DISSERTATION

AN EVALUATION OF CATTLE HANDLING CATEGORIES IN THE BEEF QUALITY ASSURANCE FEEDYARD ASSESSMENT, COMPLIANCE OF LARGE FEEDYARDS WITH THESE GUIDELINES, AND INFLUENCE OF HANDLING PRACTICES ON BEHAVIOR AND PERFORMANCE OF FEEDLOT CATTLE

Submitted by

Ruth Woiwode

Department of Animal Sciences

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer 2015

Doctoral Committee:

Advisor: Temple Grandin

Shawn Archibeque
Terry Engle
Brett Kirch
John Paterson
Bernard Rollin

ABSTRACT

AN EVALUATION OF CATTLE HANDLING CATEGORIES IN THE BEEF QUALITY ASSURANCE FEEDYARD ASSESSMENT, COMPLIANCE OF LARGE FEEDYARDS WITH THESE GUIDELINES, AND INFLUENCE OF HANDLING PRACTICES ON BEHAVIOR AND PERFORMANCE OF FEEDLOT CATTLE

Animal husbandry and management practices were surveyed in commercial feedlots to document compliance of select feedlots with Beef Quality Assurance (BQA) guidelines for cattle handling under the premise that this data warrants inclusion in the National Beef Quality Audit (NBQA). The BQA Feedyard Assessment for cattle handling has not yet been fully validated, and this work partially substantiates the current assessment categories. The inclusion of this handling data is essential in order to continue the track record of identifying target areas where improvement is needed, and to document growth and positive performance. Collecting and reporting of survey data is part of the verification and ongoing monitoring process that characterizes an effective HACCP plan, which was the system for management that was adopted during formation of the BQA program. It has been said that producers manage what they measure, and systematic measurement of categories for cattle handling and husbandry practices in the BQA can yield valuable information to assist producers in making management decisions. The NBQA, which has been conducted in five year increments since 1991 has accomplished just that, through the identification of targets where improvement is needed, with corresponding recommendations for improvement. The growing repository of data, collected over the course of time, reflects adjustments the industry has made in an effort to continuously improve the quality

and consistency of beef production, and thus increase consumer confidence. BQA is a voluntary program that allows the use of self-assessment or third party audits to ensure compliance with the guidelines of the program. The BQA Feedyard Assessment (FA) provides guidelines for cattle handling in commercial feedlots, and is a useful tool for measuring cattle handling practices. Using these guidelines, select feedlots in 3 states (Colorado, Kansas, and Nebraska) were assessed for six current BQA categories (electric prod use, falls, stumbles, jump and run, and chute operation). These states rank 5th, 3rd, and 2nd, respectively, among all states for the number of cattle on feed each year. These three states were selected based on their ranking among the top five states for number of cattle on feed, and for the high density areas of large (1000+ head) feedyards in each state, accounting for approximately 50% of all US fed cattle each year. The feedyards included in this study were all large (1000+ head capacity) yards, with a mean capacity of 34,000 head. Across 28 sites surveyed, rate of electric prod use was 3.8% vs. the 10% current BQA critical limit (CL); only 2 sites surveyed exceeded the CL with 15% and 45% respective rates; and 12 did not use an electric prod. The rate of cattle falling when exiting the squeeze chute was 0.6% vs. BQA CL 2%, and no site surveyed exceeded the CL. The rate of cattle stumbling when exiting the squeeze chute was 5.7% vs. BQA CL 10%, with 4 sites exceeding the CL and 4 sites that had no stumbles. The rate of cattle vocalizing was 1.4% vs. BQA CL 5%; for cattle that jumped or ran when exiting the squeeze chute, 52% vs. BQA CL 25%; and mean score for cattle that were improperly captured in the squeeze chute and not readjusted was 1.2%, vs. BQA CL 0%.

A second study was conducted at a commercial feedlot in Kansas. The objective of this study was to investigate if a relationship exists between handling, and behavior and ADG of feedlot cattle. Upon arrival, Hereford steers (n = 496; initial BW = 304 ± 35.6 kg) of similar genetic background were sorted into four pens to determine the effects of handling on behavior and ADG. Two handling conditions prior to processing and two conditions of release from the squeeze chute were imposed. Prior to processing, handlers were required to quietly walk all steers from their home pen to the processing area (SLOW); or handlers were permitted to bring steers to the processing area in the normal fashion (FAST). Since this condition was applied to pens, pen was considered the experimental unit for the full model. Individual steers were randomly assigned to one of two conditions of release from the squeeze chute. The first was a delay no longer than 30 seconds following the completion of procedures to allow cattle to stop struggling (DELAY); the second was release immediately following the completion of procedures (NORM). Vocalization, chute temperament, exit speed and exit behavior scores were assigned to all steers during intake processing. Paired t-tests determined that cattle exiting the chute at a walk or trot vs a run tended (P=0.08) to have higher ADG. Cattle vocalizing during restraint had lower (P=0.04) ADG than those that did not vocalize. The FAST group showed a tendency to vocalize more frequently than the SLOW group. Pearson's correlation analysis showed a significant, positive correlation between exit speed and vocalization (P= 0.0021, r= 0.14256), and a significant, negative correlation between exit speed and ADG (P= 0.0036, r= -0.13542). Using this approach, handling was correlated with behavior and ADG.

ACKNOWLEDGEMENTS

There are many who I wish to thank for their support and encouragement as I have learned and grown and encountered and overcome many challenges. I firmly believe that without such support, graduate school would not have been a reality for me. The opportunity to study with Dr. Temple Grandin has been the experience of a lifetime, and the support she has provided (whether in financial support of my graduate studies and research, or otherwise) would be difficult to measure. Though words seem inadequate to express what an impact her work and mentorship has had on my life and work, I am most proud to be considered her friend.

I would like to express gratitude and appreciated to each of my committee members, for their guidance and support. It has been an honor to learn from Dr. Shawn Archibeque, Dr. Terry Engle, Dr. Brett Kirch, Dr. John Paterson, and Dr. Bernie Rollin. Each has left a lasting impression and contributed to the development of my philosophies of teaching and research. I would also like to express my gratitude to Dr. J. Daryl Tatum for his influence and example as a former committee member. I have been fortunate to have learned from each of these individuals.

I wish to thank Marv Benton for his unwavering support. He believed in me when I doubted. He encouraged me, and at times his vision carried me when I feared I had lost mine. Words are not sufficient to describe what his support has meant. It will never be forgotten.

Finally, credit must go to the main driving force in my life: Lane. I believed the most important gift I could give was to teach by example that you can do anything you set yourself to do; and that life is nothing without passion or purpose. So I followed my passion and returned to school. Thank you to Lane for always being my biggest fan, and for loving me and believing in

me no matter what. I'm so grateful for his patience, understanding, and support when it was difficult for me to balance everything. In being Lane's mom, I am a better person.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Management practices for livestock and cattle handling can be traced back to early domestication. Prior to the modern era, stockmanship was learned by working and coexisting with livestock in an extensive environment. Many of the techniques and skills gained in this era, including the specific manner in which this knowledge was acquired specifically in this context, have not been documented in scientific literature. These skills and knowledge were gained through living on the land with animals, in a pastoral manner. This is what I refer to as “slow knowledge.” Though I have not encountered this term applied specifically to husbandry, the concept is not original. The construct was presented by Orr, where he contrasts wisdom and cleverness, and suggests that the velocity of knowledge is inversely related to the acquisition of knowledge (Orr, 2002). Such an approach to livestock production is often thought of as “old-fashioned” animal husbandry. The management of livestock under such an approach includes the observation of behavior as a critical management tool. When applied skillfully, the observation of behavior is used to provide essential information about the condition of livestock. Animal husbandry is characterized by an acknowledgement of the nature of livestock, and a commitment to managing them optimally. That is, in a humane manner that maximizes performance.

With advancements in technology, animal husbandry has been melded with animal science, where the application of technology has been utilized to enhance production. Animal science is characterized by separating the underlying systems into distinct disciplines and procedures to evaluate biological processes relative to inputs and outputs. Some advocate taking an integrated, multi-disciplinary approach to studying and managing livestock, and suggest such an approach might result in greater advancements in research (Stricklin and Kautz-Scanavy, 1983). Such an approach involves re-integrating many of the previously separated, underlying systems. This accounts for animal activity, as well as the social and physical environment and the interaction of these factors.

The physical environment of livestock includes the facilities in which they are housed and the interaction with care givers or handlers for the purposes of routine management tasks. The assessment of livestock temperaments, which is discussed at length later, is one means of understanding this interaction.

Currently, a proficiency in husbandry practices is often absent when an employee is hired to work with livestock. As a result, such skills must be learned on the job. Historically, husbandry and stockmanship skills were cultivated over long periods of time, learning from individuals (commonly ancestors) who had spent a lifetime caring for animals. Due to changing demographics in agriculture, this method of learning is rare. This type of learning system is intentional, and is driven by values. Parents would share the significant stories of their family in the hopes that their history would not fade or be forgotten; so also, husbandry practices were cultivated with the same imperative. This imperative, along with the investment of time represented in the perpetuation of this knowledge is the reason I refer to it as "slow knowledge." Learning on the job, under the pressure of meeting time and economic constraints is a less than desirable means by which skills that directly impact livestock are obtained. This is the precise challenge that many producers face given the declining skill level of today's workforce which producers have to draw from.

This is not to say that the "old-fashioned" system or the practices that were included in the production system were without fault. Referencing this historic system illustrates a great contrast in how knowledge and information were transferred. Many of these skills and techniques are not effectively learned in a classroom.

Over the past hundred years, agriculture has undergone a major metamorphosis that includes a migration of youth away from family operations which are no longer able to support multiple generations. These changes have led to the concentration of feeding and packing operations, leading to segmentation of the cattle industry. This simultaneous shift led to the creation of highly specialized jobs when dealing with the care and management of cattle in a smaller segment of production and the animal's life cycle. This segmentation, which is rooted in production efficiency, has set up a dynamic that explains the detachment of livestock care givers from the animals in their care. This shift away from the pastoral system of production in which livestock were domesticated has resulted in a flawed system. This current system consists of handlers imposing unknown stress and constraints on cattle during routine handling events, not because they are negligent or wish to impose stress. Many handlers today have limited knowledge and proficiency for determining the longer-term impact of handling events on cattle when compared to handlers who learned the "old-fashioned" husbandry system.

It is imperative to revisit the "old-fashioned" method of learning husbandry skills, and to begin to more fully quantify the effects of routine handling events on cattle raised in commercial agriculture. By applying science and technology given the constraints of the Ancient Contract, greater advancements can be made in the field of livestock behavior and welfare. Scientific methods take on a slightly different appearance when weighed against the additional constraints of the nature and sentience of livestock. Improved, scientifically based management can effect positive change for the benefit of the animal, especially for production on a larger scale.

CHAPTER II

REVIEW OF LITERATURE

BEEF QUALITY ASURANCE

History and Development

As the final decade of the 20th century approached, it was clear to the beef industry that a concerted effort was needed to address growing concerns about the safety and quality of the U.S. beef supply. Leaders of the beef industry drew on business strategies that had long since been adopted by successful manufacturing companies around the globe. These strategies, part of W. Edwards Deming's business model, consisted of shifting the focus of business management onto quality. He found that when companies focused on quality, quality would improve and cost would decrease; and on the other hand, if companies focused solely on cost, costs would increase. At the core of his model was the principle that "the industry cannot manage its quality problems until it can measure them (Deming, 1986)." This was the premise upon which the Beef Quality Assurance (BQA) program was developed, loosely modeled after the food-safety approach to management of quality, known as Hazard Analysis Critical Control Point (HACCP). The HACCP approach to ensuring quality involves measuring relatively few points that provide a great deal of information about management practices contributing to the outcomes that are measured. This approach most closely represented the diversity of management practices that characterize the segmented beef industry today. The points that are measured as part of a HACCP plan are referred to as Critical Control Points (CCPs), and each CCP has a verified acceptable level, or Critical Limit (CL). These points are routinely measured, or audited, and the system commonly relies on internal as well as third party audits as part of the verification and ongoing monitoring process. This approach provides an objective way to evaluate quality, once the quality categories have been defined relative to the objectives of the program.

With a structure and philosophy identified, it was time to begin the task of addressing industry and consumer concerns related to safety, quality, and consistency of the U.S. beef supply. To facilitate this process, the BQA program was formalized in 1991 with funding from Beef Checkoff dollars. The foundational mission of BQA is to increase consumer confidence in the safety and quality of the U.S. beef supply. BQA provides information and recommendations to producers, by industry segment, in the broad categories of record keeping; product management; and animal handling and care. It is a voluntary program that functions primarily in an educational capacity, though it does include scoring instruments with CCPs and CLs that can be assessed internally or by a third party.

It was necessary to begin the process of measuring quality in set categories on a national level, so that areas of deficiency could be identified, and areas of positive performance could be reported and tracked. To ensure that BQA objectives were met, this information had to be broadly reported so producers could assimilate and adopt the recommendations of these quality reports in the process of improving consumer confidence. In order to add to these reports and document industry progress, it was important that this process continue. Based on expert advice, it was determined that this process should optimally occur every 4 to 5 years, in order to allow the industry time to adopt recommendations, and for these changes to be reflected in production (Smith et al.).

National Beef Quality Audit

The process of defining quality and measuring industry performance in specific quality categories became known as the National Beef Quality Audit (NBQA), which launched in 1991.

The purpose of the NBQA was to meet BQA objectives of measuring and reporting deficiencies in quality, and reporting positive performance; and thus to provide information to the U.S. beef industry and consumers that would increase their confidence in the quality and consistency of beef. The audit was initially driven by concerns about residues or contaminants – most notably the presence of broken needles (attributed to improperly administered medications) and buckshot – in retail beef product. True to the foundational principle, the audit has grown as quality problems were identified beyond those initial concerns. Today the audit includes beef production across all segments of the industry, which are defined as 1) beef, 2) dairy, 3) veal, 4) fed, and 5) non-fed.

The first national audit, NBQA – 1991 occurred in 3 phases, and subsequent audits have occurred in similar fashion. Phase I in both NBQA – 1991 and NBQA – 1995 consisted of face to face interviews with retailers, purveyors, restaurateurs, and packers that identified the top ten producer-controllable concerns about the quality of beef for each group that participated. Phase II included plant audits of both slaughter floor and cooler data; and Phase III was a workshop which used the information from the previous 2 phases to define strategies for improving consistency of fed beef. By the third audit, NBQA – 2000, Phase I expanded to include top ten greatest quality challenges in the seedstock, cow-calf, stocker/backgrounder, and feedlot segments, as well as top ten greatest quality improvements for these and all previously included segments of the beef industry. From 2000 forward, this information was obtained from questionnaires mailed out to producers, as well as from personal interviews.

The conduction of the second audit in 1995 allowed for the industry to make mid-course corrections to the strategies laid out by NBQA – 1991. At this time, it was possible to evaluate what the beef industry could realistically accomplish to improve the safety and quality of beef, given what had been learned from NBQA – 1991(Smith, et al., 2005b). Those questioned during Phase I of NBQA – 1991 were able to speak to the improvements that the beef industry had made, and noted that new challenges had arisen.

Results of the National Beef Quality Audits

Phase I reported top producer-controlled concerns about quality expressed by various segments of the industry. Across the segments interviewed, frequency of bruising on carcasses was reported as a top concern in NBQA – 1991 (Smith et al., 1992), NBQA – 2000 (Smith, et al., 2000), and NBQA – 2005 (Smith, et al., 2005b). Frequency of injection-site lesions was consistently a top concern among nearly every segment interviewed during this period as well.

Presence of bruising on carcasses has been identified among top concerns for producer-controllable quality defects in NBQA – 1991 through NBQA – 2005. Carcass bruising evaluated on the slaughter floor showed that between NBQA – 1991 and NBQA – 2011, the percentage of carcasses with no bruising increased from 60.8% to 77.0% (see Table 1). This reduction in bruising has been attributed to management practices that affect the type of cattle arriving for slaughter (i.e. fewer horned cattle) (Garcia et al., 2008a; McKenna et al., 2002); and to producer attention to animal handling (Garcia et al.)Smith, et al., 2005b). This illustrates the foundational principle of BQA in action: that quality cannot be controlled unless it can be measured. The quality defect of bruising has a substantial financial impact, costing the industry millions each year. The reported reduction in bruising is a quantifiable category that can be measured. The measuring of this category has clearly been effective and resulted in greater quality over the course of the NBQAs. Despite marked improvement in this category, the actual causes of bruising have not been verified. Potential causes of bruising include horn bruises inflicted by other cattle; bruises from being ridden by other cattle; and injuries incurred during handling that can include improper catches in the squeeze chute; slips and falls; and making contact with sharp objects, corners, or edges of facilities or trailers. The attribution of reduction in bruised carcasses to improved handling practices in the NBQA had been, at best, an educated guess, and has not been verified. Furthermore, there is no consistent or verifiable means of connecting this reduction in bruising to BQA training, which underscores the weaknesses of BQA in a review conducted in 2006 (Dunn, 2006; Odde, 2006).

Table 1 National Beef Quality Audit Findings: Carcass Bruising

	NBQA – 1991[1]	**NBQA – 1995**[2]	**NBQA – 2000**[3]	**NBQA – 2005**[4]	**NBQA – 2011**[5]
Number of Bruises	% of Sample (n = 37,002)	% of Sample (n = 42,156)	% of Sample (n = 43,595)	% of Sample (n = 49,330)	% of Sample (n = 18,159)
Zero	60.8	51.6	53.3	64.8	77.0
One	25.0	30.9	30.9	25.8	18.8
Two	10.6	12.8	11.4	7.4	3.4
Three	3.5	3.7	3.5	1.6	06.
Four or More	0.2	1.0	0.9	0.4	0.3

[1](Lorenzen et al.)
[2](Boleman et al., 1998)
[3](McKenna et al., 2002)
[4](Garcia et al., 2008b)
[5](McKeith, et al., 2012)

Damage to hides from hot-iron brands is another quality defect that results in significant financial loss to the beef industry. NBQA data shows that while numerically fewer cattle were branded between 1991 and 2011, cattle with more than 1 brand increased between 2005 and 2011 (McKeith, eta al, 2012), and the mean area of hide damage due to hot iron brands has fluctuated in size for all locations assessed between NBQA – 1991 and NBQA – 2011. Most recently, as reported in NBQA – 2011, the mean area of brands for all locations was increased compared to NBQA – 1991, and the mean area of side (rib brands – constituting the location of greatest financial impact) doubled compared to NBQA – 2005, though mean area of shoulder brands dramatically decreased in that same time frame (McKeith, et al., 2012). Complete results for NBQA findings related to brands can be found in Table 2. The positive information shown by the NBQAs is that overall, branding and the frequency of hides with more than 1 brand has decreased compared to NBQA – 1991. Conversely, in the most recent account, the cost of damage to hides caused by brands is not necessarily reduced, because when rib brands are present, a larger area is damaged due to the size of the brand, and a rib brand can decrease hide value by approximately $10, with smaller hip brands resulting in a loss of $5, according to one source (USDA-APHIS, 1995). This information is twenty years old, and if this is a primary source used to quantify production losses in the U.S. beef industry, then it is possible that these losses are significantly underestimated.

Perhaps the greatest reported weakness of BQA is reflected in these reports; it remains a consistent challenge to verify that industry adoption of BQA, and associated training has actually changed producer behavior or can be credited with the reduction in number of cattle with brands. In fact, some evidence exists that BQA certification status and training does not influence producer behavior related to branding: a survey of Montana beef producers found that BQA producers were more likely to use a hot-iron brand than producers who were not BQA certified (Duffey et al.).

Table 2. National Beef Quality Audit Findings: Size and Location of Hot-Iron Brand Scars

	NBQA 1991[1]		**NBQA 1995**[2]		**NBQA 2000**[3]		**NBQA 2005**[4]		**NBQA 2011**[5]	
Brand Site	% of Sample	Brand Size[6]	% of Sample	Brand Size[6]	% of Sample	Brand Size[6]	% of Sample	Brand Size[6]	% of Sample	Brand Size[6]
Shoulder	0.8	145.2	3.0	326.0	3.6	210.1	1.2	610.1	2.5	200.7
Side	13.8	304.5	16.8	728.1	13.7	456.8	7.4	222.0	7.5	476.4
Butt	29.9	110.8	38.7	259.4	36.3	154.6	26.5	292.4	35.2	205.5
Multiple Brands	2.1	-	6.2	-	4.4	-	3.6	-	3.7	-
No Brands	55.0	-	47.7	-	49.3	-	62.0	-	55.2	-

[1](Lorenzen et al.)
[2](Boleman et al., 1998)
[3](McKenna et al., 2002)
[4](Garcia et al., 2008b)
[5](McKeith et al., 2012)
[6]Hot-iron brand scar size reported as mean cm^2

Review of BQA

In order to determine the efficacy of BQA and the NBQA, an evaluation of the program was called for. A review of BQA was presented to the Joint Evaluation Advisory Committee at the mid-year meeting of the Cattlemen's Beef Board (CBB) and the National Cattlemen's Beef Association (NCBA) in 2006 (Dunn, 2006; Odde, 2006). This review was conducted primarily by two individuals who had both years of personal experience in numerous segments of the beef industry as well as existing knowledge of the BQA program. As part of the review process, interviews were conducted with NCBA officers, state BQA coordinators, and Cooperative Extension Service personnel. This review included an assessment of strengths and weaknesses of the program, as well as recommendations for the future. The reported strengths included how dynamic the program has proven to be; buy-in from all segments of the industry; and quality of training and materials. The interviews conducted during this review made it clear that many producers believe BQA is structured in such a way that it has the potential to grow and comprehensively address quality and safety concerns across every segment of the beef industry in the U.S. Those interviewed unanimously agreed that BQA has had a positive impact on the safety and quality of the U.S. beef supply, with most referring to reduction of contaminants in retail product in support of their claim. BQA in 2006 was a dynamic program that required an evaluation of the mission and objectives of the industry in order for continued growth to occur, according to both Dunn and Odde. The greatest limitations and challenges of BQA reported in 2006 centered heavily around the lack of verification of BQA practice application; and lack of centralized reporting of BQA's scope and adoption by all segments of the industry. BQA materials and training techniques were not lacking in quality or reception by the industry, but the objectives and applications of the program vary widely across the U.S.

Though Checkoff dollars fund the core of the program at the national level, partnership with industry groups varies greatly by state. Funding at the state level helps determine objectives and application of BQA education at the state and regional level. Since there are many sources of funding for BQA across the U.S. in addition to Checkoff dollars, it is challenging to quantify total expenditures of the program. Similarly, it is difficult to quantify how and if training has actually changed producer behaviors. Many of those interviewed believed that some type of additional external verification would be necessary in order to continue to meet BQA objectives of increasing consumer confidence. There was no clear consensus regarding how this verification might occur, and some feared it might be difficult to achieve across all segments of the industry.

Feedyard Assessment

Concerns identified in the 2006 review of BQA led to the development of more comprehensive and consistent training materials, including the Transportation BQA Manual in September of 2006, and the National BQA Trainer's Manual (NCBA, 2015; NCBA 2009a). However, it wasn't until 2009 that BQA producer education materials were expanded to include a specific scoring instrument for cattle handling in the feedlot. This document, called the BQA Feedyard Assessment (FA), was developed in a collaborative effort with industry relevance, and was reviewed by two academics widely recognized by the beef industry as authorities on cattle behavior, handling, and welfare (NCBA, 2009b).

True to the HACCP scheme of BQA, the FA for cattle handling consists of specific handling categories representing CCPs, with CLs for each category. Other segments of the cattle industry have used this approach to monitor cattle handling (Grandin, 2000b, 2005). Categories identified as CCPs for cattle handling in the feedlot are: use of driving aids, cattle falling, cattle stumbling or tripping, cattle vocalizing, cattle jumping or running, and chute operation (more specifically cattle that are improperly caught and not adjusted in the squeeze chute). Each category has an associated threshold CL, and in the case of the FA, compliance with these guidelines is typically self-assessed at feedlots that participate in the voluntary BQA program. There is limited evidence that the CCPs or CLs of the current FA were initially verified, though it is likely these categories were based on previously published work of Grandin (who provided review of the FA) who implemented the concept of measuring similar cattle handling categories at slaughter plants (Grandin, 1996; Grandin 1998a; Grandin, 2000b; Grandin, 2001; Grandin, 2010; Grandin, 2012a; Grandin, 2012b). Some of the earliest published work that measured cattle handling categories was a survey designed to develop objective methods for monitoring animal welfare at slaughter plants. This survey reported the rate of cattle slipping was 9.6%; the rate of cattle falling was 10%; and the rate of electric prod use was 22.5% (Grandin, 1998b). Subsequent surveys divided handling for these categories into the rankings of 'excellent;' 'acceptable;' 'not acceptable;' and 'serious problem' (Grandin, 2000a). This was a subjective rating system recommended by Grandin, and based on her experience. The rating of "excellent" meant that the average person educated about slaughter practices could accept and achieve this rating, with the implication that this level was above and beyond industry standards. The rating of "acceptable" meant that performance in this bracket conformed with industry standards. The rating of "not acceptable" indicated that a welfare problem existed that required correction. The rating of "serious problem" was reserved for a problem requiring immediate attention, because of obvious signs of pain and distress in animals. This ranking resulted in the ensuing recommendations for cattle handling at slaughter plants, which were adopted by the American Meat Institute as part of their systematic approach to animal welfare. The categories in this set of guidelines are described as follows: in the core criteria of cattle falling, the rating of excellent means that no cattle are observed to fall during the scoring window; acceptable is defined as fewer than 1 percent of cattle falling; and unacceptable is defined as more than 1 percent of cattle falling (Grandin, 2010). While it is desirable to avoid falling, it is also necessary to account for different breed types and handling background of cattle which might explain differences in agitation which may result in slips and falls. In the same document, cattle vocalization is addressed similarly: a rating of excellent is defined as 1 percent or less vocalization; acceptable is 3 percent or less; not acceptable is between 3 and ten percent; and serious problem is defined more than ten percent. Finally, for electric prod use, excellent is defined as 5 percent or less; acceptable is 25 percent or less; not acceptable is 26 to 49 percent, and 50 percent or more is a serious problem. By comparison, the FA addressed these same categories as CCPs with CLs. For the CCP of cattle falling, the BQA FA defines the CL as 2 percent; for cattle vocalizing, the CL is ten percent; and for electric prod use, the CL is 5 percent (NCBA, 2009b). It seems reasonable from this comparison, that the guidelines established for cattle handling in the slaughter plant were used as a reference point for the development of the FA, though there is no similar survey data published that reports feedlot compliance with these guidelines.

Since carcass bruising can result from handling (among other causes), there has been an increased focus on handling events in order to minimize bruising that might result during handling. Bruises can result from improper capture in the squeeze chute, and from falls as a result of agitation when exiting the chute, to name a few. If cattle exit the squeeze chute more slowly, they may be less likely to stumble and fall, or to run into fences or other objects that may result in bruises. NBQA – 2005 credited producer attention on handling practices as a contributing factor to the reported decrease in carcass bruising (Garcia, et al., 2008; Smith, et al., 2005), but this has not been verified. In its current form, it is difficult to gauge industry adoption of BQA, and little is known about adoption of, or compliance with, guidelines for cattle handling in the feedlot. The 2006 review noted that industry adoption of BQA has been difficult to measure (Dunn; Odde), and that though anecdotal reports reference training events, etc., there is no centralized database that tracks such information. There is no centralized source that documents industry adoption of guidelines for cattle handling practices in the feedlot, nor does any information reside centrally regarding industry compliance with these guidelines. Just as NBQA has grown since it was first launched in 1991 to include new measures of quality, the inclusion of cattle handling data is a category that warrants inclusion in future NBQAs as a critical quality component of beef production with significant implications for the industry. The reporting of survey data for feedlot cattle handling CPPs and CLs is a missing and essential component of the verification process as part of a HACCP scheme.

VALIDATION AS PART OF A HACCP PLAN

The key elements contributing to the quality of an instrument of measurement are its reliability and validity. Especially relevant to an industry that experiences rapid and dynamic change (such as the beef industry) is the strength of an instrument as well as the capacity for sensitivity, or responsiveness to change over time. An instrument is considered to be valid if it measures what it claims to. An instrument may be reliable without being valid, just as a scale that has not been calibrated may display consistent weights for substances measured over time, without reporting the correct weight. According to classical test theory, results gained through the use of any instrument of measurement include both the "true" results as well as error in the actual measurement process, and so the process of validating an instrument is for the purpose of reducing error encountered in the measuring process (Crocker and Algina, 1986).

In HACCP terminology, validation means ensuring that the elements of a HACCP plan are accurate, and that the hazards identified when the plan was developed have been controlled at each CCP. Verification in this construct is the determination that the HACCP system is in compliance with the specific HACCP plan.

The components of an effective HACCP system are: describing the product and intended use; constructing a process flow diagram; identification of hazards and control measures; identification of CCPs; establishing CLs; identification of monitoring procedures; establishing corrective action procedures; and validating the HACCP plan (Mortimore, 2001). The first step consists of describing the product, which includes an evaluation of what makes it safe or desirable, and whether these are intrinsic or extrinsic factors. The next step is identifying the process flow for all steps of the program, which includes accounting for variations of practices that might occur at any step. Next, an analysis must take place in order to determine the types of hazards that might occur in the specific system. Specific to food safety, which HACCP was developed originally to assess, a hazard is defined as "a biological, chemical, physical agent in, or condition of food with the potential to cause an adverse health effect" (Codex, 1997). This step requires that likelihood of occurrence and severity of the hazard are addressed. Once this step is complete, CCPs are identified, and CLs are set. This is typically accomplished by pilot studies, and reference to existing work, or some combination of the two. Establishing monitoring procedures includes a determination of the frequency at which monitoring activities will occur. Corrective actions are developed to describe steps required to return to compliance. Finally, verification requires that records be kept – both of the HACCP plan as well as CCP monitoring records, training records dealing with CCPs, and reviewer and verification records. Verification in this fashion establishes reliability of the system and plan. Continued auditing and verification of a HACCP system is considered to be at least as important as the initial development of the HACCP plan, if not more (Sperber, 1998), because this flow of information facilitates revisions where necessary, and contributes to the overall strength of the HACCP plan.

FACILITY DESIGN

Two primary systems exist in the feedlot for routine handling of cattle for intake processing, though variations of these two systems can be found because many feedlots customize handling facilities to their specifications. One design consists of a round or curved crowd pen leading into the single file alley. Many variations of the round crowd system can be found, with perhaps the most notable original design created by cattle behavior and handling expert, Temple Grandin (See Figure 1). The other design, the Bud box, is named after Bud William, who designed this system. Bud Williams taught low-stress principles of livestock handling throughout his life, and though he is no longer alive, his teachings are still available on his website and on video for purchase (Williams, 2015). The Bud Box consists of a smaller, rectangular forcing pen perpendicular to the single file alley (See Figure 2). This system is easily constructed with panels, and can be designed at significantly reduced cost to the producer. The 2 systems capitalize on the behavioral principle that cattle always prefer to return to the place they came from (Grandin, 2008). Both systems are designed with the intent that the forcing or crowd area is a flow through point, and cattle should not be held in this area as it will defeat the handler's ability to work with the natural movement tendencies of the cattle. The use of the forcing area as a flow through system capitalizes on the natural herding instinct of cattle and their tendency to follow the leader (Grandin, 2014; Grandin, 1980; Stookey and Watts, 2007). The systems differ in that the round crowd system commonly relies on visual restraint in the form of solid side panels on the outermost perimeter (at a minimum), while the Bud Box system works more effectively if cattle can see through the Box. The visual restriction present in a round system focuses the attention of cattle on the visible path before them. Particularly in this

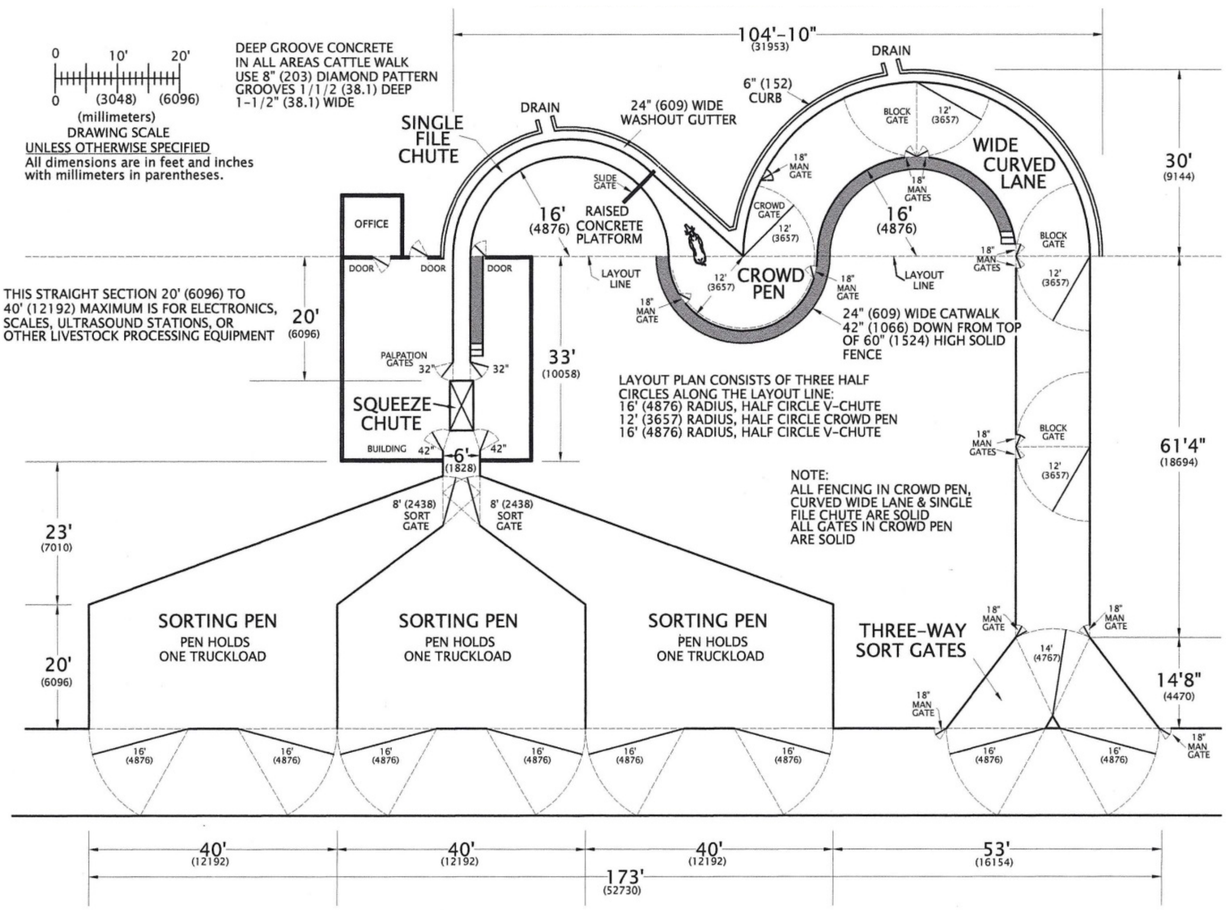
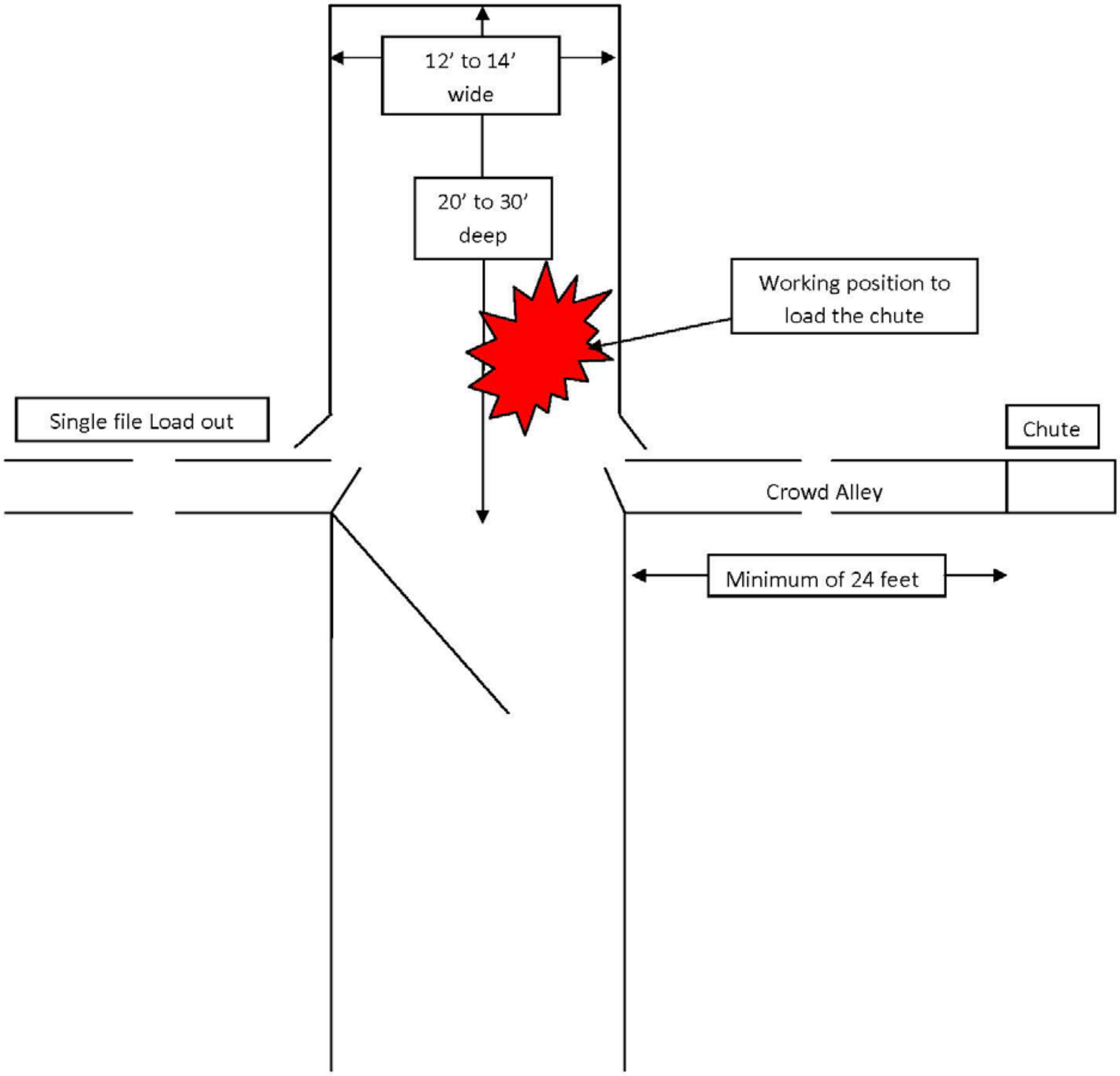


Figure 1. Classic Feedlot Corral Layout[1]

[1]Design by Temple Grandin, Grandin Livestock Handling Systems, Inc. Fort Collins, Colorado.

type of system, it is essential that right angles and the appearances of dead ends are avoided, because flow of the cattle in this system depends on their ability to see a place to go (Grandin, 2008; Stookey and Watts, 2007). The presence of solid sides can impose additional shadows at points of transition, so it is important that good lighting is present at transitions in the facilities (i.e. at the entrance of the single file chute). In contrast, because the Box is relatively shallow (only twenty to thirty feet deep), it is more effective for this system to be open-sided so cattle can see through it and will enter it more willingly. A round crowd system requires less handler skill than the Bud Box because the visual restriction imposed in a round system causes cattle to focus on the path in front of them and move through the system more automatically. Such a system typically involves a greater financial investment by the producer, due to space and material requirements alone. The Bud Box system relies on the handler working cattle from inside the box (on foot or horseback), posing greater risk of injury to the handler due to proximity. Such a system requires greater skill and understanding of behavioral and movement patterns of cattle, as this system depends on the handler understanding where to stand to apply to correct amount of pressure to encourage cattle to flow through this system and into the single file alley (Williams, 2015).



Bud Box Dimensions		
Handler	Width	Depth*
Always on foot	12'	minimum 20'
Afoot and horseback	14'	20-30'
Always horseback	16'	maximum 30'
*Dictated by size of groups handled.		

Figure 2. Design of a Bud Box[1]

[1]Diagram by Gill and Machen (2014).

TEMPERAMENT

Temperament of cattle is concerned with the reactivity or docility of the animal. Assessments of temperament are an effort to describe individual fear responses in cattle due to human-animal interactions, and sudden novel stimuli. In its broadest sense, temperament is an indication of the adaptation of cattle to husbandry practices. This is the premise from which temperament will be dealt with herein.

Temperament is used to gauge the response of cattle to their handlers (Morris et al.), and it is a feature that many producers consider when selecting breeding animals (Elder et al.). Cattle with better (calmer) temperaments tend to react less to external stimuli, while more temperamental cattle (or cattle with wilder temperaments) are more likely to become excited or show a greater fear response when presented with the same stimuli. Temperament is known to be related to measures of productivity in beef cattle. More reactive cattle have lower weight gains (Burrow and Dillon; Voisinet et al.); produce tougher meat (Voisinet et al.); and are bruised more due to injuries during transport (Fordyce et al.). Several techniques have been used to assess temperament in beef cattle, though most techniques involve subjective measures that have not been validated for their accuracy in assessing temperament over time (Curley Jr).

Techniques used to assess temperament in beef cattle include pen score or flight zone testing; entry force; chute score; exit velocity; and exit gait score. Vocalization may be included as part of an assessment of cattle temperament, but it is not advised to be used as a stand – alone measure (Watts).

Pen score or flight zone testing consists of assigning scores to cattle when they are unrestrained and can move freely about the pen where they are evaluated, and is based on the behavioral principle that cattle tend to circle around a handler (Grandin, 1980; Stookey and

Watts). This method relies on the willingness of cattle (either individuals or groups) to approach the handler (Hammond et al.). A detailed account of the descriptions and scores used by this method appears in Table 3.

Table 3. Descriptions of individual categories used to assign pen scores in evaluating animal temperament (Hammond et al., 1996).

Pen Score	Description
1	Walks slowly, can be approached slowly, not excited by humans
2	Runs along fences, stands in corner if humans stay away
3	Runs along fences, head up and will run if humans come closer, stops before hitting gates and fences, avoids humans
4	Runs, stays in back of group, head high and very aware of humans, may run into fences and gates
5	Excited, runs into fences, runs over anything in its path

Entry force scoring is assigned while moving cattle into the processing chute from the single file alley. Under this system, if cattle refuse to enter the squeeze, the handler walks quickly from the head, past the shoulder, towards the tail end of the animal. This encourages cattle to move forward because the handler crosses the point of balance (Grandin; Grandin, 1994). Cattle that enter the squeeze chute voluntarily or after encouragement without physical contact receive a score of 1 in this system. Cattle that require handler touch (a light tap to the rump) to enter the chute receive a score of 2. Cattle that require a single impulse from an electric prod to enter the chute receive a score of 3, and cattle requiring more than 1 electrical impulse to enter the chute receive a score of 4. How cattle enter the squeeze chute also is scored as entry speed: 1 = walk, 2 = trot, 3 = run or gallop under this method (Baszczak et al.).

Temperament assessment using chute score was suggested on a 7 – point (Fordyce et al.) and 6 – point scale (Tulloh), but has since been refined to include fewer categories because of the difficulty of accurately distinguishing multiple categories under field conditions (Grandin, 1993; Grandin, 2014). Four or five point scales are currently most common, with a score of 1 reflecting cattle with a calmer or better temperament, and increasing numeric scores reflecting increased agitation or a worse (more temperamental) temperament, as described in further detail in Table 4 (below).

Table 4. Description of chute scores for use in evaluating animal temperament (Grandin, 1993).

Chute Score	Description
1	Calm – no movement
2	Restless shifting
3	Squirming, occasional shaking of weigh box or chute
4	Continuous vigorous movement and shaking of weigh box or chute
5	Behaviors included in level 4 plus rearing, twisting, or violently struggling

The use of exit velocity as a measurement of temperament consists of using timers equipped with an electric eye to determine the speed at which cattle travel a fixed distance when exiting the squeeze chute (Burrow et al., 1988).

A similar assessment of cattle temperament consists of recording the gait at which cattle choose to exit the squeeze chute. Exit velocity in the form of gait scoring consists of identifying the gait at which cattle exit the chute as 1 = walk; 2 = trot; and 3 = run or gallop (Lanier and Grandin). Gait scoring was first proposed as a simple tool for producers to use in lieu of expensive equipment that measured exit velocity as a function of time and distance, and it was later discovered that gait scoring can be interchangeably used with exit speed (Vetters et al.).

Vocalization has been studied as an additional factor in the assessment of temperament. It is considered a form of communication between cattle, and is used in differing frequencies and with various acoustic parameters in response to different conditions. In a study of these factors, vocalization was found to be consistent over time for individual cattle, but highly variable between cattle, thus making it a very challenging tool for producers to use alone because of the difficulty in determining what vocalization represents on a consistent basis (Watts).

Temperament is considered to be a moderately heritable trait, with heritabilities reported between 0.18 (Le Neindre et al.) and 0.49 (Nkrumah et al.). Due to the heritability of temperament and its usefulness as a producer selection tool, it is reported as an expected progeny difference (EPD) for many breeds. The North American Limousin Foundation was the first breed association to include this as a selection tool for producers on a national basis (Beckman et al.); NALF, 1998). Though temperament has a strong genetic component, it is also influenced by environment, or on an individual basis, by experiences. The two most common methods of temperament assessment (chute scoring and flight zone or pen scoring) reflect components of each of these factors. Chute scoring is used by NALF to assign individual temperament scores to cattle as part of the EPD calculation process. This method is preferable for EPD calculation because chute scoring is considered more likely to assess the genetic component of temperament than flight zone testing (Grandin, 1998c). This is because restraint in a chute is a sudden, aversive event that is imposed upon individuals, and therefore is most likely to elicit a true, instinctive behavioral response. It is likely that the genetic component of temperament overrides experience in cattle that are highly reactive, as reported in a study where cattle assigned temperament scores of 4 or 5 (most reactive on a 5-point scale) consistently received scores of 4 or greater in repeated handling events (Grandin, 1993). In the same study, cattle that received temperament scores of 2 or lower in their first test, consistently received scores or 2 or lower throughout the study. Cattle that received scores in the middle displayed the greatest variability in temperament scores in repeated handling events. This further substantiates the overriding genetic component of temperament, for cattle in the middle group with average reactivity would be expected to demonstrate the greatest amount of environmental influence.

The impact of reactivity, or temperament, is perhaps best understood in the context of productivity in current, conventional production, because of the relationship that is known to exist between temperament and measures of productivity. Flight speed has been correlated with temperament, and cattle with more excitable temperaments exit the chute fast than those with calmer temperaments (Burrow, et al, 1988). Flight speed as a measure of temperament has been negatively correlated with ADG and DMI (Fox et al.); and cattle with more excitable temperaments had lower ADGs when compared to cattle with better (calmer) temperaments. (Petherick, et al., 2002; Voisinet at al., 1997b). Cattle with slower flights speeds had higher ADG and heavier slaughter weights (Burrow and Dillon); yielded meat tougher meat (Voisinet, et al., 1997a); and cattle that were agitated during handling (more temperamental) had 14% lower ADG than cattle with calmer temperaments (Baszczak et al.; Voisinet et al.).;

While flight speed and temperament have been included in behavioral research of cattle, as well as by producers as a management tool, the challenge is to establish and quantify what these measures explain about the underlying biological processes of cattle, particularly in terms of stress. The concept of stress was first proposed in 1936 (Selye), and though extensive research in the scientific and medical communities has been devoted to this topic, it is still limited in both understanding and definition. Stress is presently described as the biologic response that allows an animal to cope with threats to homeostasis (Moberg). Stress is by definition, what an animal experiences biologically and behaviorally during aversive events that may occur during handling, or as a result of any event that might cause fearfulness. An alarm reaction (the flight response) was first described to include enlargement of the adrenal glands, and shrinking of the thymus, spleen, and lymph nodes (Selye). Stress and ensuing deviations from homeostasis become of interest in the context of managing cattle for optimal productivity. Deviations from homeostasis may be gauged behaviorally as removal from feed, reduced feed intake, increased locomotion and vocalization, and increased urination and defecation, to name a few of the potential external indicators of stress that can be evaluated by producers. When subjected to stress, coping and maintenance are of higher priorities than growth or development for cattle. Stress reduces body stores of lipids and protein, and growth and performance are inhibited during periods of stress. This reduction in available energy as a result of stress imposes a state that is not conducive to growth, or other performance (lactation, etc.).

CHAPTER III

VALIDATION OF THE BEEF QUALITY ASSURANCE FEEDYARD ASSESSMENT OF CATTLE HANDLING

INTRODUCTION

The public is increasingly concerned about how food animals are treated (Rollin, 2004), and much of this scrutiny is focused on confinement operations. In the United States, ten to eleven million cattle are fed annually, according to recent reports (USDA, 2013a). Upon arriving at a feedlot for finishing, cattle are processed and handled a minimum of 1 time for routine procedures including weighing, sorting, vaccination, placement of identification tags and implants, vaccinations, and other veterinary procedures. In many cases, cattle are handled more frequently, either to treat morbidity, for replacing implants, or other procedures. Handling events can result in bruising (Garcia, et al., 2008; Smith, et al., 2005) and other stress to cattle. It is important to mitigate stress associated with handling through the use of good handling practices. Increased public scrutiny underscores the importance of documenting good handling practices at the feedlot. The Beef Quality Assurance (BQA) program was developed with the collaboration of experts in industry and academia to provide a system of management for producers (NCBA, 2009a). The BQA program adopted the Hazard Analysis Critical Control Point (HACCP) approach used in food safety to manage specific categories as critical control points (CCPs). Other segments of the cattle industry have used this approach to assessing cattle handling (Grandin, 2000; Grandin, 2005). Categories identified as CCPs, or guidelines for cattle handling in the feedlot are: driving aids, cattle falling, cattle stumbling or tripping, cattle vocalizing, cattle jumping or running, and chute operation. Each category has an associated threshold, or critical limit (CL), and in the case of the Feedyard Assessment (FA), compliance with these guidelines is typically self-assessed at feedlots that participate in the voluntary BQA program, though compliance may be assessed by a third party as well (NCBA, 2009b). Results of these assessments provide valuable feedback for managers to identify areas of positive performance, as well as identify areas where improvement may be necessary. These results, if included in future National Beef Quality Audits (NBQA), could provide argets for improvement as part of the beef industry's commitment to good handling practices.

MATERIALS AND METHODS

This project was approved by the Colorado State University Animal Care and Use Committee Protocol 12-3601A. Data collection took place during routine processing of cattle, and no attempt was made to modify any handling practices or procedures.

Feedlot Sample

Three states (Colorado, Kansas, and Nebraska) were selected for inclusion in this study. The 3 states selected rank 5^{th}, 3^{rd}, and 2^{nd}, respectively among the top 5 cattle feeding states in the nation, according to UDSA figures (USDA, 2013b). For purposes of economy, a feedlot directory, BeefSpotter (Spotterpublications, 2012), was used to locate areas where feedlots were clustered within the 3 states of interest. Contact was made in alphabetic order within these clusters. Fifty-six feedlots were contacted by telephone, and an appointment was requested; requests were also made in person following scheduled visits to other feedlots in the vicinity. Data were collected at 28 feedlots ranging in size from 1,800 to over 100,000 head, and the mean capacity was 34,000 head. There were no small yards included, according to the NAHMS classification that describes small feedlots as having a capacity of less than 1000 head.When a feedlot manager was contacted, the investigator explained that the purpose of the study was to survey industry adoption of BQA guidelines during cattle handling when processing cattle. The names and locations of all participants were kept anonymous in an effort to encourage participation rate.

Data Collection Methods

A single observer performed all assessments during this study in order to eliminate one source of variation. Evaluations were conducted using the BQA FA Assessor's Guide (NCBA, 2009), and 100 cattle were observed during processing at every site when possible. Processing and management practices during 28 observations included vaccinations, pouring, drenching, removal of old ear tags, placement of new ear tags and implants, and reimplants. Horn tipping was observed at 1 site; and 2 sites branded all cattle. The observer made note of the procedures performed during the observation period, and recorded additional description information including weight, sex, and breed influence of cattle for each site.

Feedyard Assessment Tool

To assess specific handling practices and cattle behavior, the observer utilized the BQA FA Assessor's Guide. The 6 key categories scored on the assessment were (1) driving aides, (2) cattle falling, (3) cattle stumbling or tripping, (4) cattle vocalizing, (5) cattle jumping or running, and (6) chute operation.

The type of driving aides carried by handlers was noted, and the primary type of driving aid used at each site was recorded. The types of driving aides used were electric prod, flag, sorting stick, and paddle. The use of electric prods was recorded, and a score was obtained for each site by calculating the percentage of cattle observed that were moved using an electric prod. Electric prod use was recorded in the single file alley and squeeze chute. Use of electric prod was defined as discharging electric current while in contact with an animal, according to BQA guidelines.

A fall was recorded if an animal's body (torso/belly) touched the ground during exit from the squeeze chute, and a stumble or slip was recorded if a knee touched the ground during exit from the squeeze chute. Vocalization was scored for any audible call emitted by cattle while entering the squeeze chute or during capture or restraint, before any procedure was performed. If the head gate was closed on the head, leg, or body of an animal, it was scored as an improper catch, and information was recorded about the position of the incorrect catch. Per BQA guidelines, improper catches that were not adjusted in the squeeze chute to the correct position were recorded. Cattle received a run score when they exited the squeeze chute faster than a trot (Vetters et al., 2013). BQA producer code of cattle care (Assurance, 2006) prohibits acts of abuse, including, but not limited to, poking sensitive areas of the animal such as the eyes or genitalia. Acts of abuse were documented if they were observed.

Additional observations of facility design were recorded for crowd pen design; type of flooring present in the crowd pen, squeeze chute, and at the squeeze chute exit; type of squeeze chute and head gate; type of primary driving aid that the workers carried in their hand; and whether the processing crew was contract crew or employee crew.

Assessments

Upon arriving at a feedlot for an assessment, the observer met briefly with the site manager when possible. This meeting consisted of a brief explanation of what assessment consisted of. When possible, the observer ask several questions that could provide descriptive information about the producer, including capacity for cattle at each site; whether processing was conducted by an employee or contract crew, and BQA training status of the feedlot and the processing crew. The assessment of cattle handling was performed in the processing area by a single observer and no attempt was made to modify handling practices during the observation period.

Statistical Analysis

The PROCFREQ and PROCMEAN procedures of SAS (SAS Inst. Inc., Cary, NC) were used to calculate frequencies and means for each category, with feedlot site considered the experimental unit. For the category or CCP of electric prod use, the number of times an electric prod was used per 100 cattle was used to calculate the prod score for each site. In similar fashion, scores for each CCP were calculated for individual feedlot; and mean, minimum, and maximum values were calculated for CCPs for all feedlots, and these means were compared to current BQA guidelines for CLs associated with each established CCP.

RESULTS AND DISCUSSION

Of 56 feedlots contacted, 28 were included, and an additional 19 feedlots contacted were willing to participate, but were not included in the survey due to scheduling conflicts or lack of cattle. Of all producers contacted, 91% were willing to participate in this study.

Assessments were conducted using the FA tool, and a minimum of 100 cattle were observed during handling and processing at each site when possible. Only 2 feedlots did not provide 100 cattle to evaluate; 90 and 78 cattle were observed at those sites. Processing most commonly consisted of the administration of vaccinations, removal of old ear tags, and placement of new ear tags and implants. Data were collected on the first 100 cattle processed when the investigator arrived at the processing barn, without bias for any specific type of cattle. Because of the expansive nature of BQA, and the concern of those who developed the program with its relevance to both a segmented industry as well as a wide variety of management practices and styles within each segment, the FA is designed to include a wide variety of breeds and types, as well as varying procedures. Under this premise, no effort was made to select specific types of cattle or handling practices, and cattle of all types were assessed in this survey. At each site, the observer documented the breed type of cattle (Holstein, Brahman, Continental/British, etc.), as well as the nature of the procedures that were performed during the observation period.

Cattle Falling

The mean rate of cattle falling was 0.8% for feedlots observed, which is below the BQA CL of 2%. Of feedlots surveyed, 26 were within BQA CLs; only 2 sites slightly exceeded the CL for this category; and 20 feedlots had no cattle fall during the observation period (See Table 5 for full results). Recent results from a survey of cattle handling at a slaughter plant include similar findings, with cattle falling reported at a rate of less than 1% (Hultgren et al., 2014), and a survey of Kansas feedlots reported cattle falling at a similar rate (Henderson, 2013). Cattle may fall due to agitation; or a flight response associated with an aversive procedure; or poor flooring at the squeeze chute exit. Falls may result in costly injuries or bruising, and these findings indicate that feedlots are aware of the importance of reducing falls. Many feedlots place a rubber mat at the exit to the squeeze chute for the purpose of providing cattle with better traction, in order to reduce slips, falls, and injuries.

Cattle Stumbling

The mean rate of cattle that stumbled when exiting the squeeze chute was 5.7%. Though higher than a recent report of 1.8% where cattle were scored similarly (Henderson, 2013), these findings are still within the BQA CL of 10%. Only 4 sites exceeded the CL, and 86% of feedlots were in compliance with the BQA CL for this category. Stumbling may be caused by agitation or by the flooring conditions at the exit of the squeeze chute. Because of the relationship between slips, stumbles, falls, and injuries, many feedlots place a heavy mat constructed of woven tire tread at the exit of the squeeze chute to reduce slips and falls.

Cattle Vocalizing

The mean rate of vocalization for all feedlots was 1.4%, which is below the BQA CL of 5%. Only 2 feedlots exceeded the BQA CL for vocalization with scores of 5.1% and 6%, respectively; while 26 sites were in compliance with this CL. These data show that feedlots surveyed have a very high rate of compliance with BQA guidelines for vocalization. Vocalization scoring is a useful tool for identifying cattle handling problems because vocalization during handling and restraint is associated with aversive events such as electric prod use or excessive pressure applied by a restraint device (Bourguet et al., 2011; Grandin, 2001; Grandin, 1998a).

Table 5. Performance on BQA feedlot cattle handling categories assessed during processing at 28 feedlots in Nebraska, Kansas, and Colorado[1]

	All Sites			
Critical Control Points (CCPs)	BQA Guideline[2]	Mean, %	Minimum, %	Maximum, %
Electric Prod	5	3.8	0	45
Falls	2	0.06	0	4.5
Stumbles	10	5.7	0	28
Vocalization	10	1.4	0	6
Jump or Run	25	52	22	80

[1]Performance in each category is reported as a mean of all feedlot scores
[2]Critical limit (CL) for each category described in the Beef Quality Assurance Feedyard Assessment

Cattle Jumping or Running

The mean rate of cattle jumping or running while exiting from the squeeze chute was 52%, which exceeds the BQA CL of 25%. Only 1 feedlot was within BQA guidelines. These data show that among feedlots surveyed, there may be room for improvement in this category. Exit velocity is positively correlated with increased plasma cortisol concentration (Curley et al., 2006). Gait scoring is a simple tool for producers to use; and as performed in the present study, has been shown to be interchangeable with exit velocity, and is a predictor of ADG (Vetters et al., 2013). Cattle that exit the chute faster have lower ADG (Cooke et al., 2009). Additionally, it may be reasonable to score cattle that jump *and* run rather than the current category in the BQA FA. In the present scoring system, if cattle walk or trot, but also jump when exiting the squeeze chute, they are counted in the present jump or run category. Additionally, cattle might not jump, but might run when exiting the squeeze chute, and they are counted in the same category. Finally, cattle that jump and run are also counted in the same category. Many feedlots (39.3%) were within BQA guidelines for every other category, and only exceeded the CLs in this category. The high rate of feedlots (96.4%) that exceeded the BQA CL in this category suggests that the present CL may not be realistic. Due to the low rate of feedlots that were in compliance with the category, the category was considered suspect, and a score was calculated for cattle that performed both the jump and run behaviors (See Table 6). After these calculations, 78.6% of feedlot scores were within the BQA guideline of 25%. When considering the range for each CCP, the CCP for the current category was the only CCP that did not have a lower limit of zero. These data show that it may be a more useful indicator of agitation to record cattle that both jump and run, rather than the approach previously described. Adopting this change to the present scoring system may improve the validity of this category as a CCP. There are many factors that influence jumping and running, and the presence of both behaviors may suggest greater agitation.

Table 6. Suggested Revisions to Beef Quality Assurance Cattle Handling Categories

	All Sites			
Critical Control Points (CCPs)	BQA Guideline[2]	Mean, %	Minimum, %	Maximum, %
Jump & Run[1]	25*	16.4	1	35
Run Only[1]	25*	28.7	2	76

[1] Suggested as a more accurate scoring category for exit behavior than the present collective category of jump *or* run
[2] Critical limit (CL) for each category described in the Beef Quality Assurance Feedyard Assessment
* Suggested critical limit (CL) for proposed categories

Chute Operation

The mean rate for feedlots that caught cattle improperly and did not adjust them was 1.2%, which exceeds the BQA CL of 0%. The presence of a CL of 0%, or a zero tolerance category implies that it is unacceptable to perform procedures on cattle that are not properly caught and safely restrained. Currently, there is no CCP or CL for cattle that are improperly caught and subsequently adjusted in the head gate. What this implies is that there could be infinite improper catches, provided that the cattle caught improperly are adjusted to be caught and restrained properly. This appears to be an oversight in considering the potential for injury and bruising that might occur as a result of improper catches, that the reported decrease in bruising has been associated with producer awareness of the importance of handling practices (Garcia, et al., 2008; Smith, et al., 2005). It is important as part of good stockmanship and management to score all improper catches and subsequent adjustments. Few studies document the full effects of improper catches, but aversion to head gate restraint can result in more time and force required to move cattle through working facilities (Goonewardene et al., 1999), which results in financial losses to producers. Though little work exists that documents the complete effect of improper catches, it is reasonable to assume that cattle experience pain when they are improperly caught. Though there are not studies that quantify the pain that might be experienced by an improper catch, it has been shown that cattle are more reluctant to enter the squeeze chute following an aversive experience, such as an improper catch with the head gate (Grandin, 1993).

A total of 2% of the cattle in this study were caught improperly, and 60% of improper catches were not adjusted. It may be reasonable based on these findings to suggest 2% as a CL for assessing total improper catches that occur during the observation period. By establishing a measurable threshold for chute operation, producers will manage this category, and additional emphasis can be placed on training for handlers that operate the squeeze chute, because of the financial implications associated with handling cattle at this point of the production system.

Facilities Findings

Two types of forcing systems were observed; a majority (89%) of sites used round crowd system, and 11% used a Bud Box system. A woven rubber tire mat (Double D Family Mat Co.) was at the exit of the squeeze chute at 22 feedlots (78.5%). Information was collected about primary driving aids, and 5 sites (17.8%) used electric prod as the primary driving aid; 15 sites (53.5%) used another tool as their primary driving aid, while handlers at 8 sites (28.5%) did not carry driving aids of any kind. Two categories of squeeze chutes were observed, with 50% scissor type, and 50% clamshell type. Feedlot employees handled cattle in 21 feedlots (75%), and the rest were contract crews that were not employed by the feedlot.

The mean scores for electric prod use and vocalization were superior to results in an initial survey of slaughter plants (Grandin, 2000a), indicating an awareness of the aversive effect of excessive prod use. Slaughter plants have greatly improved since the mid-nineties, where the mean percentage of cattle vocalizing in the stunning area was 10%. In just 5 years of audits, the average percentage of cattle vocalizing dropped to 2% (Grandin, 2006). The auditing and subsequent improvements that have been documented for cattle handling practices at slaughter plants provide a good model for similar evaluation of handling of feedlot cattle. Audits of cattle handling in slaughter plants identified areas where improvement was needed, and subsequent audits demonstrated marked improvement in the same time period represented in the NBQAs. Feedlots are an integral part of the beef supply chain, and assessing cattle handling of cattle at the feedlot level is a key component of increasing consumer confidence in the quality of life that is experienced by cattle entering the food chain.

CONCLUSIONS

It is important to continue to collect and report data on feedlot cattle handling according to BQA guidelines, and this information warrants inclusion in future iterations of NBQA. Just as the data compiled by the five iterations of NBQA to date have been used to focus attention on areas where growth is needed, and to document positive performance, the inclusion of handling data could likely have similar positive impact. Going forward, the inclusion of handling data assessed at feedlots would serve as part of the verification process as part of the HACCP structure that BQA was modeled after. Such verification and continual monitoring is essential to the successful perpetuation of the NBQA.

CHAPTER IV

INFLUENCE OF HANDLING PRACTICES ON BEHAVIOR AND PERFORMANCE OF FEEDLOT CATTLE

INTRODUCTION

Husbandry practices used in the production of cattle have long been the focus of discussion and investigation in order to better understand the impact of handling on the welfare of cattle managed in conventional production systems. Temperament is a heritable trait and is a tool that many producers use in selection, in order to maximize productivity and to reduce management problems associated with temperamental cattle. The objective of this study was to investigate if a relationship exists between handling, and behavior and ADG of feedlot cattle.

MATERIALS AND METHODS

All methods of handling applied to cattle in this project were approved by the Colorado State University Institutional Animal Care and Use Committee.

Experimental design

Two factors were used to investigate the influence of handling practices individually and as a group on the behavior and ADG of feedlot cattle. The factor applied on a group basis included two levels, or handling conditions, that were imposed to pens prior to processing. This group handling factor was defined by how handlers brought the cattle from their home pens to the processing area. The first level of the group condition consisted of handlers bringing cattle to the processing area in their usual fashion (FAST), and for the second level, handlers were asked not to use loud noises, or to move faster than a walk when herding the cattle to the processing area (SLOW).

The factor applied on an individual basis included two levels, and was defined by how cattle were released from the squeeze chute. Individual cattle were randomly assigned to two one of two conditions of release from the squeeze chute. For the first level, the handler operating the squeeze chute released cattle at his discretion following procedures (NORM). For the second level, the handler operating the squeeze chute released cattle upon a signal from the observer. The observer signaled for the release of cattle after a brief delay of no more than 30 seconds (DELAY); this delay was to allow cattle the opportunity to settle so that they were not struggling when the squeeze chute opened.

Equipment

Visual assessments were performed during routine handling events by one observer in order to reduce variation associated with different observers. In addition to these live visual assessments of behavior, three video cameras (Samsung HMX-F80) were used to further document behavior of steers during all handling events. Camera one was placed at a high angle by the head gate approximately 1.5 meters from the exit of the squeeze chute to aid in identification of individual cattle (See Figure 3). A second camera was situated in the middle of the curved, single-file alley leading up to the squeeze chute, to provide a wide-angle view. It was used to record behavior of the steers prior to and upon entering the squeeze chute. This camera was place approximately 4.5 meters behind the entry to the squeeze chute. The third camera was placed in the exit alley, 7 to 8 meters from the front of the squeeze chute. This camera was used to capture gait (walk, trot, run), and other behaviors (rear, stumble, fall) as steers exited the squeeze chute.

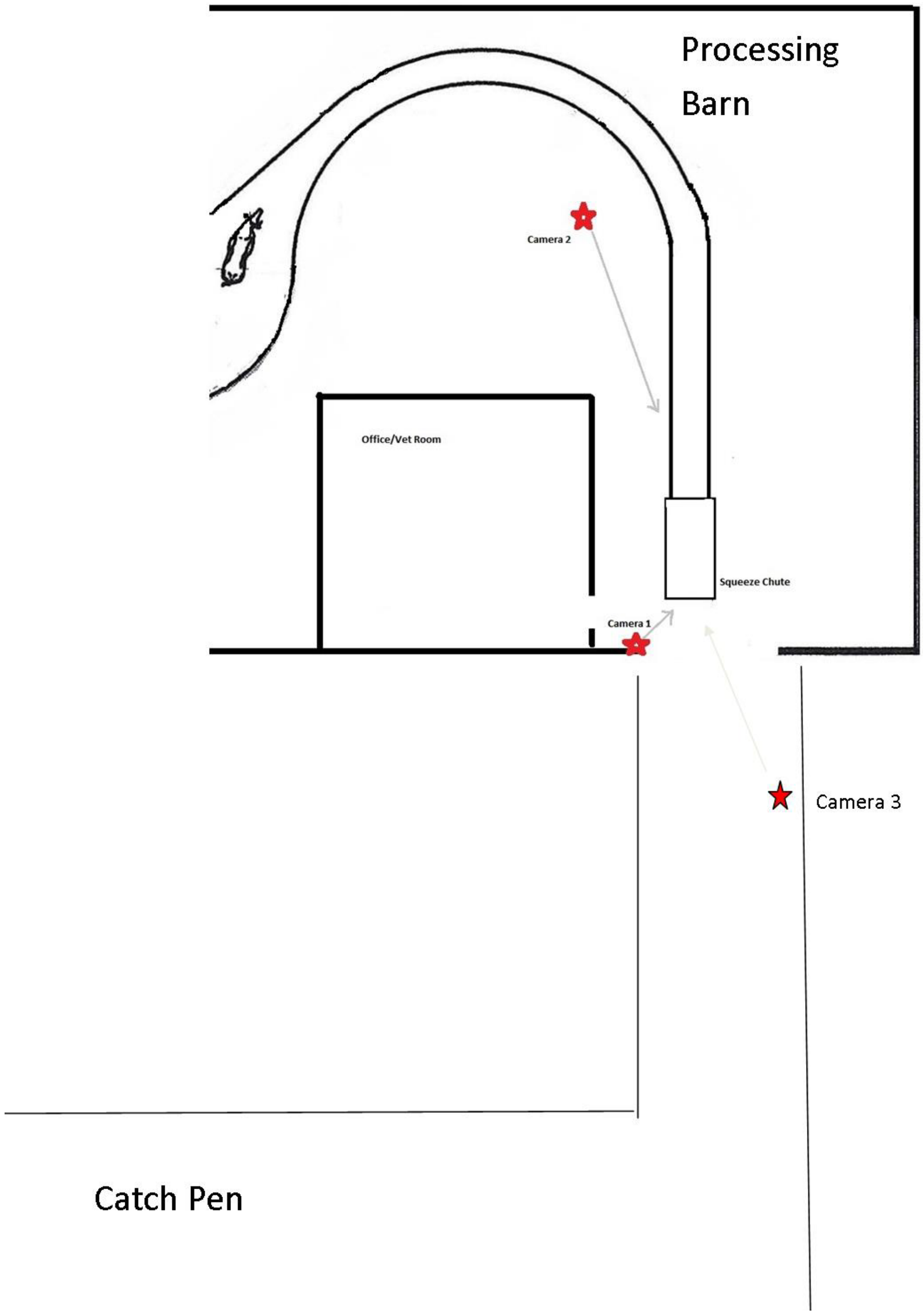


Figure 3. Placement of Video Cameras

Animals

A total of 496 yearling horned Hereford steers (initial BW = 304 ± 35.6 kg) used to assess the influence of handling on behavior and ADG. Steers originated from a single herd with similar genetic background, from a single producer in the Northwestern U.S., and were backgrounded in Kansas prior to entering the feedlot. Steers were enrolled in this study when they arrived for finishing at a commercial feedyard in Kansas. Routine handling events were recorded during the finishing period. Each steer was uniquely identified with an electronic identification (EID) ear tag, and all were eligible for the Certified Hereford Beef incentive program. Upon arrival at the feedyard, lot weights were recorded for steers, and then they were comingled and sorted into four pens to achieve uniformity of weights across pens. Records were obtained from the feedlot regarding individual treatment of illness, but no handling or behavior was recorded for these isolated practices. Steers were assigned adjoining home pens in the same alley to reduce variation due to location and management.

Routine Handling

Cattle in this study were observed within 48 h following their arrival at a Kansas feedlot. Routine intake protocol procedures were performed by feedlot employees, and these procedures included the placement of new ear tags by pen, two vaccinations, a vitamin drench, dewormer, and the placement of a subcutaneous growth promotant (Revalor XS, Merck Animal Health) in the pinna. These procedures were determined as part of the protocol administered by the consulting veterinarian retained by the feedlot, and procedures were performed strictly by feedlot employees. Institutional approval obtained for this study permitted the observer to watch these procedures are part of the normal activities of the feedlot.

Handling Conditions Prior to Routine Handling

During routine handling (as defined above) data were collected in the main processing facility at a Kansas feedyard. Final individual weights were collected in a separate event prior to shipping for slaughter, but no other data were collected at this time. Steers were gathered from home pens and driven to the processing area with assistance and supervision provided by the researcher. Pens assigned to the FAST treatment were brought to the processing area as the investigator observed. Two handlers (feedyard employees) entered the pen along the fence line and worked toward the back of the pen, at times moving at a jog. One handler stopped approximately a third of the distance from the gate to the back of the pen, and paused long enough for the second handler to near the back of the pen. The second handler would then make a right angle turn away from the far corner of the pen and begin to work the cattle away from the back of the pen towards the gate, working back and forth behind the cattle while the first handler worked parallel to the cattle, working them towards the gate. The handlers used loud whistles and snapped whips that they carried to encourage the steers to move. This prompted the steers to run, and the handlers ran with them. As the cattle moved out the gate and into the alley, the handlers trailed the cattle together, using the whips and their voices and whistles to keep the cattle moving quickly down the alley.

Under the conditions of the SLOW treatment, handlers were instructed to bring pens to the processing area quietly, without yelling, using electric prods, or exceeding a walk during this time. The investigator assisted an employee handler in bringing the pens of steers to the processing area, to ensure that the conditions of the study were followed. The investigator entered the pen along the fence line and worked towards the back of the pen, moving at a walk (See Figure 4). The second handler stopped approximately two thirds of the distance from the

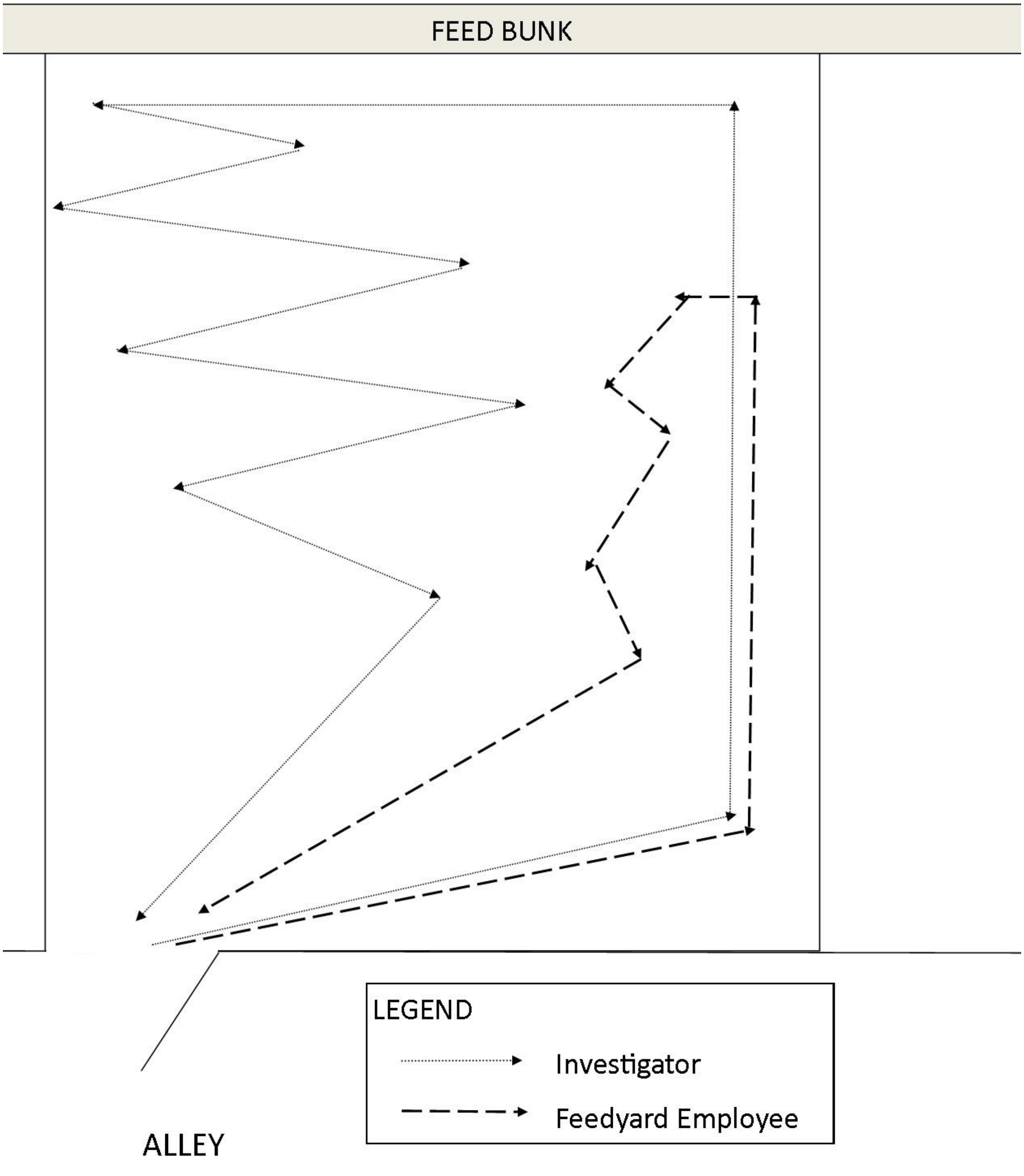


Figure 4. Movement Patterns of Handlers when Gathering Cattle

gate to the back of the pen, and waited for the researcher to reach the back of the pen and sweep the cattle towards the gate at a walk, in the manner described by Bud Williams for low-stress handling of cattle (Williams, 2015). The researcher worked toward the far corner, and turned to move parallel with the steers as they moved towards the gate. Some of the steers trotted, but neither the handler nor the investigator moved faster than a walk, and the steers returned to a walk. Feedlot employees herded steers from the holding pens through a round crowd pen and single file chute system, with no efforts made to alter handling practices between the holding pens and squeeze chute.

Chute Entry and Capture

When steers entered the squeeze chute, an entry force score (ENT) was assigned, that described the amount of handler effort required to encourage steers to enter the squeeze chute. Steers that entered the squeeze chute without any physical touch from the handler or driving aids received a score of 1. Steers that required a light touch or tap to enter the chute received a score of 2. Steers that require a single impulse from an electric prod to enter the chute receive a score of 3, and steers requiring more than 1 electrical impulse to enter the chute receive a score of 4.

How steers entered the squeeze chute was scored as entry speed: 1 = walk, 2 = trot, 3 = run or gallop under this method (Baszczak et al.).

Though improper squeeze chute capture was not a treatment or condition that was applied in this study, it was observed to occur at great enough frequency that it warranted consideration. Squeeze chute capture (CAP) was scored for each steer on a 2 – point scale (0 = correct capture; 1 = incorrect capture).

Vocalization

Vocalization (VOC) was recorded for each steer (on a yes/no basis), from the time they entered the chute, until procedures began. This was in an effort to separate vocalization as a commentary on handling (Stookey, et al., 2000) from vocalization related to aversive or distressful procedures (Schwartzkopf-Genswein, et al., 1997).

Chute Temperament

Weights were recorded for each steer while they were restrained in a Silencer (Moly Manufacturing; Lorraine, KS) hydraulic squeeze chute. During restrain, a chute score (TEMP) was assigned, using a 5 – point scale (Grandin, 2003) to categorize temperament of cattle during restraint (Tulloh, 1961b). Under this system, cattle were categorized as follows: 1 = calm – no movement; 2 = restless shifting; 3 = squirming, occasional shaking of weigh box or chute; 4 = continuous vigorous movement and shaking of weigh box or chute; 5 = behaviors included in level 4 plus rearing, twisting, or violently struggling. These temperament scores were then collapsed into two categories for analysis; scores of 3 and above on the original scale were ranked as HIGH, and scores of 1 or 2 were ranked as LOW.

Squeeze Chute Release

Within pen, individual steers were randomly assigned to one of two conditions of release from the squeeze chute. The first condition was a delay that lasted a maximum of 30 seconds following the completion of procedures (DELAY). The second condition was release immediately following the completion of procedures (NORM).

Exit Speed and Behavior

When steers were released from the chute, exit speed (EXS) was recorded as: 1 = walk; 2 = trot; and 3 = run or gallop (Lanier and Grandin). The observer documented gait and additional behaviors (stumble, rear, jump, fall) for 7 to 8 meters past the squeeze chute. Exit behavior (EXB) was scored on a 5-point scale (N = Normal; S = Stumble; R = Rear; J = Jump; F = Fall). These behaviors were collapsed into two categories with cattle classified as high or low on a reactivity scale (LOW = No behaviors other than exit speed, HIGH = Stumble, rear, jump). The researcher assisted the handlers when they returned the steers to their home pens. The same researcher assigned all scores of behavior and temperament assessed in the duration of this study, in order to eliminate one potential source of variation.

Statistical Analysis

A two-way analysis of variance was performed using the MIXED procedure in SAS (SAS Inst. Inc., Cary, NC). An interaction was observed between the group factor (TRT1) and the individual factor (TRT2). However, TRT2 was not significant and was removed from the model, and effects of TRT1 were evaluated. Paired t-tests were then performed to further investigate the effect of TRT1 on behavior and ADG by comparing mean behavior scores and mean ADG of the two groups.

Paired t-tests were used to compare mean behavior scores (TEMP, VOC, EXS, and EXB), CAP, and ADG for cattle by group for the TRT1 conditions (FAST, SLOW) and for the TRT2 conditions (NORM, DELAY). Also, mean behavior scores (as listed above) were compared for cattle by group for the CAP conditions.

Exit speed (EXS) in the form of gait scores obtained during routine handling were collapsed into two categories (SLOW = walk and trot; FAST = run) to create a simple discrete variable for exit speed analysis. Likewise, chute temperament scores (TEMP) were collapsed into two categories for analysis (HIGH denotes steers that scored 3 and above on the original scale; LOW denotes steers that scored 1 or 2 on the original scale).

Paired t-tests were used to compare mean ADG for cattle in the SLOW vs FAST groups, and to compare mean ADG for cattle that vocalized vs those that did not. Pearson's correlations were calculated for TEMP, VOC, EXS, EXB, NORM, DELAY, SLOW, and FAST using the CORR procedure of SAS (SAS Inst. Inc., Cary, NC) to determine the relationships between handling, behavior, and ADG.

RESULTS AND DISCUSSION

Paired t-tests determined that cattle exiting the chute at a walk or trot vs a run tended (P=0.08) to have higher ADG. Cattle vocalizing during restraint had lower (P=0.04) ADG than those that did not vocalize. A higher rate of vocalization occurred in the FAST group when compared with the SLOW group. Pearson's correlation analysis showed a significant, positive correlation between exit speed and vocalization (P= 0.0021, r= 0.14256), and a significant, negative correlation between exit speed and ADG (P= 0.0036, r= -0.13542). Using this approach, handling was correlated with behavior and ADG.

Squeeze Chute Capture

A high rate of improper capture (where the head gate closed on the jaw or eyes of the steer) was observed during routine handling, and because of the frequency, the researcher documented this factor. Overall, the rate of improper squeeze chute capture (CAP) was 39.9%. In some cases, the head gate was closed improperly on a steer as many as 4 times, and 15.2% of steers experienced forceful closure of the head gate on their head 2 or more times.

Steers that experienced improper CAP had numerically lighter body weights (mean weight 324.4 kg vs 327.9 kg) than steers that experienced proper CAP. The speed at which cattle enter the squeeze chute can influence a handler's ability to capture and restrain them properly, and this entry speed may be determined by temperament as well as body weight. CAP was significantly correlated ($P<0.01$) with ADG, EXS, and Vocalization; but was not correlated with TEMP ($P=0.34$).

Improper capture (either where the head gate is closed on the body or the head) may be related to the speed and force at which the steer enters the chute, or to the experience or training level of the handler operating the chute. A possible explanation for the high rate of improper CAP observed in this study may be the amount of squeeze that the handler operating the squeeze chute used. The handler used the squeeze to slow the cattle down when entering the squeeze chute, in a reported effort to reduce injuries to the shoulders. During the observation period, it was difficult for many cattle to fully advance in the squeeze chute because of the amount of squeeze, and because they could not advance freely, the head gate was closed on their heads.

Vocalization

Vocalization scores were compared by CAP method, and steers with correct CAP vocalized less than steers with incorrect CAP (23.4% vs 33.5%; $P<0.01$). Cattle may vocalize for a number of reasons; these reasons include painful experiences (Schwartzgopf-Genswein, et al, 1997), isolation (Watts, et al, 2001), restraint (Schwartzgopf-Genswein, et al, 1997; Grandin, 2005), or fear. The higher rate of vocalization observed among steers with incorrect CAP supports earlier findings that implicate pain as a cause for vocalization (Schwartzgopf-Genswein, et al., 1991, 2001). Based on the application of these findings as a communication of pain or discomfort, a logical recommendation would be to provide additional training for handlers that will be operating the squeeze chute. Improper handling techniques during this time may have an impact on short-term productivity. If the impact to the head or jaws of the cattle is forceful enough, changes in feeding behavior may result; especially reduced feed intake. Reduced feed intake would subsequently result in reduced performance, so indirectly, ADG may be related to improper CAP.

Chute Temperament

Chute temperament scores were assigned to each steer, and these scores were collapsed into HIGH and Low categories. Under this ranking system, 21.6% were ranked as HIGH, and 78.4% of steers were ranked as LOW. A majority of cattle observed had LOW temperament ratings, which may be due in part to producer selection for calm temperaments. Differences in temperament between breed are known to exist as well. Because the cattle in this study were of one breed with similar genetic heritage, some of the breed variability was reduced. A greater rate of correct CAP was observed for the LOW group when compared with the HIGH group (79.6% vs 20.4%, respectively). Calmer cattle may enter the squeeze chute more slowly, which may allow the handler to achieve proper CAP more frequently. However, in this study, TEMP was not correlated with CAP. A possible explanation for this result is that CAP occurred before TEMP scores were assigned, and improper catches, if painful in nature, could have exaggerated TEMP scores.

Squeeze Chute Release

After all routine procedures were completed by feedlot employees, steers were released from the chute under one of two randomized conditions. Under the first condition (NORM), the handler operating the squeeze chute released steers at his discretion in the normal fashion. Under the second condition, a delay was imposed for the purpose of allowing cattle to stop struggling, and based on the hypothesis that if steers were not released when struggling, they would exit the squeeze chute more slowly and be less likely to slip and fall (Stookey and Watts, 2014). Effects of squeeze chute were not found to be significant, so they were not studied or reported. Despite the lack of statistical significance for this term in the model, it would still be advisable for handlers to ensure conditions of handling that reduce the instance of slips and falls. This is a good example where an effect studied did not have statistical significance, but the financial significance may be the stronger determinant for producers. A possible reason that significance was not found in this study was the fact that a large, customized woven rubber tire mat (Double Family Mat Co., Lawrence, KS) was installed as the exit of the squeeze chute, and this mat extended roughly 5 meters from the exit of the squeeze chute into the alley. The length of the mat provided enough space for each foot to make contact with the mat a minimum of one time. It is likely that the presence of this rubber mat greatly reduced the number of falls and stumbles.

Exit Speed

The precise factors that determine the speed at which cattle exit the squeeze chute remain largely unexplained, though temperament has been shown to influence behavior in this window of time, with more temperamental cattle exiting the chute faster (Baszczak, et al., 2006). Aversive procedures that occur during restraint may also directly affect this behavior. Exit speed

(EXS) of steers was compared by capture method. Fewer steers (*P*= <0.01) ran from the squeeze chute after correct CAP compared with incorrect CAP (53.9% vs 65.4%), which further suggests that improper CAP is an aversive event that may elicit the flight response. Cattle exiting the chute faster have lower ADG (Voisinet); this emphasizes the importance of proper handling during routine events. If reductions in ADG can be documented as the result of a single handling event; the implications may be underestimated in a feedlot where cattle may be handled several times. The potential that exists for there to be a long-term cumulative impact due to handling and in particular, painful handling conditions warrants further investigation. If the conditions of CAP observed in this study were investigated using both quantitative (serum glucose and cortisol; feed inkate, etc.) and qualitative measures (TEMP, EXS, EXB), it would be possible to further explain the impacts of handling on performance of feedlot cattle.

Exit Behavior

Scores from the original 5 – point scale (described in detail earlier) were collapsed into two categories for analysis, with HIGH used to denote steers that performed any behavior or combination of the behaviors on the original scale (stumble, rear, jump, fall), and LOW used to denote steers that did not perform any of the behaviors listed above. During routine handling, steers were ranked as having LOW (58.7%) or HIGH (41.3%) behavior scores (EXB) when they exited the squeeze chute. More HIGH scores were recorded for steers with incorrect CAP when compared to those with correct CAP (*P*=<0.01). When considering the EXS and EXB of cattle, it may be useful to consider these behaviors in a cumulative effect. Little has been published about EXB of feedlot cattle, though Vetters, et al. (2013) found that jump is not continuous with walk, trot, and run for EXS. It is likely that cattle that perform behaviors in addition to EXS may be signaling greater agitation, and are exhibiting a heightened flight response. Because EXS has been negatively correlated to ADG, under the premise that EXB is a sign of greater agitation, the importance of proper handling becomes even more imperative. When considering the addition of EXB to EXS, there may be potential for modeling cumulative effects of agitation on ADG. This may have merit for investigation under more controlled conditions, such as a feed intake unit.

CONCLUSIONS

Steers that were captured incorrectly by the head gate displayed greater agitation than steers that were captured correctly. Steers captured incorrectly vocalized more; exited the chute faster; and displayed more behaviors of agitation when exiting the squeeze chute. Each of these parameters has individually been shown to have an impact on weight gain in live cattle, as well as beef quality (including increased instance of dark cutters, and increased Warner-Bratzler Shear Force values). Considered collectively, or as additive factors, it is reasonable to consider that there is an additive negative affect on cattle performance, as well. This principle is illustrated by widespread attention to handling practices in an effort to reduce losses in ADG, decrease in meat quality, cut-out due to bruising, and injury to handlers, to name a few (Smith, et al., 2005; Grandin). Because of the implications of these findings, it is important for producers to focus on training for handlers that will be operating the squeeze chute. Improper catches in the squeeze chute can result in bruising to the shoulders from hitting the head gate with too much speed, or from improper catches to the body. The financial impact of bruising has been documented previously, and though the impact of improper CAP has not been extensively studied, it is advisable from a management perspective to reduce the instance of improper CAP through training and ongoing monitoring. This should be considered a commitment to the quality of care that is provided to cattle during the final stage of production. Until further research documents the full effect of aversive events during handling, it should be this commitment to care and well-being of cattle that should inform the decision making process related to employee training and reducing handling stress in feedlot cattle.

LITERATURE CITED

Baszczak, J. A. et al. 2006. Effects of ractopamine supplementation on behavior of British, Continental, and Brahman crossbred steers during routine handling. J Anim Sci 84: 3410-3414.

Beckman, D. W., R. M. Enns, S. E. Speidel, B. W. Brigham, and D. J. Garrick. 2007. Maternal effects on docility in Limousin cattle. J Anim Sci 85: 650-657.

Boleman, S. L., S. J. Boleman, W. W. Morgan, D. S. Hale, D. B. Griffin, J. W. Savell, R. P. Ames, M.T. Smith, J. D. Tatum, T. G. Field, G. C. Smith, B. A. Gardner, J. B. Morgan, S. L. Northcutt, H. G. Dolezal, D. R. Gill, and F. K. Ray. 1998. National Beef Quality Audit - 1995: Survey of Producer-Related Defects and Carcass Quality and Quality Attributes. J. Anim. Sci. 76:96-103.

Bourguet, C., V. Deiss, C. C. Tannugi, and E. M. C. Terlouw. 2011. Behavioural and physiological reactions of cattle in a commercial abattoir: Relationships with organisational aspects of the abattoir and animal characteristics. Meat science 88: 158-168.

Burrow, H., and R. Dillon. 1997. Relationships between temperament and growth in a feedlot and commercial carcass traits of Bos indicus crossbreds. Anim Prod Sci 37: 407-411.

Burrow, H., G. Seifert, and N. Corbet. 1988. A new technique for measuring temperament in cattle. In: Proceedings of the Australian Society of Animal Production

Codex Alimentarius Commission – Joint FAO/WHO Food Standards Programme. 1997. Hazard analysis and critical control point (HACCP) system and guidelines for its application. Annex to CAC/RCP 1 – 1969, Rev. 3 1997.

Cooke, R. F., J. D. Arthington, B. R. Austin, and J. V. Yelich. 2009. Effects of acclimation to handling on performance, reproductive, and physiological responses of Brahman-crossbred heifers. J Anim Sci 87: 3403-3412.

Crocker, L., and J. Algina. 1986. Introduction to classical and modern test theory. ERIC.

Curley, K. O., J. C. Paschal, T. H. Welsh, and R. D. Randel. 2006. Technical note: Exit velocity as a measure of cattle temperament is repeatable and associated with serum concentration of cortisol in Brahman bulls. J Anim Sci 84: 3100-3103.

Deming, W. E. *Out of Crisis.* Cambridge; MIT Press. 1986. Print.

Duffey, L., J. Paterson, M. King, and K. Rolfe. 2008. Ranch management practices of beef quality assurance (BQA) and non-BQA certified producers in Montana. Journal of Extension.

Dunn, B. H. 2006. Beef Quality Assurance: Present and Future. A review of the Beef Quality Assurance Program for the Joint Evaluation Advisory Committee conducted by the

Executive Director of the King Ranch Institute for Ranch Management for the mid-year meeting of the Cattlemen's Beef Board and National Cattlemen's Beef Association. Reno, NV. July 10, 2006.

Dunn, C. 1990. Stress reactions of cattle undergoing ritual slaughter using two methods of restraint. Vet Rec 126: 522-525.

Elder, J. K., K. S. Waters, G. H. Dunwell, F. R. Emmerson, J. F. Kearnan, R. S. Morris, and S. G. Knott. 1980. A survey concerning cattle tick control in Queensland. Australian Veterinary Journal 56: 205-211.

Fordyce, G., R. Dodt, and J. Wythes. 1988. Cattle temperaments in extensive beef herds in northern Queensland. 1. Factors affecting temperament. Anim Prod Sci 28: 683-687.

Fox, J. et al. 2004. Residual feed intake of growing bulls and relationships with temperament, fertility and performance traits. In: J Anim Sci. p 6-6.

Garcia, L. G., K. L. Nicholson, T. W. Hoffman, T. E. Lawrence, D. S. Hale, D. B. Griffin, J. W. Savell, D. L. VanOverbeke, J. B. Morgan, K. E. Belk, T. G. Field, J. A. Scanga, J. D. Tatum, G. C. Smith. 2008. National Beef Quality Audit – 2005: Survey of targeted cattle and carcass characteristics related to quality, quantity, and value of fed steers and heifers. J. Anim. Sci. 86:3533-3543.

Gill, R. and R. Machen. 2014. Designing a Bud Box. http://agrilifecdn.tamu.edu/beefinfo/files/2014/01/Designing-a-Bud-Box.pdf. (Accessed 5 April 5 2015).

Goonewardene, L. A., M. A. Price, E. Okine, and R. T. Berg. 1999. Behavioral responses to handling and restraint in dehorned and polled cattle. Appl Anim Behav Sci 64: 159-167.

Grandin, T. 1980. Observations of cattle behavior applied to the design of cattle-handling facilities. Applied Animal Ethology 6: 19-31.

Grandin, T. 1993. Behavioral Agitation during Handling of Cattle Is Persistent over Time. Appl Anim Behav Sci 36: 1-9.

Grandin, T. 1994. Solving livestock handling problems. Vet. Med. (Praha) 89:989–998.

Grandin, T. 1996. Factors that impede animal movement at slaughter plants. J. Am. Vet. Med. Assoc. 209:757–759.

Grandin, T. 1997. Good management practices for animal handling and stunning. Washington, DC; American Meat Institute.

Grandin, T. 1998a. Objective scoring of animal handling and stunning practices at slaughter plants. J Am Vet Med Assoc 212: 36-39.

Grandin, T. 1998b. Review: Reducing handling stress improves both productivity and welfare. The professional Animal scientist 14: 1-10.

Grandin, T. 1998c. The feasibility of using vocalization scoring as an indicator of poor welfare during cattle slaughter. Appl Anim Behav Sci 56: 121-128

Grandin, T. 2000a. 1999 audits of stunning and handling in federally inspected beef and pork plants. In: 2000 Conference on Animal Handling and Stunning

Grandin, T. 2000b. Effect of animal welfare audits of slaughter plants by a major fast food company on cattle handling and stunning practices. J Am Vet Med Assoc 216: 848-851.

Grandin, T. 2001. Cattle vocalizations are associated with handling and equipment problems at beef slaughter plants. Appl Anim Behav Sci 71: 191-201.

Grandin, T. 2005. Maintenance of good animal welfare standards in beef slaughter plants by use of auditing programs. J Am Vet Med Assoc 226: 370-373.

Grandin, T. 2006. Progress and challenges in animal handling and slaughter in the U.S. Appl Anim Behav Sci 100: 129-139.

Grandin, T. 2008. Humane livestock handling. Storey Publishing.

Grandin, T. 2010. Recommended animal handling guidelines & audit guide: A systematic approach to animal welfare. American Meat Institute Foundation. Washington, DC.

Grandin, T. 2014. Livestock handling and transport. 4th ed. Wallingford, Oxfordshire, UK: CABI Publishing.

Hammond, A. C., T. A. Olson, C. C. Chase Jr, E. J. Bowers, R. D. Randel, C. N. Murphy, D. W. Vogt, and A. Tewolde. 1996. Heat tolerance in two tropically adapted Bos taurus breeds, Senepol and Romosinuano, compared with Brahman, Angus, and Hereford cattle in Florida. J. Anim. Sci. 74:295-303.

Hemsworth, P. H. et al. 2011. Human–animal interactions at abattoirs: Relationships between handling and animal stress in sheep and cattle. Appl Anim Behav Sci 135: 24-33.

Henderson, G. 2013. Tangible Evidence Cattlemen Care. Drover's Journal. http://www.cattlenetwork.com/drovers/Tangible-evidence-cattlemen-care-186484761.html. (Accessed 12 December 2014).

Hultgren, J., S. Wiberg, C. Berg, K. Cvek, and C. Lunner Kolstrup. 2014. Cattle behaviours and stockperson actions related to impaired animal welfare at Swedish slaughter plants. Appl Anim Behav Sci 152: 23-37.

Lanier, J., and T. Grandin. 2002. The relationship between Bos taurus feedlot cattle temperament and cannon bone measurements. In: Proceedings – American Society of Animal Science Western Section. p 97-98.

Le Neindre, P. et al. 1995. Individual differences in docility in Limousin cattle. J Anim Sci 73: 2249-2253.

Lorenzen, C. L., D. S. Hale, D. B. Griffin, J. W. Savell, K. E. Belk, T. L Frederick, M. F. Miller, T. H. Montgomery, and G. C. Smith. 1993. National Beef Quality Audit: Survey of Producer-Related Defects and Carcass Quality and Quantity Attributes. J. Anim. Sci. 71: 1495-1502.

McKeith, R. O., G. D. Gray, D. S. Hale, C. R. Kerth, D. B. Griffin, J. W. Savell, C. R. Raines, K. E. Belk, D. R. Woerner, J. D. Tatum, J. L. Igo, D. L. VanOverbeke, G. G. Mafi, T. E. Lawrence, R. J. Delmore Jr., L. M. Christensen, S. D. Shackelford, D. A. King, T. L. Wheeler, L. R. Meadows, and M. E. O'Connor. 2012. National Beef Quality Audit-2011: Harvest-floor assessments of targeted characteristics that affect quality and value of cattle, carcasses, and byproducts. J. Anim. Sci. 90: 5135-5142.

McKenna, D. R., D. L. Roeber, P. K. Bates, T. B. Schmidt, D. S. Hale, D. B. Griffin, J. W. Savell, J. C. Brooks, J. B. Morgan, T. H. Montgomery, K. E. Belk, and G. C. Smith. 2002. National Beef Quality Audit – 2000: Survey of targeted cattle and carcass characteristics related to quality, quantity, and value of fed steers and heifers. J. Anim. Sci. 80:1212-1222.

Moberg, G. P. 1999. When does stress become distress? Lab Animal 28:22-26

Moore, M. C., Gray, G. D., Hale, D. S., Kerth, C. R., Griffin, D. B., Savell, J. W., C. R. Raines, K. E. Belk, D. R. Woerner, J. D. Tatum, J. L. Igo, D. L. VanOverbeke, G. G. Mafi, T. E. Lawrence, R. J. Delmore, L. M. Christensen, S. D. Shackelford, D. A. King, T. L. Wheeler, L. R. Meadows, and M. E. O'Connor. 2012. National Beef Quality Audit–2011: In-plant survey of targeted carcass characteristics related to quality, quantity, value, and marketing of fed steers and heifers. J. Anim. Sci. 90:5143-5151.

Morris, C., N. Cullen, R. Kilgour, and K. Bremner. 1994. Some genetic factors affecting temperament in Bos taurus cattle. New Zeal J Agr Res 37: 167-175.

Mortimore, S. 2001. How to make HACCP really work in practice. Food Control 12: 209-215.

Nkrumah, J., D. H. Crews Jr., J. A Basarab, M. A. Price, E. K. Okine, Z. Wang, C. Li, and S. S. Moore. 2007. Genetic and phenotypic relationships of feeding behavior and temperament with performance, feed efficiency, ultrasound, and carcass merit of beef cattle. J Anim Sci 85: 2382-2390.

North American Limousin Foundation. 2004. Limousin breeders improve temperament. Limousin Breeder's Edge. Vol. 2. NALF, Englewood, CO.

NCBA. 2009a. Beef Quality Assurance National Manual. National Cattlemen's Beef Association, Centennial, CO 80112.

NCBA. 2009b. Beef Quality Assurance Feedyard Assessment Assessor's Guide. National Cattlemen's Beef Association, Centennial, CO 80112.

NCBA. 2015. History of BQA. http://www.bqa.org/historyofbqa.aspx. (Accessed 4 April 2015).

Odde, K. G. 2006. Beef Quality Assurance – Background, Analysis and Recommendations for the Future. A White Paper Prepared for The Joint Evaluation Advisory Committee for the mid-year meeting of the Cattlemen's Beef Board and National Cattlemen's Beef Association. Reno, NV. July 10, 2006.

Orr, D. W. 2002. The nature of design: ecology, culture, and human intention. Oxford University Press.

Rollin, B. E. 2004. Annual meeting keynote address: Animal agriculture and emerging social ethics for animals. J Anim Sci 82: 955-964.

Schwartzkopf-Genswein, K. S., Stookey, J. M., & Welford, R. 1997. Behavior of cattle during hot-iron and freeze branding and the effects on subsequent handling ease. J Anim Sci *75*: 2064-2072.

Selye, H. 1936. A syndrome produced by diverse nocuous agents. Nature 138:32.

Selye, H. 1973. The Evolution of the Stress Concept: The originator of the concept traces its development from the discovery in 1936 of the alarm reaction to modern therapeutic applications of syntoxic and catatoxic hormones. American scientist: 692-699.

Smith, G. C., J. W. Savell, R. P. Clayton, T. G. Field, D. B. Griffin, D. S. Hale, M. F. Miller, T. H. Montgomery, J. B. Morgan, J. D. Tatum, and J. W. Wise. 1992. Improving the consistency and competitiveness of beef - A blueprint for total quality management in the fed-beef industry. The final report of the National Beef Quality Audit - 1991, conducted by Colorado State University and Texas A&M University, for the National Cattlemen's Association on behalf of the Cattlemen's Beef Promotion and Research Board.

Smith, G. C., J. W. Savell, J. B. Morgan, T. H. Montgomery, K. E. Belk, J. C. Brooks, Z. L. Carpenter, T. G. Field, D. B. Griffin, D. S. Hale, F. K. Ray, and J. A. Scanga. 2000. Improving quality, consistency, competitiveness, and market share of fed-beef – the final report of the third blueprint for total quality management in the fed-beef (slaughter steer/heifer) industry. The final report of the National Beef Quality Audit - 2000, conducted by Colorado State University, Texas A&M University, Oklahoma State University, and West Texas A&M University, for the National Cattlemen's Beef Association on behalf of the Cattlemen's Beef Promotion and Research Board.

Smith, G. C., J. W. Savell, J. B. Morgan, T. E. Lawrence, K. E. Belk, T. G. Field, L. G. Garcia, D. B. Griffin, D. S. Hale, T. W. Hoffman, J. A. Scanga, J. D. Tatum, D. L. VanOverbeke, and K. L. Nicholson. 2005a. Staying On Track: Executive Summary of the 2005 National Beef Quality Audit. National Cattlemen's Beef Association, Centennial, Colorado.

Smith, G. C., J. W. Savell, J. B. Morgan, T. E. Lawrence, K. E. Belk, T. G. Field, L. G. Garcia, D. B. Griffin, D. S. Hale, T. W. Hoffman, J. A. Scanga, J. D. Tatum, D. L. VanOverbeke, and K. L. Nicholson. 2005b. National Beef Quality Audit - 2005: A new benchmark for the U. S. Beef Industry. The preliminary report of the National Beef Quality Audit - 2005, conducted by Colorado State University, Texas A&M University, Oklahoma State University, and West Texas A&M University, for the National Cattlemen's Beef Association on behalf of the Cattlemen's Beef Promotion and Research Board.

Sperber, W. H. 1998. Auditing and verification of food safety and HACCP. Food Control, 9: 157-162.

Spotter Publications. 2012. BeefSpotter. Spotter Publications, Amarillo, TX 79106.

Stookey, J. M., and J. M. Watts. 2007. Low stress-restraint, handling and weaning of cattle. In: Grandin, T, editor. Livestock handling and transport. 3rd ed. Wallingford, Oxfordshire, UK: CABI Publishing. pp: 65-75.

Stookey, J. M., and J. M. Watts. 2014. Low stress-restraint, handling and sorting of cattle. In: Grandin, T, editor. Livestock handling and transport. 4th ed. Wallingford, Oxfordshire, UK: CABI Publishing. pp: 65-76.

Stricklin, W. R., and C. C. Kautz-Scanavy. 1984. The role of behavior in cattle production: a review of research. Applied animal ethology 11:359-390.

Tulloh, N. 1961. Behaviour of cattle in yards. I. Weighing order and behaviour before entering scales. Animal Behaviour 9:20-24.

Tulloh, N. M. 1961b. Behaviour of cattle in yards. II. A study of temperament. Animal behaviour 9:25-30.

USDA-APHIS.1995. Feedlot quality assurance: National Animal Health Monitoring System. http://www.aphis.usda.gov/animal_health/nahms/feedlot/downloads/cofe/COFE_is_QualAssurance.pdf. (Accessed 4 April 2015).

USDA-NASS. 2013a. Cattle on Feed. Released by the National Agricultural Statistics Service, Agricultural Statistics Board, United States Department of Agriculture. http://www.nass.usda.gov/Publications/Todays_Reports/reports/cofd1013.pdf. (Accessed 4 February 2014).

USDA-NASS. 2013b. Rank Among States. Released by the National Agricultural Statistics Service, Agricultural Statistics Board, United States Department of Agriculture.

http://www.nass.usda.gov/Statistics_by_State/Indiana/Publications/Annual_Statistical_Bulletin/0809/pg6.pdf. (Accessed 4 February 2014).

Vetters, M. D., T. E. Engle, J. K. Ahola, and T. Grandin. 2013. Comparison of flight speed and exit score as measurements of temperament in beef cattle. J Anim Sci 91: 374-381.

Voisinet, B. D., T. Grandin, S. F. OConnor, J. D. Tatum, and M. J. Deesing. 1997a. Bos indicus cross feedlot cattle with excitable temperaments have tougher meat and a higher incidence of borderline dark cutters. Meat science 46: 367-377.

Voisinet, B. D., T. Grandin, J. D. Tatum, S. F. O'Connor, and J. J. Struthers. 1997b. Feedlot cattle with calm temperaments have higher average daily gains than cattle with excitable temperaments. J Anim Sci 75: 892-896.

Watts, J. M., & Stookey, J. M. 2000. Vocal behaviour in cattle: the animal's commentary on its biological processes and welfare. Applied Animal Behaviour Science, 67:15-33.

Watts, J. 2000. Vocal behaviour as an indicator of welfare in cattle, University of Saskatchewan Saskatoon.

Williams, B. 2015. Bud Williams Schools: Teaching Low Stress Livestock Handling Methods; Teaching Livestock Marketing Strategies. http://www.stockmanship.com. (Accessed 30 March 2015).