The Welfare of Cattle in Beef Production

A Summary of the Scientific Evidence

A Farm Sanctuary Report

1. Introduction

Beef cattle begin their lives as they always have – in pasture or on the range. What has changed significantly in recent years is the amount of time they spend there and what happens to them when they leave. At the beginning of the last century, steers were 4 or 5 years of age at slaughter. That dropped to 2 or 3 years by the 1950s, and to just 14 to 16 months today, only the first 6 to 8 months of which is spent grazing (60).

Today, after being weaned, cattle leave the farm or ranch for the feedlot to be fattened up for slaughter. Feedlots are virtual cattle cities, with up to 115,000 inhabitants – crowded, barren and filthy. Cattle exist crowded into pens with dozens of other animals, breathing in noxious fumes and standing or lying in mud and waste.

The enormous weight gain that allows a calf to go from 80 pounds at birth to 1,200 pounds within 14 months is accomplished with the use of a grain diet, protein supplements, antibiotics and growth hormones. The typical steer arrives at the feedlot weighing approximately 800 pounds and leaves about 6 months later, having eaten about 5,000 pounds of feed to gain about 600 pounds in weight.

To make cattle easier to handle during the fattening or "finishing" process they are subjected to mutilations, including castration and dehorning – almost always without the benefit of any pain relief. For identification purposes, many cattle are branded with a hot iron. They are also handled and moved by the application of aversive techniques, such as shouting, hitting and shocking with electrical prods. Cattle are trucked from farm to auction, from auction to feedlot and from feedlot to slaughter, on crowded, noisy vehicles without access to food and water or space to rest.

All these practices – weaning, grain feeding, mutilations, handling and transport – are capable of causing significant pain and distress to cattle. The practices, as well as the welfare problems that can result, are described in this report.

2. "Cow-Calf" and "Stocker" Operations

Beef cattle account for 78% of the total US cattle inventory of 95 million cattle and calves (88). These animals are found on some 775,000 operations (88). The number of cattle operations in the US has gradually declined since 1995, primarily as a result of the loss of small operations (1-49 head) and an increase in the population of beef cattle on larger operations (100+ head) (88). Operations of more than 100 head account for only 10% of all beef cattle operations but have more than half of the total US inventory of cattle (88).

Beef calves are typically born on ranches known as "cow-calf" operations and remain there with their mothers until they are weaned at approximately 6-7 months of age. At that point they may be moved directly to a feedlot, or they may be moved to a "stocker" operation where they are fed forage before being sent to a feedlot as yearlings (20).

2.1 Shelter & Environmental Conditions

Depending on the location of the ranch, cattle may be subjected to extreme weather conditions including intense heat and/or humidity, high winds or heavy rain and snow. Beef cattle are typically not provided with adequate shelter or other types of protection from the elements, and injury, illness or even death may result. While beef cattle are generally viewed as hearty animals, able to care for themselves, they are nonetheless vulnerable to the effects of severe storms. For example, at least 10,000 cattle were killed in Louisiana during the 2005 hurricane season (17, 88).

Stocker operations often confine arriving calves for 21 to 45 days in a barren drylot in order to administer antibiotics to those identified as ill. Forcing calves to cope with dusty and muddy pens, feed bunks, waterers and new feed increases stress in calves already stressed by weaning and transport (54). A study conducted by Kansas State University compared the effects of stocker drylot treatment programs with stocker pasture programs at three field sites in Kansas (54). The average morbidity rate for pasture treatment at the three sites was 10%, versus 60% for the drylot treatment, and only 5% of pasture cattle received re-treatment, while 27% of drylot cattle were treated more than once (54).

2.2 Weaning

Weaning is considered perhaps the greatest source of stress for calves (46). Weaning occurs naturally in cattle as part of the transition to adulthood, but in beef production, a young calf is forcibly denied its mother's milk and social contact with her and other adult cattle (67). Weaning is not allowed to occur normally when the cow and calf are ready but is instead determined by management factors such as calf age and weight, cow condition, forage availability, market prices and cash flow (79).

Stress from weaning causes prolonged vocalization by the calf that may irritate the respiratory tract and increase susceptibility to infection (46). In a study conducted by Stookey and others (67), during the first three days after weaning, calves moved a 1 km distance away from their mothers walked and vocalized more and ate and rested less than calves who could see, hear, smell and touch their mothers through a fence. The researchers concluded, "The wellbeing of newly-weaned calves is improved if they are allowed social contact with cows" (67).

Weaning is especially stressful when other management practices like vaccination, castration and dehorning are performed at the same time (81). Cattle operations frequently perform these procedures together to avoid extra labor and handling of the animals. Weaning is also frequently followed closely by transport of the animal to an auction or feedlot (47). Mackenzie et al. (47) found that both weaning and transport have an effect on calves' immune response, and the combination of early weaning and transport together has the greatest impact on immune responses, suggesting there are cumulative effects of the two stressors. Vaccinating and weaning calves 35 to 45 days prior to transport reduces mortality at the feedlot (7).

3. Feedlots

Cattle feedlots are mainly located in the central US near areas of high grain production and slaughter plants (12). Over 70% of all cattle finished in the US are fed in just three states – Nebraska, Kansas and Texas (68). According to the USDA National Agricultural Statistics Service (86), in 2004 there were more than 90,000 US operations for feeding cattle. Of these feedlots, 264 had a one-time capacity of more than 16,000 head of cattle, and 54 had a capacity of more than 50,000 head.

The purpose of the feedlot is "finishing," or putting weight on animals before slaughter. Cattle arriving at feedlots are generally young animals between 6 and 12 months of age, and the stay ranges from 120 days to 300 days, depending on the size and age at arrival (12, 20). Newly weaned calves weigh 400 to 660 pounds, while yearlings weigh 500 to 800 pounds (12). Cattle in feedlots typically gain over 3 pounds per day and are sent to slaughter at a finished weight of 1,000 to 1,250 pounds (12).

Housing cattle in a high-density situation and forcing them to undergo a large and rapid weight gain causes significant health and welfare problems.

3.1 Environmental Conditions

Being fed from a bunk in a high-density situation is very different from the pasture grazing that cattle are accustomed to, which can result in physical and social problems. Farm animal welfare experts AF Fraser and DM Broom (18) note that animals who cannot find a feeding place may not get sufficient food, and if subordinate cattle must feed near dominant ones, the subordinates will end up walking greater distances and taking longer to feed. Cattle in feedlots gain weight quickly but have little opportunity for exercise. Their legs are not sufficiently strong to support the abnormally heavy body, and consequences such as cartilage damage, limb pain and difficulties in standing and lying may result (18).

Feedlot cattle are able to eat what they require in much less time than cattle on pasture. As a result, they spend much of their time idle, which can lead to boredom and the development of stereotypies and other abnormal behavior (58). One consequence of living in such a barren environment is the buller-steer syndrome, where certain males demonstrate frequent antagonistic behavior toward other males (58). Research has shown that devices such as scratching/rubbing posts, salt blocks and bales of straw may be good candidates for environmental enrichment in feedlots (58, 95), although the devices may trigger aggressive behavior if they are attractive to animals but in limited supply (58).

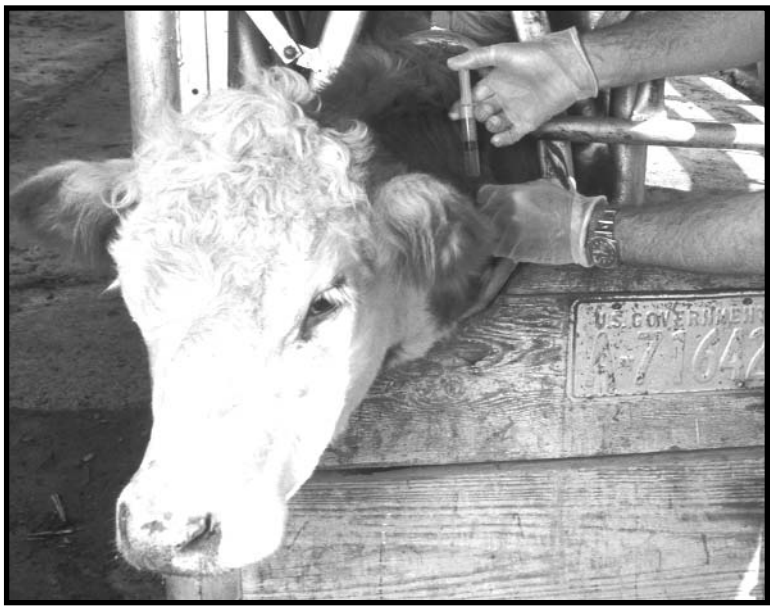
In addition to inadequate space and lack of stimulation, cattle in feedlot pens are subjected to high levels of dust and an accumulation of mud and animal waste. Cattle in feedlots are also vulnerable to the effects of adverse weather conditions including high temperatures, wind and precipitation.

A number of structural designs and management practices can be implemented to improve the welfare of feedlot cattle. For example, sprinklers should be used to both cool cattle and control dust, and surfaces should be scraped frequently to reduce mud and waste. However, most feedlots fail to provide these basic living conditions. Following is a table showing the percent of feedlots that provide certain environmental features for most or all of their cattle pens (84):

Pen Feature	Large Feedlots (8,000+ head)	Smaller Feedlots (1,000-7,999 head)	All Feedlots
Wind breaks	10.3%	56.8%	43.8%
Shade	9.6%	15.3%	17.3%
Sprinklers/misters	13.1%	13.5%	13.3%
Mounds	65.5%	59.4%	61.1%

3.2 Antibiotics

Antibiotics are routinely fed to feedlot cattle to keep the animals from getting sick. The Union of Concerned Scientists has estimated that 70% of all antibiotics used in the US each year are fed to livestock and poultry "not to treat illness, but to promote slightly faster growth and to prevent disease that would otherwise result from crowded, stressful, and unhygienic conditions" (3). More than half of the antibiotics fed to farm animals are identical to the medicines used to treat disease in humans (3), which has led to the development of antibiotic-resistant "superbugs."



A 1999 survey of US feedlots, conducted by the USDA (82-84), questioned cattle feedlot operations about antibiotic use. More than half (56.4%) indicated they administered an injectable antibiotic to cattle during initial processing (82), and nearly all (96.7%) administered injectable antimicrobials for disease treatment and/or prevention (83). In addition, 83.2% of feedlot operations said they used antimicrobials in feed or water as a health or growth management tool (84). According to the survey, the most commonly administered antimicrobials were chlortetracycline, tylosin, oxytetracycline and sulfamethazine (84).

Despite the extensive use of antibiotics, it has been determined that cattle in US feedlots are infected with an especially dangerous bacteria, Escherichia coli 0157, responsible for causing 52 deaths each year in the US (85). In 2000, the USDA (85) collected fecal samples from cattle pen floors at 73 feedlots in 11 states. Samples were collected from a total of 422 cattle pens, 248 (58.8%) of which had one or more positive sample (85). All feedlots sampled had at least one positive result during the course of the study (85). Cattle infected with the bacteria leave the feedlot, destined for the slaughterhouse where they are killed and their flesh and organs processed for human consumption.

3.3 Hormones

Cattle in feedlots in the US routinely receive growth hormone implants even though measurable hormone residues can be detected in the meat Americans eat. The US Food and Drug Administration, which does not allow hormones in poultry or pigs, has investigated the use of hormone implants in cattle. But it is unlikely they will be banned in the near future. Implants are cheap and add enough weight to animals that they can make the difference between profit and loss for an

individual beef producer.
Terry Mader (48) of the University of Nebraska claims, "No other management tool offers beef producers a greater return on investment than growth-promoting implants."

For a cost of only $1-$3 per implant, feedlots can increase the daily weight gain of cattle from 5% to 15% (48). Because of the results received, growth-promoting implants have been used extensively by the beef industry for over 30 years (48).

In responding to the 1999 feedlot survey, 92.4% of operations said they implanted cattle during initial processing procedures at the feedlot (82). For steers and heifers weighing 700 pounds or more, 82% of feedlots said they implanted some animals once, and 46.7% said they implanted some animals two times (82). For steers and heifers less than 700 pounds, 79.2% of feedlots indicated some animals were implanted two times, and 10.5% said some animals were implanted three or more times while at the feedlot (82).

3.4 Diet

US feedlots feed a readily fermentable carbohydrate diet to speed growth. Fifty-nine percent of feedlots feed finishing rations with 75% or greater high-energy concentrate, and large operations (71.7%) are more likely to feed this level of high-energy concentrates than small operations (54.7%) (82). Corn is the most common source of energy concentrates, with 98.2% of feedlots using it in their finishing ration (83). Other frequently used grains include wheat, corn byproducts and milo (83).

Roughage is necessary to maintain proper digestive functioning in cattle; however, since feeding roughage poses handling and mixing problems for feedlots, the trend has been to feed diets with less roughage (52). Roughage now makes up less than 10% of dry matter fed to cattle in feedlots (52).

A large majority of feedlots feed supplemental protein to promote growth in the form of soybean meal, cottonseed meal and urea; some even feed poultry litter as a protein source to cattle (83). Viewed as a cheap protein alternative, ingested poultry litter can transmit disease and drug residues, if not processed properly. Diets unnaturally high in energy and protein concentrates lead to two serious digestive disorders in cattle, bloat and acidosis, which are described briefly in the next section.

3.5 Morbidity & Mortality

More than 1% of cattle in feedlots die before being shipped to slaughter, market or another feedlot (82). Feedlot mortality increased from 1.4% to 1.8% between 1997 and 2003 despite the increased emphasis on animal welfare during those years (30). Dan Thomson of Kansas State University's College of Veterinary Medicine attributes the increased mortality to several factors including more cattle entering feedlots at younger ages, possibly more cattle trading through sale barns, the number of people qualified to provide health management in feedlots and an increase in the distance cattle now travel to reach feedlots (30).

Feedlot morbidity appears to be on the increase also (30). Morbidity is highest during the first 45 days in the feedlot (12). This is because feedlot calves experience a significant amount of stress during the marketing process and upon arrival at the feedlot (46). Newly arrived calves must acclimate to mud, manure, poor air quality and exposure to new social groupings and disease-producing pathogens (46). These stresses affect cattle in a number of ways including 1) endocrine responses, 2) altered energy and protein metabolism, 3) changes in appetite and growth rate, 4) possible compromised digestion and rumen functioning, and 5) a challenged immune system (46).

Stressed feedlot cattle are vulnerable to a variety of diseases, with the most common being respiratory diseases, including bovine respiratory disease (or "shipping fever"), and digestive problems, including bloat and acidosis. In response to the

USDA (84) 1999 survey, feedlot operators reported that the following percent of cattle developed disease conditions after arrival at the feedlot during the year ending June 30, 1999.

Disease	Large Feedlots (8,000+ head)	Smaller Feedlots (1,000-7,999 head)	All Feedlots
Respiratory disease	15.5%	8.7%	14.4%
Acute pneumonia	3.1%	2.9%	3.1%
Digestive problems	2.0%	1.1%	1.9%
Lameness	2.0%	1.3%	1.9%
Nervous system problems	0.4%	0.3%	0.4%

Below is a brief description of the most common feedlot-related cattle diseases.

Bovine Respiratory Disease
Bovine Respiratory Disease is the most common disease of feedlot cattle, responsible for about 50% of mortality and 75% of morbidity (12, 84). The disease is also known as "shipping fever" because it usually occurs shortly after the animal arrives at the feedlot, and stress from transport is believed to be one of the major causes of the disease (12, 29). The syndrome, which has been called the single most important disease problem of the North American cattle industry, is characterized by fever, dyspnea and fibrinous pneumonia (29). It is caused by several viruses and bacteria that do not appear capable of causing disease in healthy cattle, but interactions among the pathogens in the presence of environmental stresses result in the condition (27).

Research by Wittum et al. (96), of the USDA Meat Animal Research Center at the University of Nebraska-Lincoln, showed that 35% of feedlot steers received treatment for respiratory disease between birth and slaughter. However, pulmonary lesions consistent with pneumonia were found in 72% of feedlot steers at slaughter. While 78% of steers treated for respiratory disease had pulmonary lesions at slaughter, 68% of untreated steers also had pulmonary lesions (96). These findings suggest that half or more of all cases of respiratory disease among feedlot cattle go undetected and that the current method of treatment for clinically affected cattle is inadequate.

Bloat
Bloat is a condition of excessive gas that is observed in two forms, frothy bloat and free gas bloat (52). Frothy grain bloat is caused by ingestion of a diet that consists of more than 50% concentrations (52). Frothy bloat most often occurs in the initial feeding period and is associated with consumption of rations containing high levels of carbohydrates and natural protein and when dry matter consumption exceeds 3% of the animal's body weight (27). Free gas bloat may occur throughout the feeding period and is associated with aggressive eating behavior (27). The incidence of bloat can be decreased by the inclusion of 10% to 15% roughage in the feedlot diet (52).

Acidosis
Acidosis is a metabolic condition caused by over-consumption of readily fermented carbohydrates that results in rapid production and absorption of ruminal acids (52). When fed a diet lower in fiber, cattle eat their feed in less time and, as a result, saliva production and rumination decrease. This increases the acidity of the rumen (or ruminal acidosis). The condition occurs in subacute, acute and chronic forms, and in the acute form acidosis can be severe enough to cause serious impairment of physiological functions, leading to coma and death (52). Because grains such as barley, wheat and corn have fast rates of ruminal digestion, they are the primary culprits. According to veterinarian Dee Griffin (27), of the University of Nebraska, subacute acidosis is so common in feedlot cattle that consequences such as liver abscesses are considered acceptable if the prevalence is kept under 20% with the use of antibiotics. As with bloat, acidosis can be prevented by adding roughage to the finishing diet (52).

Lameness
Low-fiber, high-carbohydrate diets can also result in lameness. When the acidity of the rumen increases histamine and other endotoxins are released into the blood, causing vasodilation and ultimately impairing the blood circulation to the hoof and leading to laminitis and lameness (10). Eight percent of feedlots report lameness in at least one animal (84), and

slaughter plant audits suggest that the incidence of lameness in beef cattle is increasing (26).

4. Mutilations

Bath (8) identified a total of 24 potentially painful procedures performed on farm animals by farmers and ranchers, 19 of which are performed on cattle. The procedures include several mutilations, such as branding, dehorning and castration. These procedures are done in order to make the raising of large numbers of animals more efficient and convenient for the operator. Mutilations are often performed by laypersons with little or no training, and the animals are regularly subjected to the procedures without the benefit of any form of pain relief (8).

4.1 Branding

Many cattle in the US are still branded as a form of identification. Herd identification is used to discourage theft, aid return of lost cows and facilitate sorting of animals in common grazing situations (77). In its 1999 feedlot survey, the USDA (82) surveyed US feedlots about their reasons for hide branding. The most common reasons given were (multiple responses possible): branding laws (44.7%), to deter theft (40.9%), for temporary transfer to pasture before return to feedlot (32.9%), feedlot management (24.1%), customer request (23.4%), and bank requirements (10.1%) (82).

Branding is most common in western states, where 98.7% of beef cows are identified in some manner, usually by hot iron brands, which is a requirement for public grazing on some federal lands (77). A less frequently used alternative is freeze branding, which destroys the pigment-producing cells, causing the hair to turn white, or destroys the hair cell, causing the hair to fall out (44). Instead of being branded, cattle in the eastern states typically receive ear tags to provide identification (20).

According to the USDA (77) Beef '97 survey, 51% of US cattle herds report some use of herd identification, with hot iron branding (26.6%) and plastic ear tags (27.0%) being the most common methods used. In addition, 48.1% of operations used some form of individual identification on calves, with plastic ear tags (40.7%) being the most common (77). The branding site varies with the leg or hip being the most popular (82). The USDA (82) 1999 survey of feedlots reported that 34.5% of feedlot operations branded (hot or freeze) some cattle on the lower rear leg, upper rear leg, or hip, while 8.0% used the side or rib and 6.3% used the head, neck or shoulder.

Some cattle may be re-branded when sold or when transferred to a feedlot. In a 1999 audit conducted at US slaughter plants, 46% of cattle had brands, and 21% had multiple brands (61). In a 1995-96 survey of four Canadian slaughter plants, 37% of cattle had brands, and multiple brands were observed on 6% of the animals (90).

Welfare problems are associated with all invasive forms of identification. Although branding is considered the most inhumane, ear notches (made with a small punch) likely cause some discomfort to the animals, and ear tags may become caught in vegetation, causing pain and possible infection (20) and even potentially choking the animals (62). Nevertheless, ear notching is commonly recommended for cattle identification, but splitting or wattling the ear is discouraged (22, 53).

Hot-iron branding causes a third degree burn that has been shown to be painful to beef cattle (93). Freeze branding also results in a stress response in cattle, but the reaction is less severe than that observed with hot branding (44, 45, 63). Cattle subjected to both freeze and hot-iron branding show elevated blood stress hormone levels, elevated heart rates and greater escape-avoidance reactions (44, 45), and increased behaviors indicative of pain (63) compared to cattle subjected to "sham" branding (holding a room-temperature brander against the hide). The finding that freeze branding causes pain, but less so than hot-iron branding, has been shown to apply to beef cattle (63), dairy cattle (44) and crossbred cattle (45).

Cattle identification has become an actively debated issue following the discovery of cases of "mad cow" disease in the US and Canada (4, 19). Ranchers are being told that the conventional practice of branding will no longer suffice as a national animal identification system that must be able to trace cattle in the event of a disease outbreak (4). As a result, many cattle operations are in the process of switching to bar-coded ear tags with radio transponders. However, because ear tags can

get lost or stolen, other alternatives are being pursued. One option that is both permanent and painless is retinal scanning, where infrared light is used to photograph blood vessels in the eye (19). The digital photos are then stored in a database with information about the animal, allowing tracking from birth to slaughter (19).

4.2 Dehorning

Because horns can cause bruising and hide damage that reduces the value of carcasses, the horns of beef cattle are often removed (82), almost always without the benefit of analgesia. Goodrich and Stricklin (20) claim that the pain inflicted on individual animals is justified by the benefit to "other animals and the people who work with cattle."

Several procedures are used depending on the age of the animal. "Disbudding," or destruction of the horn bud, is performed on calves under 10 weeks of age by application of hot iron cautery or caustic paste. "Dehorning," or amputation of the horn, is performed on older calves by use of a scoop, saw, shears or wire. Because tissue damage is involved, it is widely acknowledged that all methods of disbudding and dehorning are probably painful (15, 59, 70).

Researchers have attempted to determine the degree to which pain caused by the procedure is affected by the specific method used and age of the animal. Petrie et al. (59) compared the effect of hot iron cautery versus scoop disbudding on 6-week-old calves and found that the scoop method caused a more prolonged rise in serum stress hormone (cortisol) concentrations and, therefore, appeared more stressful than cautery. Morisse et al. (51) found cauterization resulted in a reduced cortisol response among 8-week-old calves than the application of a caustic preparation with 4-week-old calves. Behavioral and serum cortisol levels indicated that calves disbudded by both methods in this study suffered intense pain and discomfort. Contrary results were reported in a study by Vickers et al. (91), where calves disbudded with hot iron cautery showed a stronger pain response than calves undergoing the procedure with caustic paste. Therefore, while cautery appears less painful than scoop disbudding, the difference between cautery and caustic paste is unclear.

Research has documented the benefits of analgesia and anesthesia in reducing the pain response to dehorning/disbudding. Morisse et al. (51) found that use of local anesthesia reduced the immediate reaction to both cautery and the application of a caustic preparation in 8- and 4-week-old calves, respectively. Administration of a combination of sedative and local anesthetic, as well as an anti-inflammatory drug before and after the procedure can provide effective relief from the pain experienced both during and following hot iron disbudding (15). Furthermore, Petrie et al. (59) observed benefits from the administration of a local anesthetic to 6-week-old calves during the first two hours after disbudding by the scoop method. Local anesthesia combined with wound cautery has also been shown to reduce the acute distress of dehorning by the scoop method in older calves (69).

In the United Kingdom, local anesthetic must be administered to calves undergoing disbudding or dehorning procedures after 7 days of age (15). However, in the US it is common practice to perform dehorning without anesthesia prior to the procedure or analgesia following the procedure. The care and handling guidelines of the National Cattlemen's Beef Association (53) do not require or recommend the use of anesthesia or analgesia for dehorning. The guidelines recommend that calves be dehorned prior to 120 days of age (53). However, according to the USDA (81) Beef '97 survey, the average age for dehorning on US cattle operations is 130 days, with 58.6% of operations dehorning calves at 123 or more days of age, and nearly one-fifth (19.4%) dehorning calves 215 days of age and older.

An alternative to dehorning is the practice of breeding horn-less or "polled" cattle. The polled condition avoids the need to disbud or dehorn animals (21). Unfortunately, some cattle breeders have a perception that horned cattle are superior to polled (62). However, research has demonstrated that horned and polled cattle are similar for traits associated with reproduction, growth and behavior (21).

In the USDA (81) Beef '97 survey, more than one-fourth (27.8%) of calves born during 1996 had horns. Nearly two-thirds (61.1%) of cattle born with horns were dehorned before being sold (81). Of those cattle with horns upon arrival at feedlots, about three-fourths (74.4%) have the tip of their horns cut off, while only a small number (2.3%) are dehorned at the feedlot (82). It is assumed that the remaining 23.3% undergo neither procedure and retain their full horns, which would result in approximately 2.5% of US cattle with full-length horns at slaughter. (A 1995-96 survey of four Canadian slaughter plants documented 14.8% of cattle with full-length horns (90).)

The USDA (82) points out that dehorning can result in opening the frontal sinus, which can result in infection and hemorrhage, and Grandin (22) recommends that neither dehorning nor tipping be performed at the feedlot. NCBA (53) guidelines note that cutting off the tip of horns "can be done with little impact on the well-being of individual animals", and the guidelines do not recommend against either dehorning or tipping at the feedlot.

4.3 Castration

According to Goodrich and Stricklin (20), male cattle are routinely castrated to prevent physically or genetically inferior

males from reproducing, to reduce the aggressive nature of intact males and to improve meat quality. Under modern feedlot conditions, however, mating is prevented by segregation of the sexes, and cattle are slaughtered at such young ages that differences in flesh from castrated and uncastrated males are slight (75). As to aggression, there is evidence that differences between bulls and steers is considerably less than previously thought. In comparing the behavior of a group of bulls and a group of steers, Appleby and Wood-Gush (5) found that aggressive interactions among the animals was infrequent and rarely severe and did not differ between the two groups. Tennessen and others (75) also observed groups of bulls and steers and found that, although the bulls exhibited initially higher rates of aggressive behavior when grouped together, the frequency of aggressive interactions decreased quickly, and by 10 days post-mixing, both bulls and steers showed very little aggression.

Castration is performed any time from shortly after birth up to 8 or 9 months of age. USDA (81) recommends bull calves be castrated as early as possible. Grandin (22) also recommends that male calves be castrated at an early date. NCBA (53) guidelines note, "Early castration improves animal performance gain and reduces health complications." The guidelines recommend that castration be performed before 120 days of age or when calves weigh less than 500 pounds (53). According to the USDA (81) Beef '97 survey, 25.5% of cattle operations did not castrate bull calves before they were sold. The average age at which castration was performed was 68 days (81); however, 24% of operations castrated calves between 62 and 122 days, and an additional 16.3% of operations performed castration at 123 or more days of age (81).

Castration is accomplished by three devices: knife, the emasculator (plier-like device that crushes the spermatic cord and blood vessels to the testicles) and the elastrator (rubber ring placed over the testes that causes necrosis and eventual sloughing off of the testicles). In assessing the effects of the different methods of castration, Molony et al. (50) found that all three approaches caused immediate pain and distress and that use of the rubber ring method of castration was associated with chronic pain lasting for at least 42 days. NCBA (53) guidelines do not require or recommend the use of anesthetic and/or analgesic for pain relief from castration.

The USDA (82) 1999 feedlot survey reported the type of castration method used by feedlots in the US. According to the survey, of the bulls castrated by feedlots in the year ending June 30, 1999, 48.5% were castrated by banding, and 43.3% were castrated by surgical removal of the testes (82). The USDA (82) notes potential problems with both methods – fly strike or wound infection for surgical removal and increased risk of tetanus with banding.

5. Handling

Cattle are subjected to a number of management procedures that cause pain and stress. Since many beef cattle spend the first several months of their lives in an extensive setting on the range, they are less accustomed to being handled than dairy cattle and likely find the experience more threatening and stressful. Situations that are novel or occur suddenly may be especially frightening to beef cattle, since in the wild novelty and strange sights and sounds are often a sign of danger (24, 94).

Research by Mitchell et al. (49) found that handling, transport and slaughter are different stresses that produced significantly different changes in blood hormone levels in cattle. The researchers also found that handling produced higher stress hormone levels than either transport or slaughter (49). Similarly, Zavy et al. (97) studied the effect of initial handling, weaning and transport on beef calves of different genotypes and discovered that stress hormone levels were highest during the handling period.

5.1 Aversive Practices

Beef cattle, like other farm animals, respond to the manner in which humans treat them, and an animal's experiences early in life can affect reactions to people and novel situations later on (24). Cattle handling expert Temple Grandin (23, 24) observed that cattle from feedlots with a reputation for rough handling were more difficult to handle at the slaughter plant and had more bruises than cattle from feedlots with a reputation for gentler handling.

Cattle are moved by a number of methods that are aversive to the animals, including roping, shouting, hitting, tail twisting and shocking with an electrical prod (55). Pajor et al. (55) used aversive learning techniques to determine which common handling practices dairy cattle found most objectionable. Of four aversive treatments – electric prod, repeated loud shouting, hitting, and tail twisting – cows appeared to find electric prodding and repeated shouting most aversive (55).

Since cattle can hear sounds of much higher frequencies than humans, shouting and other forms of noise may be more irritating to cattle than people (94). Waynert and others (94) tested the response of beef cattle to noise during handling and found that heifers exposed to the recordings of humans shouting and metal clanging had elevated heart rates and moved more. Of the two types of noise, the cattle appeared to be more alarmed by the humans shouting (94), perhaps due to prior negative experiences with people. The animals did not habituate to the noises over a 5-day test period, and since beef cattle are not normally handled as frequently as they were during the experiment, the researchers concluded that exposure to noises during handling may remain novel for beef cattle (94).

Rough handling can cause significant stress, pain and injury to cattle. In a review of numerous scientific studies, Grandin (25) found that blood cortisol (stress hormone) levels were two-thirds higher in cattle subjected to rough treatment. It is likely that the extent of the stress response was understated by these studies since quick procedures, like restraint in a headgate for blood sampling, would be completed before cortisol levels had the opportunity to rise (25).

Cattle who are chronically stressed as a result of repeated handling procedures are also more susceptible to bruising (6). It has been speculated that bruising from chronic stress may account for the variation in the amount of bruising that is commonly noted in cattle at slaughter (6). In a study conducted at four slaughter plants in Canada, bruises were noted on 78% of beef cattle carcasses (90).

The NCBA (53) guidelines for the care and handling of beef cattle do not prohibit the use of electric prods but indicate use should be minimized "for safety and welfare reasons." The guidelines encourage the use of non-electric driving aids, such as plastic paddles, sorting sticks, flags or streamers affixed to long handles (53).

5.2 Restraint

Simple restraint, often done for relatively minor procedures such as blood sampling or vaccination, can be stressful to cattle. Stephens and Toner (65) observed an increase in average heart rate from 100 beats per minute to more than 140 beats per minute among calves subjected to a 10-minute restraint period. Blood stress hormone levels also increased drastically – nearly four-fold – after the restraint and immobilization period (65).

Lay and others (45) found that restraint in a squeeze chute was nearly as stressful as hot-iron branding to extensively reared beef cattle, while more intensively reared dairy cattle appeared to find branding much more stressful than restraint (44). Grandin (24) also tested the effects of restraining beef bulls and steers in a squeeze chute for blood testing where the head of each animal was restrained and the body was held between two squeeze panels. She found that some of the cattle were extremely behaviorally agitated by the restraint procedure and that the agitation was persistent over a series of handling and restraint sessions, suggesting that animals do not always habituate to common handling procedures (24).

The cattle industry has attempted to use electric current to induce immobilization for veterinary procedures. A portable battery-operated apparatus was developed in the 1980s that used pulsed direct current to put the animal into a tetanic spasm that prevents movement. However, research has shown that electroimmobilization is a noxious event for animals (57). Lambooy (42) noted that the pulse rate of animals undergoing immobilization was irregular and sharply increased and that the plasma cortisol level appeared to be increased during delivery of the current. In addition, half of the animals reacted to painful stimuli during the experiment, suggesting that the procedure produced immobilization but not anesthesia (42).

5.3 Veterinary Procedures

Beef cattle are regularly subjected to veterinary procedures such as blood sampling, injections, palpation of the reproduc-

tive tract and artificial insemination. Even simple procedures are capable of causing injuries such as bruising. Hoffman and others (28) found that beef cattle marketed through livestock auctions that conducted testing for brucellosis had a greater number and severity of bruises than cattle coming from ranches or livestock auctions that did not handle cattle for testing. The researchers found the association between brucellosis testing and bruising was especially strong when cattle were transported longer distances to slaughter (28).

Handling for veterinary procedures also causes an elevated stress response in cattle. Alam and Dobson (2) documented increased plasma cortisol levels 2 to 8 times higher than baseline values for several common veterinary procedures including injection, venapuncture (blood sampling) and uterine palpation. According to the USDA (80) Beef '97 survey, pregnancy palpation and artificial insemination are practiced by 34.5% and 13.3% of beef cattle operations, respectively.

5.4 Isolation

Cattle are often separated from their peers during restraint for procedures, and this social isolation has been shown to be a source of severe psychological stress. Stookey and others (66) found that cattle became less agitated during weighing on a single animal scale if they could see another animal in the chute in front of the scale.

Researchers Boissy and Le Neindre (9) tested the effect on heifers of short-term isolation and subsequent reunion with familiar and nonfamiliar peers. They found that social isolation caused struggling, large increases in vocalization, heart rate and blood hormone levels in heifers of both beef and dairy cattle breeds (9). Except for vocalization, all effects were more severe in beef heifers. Struggling and vocalization decreased when the animals were united with a peer, regardless of whether they were previously familiar with the animal (9). However, the decline in heart rate was more pronounced when test subjects were reintroduced to their former pen mates than when introduced to strangers (9).

5.5 Downed Cows

"Downed animals" are farm animals too sick or injured to walk on their own. Owing to their size and weight, it is very difficult – if not impossible – to move downed cattle humanely. Non-ambulatory animals are frequently subjected to unnecessary pain and distress when they are dragged onto or off of trucks by the use of ropes or chains, or moved from one location to another by being scooped up with bucket loaders or forklifts.

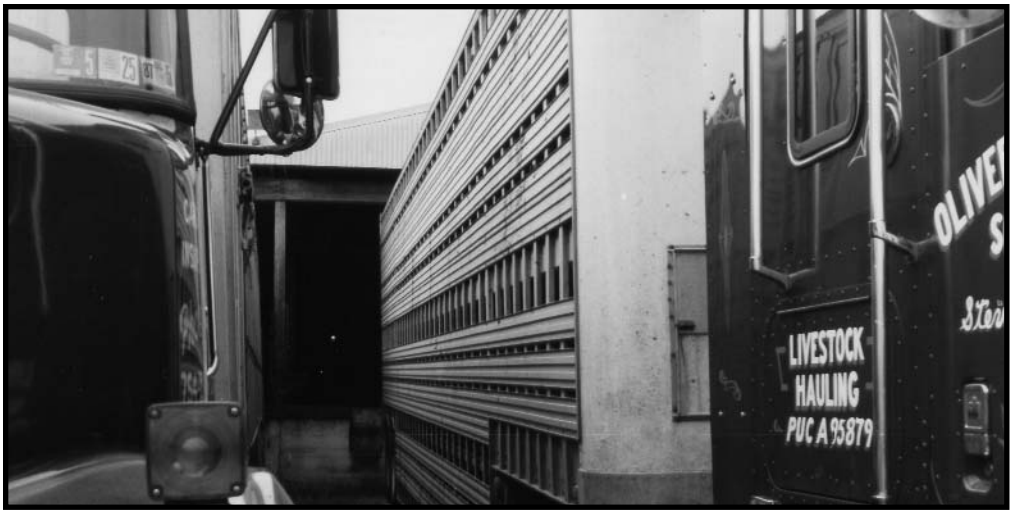
This mistreatment often results in injuries ranging from bruises and abrasions to broken bones and torn ligaments. While specific devices have been designed to move non-ambulatory animals, many farms, livestock markets, and slaughter establishments do not have this equipment available. Because downed animals are immobile, they cannot get to food and water troughs. They may lie for hours or days without having their most basic physical needs met, and many die of gross neglect. Observations at livestock markets have shown disabled cattle being left to suffer without food, water, shade or veterinary attention; being kicked or beaten; being thrown, dragged by the neck, or picked up by an ear or limb; being trampled by other animals in common pens; and being thrown alive onto piles of dead animals.

Although the issue of non-ambulatory animals is frequently considered a problem associated with the dairy industry, cattle raised for beef production may also go down and become victims of mistreatment. USDA estimates put the number of downed cattle and calves in the U.S. at 450,000 for the year 2004 (87). Of these, 160,000 were non-ambulatory cattle and calves on beef cow operations (87). According to the USDA, 49,700 beef cow operations reported non-ambulatory cattle and calves in 2004 (87).

Because of the cruelty involved, laws or regulations limiting the transportation and/or marketing of downed animals have been enacted by several states – California, Colorado, Florida, Illinois, Indiana, Maryland, Oregon, and Washington. The USDA initiated a ban on the slaughter of all downed cattle for human consumption after the discovery of bovine spongiform encephalopathy ("mad cow" disease) in a Washington State dairy cow in December 2003.

6. Transport

"Transport is generally an exceptionally stressful episode in the life of the animal and one which is sometimes far removed from an idealized picture of animal welfare," according to Drs. Knowles



and Warriss (39) of the School of Veterinary Science, University of Bristol, United Kingdom. In the US, cattle typically must endure this experience a minimum of two times in their lives – from the cow-calf operation to the feedlot and from the feedlot to slaughter. In addition, calves may also be transported from a cow-calf operation to a stocker operation, and yearlings may be transported to one or more auctions before or after finishing at a feedlot.

Jarvis and others (31) found that cattle sold through auction in the UK were more thirsty, hungry and tired on arrival at slaughterhouses than cattle sent directly from farms. Although some cattle operations in the US are using alternative forms of marketing, in 1997, the auction was still the most common method used (84.9% of operations) for selling steers (78). Marketing cattle through live auctions lengthens transport times and multiplies the number of instances in which animals are loaded and unloaded, driven, and exposed to unfamiliar settings and unfamiliar animals (37). Moreover, with a decline in the number of slaughterhouses in the US, the distance cattle must travel to slaughter is also increasing. According to the USDA (89), during a recent one-year period, between January 1, 2004 and January 1, 2005, the number of federally inspected US slaughter plants declined 4% and the number of state inspected plants dropped 5%.

The marketing process includes several stress-inducing procedures, as illustrated in the following example of weaned Tennessee cattle sold for finishing at a feedlot in Texas:

"In Tennessee, for instance, the lighter feeder cattle are generally weaned on the same day that they leave a comparatively small farm. From there they may be taken to the local sale barn to be sorted, displayed, sold, and resorted, giving them ample opportunity to become exposed to pathogens during a period of 24 to 48 hours without feed and water. After the sale, the calves may be transported to an order buyer's barn for holding and sorting into appropriate groups for sale to custom feedlot clients. They may be kept by the order buyer from 2 to 10 days, with adequate water and minimal hay available until an order or consignment is filled and shipment is made. During the approximately 1,600-km journey to Texas by truck, which takes from 30 to 40 hours, there is neither feed, nor water, no unloading for rest." (29)

Transportation subjects cattle to a variety of physical stressors including vehicle vibrations, noise, exhaust fumes, wind and temperature extremes and deprivation of food, water and sleep. Mixing groups of unfamiliar animals, especially with low space allowances, leads to increased social interactions, anxiety, psychological stress and physical exhaustion.

6.1 Deprivation of Food & Water

Food and water are not available on US transport trucks and cattle are seldom off-loaded to be fed and watered, regardless of the length of the journey. A lack of fluids and nutrition during transport leads to dehydration and weight loss in cattle.

Knowles et al. (40) observed a significant weight loss, of on average 7% of initial liveweight, among cattle transported for periods of 14 to 31 hours, even though the animals were allowed a stop for rest and water after 14 hours. The researchers also noted an increased in plasma total protein during the journeys, suggesting dehydration (40). After returning to their pens, all the animals stood, ate and drank more frequently than usual (40). Knowles and others (38, 41) also observed dehydration, as evidenced by changes in plasma total protein and albumin, and loss of weight among calves transported 19-24 hours.

Even trips significantly shorter than 24 hours, when made without access to food and water, are capable of producing adverse effects. In one experiment cattle transported by road for up to 15 hours demonstrated changes in their blood chemistry that suggested dehydration and disruption of the animals' normal feeding pattern (92). It took 5 days after the journey for the animals' weight to return to pre-transport levels (92).

In addition, Lambooy and Hulsegge (43) found increased hematocrit and hemoglobin levels in the blood of pregnant heifers transported by truck without feed and water for 18 hours. The researchers concluded that their experiments "may indicate that 18 hours is too long an interval for heifers to remain without food and water..." (43).

6.2 Environmental Conditions

Transport features several potentially stressful environmental factors including poor air quality, adverse climatic conditions and noise. For example, Agnes et al. (1) found that calves loaded onto a motionless transport simulator and exposed to noise showed increases in blood hormone levels similar to the changes observed in calves transport for a period of 30 minutes. The researchers concluded that loading-confinement and noise "can provoke similar hormonal responses not significantly different from those observed during transport simulation" (1).

Temperature extremes are another source of transport stress. The adverse effect of chilling due to low temperatures during transport is considered an important predisposing factor for bovine respiratory disease (29). In comparing the incidence of bovine respiratory disease in Australia and the US, Irwin and other (29) noted, "Both countries have daily temperature inversions during the time of year when most cattle are relocated, but American cattle are exposed to rapid, severe temperature changes and greater weather extremes."

Much greater fluctuations in body temperature have been documented in calves transported during the winter than in those transported during the summer, indicating that the calves were less able to regulate their body temperature when transported during colder weather (41). Knowles et al. (38) found that the weight of calves transported in the winter took longer to return to baseline levels after transport than those transported during summer months. According to the researchers, "[T]he calves coped less well with being transported in winter. In addition to a greater and more prolonged reduction in bodyweight, body temperature was markedly reduced for at least eight hours after the journey, and high levels of plasma total protein and albumin provided some evidence of dehydration" (38). Bruising has also been observed to increase during colder, wetter weather (13).

6.3 Stocking Density

How cattle are grouped and how much space they are allowed during transport has an impact on the animals' physical and psychological well-being. Lambooy and Hulsegge (43) found that heifers transported loose in a truck compartment had fewer skin injuries than heifers transported in pairs between gates, possibly because the loose heifers were able to turn their bodies in the direction they preferred. However, when transported loose heifers drank less water and lost significantly more weight than when transported in pairs, possibly because the water buckets, which were located in the corners of the compartment, were not easily accessible (43).

The cattle industry has an incentive to place as many cattle as possible in transport vehicles to reduce costs (13). However, low space allowances during transport have been shown to negatively affect movement patterns and injuries and physiological measures such as heart rate and weight loss. Although transport with very high space allowances is not a cause of stress, cattle in these situations may be susceptible to falling due to careless cornering and emergency stops (71).

Steers transported at a low space allowance had more bruises and lost more body weight, fat and muscle mass than steers transported at higher space allowances in research conducted by Eldridge and Winfield (13). Greater weight loss has also been documented in calves transported at higher densities (35). Tarrant et al. (72, 73) observed increased blood glucose and cortisol levels, as well as increased bruising, when steers were transported at low space allowances. The researchers found that the stress response increased with location toward the back of the truck (72). They also noted that cattle with little space suffered other problems including inhibition of movement and inability to face in the preferred direction (72).

Reduced mobility and inability to face in the preferred direction most likely increase the risk of animals losing their balance and falling (73). Animals that lie down at low space allowances may become trapped and unable to rise, and are vulnerable to being trampled by other animals (71, 73). Tarrant and others (72, 73) found that falls increased with stocking density, and when an animal went down at high stocking density he was sometimes trapped down, causing other members of the group to go down in a domino effect (72).

"The major hazard in cattle transport, that of cattle going down underfoot with consequent risk of injury, was almost exclusively associated with high stocking density. Struggles for footing frequently preceded going down. These unstable situations (struggles) were precipitated either by driving events, typically cornering, or by standing on a fallen animal, or resulted from strenuous and usually unsuccessful attempts to change position in a full pen." (72)

Calves loaded at an appropriate stocking density often choose to lie down, which gives them the opportunity to rest and

not have to work at maintaining their balance and posture, unlike steers who are transported at densities that prevent a majority of animals from lying at the same time (41). Stephens and Toner (65) found that calves who lied during transport had significantly lower heart rates than calves who stood.

6.4 Length of Journey

It is generally accepted that cattle dehydrate as journey length increases (56). There are no national limits, however, on the length of US transport journeys for cattle. The Twenty-eight Hour Law (49 USC 80502), passed by Congress in 1873, requires that animals transported for 28 consecutive hours be unloaded for 5 hours of rest and access to food and water, but the USDA has refused to apply the law to transport by truck, even though nearly all farm animals within the US are now moved by this method.

Many developed countries restrict the length of journeys. In November 2004 the European Council (14) adopted a regulation on the protection of animals during transport that sets journey limits, including a limit of 8 hours for calves less than 14 days old, and a ban on the transport of calves less than 10 days of age except if the journey is less than 100 km. Journey time for mature cattle is not to exceed 8 hours unless certain conditions are met including a rest period of at least one hour after 14 hours of travel (14). After this rest period, adult cattle may be transported for a further 14 hours at which point they must be unloaded, fed, watered and rested for at least 24 hours (14).

Research supports the need for transport limits. Bulls and steers experienced a greater weight loss on longer hauls than on shorter hauls in research by Tennessen et al. (74). Warriss et al. (92) compared the effects on cattle of road transport for 5, 10, and 15 hours. The cattle transported for 5 hours lost 4.6% of their bodyweight, while those transported for 10 hours lost 6.5% and those transported 15 hours lost 7.0%. It took 5 days for bodyweight to return to pre-journey levels, and the recovery took slightly longer for the groups transported further (92).

Blood chemistry levels, including creatine phosphokinase, urea, albumin (92) and osmolality (40, 92), have been found to be higher for cattle on longer journeys, suggesting a greater response by those animals to transport (92). Warriss et al. (92) observed that after 15 hours cattle appeared fatigued, possibly because the animals found maintaining an upright posture on the moving vehicle to be physically demanding (92).

In research conducted by Knowles and others (40) on the effects of transportation for up to 31 hours, many of the cattle chose to lie down after approximately 24 hours, and those who lied down had higher plasma cortisol levels than those who remained standing. According to the researchers this suggests, "The need to stay awake and maintain balance was taking some toll on these animals towards the end of the journey" (40). The researchers thought it significant that nearly half of the animals in the study chose to lie down during the latter stages of the journey. This is because the cattle did so only with some difficulty and at an increased risk to themselves, due to the proximity of the other animals and the motion of the vehicle (40).

The cattle industry often argues that it is better for animals to remain on the truck until their final destination than to be exposed to the stress of unloading and reloading after a rest stop. However, Kenny and Tarrant (32, 33) found no adverse response to loading/unloading and suggested that confinement on a moving vehicle was probably the most stressful aspect of transportation for steers (32) and bulls (33).

6.5 Transport of Calves

In the US, surplus beef and dairy calves are frequently transported, often when they are still under one week of age. According to Trunkfield and Broom (76), "Much evidence suggests that calves undergo considerable stress during transport." Knowles et al. (38) found that weight and blood chemistry levels took up to 7 days to stabilize following the end of a 19-hour journey, and Knowles (36) noted that the mortality rate related to transport is inversely related to the calves' age.

Calves appear to react differently to transport than mature cattle. Knowles et al. (38, 41) found that calves less than one month of age did not show the same responses in heart rate, blood glucose and blood cortisol levels as those observed in older cattle. Fell and Shutt (16) found the smallest increase in salivary cortisol levels among calves less than one month of age, and Kent and Ewbank (34) observed that increases in plasma cortisol levels were only two- to threefold in one to three-week old calves compared with at least an eleven-fold increase in cortisol levels in six-month-old calves. Researchers have speculated that calves' lack of response to transport is not because they are unaffected but because they are physiologically unadapted to coping with the stress induced by transport (41).

Because calves do not experience the usual stress responses seen in older animals, they may be more susceptible to disease (38). Comparatively few healthy calves actually die during transport, but a large number become ill or die of secondary disease within a month as a result of their inability to respond to the stress of transport (36). Staples and Haugse (64) studied mortality and morbidity among young calves imported into North Dakota and found that nearly 20% of calves 7 days old

or less died, and 64% showed signs of illness, within the first 4 weeks after purchase (64). Among calves 8 to 14 days of age, 22% died and 59% became ill within 4 weeks of purchase (64). In research conducted in Texas by Cole et al. (11), of 100 calves, 12 died and 39 were treated for respiratory tract disease during the first 20 days after transport to a feedlot. Animal transport researcher Knowles (36) characterizes mortality rates of these magnitudes as "unacceptable." He points out: "Present published work indicates that calves ought not to be marketed until at least four weeks old but further studies are required to define an acceptable age limit which may turn out to be even greater than this." (36)

7. Conclusion

Because beef cattle still live a portion of their lives in pasture or on the range, under the conditions for which they evolved, cattle ranching is often viewed as the least problematic of all modern animal production systems. However, the feedlot is essentially just another factory farming model, comparable to drylots for dairy cows, or even to battery cages for laying hens or confined feeding operations for pigs. In each case the animals are confined to crowded quarters, fed an unnatural diet, mutilated to make handling easier, and fed antibiotics and/or hormones to prevent illness and promote growth. Like other intensively raised animals, beef cattle are subjected to aversive and stressful handling practices, transported long distances in crowded vehicles without food, water or rest, and slaughtered after having lived only a fraction of their natural lifespan.

No federal laws protect the welfare of beef cattle in the US, other than the Humane Method of Slaughter Act that requires humane handling and stunning of livestock before slaughter. The US cattle industry has failed to set meaningful standards for the care and handling of beef cattle, or to take a stand in opposition to any of the various practices that result in physical or behavioral problems for animals. The industry has also failed to implement any type of welfare audit system for cattle operations and has taken the position that such audits are unnecessary.

8. References

1. Agnes F, Sartorelli P, Abdi BH, Locatelli A. Effect of transport loading or noise on blood biochemical variables in calves. Am J Vet Res 1990;51:1679-1681.

2. Alam MGS, Dobson H. Effect of various veterinary procedures on plasma concentrations of cortisol, luteinsing hormone and prostaglandin F2 metabolite in the cow. Vet Rec 1986;118:7-10.

3. Anonymous. Medical groups petition FDA to ban antibiotics as feed additives citing noncompliance with FDA guidance to protect human health (US Newswire release). April 7, 2005.

4. Anonymous. Branding on way out as ID for Montana cattle. Billings [MT] Gazette, Sept 25, 2005.

5. Appleby MC, Wood-Gush DGM. Development of behaviour in beef bulls: sexual behaviour causes more problems than aggression (abstract). Anim Prod 1986;42:464.

6. Barnett JL, Eldridge GA, McCausland IP, Caple IW, Millar HWC, Truscott TG, Hollier T. Stress and bruising in cattle. Anim Prod in Australia 1984;15:653.

7. Bartlett BB, Rust SR, Ritchie HD. Survey results of the effects of a pre-shipment vaccination program on scale, morbidity and mortality of feeder cattle in northern Michigan (abstract). J Anim Sci 1987;65(Suppl 1):106.

8. Bath GF. Management of pain in production animals. Appl Anim Behav Sci 1998;59:147-156.

9. Boissy A, Le Neindre P. Behavioral, cardiac and cortisol responses to brief peer separation and reunion in cattle. Physiol Behav 1997;61:693-699.

10. Collard BL, Boettcher PJ, Dekkers JCM, Petitclerc D, Schaeffer LR. Relationships between energy balance and health traits of dairy cattle in early lactation. J Dairy Sci 2000;83:2683-2690.

11. Cole NA, Camp TH, Rowe LD, Stevens DG, Hutcheson DP. Effect of transport on feeder calves. Am J Vet Res 1988;49:178-183.

12. Edwards A. Respiratory diseases of feedlot cattle in central USA. Bovine Pract 1996;30:5-7.

13. Eldridge GA, Winfield CG. The behaviour and bruising of cattle during transport at different space allowances. Australian J Exper Agric 1988;28:695-698.

14. European Council. Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97.

15. Faulkner PM, Weary DM. Reducing pain after dehorning in dairy calves. J Dairy Sci 2000;83:2037-2041.

16. Fell LR, Shutt DA. Adrenocortical response of calves to transport stress as measured by salivary cortisol. Can J Anim Sci 1986;66:637-641.

17. Fender J. Ranchers try to save livestock from flood. Baton Rouge Advocate, Sept 27, 2005.

18. Fraser AF, Broom DM. Farm Animal Behaviour and Welfare (3rd ed). New York: CAB International, 1997.

19. Gartner E. It's like branding, but it's painless. Associated Press, Aug 10, 2003.

20. Goodrich R, Stricklin WR. Animal welfare issues: beef. In: Animal Welfare Issues Compendium. US Department of Agriculture, Cooperative State Research, Education and Extension Service, Sept 1997.

21. Goonewardene LA, Price MA, Okine E, Berg RT. Behavioral responses to handling and restraint in dehorned and polled cattle. Appl Anim Behav Sci 1999;64:159-167.

22. Grandin T. Outline of cattle welfare critical control points on feedlots, ranches, and stocker operations. Grandin Livestock Handling Systems, no date. Available at: http://www.grandin.com.

23. Grandin T. Bruises on southwestern feedlot cattle (abstract). J Anim Sci 1981;53(Suppl 1):213-214.

24. Grandin T. Behavioral agitation during handling of cattle is persistent over time. Appl Anim Behav Sci 1993;36:1-9.

25. Grandin T. Assessment of stress during handling and transport. J Anim Sci 1997;75:249-257.

26. Grandin, T. Perspectives on transportation issues: the importance of having physically fit cattle and pigs. Presentation at the Transportation Symposium at the American Association of Animal Science, July 2000. Available at: http://www.grandin.com.

27. Griffin D. Feedlot diseases. Vet Clinics NA: Food Anim Pract 1998;14:199.

28. Hoffman DE, Spire MF, Schwenke JR, Unruh JA. Effect of source of cattle and distance transported to a commercial slaughter facility on carcass bruises in mature beef cows. J Am Vet Med Assoc 1998;212:668-672.

29. Irwin MR, McConnell S, Coleman JD, Wilcox GE. Bovine respiratory disease complex: a comparison of potential predisposing and etiologic factors in Australia and the United States. J Am Vet Med Assoc 1979;175:1095-1099.

30. Ishmael W. More than money. Beef Magazine, Sept 1, 2005.

31. Jarvis AM, Harrington DWJ, Cockram MS. Effect of source and lairage on some behavioural and biochemical measurements of feed restriction and dehydration in cattle at a slaughterhouse. Appl Anim Behav Sci 1996;50:83-94.

32. Kenny FJ, Tarrant PV. The physiological and behavioural responses of crossbred Friesian steers to short-haul transport by road. Livestock Prod Sci 1987;17:63-75.

33. Kenny FJ, Tarrant PV. The reaction of young bulls to short-haul road transport. Appl Anim Behav Sci 1987;17:209-227.

34. Kent JE, Ewbank R. The effect of road transportation on the blood constituents and behaviour of calves. II. One to three weeks old. Br Vet J 1986;142:131-140.

35. Kent JE, Ewbank R. The behavioural response of 3-month-old calves to 18 hours road transportation. Appl Anim Behav Sci 1990;26:289.

36. Knowles TG. A review of post transport mortality among younger calves. Vet Rec 1995;137:406-407.

37. Knowles TG. A review of the road transport of cattle. Vet Rec 1999;144:197-201.

38. Knowles TG, Brown SN, Edwards JE, Phillips AJ, Warriss PD. Effect on young calves of a one-hour feeding stop during a 19-hour road journey. Vet Rec 1999;144:687-692.

39. Knowles TG, Warriss PD. Stress physiology of animals during transport. In: T. Grandin

(ed) Livestock Handling and Transport (2nd ed). New York: CABI Publishing, 2000, p. 385-407.

40. Knowles TG, Warriss PD, Brown SN, Edwards JE. Effects on cattle of transportation by road for up to 31 hours. Vet Rec 1999;145:575-582.

41. Knowles TG, Warriss PD, Brown SN, Edwards JE, Watkins PE, Phillips AJ. Effects on calves less than one month old of feeding or not feeding them during road transport of up to 24 hours. Vet Rec 1997;140:116-124.

42. Lambooy E. Electroanaesthesia or electroimmobilisation of calves, sheep and pigs by the Feenix Stockstill. Vet Quart 1985;7:120-126.

43. Lambooy E, Hulsegge B. Long-distance transport of pregnant heifers by truck. Appl Anim Behav Sci 1988;20:249-258.

44. Lay DC, Friend TH, Bowers CL, Grissom KK, Jenkins OC. A comparative physiological and behavioral study of freeze and hot-iron branding using dairy cows. J Anim Sci 1992;70:1121-1125.

45. Lay DC, Friend TH, Randel RD, Bowers CL, Grissom KK, Jenkins OC. Behavioral and physiological effects of freeze or hot-iron branding on crossbred cattle. J Anim Sci 1992;70:330-336.

46. Loerch SC, Fluharty FL. Physiological changes and digestive capabilities of newly received feedlot cattle. J Anim Sci 1999;77:1113-1119.

47. Mackenzie AM, Drennan M, Rowan TG, Dixon JB, Carter SD. Effect of transportation and weaning on humoral immune responses of calves. Res Vet Sci 1997;63:227-230.

48. Mader TL. Implants. Vet Clinics NA: Food Anim Pract 1998;14:279.

49. Mitchell G, Hattingh J, Ganhao. Stress in cattle assessed after handling, after transport and after slaughter. Vet Rec 1988;123:201-205.

50. Molony V, Kent JE, Robertson IS. Assessment of acute and chronic pain after different methods of castration of calves. Appl Anim Behav Sci 1995;46:33-48.

51. Morisse JP, Cotte JP, Huonnic D. Effect of dehorning on behaviour and plasma cortisol responses in young calves. Appl Anim Behav Sci 1995;43:239-247.

52. Nagaraja TG, Galyean ML, Cole NA. Nutrition and disease. Vet Clinics NA: Food Anim Pract 1998;14:257-277.

53. NCBA (National Cattlemen's Beef Association). Guidelines for Care and Handling of Beef Cattle, no date.

54. Paisley SI, Falkner TR, Brazle FK, Stokka GL. Drylot receiving program vs. pasture conditioning with micotil metaphylaxis for grazing stocker calves. Cattlemen's Day 2000, 65-67.

55. Pajor EA, Rushen J, de Passille AMB. Aversion learning techniques to evaluate dairy cattle handling practices. Appl Anim Behav Sci 2000;69:89-102.

56. Parker AJ, Hamlin GP, Coleman CJ, Fitzpatrick LA. Quantitative analysis of acid-base balance in Bos indicus steers subjected to transportation of long duration. J Anim Sci 2003;81:1434-1439.

57. Pascoe PJ. Humaneness of an electroimmobilization unit for cattle. Am J Vet Res 1986;47:2252-2256.

58. Pelley MC, Lirette A, Tennessen T. Observations on the responses of feedlot cattle to attempted environmental enrichment. Can J Anim Sci 1995;75:631-632.

59. Petrie NJ, Mellor DJ, Stafford KJ, Bruce RA, Ward RN. Cortisol responses of calves to two methods of disbudding used with or without local anaesthetic. NZ Vet J 1995;44:9-14.

60. Pollan M. This steer's unnatural life. New York Times Magazine, March 31, 2002.

61. Roeber DL, Mies PD, Smith CD, Belk KE, Field TG, Tatum JD, Scanga JA, Smith GC. National market cow and bull beef quality audit – 1999: A survey of producer-related defects in market cows and bulls. J Anim Sci 2001;79:658-665.

62. Rollin BE. Farm Animal Welfare: Social, Bioethical, and Research Issues. Ames, IA: Iowa State University, 1995.

63. Schwartzkopf-Genswein KS, Stookey JM, Crowe TG, Genswein BMA. Comparison of image analysis, exertion force, and behavior measurements for use in the assessment of beef cattle responses to hot-iron and freeze branding. J Anim Sci 1998;76:972-979.

64. Staples GE, Hauge CN. Losses in young calves after transportation. Br Vet J 1974;130:374-378.

65. Stephens DB, Toner JN. Husbandry influences on some physiological parameters of emotional responses in calves. Appl Anim Ethol 1975;1:233-243.

66. Stookey JM, Nickel T, Hanson J, Vandenbosch S. A movement-measuring device for objectively measuring temperament in beef cattle and for use in determining factors that influence handling (abstract). J Anim Sci 1994;72(Suppl 1):207.

67. Stookey JM, Schwartzkopf-Genswein CS, Watts JM. Effects of remote and contact weaning on behaviour and weight gain of beef calves (abstract). J Anim Sci 1997;75(Suppl 1):157.

68. St-Pierre NR, Cobanov B, Schnitkey G. Economic losses from heat stress by US livestock industries. J Dairy Sci 2003;86:E52-E77.

69. Sylvester SP, Mellor DJ, Stafford KJ, Bruce RA, Ward RN. Acute cortisol responses of calves to scoop dehorning using local anaesthesia and/or cautery of the wound. Aust Vet J 1998;76:118-122.

70. Sylvester SP, Stafford KJ, Mellor DJ, Bruce RA, Ward RN. Acute cortisol responses of calves to four methods of dehorning by amputation. Aust Vet J 1998;76:123-126.

71. Tarrant PV. Transportation of cattle by road. Appl Anim Behav Sci 1990;28:153-170.

72. Tarrant PV, Kenny FJ, Harrington D. The effect of stocking density during 4 hour transport to slaughter on behaviour, blood constituents and carcass bruising in Friesian steers. Meat Sci 1988;24:209-222.

73. Tarrant PV, Kenny FJ, Harrington D, Murphy M. Long distance transportation of steers to slaughter: effect of stocking density on physiology, behaviour and carcass quality. Livestock Prod Sci 1992;30:223-238.

74. Tennessen T, Price MA, Berg RT. Comparative responses of bulls and steers to transportation. Can J Anim Sci 1984;64:333-338.

75. Tennessen T, Price MA, Berg RT. The social interactions of young bulls and steers after re-grouping. Appl Anim Behav Sci 1985;14:37-47.

76. Trunkfield HR, Broom DM. The welfare of calves during handling and transport. Appl Anim Behav Sci 1990;28:135-152.

77. USDA (US Department of Agriculture). Info Sheet: Identification in beef cow-calf herds. Veterinary Services, July 1997.

78. USDA (US Department of Agriculture). Info Sheet: Marketing practices in beef cow-calf operations. Veterinary Services, May 1998.

79. USDA (US Department of Agriculture). Info Sheet: Nutritional management in beef cow-calf herds. Veterinary Services, May 1998.

80. USDA (US Department of Agriculture). Info Sheet: Reproductive technology in beef cow-calf herds. Veterinary Services, May 1998.

81. USDA (US Department of Agriculture). Info Sheet: Weaning management in beef cow-calf herds. Veterinary Services, May 1998.

82. USDA (US Department of Agriculture). Feedlot '99. Part I: Baseline Reference of Feedlot Management Practices, 1999. Veterinary Services, National Animal Health Monitoring System, May 2000.

83. USDA (US Department of Agriculture). Feedlot '99. Part II: Baseline Reference of Feedlot Health and Health Management, 1999. Veterinary Services, National Animal Health Monitoring System, November 2000.

84. USDA (US Department of Agriculture). Feedlot '99. Part III: Health Management and Biosecurity in U.S. Feedlots, 1999. Veterinary Services, National Animal Health Monitoring System, December 2000.

85. USDA (US Department of Agriculture). Escherichia coli 0157 in United States Feedlots. Veterinary Services, National Animal Health Monitoring System, October 2001.

86. USDA (US Department of Agriculture). Cattle on feed, number of operations. National Agricultural Statistics Service, 2004.

87. USDA (US Department of Agriculture). Non-ambulatory cattle and calves. National Agricultural Statistics Service, May 2005.

88. USDA (US Department of Agriculture). 2004 US Animal Health Report. Agriculture Information Bulletin No. 798. Animal and Plant Health Information Service, August 2005.

89. USDA (US Department of Agriculture). A Preliminary Assessment of the Effects of Katrina and Drought on US Agriculture. Office of Chief Economist, Sept. 19, 2005.

90. Van Donkersgoed J, Jewison G, Mann M, Cherry B, Altwasser B, Lower R, Wiggins K, Dejonge R, Thoriakson B, Moss E, Mills, C, Grogan H. Canadian beef quality audit. Can Vet J 1997;38:217-225.

91. Vickers KJ, Niel L, Kiehlbauch LM, Weary DM. Calf response to caustic paste and hot-iron dehorning using sedation with and without local anesthetic. J Dairy Sci 2005;88:1454-1459.

92. Warriss PD, Brown SN, Knowles TG, Kestin SC, Edwards JE, Dolan SK, Phillips AJ. Effects on cattle of transport by road for up to 15 hours. Vet Rec 1995;136:319-323.

93. Watts JM, Stookey JM. Effects of restraint and branding on rates and acoustic parameters of vocalization in beef cattle. Appl Anim Behav Scie 1999;62:125-135.

94. Waynert DF, Stookey JM, Schwartzkopf-Genswein KS, Watts JM, Waltz CS. The response of beef cattle to noise during handling. Appl Anim Behav Sci 1999;62:27-42.

95. Wilson SC, Mitlohner FM, Morrow-Tesch J, Dailey JW, McGlone JJ. An assessment of several potential enrichment devices for feedlot cattle. Appl Anim Behav Sci 2002;76:259-265.

96. Wittum TE, Woollen NE, Perino LJ, Littledike ET. Relationships among treatment for respiratory tract disease, pulmonary lesions evident at slaughter, and rate of weight gain in feedlot cattle. J Am Vet Med Assoc 1996;209:814-818.

97. Zavy MT, Juniewicz PE, Phillips WA, Von Tungeln DL. Effect of initial restraint, weaning, and transport stress on baseline and ACTH-stimulated cortisol responses in beef cattle of different genotypes. Am J Vet Res 1992;53:551-557.

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