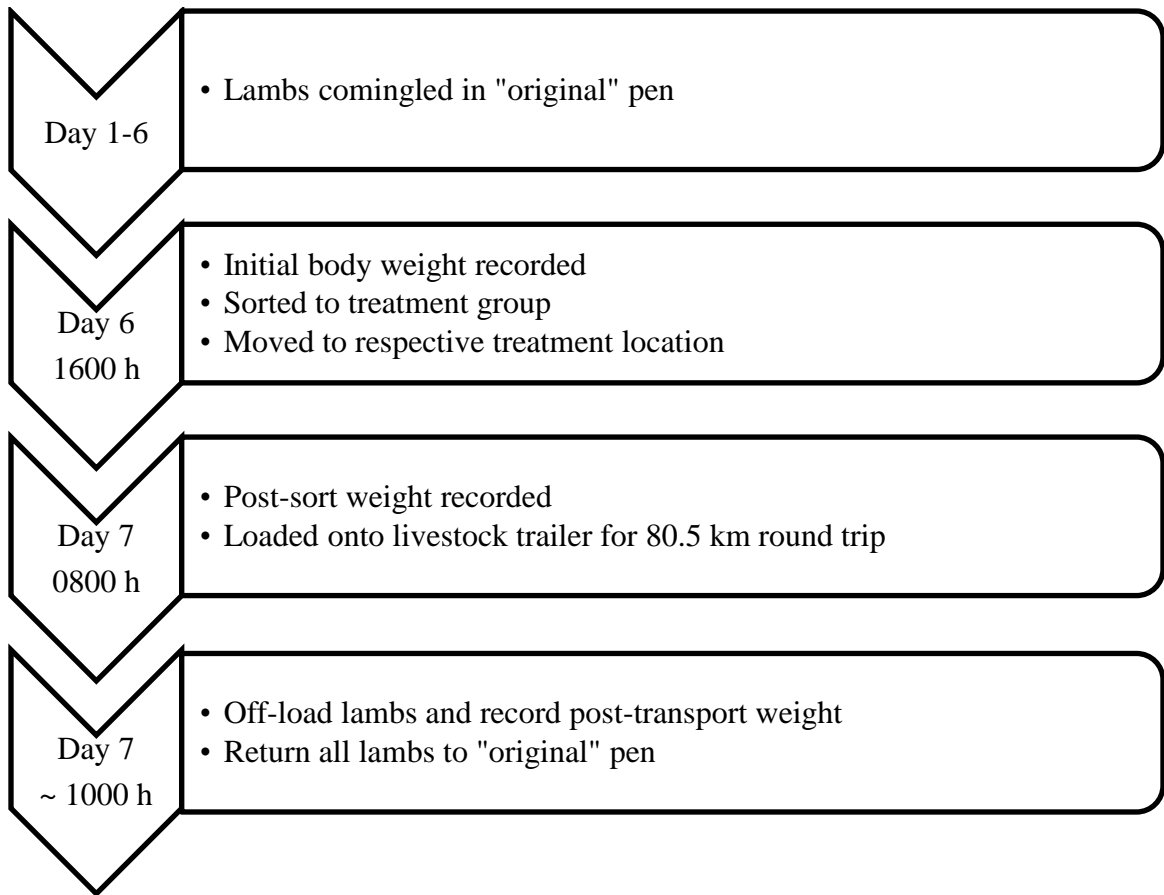
improve profitability in a sheep operation. Given the results of this study for feeder lambs in a farm flock production system the least overall shrink loss would occur with pre-marketing practices that held lambs in a common environment or in a transition pen just prior to transport to the point of sale; however feeder lambs on an overnight stand was be expected to the lightest weight at the point of sale. For typical weight feeder lambs in the North Central Region (32 kg), an overnight stand would need to command an additional \$6.86 per cwt to return the same dollars as lambs under pre-marketing management similar that described as ORG or TRANS. For 62-kg finished lambs, an additional \$5.02 per cwt is needed to compensate for the difference in shrink loss between overnight stand and the other common pre-marketing practices evaluated in this study. Minimizing stress such as limiting sorting, isolation or new environments, or changes in feed can help reduce shrink loss in lambs. For many small sheep production operations in the North Central Region lambs are likely sorted and transported immediately prior to marketing, the data collected in this study shows that lambs, both feeder and finished, experience the least numeric overall shrink loss when held in a familiar environment with their contemporaries until transport for the purpose of marketing.

<b>Group</b>	<b>Period 1</b>	<b>Period 2</b>	<b>Period 3</b>
<b>A</b>	ORG	ONS	TRANS
<b>B</b>	TRANS	ORG	ONS
<b>C</b>	ONS	TRANS	ORG

**Figure 2.1. 3 x 3 Latin square experimental design for experiments 1 and 2.**

Treatment groups: ORG: original pen, sorted and returned to original pen with original feed; TRANS: transition pen, sorted and moved to a new pen with original feed; ONS: overnight stand, sorted and moved to new pen with change in dietary ingredients.





**Figure 2.2. Animal handling steps for data collection in experiment 1 and 2.**

**Table 2.1. Feeder and finished lamb dietary treatment ingredients (DM basis)**

Ingredient	Management treatment <sup>a</sup>		
	ORG	TRANS	ONS
		% DM Basis	
Grass hay	0	0	100
Soyhulls	19.0	19.0	0
Whole corn	60.0	60.0	0
Soybean meal	16.6	16.6	0
Urea	0.1	0.1	0
Limestone	1.5	1.5	0
Supplement <sup>b</sup>	2.8	2.8	0

<sup>a</sup> ORG: original pen, sorted and returned to original pen with original feed; TRANS: transition pen, sorted and moved to a new pen with original feed; ONS: overnight stand, sorted and moved to new pen with new feed

<sup>b</sup> Supplies 4.2 kg/ton of sodium chloride, 75 g/ton of manganese, 0.28 g/ton of cobalt, 1.22 g/ton of iodine, 3.19 g/ton of selenium, 78.81 g/ton of zinc, 51.12 g/ton of iron, 430 g/ton of calcium, 2,400,000 IU of vitamin A acetate, 440,000 IU of d-activated animal sterol, 242,000 IU of dl-alpha tocopheryl acetate, 40.8 mg/lb of decoquinate, 0.25% ammonium chloride, 1.0% soy oil

**Table 2.2. Feeder and finished lamb nutrient composition of dietary treatments**

	Management treatment <sup>a</sup>		
	ORG	TRANS	ONS
Analyzed composition			
DM, %	89.75	89.73	88.23
CP, %	13.43	13.99	6.48
NDF, %	18.84	18.56	66.93
ADF, %	10.90	10.86	43.35
Ash, %	4.80	4.95	8.77
Calculated values <sup>b</sup>			
ME, Mcal/kg	2.97	2.97	2.10
DIP, % <sup>c</sup>	58.47	58.47	70.00
Ca, %	0.78	0.78	0.31
P, %	0.27	0.27	0.17

<sup>a</sup>ORG: original pen, sorted and returned to original pen with original feed; TRANS: transition pen, sorted and moved to a new pen with original feed; ONS: overnight stand, sorted and moved to new pen with new feed

<sup>b</sup>Indicates a value calculated using Small Ruminant NRC (2007)

<sup>c</sup>DIP = degradable intake protein

**Table 2.3. Effect of management practices and transportation on shrink loss in feeder lambs**

	Management treatment <sup>a</sup>			SEM	P-value
	ORG	TRANS	ONS		
Initial wt, kg <sup>b</sup>	40.30	40.29	40.03	1.449	0.729
Management shrink <sup>c</sup>					
Wt, kg	-0.30 <sup>d</sup>	0.26 <sup>d</sup>	1.09 <sup>e</sup>	0.295	0.027
% of BW	-0.33 <sup>d</sup>	0.29 <sup>d</sup>	1.23 <sup>e</sup>	0.331	0.023
Post-sort wt, kg <sup>b</sup>	40.61 <sup>x</sup>	40.02 <sup>x</sup>	38.94 <sup>y</sup>	1.463	0.063
Transport shrink <sup>c</sup>					
Wt, kg	0.65 <sup>d</sup>	0.67 <sup>d</sup>	0.47 <sup>e</sup>	0.079	0.023
% of BW	0.73 <sup>d</sup>	0.77 <sup>d</sup>	0.55 <sup>e</sup>	0.111	0.025
Final wt, kg <sup>b</sup>	39.96 <sup>x</sup>	39.35 <sup>xy</sup>	38.48 <sup>y</sup>	1.518	0.083
Overall shrink <sup>c</sup>					
Wt, kg	0.35 <sup>d</sup>	0.93 <sup>de</sup>	1.56 <sup>e</sup>	0.266	0.035
% of BW	1.36 <sup>d</sup>	1.14 <sup>d</sup>	1.77 <sup>e</sup>	0.086	0.017

<sup>a</sup>ORG: original pen, sorted and returned to original pen with original feed; TRANS: transition pen, sorted and moved to a new pen with original feed; ONS: overnight stand, sorted and moved to new pen with new feed

<sup>b</sup>Initial wt: recorded on d 6; Post-sort wt: recorded on d 7; final wt: recorded after 80.5 km trailer ride on d 7

<sup>c</sup>Management shrink = (post-sort wt – initial wt); transport shrink = (final wt – post-sort wt); overall shrink = (final wt – initial wt)

<sup>de</sup> Means within a row that lack common superscripts differ ( $P \leq 0.05$ ).

<sup>xy</sup> Means within a row that lack common superscripts tend to differ at ( $0.05 < P \leq 0.10$ ).

(-) = weight gain

**Table 2.4. Effect of management practices on feed and water intake in feeder lambs**

	Management treatment <sup>a</sup>			SEM	P-value
	ORG	TRANS	ONS		
Feed intake, kg/animal	1.32 <sup>b</sup>	1.14 <sup>b</sup>	0.26 <sup>c</sup>	0.082	0.001
Feed intake, % of BW	1.49 <sup>b</sup>	1.28 <sup>b</sup>	0.30 <sup>c</sup>	0.066	<0.001
Water intake, L/animal	1.11 <sup>b</sup>	1.36 <sup>c</sup>	0.70 <sup>d</sup>	0.173	0.002
Water to DM ratio, L/kg	0.82 <sup>b</sup>	1.19 <sup>b</sup>	2.72 <sup>c</sup>	0.354	0.025

<sup>a</sup>ORG: original pen, sorted and returned to original pen with original feed; TRANS: transition pen, sorted and moved to a new pen with original feed; ONS: overnight stand, sorted and moved to new pen with new feed

<sup>bcd</sup> Means within a row that lack common superscripts differ ( $P \leq 0.05$ ).

**Table 2.5. Effect of management practices and transportation on shrink loss in finished lambs**

	Management treatment <sup>a</sup>			SEM	P-value
	ORG	TRANS	ONS		
Initial wt, kg <sup>b</sup>	54.28	54.83	54.73	1.243	0.719
Management shrink <sup>c</sup>					
Wt, kg	-1.02 <sup>d</sup>	-0.56 <sup>d</sup>	1.27 <sup>e</sup>	0.330	0.017
% of BW	-0.85 <sup>d</sup>	-0.47 <sup>d</sup>	1.05 <sup>e</sup>	0.274	0.017
Post-sort wt, kg <sup>b</sup>	55.61 <sup>x</sup>	55.39 <sup>x</sup>	53.47 <sup>y</sup>	1.246	0.085
Transport shrink <sup>c</sup>					
Wt, kg	0.78	0.89	0.64	0.090	0.251
% of BW	0.64	0.73	0.54	0.077	0.322
Final wt, kg <sup>b</sup>	53.41	54.37	52.83	1.024	0.425
Overall shrink <sup>c</sup>					
Wt, kg	-0.24 <sup>d</sup>	0.33 <sup>d</sup>	1.91 <sup>e</sup>	0.294	0.015
% of BW	-0.20 <sup>d</sup>	0.27 <sup>d</sup>	1.58 <sup>e</sup>	0.245	0.015

<sup>a</sup> ORG: original pen, sorted and returned to original pen with original feed; TRANS: transition pen, sorted and moved to a new pen with original feed; ONS: overnight stand, sorted and moved to new pen with new feed

<sup>b</sup> Initial wt: recorded on d 6; Post-sort wt: recorded on d 7; final wt: recorded after 80.5 km trailer ride on d 7

<sup>c</sup> Management shrink = (post-sort wt – initial wt); transport shrink = (final wt – post-sort wt); overall shrink = (final wt – initial wt)

<sup>de</sup> Means within a row that lack common superscripts differ ( $P \leq 0.05$ ).

<sup>xy</sup> Means within a row that lack common superscripts tend to differ at ( $0.05 < P \leq 0.10$ ).

(-) = weight gain

**Table 2.6. Effect of management practices on feed and water intake in finished lambs**

	Management treatment <sup>a</sup>			SEM	P-value
	ORG	TRANS	ONS		
Feed intake, kg/animal	1.85 <sup>b</sup>	1.60 <sup>b</sup>	0.30 <sup>c</sup>	0.083	<0.001
Feed intake, % of BW	1.54 <sup>b</sup>	1.32 <sup>b</sup>	0.24 <sup>c</sup>	0.065	<0.001
Water intake, L/animal	1.75	2.18	1.42	0.217	0.154
Water to DM ratio, L/kg	0.94 <sup>b</sup>	1.36 <sup>b</sup>	4.97 <sup>c</sup>	0.657	0.022

<sup>a</sup>ORG: original pen, sorted and returned to original pen with original feed; TRANS: transition pen, sorted and moved to a new pen with original feed; ONS: overnight stand, sorted and moved to new pen with new feed

<sup>bc</sup> Means within a row that lack common superscripts differ ( $P \leq 0.05$ ).

## **CHAPTER 3**

# **EVALUATING MARKETING AND MANAGEMENT PRACTICES OF LAMBS IN THE NORTH CENTRAL REGION**

## **INTRODUCTION**

Due to different production systems and locations of flocks in the US, management practices of feeder and finished lambs prior to marketing can vary from flock to flock. Larger flocks that graze range in the western half of the US (NRC, 2008) commonly sell more feeder lambs to commercial feed yards either direct or through an auction barn (USDA, 2001). Smaller flocks, or farm flocks, that are more commonly found in the Midwestern states are fed in a drylot or grazed on improved pastures (NRC, 2008). Farm flock lambs also are often fed out to a finished weight on the operation where they were born and then shipped either direct to the packer, direct to the consumer, or through an auction barn (USDA, 2011). However, little detail is available as to how lambs are handled during the pre-marketing phase.

Shrink loss, or live BW loss, is most common during periods of stress or when homeostasis has been disrupted (Grandin, 1997; Stott, 1981). These periods occur commonly during everyday industry practices such as sorting, transportation, and feed and water deprivation. Shrink loss experienced in feeder lambs prior to arrival to the feedlot may affect their performance (Hogan et al., 2007) once they are received and as a result can have an economic impact. (Coffey et al., 2001). In finished lambs, however,



shrink loss has the potential to affect the producers return (Coffey et al., 2001) and meat quality of the lambs to be slaughtered (Hogan et al., 2007; Kirton et al., 1971; Thompson et al., 1987; Wythes et al., 1980). Animals that are sold on a live basis are sometimes subject to a pencil shrink, or computed weight discount of 3 to 6% depending on the condition of the lambs sold. However, animals that have experienced a long transport period should not be applied a pencil shrink (Blue et al., 2000).

As percentage shrink loss increases animal net return is expected to decline. Decrease in value is a result in loss of live BW for animals that are sold on a live weight basis, but also can be a loss of value for animals sold on a grid basis if there is a loss of carcass and tissue weight (Blue et al., 2000). The price that producers receive for their livestock is often times adjusted for expected shrink loss specifically to account for gut fill or pelt condition (Coffey et al., 2001; Shroeder et al., 1988). However, when the shrink loss percentage goes beyond expectations, even after a price adjustment due to shrink, producers many times will incur another \$10-25 decrease in calf value (Coffey et al., 2001). It is common for animals that experience an excess shrink to not be able to recover the financial loss by receiving a higher price (Blue et al., 2000). Therefore, the objective of this experiment was to administer a survey to determine the pre-marketing management practices of sheep producers in the North Central Region to make inferences on the sources of lamb shrink loss.

## **MATERIALS AND METHODS**

All protocols used in this experiment were approved by South Dakota State University Human Subjects Committee (IRB-1607004-EXM).

### Survey design and administration

A 16-question survey (Table 3.1) was developed and administered to sheep producers in the North Central Region through Question Pro. The survey was distributed to over 12,000 producers with the assistance of industry partners (Pipestone Veterinary Services, Premier Sheep Supplies, Ltd., and Sydell, Inc.). Although the email lists of industry partners include producers from across the US, their customer bases are primarily located in the North Central Region. Producers were asked to respond, anonymously, by providing details of their operations and lamb marketing management practices. Ordinal data included flock size, years of experience, distance from a common point of sale, and how important shrink loss is to their operation. Categorical data included whether producers sold feeder or finished lambs or both, type of marketing methods, and to identify their common pre-marketing management practices.

### Statistical analysis

Only survey responses from producers ( $n = 165$ ) that reside within the geographical area known as the North Central Region as defined by the Cooperative Extension Service were used in the analysis. Data were analyzed in a Chi-square analysis, fit x by y with the expectation of no difference between marketing practices or methods. Feeder lamb and finished lamb responses were analyzed independently. Differences between true and expected observations were considered significant at  $P \leq 0.05$ , and a tendency considered at  $0.05 < P \leq 0.10$ .

## RESULTS AND DISCUSSION

Flock size amongst survey respondents is reported in Fig. 3.1. Six producers did not answer the question regarding flock size. The flock size demographics in the current survey mirrors a producer survey completed in 2010 from the American Sheep Industry (ASI). In the ASI (2010) study, the largest group of producers had flock sizes of less than 100 ewes, similar to the current survey where producers with less than 100 ewes accounted for nearly 75% of the response population.

Distance traveled to point of sale by flock size is shown in Fig. 3.2. The marketing characteristics of distance traveled and flock size tended to be different ( $P = 0.09$ ). Fifty-five percent of the small flock producers, those with flock size from 1 to 50 ewes, drove less than 81 km to a marketing point of sale with either their feeder or finished lambs. Forty-five percent of all producers (feeder and finished lamb) that responded reported that they drove 81 km or less to the point of sale, while 29% of responding producers reported they drove 82 to 161 km. According to Kolthoff et al. (2017; unpublished data), lamb that travel short distances to point of sale experience less than 1 kg of shrink loss during the marketing process. This would be most ideal in situations where lambs are sorted and moved to a new location before being transported as it would help minimize shrink loss. Thompson et al. (2010) also reported shrink loss in sheep that were exposed to transport and a fast had a shrink loss of 0.73% during the transport phase. In contrast, previous reported shrink values due to transport ranged from 6.5% to 11.9 % of BW for lambs that were subject to transport for 12 h or more (Tippets et al., 1957; Self and Gay, 1972; Camp et al., 1981; Thompson et al., 1987; Fischer et al.,

2010; Marques et al., 2012). Producers who responded to the current survey that travel 162 km or greater distance to the nearest point of sale would incur greater degree of lamb shrink loss despite their pre-marketing management strategies.

Figure 3.3 illustrates the number of producers who market feeder lambs and/or finished lambs by flock size. The number of producers that market feeder lambs tended to differ by flock size ( $P = 0.082$ ); however, there was no difference in the marketing of finished lambs based on flock size ( $P = 0.78$ ). Similar to the present survey, ASI (2010b) found that the percentage of producers who marketed feeder lambs was 53% while the 54% of producers market finished lambs, thus most producers sell both feeder and finished lambs. In the present survey, the smaller flocks had a nearly identical percentage.

Survey results for feeder and finished lamb shipping weights are presented in Fig. 3.4 and Fig. 3.5. Fifty-three percent of the feeder lamb producers shipped lambs between 23 to 31 kg and 32% of producers targeted the 32 to 40 kg weight range. In the survey by ASI (2010b), producers reported similar target feeder lamb marketing weights with 19 to 27 kg, 28 to 36 kg, and 37 to 45 kg the most popular. In the present study, the most common (65% of producer responses) market weight for finished lambs was 57 to 67 kg. This is similar to data reported from the USDA and National Agricultural Statistical Service (NASS) where that the average slaughter weight of lambs in the US reported in the 2015 USDA Livestock Slaughter Summery was 62 kg (USDA, 2016).

Survey results for pre-marketing procedures are shown in Fig. 3.6. Twenty-four percent of producers reported that they weighed their feeder lambs prior to shipment ( $P = 0.11$ ). Only 2% of producers utilize an overnight stand after weighing their feeder lambs ( $P = 0.45$ ). Eleven percent of producers move lambs to a transition pen ( $P = 0.38$ ) or sort

and transport the night before sale (i.e., overnight stand;  $P = 0.025$ ), and 29% of producers sort and transport their feeder lambs immediately prior to selling ( $P = 0.005$ ). Forty-two percent of producers marketing finished lambs weighed prior to shipment ( $P < 0.001$ ). Five percent of producers utilized an overnight stand prior to shipment ( $P = 0.052$ ), 19% of producers moved lambs to a shipment pen ( $P < 0.001$ ), 24% of producers responded to sorting and shipping the night prior to sale ( $P < 0.001$ ), and 55% of producers reported sorting and shipping finished lambs immediately prior to sale ( $P < 0.001$ ). One of the main sources of shrink in lambs is pre-marketing sorting from their pen mates and subjecting them to feed and water withdrawal (Kannan et al., 2002; Kolthoff et al., unpublished data, 2017). Producers whose lambs were subject to an overnight stand, moved into a shipment pen prior to shipping, or sorted and shipped prior to sale could experience greater shrink loss.

Preferred marketing methods of survey respondents are presented in Fig. 3.7. Seventy-six percent of these producers chose to sell feeder lambs at a public auction ( $P < 0.0001$ ). Sixteen percent sell feeder lambs at a buying station ( $P < 0.0001$ ), 17% of producers sell to commercial lamb feeders ( $P < 0.001$ ), and 13% of producers sell feeder lambs in the ethnic trade ( $P < 0.001$ ), these marketing outlets are essentially direct sales between the producer and a buyer at a negotiated price. Only 2% of producers responded with participating in packer contracts ( $P < 0.13$ ). Similar to feeder lamb producers, public auction was the most popular with 53% of producers choosing to market finished lambs ( $P < 0.0001$ ). Twenty-six percent of producers chose to market finished lambs at a buying station ( $P < 0.001$ ), 6% of producers responded to the survey stating that they utilize an electronic auction to sell their finished lambs ( $P < 0.033$ ), 13% of producers marketed

their lambs direct to the packer-live ( $P < 0.001$ ), while only 4% of producers market direct to the packer in the meat ( $P = 0.082$ ). Additionally, 47% of producers stated that they sell some finished lambs direct to the consumer ( $P < 0.001$ ). These results are similar to the observations found in the ASI survey in 2010. Livestock auction was the most popular response amongst survey respondents at 52.8% (ASI, 2010b). Similar to the current study, ASI also reported producers selling finished lambs direct to consumer as the 2<sup>nd</sup> most popular marketing option at 42.3% (ASI, 2010b)

Producer responses on the importance of controlling shrink loss in their operation is reported in Fig. 3.8 (feeder lambs) and Fig. 3.9 (finished lambs). While responses were significant for both producers marketing feeder ( $P = 0.02$ ) or finished lambs ( $P = 0.004$ ), the distribution of the importance of shrink is interesting. Twenty-six percent of feeder lamb producers stated that controlling shrink loss was important or extremely important while 32% of finished lamb producers thought that controlling shrink loss was important or extremely important in their operation. However, only 12% ( $n = 11$ ) of feeder lamb and 8% ( $n = 9$ ) of finished lamb producers reported knowledge of shrink loss for their operations. Of the known degree of shrink loss, 90% of responses reported a shrink loss of 2% or greater and were from producers who felt that shrink loss was not important, somewhat important, or only marginally important. Feeder lamb producers seem to be less concerned in controlling shrink loss compared to producers marketing finished lambs.

Producer knowledge of the lamb shrink loss incurred on their operation is reported in Fig. 3.9. A difference ( $P = 0.003$ ) was shown with only 25 producers (17%) stating they have knowledge of lamb shrink loss while 124 producers (83%) reported not

knowing the degree of shrink loss. Additionally, shrink loss amounts were collected if producers selected 'yes' to knowing their shrink loss at marketing. Although not significant ( $P = 0.74$ ), respondents reported shrink loss in a range from 0 to 10%.

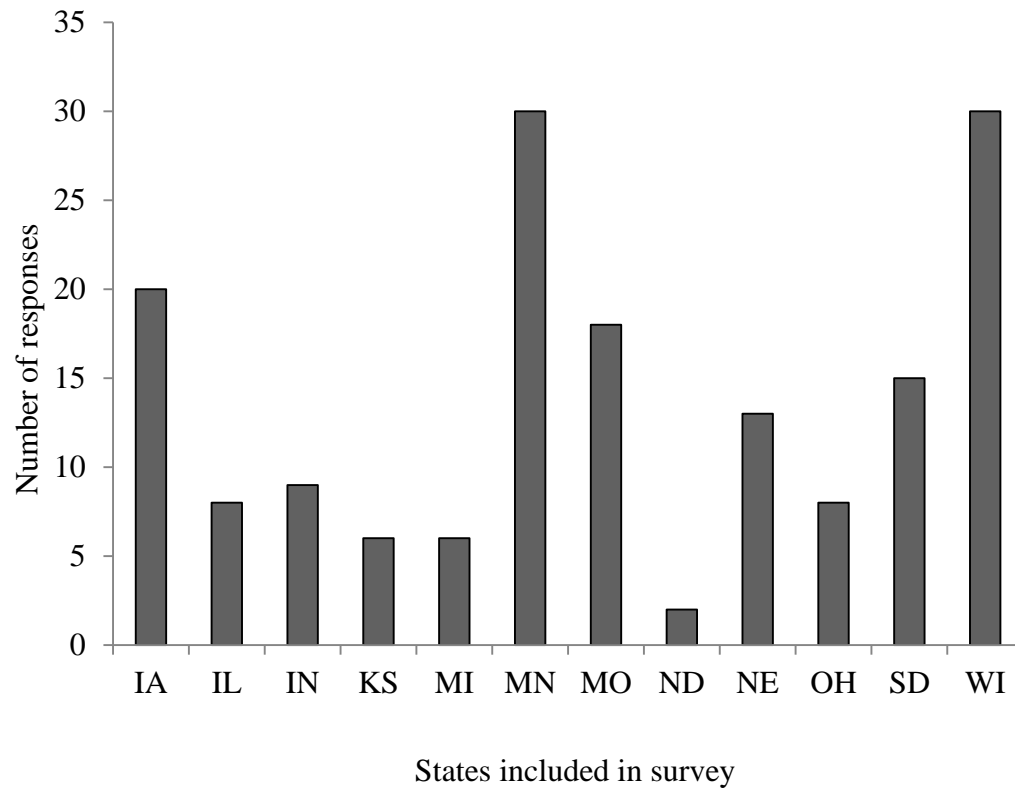
While it's hard to pinpoint the average range of shrink loss producers reported in the survey due to a low number of responses (feeder lambs,  $n = 11$ ; finished lambs,  $n = 9$ ), the variability in pre-marketing management practices and distance traveled to point of sale could have a large impact on producer's net return. Based on the survey less than half of the producers weigh their lambs as a pre-marketing practice, subsequently they cannot calculate shrink loss.

### Conclusion

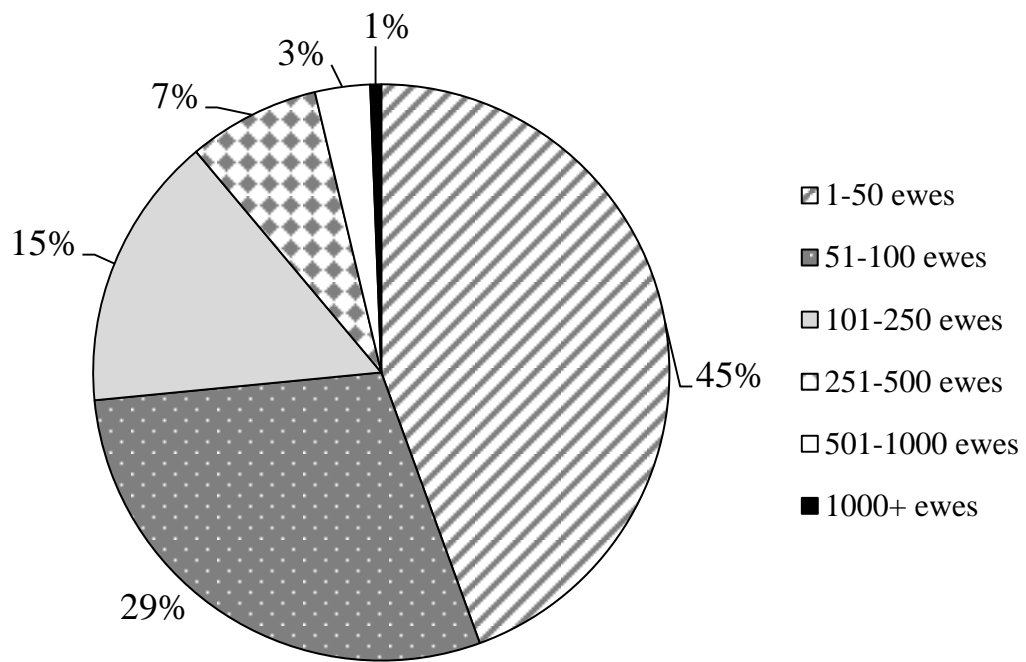
Shrink loss in lambs is a natural phenomenon and although highly variable, it can be effectively managed. The results from this survey showed how sheep producers in the North Central Region of the US manage their lambs through the marketing process. Producers that are able to weigh, sort, and immediately transport lambs short distances to points of sale are going to observe less shrink in their lambs which should yield more return. Longer distances to point of sale and lack of facilities for some sheep producers can limit intervention strategies to minimize shrink loss. When combined with shrink loss data from Kolthoff and others (unpublished data, 2017), feeder lambs (32 kg) that are exposed to an overnight stand would need to command an additional \$6.86 per cwt to return the same dollars as lambs that are moved to a transition pen or sorted and shipped the same morning. Finished lambs (62 kg) under an overnight stand would need an extra \$5.02 per cwt to compensate for the amount of shrink loss experienced in comparison to the other pre-marketing practices.

Given the results from this survey the majority of producers could benefit from producer education programming to focus on variables that impact shrink loss in lambs including pre-marketing management. Encouraging producers to objectively monitor the level of shrink loss on their operation and becoming aware of expectations at points of sale will aid in modifying pre-marketing practices on farm to limit shrink loss and increase the net return to the producer.

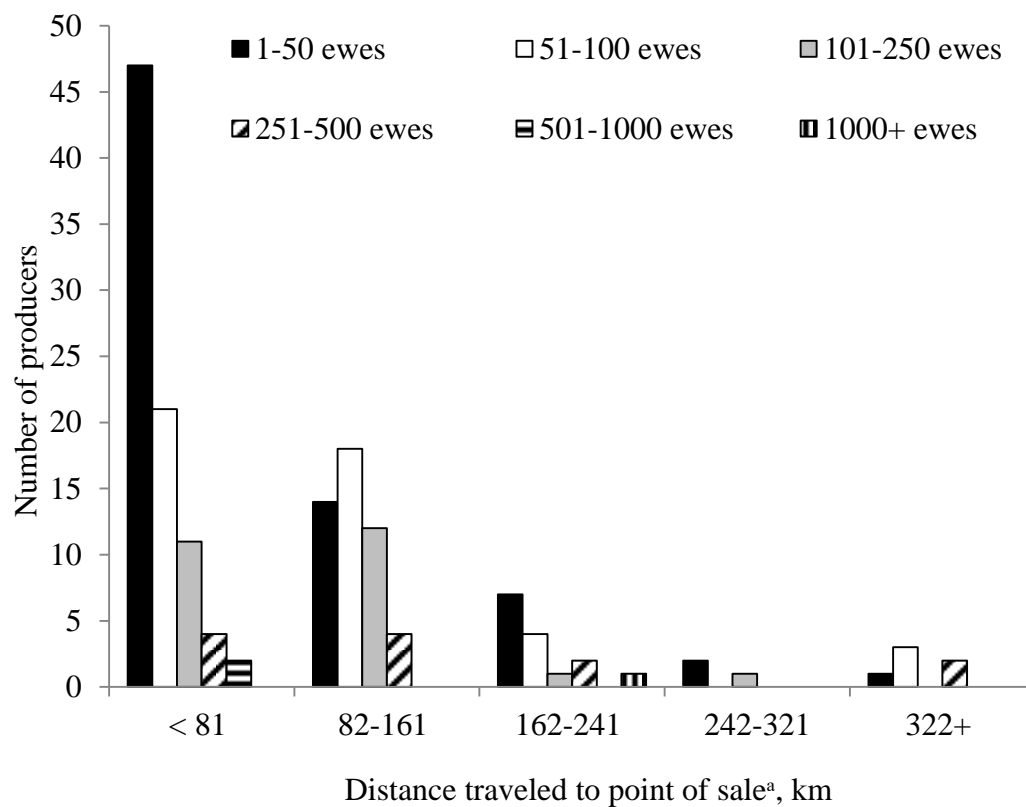




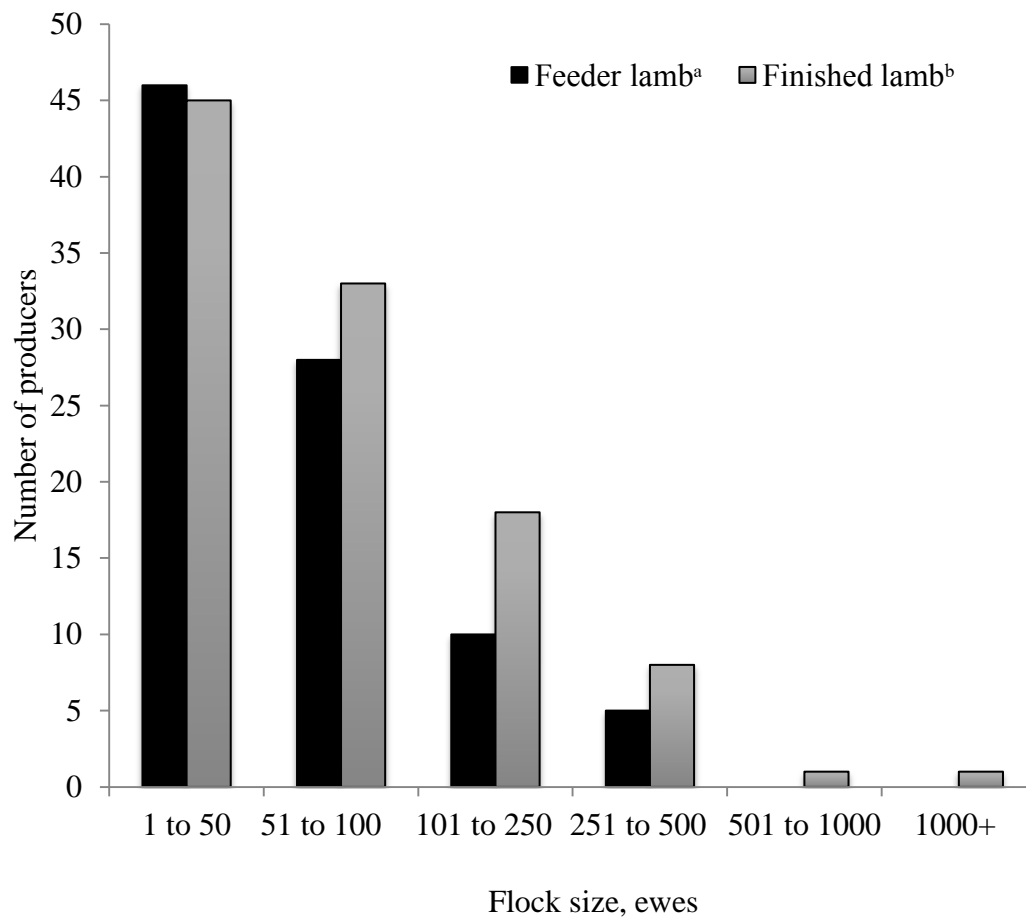
**Figure 3.1. Producer location.**



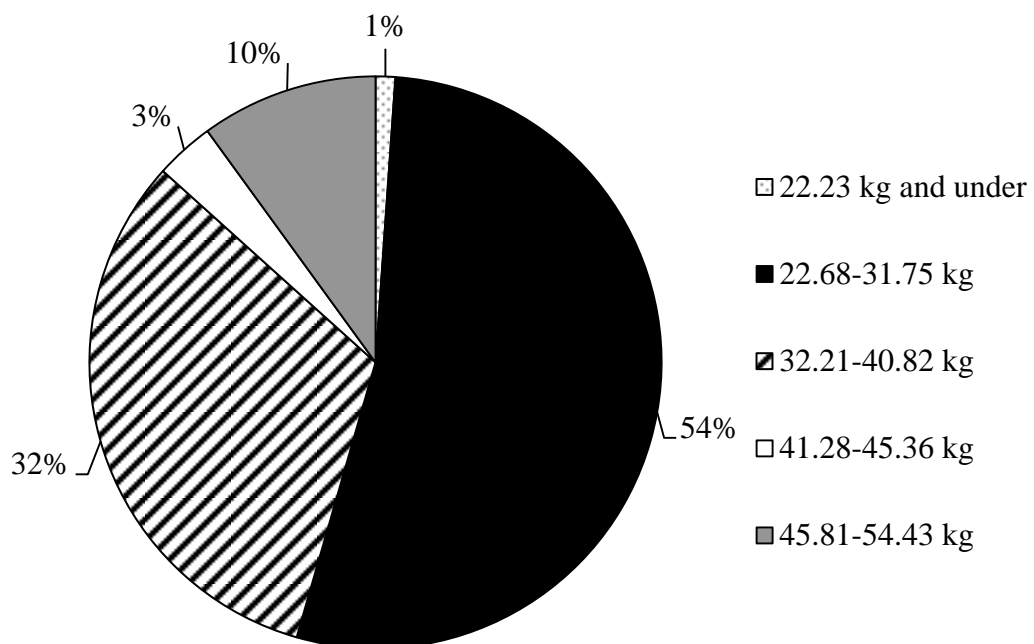
**Figure 3.2. Mature flock size.**



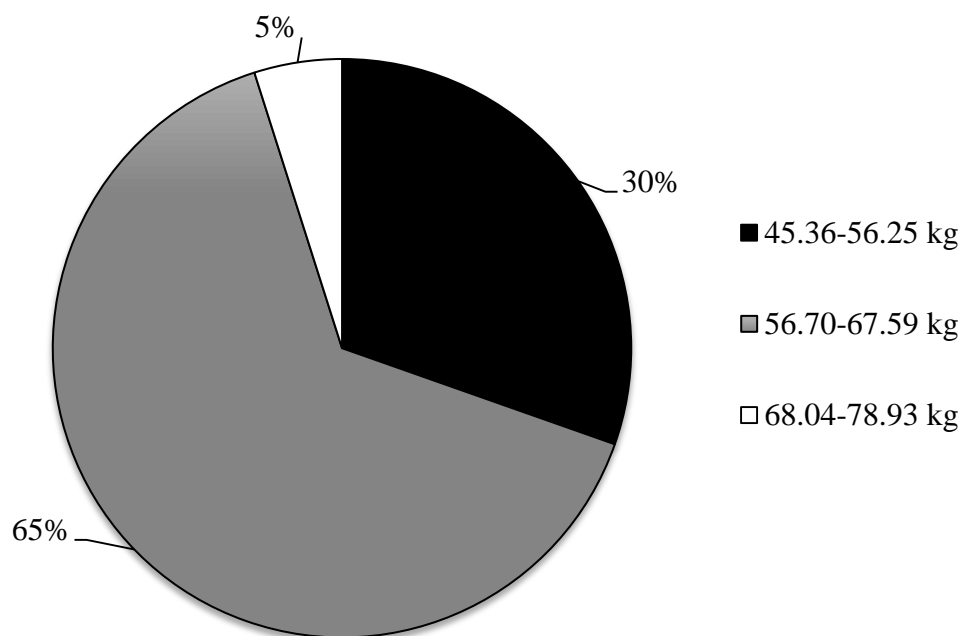
**Figure 3.3. Distance traveled to point of sale by ewe flock size<sup>a</sup>.** <sup>a</sup> Chi-square ( $P = 0.090$ )



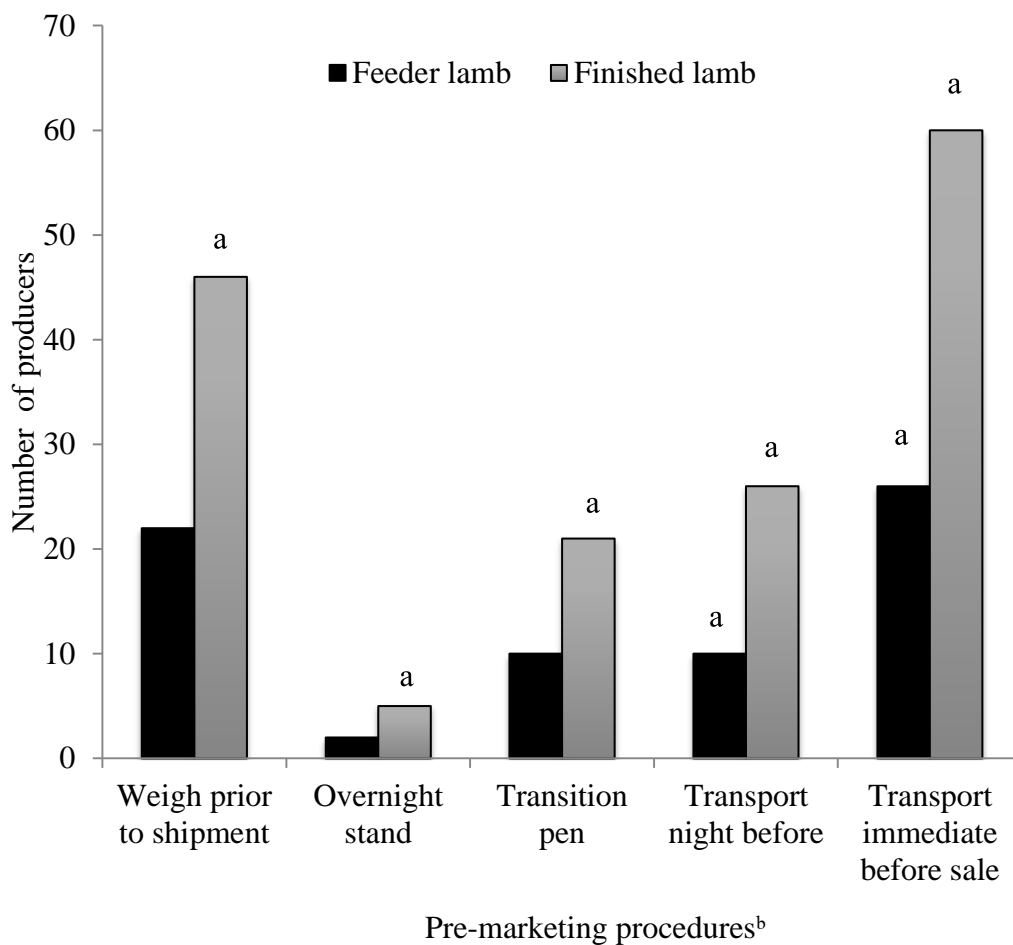
**Figure 3.4. Number of feeder or finished lamb producers by ewe flock size.** <sup>a</sup> Chi-square ( $P = 0.082$ ), <sup>b</sup> Chi-square ( $P = 0.781$ )



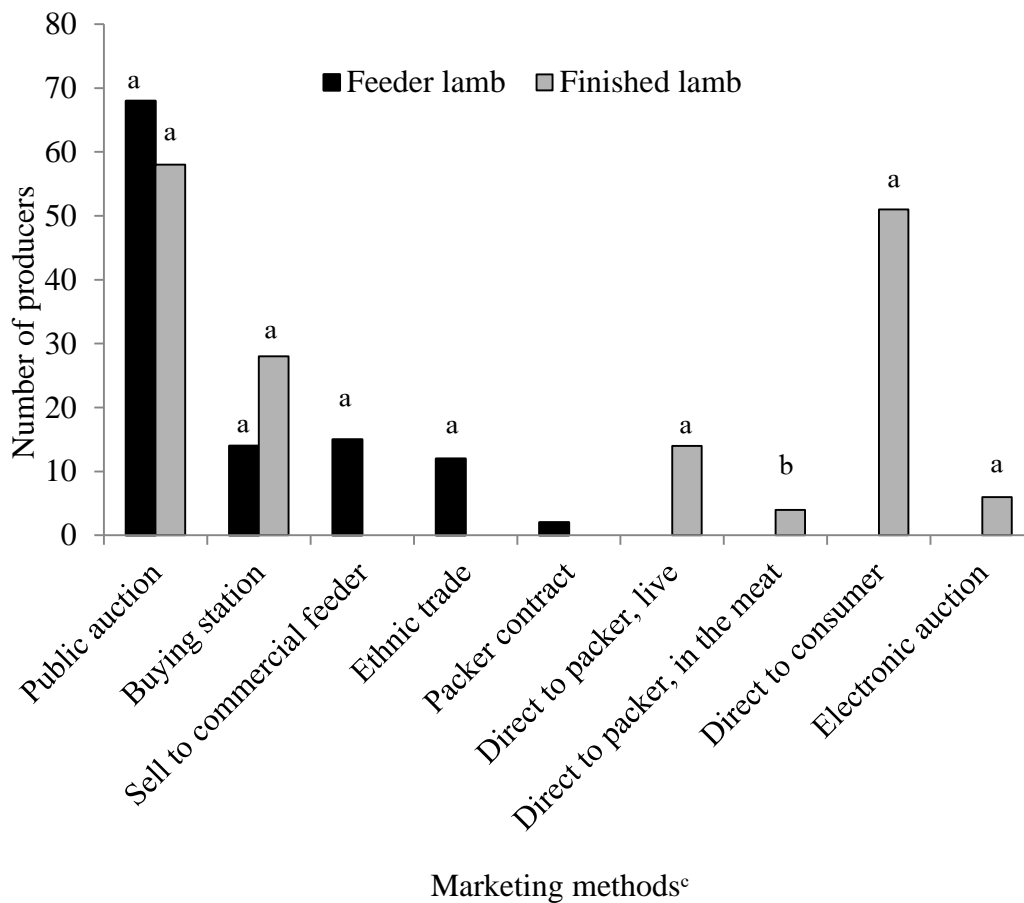
**Figure 3.5. Feeder lamb marketing weight.**



**Figure 3.6. Finished lamb marketing weight.**

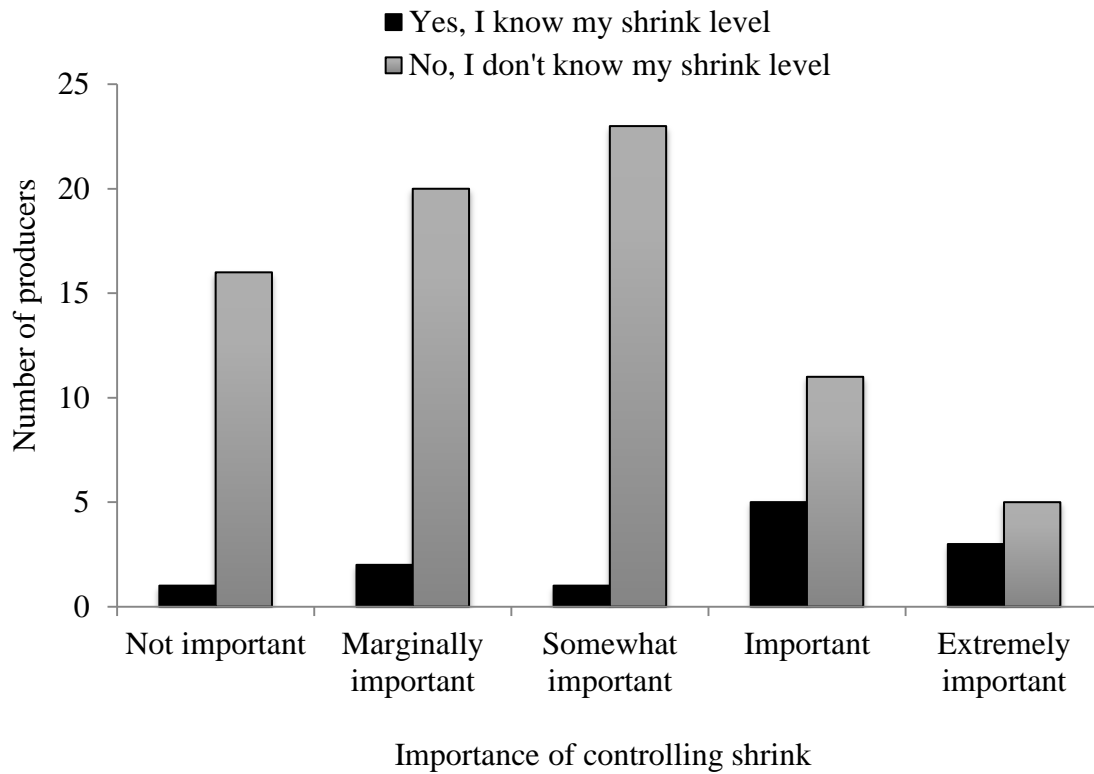


**Figure 3.7. Pre-marketing procedures for feeder and finished lambs.** <sup>a</sup> Chi-square ( $P \leq 0.05$ ). <sup>b</sup> Pre-marketing procedures: weigh prior to shipment; overnight stand = move lambs to a new pen, offer *ad libitum* grass hay; transition pen = move to a new pen, offer previous diet; transport night before = sort and transport to point of sale night before sale; transport immediate before sale = sort and transport 1-2 hours prior to sale time.

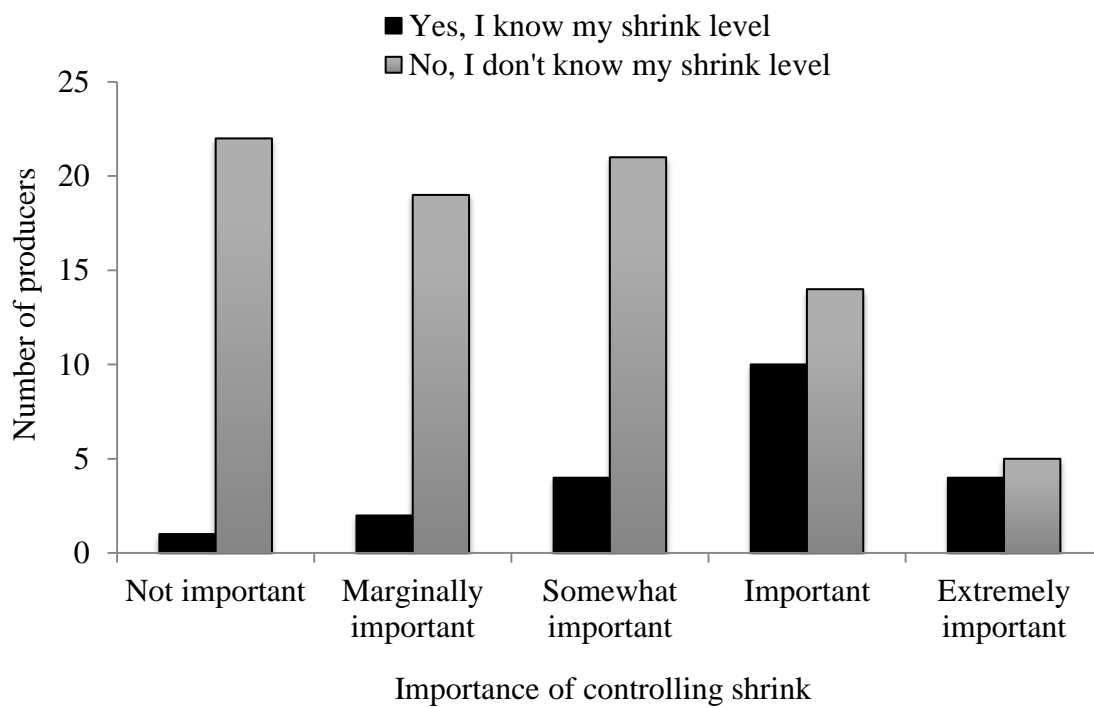


**Figure 3.8. Preferred method of marketing of feeder and finished lambs.** <sup>a</sup> Chi-square ( $P \leq 0.05$ ), <sup>b</sup> Chi-square ( $P = 0.082$ ) <sup>c</sup> Denotes answers available: feeder lamb producers: Public auction, buying station, sell to commercial feeder, ethnic trade, packer contract; finished lambs: public auction, buying station, direct to packer live, direct to packer in the meat, direct to consumer, electronic auction.

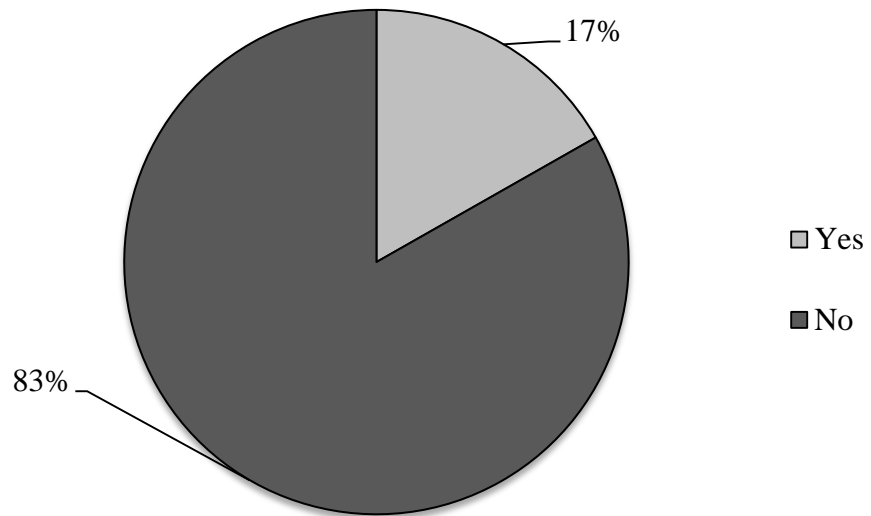




**Figure 3.9. Importance of controlling shrink in feeder lambs.** Chi-square ( $P = 0.019$ )



**Figure 3.10. Importance of controlling shrink in finished lambs.** Chi-square ( $P = 0.004$ )



**Figure 3.11. Knowledge of individual operation's shrink loss. Chi-square ( $P \leq 0.05$ )**

**Table 3.1. Survey questions and answers evaluating pre-marketing and management practices of producers in the North Central Region.**

Questions	Answers
1 Please choose the location for your primary sheep operation. (Choose from the list of states)	
2 How many years have you been in the sheep industry?	1. 1 to 10 yrs 2. 11 to 20 yrs 3. 21 to 30 yrs 4. 31+ years
3 Please select the option(s) that best describes your sheep operation. (check all that apply)	1. Range 2. Farm-flock 3. Custom feedlot 4. Seedstock 5. Commercial
4 Number of mature ewes in the flock.	1. 1 to 50 ewes 2. 51 to 100 ewes 3. 101 to 250 ewes 4. 251 to 500 ewes 5. 501 to 1000 ewes 6. 1000+ ewes
5 What is the distance traveled to the most common point of sale?	1. < 81 km 2. 82 to 161 km 3. 162 to 241 km 4. 242 to 321 km 5. 322+ km
6 Please select the season you <u>market</u> the majority of your lamb crop	1. Winter (December-February) 2. Spring (March-May) 3. Summer (June-August) 4. Fall (September-November)
The following questions are related to marketing feeder and finished lambs.	
Feeder Lambs	
7 Do you market feeder lambs?	1. Yes (then answer questions 7a, 8, 9.) 2. No (then skip to finished lamb questions)
7a What percentage of your lamb crop is marketed as feeder lambs?	
8 What is the typical weight range for your feeder lambs?	1. 22 kg and under 2. 23 to 31 kg 3. 32 to 40 kg 4. 41 to 45 kg 5. 46 to 54 kg
9 Which method(s) are utilized to market feeder lambs? (check all	1. Public livestock auction 2. Buying station

	that apply)	<ol style="list-style-type: none"> <li>3. Direct to commercial lamb feeder</li> <li>4. Ethnic trade</li> <li>5. Packer contract</li> </ol>
Finished Lambs		
10	Do you market finished lambs?	<ol style="list-style-type: none"> <li>1. Yes (then answer questions 11 and 12)</li> <li>2. No (then skip question 14)</li> </ol>
11	What percent of the lambs you finish are?	<ol style="list-style-type: none"> <li>1. Home reared lambs _____</li> <li>2. Purchased feeders _____</li> <li>3. Custom fed lambs _____</li> </ol>
12	At what weight do you market finished lambs?	<ol style="list-style-type: none"> <li>1. 45 to 56 kg</li> <li>2. 57 to 67 kg</li> <li>3. 68 to 79 kg</li> <li>4. 80 kg and up</li> </ol>
13	Which method(s) are utilized to market finished lambs? (check all that apply)	<ol style="list-style-type: none"> <li>1. Public livestock auction</li> <li>2. Packer buying station</li> <li>3. Electronic auction</li> <li>4. Direct to packer – live</li> <li>5. Direct to packer – in the meat</li> <li>6. Direct to consumer</li> </ol>
14	What are your marketing and/or shipping practices for feeder or finished lambs? (Please select all that apply.)	<ol style="list-style-type: none"> <li>1. Weigh prior to shipment either before or after sorting</li> <li>2. Sort and overnight stand prior to transport, limited diet and free choice access to water</li> <li>3. Sort to a “shipment pen” over night before transportation with access to diet and free access to water</li> <li>4. Sort then transport to point of sale the night before sale</li> <li>5. Sort then transport immediately to point of sale</li> </ol>
15	How important is controlling shrink loss to your operation in marketing feeder or finished lambs?	<ol style="list-style-type: none"> <li>1. 1= not important</li> <li>2. 2 = marginally important</li> <li>3. 3 = somewhat different</li> <li>4. 4 = important</li> <li>5. 5 = extremely important</li> </ol>
16	Do you know the typical % shrink loss (do not include pencil shrink) for your lambs associated with the marketing process?	<ol style="list-style-type: none"> <li>1. Yes</li> <li>2. No</li> </ol>
16a	What is the percent shrink loss you incur?	

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