THESIS

DAIRY COW MANAGEMENT SYSTEMS: HANDLING, HEALTH, AND WELL-BEING

Submitted by

Ashley E. Adams

Department of Animal Sciences

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Summer 2012

Master’s Committee:

Advisor: Ivette N. Román-Muñiz

Francisco J. Olea-Popelka
Dale Woerner
Temple Grandin

ABSTRACT

DAIRY COW MANAGEMENT SYSTEMS: HANDLING, HEALTH, AND WELL-BEING

Dairy cows are handled more regularly than other forms of livestock. Besides the daily milking routine, reasons for handling dairy cattle so frequently include routine veterinary checks, reproductive management, and vaccinations. Regardless of the reason for handling cows, a working facility that meets the needs of a particular dairy is necessary. An ideal facility allows for all aspects of cow management to be accomplished in one spot, with minimal risk of injury to either the handler or the cow, as efficiently as possible. The main objectives of this survey were: 1) to determine if there is a need for a new type of handling facility for working dairy cows, similar to that of a management rail, that would allow all injections to be administered according to Dairy Beef Quality Assurance (**DBQA**) standards; 2) to establish if Colorado dairy producers were concerned with DBQA; and 3) to assess the differences in responses by dairy owners and management/herd-personnel. Additionally, the survey was designed to enhance our current understanding of the Colorado dairy industry by improving knowledge on demographics, record keeping, culling decisions, synchronization programs, and cull cow marketing options.

Of the 95 dairies contacted via electronic mail and telephone, 20 agreed to participate in the survey, for a response rate of 21%. The median number of cows per herd was 1177.50, with 90% of the respondents representing conventional dairy herds. The most common type of working facility was determined to be headlock stanchions, with 95% of the dairies using them as a form of restraint while handling cows. Just over half of those surveyed (55%) indicated that they would be willing to install a management rail when building a new handling facility. When asked to rank, in order of importance, 7 traits to consider when designing a new handling facility,

75% of producers ranked having the ability to administer injections as per Beef Quality Assurance (**BQA)** standards as last or second to last, illustrating the lack of concern for BQA protocols on Colorado dairy operations.

When considering the actual drug administration practices, the majority (79%) of dairy producers stated that the preferred location for administering all intramuscular (**IM**) injections is in the neck, although only 20% confirmed that all IM injections are given in that area 100% of the time. The results of the survey in Chapter II demonstrate a vast difference in the ideal situation versus what is actually carried out in practice. These findings support the theory that, while producers may be aware that all IM injections should be given in the neck region, most dairy producers are not concerned enough about BQA to ensure that all injections are actually given in that location. By implementing stricter BQA protocols dairy owners could prevent the risk of discounts, potentially increasing the amount of revenue gained by the sale of these animals, ultimately increasing the percentage of income derived from cull cows.

Survey results indicate a need for better DBQA practices on many Colorado dairies, and handling facilities that allow the safe and consistent administration of all medications in the neck area of dairy cows. More effective educational programs are needed in order to make the incentives tied to high quality dairy beef more apparent to dairy producers. These educational opportunities should also focus on the responsibility of providing a wholesome product to the consumer, free of lesions and drug residues.

An additional study was carried out investigating associations between increases in body temperature and common production diseases of dairy cattle, which is presented in Chapter III. Body temperature monitoring is a common practice employed on dairy farms as a way of detecting disease in dairy cows. Common production disorders of dairy cows that can result in a

deviation of the animal's body temperature from normal include metritis, mastitis, some causes of lameness, and pneumonia. The objective of the study was to investigate associations between increases in core body temperature in cows and the diagnosis of metritis, mastitis, lameness, and pneumonia by dairy personnel.

A prospective case-control study was completed on a 2175-cow dairy operation in Colorado from May 2010 to April 2011. Each cow received an orally administered temperature sensing reticular bolus after parturition and reticular temperature measurements were recorded 3 times per day as lactating cows exited the milking parlor. A cow was identified as having an increased core body temperature when a deviation of 0.8°C above baseline (average of readings of previous 10 days) was recorded by the TempTrack® Sofware. During the same study period, dairy personnel without access to reticular temperature data, recorded health events and classified them according to clinical signs observed. A total of 201 health events (cases) were included in the data analysis. Cows with clinical mastitis and pneumonia had significantly higher odds (6.7 and 7.5 times higher, respectively) of having an increased core body temperature within 4 days preceding diagnosis when compared to control cows. No significant difference in core body temperature was found for cows diagnosed with lameness or metritis. Results of the study in Chapter III suggest that reticular temperature monitoring can be a useful tool in the early detection of mastitis and pneumonia in dairy cows.

Key words: Dairy Cow, Diseases, Facilities, Handling, Reticular Temperature, Well-Being

TABLE OF CONTENTS

Page

Chapter I: Literature Review..1

Chapter II: Dairy Management Rails: Current Use and Needs of Colorado Dairies....................21

Chapter III: Using temperature-sensing reticular boluses to aid in the detection of production diseases in dairy cows...36

Appendices:

I. Survey Instrument..52

II. Category listings for open-ended questions..59

Chapter I: Literature Review

Throughout the dairy industry cows are housed and handled under a variety of management systems. Regardless of these differences the goal of each operation remains the same: for the cows to remain productive and healthy. Proper housing and equipment help to ensure that the animals are taken care of appropriately and that adequate facilities are available to manage the cows effectively. Regardless of a dairy having a free-stall barn or open-lot pens for housing facilities, they should meet the needs of the animals and be climate appropriate (Bickert, 2000). Accordingly, the handling facility on the dairy should facilitate the various management practices put in place on a dairy and allow for cows to be managed on a regular basis.

Dairy Cow Handling Facilities

Not every handling facility is ideal for every dairy operation. The best facility for a particular dairy depends on the herd size, expected treatment regimen, housing layout, labor force, and the frequency of handling (Bickert, 1998; Bickert et al., 2000). Bickert et al. provided a list of things that should be considered when designing a new handling facility on a dairy operation, including: animal handling lanes that promote smooth cow traffic flow with maximum safety for handlers and cattle; restraint facilities that allow for medical examinations, treatments, artificial insemination (**AI**), calving, and routine hoof trimming; ease of cleaning and maintenance; good lighting; and access to assist down cows (Bickert et al., 2000). Similarly, Grandin (1999) lists features of a safe handling facility, including: solid sides to prevent the animal from seeing the handler; man-gates to allow workers to easily escape; nonslip flooring to prevent cows from losing their footing; noise reduction in order to minimize animal agitation; repairs to prevent broken facilities from causing injury to both animals and handlers; distraction removal so as to prevent balking; and proper lighting to facilitate animal movement. The most common facilities found on dairy operations are single-file chutes, fence-line stanchions (headlocks), and herringbone palpation rails (Bickert et al., 2000).

Single File Chute –

The single file cow chute varies widely in design and sophistication. There are simple self-locking head catches, where the opening is large enough for the cows head, but her shoulders catch the side panels forcing it into the locked position. Head catches are generally designed to completely open from top to bottom, allowing the animal to exit through the front (Bickert et al., 2000). The only part of the body that is restrained is the cow’s head, with the rest of her body free, allowing her most of her natural movements (including swinging her body and kicking). Squeeze chutes are so called because they allow a squeeze to be applied, restricting the animal’s movement and preventing side-to-side motion. There are squeeze chutes that can either be automatic (self-locking) or manual (the operator is in charge of locking the cow as she passes through the chute), with sides all around the animal. This type of chute allows full control of the animal when the squeeze is applied, by holding the cow in one spot and preventing her from swinging and kicking. The more high-tech options are hydraulic squeeze chutes, where the controls are hydraulically powered and thought to be more user and animal friendly.

Single-file chutes are generally located near the hospital pen or exit lanes of the milking parlor, allowing quick segregation of individual cows (Chastain, 2000). These facilities allow for complete access to the animal, along with the ability to manage many aspects of animal health efficiently (Bickert et al., 2000). For example, while a cow is caught in the chute one can easily administer oral fluids to a dehydrated cow, administer intravenous (**IV**), intramuscular (**IM**), or subcutaneous (**SQ**) medications, conduct a thorough physical examination of the body and udder of an animal, assist in calving, or even complete a DA surgery. Single-file chutes are generally not believed to be the most efficient handling systems when working large numbers of dairy cows, and are usually only utilized for the reasons listed above.

Headlocks –

Self-locking stanchions, or headlocks, are one of the most common handling systems employed on dairy farms as restraint facilities due to ease of use and cow comfort (Wagner-Storch and Palmer, 2002). Generally, headlocks are located along the feed bunk, allowing cows to remain on feed while they are being managed. The locking mechanism allows for the easy catch and release of all of the cows at the feed bunk because a cow will easily lock herself when she places her head through the lock and drops it down to consume feed, effectively engaging the locking mechanism (Bickert et al., 2000; Bewley et al., 2001).

It is believed that producers prefer headlocks over any other type of working facility due to the fact that cows are able to remain on feed while being assessed or treated, there is no need to sort animals, and they allow for the management of a large number of cows with little effort on the human side (Wagner-Storch and Palmer, 2002). An ideal headlock set-up consists of at least the same number of stanchions in a pen or area as the number of cows in the group (Bickert et al., 2000). A case-study conducted by Wagner-Storch and Palmer (2002) found the following pros of headlocks: flexibility as multiple management practices were allowed to be conducted simultaneously (i.e. breeding and health checks); ideal animal arrangement because cows were locked in a manner that allowed for easy identification and examination of specific animals; improved animal movement and decreased mixing, since sorting was not necessary the movement of other cows in the herd was not impeded by those that were to be examined, nor was there a concern of cows mixing with cows from different pens; improved sick animal identification because cows that were sick were generally the ones that did not lock, allowing for prompt identification of cows needing assessment and treatment. In the same study, the cons of self-locking stanchions were reported as: increased initial cost since a headlock is necessary for each cow in the pen for efficient locking; reduced animal safety as cows that did not lock on their own were often pinned between those that were locked, or in a corner of the stall, resulting in increased stress and risk of injury; reduced worker safety because palpating a cow with empty stalls adjacent to her increased the animal's range of movement, making it difficult to safely and adequately examine the animal; and increased time away from home stalls as increased treatment time caused cows to spend extended periods of time standing, as opposed to resting and ruminating in their stalls.

Management Rails –

A newer type of handling system, management (or palpation) rails, has started to become popular on some dairies as an inexpensive alternative to headlocks (Bickert et al., 2000; Bewley et al., 2001). Management rails are relatively simple and inexpensive to design, and consist of a breast-rail and a rump-rail running parallel to each other (Figure 1.1), with the front and back gates angled, similarly to a herringbone milking parlor, for ease of loading (Wagner-Storch and Palmer, 2002).

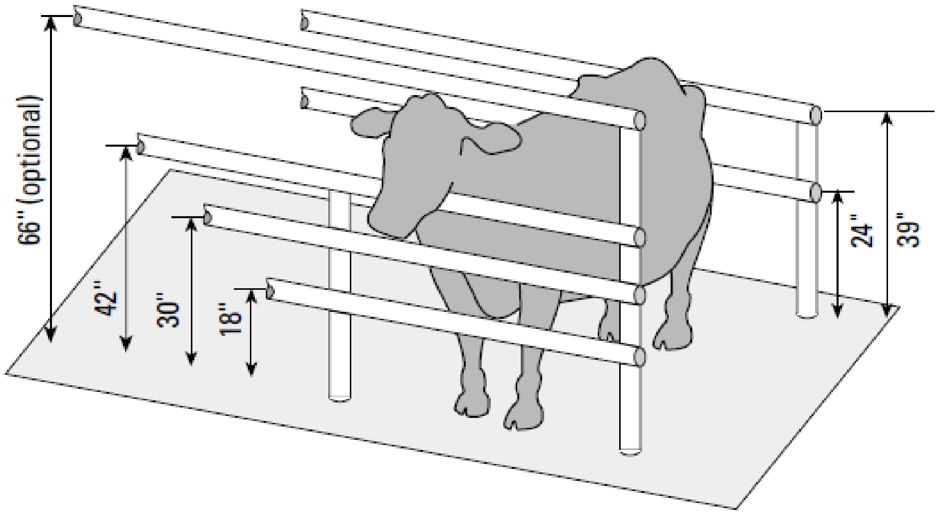

Figure 1.1 Front view of a cow positioned correctly in a management rail (Bickert et al., 2000).

A palpation rail is designed to hold multiple cows, with the length of the facility determining the size of the group that can be handled (Bickert et al., 2000). A management rail is easily loaded with the lead cow stopping at the front gate and the following cows stacking in tightly after her, latching the back gate behind the last cow (Figure 1.2). Ideally, there are an adequate number of animals to fill the entire palpation rail, so as to prevent excess cow movement and to prevent injury of either humans working with cattle or the animals themselves.

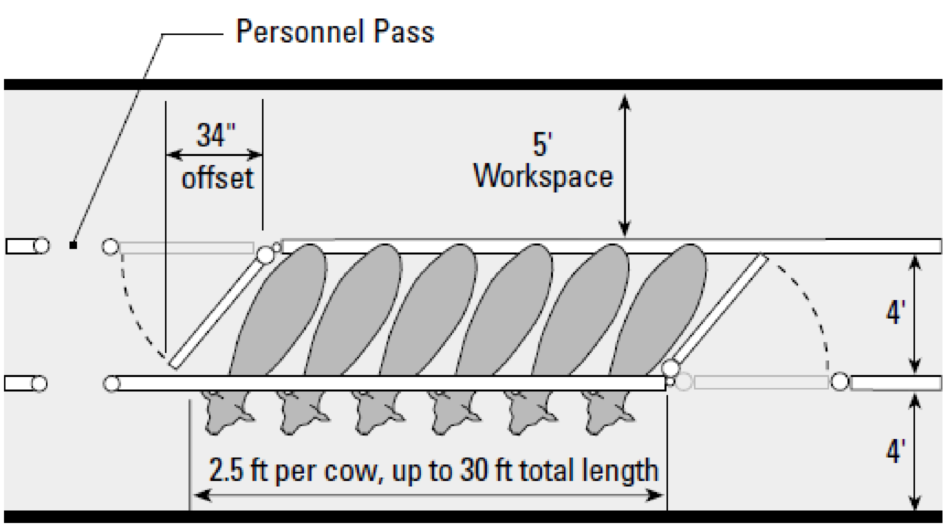

Figure 1.2 Top view of cows loaded correctly in a management rail (Bickert et al., 2000).

Management rails are generally seen on larger dairies who are interested in working through large groups of cattle quickly. They are also called palpation rails since the design allows for the cows to be stacked in securely with all of them facing the same direction, allowing easy access for palpating and examining the animal from behind (Wagner-Storch and Palmer, 2002). As with headlocks, Wagner-Storch and Palmer compared the pros and cons of palpation rails, determining the pros to be: ease of animal access since the necessary animals were located and restrained in one location, allowing for efficient breeding and palpating; improved worker safety since the restraint of the cows prohibited them from moving too much and kicking those breeding and palpating them; reduced cost because the simple design of the rail system allowed for a low initial cost of installation; and convenient location with management of the animals being conducted in a central location rather than in multiple pens throughout the farm. The cons were determined to be: lack of feed and water; difficulty loading animals as at least two people were required to efficiently load the rail and ensure the animals were positioned correctly; impeding animal traffic because, depending on the location of the rail, cows being treated would potentially inhibit traffic to and from the milking parlor and their home pens; increased potential of mixing since sorting of animals was necessary and workers needed to ensure that cows were returned to their home pens and were not mixed in with cows from a different group; wasted time because the sorting of animals is dependent upon their exit from the milking parlor meaning that there was the potential for the veterinarian and others to waste time while waiting for the correct cows to arrive at the restraint area.

A handling facility that may work superbly on one dairy facility may not be efficient on another. One must keep in mind the pros and cons of each type and decide which one will work best for their operation. The ideal handling facility depends on the particular goals of each dairy, as it is not one size fits all.

Safe Handling of Dairy Cows – Ensuring Human and Animal Safety

Agricultural workers face a higher risk of injury, both fatal and non-fatal, when compared to other industries in the United States (Demers and Rosenstock, 1991; Stallones and Beseler, 2003; NCFH, 2009). In 2007 it was estimated that there were 25.7 occupational deaths for every 100,000 agricultural workers in the U.S., compared to 3.7 deaths for every 100,000 workers in other industries (NCFH, 2009). The National Center for Farmworker Health also estimates that 243 workers involved in agricultural activities are injured each day, resulting in lost work-time. Research reports that livestock, farm machinery, and falls are the predominant sources of occupational injuries in agriculture (McCurdy and Carroll, 2000; Douphrate et al., 2009). One study found falls to represent up to 25% of the injuries reported on a farm, although caution must be taken when interpreting these results as the study included all sectors of agriculture, including the fruit industry where workers are often at high heights for harvesting (McCurdy and Carroll, 2000). Researchers have found that animals cause between 12 and 33% of all injuries in agriculture (Cleary et al., 1961; Cogbill et al., 1985; Brison and Pickett, 1992; Pratt et al., 1992; Zhou and Roseman, 1994; Layde et al., 1995; Nordstrom et al., 1995; Pickett et al., 1995; Gerberich et al., 1998; Lewis et al., 1998; Myers et al., 1998; Von Essen and Donham, 1999; McCurdy and Carroll, 2000; Sprince et al., 2003; Roman-Muniz et al., 2006; Douphrate et al., 2009). A study conducted by Roman-Muniz et al. (2006) investigating the causes of injuries sustained in the Colorado dairy industry it was found that direct contact with cows and bulls was responsible for 51.2% of all injuries reported, illustrating that caution must be taken when handling these animals.

The key to moving cows safely begins with understanding and respecting their natural behavior (Grandin, 1999). Although dairy cows are accustomed to being handled and are considered quite tame when compared to other types of livestock (i.e. a beef cow that is not used to interacting with humans on a daily basis), they still possess the same natural behaviors and can be worked in basically the same manner. As with other livestock, dairy cows possess both a *flight zone* and a *point of balance*, though these may not be as pronounced as in wilder animals (SCA, 1991; Albright and Arave, 1997; Grandin, 1999, 2000, 2010). A cow's flight zone is considered their safety zone (Figure 1.3), and can be determined by the distance between the animal and a slowly approaching person when the cow moves away from the person (Grandin, 2010). Since dairy cows are accustomed to being handled often, their flight zone is considerably small compared to a sheep or beef cow (Grandin, 1999).

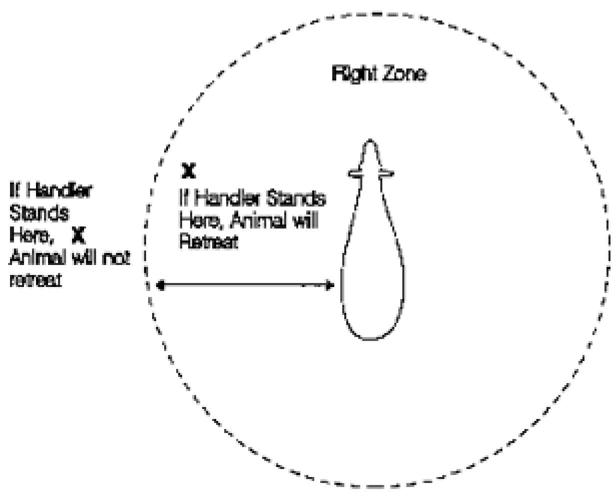

Figure 1.3 Circle representing the edge of a cow's flight zone. Stepping within the flight zone will cause the animal to retreat. Retrieved from: http://www.dpi.nsw.gov.au

A cow's point of balance is located at her shoulder and is named so because it is the imaginary line that, when crossed, causes the animal to move in the opposite direction of the movement (Grandin, 1999, 2010). In other words, if a person were to walk towards the rear of the animal, she would likely walk forward once the person stepped past her shoulder (Figure 1.4). As illustrated in Figure 1.4 as well, cows also possess a point of balance that runs the length of their body, and is how a handler can get them to turn in the desired direction.

Understanding how dairy cows perceive their surroundings will greatly improve one's ability to move them safely (SCA, 1991). Sharp contrasts in light will cause them to balk (hesitate or stop while walking), so it is important to work them in an evenly lit area (SCA, 1991; Grandin, 2010). Contrary to popular belief cows aren't color-blind; they have dichromatic vision which allows them to see yellowish-green and blue-purple, along with causing them to be more

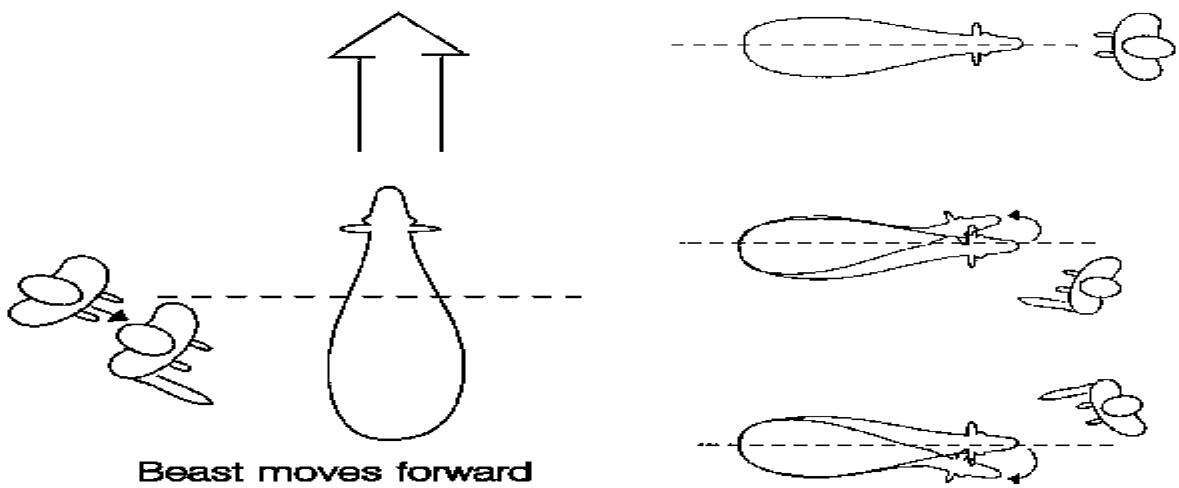

Figure 1.4 Line indicating a cow's point of balance, which, when crossed will cause her to move in the opposite direction. Retrieved from: http://www.dpi.nsw.gov.au

sensitive to sudden movements (SCA, 1991; Albright and Arave, 1997; Grandin, 2010). One should keep this in mind when designing a handling system, keeping it one color, and ensuring that there are no objects nearby that may frighten the cows and cause them to balk. The following are examples of things that may cause a dairy cow to balk: a flag whipping in the wind; a fan blade whirling in a nearby pen; a car parked nearby with the sun reflecting off of it; a puddle of water; and a shadow crossing the alley (Grandin, 2010). Cows are also curious animals, and tend to investigate new objects in familiar areas (Albright and Arave, 1997).

Allowing the animal to investigate the object prior to pushing them passed it reduces their fear and stress, because until they get a chance to investigate it they are likely to be fearful and wary of it.

Along with being sensitive to different colors and shades, cows are also sensitive to noise, especially high-pitched sounds (SCA, 1991; Albright and Arave, 1997; Grandin, 1999, 2010). Though it is common to hear yelling and whistling when working cattle, this is not generally accepted as the best way to calmly move them (Grandin, 1999). In a study using a Y-maze to examine the preference of dairy cows to certain handling treatments, researchers found that cows chose the less aversive handling treatment in all three of their tests (feeding vs. control; hitting and shouting vs. control; hitting and shouting vs. feeding; Pajor et al., 2002). Another experiment in the same study showed that there was no significant difference between the choice of aversive treatments (hitting vs. shouting; control vs. tail twist; and cattle prod vs. shouting), suggesting that shouting at cows is just as upsetting to them as striking or using an electric prod on them is. Pajor et al. (2000) conducted a study examining different techniques for moving dairy cows through a handling facility. The results of the study revealed that dairy cows that had been moved using an electric prod, along with those that had been yelled at while being handled, took longer to move through the facility than control cows (no interaction from the handler), those that were hit on the rump, and those who’s tails were twisted at the base. These findings support previous research indicating that cattle are able to remember painful and aversive experiences when being handled, therefore making it more difficult to handle them in similar situations in the future (Rushen et all, 1997; Grandin, 1999; Munksgaard et al., 2000; Pajor et al., 2000; Grandin, 2010). Ensuring that a cow’s first experience with a handling facility is a positive one will help when working her there in the future (Grandin, 1999; Grandin, 2010).

Handling a dairy cow calmly, respecting her natural behaviors, will ensure that the entire experience is completed safely, for both the humans and animals involved. More times than not, an injury can be blamed by inexperienced or careless handlers, and can be avoided if the cows are handled correctly.

Proper Injection Techniques

Medications all contain labels or instructions indicating the correct dosage for a certain animal, along with the proper administration technique. Following a medication's label ensures that the drug will be absorbed properly and have the desired effect (Griffin et al., 1998). There are four common routes of administering medications to dairy cows, and they include intramuscular (IM), intravenous (IV), subcutaneous (SQ), and intramammary (IMM). To ensure DBQA, administration of medications via SQ route is preferred to IM route in order to prevent the formation of lesions at the injection site (Griffin et al., 1998; NBQA). Also in accordance with DBQA, all IM and SQ injections should be given in the neck of the animal in order to preserve the better quality meat cuts (the top butts and rounds) located along the rear of the cow (Griffin et al., 1998; Tozer et al., 2005; Ahola and Glaze, 2009; Glaze and Chahine, 2009; Li et al., 2012). Studies have also shown that the neck region heals faster than the rump area, providing one more reason that injections should be administered in that location (Li et al., 2012). Even in the face of all of the research published concerning the issue, dairy producers continue to administer injections in the upper hip and rear leg (Rogers et al., 2004; Tozer et al., 2005; Glaze and Chahine, 2009).

Dairy Beef Quality Assurance

Beef quality assurance (**BQA**) is defined as a program designed to ensure that dairy and beef cattle are produced in a manner that results in safe, wholesome, high-quality, and consistent beef and beef products for consumers (Glaze and Chahine, 2009). The BQA program provides guidelines for producers to follow, which are available in their Beef Quality Assurance Manual (BQA 2012). Even though most producers know that the ideal location for BQA to administer injections is in the neck, they continue to give them in the hind end due to ease of administration and management (Tozer at al., 2005). Practices such as this greatly compromise DBQA and the image of the dairy industry to both the beef industry and to consumers. It has been reported that injection site lesions rank second in importance of leading BQA issues, with only the occurrence of antibiotic residues being of greater concern (Roeber, 2003). Research has shown that dairy cow carcasses have significantly greater injection site lesions in outside round muscles than beef cow carcasses (49 and 26% respectively), illustrating that BQA practices are lacking on many dairy operations (Roeber et al., 2002). The incidence of injection site lesions in muscle rounds from dairy cattle has declined over time, from 60% in 1998 to 35% in 2000, although much work is still needed to improve upon this, because an incidence rate of 35% means that one out of every three carcass has a lesion (Roeber et al., 2002; Roeber, 2003).

The majority of income on a dairy farm is generated from the sale of liquid milk, though there are other sources of income, including the sale of cull cows and bulls for slaughter. It has been reported that the cull cows and bulls comprise 4% of the income of dairy sales (Roeber, 2003; Ahola et al., 2011). With an average replacement rate of 30-35%, cull dairy cows accounted for 8.7% of the beef animals slaughtered in 2011 (Rogers et al., 2004; Glaze and Chahine, 2009; USDA, 2012). A survey conducted examining California dairy operations found that producers were hesitant to participate in a quality assurance program primarily due to financial reasons; doubt that benefits would outweigh costs was evident (Payne et al., 1999). These results contrast projections that injection site lesions result in an astounding $9,000,000 loss to the beef and dairy industries (Roeber et al., 2002; Roeber, 2003). It has been estimated that quality defects were responsible for a deduction of $68.82 per cow, with injection site blemishes accounting for $11.49-13.82 of that loss (Roeber et al., 2001; Tozer et al., 2005; Glaze and Chahine, 2009; Ahola et al., 2011). Published results support the argument dairy producers would benefit financially if they were to implement and consistently follow a DBQA program on their operations.

Financial losses from injection site blemishes are due mainly to the loss of saleable meat that has to be removed prior to it being sold to the consumer (Roeber et al., 2002; Roeber, 2003). Lesions vary in size and consistency depending on the medication administered and the amount of time that has elapsed between injection and slaughter (George et al., 1995a, 1995b; Roeber et al., 2002; Roeber, 2003). Lesions that are clear or woody are those that have been administered to cattle early in life, metallic and nodular blemishes occur with injections given during the mid-to-late finishing phases, and cystic lesions are those administered shortly before harvest (Dexter et al., 1994; George et al., 1995a, 1995b; Roeber et al., 2003). Research has proven that injections given during the early stages of life (i.e. as calves) can result in lesions persisting until the animal is slaughtered as an adult, illustrating the importance of BQA procedures being followed throughout all stages of production (Dexter et al., 1994; George et al., 1995a, 1995b). Lesions classified as cystic tend to be larger than those classified as clear, woody, metallic, or nodular, and require trimming of greater amounts of saleable meat (Roeber et al., 2003). Injection site lesions are not commonly found at the packing plant since they tend to be concealed within muscle or subcutaneous fat, resulting in their detection at the retail level, or potentially at the consumer level (Roeber et al., 2001, 2002). George et al. (1995b) conducted a study investigating the tenderness of the meat surrounding injection site lesions, and discovered that reduced tenderness can be detected at distances of 7.62 cm from the center of the lesion. The Warner-Bratzler shear value (a measurement of tenderness) was recorded at 5.80 kg at that distance, with was greater than that considered acceptable for restaurant quality (<3.86 kg) and that for sale at the retail level (<4.45 kg), suggesting that even though the blemish has been removed, the quality of the remaining cut of meat has been diminished. Since a greater percentage of dairy carcasses are being fabricated into more valuable whole muscle cuts than in previous years, it would be in the producer's best interest to reduce the occurrence of injection site lesions in order to take advantage of this price incentive (Ahola et al., 2011).

Culling Behavior

Culling can be described as selecting cows to be removed from the herd and replacing them, usually with a first lactation heifer (Hadley et al., 2006). It is a practice employed to improve the herd by removing the older, less productive individuals and replacing them with animals that have improved genetic potential. Optimum culling rates for profitability have been estimated between 19 and 30% (Rogers et al., 1988; Bauer et al., 1993; Stott, 1994; Bascom and Yong, 1998; Hadley et al., 2006). Actual culling rates tend to be higher than this. In the Northeast it was estimated that the average cull rate is 34%; culling rates in 2001 for upper Midwest DHIA herds was reported at 38%; a study conducted examining the DHI records for 5 Upper Midwest states and 5 Northeast states found the average culling rate to be 35.1%; finally, a survey of New Mexico dairies found the average culling rate to be 33% (Bascom and Young, 1998; Rogers et al., 2004; Hadley et al., 2006;). Culling of dairy cows can be classified as either voluntary or involuntary (Gröhn et al., 1998; Rajala-Shultz and Gröhn, 1999; Hadley et al., 2006). Voluntary culling refers to cows chosen by the owner or herd manager to be removed from the herd, generally for low milk production or an excess of animals, while involuntary culling represents animals removed from the herd for reasons outside of the owner or herd managers control, such a-s illness, injury, infertility, or death. The most common reasons for culling cows have historically been reproductive problems, mastitis, and low production (Bascom and Young, 1998; Lehenbauer and Oltjen, 1998; Groenendaal et al., 2004; Hadley et al., 2006).

The number of dairy cows in Colorado has consistently been on the rise in the past decade (USDA, 2008). There is little information available comparing the Colorado dairy industry to others in the nation. The survey was designed to gain basic information on Colorado dairies, as well as to learn various aspects about their handling facilities, DBQA protocols, and management practices.

REFERENCES

Ahola, J. K. and J. B. Glaze, Jr. 2009. Animal Identification and Beef Quality Assurance Topics Offered in Combined Workshops to Increase Effectiveness and Participation. J. Ext. 47(4):1-6

Ahola, J. K. 2010. Are market dairy cows undervalued? Beef Issues Quarterly. 2(1):1-5

Ahola, J. K., H. A. Foster, D. L. VanOverbeke, K. S. Jensen, R. L. Wilson, J. B. Glaze, Jr., T. E. Fife, C. W. Gray, S. A. Nash, R. R. Panting, and N. R. Rimbey. 2011. Survey of quality defects in market beef and dairy cows and bulls sold through livestock auction markets in the Western United State: I. Incidence rates. J. Anim. Sci. 89:1474-1483

Albright, J. L. and C. W. Arave. 1997. The Behaviour of Cattle. CAB International, Oxon, UK.

Bascom, S. S. and A. J. Young. 1998. A Summary of the Reasons Why Farmers Cull Cows. J. Dairy Sci. 81:2299-2305

Bauer, L., G. Mumey, and W. Lohr. 1993. Longevity and genetic improvement issues in replacing dairy cows. Can. J. Agric. Econ. 41:71-80

Bewley, J., R. W. Palmer, and D. B. Jackson-Smith. 2001. A Comparison of Free-Stall Barns Used by Modernized Wisconsin Dairies. J. Dairy Sci. 84:528-541

Bickert, W. G. 1998. Sorting, Handling and Restraining Lactating Cows for Treatment and Other Purposes. Pages 160-167 in Natl. Mastitis Counc. Ann. Mtg. Proc., St. Louis, MO. Natl. Mastitis Counc., Inc., Verona, WI.

Bickert, W. G., B. Holmes, K. Janni, D. Kammel, R. Stowell, and J. Zulovich. 2000. Special Handling and Treatment Facilities. Pages 65-74 in Dairy Freestall Housing and Equipment. 7th ed. Midwest Plan Service, Ames, IA.

Boyle, D., S. G. Gerberich, R. W. Gibson, G. Maldonado, R. A. Robinson, F. Martin, C. Renier, and H. Amandus. 1997. Injury from Dairy Cattle Activities. Epidemiology. 8(1):37-41

BQA. 2010. Beef Quality Assurance Manual. Beef Quality Assurance. Fort Collins, CO

Brison, R. J. and C. W. Pickett. 1992. Non-fatal farm injuries form 117 Eastern Ontario beef and dairy farms: A one year study. Am. J. Ind. Med. 21:623-636

Cleary, J., J. Benzimiller, E. Kloppedal, D. Gallagher, and A. Evans. 1961. Farm injuries in Dane Country, Wisconsin. Arch. Environ. Health. 3:83-90

Chastain, J. P. 2000. Design of Spaces to Enhance Cow Management and Care. Clemson University: Department of Agricultural and Biological Engineering. Clemson, SC.

Cogbill, T., H. Busch, and G. Stiers. 1985. Farm accidents in children. Pediatrics. 76:562-566

Demers, P. and L. Rosenstock. 1991. Occupational Injuries and Illnesses among Washington State Agricultural Workers. Am. J. Public Health. 81(12):1656-1658

Dexter., D. R., G. L. Cowman, J. B. Morgan, R. P. Clayton, J. D. Tatum, J. N. Sofos, G. R. Schmidt, R. D. Glock, and G. C. Smith. 1994. Incidence of injection-site blemishes in top sirloin butts. J. Anim. Sci. 72:824-827

Douphrate, D. I., J. C. Rosecrance, L. Stallones, S. J. Reynolds, and D. P. Gilkey. 2009. Livestock-Handling Injuries in Agriculture: An Analysis of Colorado Workers' Compensation Data. Am. J. Ind. Med. 52:391-407

George, M. H., P. E. Heinrich, D. R. Dexter, J. B. Morgan, K. G. Odde, R. D. Glock, J. D. Tatum, G. L. Cowman, and G. C. Smith. 1995a. Injection-site lesions in carcasses of cattle receiving injections at branding and at weaning. J. Anim. Sci. 73:3235-3240

George, M. H., J. B. Morgan, R. D. Glock, J. D. Tatum, G. R. Schmidt, J. N. Sofos, G. L. Cowman, and G. C. Smith. 1995b. Injeciton-site lesions: incidence, tissue histology, collagen concentration, and muscle tenderness in beef rounds. J. Anim. Sci. 73:3510-3518

Gerberich S., R. Gibson, L. French, T. Lee, W. Carr, L. Kochevar, C. Renier, and J. Shutske. 1998. Machinery-related injuries: Regional Rural Injury Study-I (RRIS-I). Accid. Anal. Prev. 30:793-804

Glaze, J. B., Jr. and M. Chahine. 2009. Assessment of management of basic beef quality assurance practices on Idaho dairies. J. Dairy Sci. 92:1265-1271

Grandin, T. Behavioral Priciples of Livestock Handling. 1989, Updated 2010. The Prof. Anim. Scientist. 1-11

Grandin, T. Safe Handling of Large Animals (Cattle and Horses). 1999. Occupational Medicine: State of the Art Reviews. 14:2

Grandin. T. The design and construction of facilities for handling cattle. 2000. Colorado State University: Department of Animal Science. Fort Collins, CO.

Griffin, D. D., D. R. Smith, and D. M. Grotelueschen. 1998. G98-1351 Proper Injection Procedures for Cattle. University of Nebraska – Lincoln. Lincoln, NE.

Groenendaal, H., D. T. Galligan, and H. A. Mulder. 2004. An Economic Spreadsheet Model to Determine Optimal Breeding and Replacement Decisions for Dairy Cattle. J. Dairy Sci. 87:2146-2157

Gröhn, Y. T., S. W. Eicker, V. Ducrocq, and J. A. Hertl. 1998. Effect of Diseases on the Culling of Holstein Dairy Cows in New York State. J. Dairy Sci. 81:966-978

Hadley, G. L., C. A. Wolf, and S. B. Harsh. 2006. Dairy Cattle Culling Patterns, Explanations, and Implications. J. Dairy Sci. 89:2286-2296

Layde P., D. Nordstrom, D. Stueland, L. Wittman, M. Follen, K. Olson. 1996. Animal-related occupational injuries in farm residents. Ann. Epidemiol. 5:41-426

Lehenbauer, T. W. and J. W. Oltjen. 1998. Dairy Cow Culling Strategies: Making Economical Culling Decisions. J. Dairy Sci. 81:264-271

Lewis M., N. Sprince, L. Burmeister, P. Whitten, J. Torner, C. Zweling. 1998. Work-related injuries among Iowa farm operators: An analysis of the Iowa Farm Family Health and Hazard Surveillance Project. Am. J. Ind. Med. 33:510-517

Li, W., Y. Yin, F. Wang, and S. Miao. 2012. Beef Quality Assurance Injection Sites and Techniques. J. Agric. Sci. 4(1):91-96

McCurdy, S. A. and D. J. Carroll. 2000. Agricultural Injury. Am. J. Ind. Med. 38:463-480

Munksgaard, L., A. M. DePassille, J. Rushen, M. S. Herskin, and A. M. Kristensen. 2001. Dairy cows' fear of people: social learning, milk yield and behavioral at milking. Appl. Anim. Behav. Sci. 73:15-26

Myers, J. R. 1998. Injuries among farm workers in the United States, 1994. National Institute For Occupational Safety and Health. Publication No. 98-153

NCFH. 2009. Occupational Health and Safety. National Center for Farmworker Health, Inc. Budah, TX.

Nordstrom D., P. Layde, K. Olson, D. Stueland, L. Brand, M. Follen. 1995. Incidence of farm-work-related acute injury in a defined population. Am. J. Ind. Med. 28:551-564

Pajor, E. A., J. Rushen, and A. M. B. de Passillé. 2000. Aversion learning techniques to evaluate dairy cattle handling practices. Appl. Anim. Behav. Sci. 69:89-102

Pajor, E. A., J. Rushen, and A. M. B. de Passillé. 2003. Dairy cattle's choice of handling treatments in a Y-maze. Appl. Anim. Behav. Sci. 80:93-107

Payne, M., C. M. Bruhn, B. Reed, A. Scearce, and J. O'Donnell. 1999. On-Farm Quality Assurance Programs: A Survey of Producer and Industry Leader Opinions. J. Dairy Sci. 82:2224-2230

Pickett, W., R. Brison, H. Niezgoda, M. Chipman. 1995. Nonfatal farm injuries in Ontario: A population-based study. Accid. Anal. Prev. 27:425-433

Pratt, D., L. Marvel, D. Darrow, L. Stallones, J. May, and P. Jenkins. 1992. The dangers of dairy farming: The injury experience of 600 workers followed over two years. Am. J. Ind. Med. 21:637-650

Rajala-Schultz, P. J. and Y. T. Gröhn. 1999. Culling of dairy cows. Part I. Effects of diseases on culling in Finnish Ayrshire cows. Prev. Vet. Med. 41:195-208

Roeber, D. L. 2003. Meat Quality and Dairy Veterinary Practice. Proc. MN Dairy Health Conf. College of Vet. Med. Univ. Minn, St Paul, MN.

Roeber, D. L., R. C. Cannell, W. R. Wailes, K. E. Belk, J. A. Scanga, J. N. Sofos, G. L. Cowman, and G. C. Smith. 2002. Frequencies of Injection-Site Lesions in Muscles from Rounds of Dairy and Beef Cow Carcasses. J. Dairy Sci. 85:532-536

Roeber, D. L., P. D. Miles, C. D. Smith, K. E. Belk, T. G. Field, J. D. Tatum, J. A. Scanga, and G. C. Smith. 2001. National market cow and bull beef quality audit-1999: a survey of producer-related defects in market cows and bulls. J. Anim. Sci. 79:658-665

Rogers, C. A., A. C. Fitzgerald, M. A. Carr, B. R. Covey, J. D. Thomas, and M. L. Looper. 2004. On-Farm Management Decisions to Improve Beef Quality of Market Dairy Cows. J. Dairy Sci. 87:1558-1564

Rogers, G., J. van Arendonk, and B. McDaniel. 1988. Influence of production and prices on optimal culling rates and annualized net revenue. J. Dairy Sci. 71:3453-3462

Roman-Muniz, I. N., D. C. Van Metre, F. B. Garry, S. J. Reynolds, W. R. Wailes, and T. J. Keefe. 2006. Training Methods and Association with Worker Injury on Colorado Dairies: A Survey. J. Agromedicine. 11(2):19-26

Rushen, J., L. Munksgaard, A. M. B. de Passillé, M. B. Jensen, and K. Thodberg. 1998. Location of handling and dairy cows' responses to people. Appl. Anim. Behav. Sci. 55:259-267

SCA. 1991. Farm Cattle Handling. Report No. 35. Standing Committee on Agriculture. East Melbourne, Victoria, AU

Sprince, N. L., H. Park, C. Zwerling, C. F. Lynch, P. S. Whitten, K. Thu, L. F. Burmeister, P. P. Gillette, and M. C. R. Alavanja. 2003. Risk Factors for Animal-related Injury Among Iowa Large-livestock Farmers: A Case-control Study Nested in the Agricultural Health Study. J. of Rural Health. 19(2):165-173

Stallons, L. and C. Beseler. 2003. Farm work practices and farm injuries in Colorado. Inj. Prev. 9:241-244

Stott, A. 1994. The economic advantage of longevity in the dairy cow. J. Agric. Econ. 45:113-122

Tozer, P. R., G. A. Varga, W. R. Henning, and L. A. Holden. 2005. Do Dairy Producers Use Effective Management Practices to Improve the Value of Market Cows? The Prof. Anim. Scientist. 21:272-277

USDA. 2008. Dairy 2007 Part II: Changes in the U.S. Dairy Cattle Industry, 1991-2007. United States Department of Agriculture, APHIS-VS, CEAH. Fort Collins, CO.

USDA. 2012. Livestock Slaughter – 2011 Summary. United States Department of Agriculture, Natl. Agric. Stat. Serv., Washington, DC.

Von Essen, S. and K. Donham. 1999. Illness and injury in animal confinement workers. Occup. Med. 14:337-350

Wagner-Storch, A. M. and R. W. Palmer. 2002. Case Study: Animal Handling Procedures and Facilities Used by Dairy Producers to Conduct Health and Reproductive Examinations. The Prof. Anim. Scientist. 18:332-336

Zhou, C. and J. Roseman. 1994. Agriculture injuries among a population-based sample of farm operators in Alabama. Am. J. Ind. Med. 25:385-402

Chapter II: Dairy Management Rails:

Current Use and Needs of Colorado Dairies

INTRODUCTION

Dairy cows are handled more regularly than most other livestock animals. Besides being handled as part of their daily milking routine, dairy cows are handled for routine veterinary checks, reproductive management, and vaccinations. Not considering milking practices, the frequency of handling depends on the dairy, and can vary from daily for intensive reproductive programs where heat breeding and estrous synchronization are common practice, to once every week or so for veterinary and pregnancy checks. No matter what the reason for the handling of dairy cows, a working facility that meets the needs of a particular dairy is necessary. Many dairy operations in Colorado use headlocks or palpation rails when working cows, usually administering whatever drugs are necessary by the easiest and safest means possible. The main objectives of the survey were: 1) to determine if there is a need for a new type of handling facility for working dairy cows, similar to that of a management rail, that would allow all injections to be administered via Dairy Beef Quality Assurance (**DBQA**) standards; 2) to establish if Colorado dairy producers were concerned with DBQA; and 3) to assess the differences in responses by dairy owners and management/herd personnel. Additionally, the survey was designed to enhance our current understanding of the culling decisions, synchronization programs, and cull cow marketing options on Colorado Dairy operations.

MATERIALS AND METHODS

A survey was developed to assess the potential need of a new handling facility that would allow for dairy operations to more easily follow DBQA standards. Questions for the survey were developed that would help researchers assess the current needs and uses of working facilities on Colorado dairies, along with determining the importance of Dairy Beef Quality Assurance (D**BQA**) on dairy operations. In order to obtain basic information about the Colorado dairies surveyed, questions were included pertaining to herd size, housing method, stocking percentage, and general management practices. Also, several questions were included to gain an understanding of culling behavior on Colorado dairies. As one of the objectives of this study was to assess the need for a new handling facility similar to that of a management rail, producers were asked if they would be willing to install a management rail when considering building a new handling facility. The final survey consisted of 45 questions, both open- and close-ended questions, along with some individual questions that required multiple responses (see Appendix 1). Dairy operations were solicited by electronic mail and phone, with a total of 95 dairies being contacted. The list of dairies contacted was derived from Colorado State University Dairy Extension personnel and from previously published lists from Colorado dairy and livestock groups. The survey protocol was approved by the Colorado State University Institutional Review Board Human Subjects Research Policy (#11-2698H).

Upon approval from the dairy owner, a member of the research committee visited the dairy operation and completed the questionnaire with the owner, and when applicable, a second part of the questionnaire with the manager/herdsperson. The second part of the questionnaire was not completed in instances where the owner reported to be the acting herdsperson. The questions for the herdsperson paralleled those of the owner in order to detect discrepancies between upper management (owners) and those working firsthand with the animals (herdsperson).

All data was entered into a spreadsheet and analyzed using SAS Version 9.3 (SAS Institute Inc., Carey, NC). For all close-ended questions, answers were coded as “1” if the respondent stated that choice or yes, and “0” if they chose no or did not state that choice. All open-ended questions were examined and placed into categories of similarity based on their response, with no more than 6 categories being present for each question (see Appendix 2) and each category being assigned a number between 1 and 6. Once categories had been assigned, answers were coded as either “1” if that choice was marked, or “0” if it was not. All questions were organized as stated above, with the exception of continuous data (i.e. herd size), and the ranking of 7 traits of a new handling facility in order of importance. PROC UNIVARIATE in SAS was used to calculate the median herd size, along with frequencies concerning types of handling and housing facilities, and the different management practices employed on the operations. PROC FREQ was utilized to obtain the Chi-squared and Fisher’s exact test in order to evaluate associations between owner and herdsperson responses.

RESULTS

Of the 95 dairies contacted via electronic mail and telephone, 20 agreed to participate in the survey, for a response rate of 21%. This response rate was similar to one conducted in the Intermountain region of the United States by Buttars et al. (2006), who had a response rate of 13 to 29%. However, this response rate is lower than that of Glaze et al. (2009) with a response rate of 36.9% for dairy producers in Idaho who were asked about BQA principles and practices, and also for that of Rogers et al. (2004) with a response rate of 31% for dairy producers surveyed on management decisions to improve quality of market cows. The dairies surveyed represent 38,210 cows, which is 33.2% of the total number of cows in Colorado, according to the USDA (2008).

Overall, the mean number of cows per herd was 1910.50, with a median of 1177.50, and a range of 200 to 5500 head. Figure 2.1 illustrates the distribution of herd size. Whether or not a dairy was closed (no new animals added in the previous year) or open was split fairly evenly, with 45% being closed for the past 12 months, and 55% being open. The majority (90%, n = 18) of dairies surveyed were conventional, and 10% (n = 2) being USDA certified organic.

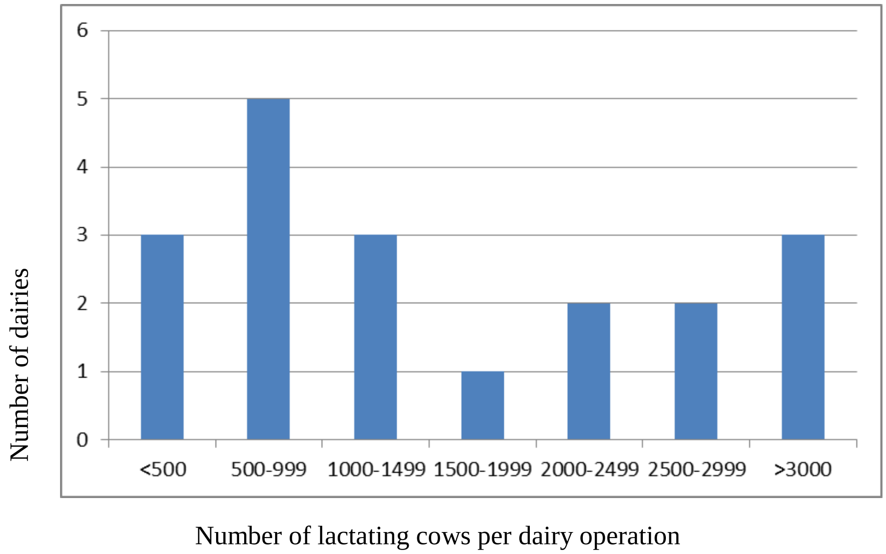

Figure 2.1 Distribution of herd size of the Colorado dairies surveyed.

Of the various housing options available, 85% (n = 17) reported housing at least some of their cows in open lots, 60% (n = 12) had free-stall barns with exercise lots attached, 15% (n = 3) used some free-stall barns with no access to an open-lot, and 5% (n = 1) reported using compost barns to house some of their herd. For those who stated using open-lots to house cows, 77% (n = 13) provided a wind-break for their cows, and 59% (n = 10) had a shade structure. When presented with a multiple choice question pertaining to pen stocking percentage, with stocking percentage being determined by the number of cows and the number of available headlocks, 50% of respondents reported a rate of 75 to 100%, 45% stated their pens were stocked between 100 and 125%, with only 5% (n = 1) claiming a stocking percentage of 50 to 75%.

Most of the dairy producers questioned (90%, n = 18) stated routinely using antibiotics and reproductive hormones on their operation, with only 2 dairies (10%) not using them. The estrous synchronization program most often used was double-Ovsynch (45%), followed by Presynch-Ovsynch (25%), and straight heat detection (15%). Other synchronization protocols reported were Prostaglandin $F2_{\alpha}$, Ovsynch, andG-7-G, each of which was used on one dairy a piece. The majority of dairies (85%, n = 17) did not used rBST for increased milk production.

When questioned about the types of handling facilities used on their dairy, 95% (n = 19) of dairy owners said that they use headlocks, 90% (n = 18) reported using a chute, 50% (n = 10) specified using palpation rails, and only 5% (n = 1) stated using a head-gate in an alley. Approximately half (45%) stated that they would not consider installing a management rail, while 55% stated that they would. Producers who wouldn’t consider building a management rail indicated the need to sort cows as the main reason against building it, while those in favor expressed that they felt rails were safer for the humans involved and more efficient than other handling systems. Producers were asked to rank in order of importance 7 traits when designing a new handling facility (Figure 2.2). Many of the producers (70%) ranked human safety as first or second in priority (35% each), 55% ranked animal safety as first or second (20 and 35% respectively), while being able to administer injections per BQA standards ranked 6^{th} or 7^{th} for 75% of producers (35 and 40% respectively).

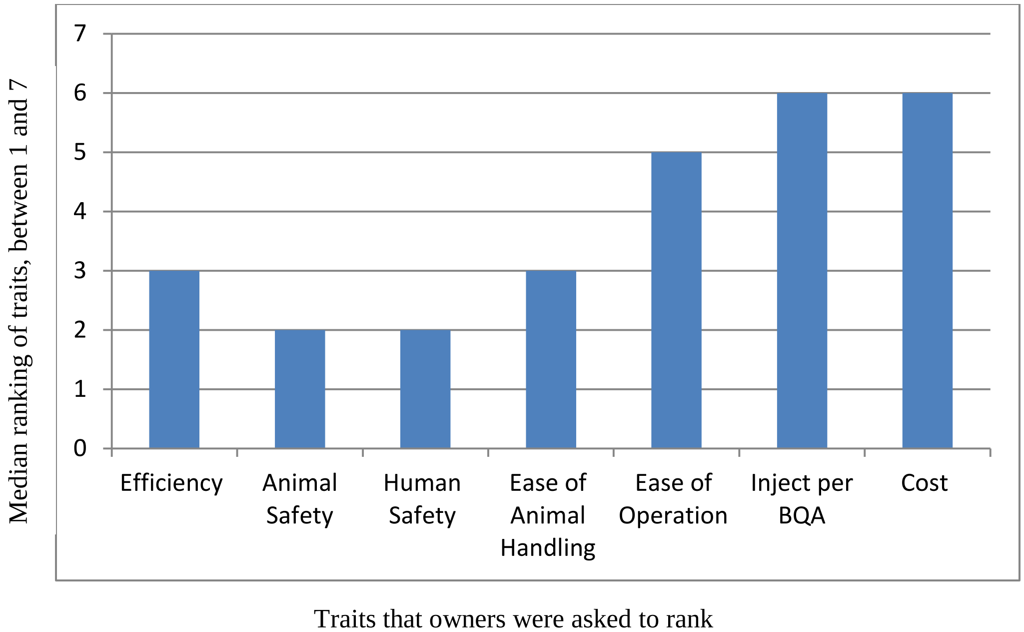

Figure 2.2 Median responses of dairy owners when ranking traits of a new handling facility in order of importance, between 1 and 7, with 1 being important and 7 being of least importance.

The majority of owners (60%, n = 12) reported low milk production as the number one reason for marketing cull cows, with the remaining 40% (n = 8) stating reproductive problems as the primary reason. Reproductive problems were ranked as the second reason for culling cows for 35% (n = 7) of respondents who didn't put it as their number one reason, and 20% (n = 4) ranked low milk production as the second reason for culling of those who didn't put it as their number one reason. Additionally, 25% (n = 5) reported mastitis and 20% (n = 4) chose lameness as their second most common reason for sending cull cows to market. When asked about the preferred channel for marketing their cull cows, 40% (n = 8) stated that they send all cull cows to the sale barn (auction market), while the other 60% (n = 12) reported utilizing both the auction market as well as direct sale to the slaughter plant. When asked about the handling of cull cows, 50% of producers stated that they handle cull cows differently depending on the animal's destination (slaughter plant or auction house), which was dependent upon the reason for culling.

The general consensus was that weaker cows were sent directly to the packer, with the other animals going to the auction. Half of the owners surveyed reported receiving at least one carcass discount or condemnation in the past 12 months, with the leading reason of condemnation at the packing plant being due to cancer. The average age of cull cows for Colorado dairies surveyed was 4.28 years. Dairy owners estimated the average annual income from the sale of cull cows to be 4.55% of all dairy income.

The survey was also designed to assess DBQA practices, along with any discrepancies between owners and herd personnel. Table 2.1 shows the percentage of positive responses for both owners and herds-personnel, to a series of questions pertaining to animal and worker injuries, BQA procedures, and record keeping.

Table 2.1 Percentage of positive responses, illustrating potential differences between Colorado dairy owner and herds-personnel

	Owner	n	Herdsperson	n	*P*
Have any workers been injured in the last 12 months?	0%	18	33%	15	0.013[a]
Have any animals been injured in the last 12 months?	33%	18	47%	15	0.493
Are there Standard Operating Procedures for BQA?	85%	20	64%	14	0.228
Are records kept on withdrawal times for all drugs administered?	100%	18	86%	14	0.184
Are cows with drug withdrawals isolated from others?	100%	18	93%	15	0.455

[a]A difference was found between owner and manager responses using the Fisher's Exact Test ($P < 0.05$)

The results presented allow for the comparison of owner and herdsperson responses. Similarly, both owners and herds-personnel were asked about medication administration practices (Table 2.2). Not all participants provided a response to the actual location of injections.

Table 2.2 Preferred and actual location of S.C., I.M., and I.V. injections as reported by Colorado dairy owners and herds-personnel

	Owner				Herds-personnel				*P*
	Neck	Rump	Both	n	Neck	Rump	Both	n	
Preferred SC	95%	0%	5%	19	93%	0%	7%	15	1.00[a]
Actual SC	53%	0%	47%	15	50%	8%	42%	12	0.68[a]
Preferred IM	79%	21%	0%	19	73%	27%	0%	15	1.00[a]
Actual IM	20%	33%	47%	15	25%	25%	50%	12	1.00[a]
Preferred IV	90%	5%	5%	19	87%	13%	0%	15	0.76[a]
Actual IV	80%	7%	13%	15	83.3%	8.3%	8.3%	12	1.00[a]

[a]No differences were found between owner and herds-personnel responses

DISCUSSION

According to the USDA (2008), the average dairy herd size in Colorado was 182.5 cows in 2006, which is substantially smaller than the median herd size of the current study. One can deduct that the average herd size has continued to increase since 2006, though it is doubtful that it has increased so dramatically as to coincide with the current study's findings. As the letter soliciting participants indicated that the goal of the survey was to assess the current use and needs of handling systems, it is possible that smaller dairies did not respond due to the lack of any substantial handling facility. Whatever the reason, it is possible that smaller dairies are underrepresented in the current study. The fact that the percentage of conventional dairies surveyed matched the percentage of dairy farms using antibiotics and reproductive hormones is expected, since the use of all antibiotics and hormones is prohibited on USDA certified organic dairies (USDA, 2012). The percentage of dairy farms using rBST in Colorado agrees with the national average of 15.2% reported by the USDA (2008).

As expected, the majority of operations surveyed used headlocks as a form of restraint on their facility, which coincides with previous findings by Wagner-Storch and Palmer (2002). As the stocking rates most ideal for effectively working cattle in headlocks allows enough room for every cow in a group to lock (Bickert et al., 2000), the producers with an average stocking percentage above 100% are not allowing for the most efficient handling system when working their cows in headlocks. Cows that are unable to lock due to the lack of an available space, or those that habitually avoid locking by eating in broken stanchions or towards the end of the pen where no locks exist, will have to be restrained in another manner, possibly being pushed out of the pen and worked through a separate facility, or being pinned between other animals. It should be noted that the average stocking percentage was for the whole herd, and that it is possible that the breeding pens (usually the pens worked most frequently) were not stocked above 100%. Stocking percentage practices were not examined in the current study.

The proportion of producers willing to install a management rail is quite similar to that of the proportion that currently have a rail on their operations, lending to the thought that those who are already using one would be more likely to install another in the future. This did tend to be the case, although there was one dairy owner who had both rails and headlocks on his/her operation who expressed his/her preference for headlocks; contrary to this, there were two producers who did not have management rails who stated they would consider building one in the future. The fact that the need to sort cows was a reason given by those who were not interested in installing a management rail was not surprising, as Wagner-Storch and Palmer (2002) had previously stated that producers preferred headlocks for that exact reason. With the majority of producers ranking human safety as first or second in importance when designing a new handling facility, one may expect that more producers would be interested in installing a management rail, since one of the reasons in favor of them was for the increased human safety. It is quite possible, however, that those who have never worked cows through a management rail are not aware of the improvement to human safety gained by using that type of facility.

Similar to the results of other studies investigating culling behavior of dairy producers, the most prevalent reasons for culling cows in Colorado were low milk production, reproductive problems, mastitis, and lameness. A study of dairies in the Northeast determined the leading causes of culling to be reproduction (20%), mastitis (15%), and low milk production (14%; Bascom and Young, 1998). A survey conducted by Rogers et al. (2004), which investigated the culling behavior on New Mexico dairies, found the predominant reasons producers culled cows to be low milk yield (31%), reproductive failures (25%), chronic mastitis (13%), deteriorating locomotion (9%), and disease and other health problems (8%). A similar study in Idaho determined the following reasons for culling cows: reproductive problems (30%), low milk production (28%), mastitis (25%), health concerns (14%), and feet and leg problems (13%; Glaze and Chahine, 2009). When asked about marketing cull cows, 60% of producers stated utilizing both auction markets and direct sale, which was similar to culling practices reported in previous studies (Rogers et al., 2004; Glaze and Chahine, 2009).

Dairy producers in Colorado overwhelmingly stated that the preferred location for administrating medications is in the neck region, although 80% of them reported that not all IM injections were always administered in that location, and roughly half (47%) stated that SQ injections were routinely administered in both the neck and rump area. The majority of producers

(90%) did state that all IV injections were given in the neck (jugular vein), though there were some who either preferred or saw no problem with injections being administered via the milk vein. Though previous studies have investigated the administration practices of medications on dairies, this is the first that has included data for preferred versus actual administration, illustrating the difference between the ideal situation and what is actually carried out in practice. In the current study, the percentage of injections being administered according to DBQA guidelines, in the neck region, was smaller than those found in previous studies. Glaze and Chahine (2009) conducted a study in Idaho investigating the beef quality assurance practices of dairy operations, and found that 59 to 87% of routine IM and SQ injections were administered following DBQA guidelines (Glaze and Chahine, 2009). In contrast, a similar study conducted in Pennsylvania reported that 65% of injections were administered in areas other than in the neck muscle, with the majority of them being given in the tail-head or hip/rump/flank areas (Tozer et al., 2005). These findings support the theory that, though they may be aware that all injections should be given in the neck region, most dairy producers are not concerned enough about BQA to ensure that all injections are actually given in that location.

One explanation as to why most dairy producers are not concerned about DBQA is the lack of an apparent incentive for them to follow the standards laid out by the Beef Quality Assurance program. The proportion of income derived from cull cows on Colorado dairies (4.55%) is only slightly higher than the average of 4% that has previously been reported (Roeber, 2003; Ahola et al., 2011). When only accounting for such a small amount of income there is little motivation for dairy producers to put more of an emphasis on DBQA. When asked how important they felt that the ability to administer injections according to BQA standards was when designing a new handling facility, the majority of producers (75%) ranked it last or second to last. One producer went so far as to rank all of the traits as first in priority, with the exception of BQA, which was ranked as not important. Another producer stated that “I am in the dairy industry and I have cows to produce milk, not to produce beef”. These statements make it apparent that BQA is not a priority of all dairies in Colorado.

Contrary to how some dairy producers feel, Ahola (2010) suggests that dairy cows are an important contributor to the nations beef supply, and that there is currently an opportunity for the dairy industry to take advantage of the increasing value of market cull cows, ultimately increasing their income from the sale of these animals. In order to accomplish this, however, producers must provide better quality carcasses with fewer defects, resulting in fewer discounts. As an increasing percentage of each dairy cow carcass is being fabricated into whole muscle and higher priced cuts, injection site blemishes prevent many dairy farmers from benefiting from this improved price (Ahola, 2010; Ahola et al., 2011). By following BQA guidelines and providing a better quality product at auction, dairy producers could see market cull cows accounting for much more than 4.55% of their annual income. In order for this to become a reality, however, dairy producers need to embrace the fact that they are producing more than just one product; they are producing many, including beef.

As with any industry, open communication between dairy ownership and management is an important step to a successful operation. There have been many critics who claim that as dairy operations get larger, owner involvement with the day to day operation has decreased. In order to investigate this theory, many questions were included in the current study to assess differences between owner and herdsperson responses, to determine if there is a lack of communication between those making the calls and those actually working in the pens with the animals. Of all of the questions asked there was only one difference found between the two groups. Interestingly enough still, it concerned human workers, and not dairy cows. All of the owners stated that no human workers had been injured while working with animals in the handling facility, whereas a third (33%) of the herdsmen confirmed that injuries had actually occurred in the area. It is possible that this difference is due to the severity of the injuries involved. It seems likely that in the case of an injury not requiring medical attention only the worker's immediate supervisor, the herdsperson, would be aware of the injury. Injuries not requiring paper work may not make it to the owner's attention, as minor injuries such as scrapes and bruises are commonplace when working in agriculture.

Caution must be taken when interpreting the lack of significance between differences in owner and herds-personnel responses, due to the small number of dairies willing to take part in the survey. Although there is no significant difference between the proportion of owners and herds-personnel who stated that there were standard operating procedures for BQA, there was a 21% difference between responses of the two groups. It might be expected that this difference would become significant when examined on a larger number of dairies. It can be argued that the more progressive dairies in which handling systems and beef quality assurance are a seen as a priority were the ones willing to participate in this survey. If this assumption is valid, trends seen in responses could be even stronger if responses were obtained from those dairies not interested in participating in this type of study.

CONCLUSIONS

The Colorado dairy industry is quite complex, with no two operations being the same. The differences in size, type (conventional versus organic), housing, and management practices are just a few of many. In spite of these differences, there were many similarities that emerged in this study's results. Most of the owners and herds-personnel agreed that the preferred location for IM and SQ injections was in the neck area, though a very small amount confirmed that 100% of injections were given in that area. This illustrates that a need does exist for a handling facility which allows for the safe and efficient administration of all medications in the neck of dairy cows, though dairy producers consistently ranked administering injections according to BQA standards as last in priority when designing a new handling facility. In order for DBQA protocols to become commonplace on a dairy operation, producers need the incentive to do so. An incentive does exist, however, but in order to take advantage of it the dairy industry needs to embrace that their animals produce more than just milk (and the according dairy products); they also produce beef. Dairy producers are the first step in many ensuring that the meat that comes from their operation is safe and satisfactory for consumers, and just as they are committed to producing safe and nutritious milk for their customers, they should be committed to producing the best quality meat as well. By making DBQA a priority, the dairy industry would not only be benefiting from increased profits from the sale of their cull cows, but would also be proactively improving their image, not only to those who have to process and package the meat product, but also to their consumers.

REFERENCES

Ahola, J. K. 2010. Are market dairy cows undervalued? Beef Issues Quarterly. 2(1):1-5

Ahola, J. K., H. A. Foster, D. L. VanOverbeke, K. S. Jensen, R. L. Wilson, J. B. Glaze, Jr., T. E. Fife, C. W. Gray, S. A. Nash, R. R. Panting, and N. R. Rimbey. 2011. Survey of quality defects in market beef and dairy cows and bulls sold through livestock auction markets in the Western United State: I. Incidence rates. J. Anim. Sci. 89:1474-1483

Bascom, S. S. and A. J. Young. 1998. A Summary of the Reasons Why Farmers Cull Cows. J. Dairy Sci. 81:2299-2305

Bickert, W. G., B. Holmes, K. Janni, D. Kammel, R. Stowell, and J. Zulovich. 2000. Special Handling and Treatment Facilities. Pages 65-74 in Dairy Freestall Housing and Equipment. 7th ed. Midwest Plan Service, Ames, IA.

Buttar, N. K., A. J. Young, and D. Bailey. 2006. Adoption of security systems by dairy farms to address bioterrorist threats in the Intermountain United States. J. Dairy Sci. 89:1822-1829

Glaze, J. B., Jr. and M. Chahine. 2009. Assessment of management of basic beef quality assurance practices on Idaho dairies. J. Dairy Sci. 92:1265-1271

Roeber, D. L. 2003. Meat Quality and Dairy Veterinary Practice. Proc. MN Dairy Health Conf. College of Vet. Med. Univ. Minn, St Paul, MN.

Rogers, C. A., A. C. Fitzgerald, M. A. Carr, B. R. Covey, J. D. Thomas, and M. L. Looper. 2004. On-Farm Management Decisions to Improve Beef Quality of Market Dairy Cows. J. Dairy Sci. 87:1558-1564

Tozer, P. R., G. A. Varga, W. R. Henning, and L. A. Holden. 2005. Do Dairy Producers Use Effective Management Practices to Improve the Value of Market Cows? The Prof. Anim. Scientist. 21:272-277

USDA. 2008. Dairy 2007 Part II: Changes in the U.S. Dairy Cattle Industry, 1991-2007. United States Department of Agriculture, APHIS-VS, CEAH. Fort Collins, CO.

USDA. 2012. National Organic Program: Organic Standards. United States Department of Agriculture, Agric. Marketing Serv. Washington, DC.

Wagner-Storch, A. M. and R. W. Palmer. 2002. Case Study: Animal Handling Procedures and Facilities Used by Dairy Producers to Conduct Health and Reproductive Examinations. The Prof. Anim. Scientist. 18:332-336

Chapter III: Using temperature-sensing reticular boluses to aid in the detection of production diseases in dairy cows

INTRODUCTION

Body temperature monitoring is a common practice employed on dairy farms as a way of detecting disease in dairy cows (Shutz and Bewley, 2009). Nakamura et al. (1983) describe body temperature as the single most useful measurable parameter and a sensitive indicator of the reactions of the animal to physico-environmental factors, disease processes, and physiologic functions such as nutrition, lactation, and reproduction. Common production disorders of dairy cows that can result in a deviation of the animal's body temperature from normal include metritis, mastitis, lameness, and pneumonia (Schutz and Bewley, 2009).

Metritis is considered to be one of the most common diseases afflicting dairy cows (Lewis, 1997). Puerperal metritis (PM) occurs within the first 21 DIM, involves all of the layers of the uterus, and is characterized by a fetid watery red-brown uterine discharge, accompanied by clinical signs such as decreased milk yield, dullness, or other signs of toxemia and a fever greater than 39.5°C (Sheldon et al., 2006; Benzaquen et al., 2007). When examining the impact of metritis on performance in following lactations, researchers have concluded that metritis results in economic losses due to decreased milk yield, reduced reproductive success, increased cull rates, and increased treatment costs (LeBlanc et al., 2002; Melendez et al., 2004, 2005).

Mastitis is thought to be the most costly disease in the dairy industry, with losses in the US totaling more than 2 billion dollars per year (Akers and Nickerson, 2011). Zhao and Lacasse (2008) define mastitis as an inflammation of the mammary gland, usually in response to an intramammary bacterial infection. Losses from mastitis are attributed to decreased milk production, increased labor, discarded milk, treatment and veterinary costs, diminished milk quality, decreased longevity, and increased culling rate (Colak et al., 2008; Akers and Nickerson, 2011).

Lameness has a considerable impact on the dairy industry due to economic losses and animal welfare issues related to the disease (Bicalho et al., 2009). Many producers employ visual locomotion scores to identify lame cows and assess the degree of lameness (Bicalho et al., 2007). Lameness has been defined by Kelton et al. (1998) as a cow with an abnormal gait attributable to either the foot or leg, regardless of etiology or duration. Economic losses due to lameness are associated with decreased milk yield, increased risk of culling, decreased fertility, increased veterinary costs, increased labor, and a prolonged calving interval (Juarez et al., 2003; Bicalho et al., 2009; Cha et al., 2010). Along with monetary losses, lameness is one of the most obvious animal welfare concerns plaguing the dairy industry due to the apparent pain and discomfort of the affected animals (Juarez et al., 2003; Vermut, 2007). Although not all etiologies of lameness produce an elevated body temperature, some common causes of lameness on dairy operations, such as foot rot, can be accompanied by a fever (Kausche and Robb, 2003).

Although pneumonia is not as prevalent amongst dairy cows as it is amongst beef cattle, it does have a significant economic impact on the dairy industry (Gorden and Plummer, 2010). Bovine respiratory disease (BRD) is a multifactorial disease with many different causative agents that results in a variety of clinical signs and economic implications (Bowland and Shewen, 2000; Snowder et al., 2006). While only responsible for 3.3% of all illnesses reported annually by dairy owners, respiratory disease accounts for 11.3% of all cow deaths, illustrating the importance of the disease in the dairy industry (USDA, 2007).

There are many different techniques employed in the dairy industry to aid in the detection of sick cows. Some of these methods include monitoring daily walking activity, milk yield, rectal temperatures and reticular temperatures (Edwards and Tozer, 2004; Bewley et al., 2008a; Colak et al., 2008; Wenz et al., 2011). Although it is not commonly used, monitoring walking activity is a method available for detecting dairy cow health disorders. While cows with some diseases demonstrate restricted movement, using walking activity alone may not be the best alert system as cows with other diseases have been found to be more active than the average cow prior to disease diagnosis (Edwards and Tozer, 2004). A popular method of identifying sick cows on many dairies is monitoring milk yield. Dairies that are equipped with milk meters in their parlors are able to quickly and easily identify cows that have experienced a deviation from their normal milk production, prompting dairy personnel to examine those cows further for illness (Edwards and Tozer, 2004). Once the technology is installed, using milk yield monitoring as an aid in the detection of dairy cow diseases is an excellent tool, as only cows that are in question will be examined. Drawbacks of this method include examining a cow unnecessarily after an inaccurate reading, missing information when a cow drops her head in the parlor and her measurement isn't recorded, along with the substantial input costs of installing the system.

Measuring body temperature using a rectal thermometer is the most common method employed on dairy farms to identify and survey sick cows, mainly because of ease of use and low input costs (Burfeind et al., 2010). A disadvantage of using rectal temperature to monitor herd health is the manpower required, as the process of measuring the temperature of each cow in a specific pen can be quite time consuming.

Monitoring cow health by using temperature-sensing reticular boluses (**TSRB**) is becoming more common on dairy operations due mainly to ease of use. The TSRB is administered orally to cows using a bolus gun. Once the TSRB has been placed, there is no other human intervention needed as the bolus will reside in the cow's reticulum and provide continuous temperature monitoring. It has been shown that reticular temperatures (**RT**) are strongly correlated with rectal temperatures, with RT being on average approximately 0.45 ±0.33°C greater than rectal temperatures (Bewley et al., 2008a). Previous studies have examined the influence of water consumption on reticular temperatures, but research is lacking on using TSRBs in monitoring cow health (Bewley et al., 2008b). The objective of this study was to investigate associations between increases in core temperature in cows and the diagnosis of metritis, mastitis, lameness, and pneumonia by dairy personnel. The purpose of the current study was to examine the feasibility of using a TSRB to aid in the early detection of common dairy cow diseases.

MATERIALS AND METHODS

Cows and Herd Management

The study examined data collected from May 10, 2010 to April 25, 2011, on a single commercial dairy farm consisting of approximately 2175 lactating Holstein cows in Colorado. Prior to calving, primiparous and multiparous cows were housed separately in dry lot pens. Dairy employees monitored cows on a daily basis, and moved those that appeared close to calving to the fresh pen. After calving, cows were housed in a postpartum pen until their milk was deemed salable (1 to 2 d), at which time they were moved into a fresh pen for approximately 35 days. Primiparous and multiparous cows were housed in separate postpartum pens. Throughout lactation, primiparous and multiparous cows remained separate and were housed in free stall barns, compost barns, or dry lot pens, depending on stage of lactation and reproductive status. Cows were fed a TMR and milked three times a day, with a rolling herd average of 67.7 pounds of milk per day throughout the course of the study, without the use of bovine somatotropin hormone.

A total of 705 health events were recorded during the study period. All identical events following the first occurrence of a disease for an individual cow were excluded from this study. Health events occurring within the first 7 DIM were excluded in order to remove the question of whether the temperature of the cow was due to the disease or due to the recent freshening event, with the exception of common fresh cow ailments (i.e. retained placenta, and metritis). Finally, health events were excluded from the analysis if 1 or more days of RT data were missing from the observational period, leaving 201 health events in the study. Of the 201 health events considered in the study, 109 were mastitis cases, 64 were lameness, 15 were reproductive disorders, and 13 were pneumonia.

Study Design and Definitions

A prospective case-control study was completed. At the time of calving (freshening), each cow in the study received a Wireless Battery Free Temperature Sensing Bolus (**WBFTSB**, DVM Systems, LLC, Greeley CO), which was administered orally using a bolus gun and came to rest in the reticulum of the cow. When the cow exited the milking parlor she passed a stationary panel reader, which served to power the bolus and obtain a temperature reading of the cow's core body temperature. The reticular temperature (RT) was then transferred to the bolus company's TempTrack® Software, where it was available for viewing and further analysis. The baseline for individual cows was calculated by averaging readings from the previous 10 days.

Readings taken around the same time of day and near 38.9°C (the modal temperature across all animals) were given more emphasis using proprietary algorithms developed by DVM Systems, LLC.

Case definition. Cases were defined as a cow diagnosed by farm personnel with one of the production diseases in question: mastitis, metritis, lameness or pneumonia. Cows were monitored daily until 12 DIM by farm personnel, using rectal temperature and rectal palpation to identify fresh cow health disorders. Cows with an elevated rectal temperature reading (>39.5°C) and an abnormal, foul smelling, vulvar discharge upon palpation were diagnosed with metritis. Mastitis was diagnosed by the observation of abnormal milk during foremilk stripping by the milking parlor staff, and lame cows were diagnosed visually, using locomotion scoring. Farm personnel identified cows diagnosed with pneumonia in the pens by performing a physical examination, which included rectal temperature.

Comparison group ("controls"). For mastitis, lameness, and pneumonia, cows were used as their own healthy controls if they had 37 days with no recorded disease prior to the week of their health event. RT data for the time period 31 to 37 d prior to the health event were used as healthy controls when examining the data for the 7 d prior to the health event, and RT for the time period 31 to 34 d prior to the health event were used as healthy controls when examining the data for the 4 d health event interval. A separate group of controls was selected for comparison purposes for cows diagnosed with metritis because their diagnosis occurred shortly after calving and no RT data was collected on them prior to freshening. The control group for metritis consisted of 63 cows (approximately 4 times the number of healthy cows as those diagnosed with a health event), and was chosen using the random number generator in Microsoft Excel 2010 (Microsoft®, Redmond, WA) from a group of cows that did not have a health event occur within 17 DIM. This was done in order to ensure that any temperature change was not influenced by calving.

Exposure status. A dichotomous variable was created to indicate the presence or not of an increase in cows' core temperature. When a deviation of 0.8°C (1.4°F) above baseline was observed, a "temperature increase" was recorded as 1 (yes), otherwise a 0 was recorded indicating no temperature increase. Increases in core body temperature were evaluated for two different timeframes: first we assessed associations between core body temperature increases within 7 d prior to the health event (and for 7 d among control cows), and secondly for a time frame of 4 d preceding the health event (and 4 d among control cows).

Data generated by the WBFTSB in cows enrolled in the study and gathered by the TempTrack® software was not available to the farm personnel during the first 60 DIM. All cows with a health event were identified by farm personnel as showing clinical signs corresponding to the diseases examined in the study. As farm personnel had no knowledge of temperature readings recorded by the WBFTSB, reticular temperatures were not used to identify cows with health events.

Data Management

Data for the date of calving and farm personnel-identified health events were obtained from the on-farm dairy management software (DHI-Plus, DHI Computing Service, Inc., Provo, UT). Reticular temperatures were collected using the WBFTSB and obtained from the bolus company's monitoring software (TempTrack® Software).

Statistical Analysis

SAS Version 9.3 (SAS version, SAS Institute Inc., Cary, NC) was used for data management and for the analysis. Associations between increases in core temperature readings by the RT and the presence of health related events were evaluated using standard cross tabulation (2x2 tables). Odd ratios were calculated and the Chi-squared and Fisher's exact test were used (when appropriate based on the data distribution) to evaluate associations between health events and core temperature readings for the two timeframes (4 and 7 d) in this study. Statistical significance was declared at $P < 0.05$.

RESULTS AND DISCUSSION

The associations between increases in core temperature in cows and the diagnosis of metritis, mastitis, lameness, and pneumonia by dairy personnel are shown in Table 3.1. Our results indicate that within a 4 d time frame previous to the diagnosis of a health event, cows with clinical mastitis have 6.7 times higher odds ($P < 0.001$) of having an increase in core body temperature compared to control cows (same cow in a time frame in which clinical mastitis was not diagnosed). Cows diagnosed with pneumonia have 7.5 times higher odds ($P = 0.047$) of having an increase in core body temperature than cows without pneumonia (Table 3.1). The majority of cows diagnosed with either mastitis or pneumonia (67% and 77% respectively) exhibited an increase in core body temperature (greater than 0.8°C above their baseline temperature), versus only 23% and 31% respectively of cows without mastitis and without pneumonia that showed signs of an elevated core body temperature (Table 3.1). When examining the 7 d leading up to diagnosis, mastitis cases had higher odds of having an increase in core temperature recorded (OR = 5.0; 95% CI = 2.7 to 9.4; $P < 0.001$) compared to the time in which no mastitis was observed. The relationship between cows with pneumonia and controls with temperature increases were identical to that observed in a 4 d period (Table 3.1).

Table 3.1. Data for 4 days prior to diagnosis of cows presenting with an increased reticular temperature (**RT**) of > 0.8°C above their baseline temperature and the presence or absence of mastitis, lameness, metritis, or pneumonia

Health Event		RT >0.8°C above baseline Yes	No	Proportion of RT >0.8° above baseline	Odds Ratio	*P*	95% OR CI
Mastitis	Present	73	36	67%	6.73[a]	<0.0001	3.55, 12.85
	Absent	25	83	23%	Ref		
Lameness	Present	13	51	20%	0.83	0.6690	0.33, 2.09
	Absent	15	49	23%	Ref		
Metritis	Present	10	5	67%	2.20	0.1847	0.60, 9.09
	Absent	30	33	48%	Ref		
Pneumonia	Present	10	3	77%	7.50[a]	0.0472	1.38, 40.59
	Absent	4	9	31%	Ref		

[a]Temperatures differ between cows when disease present or absent ($P < 0.05$).

There was no difference ($P = 0.67$) between the cows diagnosed as being lame and those that were not and the proportion of cows showing an increase in core body temperature in each group. The fact that only some causes of lameness are known to produce elevated body temperatures could explain these findings. Future studies involving a larger experimental group, in which lameness events are classified according to etiology and severity should provide more information on the potential benefits of core temperature monitoring in the early diagnosis of lameness in cattle.

Although Sheldon et al. (2006) have indicated that it is likely that a temperature greater than 39.5°C is associated with a cow that has metritis, in this study there was no difference (P = 0.18) between the proportion of cows with an increased temperature that were diagnosed with metritis and those with no health event. This is supported by others who found that not all cows suffering from metritis have an increase in core temperature (Palenik et al., 2009). In a study conducted by Benzaquen et al. (2006) 58.5% of cows with metritis did not have an increased temperature upon diagnosis. Similarly, other studies have indicated that temperature monitoring alone is not an adequate indicator of illness in fresh cows primarily because a high percentage of "healthy" cows have an elevated temperature following calving (Kristula et al., 2001; Wenz el al., 2010).

Due to the fact that core temperature was not measured until parturition, a baseline had not been properly established for postpartum cows as they were enrolled in the study and increases in body temperature during the first days of lactation could not be included in the data analysis. The authors recommend administering the temperature sensing bolus at dry off in order to obtain approximately two months of baseline core temperature and be able to better evaluate temperature changes in the peri- and postpartum period of each milking cow.

Because disease diagnoses were made by dairy personnel, it could be argued that there is a degree of uncertainty in the consistency among employees responsible for classifying cows into the various categories of disease examined in this report. It should also be stated that although dairy personnel did not have access to the RT data during the duration of the study, it is possible that those employees responsible for identifying sick animals became more aware of the health status of milking cows following bolus placement. If this were the case, it could be argued that dairy personnel were more aware and identified more sick animals than they would normally. As a result of this potentially increased awareness, the proportion of cows diagnosed with a health event may be higher than it would be under routine circumstances. Also, because health disorders were classified by body system affected and the resulting clinical signs and not by specific etiology, it is very possible that the value of increased core temperature as a predictor of disease caused by a specific agent wasn't apparent in this study. This could well be the case of lameness as a sign of disease. Future studies should focus on etiological agents and the likelihood of a fever prior to clinical signs of disease.

Although the normal body temperature of dairy cows is 38.6 ± 0.5°C, variation can occur between cows due to diurnal variations, activity level, estrus, and environmental conditions (Andersson and Jónasson, 1993). Being able to establish a baseline temperature, taking into account diurnal and environmental variations, allows for a more accurate assessment on the individual cow level (Lefcourt et al., 1999). Not every cow maintains the same core body temperature, making a defined cutoff for disease diagnosis difficult. A cow whose normal body temperature rests in the upper percentile of the normal temperature range, at 39.1°C, may be completely healthy yet be considered to possess a fever when her temperature is 39.5°C, potentially receiving unnecessary medical treatment. On the other hand, some cows maintain core body temperatures on the lower end of the accepted range, at 38.1°C. At 39.0°C these cows would have a fever, but would be considered normal and may not be treated for a disease that they did have, potentially resulting in increased treatment costs later, if the producer is using a cutoff point instead of a baseline measurement. Using individual cow baselines to monitor core body temperature removes the cow-to-cow variability and allows producers to manage herd health more efficiently while addressing each animal's status and needs individually.

Although not every cow with eleveated body temperature will have a health disorder, this study indicates that 67% of them did have an increase in core body temperature 4 d before the clinical diagnosis of mastitis, hence the importance of continuing this practice on dairy farms (Kristula et al., 2001; Wenz et al., 2010). A TSRB, such as the battery free one used in this study, can be a useful tool to aid dairy producers in monitoring their cows for deviations from the cow's baseline temperature and in the early diagnosis of health events. The bolus used in this study, the WBFTSB, lasts the life of the cow since it is battery free, while other TSRBs may be powered by a battery and only transmits temperatures for the life of the battery. Using a TSRB allows producers to employ a relatively non-invasive means of monitoring temperature while removing external manipulating factors, reducing the stress on the animals as restraint is not necessary to measure body temperature, and decreasing labor efforts (Hicks et al., 2001; Bewley et al., 2008). Concerns related with using a TSRB include the initial monetary inputs required for system installation, along with the decrease in reticular temperature that occurs when a cow drinks water just prior to temperature reading (Bewley et al., 2008).

Once the TSRB has been placed, the producer is able to closely monitor cows that are at high risk for increased body temperature, such as cows in the hospital and fresh pens, along with cows that are in the milking pens, which would not normally be monitored in this way. The benefits of having a TSRB in fresh and hospital cows is apparent, as most operations monitor their fresh cows on a daily basis and a TSRB removes the need for farm personnel to manually measure the temperature of each cow; however, the benefits gained in the milking pens are less obvious. Results from this study indicate that prior to being diagnosed with pneumonia or mastitis, a cow is likely to have a fever. Examination of these cows at the onset of fever could allow for earlier disease diagnosis and potentially lead to a more timely treatment and quicker recovery and return to the milking system, thus reducing the economic impact of the disease. Although not every cow with elevated body temperature will have a health disorder, the probability that she will is high enough to warrant an examination by farm personnel for other signs of disease. For example in the case of mastitis, out of every 3 cows with a fever that are examined, approximately 2 will have mastitis, and 1 will not, allowing the 2 cows with mastitis to receive prompt treatment. False positive cows (those with a fever, but without clinical mastitis) should be examined for signs of other diseases.

The authors agree that although the TSRB can be a helpful tool in the management of dairy cow health, dairy personnel should not rely on this tool as a sole method for the identification of sick cows. No single measurement should replace careful observation and husbandry practices that promote early disease identification and prompt and appropriate treatment of ill animals; however, a TSRB could be used in conjunction with daily observations and other diagnostic tools as a way to individually manage animals at risk of developing disease, increasing their chances of remaining in the herd as healthy and productive dairy cows. Associations between body temperature measured by TSBR and its ability to assist in the early detection of illness among dairy cows should be further investigated to determine if the results of this study in one dairy are consistent in a larger dairy population sample when controlling for potential confounding factors at the animal, herd and working personnel level.

CONCLUSIONS

Temperature monitoring is a useful practice to aid in the early detection of dairy cow diseases. Incorporating a TSRB into the health monitoring program is likely to improve disease detection and overall herd health on commercial dairy farms. Placing the TSRB at dry off would allow an adequate baseline temperature to be established for each cow prior to calving, enabling dairy personnel to easily monitor changes in body temperature, examining those cows that present an increase in RT. Although not every cow with an increase in temperature from its baseline will be diagnosed with an illness, it is important that cows with an elevated RT are examined. By including a TSRB monitoring system on their facility, producers would be adding one more tool to their herd health tool-belt; one that will promote close monitoring of individual dairy cows and aid in the prompt identification and treatment of cows that are diagnosed with common production diseases.

REFERENCES

Akers, R. M., and S. C. Nickerson. 2011. Mastitis and its Impact on Structure and Function in the Ruminant Mammary Gland. J. Mammary Gland Biol. Neoplasia. 16:275-289.

Benzaquen, M. E., C. A. Risco, L. F. Archbald, P. Melendez, M. J. Thatcher, and W. W. Thatcher. 2007. Rectal Temperature, Calving-Related Factors, and the Incidence of Puerperal Metritis in Postpartum Dairy Cows. J. Dairy Sci. 90:2804-2814.

Bewley, J. M., M. E. Einstein, M. W. Grott, and M. M. Schutz. 2008a. Comparison of Reticular and Rectal Core Body Temperature in Lactating Dairy Cows. J. Dairy Sci. 91:4661-4672.

Bewley, J. M., M. W. Grott, M. E. Einstein, and M. M. Schutz. 2008b. Impact of Intake Water Temperatures on Reticular Temperatures of Lactating Dairy Cows. J. Dairy Sci. 91:3880-3887.

Bicalho, R. C., S. H. Cheong, G. Cramer, and C. L. Guard. 2007. Association Between a Visual and an Automated Locomotion Score in Lactating Holstein Cows. J. Dairy Sci. 90:3294-3300.

Bicalho, R. C., V. S. Machado, and L. S. Caixeta. 2009. Lameness in dairy cattle: A debilitating disease or a disease of debilitated cattle? A cross-sectional study of lameness prevalence and thickness of the digital cushion. J. Dairy Sci. 92:3175-3184.

Bowland, S. L., and P. E. Shewen. 2000. Bovine respiratory disease: Commercial vaccines currently available in Canada. Can. Vet. J. 41:33-48.

Burfeind, O., M. A. G. von Keyserlingk, D. M. Weary, D. M. Veira, and W. Heuwieser. 2010. *Short Communication:* Repeatability of measure of rectal temperature in dairy cows. J. Dairy Sci. 93:624-627.

Cha, E., J. A. Hertl, D. Bar, and Y. T. Gröhn. 2010. The cost of different types of lameness in dairy cows calculated by dynamic programming. Prev. Vet. Med. 97:1-8.

Colak, A., B. Polat, Z. Okumus, M. Kaya, L. E. Yanmaz, and A. Hayirli. 2008. *Short Communication*: Early Detection of Mastitis Using Infrared Thermography in Dairy Cows. J. Dairy Sci. 91:4244-4248.

Edwards, J. L., and P. R. Tozer. 2004. Using Activity and Milk Yield as Predictors of Fresh Cow Disorders. J. Dairy Sci. 87:524-531.

Gordon, P. J., and P. Plummer. 2010. Control, Management, and Prevention of Bovine Respiratory Disease in Dairy Calves and Cows. Vet. Clin. Food Anim. 26:243-259.

Hicks, L. C., W. S. Hicks, R. A. Bucklin, J. K. Shearer, D. R. Bray, P. Soto, and V. Carvalho. 2001. Comparison of Methods of Measuring Deep Body Temperatures in Dairy Cows. Pages 432-438 in Livestock Environment VI: Proc. Of the 6th International Symposium. Louisville, KY.

Juarez, S. T., P. H. Robinson, E. J. DePeters, and E. O. Price. 2003. Impact of lameness on behavior and productivity of lactating Holstein cows. Appl. Anim. Behav. Sci. 83:1-14.

Kausche, F. M., and E. J. Robb. 2003. A Comprehensive Review of Ceftiofur Sodium and Hydrochloride Formulations for Treatment of Acute Bovine Foot Rot*. Vet. Therapeutics. 4(1):83-93

Kelton, D. F., K. D. Lissemore, and R. E. Martin. 1998. Recommendations for Recording and Calculating the Incidence of Selected Clinical Diseases of Dairy Cattle. J. Dairy Sci. 81:2502-2509.

Kristula, M., B. I. Smith, and A. Simeone. 2001 The use of daily postpartum rectal temperatures to select dairy cows for treatment with systemic antibiotics. Bovine Pract. 35:117-125

LeBlanc, S. J., T. F. Duffield, K. E. Leslie, K. G. Bateman, G. P. Keefe, J. S. Walton, and W. H. Johnson. 2002. Defining and Diagnosing Postpartum Clinical Endometritis and its Impact of Reproductive Performance in Dairy Cows. J. Dairy Sci. 85:2223-2236.

Lefcourt, A. M., J. B. Huntington, R. M. Akers, D. L. Wood, and L. Bitman. 1999. Circadian and ultradian rhythms of body temperature and peripheral concentrations of insulin and nitrogen in lactating dairy cows. Domest. Anim. Endocrinol. 16(1):41-55.

Lewis, G. S. 1997. Symposium: Health Problems of the Postpartum Cow. Uterine Health and Disorders. J. Dairy Sci. 80:984-994.

Melendez, P., J. McHale, J. Bartolome, L. F. Archbald, and G. A. Donovan. 2004. Uterine Involution and Fertility of Holstein Cows Subsequent to Early Postpartum $PGF_{2\alpha}$ Treatment for Acute Puerperal Metritis*. J. Dairy Sci. 87:3238-3246.

Melendez, P., and C. A. Risco. 2005. Management of Transition Cows to Optimize Reproductive Efficiency in Dairy Herds. Vet. Clin. Food Anim. 21:485-501.

Nakamura, R.M., C.T. Araki, N.L. Clarke, and L.W.G. Kam. 1983. Temperature telemetry studies in dairy cattle in hot climates. Pages 464-469 in National Conference on Agricultural Electronics Applications. Amer. Soc. of Ag. Eng., Chicago, IL.

Palenik, T., R. Dolezel, J. Kratochvil, S. Cech, J. Zajic, Z. Jan, and M. Vyskocil. 2009. Evaluation of rectal temperature in diagnosis of puerperal metritis in dairy cows. Vet. Med. 54(4):149-155.

Schutz, M. M., and J. M. Bewley. 2009. Implications in Changes in Core Body Temperature. Pages 39-54 in Tri-State Dairy Nutr. Conf. Proc. Columbus, OH

Sheldon, I. M., G. S. Lewis, S. LeBlanc, and R. O. Gilbert. 2006. Defining postpartum uterine disease in cattle. Theriogenology. 65:1516-1530.

Snowder, G. D., L. D. Van Vleck, L. V. Cundiff, and G. L. Bennet. 2006. Bovine respiratory disease in feedlot cattle: Environmental, genetic, and economic factors. J. Anim. Sci. 84:1999-2008.

USDA. 2007. Dairy 2007, Part I: Reference of Dairy Cattle Health and Management Practices in the United States, 2007. USDA-APHIS-VS, CEAH. Fort Collins, CO

Vermunt, J. J. 2007. Guest Editorial: One step closer to unraveling the pathophysiology of claw horn disruption: For the sake of the cows' welfare. The Vet. Journal. 174:219-220.

Wenz., J. R., D. A. Moore, and R. Kasinmanickam. 2011. Factors associated with the rectal temperature of Holstein dairy cows during the first 10 days in milk. J. Dairy Sci. 94:1864-1872.

Zhao, X., and P. Lacasse. 2008. Mammary tissue damage during bovine mastitis: Causes and control. J. Anim. Sci. 86:57-65.

Appendix 1:

Survey Instrument

Section to be answered by interviewing producer: Date: _______________

1. Total number of lactating cows: __________
2. Type of herd:

____closed ____open

____conventional ____organic ____natural

3. Cow housing:

____freestall barn with open lot
____freestall barn without open lot
____dry lot
Windbreaks? ____Yes ____No
Shades? ____Yes ____No
____compost barn

4. Average animals per pen: _____________

5. Pen stocking percentage: <50 50-75 75-100 100-125 >125

6. Milking parlor design:

____herringbone ____single ____double ____multiple
____parallel ____single ____double ____multiple
____rotary
Total number of milking stalls:_________

7. Restraint facilities
a. # of Restraint facilities ____
b. Types:
____headlocks
____palpation rail
____alley with head gate
____chute
____single file palpation stanchions
c. Design:
____outside
Roof or shade present? ____yes ____no
Are there any sides? ____yes ____no
If yes, how many? ____
____inside
Is the facility fully enclosed? ____yes ____no
Are animals able to see straight through facility? ____yes ____no
Is the facility properly lit? ____yes ____no
d. Is the restraining area used as intended? ____yes ____no
If "no" please explain why?____

____
____
____
8. Have you had issues with early morning or late afternoon sun when working in the restraining area? ___yes ____no
If "yes", please explain:____
____
____
____
9. How many workers use the restrain/management rail area? (per day/week/month)? ___________
10. In the last 12 months, how many workers got injured while handling animals in that area? ___________
11. Please describe the injuries: ____
____
____
____
12. What are the most common causes of injury in that area?__________________________
____
____
13. How many of the injured workers sought medical attention? _______
14. How many of the injured workers missed work? _______ How many days? ________
15. In the past 12 months, how many animals got injured in that area? ________
16. Please describe the injuries: ____
____
____
____
Additional Comments: ____
____
____
____
17. What is your current synchronization program? ___________________________________
18. Which of the following do you use on this operation? (choose all that apply)
____antimicrobial drugs
____reproductive hormones
____BST
19. What is the preferred location for the following?
Subcutaneous injections: ____
Intramuscular injections: ____
Intravenous injections: ____
20. Does the operation have standard operating procedures for Beef Quality Assurance?
____yes ____no
21. Do you offer training to employees about BQA? ____yes ____no
If "yes", which language is the training offered in? ____English ____Spanish ____Both
22. Do you keep records on withdrawal times for all drugs administered on the farm?
____yes ____no

22a. Where are cows with drug withdrawals housed? Are they isolated from other cows in the herd? How are they identified?________________________________

____

____

____

22b. How do you ensure that cows with milk withdrawal are not milked into the bulk tank?____

____

____

____

22c. How do you ensure that cows with meat and milk withdrawals are not sold for slaughter?____

____

____

____

23. What is the usual avenue for marketing cull cows?

____sale barn

____semi-load or trailer directly to slaughter plant

24. Do you dry off lactating cows before culling? ____yes ____no

25. Do you handle cull cows differently according to the reason for culling?

___yes ____no

If "yes", please explain:

____

____

____

26. Have you had any carcass discounts or condemnations reported from the purchaser of your cull cows in the last 12 months?

____yes ____no

If "yes", what were the reasons for deductions or condemnations?

____

____

____

27. Please rank the top 5 reasons for culling?

____Low milk production

____Mastitis

____Cancer

____Reproductive problems

____Lameness

____Johne's disease

____Displaced abomasum

____Injury

____Pneumonia

____Price of milk

____Price of beef

____Aggressive behavior
____Bloody gut
____Other ___________________________

28. What is the approximate percentage of the dairy income that is derived from cull cows? ______________

29. What is the average age of culled cows? ______________

30. What are the best and worst parts of your current animal restraint facilities?
____
____
____

31. Let's imagine that you are building new animal restraint for this operation:

31a. Would you consider building a management rail? ____Yes ____No

31b. Why or why not?____
____
____
____

(If answered yes for 31a, please complete 31c and 31d)

31c. Please rank the following traits according to how important they would be in the designing and planning of a management rail?

____Efficiency (animal throughput)
____Animal safety
____Human Safety
____Ease of animal handling
____Ease of operation
____Being able to inject animals according to dairy beef quality standards
____Cost

31d. How much (per head of lactating cows) would you be willing to spend on a management rail system that would satisfy the needs of the operation and possess all of the important characteristics ranked above? _______________

Section to be answered by interviewing manager/herdsman:

32. Restraint facilities
    a. Design:
        ____outside
            Roof or shade present? ____yes ____no
            Are there any sides? ____yes ____no
                If yes, how many? ____
        ____inside
            Is the facility fully enclosed? ____yes ____no
            Are animals able to see straight through facility? ____yes ____no
            Is the facility properly lit? ____yes ____no
    b. Is the restraining area used as intended? ____yes ____no
        If "no" please explain why?____
____
____
____

33. Have you had issues with early morning or late afternoon sun when working in the restraining area? ___yes ____no
If "yes", please explain:____
____
____
____

34. How many workers use the restrain/management rail area? (per day/week/month)?
____

35. In the last 12 months, how many workers got injured while handling animals in that area? __________

36. Please describe the injuries: ____
____
____
____

37. What are the most common causes of injury in that area?_____________________
____
____

38. In the past 12 months, how many animals got injured in that area? _________

39. Please describe the injuries: ____
____
____
____

Additional Comments: ____
____
____
____

40. What is the preferred location for the following?
    Subcutaneous injections: ____

Intramuscular injections: ____

Intravenous injections: ____

41. Does the operation have standard operating procedures for Beef Quality Assurance?

____yes ____no

42. Do you keep records on withdrawal times for all drugs administered on the farm?

____yes ____no

42a. Where are cows with drug withdrawals housed? Are they isolated from other cows in the herd? How are they identified?____________________________________
____
____
____

42b. How do you ensure that cows with milk withdrawal are not milked into the bulk tank?____
____
____
____

42c. How do you ensure that cows with meat and milk withdrawals are not sold for slaughter?____
____
____
____

43. Do you dry off lactating cows before culling? ____yes ____no

44. What are the best and worst parts of your current animal restraint facilities?
____
____
____

45. Please rank the following traits according to how important they would be in the designing and planning of a management rail?

____Efficiency (animal throughput)

____Animal safety

____Human Safety

____Ease of animal handling

____Ease of operation

____Being able to inject animals according to dairy beef quality standards

Appendix II:

Category listings for open-ended questions

Owner Responses

Question #8

1. No shade in the palpation area – cows hesitant to lock up
2. Cows do not lock up effectively in the winter
3. Anything weather related makes moving cows more difficult
4. Cows are hesitant to lock when the sun is shining in their eyes

Question #12

1. Gates – pinches etc.

Question #16

1. Chocked in headlock and died
2. Slips and falls
3. Cows jumping rails, but no serious injuries

Question #17

1. Double Ovsynch
2. Presynch-Ovsynch
3. $PGF_2\alpha$
4. Ovsynch
5. Heat Detection
6. G-7-G

Question #22a - Housing

1. Hospital pen
2. Locked hospital pen

Question #22a – Identification

1. Leg bands
2. Housed in hospital pen
3. Records
4. RFID/Computer alert

Category Classification

Question #8

1. Cows hesitant when sun in eyes (1 and d)
2. Cows hesitant in the winter (2)
3. All weather events makes moving cows more difficult (3)

Question #12

1. Gates – pinches etc. (1)

Question #16

1. Chocked in headlock and died (1)
2. Slips and Falls (2)
3. Cows jumping rails, but not serious injuries (3)

Question #17

1. Double Ovsynch (1)
2. Presynch-Ovsynch (2)
3. $PGF_2\alpha$ (3)
4. Ovsynch (4)
5. Heat Detection (5)
6. G-7-G (6)

Question #22a – Housing

1. Hospital pen (1)
2. Locked hospital pen (2)

Question #22a – Identification

1. Leg bands (1)
2. Housed in hospital pen (2)
3. Records (3)
4. RFID/Computer alert (4)

Question #22b

1. Housed and milked separately
2. Milked last
3. Test prior to clearance
4. Hospital pen locked
5. Milking of hospital barn supervised
6. RFID alerts
7. Leg bands
8. One worker in charge of moving cows from the hospital pen
9. Test bulk tank prior to shipping

Question #22b

1. Isolation (1, 2, and 4)
2. Testing (3 and 9)
3. Leg bands (7)
4. RFID/Computer alerts (4)
5. Management (5 and 8)

Question #22c

1. Records
2. Follow label strictly
3. Manager review's all cows prior to clearance for slaughter
4. Urine sampling
5. Delvo test for milk

Question #22c

1. Records (1)
2. Follow label strictly (2)
3. Management (3)
4. Testing (4 and 5)

Question #25

1. Sent to different places depending on reason for culling
2. Weak/Lame cows held in separate pen until sellable
3. Trailer loaded lighter for weak and lame cows

Question #25

1. Destination dependent on reason for culling (1)
2. Handling/housing different prior to culling (2)
3. Shipping practices dependent on reason for culling (3)

Question #26

1. Cancer
2. Sick
3. Non-ambulatory
4. Antibiotic residues
5. Too thin
6. Lame

Question #26

1. Cancer (1)
2. Sick (2)
3. Non-ambulatory (3)
4. Antibiotic residues (4)
5. Too thin (5)
6. Lame (6)

Question #30 – Pros of headlocks

1. Easy for everyday use
2. Self-locking
3. No sorting necessary
4. Cows remain in their pen, in their normal environment
5. Cows remain on feed
6. Animals remain quiet and easy to handle
7. Cows lock easily
8. Happy with locks

Question #30 – Pros of headlocks

1. Efficient (3)
2. Ease of handling (1, 2, 6, and 7)
3. Cow comfort/Low stress (4 and 5)
4. Happy with locks (8)

Question #30 – Pros of palpation rails

1. Cheaper
2. Handle a lot of cows quickly
3. Works well for drying cows
4. Shade present

Question #30 – Pros of palpation rails

1. Cheaper (1)
2. Efficient (2)
3. Works well for drying cows (3)
4. Shade present (4)

Question # 30 – Cons of headlocks

1. Maintenance
2. Cows able to move/swing
3. Not all cows lock
4. Difficult to examine the entire cow
5. Release of fallen cows difficult
6. Having cows locked in inclement weather

Question #30 – Cons of headlocks

1. Maintenance requirements (1)
2. Increased risk of human injury (2)
3. Not all cows lock (3)
4. Full examination of cow difficult (4)
5. Difficult to release fallen cows (5)
6. Increased time in inclement weather (6)

Question #30 – Cons of palpation rails

1. Sorting of cows necessary
2. Distance from pens
3. Dangerous for animals
4. Traction

Question #30 – Cons of palpation rails

1. Sorting of cows necessary (1)
2. Location – distance from pens (2)
3. Traction/Footing causes animals to fall (3 and 4)

Question #31b – Why

1. For cows that don't lock
2. Less labor
3. Efficient
4. Easier on the cow
5. Ease of use
6. Safer for workers
7. Decrease distance cows have to walk
8. Happy with current rails

Question #31b – Why not

1. Dislikes rails
2. Happy with current headlocks
3. Dairy size – not necessary
4. Stressful on cows
5. Not convinced of the benefits
6. Inefficiency of reproductive management
7. Holdings pens necessary – blocking other dairy movement

Question #33

1. Sun in employee's eyes
2. Cows more difficult to move in the summer, when it's hot

Question #36

1. Finger pinch

Question #37

1. Slips and falls
2. Human error
3. Kicked by cows

Question #31b – Why

1. For cows that don't lock (1)
2. Efficiency (2, 3 and 5)
3. Easier on cows (4 and 7)
4. Reduced risk of human injury (6)
5. Happy with current rails (8)
6. J
7. J
8. J

Question #31b – Why not

1. Dislikes rails (1 and 5)
2. Happy with current headlocks (2)
3. Stressful on cows (4)
4. Doesn't meet the needs of the operation (3 and 6)
5. Holding pens necessary – blocking other dairy movement (7)

Question #33

1. Sun in employee's eyes (1)
2. Cows more difficult to move in the summer, when it's hot (2)

Question #36

1. Finger pinch (1)

Question #37

1. Slips and falls (1)
2. Human error (2)
3. Kicked by cows (3)

Question #39

1. Slipped on concrete
2. Chocked in headlocks – died
3. Ducking underneath free-stall divider

Question #42a – Housing

1. Hospital pen
2. Locked hospital pen

Question #42a – Identification

1. Records
2. Leg bands
3. Housed in hospital pen

Question #42b

1. Housed and milked separately
2. Tested prior to clearance
3. Leg bands
4. RFID/Computer alerts
5. Records
6. Signage

Question #42c

1. Records
2. Follow labels strictly
3. Keep past label suggestions to ensure withdrawal met
4. Hospital managers "know" when cows have met withdrawal time

Question #39

1. Slipped on concrete (1)
2. Chocked in headlocks – died (2)
3. Ducking underneath free-stall divider (3)

Question #42a – Housing

1. Hospital pen (1)
2. Locked hospital pen (2)

Question #42a – Identification

1. Records (1)
2. Leg Bands (2)
3. Housed in hospital pen (3)

Question #42b

1. Isolation (1)
2. Testing (2)
3. Leg bands (3)
4. RFID/Computer alerts (4)
5. Records (5 and 6)

Question #42c

1. Records (1)
2. Follow label strictly (2)
3. Keep past label suggestions to ensure withdrawal met (3)
4. Management (4)

Question #44 – Pros of headlocks

1. Efficient
2. Cow comfort
3. No sorting necessary
4. Cows restrained properly
5. Easy to administer injections
6. All task able to be completed
7. Cows lock easily
8. Safer for cows
9. Happy with current headlocks

Question #44 – Pros of palpation rails

1. Ease of use
2. Safer for workers
3. Efficient
4. Happy with current rails

Question #44 – Cons of headlocks

1. Maintenance
2. Not all cows lock
3. Cows slip/fall when locking up
4. Not protected from the elements

Question #44 – Cons of palpation rails

1. Not efficient when no sort gate present
2. Not conducive to cow comfort
3. Not easy to load
4. Not protected from the elements

Question #44 – Pros of headlocks

1. Efficient (1 and 3)
2. Ease of handling (4, 5, 6 and 7)
3. Cow comfort/Low stress (2 and 8)
4. Happy with current headlocks (9)

Question #44 – Pros of palpation rails

1. Efficient (1 and 3)
2. Reduced risk of human injury (2)
3. Happy with current rails (4)

Question #44 – Cons of headlocks

1. Maintenance requirements (1)
2. Not all cows lock (2)
3. Cows slip/fall when locking up (3)
4. Not protected from the elements (4)

Question #44 – Cons of palpation rails

1. Not efficient when no sort gate present (1)
2. Not conducive to cow comfort (2)
3. Not easy to load (3)
4. Not protected from the elements (4)