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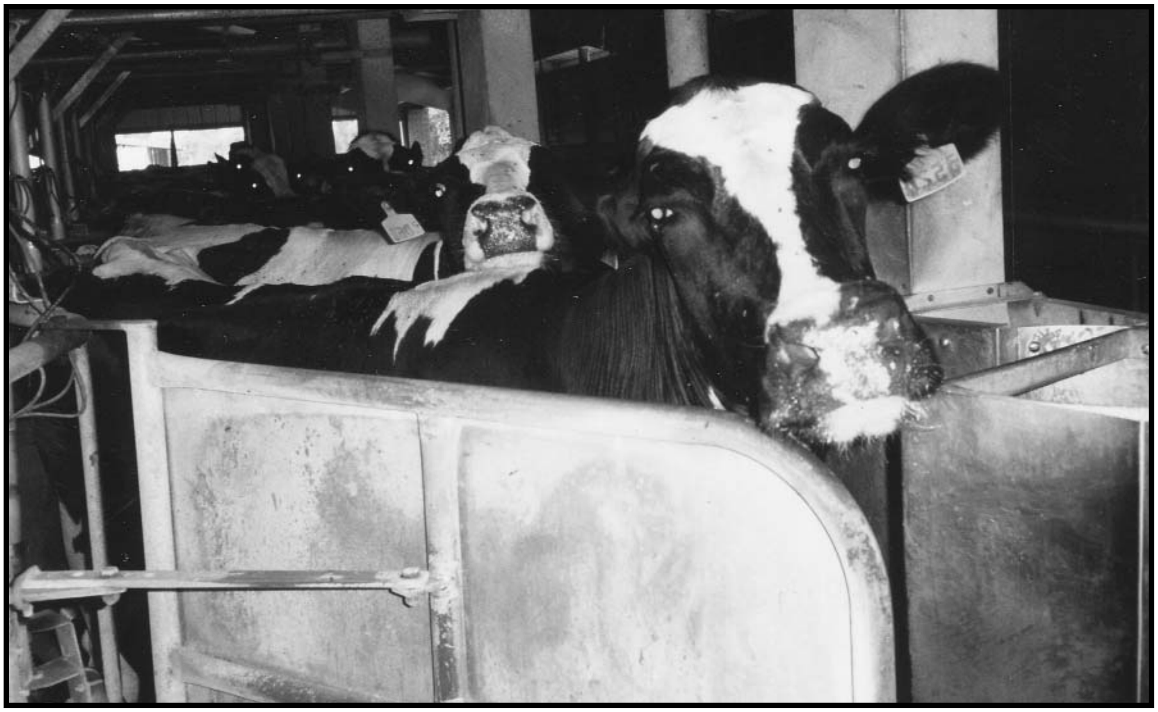
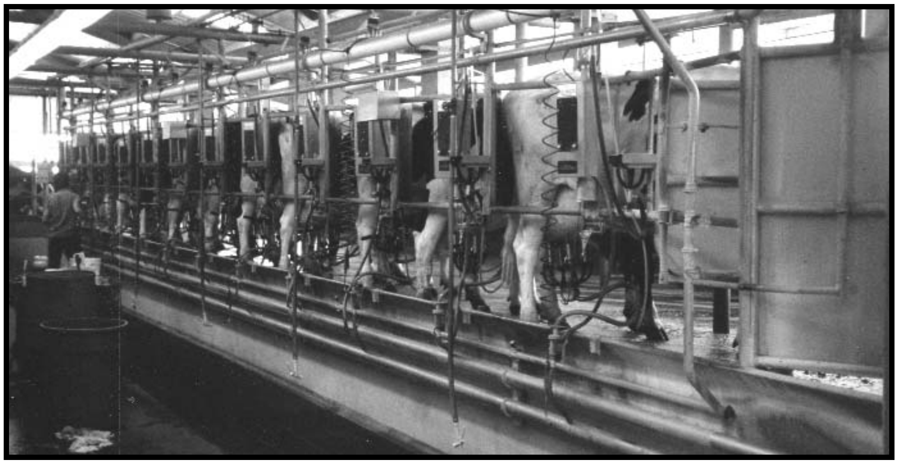
The Welfare of Cattle in Dairy Production



A Summary of the Scientific Evidence

A Farm Sanctuary Report

1. Introduction



Public perception of dairy cows is of animals enjoying tranquil lives in a bucolic setting – grazing in lush pastures during the day and sleeping in straw-bedded barns at night. Reality, however, is quite different. Three out of four dairy cows in the United States never graze in pasture, and a significant proportion are not provided routine access of any kind to the outdoors. Those who are housed outside are usually confined to a large, barren dirt lot that is hot and dusty in summer and cold and muddy in winter.

Dairy cattle in the U.S. are increasingly being raised on large corporate operations employing factory-farming techniques. These mega-dairies have decreased costs through intensively raising hundreds or thousands of animals, while they've increased revenues through continually pushing their cows to produce more milk. Small, family dairy farms cannot compete and are slowly being driven out of business.

Since 1991, the number of total U.S. dairies has dropped 55%, while the number of dairies with a herd of 100 or more cows has increased 94%, as illustrated in the table below. According to the U.S. Department of Agriculture (USDA), National Agricultural Statistics Service, there were 1,310 U.S. dairy operations with 1,000 or more cows in 2004. The average number of cows per dairy in California, the nation's largest dairy state, increased from 472 in 1990 to 721 in 2001 (7). Plans have been announced to build the West's largest dairy, housing 90,000 cows on 2,000 acres in southern California's Mojave Desert (4).

NUMBER & SIZE OF U.S. DAIRY OPERATIONS, 1991 – 2004

Year	No. of Dairies (thousands)	Dairies with 100+ Cows (percent)
1991	180.6	11.5
1992	170.5	13.0
1993	157.2	13.7
1994	148.1	14.5
1995	139.7	15.2
1996	131.0	16.1
1997	123.7	17.3
1998	117.2	18.4
1999	111.0	19.0
2000	105.2	19.9
2001	97.6	20.8
2002	92.0	21.3
2003	86.4	21.7
2004	81.4	22.3

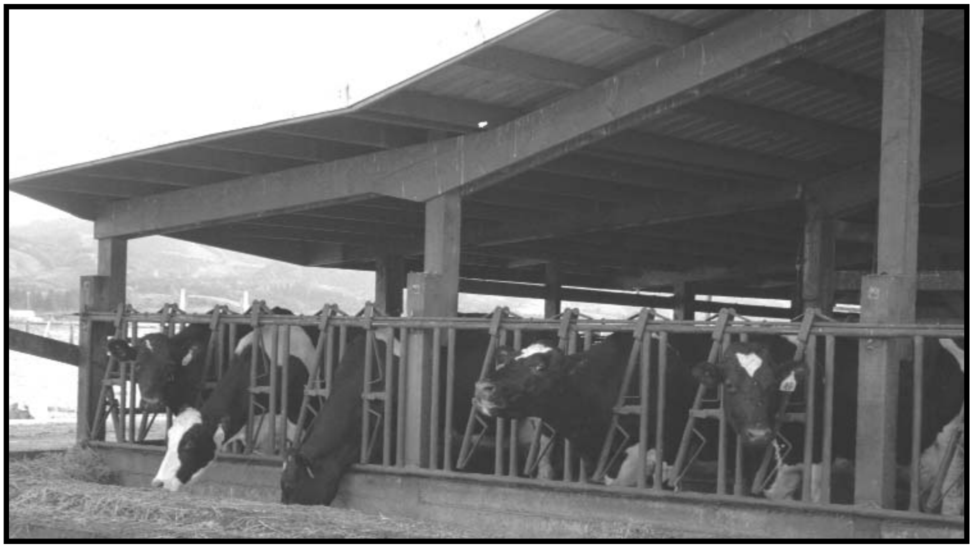
Sources: USDA, APHIS, National Animal Health Monitoring System. Dairy 2002, Part II: Changes in the United States Dairy Industry, 1991-2002. June 2003; USDA, National Agricultural Statistics Service. Agricultural Statistics, 2004.

Consolidation of the U.S. dairy industry is being accomplished by increasing the amount of milk produced by each cow while reducing the costs of caring for the animals. Dairy cattle are suffering a variety of physical, psychological, and behavioral problems as a result. This report offers a portrayal of how both standard industry husbandry practices (feeding, housing, flooring, sanitation, surgical mutilations, and handling methods) and industry production practices (nutrition, milking and reproduction procedures, and the administration of growth hormones) affect the health and welfare of dairy cattle.

2. Husbandry Practices

This section includes discussions of feeding, housing, and handling practices as well as environmental conditions that affect the health and welfare of dairy heifers and cows. The treatment of dairy calves, both male and female, is also addressed.

2.1 Feeding Practices



The feeding of dairy cattle – including the number, size, and location of feeding stations – has an impact on the health and welfare of the animals. The timing of feed delivery also has an effect. Some dairy cows are fed restricted amounts, while others are fed ad libitum. In either case, feed is usually delivered at set times, twice daily.

The most common practice is to deliver feed while cows are away for milking. It is thought that the presence of fresh feed immediately upon return from milking dissuades cows from lying down right away, thus reducing the risk of infection that may occur from open teat canals coming in contact with the floor surface. Providing feed allows time for the canals to close while the cows eat (34). In fact, DeVries et al. (34) found that cows who did not have fresh feed immediately available upon return from milking lay down, on average, 20 minutes sooner than cows who had feed available. However, the researchers also noted that cows fed 6 hours after milking increased their total daily feeding time and had fewer aggressive interactions at the feed galley after returning from milking (34). Therefore, it appears there may be welfare advantages to both feeding immediately after milkings and feeding between milkings.

Indoor housing for dairy cows typically consists of barns with either open or tether stalls (see Housing section). In most stall barns the stalls are not evenly distributed in relation to the distance cows must walk to reach feed and water troughs. As a result, dominant, higher-ranking animals that are able to secure stalls close to troughs are at an advantage. In barns with higher animal density and reduced space allowances, aggression is more common because cows must compete for lying and eating spaces (47). Those animals less successful in competing for space will have to eat at less desirable times and may eat lesser amounts of feed.

Dairies attempt to reduce construction and maintenance costs by building larger barns that accommodate more animals. Larger herds, however, may translate to more heterogeneous groups and the mixing of animals of different sizes and temperament. Hindhede et al. (59) found that when dairy heifers of different sizes were grouped together, the welfare of light heifers was negatively affected by their spending less time eating than when grouped with animals of a similar size. On the other hand, heavy heifers benefited from heterogeneous housing because they were able to "steal" feed from the smaller heifers (59).

Some dairy operations also attempt to save money by limiting the size of the feeding area and/or the number of feeding stations. Olofsson (92) studied the ad libitum intake of feed with 1 versus 4 cows per feeding station and found that the number of displacements at the feeding stations increased dramatically with the higher level of competition. Cows of lower social rank were typically displaced when eating by cows of higher rank (92). Olofsson & Wiktorsson (93) also observed displacements and shortened feeding times in studying the feeding of a restricted diet with 1 or 4 cows per feeding station.

Swedish animal protection law recommends that competition not exceed three cows per feeding space for ad libitum feeding (92). No regulations pertaining to feeding space exist in the U.S.; however, the U.S. Milk and Dairy Beef Quality Assurance Center recommends that dairy cows be provided 24 to 30 inches of bunk space "to allow every animal uninterrupted feeding" (22). The guidelines also recommend that space be provided to allow all heifers to eat simultaneously (22).

2.2 Surfaces and Lameness

Lameness is considered by some to be the single most common cause of suffering in dairy cattle (19). The incidence of lameness in a herd is likely related to multiple factors including diet, feeding practices, housing, and environmental conditions. Abnormally large udders, due to overproduction of milk, also cause dairy cows to have an unnatural gait and damage to the hind feet. One survey of 37 dairy farms in Britain documented a mean annual lameness prevalence rate of 20.6% (27).

In the U.S., producers responding to a 2001 survey conducted by the National Animal Health Monitoring System reported a lameness incidence rate of 11.6% (134). Producers responding to the survey also indicated lameness was the cause of 16.3% of dairy cow culling in 2001 (134). The occurrence of the problem is likely higher than reported by producers. A study conducted by Wells and others (152) found that the actual prevalence of lameness in 17 dairy herds in Minnesota and Wisconsin was 2.5 times greater than that which had been estimated by the herd managers. The herd managers had classified as lame only 40% of the cows judged to be lame by the investigators, suggesting that many cases of mild to moderate lameness go undetected.

Lameness is commonly caused by laminitis lesions. Murray et al. (88) documented 15 different types of hoof lesions associated with lameness in a sample of 5,000 dairy cattle from 37 farms in England and Wales. The most common lesions were sole ulcer, white line lesions, local sole bruising, and digital dermatitis. Of the 8,645 lesions documented by the survey, 92% were in the hind limb and 8% in the front limb. The outer hoof was the site within the foot of 68% of the lesions; 12% were in the inner hoof, and 20% of the lesions were associated with the skin.

A study on four New York dairy herds found that cows with laminitis lesions were 1.77 times more likely than cows without lesions to be culled (91). According to Nelson and Cattell (91), an unpublished study of 815 dairy cows at slaughter found 84% of the animals had laminitis lesions on one or both of their hind feet.

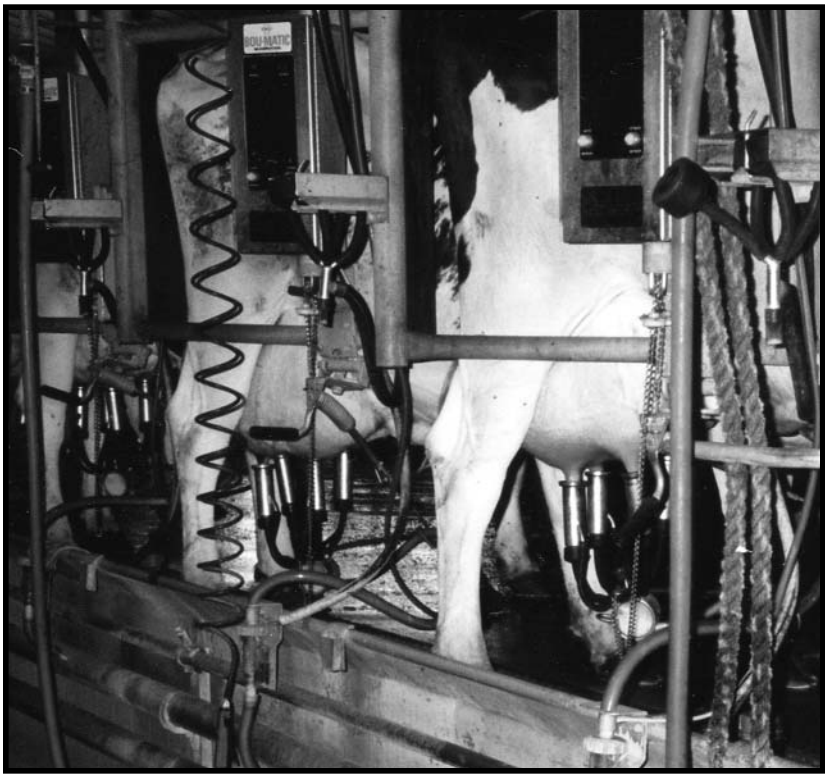
Given that a vast majority probably experience a foot or leg problem at some point in their lives, the potential for suffering in dairy cattle as a result of lameness is great. Whay et al. (155) attempted to measure pain in lame dairy cattle by measuring sensitivity to noxious stimuli. The researchers found that cows exhibiting lameness in either one (unilateral) or both (bilateral) hind legs demonstrated significantly increased sensitivity to noxious stimuli, and they found that the sensitivity in unilaterally lame cows persisted even 28 days after treatment for lameness.

Broom (20) noted that the ability of lame dairy cows to perform various behaviors is impaired, which may have negative consequences for their normal biological functioning. "Lameness always means some degree of poor welfare and sometimes means that welfare is very poor indeed," stated Broom.

2.2.1 Indoor Walking Surfaces

Ideal walking surfaces for dairy cattle provide good grip without coarse projections (41). Very smooth surfaces can cause cows to slip and fall, while surfaces that are too rough result in bruising and other injuries that can lead to lameness. A two-year survey of British dairies evaluated the adequacy of 3,190 walking surfaces and classified 75% of the surfaces as unsatisfactory the first year and 66% as unsatisfactory the second year (41). Wells et al. (151) reported that dairy herds with the highest rates of digital dermatitis walked on grooved, slatted, or smooth concrete and herds with the lowest rates walked on textured concrete.

The presence of excreta on walking surfaces causes discomfort to cows and predisposes them to developing leg and foot problems. Fecal contamination reduces the cow's walking speed and produces an abnormal walking pattern (101). Poor hygienic conditions, including damp cubicles, were reported to be a risk factor in the development of heel erosion in research results reported by Philipot et al. (98). Wells and others (151) determined that rates of digital dermatitis were higher in cows standing on floor that was always wet compared with cows standing on floor that was wet about half the time or usually dry.



2.2.2 Mattresses and Bedding

Most cattle confined indoors in the U.S. are kept on concrete. Cows housed on bare concrete floors have difficulty standing up and lying down (56). Prolonged standing on bare concrete may result in circulatory problems and the development of sole lesions and other forms of lameness (47, 120). Somers et al. (121) reported that over 80% of cows exposed to concrete flooring suffered from at least one hoof disorder.

Faull and others (41) evaluated 2,000 stall beds at 37 British dairies and found that 75% had a concrete base, and of those 74% were classified as having inadequate bedding.

Use of cushioning mattresses and bedding can lessen the negative effects of a concrete base. Cows housed on some type of mat or mattress exhibit increased comfort by spending more time lying. In a study by Haley et al. (56), cows housed on mattress flooring spent on average 1.8 hours per day longer lying, and the length of the individual lying bouts increased by 16 minutes, compared with cows housed on concrete. Covering mattresses with additional bedding also facilitates lying behavior. When Tucker and Weary (131) allowed cows to choose between bare mattresses and mattresses covered with either 1 or 7.5 kg of sawdust, all animals spent a majority of their time lying or standing on the mattresses with the thickest bedding.

Several studies have been conducted to determine dairy cow preference for various types of mattresses and bedding materials, including sawdust, sand, waterbeds, foam mattresses, rubber-filled mattresses, mattress containing a combination of foam and rubber, and rubber mats. Tucker and others (132) found that mattresses were less preferred than either sand or sawdust. In studying skin lesions associated with those bedding surfaces, Weary and Taszkun (149) found more numerous and more severe lesions on cows housed on mattresses than on cows housed on sand beds, with lesions on cows housed on sawdust being intermediate between the other two. When testing different types of stall bases, Wagner-Storch et al. (144) recorded cow preferences for the various surfaces in the following order (from most to least preferred): sand, mattress type 1, mattress type 2, waterbed, rubber mat, and concrete. Sand has also been shown to be associated with significantly less lameness than the combination of rubber-filled mattress and sawdust bedding (32).

The differences between rubber mattresses, rubber mats, and rubber slats may be only minor. Laven and Livesey (74) reported no benefit on lameness from replacing rubber mats with thicker mattresses filled with chopped rubber. In addition, Hultgren (64) observed that cows on rubber slatted flooring took less time preparing to lie down and slipped less frequently during rising than cows on solid rubber mats; however, there was some evidence that the cows preferred lying on a solid floor. Chaplin et al. (24) found that cows on mattresses tended to be dirtier than cows on mats, but cows on mattresses appeared to be more comfortable, spending more time eating, ruminating, and lying, and spending a greater proportion of their lying time ruminating. Cows seem to generally prefer the thicker mattresses to mats, but both type beds have been shown to lose their cushioning ability over time (46).

2.2.3 Outdoor Walking Surfaces

While natural ground surfaces appear to present less of a threat to animal welfare than indoor concrete, they can still pose problems. Fields exposed to hot, dry weather may become hard and rough (63). Faull and others (41) evaluated outdoor walking surfaces at 3,335 sites in Britain over 2 summers. They found that, overall, only about 25% of the outdoor surfaces were satisfactory, while 70% were scored as too rough, of which about one-third were considered very rough. The outdoor walking surfaces evaluated included fields, tracks, gateways, and the area surrounding water troughs.

When dairy cows are kept on pasture, they make paths between pasture and water troughs and between pasture and the milking facilities. When allowed to choose their path, cows repeatedly walk on a particular one. Ward (145) observed that dairy cows walking on these paths looked carefully at where they placed each front foot to avoid stones. If cows are rushed or forced to walk too closely together, they cannot see the ground and may harm their feet by stepping on stones (145). Clackson and Ward (26) observed increased incidence of lameness when the farmer demonstrated impatience by using a tractor or dog to push the cows along the path. Because lame cows typically walk at the back of the herd they are more affected by an impatient handler; they are crowded together and cannot see where to place their feet (26).

Allowing vehicles to use cow paths can be detrimental because they may cause damage to the paths and deposit small stones that injure the cows' feet. In addition, it is important that paths be regularly maintained to allow for drainage after a heavy rain and prevent the accumulation of mud. Clackson & Ward (26) observed a higher lameness incidence where paths were less maintained. The design and condition of gateways that cows must walk through are also important, as bottlenecking may prevent the animals from placing their feet properly (26).

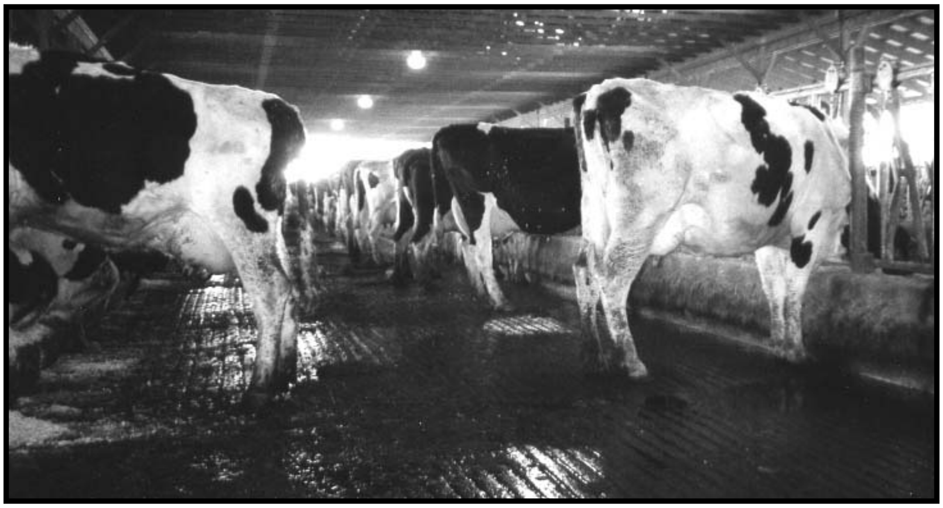
Cows appear to experience less difficulty walking on some surfaces as compared to others. Clackson and Ward (26) describe ideal outdoor cattle walking surfaces as "soft, springy field with no stones; smooth swept tarmac; or grassy track or walk without stones." Hughes et al. (63) conducted a study of outdoor walking surfaces in which cows were allowed to choose between walking on purpose-built paths covered with coarse wood chips, purpose-built paths covered with a quarry dust, or an undeveloped hard, pitted lane previously used by both cows and vehicles. Almost immediately, the cows chose to walk on the developed paths regardless of the surface material. They walked with confidence and their pace quickened on the prepared paths; moreover, lame cows were noticeably less lame on the maintained surfaces.

2.3 Housing

Several different methods are used to house dairy cattle. These include pastures; loose housing in earthen corrals ("drylots"); loose housing in indoor- or outdoor-bedded pens ("straw yards"); barns with open cubicles ("free stalls"); and barns with tether cubicles ("tie stalls"). Many operations employ a combination of housing types. For example, cows may graze in pastures during the day and be housed in free-stall barns at night. Cows housed primarily indoors in either tie or free stalls may be allowed outside in corrals for periods of exercise each day. Or, cows may be housed in dirt corrals with free access to open-air stall barns. The type of housing may vary by the season of the year or the production stage of the animal.

The USDA (134) periodically surveys dairy operations regarding their primary housing facilities for unweaned dairy heifers, weaned dairy heifers, lactating dairy cows, and maternity housing. Housing of dairy cows in the U.S. generally varies by the weather and geographic conditions of the region of the country where the dairy is located. Dirt lots with head-locking feed troughs are located in warm, semi-arid regions. Pastures and shelters are used in warm, humid areas; naturally ventilated barns with free stalls are common in cool, humid climates, and insulated barns with tie stalls are used in colder regions (1).

2.3.1 Tie Stalls



In 2001, tie stalls were the primary type of inside housing for lactating dairy cows on 52.5% of U.S. dairy operations (134). In addition, 16.5% of dairies used tie stalls as the primary indoor housing type for maternity cows (134). This housing method has been shown to have significant negative health and behavioral consequences for dairy cows.

How often and for how long cows lie and how long cows stand without eating are probable behavioral indicators of cow comfort (57). Dairy cows restrained in tie stalls lie for shorter periods and stand idle, without eating, for longer periods than cows housed individually in large pens with mattress flooring (57). They also change from a lying to a standing posture, and vice versa, less frequently, suggesting that cows in tie stalls are more reluctant to change position than unrestrained cows (57).

Moreover, tied cows take considerably longer to complete the process of lying down than cows unrestrained in a straw pen, and cows in tie stalls make four to five times more attempts to lie down per completed lying-down than cows on pasture (64). Regula et al. (106) found that cows exhibiting delayed or abnormal rising from a lying position were more likely to experience lameness, skin injuries, teat injuries, and dirty udders. This research suggests that cows in tie stalls experience a lower level of welfare than cows housed in free stalls.

Cows in tie stalls also have more limited social interactions with other cows than unrestrained cows. Isolating cows in this manner and restricting or depriving their opportunity to lie down freely can result in stress. Munksgaard and Simonsen (87) found that both the amount of leaning and the frequency of grooming and standing idle increased when cows were prevented from lying down or were isolated from other cows. When cows housed in this manner were exposed to novel situations, the animals exhibited behavioral and physiological responses indicative of stress, leading the researchers to conclude that socially isolated cows experience frustration and that cows find being deprived of the chance to lie down aversive (87).

Health problems have also been associated with use of tie stalls. Mammary infections and/or teat injuries have been found to be more common in cows kept in tie stalls compared to cows kept in free stalls or straw yards (65, 106). Bartlett et al. (12) reported increased prevalence of mastitis-associated environmental streptococci with tie stall use, and Gustafson (55) noted that dairy cows tied continuously had more cases of subclinical mastitis than cows given the opportunity to exercise each day. Gustafson (55) also reported that continuously tied cows had more frequent treatments for disease overall and a higher culling rate, as well as increased occurrences of parturient paresis, bloat, and hoof and leg disorders. Cows in tie stalls with minimal outdoor access had higher rates of lameness, skin injuries around the hock, and callosities at the carpal joints than cows in tie stalls with regular outdoor exercise or cows in loose housing with regular outdoor exercise in research reported by Regula et al. (106).

2.3.2 Free Stalls

According to the USDA (134), in 2001, 30.8% of U.S. dairies used free stalls as their primary type of indoor housing for lactating cows.

The incidence of mastitis has been found to be lower in free stalls than tie stalls (65). In addition, free-stall housing allows cows to behave more normally than tie stalls (see discussion of Tie Stalls). While the welfare of dairy cows appears to be generally higher in free stalls as compared to tie stalls, problems may result if there are too few stalls for the number of cows, or if the stalls are poorly designed, too small, or not well maintained.

The size and design of stalls is important because it affects the social and physical behavior of cows, which in turn affects susceptibility to lameness and other health problems. Poorly designed or maintained stalls cause cows to spend less time resting and more time standing idle, which can contribute to lameness by increasing exposure to damaging mechanical forces and slurry (16, 50). Cook et al. (32) noted several studies that have reported higher rates of lameness in free stalls than tie stalls and suggested that the cause may be differences in hoof hygiene, factors influencing free stall access by cows, and differences in cow behavior between the two systems.

Faull and others (41) studied dairy cows at pasture and found that they required approximately 240 cm x 120 cm lying space and an additional 60 cm lunging space for rising. They then evaluated 170 cubicles on 37 British dairy farms and determined that 87% of the stalls did not meet these space requirements. After observing over 1,500 cow attempts at lying down, rising, and standing, the researchers concluded that only 12% of the cubicles permitted freedom of movement. They found that 10% of cows were moderately or severely restricted when lying down, 33% when rising, and 55% when standing.

One particular problem with stall design is the height of the curb, or the step up from the passageway to the stall. Faull et al. (41) classified 76% of the curbs they observed as being more than 20 cm high or "very high." In another survey of nearly 5,000 dairy cows on 160 French dairy farms, step heights of 20 cm or more were associated with an increased incidence of lameness (98). Steps can also present problems at the entrance to milking parlors and feeding areas. High steps at any location in the dairy force cows to transfer their weight onto their hind feet for a long period of time and/or repeatedly during the day (98).

According to Broom (20), cubicle housing systems "do not provide an environment to which cows can adapt easily" and "even the best cubicle housing systems seem to have some lameness problems which are exacerbated by social factors." For example, the length of free stalls has been associated with skin and foot/leg problems. Weary and Taszkun (149) found a significant correlation between stall length and skin lesions, with cow using shorter stalls having more severe lesions. The researchers speculated that producers might prefer shorter stalls to save on building costs or to prevent cows from defecating in the stall as opposed to the free stall alley, which is more easily cleaned.

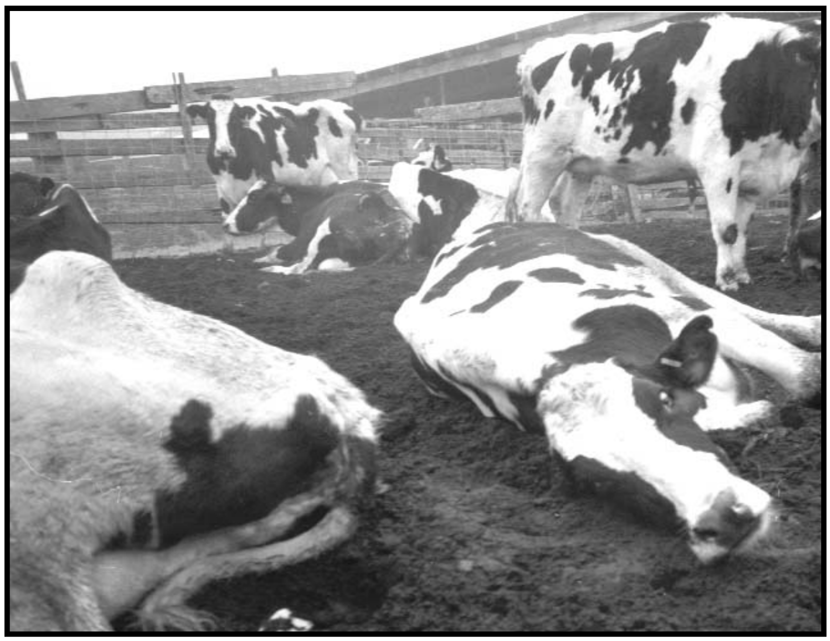
Berry (16) agrees that long stalls will result in cows defecating and urinating on their bedding, which will increase maintenance costs and may contribute to the occurrence of mastitis. Tucker et al. (133) found that both stall length and width affected the amount of time cows spent standing with only the front hooves in the stall. In their study cows tended to spend more time standing with all four hooves in the stall when the stalls were wider, but these stalls also were more likely to become soiled. Therefore, larger stalls appear to be more conducive to animal welfare, but they require proper management to avoid health problems such as mastitis and lameness.

The ratio of stalls to cows is also very important to animal welfare. Animal care guidelines of the Milk and Dairy Beef Quality Assurance Center note that because not all animals will want to be in stalls at the same time, having more than 1 animal per stall is acceptable, up to a maximum of 1.2 cows per stall (22). However, research suggests the opposite: that dairies should provide more available stalls than the total number of animals. In a study where heifers were housed at a 2:1 heifer-to-cubicle ratio, individual lying times varied widely with some cows spending consistently longer lying down than others (76). The individuals with shorter lying times were far more likely to become lame than the cows who were able to lie for longer periods of time. In another study, a 1:1 cow-to-cubicle ratio resulted in a lameness incidence rate of 42% (49). Overcrowding appears to be a particular problem for lower-ranking cows whose movement through passageways is often blocked by higher-ranking individuals. As a result, lower-ranking cows spend less time lying and more time standing idle while they wait for available spaces to move to or stalls to lie down in (49, 50). Lower-ranking cows are more likely to stand only part way inside a cubicle as a means of avoiding dominant individuals. It is likely easier for a lame cow to lie outside a cubicle than compete for a cubicle space (48). Galindo et al. (49) proposed that these low-ranking cows who stand halfway inside cubicles have a greater reduction in the depth of their heel, which predisposes them to infection and lameness.

Galindo and Broom (47) offer the following recommendations for stall housing design to reduce the incidence of lameness:

All possible modifications to encourage and allow lying behaviour should be made including a high quality floor and proper bedding and design of cubicles. The cubicle to cow ratio generally recommended is 1:1. However, this does not mean that all cows in a group will have a lying place guaranteed and that they will be able to lie for the length of time they want. It is advisable, therefore, that farmers always have a spare number of cubicles to provide options for lying to those cows reluctant to use specific cubicles or that are displaced more frequently from some areas.

2.3.3 Straw Yards



Straw yards are multiple-animal, bedded pens, used primarily by dairies in Europe. The pens may be located indoors or outdoors. In the U.S., 11.2% of dairy operations use multiple animal pens for housing lactating dairy cows, and 29.3% use multiple animal pens for maternity housing (134). However, the surface of these pens is not reported, and therefore the research regarding the animal welfare impacts of straw-bedded yards may not be applicable.

Bedded pens, whether indoors or outdoors, offer some benefits in terms of animal comfort and the opportunity for social interaction and exercise. Broom (20) suggests that well maintained straw yards may be the most successful form of dairy cow housing "as they give the cows more opportunity to control their interaction with their environment." In comparing the health and behavior of dairy cows housed in straw yards and those housed in stalls, Phillips and Schofield (102) found that straw yard cows spent more time lying and feeding and less time standing or walking, except during estrus. They also performed more social behavior during estrus, such as sniffing and licking other cows. Other studies have reported that cows housed in straw yards spend more time lying down and ruminating than cows housed in stalls (45, 119, 120). Ward (145) observed that a herd of very large cows lay for as long on a straw yard as did cows in another herd kept on pasture.

Standing on straw yards appears to cause less foot damage than standing on concrete. Switching cows from stall to straw-yard housing significantly reduced the incidence and persistence of lameness in two studies reported by Hughes et al. (63). Phillips and Schofield (102) and Webster (150) found less reduction in heel depth in cows housed in straw yards than cows in stalls. Webster (150) also documented less severe and persistent hemorrhagic lesions of the sole among straw-yard housed cows. White line hemorrhages, another contributing factor in cow lameness, are exacerbated by cubicle housing and alleviated by housing in straw yards (75). Moreover, housing first-time lactating cows in straw yards significantly reduced the occurrence of hoof horn hemorrhages in a study conducted by Laven and Livesey (74). In another large study comparing several housing methods, cows kept in straw yards had significantly fewer numbers of hoof disorders than cows housed by any other method (121).

The impact of housing in straw yards on mastitis incidence is less clear. Hultgren (65) found that clinical mastitis and teat injuries decreased when cows were switched from tie stalls to open stalls or straw yard housing. Other studies have shown higher mastitis rates among cows housed in straw yards than among cows housed in open stalls (15, 45, 96). It has been suggested that higher rates of mastitis in straw yards may be explained by the increased periods of lying down (15) and may be related to the cleanliness of the yard (63) (see discussion of Environmental Sanitation and Mastitis).

2.3.4 Drylots

The use of unpaved dirt lots for full-time housing of dairy cows, both lactating and dry, has become popular in California and the southwestern U.S. (1). According to a survey conducted in 2001 by the USDA (134), drylots were the primary outdoor housing area for weaned heifers on 40.2% of U.S. dairy operations. Drylots were the primary outdoor housing for lactating cows on 31.0% of operations and the primary outdoor housing method for maternity cows on 26.9% of U.S. dairies (134).

Cows may be kept in drylots continuously except for milking. Their ability to feed, sleep, and exercise is limited by environmental conditions, as well as the amount of space allotted per animal. Animals of lesser social rank have difficulty escaping more aggressive animals and, as a result, may not get enough feed or rest. To save on labor costs, some drylot operations make use of self-locking feeding stanchions, which are upright posts that fit around a cow's neck to limit forward and backward motion (18). However, restraining dairy cows in self-locking stanchions has been shown to affect behavior. Bolinger et al. (18) found that cows restrained for 4 hours per day spent more time lying after release, ate less frequently, ruminated less during the day following release, and increased grooming during all times when they were not locked up. Aggression between cows also increased following restraint. These behaviors suggest that restraint of this type has a negative impact on the animal's welfare.

Dirt lots often fail to provide adequate protection from environmental elements, including excessive wind, solar radiation, and precipitation. Heavy rains can cause dairy cows to be mired in several inches of mud and manure. The cows become exhausted by not being able to lie down (which they normally do for about 12 hours per day) or to eat, and may die as a consequence. During the winter of 2004-2005, torrential rain in southern California caused cows stuck in mud to die at 10-15 times the normal rate (14, 60). Dairy care guidelines published by the Milk and Dairy Beef Quality Assurance Center note, "All animals should have the opportunity to lie down on dry areas." (22) However, many dairy drylots don't meet this requirement.

Cows housed continuously in dirt lots may be at increased risk of developing mammary infections due to the presence of environmental pathogens in the dirt and manure. Therefore, corrals must be cleaned frequently to prevent the accumulation of mud and manure. The density of cows per acre of drylot may be so high, however, that proper management of the waste is extremely difficult. In 1972, the average number of lactating cows at a 30- to 40-acre dairy in southern California was 250; today, the average number of cows at the same size dairy is 800-1,000, or 3 to 4 times higher (113).

Drylots may also contribute to lameness, especially if the ground is frequently muddy. In one of the few studies to evaluate the effect of drylot housing on dairy cow health, Wells et al. (151) found a higher incidence of papillomatous digital dermatitis among lactating cows housed only in drylots (36.6%) compared to cows housed in pasture and drylot (21.0%) or cows housed solely in pasture (10.7%). Digital dermatitis, or "footwarts," is a superficial skin disease causing painful lesions and is considered a significant cause of lameness in dairy cows (151). In an analysis of 37 southern California dairies, the odds of having more than 5% of cows affected with digital dermatitis was 20 times greater in dairies with muddier corrals than in dairies with drier lots (108).

2.3.5 Pasture

In 2001, 75.3% of dairy cows in the U.S. had no access to pasture (134). The percent of cows with no access to pasture is up sharply from 1996, when 50% had some form of pasture access (134). That year 15.1% of dairies provided lactating cows with no access of any kind to the outdoors, and 30.9% had no outdoor access for maternity cows (134). In most cases where outdoor access is provided, it is in the form of drylot corrals with no pasture grazing.

Pasture grazing allows cows to behave more naturally and reduces stress. Galindo and Broom (50) observed significantly fewer aggressive interactions between cows when on pasture than confined. They also found that while grazing during the most active part of the day, approximately 80-90% of cows at pasture showed behavioral synchrony (meaning they performed the same behaviors like eating and sleeping simultaneously) compared to only 50-60% of the same cows when housed indoors.

Cows kept on pasture are at a reduced risk of developing lameness (20). Wells et al. (151) found that lactating cows with daily access to pasture in winter were less likely to develop papillomatous digital dermatitis. Somers et al. (121) reported that cows housed indoors year-round and receiving no grazing were at higher risk for most hoof disorders compared with cows given some pasture access. Similarly, a large study of lameness among 5,000 dairy cattle found the incidences of hoof lesions were lower among cows on grass (88). In this study, each common hoof lesion, with the exception of penetration of the sole by a foreign body, occurred more frequently in the winter housing period than during the summer grazing period. Even only partial confinement feeding can increase the incidence of lameness-associated conditions over complete pasture grazing (99). However, pasture cows may experience some leg and foot problems if pastures are overcrowded, muddy, or rocky (13) or if cow paths are not well maintained (see Outdoor Walking Surfaces).

Other health problems, including dystocia, retained placenta, parturient paresis, and ketosis, may be less common among grazing cows (13). Several studies have documented a decrease in incidence rates of mastitis (9, 13, 116, 143, 146, 147), tramped teats (13), and udder health problems (51) among cows allowed to graze. Washburn et al. (147) reported cows in confinement had 1.8 times more cases of mastitis and were culled eight times more often for mastitis than cows on pasture.

While confinement dairies often argue that pasture grazing is not economical, cost comparisons of grazing and confinement systems have demonstrated that grazing of pastures can be a competitive alternative for dairy cow feeding. A pilot grazing project in Minnesota documented a higher average net return of $64 per cow for grazing than for confinement due to lower costs for feeding, facilities, equipment, and labor in the pasture system (112).

2.4 Environmental Conditions

A dairy cow's physical environment, both indoors and outdoors, have a direct effect on her physical health and welfare. Environmental conditions discussed in this section include environmental sanitation, air temperature and humidity, and stray electrical voltage. (The effect of lighting levels on dairy cattle welfare is discussed in the Production section.)

2.4.1 Environmental Sanitation and Mastitis

Mastitis is a major health and welfare issue for dairy cows. U.S. dairy producers named mastitis as the most common reason for culling dairy cows and the second most common cause of death in dairy cows in 2002 (134). That year, U.S. dairy producers reported 26.9% of their dairy cows were culled for mastitis, and 17.1% of on-farm deaths in dairy cows were due to the disease (134). In a survey of 3,009 milk operations in Great Britain, the mean incidence of clinical mastitis was reported as 22.8% (96).

Mastitis is an infection of the mammary gland caused by the transmission of either contagious or environmental pathogens (96, 115). The most common contagious mastitis pathogens include streptococci and staphylococci, and the primary route of transmission is contact with contaminated equipment or the hands of dairy workers at milking (115). The most common environmental mastitis pathogens are E. coli, klebsiella, and environmental streptococci. Primary routes of environmental pathogen transmission are dairy cow walkways and housing, particularly bedding contaminated with manure (96, 115). Use of sawdust or wood bedding has also been associated with the prevalence of environmental mastitis pathogens (12).

When a cow's teats and udder become wet and soiled by dirt or manure, bacteria may enter the udder and cause an infection. The presence of somatic cells in milk is evidence of a cellular defense against udder infections (69). It is thought that cows producing milk that contains higher somatic cell counts may have a form of subclinical mastitis and be at risk for developing clinical mastitis (96), and in fact herds with higher bulk milk somatic cell counts have been shown to exhibit higher incidence rates of clinical mastitis than herds with a lower count (9).

Research has demonstrated an association between poor environmental conditions and the occurrence of mastitis. In a survey of British dairy farms, the incidence of mastitis was lower on farms that removed manure at least twice a day from the gathering yard used before milking; the incidence of mastitis was also found to be higher on farms that mucked out the calving area less frequently than once a month (96). Another survey of British and Welsh dairies found higher incidences of mastitis among farms with poor housing management, such as not scraping out manure frequently enough, using insufficient or wet bedding, and not having enough cubicles for the number of cows or enough lying space per animal (15). Likewise, in a study of straw yards, Hughes et al. (63) observed that the incidence of mastitis appeared to be related to the cleanliness of the yard.

Barkema et al. (10) found a relationship between management style and milk quality in a study of 300 Dutch dairy herds. The researchers classified farmers as being either "clean and accurate" or "quick and dirty." Farmers in the clean and accurate category had fewer cows, knew their cows better, were precise rather than fast, and practiced better hygiene. There was a strong statistical correlation between management style and milk somatic cell counts, with 74% of herds with a low cell count being managed by farmers classified as clean and accurate.
In a study of 48 dairy herds in Ohio, Bartlett et al. (12) documented higher levels of coliform and streptococcal bacterial infection among farms with poor sanitation. The researchers could predict the occurrence of coliform mastitis by the level of environmental sanitation. Moreover, data from a study of 1,250 lactating dairy cows from 8 commercial dairies in Wisconsin showed that milk somatic cell counts increased as udder hygiene decreased (114). Cows with dirty or very dirty udders were also 1.5 times more likely to have major mastitis-causing pathogens isolated from milk samples than cows with clean or somewhat clean udders. The researchers claim that theirs is the first study to confirm the relationship between cleanliness of cows and the occurrence of subclinical mastitis (114).

2.4.2 Air Temperature and Humidity

The combination of heat and humidity is known to be a significant cause of environmental stress in dairy cows. Periods of high temperatures combined with high relative humidity compromises the dairy cow's ability to dissipate excess body heat (150). According to Armstrong (3), dairy cows respond to heat stress by: 1) reduced feed intake, 2) increased water intake, 3) changed metabolic rate, 4) increased evaporated water loss, 5) increased respiration rate, 6) increased body temperature, and 7) changed blood hormone concentration. The decline in plasma cortisol levels in cattle after prolonged exposure to high ambient temperatures is evidence of an adaptation mechanism to prevent increases in metabolic heat production (109). Cows that have had one or more previous pregnancies and higher producing dairy cows are at highest risk for experiencing heat stress (3).

Cows kept in drylot conditions in the southwestern and western U.S. are particularly vulnerable to heat stress. In addition, weather conditions in the Southeast subject dairy cows to a combination of heat and humidity. St-Pierre et al. (123) estimated 1.3 deaths from heat stress for every 1,000 one-to-two year old dairy heifers in the U.S., with Louisiana, Texas, Florida, and Mississippi being the states with the biggest projected losses. Although some dairies merely provide shade to reduce sun exposure, shade alone has no effect on air temperature or relative humidity and additional cooling through air movement and evaporative cooling is needed (153). The combination of shade, fans, and sprinklers has been shown to have the greatest cooling effect (66, 153).

2.4.3 Stray Voltage

Stray voltage or electrical current can result in discomfort to dairy cows and lower their milk output. It may be caused by poor electrical connections, corrosion of switches, frayed insulation, faulty equipment, or overloaded power lines (1). Dairy cows can perceive voltages as low as 1.0 V when applied between water bowls and their rear hooves (52). Cows demonstrate sensitivity to voltage around their water bowls by increasing the amount of time before returning to drink after receiving a shock. In studies, some animals receiving up to 6 V did not drink for 36 hours, at which time the voltage was disconnected (52).

2.5 Mutilations

Like other farmed animals, the bodies of dairy cows are routinely altered by various invasive surgical procedures, typically performed without the benefit of anesthesia or analgesia. Although industry officials justify these mutilations by claiming animal health and welfare advantages, research has shown little to no benefit to the animals and significant costs in terms of short or long-term pain and altered behavior. Mutilations performed on dairy cows include tail docking, dehorning, and teat removal.

2.5.1 Tail Docking

Animal hygiene is one justification given by dairy producers for docking the tails of cows. Supporters of tail docking claim that docking keeps cows and milking parlors cleaner. However, tail docking is actually performed for worker comfort and convenience. It is more convenient for milkers to attach milking units from behind the cow through the hind legs, as is done in parallel or rotary parlors (see description in Milking Procedures), if the cow's tail is docked (16, 103, 125).

The prevalence of tail docking in the U.S. has exploded in the past 10 years, according to Dr. Pamela Ruegg of the Department of Dairy Science at the University of Wisconsin-Madison (68). The increase in tail docking coincides with a rise in the popularity of parallel milking parlors. A survey of dairy producers conducted in Australia, where the practice of tail docking originated, identified the following reasons for performing the procedure: worker discomfort if hit by intact tail, important for operator comfort, reduced obstruction of udder, quicker milking, reduced risk to operator of leptospirosis, and reduced mastitis (11). Of these justifications, only the last one (reduced mastitis) involves any kind of benefit to animal welfare.

The percentage of U.S. dairy producers docking the tails of cows is not reported. In the Australian study, 35% of dairy farms practiced tail docking. Of those, 75% used a method involving application of a rubber ring to the tail (11), where the tail becomes necrotic and falls off 3 to 7 weeks after banding (125). Tails are also docked by use of a docking iron (a heated scissors-like tool used to remove the tails of lambs), or by use of an emasculator or surgical instrument such as a knife, shears, or guillotine (11, 125). The amount of tail removed typically varies between one-third and two-thirds of the tail (125).

Studies have shown that tail docking results in short-term pain or discomfort to dairy cows (36, 128). Long-term effects of tail docking have not been as well analyzed, although Barnett et al. (11) reports evidence that neuromas have been observed in cows at slaughter that had been docked when the animals were 12 to 18 months old. Researchers Susan Eicher and Heng-wei Cheng, of the USDA Livestock Behavior Research Unit, have documented both physiological and behavioral signs that cows may suffer from chronic pain after docking similar to "phantom limb" pain in people, and that young calves respond to the pain more than adult cows do, a finding counter to the practice of conducting painful procedures on younger animals without the administration of analgesia medication (31).

In addition to causing pain and discomfort, docking has an impact on several aspects of dairy cow behavior. Cows use their tails to communicate information to others and perhaps as a means of self-stimulation (37). The main function of a cow's tail is to deter flies and other insects from landing and biting on the posterior portions of the body, and research has shown that tail docking affects this behavior. One study by Eicher et al. (38) compared fly counts on the front and rear legs of docked and undocked cows housed in tie stalls. They found docked cows had greater total fly counts and rear leg counts; front leg counts were similar. Docked cows in that study appeared to use foot stomping as an alternative means of deterring flies. In a second study of young calves housed in hutches, docked calves showed greater fly numbers and increased fly avoidance behaviors (36). The researchers noted, "It is clear that fly numbers increase on the rear legs of cattle with docked tails in all housing systems examined to date" (38).

Not only has it been shown that tail docking causes discomfort and increased fly numbers, there is evidence refuting the presumed benefit of tailing docking on the occurrence of mastitis. Tucker et al. (130) evaluated 223 docked and 190 undocked cows and found no differences in four measures of cow cleanliness, two measures of udder cleanliness, or udder health. Given the disadvantages in terms of discomfort and altered behavior and the lack of health benefits, the researchers concluded, "We see little merit to adopting this procedure." In addition, a similar study of 1,250 Wisconsin dairy cows noted no significant difference in culling rates, the prevalence of mammary infection, or udder and leg hygiene scores between docked and undocked cows (114).

After reviewing all available research on tail docking, Stull et al. (125) concluded, "Presently, there are no apparent animal health, welfare, or human health justifications to support this practice. Until evidence emerges that tail docking has benefits to animal well-being, health, or public health, the routine practice of tail docking should be discouraged." In fact, tail docking of cattle is already prohibited in several countries including Denmark, Germany, Scotland, Sweden, and the United Kingdom (125). Position statements of the American and Canadian veterinary medical associations also oppose tail docking of cattle as a routine management practice (6, 125).
Animal care guidelines of the U.S. Milk and Dairy Beef Quality Assurance Center acknowledge that research has not shown any health or welfare benefits from docking, but they do not discourage the practice (22). The guidelines recommend that if tail docking is practiced, it should not be done until the heifer is confirmed pregnant. Regular trimming of the switch, or the tuft of hairs at the end of the tail, is widely recognized as a viable alternative to tail docking (16, 22, 103, 125).

2.5.2 Dehorning

Because horns can produce injuries that reduce milk production and growth, the horns of dairy calves are removed, usually without the benefit of analgesia. 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 (40, 97, 127).

Researchers have attempted to determine the degree to which pain caused by the procedure is affected by the specific method and age of the animal. Petrie et al. (97) 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 cortisol concentrations and, therefore, appeared more stressful than cautery. Morisse et al. (84) also 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 of Vickers et al. (142) where calves disbudded with hot iron cautery showed a stronger pain response than calves undergoing the procedure with caustic paste. While cautery appears less painful than scoop disbudding, the difference between cautery and caustic paste is unclear.

There appears to be less difference between the degrees of pain caused by the various methods when dehorning is done on older calves. Sylvester et al. (127) found similar cortisol responses among calves 5-6 months of age to four different methods of dehorning – scoop, guillotine shears, saw, and embryotomy wire. Wound healing from the different methods was not studied. Another study compared the effects of shallow versus deep-scoop dehorning on plasma cortisol levels in 15-week-old calves. Although it was anticipated that shallow wounds might result in a smaller distress response, no difference was detected (82).

Research has documented the benefits of analgesia and anesthesia in reducing the pain response to dehorning/disbudding. Morisse et al. (84) 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. Calves treated with local anesthetic showed no reduction in pain response after caustic paste application in research conducted by Vickers et al. (142). However, in this study, use of a sedative for disbudding with caustic paste resulted in less pain than hot iron disbudding with both a sedative and local anesthetic.

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 (40). Furthermore, Petrie et al. (97) 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 (126).

In the United Kingdom, local anesthetic must be administered to calves undergoing disbudding or dehorning procedures after 7 days of age (40). However, in the U.S. it is common practice to perform dehorning without anesthesia prior to the procedure, or analgesia following the procedure. The animal care guidelines of the Milk and Dairy Beef Quality Assurance Center recommend hot iron cauterization over scooping or use of caustic paste; however, local anesthetic is advised only for animals over 4 months of age, and the use of post-procedure analgesia is not mentioned at all (22).

2.5.3 Supernumerary Teat Removal

It is not uncommon for dairy calves to be born with 1 or 2 extra teats on the udder (beyond the customary 4) that may develop like a normal teat (1). Dairies consider supernumerary teats undesirable because they are not aesthetically appealing, and because they may get in the way of milking and may become infected (1). Animal care guidelines of the Milk and Dairy Beef Quality Assurance Center recommend that extra teats be removed in the first 3 months with a scalpel or sharp scissors (22). The guidelines suggest a veterinarian be consulted before teats are removed from adult animals; however, the guidelines do not advise that a veterinarian perform the procedure or that painkillers be given. Albright (1) recommends that extra teats on older calves and heifers close to calving should be done under local anesthetic by a “qualified person.” In the United Kingdom, teat removal after 3 months of age must be performed by a veterinary surgeon (39).

2.5.4 Animal Identification

Dairy cows are typically identified in two locations on their body by a method that is permanent and can be easily read by workers (22). Microchips can be inserted under the skin with little discomfort to the animal, but they require electronic transponder equipment for reading, and another means of visual identification is still required. Neck chain tags are not recommended because they can become lost and the chain may become inadvertently entangled in a fence or vegetation, leading to injury of the animal (22). Ear tags are popular because they are readable at some distance, but need to be lightweight and inserted in the proper location to avoid damage to the ear (39). According to the Farm Animal Welfare Council (39), plastic tags have been shown to cause less damage than metal ones. The Milk & Dairy Beef Quality Assurance Center does not recommend branding of dairy cows (22).

2.6 Handling Practices

Dairy cows respond to the manner in which humans treat them. They are capable of recognizing and remembering people who treat them gently as well as people who treat them aversely. The type of treatment cows receive may affect both their health and milk production.

Pajor et al. (94) used aversive learning techniques to determine which common handling practices dairy cattle found most objectionable. Of four aversive treatments – electric prod, shouting, hitting, and tail twisting – cows appeared to find electric prodding and shouting most aversive. The researchers note that dairy cows refusing to enter the milking parlor is a common problem in the dairy industry, and that even non-aggressive human contact, such as stroking or taking food from the hand of an unfamiliar person, may be aversive to some dairy cattle, particularly heifers. Lack of patience on the part of the person handling the cow can also have an impact on the physical health of the animal. Studying cows walking from a field to the milking parlor, Ward (145) found that cows who were pushed by the farmer (sometimes literally) were more likely to be lame.

Several studies have attempted to determine the degree to which dairy cows can discriminate between people based on how the individuals handle them. In experiments with calves, de Passille et al. (95) found that after being subjected to a number of either positive or negative treatments, calves made more contact with the positive handler than the aversive handler. In some cases, the fear of aversive handlers carried over to places other than those in which they were originally handled. Other research conducted with cows (86) similarly showed that animals could learn to discriminate among aversive and gentle handlers, partially based on the color of clothes worn by the handlers. Rushen et al. (111) found that for cows best able to discriminate between handlers, the presence of an aversive handler increased movement and heart rate during milking, suggesting the animals experienced stress and fear.

2.7 Downed Cows

"Downed animals" are farmed 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 a downed cow humanely (54). 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. In conducting quality assurance audits of dairies, Environmental Management Solutions observed 13% of dairies dragging downed cows by chains or ropes around the head or legs (122). Since the dairies were aware of the audit, the actual percent of dairies involved in this practice is probably considerably higher.

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 animals 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.

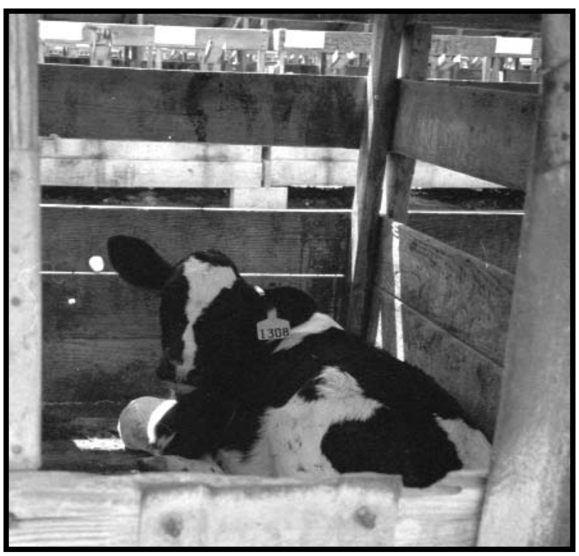
USDA and industry estimates put the number of downed cattle in the U.S. at 195,000 annually (107). According to livestock expert Dr. Temple Grandin (54), dairy cattle make up 75% of downers. In a survey conducted by the Canadian Food Inspection Agency in 2001, 90% of the non-ambulatory cattle arriving at Canadian slaughter plants were dairy cows (35). Similarly, in a study of downed animals by the California Department of Food and Agriculture, 91% of downers at California non-fed slaughterhouses were dairy cows and 9% were beef (134).

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 (107). In December 2004, Canada proposed a ban on the transport of all downed animals except for purposes of veterinary treatment (21).

2.8 Calf Rearing Practices

Some of the most controversial aspects of dairy production involve issues related to the treatment of calves. Most female calves are used as replacements for dairy cows that are removed from the herd and slaughtered due to disease or decreased milk production. Female calves are typically raised at the dairy where they were born, although a small percentage (7.2%) is born at the dairy and raised somewhere else (134).

Male calves are an unwanted consequence of dairy production and, as a result, often receive inferior care. Males may be slaughtered for "bob veal" shortly after birth, or raised at a special-feeding operation and slaughtered at 4-5 months for "veal;" or they may be raised at a feedlot like other cattle and slaughtered at 13-14 months for "beef." The primary animal welfare concerns for dairy calves include at what point they are separated from their mothers, how and what they are fed, and how and where they are housed.



2.8.1 Separation from Cow

Separation of a calf from a dairy cow represents a situation where industry is unable to meet the welfare needs of both animals. Because allowing calves to suckle for several months, as they would do naturally, is not profitable for the dairy industry, calves are removed from their mother and fed artificially. The removal is stressful to both calf and cow regardless of when it is done.

Some recommend separation soon after birth because it allows dairy workers to ensure calves receive adequate colostrum (16). The USDA (136) recommends separation immediately after birth to decrease calf exposure to environmental pathogens since the immune system of young calves is not well developed. Industry guidelines developed by the Milk & Dairy Beef Quality Assurance Center advise that calves be removed immediately following birth (22). According to the USDA (135), in 2002, 52.9% of U.S. dairies removed calves immediately at birth, without nursing, up from 28.0% in 1992. In 2002, 22.5% of the remaining producers removed calves less than 12 hours after birth, 15.9% between 12 and 24 hours, and 8.7% after more than 24 hours (136).

Industry and some humane advocates support early separation because it appears to be less stressful to both cows and calves than separation at a later age. Weary and Chua (148) conducted an experiment to determine the effects of separation on cows and calves at 6 hours, 1 day, and 4 days after birth. They found that calves separated at older ages spent significantly more time moving and standing in the pen and more time with their heads out of the pen than calves separated 6 hours after birth. The researchers also documented that cows whose calves were removed after 4 days called at approximately 4 times the rate of those separated at 6 hours or 1 day. In another study, Flower and Weary (44) found that cows whose calves were removed 2 weeks after birth had higher rates of calling and moved and stuck their heads outside the pens more than cows whose calves were separated at 1 day. However, although calves in the late-separation group also showed more signs of stress than early-separated calves, they gained more weight and displayed more developed social behavior.

The Farm Animal Welfare Council of the United Kingdom (39) has offered the opinion that early separation is the least stressful option, given that "leaving a calf with his/her mother until weaning and separation occur naturally is not practicable within the present modern dairy industry." However, Krohn (11) reviewed the effects of different suckling systems on calves and cows and concluded that short-term suckling had benefits on production and the health and behavior of both calves and cows over immediate separation. (Short term suckling was defined as cows and calves kept together for the 3-5 day colostrum period.) Krohn found that separation after a short-term suckling period did not appear to cause the level of trauma observed as a result of separation after a longer, 2-3 month suckling period.

2.8.2 Calf Feeding

The Milk and Dairy Beef Quality Assurance Center recommends that dairy calves receive at least 4 quarts of colostrum from one cow within 30 to 60 minutes of birth (22). According to the USDA (134), dairy operations provide colostrum by the following methods: nursing from cow (30.5%), hand-fed from bucket or bottle (64.8%), and hand-fed using esophageal feeder (4.4%). In addition, 0.3% of operations did not administer colostrum (affecting 0.7% of U.S. dairy calves) (136). Data from a dairy auditing company showed 7% of dairies do not provide colostrum to replacement calves within 3 hours of birth (122).

Following administration of colostrum, dairy calves are typically fed, by bottle or bucket, restricted milk meals twice a day. A calf left with his or her dam, however, will suckle 7 to 10 times a day and consume much larger quantities of milk (67). Feeding calves by use of an artificial teat allows the expression of natural sucking behavior, and artificial teat-fed calves drink more milk and are not more likely to experience diarrhea than bucket-fed calves (2). Feeding by teat also reduces the incidence of cross sucking among calves, which is considered undesirable because of potential transmission of disease-causing pathogens (25). Therefore, using artificial teats for feeding may allow for group housing of calves (2) (see discussion of Calf Housing).

Many producers restrict the amount of milk fed to calves, perhaps because of concerns that increased milk intake results in diarrhea or reduced weight gains after weaning (67). It is also more convenient for producers to feed twice daily than to ensure that animals have a continuous supply of milk. Appleby and others (2) found that feeding calves ad libitum allows the animals control over their own milk intake and feeding schedule, as they would do if left with their dam. Jasper & Weary (67) reported that calves fed milk ad libitum consumed 89% more milk and gained 63% more weight than conventionally fed calves prior to weaning. Moreover, feeding milk ad libitum did not increase the incidence of diarrhea and had no adverse effect on the intake of solid food after weaning.

Phillips (100) found that providing forage such as grass reduced the time that calves spent eating straw bedding and facilitated rumination. Grass also appeared to provide a stimulating activity for calves, as the amount of time spent licking their buckets, vocalizing, and investigating their pens decreased. Calves receiving grass also ate for longer periods when allowed to forage in pasture (100).

2.8.3 Calf Housing

Dairy calves are commonly isolated from each other to reduce the transmission of infectious diseases. The Milk and Dairy Beef Quality Assurance Center recommends that calves not touch each other until 5 weeks of age (22).

A 2001 survey of U.S. dairy operations by the USDA (136) reported that 77.2% of dairies restricted physical contact between unweaned calves and weaned calves; 86.7% restricted contact between unweaned calves and bred heifers, and 84.6% prevented contact between unweaned calves and adult cattle. The percentage of dairies isolating unweaned calves from other unweaned calves was not cited in the report.

While disease transmission is given as the rationale for isolating calves, there is little research documenting the risk. On the other hand, significant benefits from group housing of calves have been identified. Phillips (100) found that calves reared in groups of 3 exhibited less time vocalizing, investigating their pen, and licking their bucket than individually reared calves. Isolated calves are thought to develop oral vices, such as excessive licking and tongue playing, as a stress reduction strategy and as a result of being denied the opportunity to lick and suck other calves (100).

Another study compared the health, performance, and behavior of individually and pair-housed calves (25). At weaning, pair-housed calves gained weight normally, while individual-housed calves experienced a temporary decline in weight gain. In addition, paired calves spent more time moving and less time with their head out of the pen; observations of aggressive behavior and cross-sucking among paired calves were very low. The researchers concluded, "Housing dairy calves in pairs allows benefits such as increased space for movement and social opportunities with no disadvantages in health and weight gains."

Dairy calves may be raised at the dairy where they were born or at a specialty calf ranch. Calves are typically housed indoors in small crates or outside in small hutches. For hutch housing, calves may be confined to the hutch by a tether. Or the calf may be allowed access to a small, fenced grass or dirt area outside the hutch. In some cases, the sides of the crate or hutch may be solid, preventing calves from enjoying even the sight of other animals. Animal care guidelines of the Milk and Beef Dairy Quality Assurance Center do not set minimum space allowances for calves. Some calves in the U.S. are housed in crates or hutches so small that the animals are not able to turn around (122).

To test the effect of crate size on dairy calves, Ferrante et al. (42) made behavioral observations and took blood samples from calves housed in crates of two different dimensions for a period of 30 days. The researchers concluded that the smaller crates "did not satisfy the resting requirements of the calf." Calves in the larger crates spent more time lying, grooming, and exploring, while the calves in smaller crates spent more time searching for feed. Furthermore, lymphocyte production was lower in calves reared in smaller crates, an indicator of "poor welfare caused by a stressful environment," according to the researchers (42).

2.8.4 Handling of Male Calves

Because male calves are not needed at the dairy and are worth far less than females, bull calves are often provided inadequate care and handling. Some dairies do not even provide colostrum to males before sending them off to market or to a veal facility (122). Many are transported off the dairy to be sold or raised for meat (veal or beef) within a day or so of birth, when they are too weak and young to nurse or walk by themselves (16). Morality rates for young calves of more than 20% during transportation have been reported (58). Because of this, Canada and England prohibit the sale of calves less than 1 week of age (1). Livestock handling expert Temple Grandin (53) recommends that calves not be brought to market until they are strong enough to walk without assistance, or approximately 5 days old.

The veal industry exists as a by-product of the dairy industry, taking advantage of a constant supply of unwanted male

calves. To obtain the desired light-colored flesh, veal calves are fed an all-liquid milk substitute that is deficient in iron and fiber. The animals are tethered or confined for up to 16 weeks in crates that are just two feet wide, and they are unable to walk or exercise throughout their entire lives. When calves are denied these basic needs, they suffer various physical ailments including digestive problems, physical discomfort, impaired locomotion, a greater susceptibility to disease, and anemia.

Dairy bull calves transported to veal production operations or other collection facilities suffer from various physical problems. A study of 758 calves arriving at five veal farms found 27% of the calves were clinically or marginally anemic, and 43% were colostrum deficient indicated by low total serum protein concentrations (157). Calves with the lowest serum protein concentrations had more respiratory and total medical treatments than calves with higher protein levels. Upon arrival at the veal facility, 21% of the calves in this study had unacceptable body fat scores (too thin); 32% had unacceptable navel scores (swelling or discharge); 32% had unacceptable nose scores (skin cracked, discharge), and 22% received undesirable scores for hair coat appearance (dirty, matted, dry, or hairless patches).

3. Production Practices

Milk production per cow in the U.S. has steadily increased over the past half century. Between 1965 and 2004, milk production per cow rose 141%, from 7,865 to 18,957 pounds per cow per year (see table below). It is common for modern dairy cows to be pushed to produce 10 times as much milk as needed to suckle her calf.

Year	Pounds	Year	Pounds
1965	7,865	1993	15,722
1970	9,543	1994	16,179
1975	10,142	1995	16,405
1980	11,627	1996	16,433
1985	12,758	1997	16,871
1986	13,285	1998	17,185
1987	13,819	1999	17,763
1988	14,185	2000	18,197
1989	14,323	2001	18,162
1990	14,782	2002	18,608
1991	15,031	2003	18,760
1992	15,570	2004	18,957

Sources: USDA, National Agricultural Statistics Service. Agricultural Statistics 2004; USDA, National Agricultural Statistics Service. Agricultural Statistics 1997; Rauw et al. Livestock Prod Sci 1998;56:15-33. (For the years 1965-1985 milk per lactation, in kilograms, was converted to milk per year, in pounds.)

Milk Production Per Cow, United States, 1965 – 2004

The dairy industry has managed to continually increase milk yield per cow by a variety of methods, including the manipulation of dairy cow nutrition, milking procedures, growth hormones and antibiotics, lighting periods, reproduction, and genetic selection. Even audio recordings of young calves calling for their mothers have been used to get an extra pound or two of milk from a cow (81).

The industry has been assisted in this effort by agricultural production scientists based at U.S. land-grant colleges and universities. While scientists in Europe have led the way in studying how to improve dairy cow welfare, U.S. scientists have led the way in researching milk production efficiency. However, at least one American scientist is questioning the ethics of increasing production to the detriment of animal welfare. Ray Stricklin (124), of the Department of Animal and Avian Sciences at the University of Maryland, offered the following comments at a conference on the science and ethics of animal welfare assessment:

What is the impact of continuing to increase the amount of milk produced per cow? We know that higher producing cows have more mastitis, more feet and leg problems, and lower fertility, all contributing to shorter longevity in the herd. Yet, we continue to conduct research whose goal is to increase efficiency – which in fact is a term we use for nothing more than more milk per cow. Is here no upper limit to the amount of milk we will ask of one cow? How can we say we serve the interests of producers knowing that increased production per cow will force more producers out of business? And can we honestly say our mission is to improve animal welfare if we endorse increased levels of production per animal when we know that this results in cows experiencing greater stressors?

This section of the report will describe the methods used to increase milk production and their effects on the health and welfare of dairy cattle.

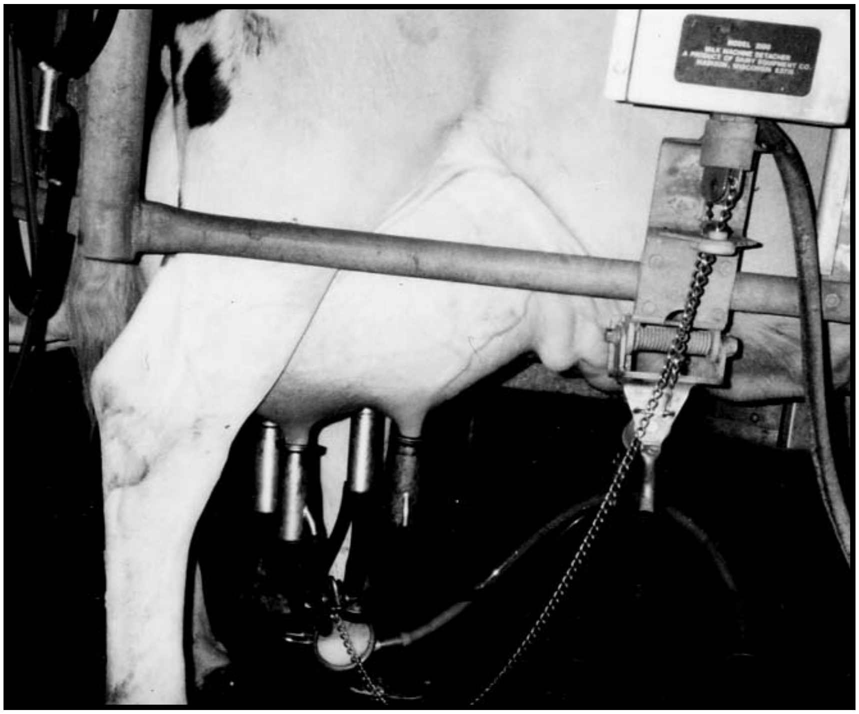
3.1 Nutrition

Cows naturally consume high-fiber, low-density diets and do not adapt well to diets low in fiber and high in grain or protein (20). However, dairy producers increasingly provide dairy cows with high concentrate diets in order to increase milk production (8). In fact, high milk yields require corresponding increases in the amount of concentrates in the diet (43). These high-concentrate diets provide readily digestible forms of carbohydrates, which increase the energy concentration of the diet but decrease the fiber (29). Switching cows from a forage diet to one higher in concentrates at the beginning of lactation can cause digestive and other metabolic problems; problems may also be seen going in the opposite direction at the end of lactation (16).

Due to the abnormally high levels of milk produced, lactating cows are in a state of negative energy balance, despite being fed a diet of concentrates. Collard et al. (29) described the metabolic stress caused by high milk production as follows:

In early lactation, dietary intake is unable to meet the demands of high milk production. The cow therefore enters a period of negative energy balance, which leads to a mobilization of body reserves to balance the deficit between food energy intake and milk energy production. The process of mobilization seems to affect the well being of the cow, and other biological pathways are compromised as intake energy is directed toward production.

In addition, an association has been documented between negative energy balance due to high production, diets high in energy concentrates, and the incidence of lameness (29, 43, 75, 79, 80, 145). According to Collard et al. (29), “Laminitis can be caused by the cow’s inability to consume sufficient dry matter during early lactation to meet the demands of high production.” Dairy operators often respond to this situation by increasing the feeding of more readily digestible forms of carbohydrates, which increases the energy concentration of the diet and decreases the amount of fiber. When fed a diet lower in fiber, cows eat their feed in less time and, as a result, saliva production and rumination decrease. This increases the acidity of the cow’s rumen (or ruminal acidosis). Histamine and other endotoxins are then released into the blood, causing vasodilation and ultimately impairing the blood circulation to the hoof and leading to laminitis (29).



3.2 Milking Procedures

For many years dairy cows were milked twice per day. Today, dairy cows are typically milked three times a day, sometimes more, to increase production (33). Dairy cows were also originally milked in stalls. However, today, a majority (70%) of dairy cows in the U.S. are milked in a milking parlor, although only 37.1% of operations use a parlor as their primary milking facility (134). Tie stall or stanchion barns are used as the primary milking facility at 61.9% of dairies; however, only 28.9% of cows are milked in this type facility (134). These statistics indicate that larger operations are using milking parlors, while smaller dairies continue to use tie or stanchion barn milking.

In a parlor milking system, cows walk at scheduled times to the milking parlor and are kept in a holding pen until it's their turn to enter the milking compartment and be milked. Milking parlors utilize one of three basic designs – rotary, herringbone, or parallel. Rotary systems are capable of moving 64 cows and milking machines on a rotating platform, while herringbone systems generally milk two rows of 4 to 20 cows from a central pit (1). In the parallel milking system, milking machines are attached from the rear between the cow's legs instead of from the traditional side position, and the cows stand at 90 degrees to the operator with their heads restrained in self-locking stanchions (1).

Dairies have increased economic efficiency and decreased labor costs by installing powered crowd gates and rapid-exit stalls (1). Some operations may use crowd gates to forcibly rush cows. With large dairies and pens containing up to 200 animals, cows may be forced to stand on concrete during the holding and milking periods for hours at a time (16), predisposing them to lameness. Van Reenen et al. (141) documented that the initiation of milking may be a stressful experience to some heifers. Close interaction with a human handler, an unfamiliar environment, and the novelty of the situation may be some of the factors that cause primiparous (first pregnancy) dairy cows stress, exhibited by such signs as higher heart rates and increased levels of plasma cortisol (141).

To facilitate more frequent milking and higher milk yields, some dairy operations have installed automatic milking systems, where feed is used to encourage cattle to come voluntarily to robotic milking compartments (139). It has been argued that automatic milking increases animal welfare by giving the cows more control over their environment; however, because feeding order is related to social rank, low-ranking animals may be forced to visit automatic milking parlors during the night when they would normally be resting (62). This may have a negative impact on the animals' health and welfare.

Hopster et al. (62) found little difference between automatic and conventional milking in terms of behavioral and physiological responses, although automatically milked cows tended to have higher blood cortisol concentrations, suggesting increased stress. Uetake et al. (138), however, documented a disturbance in the behavioral pattern of dairy cows milked in an automatic milking system that could affect the animals' well being. When comparing the behavior of cows in an automatic milking system with a holding area to the behavior of cows in a conventional milking parlor, the researchers found that the automatic-milking cows spent less time eating at the feed bunk and standing in the stalls to compensate for the time they spent standing in the automatic milking holding area. This suggests that automatic milking with a holding area "affects social synchronization of cows eating and resting and reduces time spent eating significantly more than parlor milking" (138).

While it has been suggested that automatic milking may be beneficial to udder health by increasing the frequency of milking, no decrease in somatic cell counts has been documented as a result of the introduction of automatic milking (61). On the contrary, an increase has been seen. Researchers speculate this may be the result of the milking interval, which varies widely among automatically milked cows (61). Albright (1) implies that automation may improve animal welfare by reducing stress on workers and freeing them up for more human-animal interactions. It seems much more likely, however, that with automatic milking dairies would simply reduce their workforce and labor costs instead.

3.3 Growth Hormone

Milk and dairy products produced in the United States - unless otherwise labeled - may come from cows routinely injected with a genetically engineered hormone called bovine somatotropin (or bST), also known as bovine growth hormone (BGH). BST is a synthetic hormone, produced by gene-splicing techniques, that is injected into dairy cows to artificially manipulate lactation. Administration of bST typically increases a cow's daily milk yield by about 14% (72) or 10 pounds (134).

As of 2002, bST was being injected into 22.3% of U.S. dairy cows, according to the USDA's National Animal Health Monitoring System (134). In 2002, when the USDA surveyed dairy operators regarding bST use, the single most common reason cited for not using the hormone was animal health (134). Other reasons included cost, public health, and difficulty in administration.

The drug's label summarizes its adverse effects on dairy cow health: reduced fertility, increased frequencies of cystic ovaries, mastitis, increased body temperature, indigestion, bloat, diarrhea, anorexia, enlarged hocks, foot lesions, and injection site reactions (72). Two early bST studies suggested a doubling of the culling rate for cows injected with the hormone (72).

Administration of growth hormone can cause dairy cows to suffer catabolic stress, or "burnout," by doubling the normal period during which lactating animals must utilize body stores of fat and protein until their feed intake matches the demand of producing high levels of milk (72). The administration of bST exacerbates the already deleterious effects of high milk production, described in the preceding section on Nutrition.

Catabolic stress occurs during the first 2 to 3 months of a lactation cycle and can result in decreased milk production and higher pulse rate, respiration, and body temperature (72). Increased body temperature causes the cows to be less heat tolerant and more vulnerable to heat stress (28), especially during hot, humid weather conditions (154). This is true for both lactating and non-lactating cows receiving bST (28). To keep up with the metabolic demands of high milk production, bST-treated cows must consume a highly concentrated diet, which in turn can lead to gastrointestinal disorders, other metabolic diseases, and lameness (see section on Nutrition).

Metabolic stress also inhibits ovulation. Kronfeld (72) reviewed reproduction rates from 27 long-term rBGH trials and found that about 20% of cows given bST failed to become pregnant as compared to about 10% of control animals. In a study conducted by Bilby et al. (17), significantly lower pregnancy rates were reported in cows treated with bST (27%) than in cows not treated with the hormone (64%).

Administration of bST has been associated with increased occurrences of both mastitis and lameness, the most common causes of culling of dairy cows. Willeberg (156) re-evaluated published data from several bST trials by applying general epidemiological methods and found that bST treatment is associated with an increase of 15-45% in the incidence of clinical mastitis, probably indirectly through the effect of increased milk production. However, Kronfeld (72) reviewed published data on mastitis among bST- treated cows and noted mean increases of 34-76% in mastitis incidence, which is beyond that which can be accounted for by a 14% increase in milk yield alone. An analysis of data from bST trials conducted by an expert panel of the Canadian Veterinary Medical Association documented a 50% increase in the incidence of lameness among bST-treated cows (73). Even research conducted and published by Monsanto, the producer of the hormone, has shown an increase in foot and hock problems, and an increase in the use of medications to treat acute foot disorders, for cows receiving bST (30).

Following approval of bST for use on U.S. dairies by the U.S. Food and Drug Administration, Canada's Health Protection Branch reviewed research data on the hormone and came to a starkly different conclusion regarding the drug's safety. Concerned that the U.S. had ignored or overlooked evidence showing adverse effects on animal welfare, Canada rejected approval of the hormone (73). When the European Union commissioned two independent committees of internationally recognized experts to review the animal and human health effects of bST use, the committees reached the same conclusion as the Canadian health service and recommended a moratorium on use of the hormone (73).

3.4 Antibiotics

Dairies routinely administer drugs – antibiotics in particular – to prevent and treat the various diseases related to milk overproduction. The medications most commonly given to dairy cattle include penicillin, tetracycline, sulfamethazine, neomycin, and gentamycin. Use of these drugs is illegal if the drug is administered in doses exceeding label recommendations, if the drug is not specifically approved for use in cattle, or if administration of the drug is not withheld for an appropriate period of time prior to the animal going to slaughter. In all these situations, administration of the medication may result in the presence of illegal drug residues in animals at slaughter. The U.S. Food and Drug Administration (FDA) tests animal carcasses for the presence of such illegal residues and issues warnings to dairy operations found to be in violation. A review of records available on the FDA website conducted for this report has revealed 75 warning letters for unauthorized drug use in U.S. dairy cows and calves during the 2004 calendar year. Of these warnings, dairy operations received 68, while 7 were issued to veterinarians.

3.5 Lighting

Lighting is being used as a means to apply additional pressure to cows already stressed by an unnatural diet, frequent milking, and artificial growth hormones. The dairy industry considers managing the amount of light to which dairy cows are exposed to be an easy, safe, and effective means of increasing milk production throughout the lactation cycle (5, 83). Increasing the daily light period to 16 hours during lactation has been shown to increase milk yield by approximately 4 pounds a day (33). On the other hand, short-day lighting – 8 hours of light followed by 16 hours of darkness – during the dry period between lactations increases milk production in the next lactation by as much as 6 pounds per day compared with cows exposed to long-day lighting during the dry period (83).

In response to these findings, researchers are recommending that photoperiod manipulation be considered throughout the reproduction cycle as a means of maximizing milk yield (83). It has also been shown that photoperiod manipulation used in combination with bST can achieve greater increases in milk yield than either technique alone (33). In fact, Dahl et al. (33) suggest that the largest production results might be obtained by the combination of photoperiod manipulation, bST administration, and three times/daily milking.

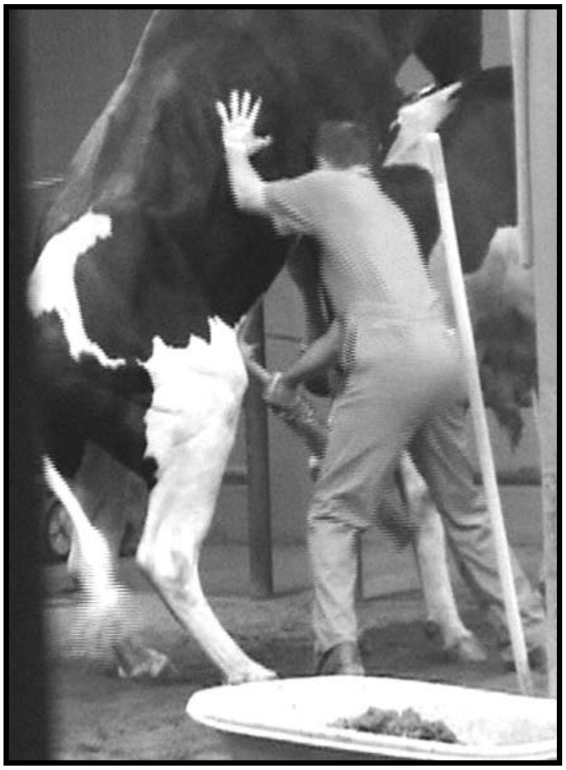
3.6 Reproduction

A dairy cow is made to give birth as often as possible to keep her producing milk. Dairy operations manipulate cow reproduction to ensure that the animals calve and reach peak milk production as quickly and as often as possible (134). Dairy cattle are inseminated within 3 months of giving birth so that gestation and lactation overlap until the cow's dry period before giving birth again (77). On average, dairies in the U.S. allow cows only 60 "days dry" – or days of rest – between lactations (134).

The length of time between calvings is seen as a measure of reproductive efficiency in the dairy industry. According to the USDA (134), during 2001 the average calving interval for dairy cows in the U.S. was 13.3 months. Only 4% of operations reported a 16-month or longer calving interval (134). Since the cow's gestation period is 9 months, giving birth every 13 months is physically demanding. Frequent, repeated calvings subject dairy cows to physiological stress and may lead to udder health and reproductive problems that result in early culling.

Dairy reproduction is being accomplished increasingly by artificial means. The USDA's Dairy 2002 report notes that, in January 2002, 45.1% of U.S. dairy operations had no bulls, and an additional 31.1% of dairies used only one bull for breeding (134). On most large dairies, breeding is done by artificial insemination. Cows are inseminated and, only if the breeding is unsuccessful after a certain number of attempts, are bulls used. Insemination allows dairies to choose semen from bulls with the specific characteristics they find desirable.

To collect semen for insemination, bulls are subjected to electrical stimulation. It is known that electroejaculation without anesthesia in humans is painful and, therefore, is most likely painful to bulls as is demonstrated by the observation that some bulls vocalize during the procedure (85). In one study, conventional electroejaculation increased the heart rate of bulls an average of 21 beats per minute, and the administration of an epidural anesthetic tended to lessen the increase in heart rate (85).



Insemination also presents welfare issues for the cow. Animals being inseminated may be restrained in cubicles for prolonged periods of time, which is known to result in stress. Murray and Ward (89) describe the artificial insemination process and its impact on cows as follows:

When in the stall, they usually face a wall or other solid structure, are unable to turn round and lick themselves, are unable to lie down, and no food or water is provided. Both holding yard and AI [artificial insemination] stall are often sited away from the remainder of the herd, in surroundings unfamiliar to the animal. Here the cow has to wait or stand with little contact between it and its herdmates.

In recent years, embryo transfer technology has been advanced to allow ova to be collected from living or dead cattle, fertilized in the laboratory, and kept frozen until implanted into recipient cows. The procedure is more difficult than artificial insemination and requires skill and training, although surgery is not typically required. Embryos fertilized in the laboratory have been implicated in the production of oversized calves, which may necessitate surgical (caesarean section) delivery and threaten the health and well being of the cow (39, 89). In addition, the use of drugs to induce super-ovulation and repeated administration of epidural anesthesia, to either collect ovum or implant the fertilized embryo, may cause welfare problems such as chronic pain in the tail head and fused vertebrae (39). Dairies may select maiden heifers for the procedures because they are perceived as being more "expendable" than mature cows in the event of complications resulting from the risky procedure (89).

3.7 Genetic Selection

Dairy cattle are selected for breeding based on their milk yield. This has led to the breeding of larger cows that may be more prone to physical problems such as lameness and mastitis. Another consequence of breeding larger animals is that they do not fit into stalls built 10-20 years ago (89). Larger cows spend more time lying partially outside of stalls in alleyways that may be covered in slurry and are also at an increased risk of being stepped on by other animals.

The dairy industry in the U.S. does not typically breed based on resistance to disease, presumably because the heritability of diseases like mastitis is low (117). However, genetic variation for disease incidence is large enough to have a significant impact on welfare. Lyons and others (78) reviewed the heritability of several traits in dairy cattle and found that reproductive and respiratory conditions were least heritable; mammary and locomotive conditions were slightly more heritable, and digestive conditions were most heritable. The researchers concluded that genetic selection for reduction of health problems is possible (78). Finnish researchers determined that milk somatic cell counts (see discussion in Mastitis section) can be used as a tool for selection for mastitis resistance, and in certain countries (Finland, Denmark, Norway, Sweden) mastitis is included as a selection objective for dairy cattle breeding (69).

Genetic selection for high production in farmed animals results in behavioral, physiological, and immunological problems with negative consequences for animal welfare (105). Several genetic and epidemiological surveys have documented associations between health problems and milk production in dairy cows. In one calculation by Lyons et al. (78) milk production was positively correlated with mammary, digestive, locomotive, and respiratory conditions. Only reproductive problems were reduced with increased production; however other studies have reported that reproduction is compromised by the demands of high milk production (77, 90).

Increased milk yield was associated with higher incidences of mammary infections in one study conducted on 116 lacta tions from one herd (104), and in another study of lactations of more than 70,000 heifers (143). Genetic correlations between milk yield and both mastitis and ketosis were demonstrated in analyses performed by Simianer et al. (118) and Uribe et al. (140). A review of the lactations of 1,074 cows from 10 dairies in Germany found correlations between milk yield and several disorders (mastitis, milk fever, retained placenta, ovarian cysts, hoof diseases, ketosis, and displaced abomasum) (43).

The evidence is clear that selection for milk yield is accompanied by increased susceptibility to disease. It is often argued that loss from increased disease is more than made up for by increased revenue from production. However, the complete cost of disease has never been accurately estimated, and attempts to analyze costs typically don't take into account costs to animal welfare. G.E. Shook (117), of the Dairy Science Department at the University of Wisconsin, expressed the following concerns regarding selection for milk production:

When genetic trends are projected over a long term, considerably increased health problems can be forecast. Can we expect continued improvements in management to forever offset genetic deterioration of disease resistance? Do ethical and animal welfare considerations allow us to ignore animal health in our breeding programs?

Since Shook raised these questions in 1989 milk production in the U.S. has risen more than 20%.

4. Conclusion

In 2001, 25.5% of all U.S. dairy cows were removed permanently from their herds (134). Of those animals, 5.7% were moved to another dairy and 94.3% were sent to slaughter. Most dairy cows are sold and slaughtered for "beef" after only 3 or 4 lactations, sometimes fewer, while a cow living in a healthy environment would live 25 years or more. The reasons given by dairy producers for culling cows include udder or mastitis problems (26.9%), reproductive problems (26.5%), poor production (19.3%), lameness or injury (16.3%), and disease (6.0%) (134). As described in this report, all these conditions may be caused or worsened by the manner in which the animals are treated and the production demands placed upon them.

The U.S. dairy industry has failed to set meaningful standards for the care and handling of dairy cattle, or to take a stand in opposition to any of the various practices that result in physical or behavioral problems for animals. To date, the industry has given no indication that it intends to curtail efforts to pressure cows to continually produce greater amounts of milk, regardless of the widely recognized costs to animal health and welfare.

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