A Literature Review on Injection-site Lesions in Dairy Cows and Culling Decisions

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Abstract

Currently dairy producers face particular problems concerning their culled cows and bulls, these problems must be addressed so dairy producers have the opportunity to improve the quality of beef produced from their cull dairy cows. At the moment, not much is known about culling decisions outside “break-even” numbers and poor cow conditioning. This literature review outlines the strategy behind culling decisions and looks into potential plans to develop progressive body conditioning and quality of meat sent to auction. Currently the dairy industry is not placing much demand into providing the livestock auctions and harvest plants with higher quality meat. This is due to the low level of economic importance culling is to dairy producers. Dairy producers must develop a stigma surrounding culling and start to place more care into these cows that are on their way out of the herd. National Market Cow and Bull Beef Quality Audits have done a tremendous job at outlining the strengths and weaknesses of the current dairy industry and develop clear directions for improvement.

Another large issue in the dairy industry is injection-site lesions, dairy cows are very prone to developing these lesions because dairymen look at production numbers and health of their cows before the culling in the future. Injection-site lesions are one of the main concerns when dairy cows are harvested, the amount of trim loss directly associates to lower quality of meat and decreased value. Informing dairy producers of the detrimental impact injection-site lesions have on carcasses can lead to a decreased number of lesions, which will result in a higher quality of meat. 11% of dairy cows reported of containing injection-site lesions (National Cattlemen’s Beef Association,

2007). These numbers have decreased throughout the past couple of decades, but further education must be provided.

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Introduction

National Market Cow and Bull Beef Quality Audits have been performed three times in the past twenty years. With each audit, more information is released to the dairy and beef industry's outlining the current status, pros and cons, and future goals for the industries. The first audit was performed in 1994, the purpose was to develop strategies for improving quality and minimizing economic losses. With each report performed by the National Cattlemen's Beef Association shows points of improvement within each subsection of the industries. One section of the dairy industry that continuously draws emphasis on is improving the cattle care and culling strategies. Each year devastating economic losses come from cull cows and bulls at slaughter. Bruises, antibiotic residue, arthritic joints, carcass trim loss, body conditioning and lameness, and high condemnation rates are examples of devastating economic losses to dairies.. Injection-site lesions are not well documented, which may be due to the relatively minimal economic impact culling cows and bulls have on the overall income for dairies. The 1999 U.S. Market Cattle Audit concluded quality defects cost about $70 for every cow or bull marketed that year, which was about 15% of the total cash return to the producer. (Roeber et al., 1999). When the 2007 National Market Cow and Bull Audit was released the number of quality defects decreased, however, still resulted in substantial economic losses. These defect numbers included a decrease in visible knots in the round from 1999 to 2007 (4.2% in 1999 to .7% in 2007). There was an increase in incidences of visible knots in the neck area from .6% in 1999 to 8.8% in 2007. These numbers correlate to the percentage of injection-site lesions. In that same audit, it showed 11% of dairy cows had

lesions, measured into small, medium and large scale; 2% minor injection site lesions (resulting in trim less than one pound), 4% medium size lesion (size between golf ball and softball), 3% had major lesions (larger than a softball, requiring substantial trim loss), and 2% extreme (results in trimming almost the entire primal cut) (National Cattlemen's Beef Association, 2007). Although these numbers have decreased since the 1999 audit, it is clearly apparent that work needs to be done on minimizing these detrimental trim losses.

The decision behind when to cull was also looked into, culling only accounts for an estimated 4% of a dairy producer's overall income, while 90-95% of the total dairy income for dairies is from the sale of the fluid milk. (Lehenbauer and Oltjen, 1998). The decision to cull involves a variance of factors that all add up to a proper time for the dairy producer to choose to cull.

Along with injection-site lesions, cow comfort is of the upmost importance to running a successful, highly productive dairy. Body conditioning (BCS), lameness, and bruising are the major factors that result in loss at the processing plant. With approximately 49% of dairy cows evaluated prior to slaughter were lame this should be alarming to both the dairy and beef industry(California Beef Council, 2008). A low body conditioning score can result in increased bruising, more likely to become "downers," and produce a lower-quality carcass. Downer cows are cows that on examination ought to rise but doesn't. There are many causes of a downer cow including, trauma, bone fracture or nerve paralysis, milk fever, metritis or mastitis. All these factors result in decreased yield and lower quality beef to the consumers.

Literature Review

Dairy Cows and Culling

When running a dairy, many things are on the owner's and manager's minds, it is crucial to stay on top of all aspects of the dairy such as, nutrition, calving, reproduction, and milk production. One aspect of dairying that must not be overlooked is cow comfort; with positive cow comfort strategies in place, it can correlate into success in all aspects of the dairy. Great cow comfort also leads to better quality of meat when it comes time to cull the animals from the herd. During the culling process a variance of factors add up to cause an impact to the dairymen's wallet. The 1999 National Market Cow and Bull Quality Audit outlined the several major factors that caused the dairymen economic loss. The audit averaged a loss of around $69 per head in the US. When looking into each factor that tallied up the loss, each problem can be improved upon and done fairly cheaply or with minor effort to receive positive results. Inadequate muscling and lightweight carcasses and trim loss were the two major factors that resulted in decreased profits in the culling process. The trim loss factor includes arthritic joints, bruises, and injection site lesions. Each of the trim loss problems can easily be avoided with safe and careful cow comfort. When talking to dairy industry experts, the majority of them would put cow and calf comfort as one of the top factors in creating a healthy and productive dairy. It is an area in every dairy that can improve on; it leads to so many various beneficial factors that can increase profits for all dairymen.

Body Conditioning Scores and Other Cow Comfort Factors

Thinness or fatness in cows can be a clue to underlying nutritional deficiencies, health problems, or improper herd management. If done on a regular basis, body condition scoring can be used to troubleshoot problems and improve the health and productivity of the dairy herd. Body condition scoring is an important management tool for maximizing milk production and reproductive efficiency. BCS scoring is based on a 5-point scale with 1 being very emaciated and 5 being abnormally fat. Ina survey conducted in 2007 by Hale et al. targeted a decent BCS range of 2.5 to 3.5, and in their study it included 58.8% of cows and 83.3% of bulls in the current survey. Dairy cattle in these categories evaluated during the National Market Cow and Bull Beef Quality Audit (NMCBBQA) in 2007 found an inadequate BCS of 2.0 or less was observed in 34.8% of market dairy cows and 10.4% of dairy bulls. (Hale et al., 2007) The numbers provided by the NMCBBQA prove to show the lack of importance dairymen are putting into body condition scoring and the amount of work that needs to be put into making sure these cows and bulls are being properly fed and maintained. With 34.8% of the cows in the audit showing a body condition score lower than 2.0; the problem needs to be addressed to the dairymen so they may find ways to improve the situation.

There are some key factors that need to be evaluated when managing and marketing cull cows. The factors that stand out to me include; Body conditioning and muscling, injection-site quality control, lameness and bruising, drug residues, and bio-security. Body conditioning is a major problem in the dairy industry, the Dairy Animal Care Quality Assurance audit reported that 63%of dairy cows had a body conditioning

score of 2.5 or less. When dairymen look at these records, not much importance is derived into increasing their herd average body conditioning score (BCS) if the cows are still producing high milk numbers. When it comes down to culling though the amount of money lost because of poor body conditioning is substantial. DACQA reported that cows within the 3.0 to 3.75 BCS produced the most valuable beef. When comparing the difference between a cow with a BCS of 2.0 and a cow with a BCS of 3.0, it is estimated that the value is about $140/head. With a low BCS the cow is more susceptible to bruising, more likely to become “downers” and also produce a lower-quality carcass. (California Beef Council, 2008).

Table 1. Major factors and estimated loss to bull's and cow's nationally. Source: 1999 National market cow and bull audit.

Item	Loss
Inadequate muscling and lightweight carcasses	$19.98
Trim Loss (arthritic joints, bruises, injection sites, etc.)	$14.40
Excess external fat	$10.17
Condemnations, residues, and disabled or "downer" cattle	$10.11
Yellow external fat and dark cutting muscle	$7.89
Hide value loss (brands, insects, etc.)	$6.27
Total Loss per Head	$68.82

Lameness and bruising are included in part of the trim loss factor when culling cows. Each of these factors can be avoided with sound dairy management practices. I

previously stated that bruising can easily occur when low body conditioning scores are apparent in the herd, cows that are too thin are also more prone to metabolic problems and diseases and have decreased milk yield. Studies indicate that cows with lower body condition scores and loss of weight have lower conception rates and decreased efficiency of heat detection, compared to cows that are gaining weight and have higher body condition scores. (Kellogg, 2010). The 2007 National Market Cow and Bull Beef Quality Audit found 51% of dairy cows to show no sign of lameness, with 4% of all the cattle in the research to receive scores of 4 and 5; this would qualify these animals as very disabled (National Cattlemen's Beef Association, 2007). Disappointing numbers were received with the 2007 audit. There was an increase of dairy cows considered lame, in 2007, 49% of dairy cows were lame, up from 39% in the 1999 audit (National Cattlemen's Beef Association, 2007). Dairy lameness correlates to loss in culling value and further hurt the pockets financially of dairymen.

In addition to economic losses, trimmings and bruises negatively affect meat quality and carcass value, they are indicators of compromised animal welfare practices which may include poor handling, harmful situations and potential pain and suffering (Strappini et al., 2013). The 2007 dairy cow and bull audit comprised the numbers of bruises found in their study. They found fewer cases of bruises than in the 1994 and 1999 audit, proving additional care and importance to cow welfare. The highest incidence of bruising in the dairy cattle was in the rump at 14% of the dairy cow carcasses, followed by 10% FPB, 6% loin, 3% rib, and 2% chuck. Although most of these bruises were determined to be minor and most likely accidental, the meat processor is still the one losing trim when bruises consistently are found, especially when it high value cuts are

bruised. For cattle, several potentially bruising events have been specified, such as inadequate design of the slaughter facilities (Weeks et al., 2002), forceful handling (Grandin, 2000), mounting and butting between animals (Warriss, 1990), especially during loading (Minka and Ayo, 2007), and rough driving during transport (Broom, 2003). The contribution of each of these potential bruising events to actual bruising of the carcass is not well documented. (Strappini et al., 2013).

Culling Decisions

When it becomes time to cull, these cows and bulls are on their way out and dairymen don't usually spend the time to care for them because they are very little value compared to the entire milking operation. In the US, an average of 30-35% of the cows are culled each year (Lehenbauer and Oltjen, 1998). Dairies cull their cows so rapidly because of the amount of work and stress that is put on these cows. Production numbers increase every year with new science and milking techniques are achieved. The reasoning behind the decision to cull cows is based on many factors. Dairies usually start with a list of milk production. Test day information through the dairy's computer program calculates a minimum value and a "break-even" production cutoff, to decide whether the individual cow is making a profit for the dairy (Lehenbauer and Oltjen, 1998). Next steps in determining the decision to cull or not is the stage of lactation, reproductive status and age of the cow (Lehenbauer and Oltjen, 1998). These "break-even" numbers are the main

factor to deciding when to cull, but day to day situations can manipulate when the right time to cull would be.

The current culling market has to deal with various types of cows with different physical situations. Most cows are the ones considered “target” cows by Imler et al., 2012, but other cows may include “bad image” cows and “fat” cows. A "fat" cow is culled for low milk production or reproductive inefficiency with a body condition score (BCS) of 5 (Scale 1-5; 1 = emaciated, 5 = obese). These are not as common on dairies, however still prevalent. A "bad image" cow is culled for poor health and/or lameness with multiple defects and a BCS of 1. These are the problem cows that need the most attention and directive action needs to take place. Around 20% of the cows culled each year fall under this category (Imler et al., 2012). The ideal cow is the “target” cow, these cows are culled for low milk production or reproductive inefficiency with no visible defects and a BCS of 3 (Imler et al., 2012). Below is a diagram that illustrates the endpoints of the culled cows.

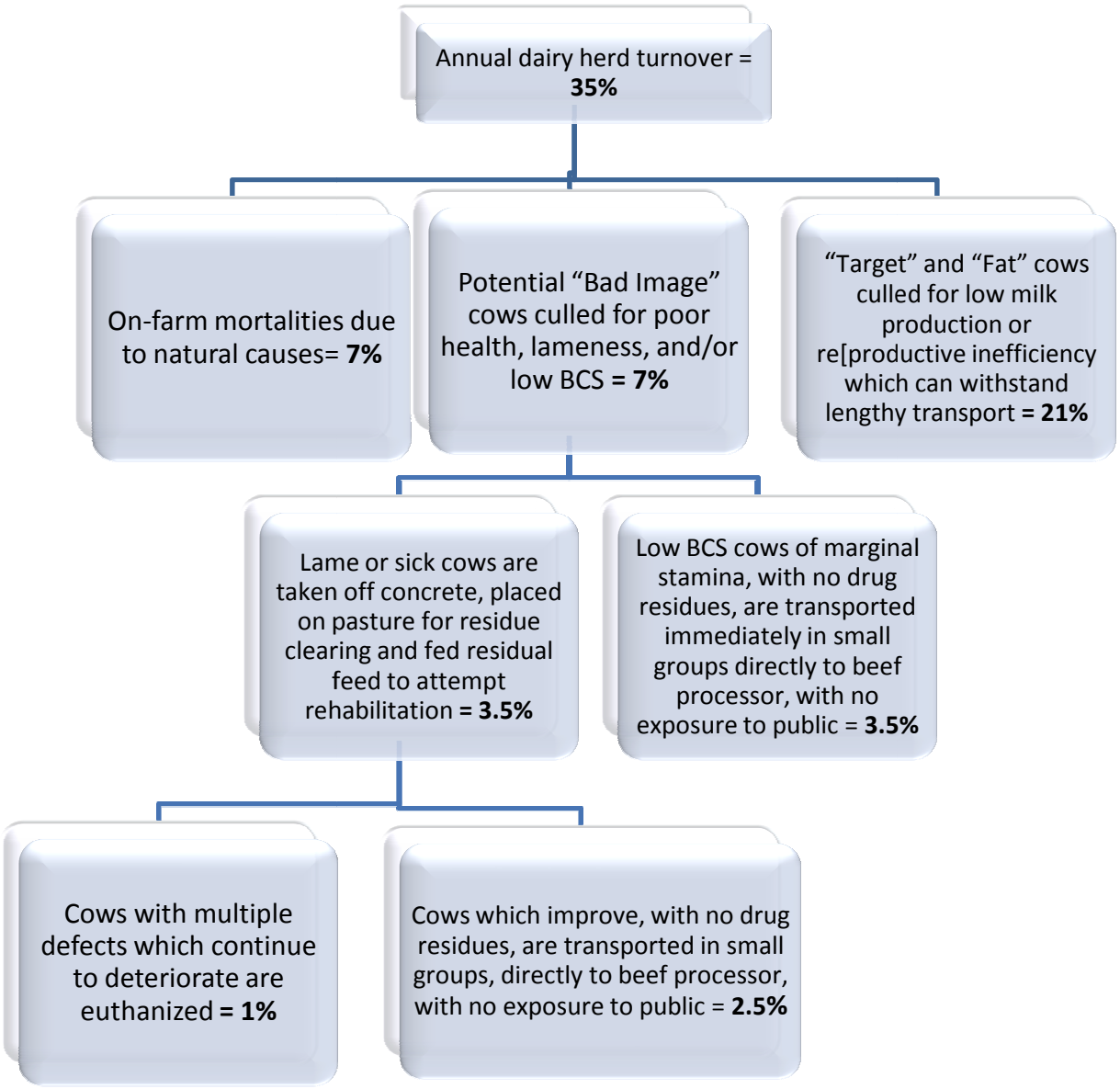

Figure 1.

A Diagram of realistic goals for cow endpoints within dairy herds annual.
*Source: Imler et al., 2012

The dairy industry must strive for improvement to the cows that are culled each year. With a percentage of cows deemed unacceptable to harvest due to lameness or sickness is inexcusable and must be addressed. The above figure illustrates rough estimates of the percentages of each type of cow culled, the "target" cow is what every dairy producer must strive to present to the market.

The University of Idaho conducted a survey for all the dairies in the state on Beef Quality Assurance program and their culling programs. The findings helped provide accurate demographics, BQA practices and dairy management and marketing practices. Within the survey it asked why cows are culled and percentages of each. The results found the average percentage of cows leaving the herd due to reproductive problems was 30% as the number one contributor, followed by low milk production (28%), mastitis (25%), health concerns (14%), and feet and leg problems (13%). (Chahine and Glaze Jr., 2009). The reason to cull also is determined by the economic situation at the time, after sitting down with John Draxler from JCJ Dairy in Hanford, CA he informed me of his decision behind when to cull. The outside variables that come with the decision to cull include feed price, the price for springer calves and replacement heifers and the price for beef. In addition to these outside variables, further consideration needs to take place for the stage of lactation, reproductive status and age of the cow (Lehenbauer and Oltjen, 1998). Many factors play into the decision to cull, thus creating a challenging and immensely important decision as to when to cull from the herd. The current price for beef and feed is quite high right now (January 2014), along with feed costs, the choice to cull seems very reasonable instead of choosing to treat her and keep her in the herd. The purpose of the report by Lehenbauer and Oltjen was to discover the importance of

economic elements in culling decision and assist managers and their decision making to cull.

The research done by Glaze and Chahine Jr., 2009, was to assess the management and practices on Idaho dairies. They wanted to find the economic impact that the beef quality in the dairy industry has in Idaho. These researchers found that beef quality inconsistencies and shortfalls is costing the dairy and beef industry in Idaho $68.82 for every market cow and bull. With dairies not familiar with the impact they are having on beef quality, numbers are assumed to be much higher in dairy cows and bulls. (Glaze and Chahine, 2009). Considering the numbers of dairy cows in Idaho, the total cost to the Idaho beef industry is estimated to exceed $9 million dollars. These shortfalls help drive the beef prices up and supply lower quality meat to the consumer. The dairies that were included in the Idaho study proved to at least be aware of Beef Quality Assurance techniques. When asked if any of the dairymen knew about BQA recommendations during animal care activities (injections, cow comfort, handling, etc.), 89% indicated that they were following those practices. Most of these dairymen are aware of BQA, but are still not implementing it into their entire operations. Even though 89% of the surveyors stated they followed BQA practices, injection site lesions and various trim loss factors are still popping up throughout the industry.

Traditional methods for culling start with the most recent test-day production numbers. If a cow is performing below a specified daily amount they are considered for culling. Production numbers is the biggest factor when looking to cull because 90-95% of the total dairy income for dairies is from the sale of the fluid milk (Lehenbauer and Oltjen, 1998). Genetic worth can further be considered for when to cull, this may

including the contribution to herd value, such as pedigree information, the percentage of herd mature equivalent production, or ranking of the particular cow in a listing of estimated relative producing ability. Additionally, individual cow attributes are often taken into account, such as the existence of chronic health problems or specific conformational defects. (Lehenbauer and Oltjen, 1998). The variance in factors that can be involved in the culling decision also make it challenging for dairymen to decide when the optimum time it would be to cull a cow from the herd.

Culling cows needs to become a main focus for economic decision making on dairies. Sole profit is a necessary building block to determine a dairy's current financial standing, with cash flow being an easy figure determining the short run profits. This cash flow is what assists the dairymen in their decision to cull a cow as a non-fed beef animal and replace with a heifer. The short run negative cash flow might seem detrimental to the herd, but the future profits can easily out run the short term loss (Lehenbauer and Oltjen, 1998). Current market standings are a huge factor in determining a good time to send cows to harvest, even though the study created long and tedious mathematical equations for solving culling decisions, to a dairymen they usually will look at price of beef and compare it to price of replacement heifers. Further understanding Lehenbauer and Oltjen's formulas can better a dairymen's economical decision behind culling, however, the likelihood of dairymen being able to perform and implement the equations done by this study are highly doubtful.

The main focus on the dairy is producing fluid milk, however, around 4% of a dairymen's revenue is from the sale of culled cows and bulls (Smith, 2001). These numbers would justify why there is very little emphasis in determining when and why to

cull in the herd. Looking at a big perspective, losing 4% of profits due to mishandling or death loss can become a detrimental impact on profit. Financial incentives can easily be noticed if the dairymen are well informed on the ability to gain profits from minimizing shortcomings such as defects in herd health, monitoring and implementing protocol to herd health and marketing and salvaging culled cows at the optimum time. (Smith, 2001)

Unfortunately, market cows and bulls are believed to be "junk" meat and to be used only for sausage and inexpensive hamburger meat. With this mentality, dairymen do not put in the effort to maximize quality because of the belief that their cows can't be sold for much value. The 1999 National Market Cow and Bull Beef Quality Audit reported that 43.6% of cow and bull beef was sold as 100% Visual Lean (for use in restructured beef roasts) or as primal/sub primal (for sale as steaks/roasts in supermarkets and food-service operations (Smith, 2001). A very large portion of beef from dairy cattle is sent to supermarkets and restaurants, improving quality in the cows culled can increase these numbers and increase profits if dairymen provide a way to improve the quality of meat in their culled cows.

There are programs available that can assist dairy producers in making the correct decision when to cull. DairyBeef: Maximizing Quality and Profits (http://dairybeef.ucdavis.edu) is a modular, distance learning program that focuses on three aspects to the current dairy beef in the U.S., the program wants to improve the quality, increase the profitability, and maintain the integrity of dairy cattle going to slaughter (Moore et al., 2004). The focus should be on education with these producers, in 1998, the USDA Food Safety Inspection Service and the Livestock Conservation Institute conducted educational programs for producers, veterinarians, and others on "Surviving in

a HACCP World." The purpose was to focus on the implementations that can be put into place from the adoption of quality assurance programs to meet new demands by meat packers (USDA: Food Safety and Inspection Service, 1998). The dairy culling industry is not the most admired and glamorous positions, improvement on animal welfare and implementing proper handling and quality assurance programs can benefit the industry tremendously and improve the consumers' perception of meat processing.

Traceability and HAACP Plan for Cull Cows on Dairies

Traceability systems help processors isolate the source and extent of safety or quality-control problems, these systems or programs help minimize the production and distribution of unsafe or poor quality products, which in turn minimizes the potential for bad publicity, liability and recalls (Golan et al., 2004). Traceability is one of the finest parts of implementing a HAACP plan into an operation. The USDA published a final ruling on July 25, 1996 for food safety regulations pertaining to pathogen reduction and Hazard Analysis Critical Control Points (HAACP). (Stefan, 1997). These HAACP plans were to target harvest and processing facilities to become better aware of pathogen risk and the impacts it can have on one's operation and to protect the consumer. In recent time, HACCP programs have become a staple to the success of food production operations by implementing steps to provide structure, organization, formalization, planning, and demonstration. "New on-farm programs to reduce residues and pathogen

loads in market cattle must be developed and implemented by dairy producers to improve the quality of cattle going to slaughter (Moore et al., 2004)."

Drug residues can be easily prevalent in dairy cattle being culled if the producers do not allow the proper withdrawal times before sending them to market. The U.S. Food and Drug Administration (FDA) regulates the use of veterinary drugs in food-producing animals and sets tolerances for drug residue levels in animal-derived food products. Drug residues can be extremely detrimental to the beef industry, it is critical to follow label directions and proper withdrawal periods when drugs are administered. If animals are harvested without clearing the proper drug withdrawal time, it could lead to possible retention of animals due to these violations. Monitoring of these food products is performed to ensure that levels of drug residues are not present in the food supply (Mastovska et al., 2010).

The purpose of a HACCP program is to control critical points in food handling to prevent food safety problems. When implementing a HACCP plan it is essential to identify specific hazards and measures to ensure the safety of food. HACCP is based on prevention and reduces the reliance on end-product inspection and testing. Not only is HACCP preventing outbreaks and reliance on inspection and testing, but benefits by effectively using resources to timely respond to food safety concerns and save an immense amount of money throughout the food industry. In return, confidence in product is increased dramatically from farm to fork; the buyer's confidence can grow and a well-informed consumer results in market growth. By providing certain information on the background of cull cows and bulls, it may improve the marketability of these animals (Stefan, 1997).

The success of HACCP in the food harvesting and processing industries gives idea to implementing a similar program to the dairy industry especially for culling cows. By having such a program, the dairymen would be able to work within programs like DHI-Plus and Dairy Comp305 to gather analysis on the selection, timing and use of animal drugs. The documentation could provide assurance to harvesting facilities and further ensure the safety of product (Stefan, 1997). Dairy Comp305 and DHI-Plus currently allows the dairymen to look up withdrawal times and beefing dates along with the ability to identify current or potential problem areas when dealing with herd management (Lehenbauer and Oltjen, 1998). Injection-site lesions can be produced uniquely to pinpoint original source is a challenge to dairy producers and the meat processors. DairyComp305 and DHI-Plus have the ability to expand their programs to displaying more on injections. It can be as simple as stating where the injection took place, or by who administered the drug. Written records for every injection incidence could help trace injection-site lesions directly to the source instead of meat processors receiving carcasses with injection-site lesions that they were unaware of.

The seven principles of HACCP are: (1) hazard analysis, (2) critical control point identification, (3) establishment of critical limits, (4) monitoring procedures, (5) corrective actions, (6) record keeping, and (7) verification procedures (HACCP principles website). With these 7 principles, dairies can have the ability to take a closer look into their cull program and develop a better consensus and understanding to how they should run their program. In the case of injections, dairies can create a HACCP plan to include injection sites and complete documentation as of when and where the drug was administered. For the case of mastitis, implementing a HACCP program can benefit the

herd's health. By documenting the procedures performed, it leaves evidence of corrective actions performed. This can result in auctions and buyers of cull cows to develop and build enhanced reputations with the dairymen and proving the buyers of a particular dairy's quality assurance.

Marketing Cow Cull Feeding Program

Market cows and bulls are generally not viewed as a product to which value can be added to before slaughter. A study done by New Mexico state found that management strategies such as additional feeding can result in quality increase, decrease in antibiotic residues and carcass condemnation (Rogers et al., 2004). Developing a feeding program pre-culling has the ability to increase profits and quality. The study preformed included a 0 day, 30 day and 60 day feeding program, assessing average daily gain (ADG), body conditioning score (BCS), and carcass characteristics. The additional feeding protocol included a study with seventy-seven non lactating Holstein market cows from 4 commercial dairies in the Southwest. Each of the cows were administered an oral probiotic gel paste (30 g; RXV-BP-1 Bovine, AGRIpharm, Grapevine, TX) containing a bovine-specific mixture of bacteria. The cows that were fed on the 30-day or 60 –day feeding program were administered an intramammary treatment with cephapirin sodium (ToDAY®, Fort Dodge Animal Health, Fort Dodge, IA) to minimize udder infections during the feeding period (Rogers et al., 2004). To determine the antibiotic residue withdrawal time from meat tissue, the unhealthy cows were administered procaine penicillinG (1 mL/45 kgBWi.m.; Pfi-Pen G; Pfizer Animal Health, New York, NY;10-d

meat withdrawal) (Rogers et al., 2004). Daily urine tests were taken 2-days prior to recommended withdrawal time and were then continued till clearance of antibiotic residue was apparent by using the ELISA test (Rogers et al., 2004). The results found that having the cows on a 30-day or 60-day feeding protocol pre-culling provided an insignificant impact to quality of carcass by means of hot carcass weight (HCW); longissimus muscle area (LMA); percentage kidney, heart, and pelvic fat (%KPH); back fat thickness, and fat color of carcasses from market dairy cows fed 0, 30, or 60 days (Rogers et al., 2004) . In addition to the results not providing a significant quality impact, the cost of the feeding program would be detrimental to the dairies. The economic feasibility of feeding pre-culled cows is dependent on what time of the year, for this study, the mean price received from the sale of all market cows in the present study was $44/cwt of live body weight. The cows fed for 30 days gained an average of 3.1 lbs/day. With the market prices received during the experiment, the 30 extra days on feed would increase the value of the animal $1.23/day. However, the feed costs per cow were $2.34 resulting in a $1.11/day loss. (Rogers et al., 2004). The final phase in the study was the antibiotic withdrawal time. The studies found that out of the 62 cows administered the procaine penicillin G, 31% of the cows exceeded the 10 day label withdrawal recommendation by an average of 3.1 ± 1.9 days.

The study performed by New Mexico state university concluded that feeding market cows do not influence significant improvement in carcass quality, but can increase average daily gain and ensure antibiotic withdrawal time. It does not seem feasible to implement a feeding program on your dairy before the dairymen decides to cull his herd.

Dairy & Beef Quality Audit Summary

The 2007 National Market Cow and Bull Beef Quality Audit was released by the Beef Checkoff national program. The document summarizes research conducted in the beef and dairy industry to review the past, recognize the problems of today, and improve the quality of the future. The 2007 edition was comprised of 4 phases:

Phase I: researchers conducted audits in packing plants to identify quality defects in cows and bulls in receiving areas and holding pens, and in their carcasses on harvest floors and in chill coolers. Packing plants were audited for fabrication and traceability (National Cattlemen's Beef Association, 2007).

With each phase, the amount of contribution to the studies is tremendous, the packing plant phase of the audit was the result of the work of over 70 auditors, including faculty, staff and graduate students, as well as state beef council personnel and other members of the industry, working in collaboration with seven universities. The audit took place in 23 packing plants in 11 states. Collectively, these plants harvest more than 15,000 head per day. The audit surveyed approximately 5,500 live animals, 5,000 carcasses during harvest, and 3,000 carcasses in the coolers (National Cattlemen's Beef Association, 2007).

Phase II consisted of interviewing two people at each of the participating plants; one packer and one Food Safety Inspection Service (FSIS) employee. These interviews consisted of free response and aided questionnaires. The purpose of the interviews was to

determine improvements and declines in the quality of cattle since the 1999 audit (National Cattlemen's Beef Association, 2007).

In Phase III, the audits consisted of interviews with eight end users, looking specifically at sub primal defects, caps, bottom round flats, and top sirloin center cuts. They also looked for injection-site lesions and other defects that would cause devaluation (National Cattlemen's Beef Association, 2007)

In Phase IV, researchers, producers, packers, processors, retailers, restaurateurs, and government representatives met for a two-day workshop to discuss strategies and tactics to ensure continued quality and animal-handling improvements (National Cattlemen's Beef Association, 2007).

The Ahola et al. study went to 10 major livestock auction markets in Western United States and surveyed the quality defects in market beef and dairy cows and bulls. The purpose of this study was to provide more research on Beef Quality Assurance (BQA) issues related to the defects in dairy and beef cattle directly after leaving the farm or ranch. The purpose is to give a different perspective to quality defect incidence coming from a different step in the culling process. Most literature that has been published looks at quality defects in holding pens at packing plants (NCBA, 1994; Roeber et al., 2000; Delmore et al.,2006; Hale et al., 2007). The research was done from the viewpoints of the buyers, by doing so it provided both beneficial and detrimental evidence. The beneficial side to this design was to survey the livestock auctions in the same viewpoints as buyers to simulate actual buyer's visual ability when cattle were auctioned. The detrimental side of doing a survey in the viewpoint of the buyers is being able to evaluate the BQA-related

traits only from afar and not at a close distance (less than 6 meters). The data collectors couldn't make the most accurate evaluations when performing the study due to the distance they were at and the amount of time they were able to view the animal (approximately 20 seconds/lot) (Ahola et al., 2011).

Table 2. Incidence rates for Beef Quality Assurance (BQA) defects in market dairy cows and bulls evaluated at auction
*Source: (Ahola et al., 2011)

BQA defects	Percent of animals with defects (%)	
	Cows	Bulls
Foot abnormalities	0.37	0.57
Mastitis	3.01	---
Sore on knee	0.08	0.38
Sore on hip	0.49	0.57
Sore on hock	0.15	0.57
Visibly sick	2.95	1.15
No sale	1.48	---
Knot on neck	0.14	---
Knot on shoulder/rib	0.21	---
Knot on rump	0.09	---

Data were collected during 125 sales at 10 major livestock auction markets with regular weekly sales in California (n = 4), Idaho (n = 5), and Utah (n = 1)

Injection Site Lesions

What is an injection site lesion? It is the result of an intramuscular injection usually found in the rump or neck muscles. They are a result of an injected animal health product irritating and damaging the tissue and atrophied (shrunken) muscle fibers, leading to unappetizing scar and lesions in products fabricated in these particular areas (Belk, 2004). The tenderness of the meat can be impacted within a 3 inch diameter from the lesion (National Cattlemen's Beef Association, 2007). In rare occurrences, injection lesions can reach the consumer which can adversely affect the consumers' confidence in beef and reflect poorly on the beef industry as a whole. Injection site lesions can vary in appearance and are classified as either; clear, nodular, metallic, woody callus or cystic. Clear lesions and woody calluses are typical of injections given to animals in earlier stages of their life (as calves or at times before weaning), metallic and nodular lesions are typical of pharmaceuticals administered to cattle mid-to-late feeding phases, and cystic lesions are typical of injections given to cattle late in the finishing phase (Dexter et al., 1994; George et al., 1995a, 1995b). Injection site lesions are a problem in the meat industry due to the amount of trim they lose, the dairy industry is the least aware and the least worried about such things because it doesn't directly affect the industry. The works by each of these studies on injection site lesions is to provide the dairy and beef industry about the current impact financially it has. There has been much progress in the past 15 years on improving the problem, but much more knowledge needs to be brought forth and presented to better each of the industries.

Injection site lesions are one of the main factors in dairy beef, it affects the quality of meat and economic loss is substantial. In 1998, 31% of beef rounds and 60% of dairy rounds had injection site lesions. (Roeber et al., 2002). Before 2000's lesions were found regularly in dairy beef and was costing a vast amount of money. In the 1999 Beef and Dairy Cow and Bull Audit it was estimated that about $69 per head was lost for every cull cow and bull that was harvested in the U.S. (California Beef Council, 2008). Trim loss was at the forefront in production setbacks, averaging $14.40 per head, right behind inadequate muscling and lightweight carcasses, $19.98. Within the dairy industry in the U.S, 35% of dairy cattle are culled each year, when correlating the percent of cows culled to the amount of money lost from each cow or bull, in a 1,000 cow herd, the dairy is losing roughly $24,000 annually from problems at harvest (California Beef Council, 2008).

Two studies were reported on in the paper by Ahola et al., one survey was from 69 Pennsylvania dairy farms with an average respondent herd size of 250 cows (much smaller herd numbers compared to California averages: 1,000 herd average throughout California (Progressive Dairymen, 2010). The Pennsylvania dairy cows received an average of 19 ± 12.4 injections annually, and 65% of injections were not given in the neck (Tozer et al., 2004). Idaho dairies completed a similar survey of 759 Idaho dairies and categorized three herd sizes; small (n <201 cows: 53.5%), medium (n= 201 to 1,000 cows: 27.1%), and large herd size (n > 1,000: 19.4%). The Idaho study indicated that the neck region was used by 68% for intramuscular and 80% for subcutaneous injections in cows. (Glaze and Chahine, 2009). Much awareness has to be made across the country on injection sites and the dramatic consequences that comes with improper injections and

injection sites. Injection site lesions are most commonly found in the rump of dairy cows. Within the rump are high value and high quality cuts of beef such as $3.98/pound for rump roast and $6.99/pound rump steak natural averages for February 07-13, 2014 (USDA, 2013).

Table 3. Location of routine intramuscular injections in Idaho dairies
*Source: Glaze and Chahine 2009

Dairy Size	Neck (%)	Shoulder (%)	Upper rear leg (%)	Side or ribs (%)	Lower rear leg (%)	Tail-head (%)
Small (n = 139)	64.0	10.0	31.7	3.6	7.9	18.7
Medium (n = 74)	64.9	14.9	29.7	2.7	14.9	13.5
Large (n = 54)	87.0	11.1	18.5	0.0	13.0	22.2
	Small = <200 cows; medium = 201 to 1,000 cows; large = >1,000 cows.					

There has been much improvement on injection site location and I believe this is due to the overall effort that the beef industry has put into informing the dairy industry on the subject matter. Companies are now providing pamphlets and posters on proper injection sites and economic impacts it can have. For the case of the Idaho study, it seems that commercially, steps have been put in place amongst the dairies to take pride in their animals cow comfort and believe in the quality of their product they produce. The dairies that are incorporating new injection methods the most are the large scale dairies. I believe this is due to their efficiency and production skills that place them above the other sized dairies. The large scale dairies (>1,000) most likely have more standard operating procedures (SOP'S) in place because running on a larger scale takes a great deal of

management skill and efficiency. Herd management is essential to the success of dairies, Miguel Morales a veterinarian for Elanco Animal Health stated:

> "Today the success of dairies, heifer centers, calf operations, ag-business in general, results from the right people consistently doing the right things… Managers are faced with the challenge of attracting the right person and subsequently train, develop and retain employees able to perform their jobs" (Morales, 2014).

Having employees that are well disciplined and managed will result in better quality and production from their cows. This is also true with injection site lesions, a well-disciplined employee will understand the benefits and detrimental impacts the injections and the sites chosen may have on the cow, further educating employees will benefit the overall cows' health and comfort. The Idaho survey asked if individuals on the dairy giving injections were trained in doing so. For large scale dairies, the percentage of trained workers was 92.3%, which was much greater than smaller dairy operations (75.8%) of workers (Glaze and Chahine, 2009). It is a mindset that the industry must instill in dairymen to want to contribute and enhance both the dairy and beef industry.

Injections in Hind Quarter Study

Reasoning behind the frequent occurrence of dairy cattle being administered injections in the rump is due to the dairy layout. Most drugs are administered while the cows are in self-locking gates during feeding or in the milking parlor. Veterinarians and

dairy managers have easy access to the rump region during these times. A study by Roeber et al., 2002 was conducted on the frequency of injection-site lesions in the muscles from rounds of dairy cow carcasses.

> "Lesion location was recorded by the muscle (biceps femoris or semitendinosus) and the region or quadrant in which it was present. The quadrants were identified as Q1 through Q4. Quadrant Q4 was located at the cranial (or proximal) end of the primal cut (outside round) and contained only the biceps femoris muscle. The remaining three quadrants Q1, Q2, and Q3 were defined as even thirds of the remaining primal cut (containing both the biceps femoris and semitendinosus muscles) with Q3 adjacent to Q4, and with Q1 being the most caudal (or distal) third, at the shank end (Roeber et al., 2002)."

In the findings, injection lesions were found more frequently in the semi-membranosus muscles (Top (inside) round meat cut) (Q1 and Q2). Since 2001, the amount of injection administration in the rump has decreased significantly, resulting in the decrease of injection lesions found in the rump. (Roeber et al., 2002). The national cow and bull audit plays an important role on informing the dairy industry about injection-site lesions.

The 2007 National market cow and bull beef quality audit stated the incidence of knots in the round area decreased from 4.2% in 1999 to 0.7% in 2007. Although the increase of shoulder knots went drastically up, 0.6% in 1999 to 8.8% in 2007, it is evident that dairymen are learning of the drawback of administering injections in the rump area. Clearly noted, with the sharp rise in injection-site lesions in the shoulder, the dairymen have much to learn about proper injection techniques. They are demonstrating

improvement and understanding when administering drugs, the audits have shown success with connecting to the dairymen and it seems clear that people are adapting to change when presented the opportunity.

Below is a table depicting the types of lesions present in muscles from the rounds of cows, it can be noted that the consistency of each type of lesion is consistent through the years, besides the increase in clear lesions in 2000.

Table 4. Injection-site lesion frequency data, by kind of lesion, for all plants in 1998, 1999, 2000, as percentage of total lesions.
*Source Roeber et al., 2002 Frequency of injection site lesions in muscles from rounds

	Year		
Kind of Lesion	1998	1999	2000
Clear	50%	45%	67%
Woody	39%	46%	29%
Nodular	6%	7%	2%
Metallic	1%	NA	NA
Cystic	4%	2	2

Clear: Lesion containing primarily clear connective tissue.
Woody: Lesion characterized by infiltration with organized connective tissue and fat.
Nodular: Lesion with nodules, the central foci of necrosis, surrounded by granulomatous inflammation.
Metallic: Lesion containing mineralized remnants of muscle cells.
Cystic: Encapsulated lesion containing fluid.

NA: Frequency of lesions in this category for a given year accounted for less than 1 percent of all lesions identified.

With the rise in clear lesions in 2000 we can assume that people have become more aware of the effects injections have on the muscle in late stages of life for the cows, but unaware that injections admitted during time as calves and pre weaning still leave behind injection-site lesions. The clear and woody injection-site lesions are classified as "older" lesions, because they are composed of organized connective tissue and fat (woody callus) or of white fibrous scar tissue (clear scar). (Dexter et al., 1994). The problem with injection site lesions is that the only people that receive repercussions from the losses due to injection-site lesions are the meat processors. The calf ranches still receive the same amount of money no matter where the injections are administered. Same applies to the dairy farmers that send their cows off to livestock auctions and packing plants, as long as there are no visible signs of lesions, it is challenging for the packing plants to determine these lesions until post slaughter.

Table 5. Frequency of injection-site lesions in 1998, 1999, 2000
*Source Roeber et al., 2002. Frequency of injection site lesions in muscles from rounds

	Year		
	1998	1999	2000
Total pieces audited	243	586	666
Pieces with lesion(s)	146	299	230
Percent of rounds with lesion(s)	60	51	35
Number of lesions per piece with lesion (mean ± S.E.)	1.6 ± 1.3	1.6 ± 1.2	1.7 ± 1.2
Maximum lesions in one round	11	12	8

Injection lesions can occur and remain in the animal for a long period of time, injections administered to calves pre-weaning still can be detected at the final stages of life and thus leading to sufficient trim loss. (George et al. 1995). Injections lesions having the ability to continue throughout the lifetime of cattle impacts every process within the dairy industry. Dairy producers need to be praised for decreasing the number of injections going into the round, but further education is needed on the importance of proper injection site placement and the method of administration. Giving subcutaneous injections in the neck as opposed to the round area will further improve, and add value to the carcasses making them more profitable. This figure below shows the proper injection-site when administering drugs sub-cutaneous and intramuscular. Following this protocol helps reduce the amount of injection-site lesions, especially when you administer sub-cutaneous rather than intramuscular.

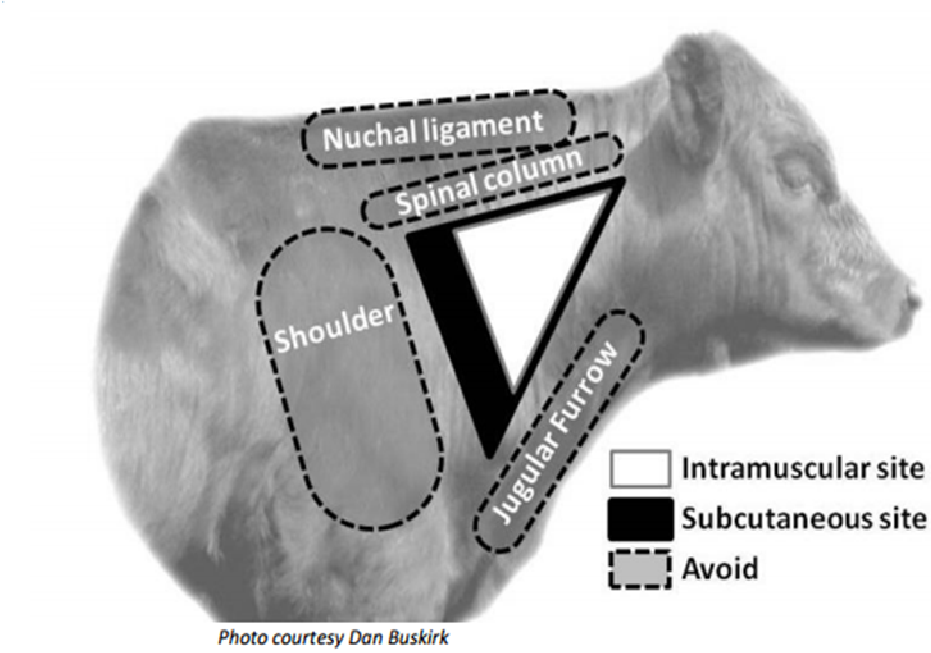

Figure 2. Proper injection site in neck
*Source:Beef Quality Assurance- Animal Health Records Manual

Intramuscular injection of dinoprost or GnRH in dairy cows on beef quality

A study performed at North Dakota State was looking into the tissue damage from the result of intramuscular injections of dinoprost and gonadotropin-releasing hormone. These drugs are commonly administered in dairies across the country and the purpose of such study was to provide evidence to the belief that intramuscular administered reproductive hormones still effect the quality of beef compared to vaccines and antimicrobial drugs (Fajt et al., 2011). The Warner-Bratzler shear force test is commonly used to determine the effect on the quality of meat. For this study, tissue damage was estimated by finding serum concentrations of the muscle enzyme creatine kinase (Fajt et al., 2011). Creatine kinase (CK) is a "leakage" enzyme present in high concentration in the cytoplasm of myocytes and responsible for maintaining energy homeostasis at the sites of high Adenosine TriPhosphate (ATP) (Dieni and Storey, 2009). The activity of CK found in plasma or serum is used to diagnose muscular damage in many species (Hornikova et al., 2009). When CK is found in the blood plasma it indicates muscle damage (Hornikova et al. 2009). Rupture of muscles causes the release of CK which is deposited into the blood (Vojtic, 2000). The blood concentrations of CK would help determine the amount of tissue damage done to the intramuscular injections. For this test, cows were injected once weekly semimembranosus or semitendinosus with dinoprost, GnRH, flunixin meglumine, saline solution, or needle alone. Each injection was then systematically rotated to avoid injecting in the same site (Fajt et al., 2011).

Table 6. Estimated grams of muscle damage associated with injection of reproductive hormone dinoprost (25 mg, 5 ml), and GnRH (100 µg, 2 ml), funixin meglumine (250 mg, 5 ml), saline solution (5 ml), and a 20 gauge needle into dairy cows only into the semimembranosus and semitendinosus muscles

*Source: Fajit et al., 2011

Injection	Estimated muscle damage ± SD, g
Dinoprost [1]	33.2 ± 5.2
GnRH [2]	15.5 ± 5.2
Flunixin [3]	32.5 ± 4.9
Saline	23.7 ± 4.9
Needle Only	11.9 ± 4.6

[1]Dinoprost (Pfizer Animal Health, Kalamazoo, MI), [2]GnRH (Merial, Deluth, GA), [3]Flunixin (Intervert/Schering-Plough, Summit NJ).

Blood samples (5 ml) were then collected via jugular vein immediately before injection and at 2, 4, 8, 24, 48, and 72 hours after injection. Samples were allowed to clot at room temperature and then centrifuged, the serum was then removed using a pipette and placed in a sterile polystyrene tube. (Fajt et al., 2011). After separation, serum was evaluated for CK concentrations using the VetTest 8008 Chemistry Analyzer (IDEXX Laboratories, Westbrook, ME) according to the manufacturer's instructions (Fajt et al., 2011). The results concluded greater estimated muscle tissue damage in the dinoprost and flunixin. Flunixin is a commonly known drug for developing extensive tissue damage, this made the drug a good control towards developing a consensus on how problematic GnRH and dinoprost injections were towards tissue damage. Some of the cows were

injected with only a needle and no substance, these results found that the needle was effecting the tissue damage marginally as expected. However, the findings also found that the GnRH injections resulted in similar findings compared to the needle only injections. This is good news for dairymen that work with GnRH on a regular basis, but it is important to realize that these injections are still causing tissue damage resulting in trim loss.

Conclusion

Dairy cattle producers have several opportunities to improve the quality of the meat the send to market. The problem with getting the producers on board with the idea of implanting change to their operations is challenging due to the minimal percentage of profits culled cows and bulls has compared to a dairy producers entire operations. Change must be made to further provide the meat industry and the consumer with a high quality product consistently. Drastic improvement has been made since the early 2000's with education on the impact of quality defects in dairy cows. With education, the producer's knowledge and understanding behind culling decisions and cow comfort result in adaptation to dairies to implement quality assurances within each operation. With three national beef quality audits coming out in 1994, 1999 and 2007, advancements have been made to culling decisions, injection-site lesions and proper cow comfort on dairies. These audits highlight the strengths and weakness in the dairy and beef industries to bring forth the evidence and facts on where the industry stands and how they can improve in the future.

The decision to cull cows on a dairy rely on various factors that all add up to decide the time to cull. Milk production numbers are usually the reason behind culling. And finding the break-even price in a cow plays the biggest economical factor in deciding to keep a cow in your herd. However, other factors can arise in the decision to cull earlier or later including stage of lactation, reproductive status, and age of the cow. The final factor is the economic status of the agriculture community. With high price in beef, the decision to cull is quicker, especially when feed prices are through the roof. When it comes time to cull though, it is important for the dairy producer to provide the

meat processors with a quality product that doesn't contain injection-site lesions, bruising, lameness, poor body conditioning, drug residues and various other factors. These quality defects are very prevalent in the dairy industry; the audits have done an excellent job in highlighting the defects and provide improvements to each category.

Injection-site lesions result in a decent trim loss to beef and especially dairy cattle. The insistences of the lesions in a dairy cows is 11% of all dairy cows sent to market. Although this percentage might seem small, the economic impact greatly affects the dairy and beef industry. In the research done by Glaze and Chahine, 2009, in Idaho alone the total cost to the beef industry is estimated to exceed $9 million dollars from dairy cattle's trim loss. Knowing when injection-site lesions occur can help the dairy and beef industry better understand the impact these dairy producers are having on the quality of meat. This puts more pressure on dairymen to administered drugs the proper way, whether that be choosing to administer sub-cutaneous or even choosing the proper injection-site, in the neck over the rump.

Transparency amongst the dairy producers and meat processors is the best way to improve the meat coming from these culled dairy cows and bulls. Although these dairymen sell their culled cows no matter the price, if the level of beef quality is raised amongst the dairy community, it may correlate to higher prices of beef for the dairymen's culled cows.

Major problems and losses occur in cull cows and bulls due to multiple cow comfort factors. Too many cows are not harvested in a timely manner; this could be the result of not efficient muscling and low body conditioning scores. The challenge with

selling cull cows that have low BCS is that it leads to bigger, more detrimental traits including bruising, disabled or “downer” cows, or condemned carcasses. The importance animal welfare should not stop once the decision to cull becomes prevalent on the dairy.

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