Chapter 6: Guidelines for Dairy Cattle Husbandry

Dairy cattle include replacement heifer calves and yearlings, dry cows, lactating cows, and breeding bulls used for research and teaching purposes related to milk production. The basic requirements for safeguarding the welfare of dairy cattle are an appropriate husbandry system that meets all essential needs of the animals and high standards of handling (Agriculture Canada, 1990).

FACILITIES AND ENVIRONMENT

Physical accommodations for dairy cattle should provide a relatively dry area for the animals to lie down in and be comfortable (Jarrett, 1995) and should be conducive to cows lying for as many hours of the day as the cows desire. Recent work indicates that blood flow to the udder, which is related to the level of milk production, is substantially higher (28%) when a cow is lying than when a cow is standing (Metcalf et al., 1992; Jarrett, 1995).

Criteria for a satisfactory environment for dairy cattle include thermal comfort (effective environmental temperature), physical comfort (injury-free space and contact surfaces), disease control (good ventilation and clean surroundings), and freedom from fear. Cattle can thrive in almost any region of the world, if they are given ample shelter from excessive wind, solar radiation, and precipitation (Webster, 1983). Milk production declines as air temperature exceeds 24°C (75°F) or falls below -12°C (10°F) for Holstein and Brown Swiss cows or below -1°C (30°F) for Jerseys (Yeck and Stewart, 1959).

Heat stress affects the comfort of cattle more than cold stress does. Milk production can be increased during hot weather by the use of sunshades, sprinklers, and other methods of cooling (Roman-Ponce et al., 1977; Bucklin et al., 1991; Armstrong, 1994; Armstrong and Welchert, 1994) as well as by dietary alterations. Temperatures that are consistently higher than body temperature can cause heat prostration of lactating cows, but additional energy intake (+1%/°C) and higher heat production by the cow can compensate for lower temperatures, even extremely low ones. Consideration also needs to be given to humidity levels and wind chill factors in determining effective environmental temperatures. Adaptation to cold results in a thicker haircoat and more subcutaneous fat, which also reduces cold stress (Curtis, 1983; Holmes and Graves, 1994).

The newborn dairy calf has a lower critical temperature of 8 to 10°C (50°F) (Webster et al., 1978). The intake of high energy colostrum permits rapid adaptation to environmental temperatures as low as -23°C (-9°F) and as high as 35°C (95°F) in dry, individual shelters with pens (Erb et al., 1951) or in hutches (Jorgensen et al., 1970).

Calves may be housed individually in outdoor hutches or inside buildings in bedded pens or elevated stalls. If calves are exposed to low temperatures, they should be provided with dry bedding and should be protected from drafts. Proper ventilation is critical in closed buildings with multiple animals. Hutches should be sanitized by cleaning, followed by moving the hutch to a different location or leaving the hutch vacant between calves (Bickert et al., 1994). In hot climates or during hot summer weather, calf hutches need to be environmentally modified to ensure that the calf does not experience severe heat stress.

Housing and handling systems vary widely, depending on the particular use of the cattle in research and teaching (Albright, 1983, 1987). Recommended facilities for dairy cattle range from fenced pastures, corrals, and exercise yards with shelters to insulated and ventilated barns with special equipment to restrain, isolate, and treat the cattle. Generally, headlocks (one per cow), corrals, and sunshades are used in warm semi-arid regions. Pastures and shelters are common in warm humid areas, naturally ventilated barns with free stalls are used widely in cool humid climatic regions, and insulated and ventilated barns with tie stalls are common in colder climates.

Early research showed an economic advantage in providing housing for dairy cows during the winter instead of leaving them outside (Plumb, 1893). During good weather, to enrich the environment and to improve overall health and well-being, cows should be moved if possible from indoor stalls into the barnyard, where they can groom (Wood, 1977) themselves and one another, stretch, sun themselves, exhibit estrous behavior, and exercise (Albright, 1993b). Exercise decreases the incidence of leg problems, mastitis, bloat, and calving-related disorders (Gustafson, 1993).

Keeping cows out of mud increases their productivity and reduces endoparasitic and foot infections. Current trends and recommendations favor keeping dairy cows on unpaved dirt lots in the Southwest and on concrete in the North throughout their productive lifetimes. Concrete floors should be grooved to provide good footing and to reduce injury (Albright, 1994, 1995a; Jarrett, 1995). The concrete surface should be rough but not abrasive, and the microsurface should be smooth enough to avoid abrading the feet of cattle.

Data are limited on the long-term effects of intensive production systems; however, concern has been expressed

about the comfort, well-being, behavior, reproduction, and udder, foot, and leg health of cows kept continuously on concrete. As a safeguard, cows should be moved from concrete to dirt lots or pasture, at least during the dry period. Also, rate of detection and duration of estrus are higher for cows on recommended dirt lots or pastures than for cows on concrete (Britt et al., 1986).

Exercise during the dry period does not adversely affect milk production, but does result in cows that are fit. Forced exercise after parturition reduces energy intake and milk production; therefore, forced exercise is not recommended (Lamb et al., 1979).

For recommendations for housing cattle in intensive laboratory environments (e.g., lighting, excreta collection, and metabolism or environmental chambers), refer to Chapter 5.

Area

Between and within breeds, ages, and body conditions, critical dimensions of dairy cattle vary less with weight than with age. Body length and hip width are relatively uniform (± 5%) across breeds at weights between 180 and 450 kg (400 and 1000 lb) (ASAE, 1987). More than 94% of the dairy cattle in the US are Holsteins, and area recommendations for female calves and heifers are usually related to age groupings for Holsteins (Woelfel and Gibson, 1978; Graves and Heinrichs, 1984; Heinrichs et al., 1994; MWPS, 1995). Average normal growth curves relate heart girth and live weight to age (Woelfel and Gibson, 1978; Graves and Heinrichs, 1984; Heinrichs et al., 1994; MWPS, 1995).

The length of individual stalls should be the length of the animal (Goodman, 1926), defined as the distance between

TABLE 6-1. Recommended Options and Sizes[a] for Pens and Stalls for Dairy Cattle Used in Agricultural Research and Teaching.

Components	Options	Sizes	
Individual calves	Hutches and yard or tether	1.5 to 3 m^2/head	(6 to 12 ft^2/head)
Until 2 mo [to 91 kg (to 200 lb)]	Bedded pen	2.2 to 3 m^2/head	(24 to 32 ft^2/head)
Until 7 mo [to 182 kg (to 400 lb)]	Stall[b]	.6 to .8 × 1.5 to 1.8 m^2/head	(10 to 15 ft^2/head)
Groups[c] of weaned calves			
[182 kg (<400 lb; 3 to 12/group)]	Movable shed (super calf hutch) plus yard	2 m^2/head	(21 ft^2/head)
	Inside pen	2.3 to 2.8 m^2/head	(25 to 30 ft^2/head)
	Bedded pack	3.1 × 4.9 to 6.1 m	(10 × 16 to 20 ft)
	Scraped alley	3.1 × 2.4 to 3.1 m	(10 × 8 to 10 ft)
Groups[c] of heifers in pens, 6 to 20/group	With free stalls	(see Table 6-2)	
181 to 454 kg (400 to 1000 lb)	With bedded pack	8 to 12 m^2/tonne	(4 to 6 ft^2/cwt)
34 to 136 kg (75 to 300 lb)		1.5 to 5.6 m^2/head	(16 to 60 ft^2/head)
		5. to 8 m^2/tonne	(2.5 to 4 ft^2/cwt)
	With slotted floor[d]	1.5 to 2.3 m^2/head	(16 to 25 ft^2/head
	With counterslope		
	Floors and	6 to 8 m^2/tonne	(3 to 4 ft^2/cwt)
	litter alley	1.5 to 3 m^2/head	(16 to 30 ft^2/head)
Dry cows and heifers [454 kg (>1000 lb)]	Bedded pack and	8 to 12 m^2/tonne	(4 to 6 ft^2/cwt)
	paved alley	4 to 9 m^2/head	(40 to 96 ft^2/head)
Maternity or isolation pens (5% of cows)[e]	With bedded nonslip floors	9.3 to 14.9 m^2/head	(100 to 160 ft^2/head)
		3.1 × 3.1 to 3.7 × 4.3 m	(10 × 10 to 12 × 14 ft)
Individual mature bulls	Rugged pens	13 to 22.3 m^2/head	(140 to 240 ft^2/head)
		3.1 × 4.3 m	(10 × 14 ft or larger)
	Tie stalls	1.4 × 2.5 to 2.6 m	(54 × 97 to 102 in
		to 1.8 × 360 m	to 72 × 188 in)
Milking cows	Free stalls	(see Table 6-2)	
	Tie stalls	(see Table 6-2)	
	Paved lots	9 m^2/head	(100 ft^2/head)
	Unpaved corrals	46 m^2/head	(500 ft^2/head)

[a]Sizes exclude access for feeding and cleaning.
[b]Research protocol may require the use of individual stalls for calves.
[c]Different sources use different age groups. Weight variation increases with age.
[d]Space decreases with age. Spacing between slats is 3.18 cm at 169 kg, 3.82 cm at 170 kg, and 4.45 cm at 250 to 500 kg (1.25 in at 374 lb, 1.5 in at 375 lb, and 1.75 in at 550 to 1100 lb) (Woelfel and Gibson, 1978).
[e]In addition to maternity pens, treatment and handling facilities are recommended (Anderson, 1983; Anderson and Bates, 1983; Bates and Anderson, 1983; Graves, 1983; Veenhuizen and Graves, 1994; MWPS, 1995).

the pin bones and the front of the shoulders (ASAE, 1987) or between the pin bones and the brisket (Irish and Merrill, 1986). For stanchions and tie stalls, stall width to length ratio should be at least .8 (Goodman, 1926) to .7 (MWPS, 1985). The width of free stalls should be twice the hip width (Irish and Merrill, 1986). These dimensions have been taken into account for the recommendations for Holsteins shown in Tables 6-1 and 6-2.

Dairy cows prefer larger, more comfortable stalls and use free stalls 9 to 14 hr daily (Schmisseur et al., 1966; Irish and Martin, 1983). Free-stall systems may be adapted for feeding trials utilizing electronic gates. Free stalls are recommended for dairy cattle used in teaching, extension, and research programs throughout much of the United States. The range of effective dimensions of stalls for mature Holstein cows (Graves, 1977; MWPS, 1995) is presented in Tables 6-1 and 6-2.

Bedding

Resting dairy cattle should have a dry bed. Stalls ordinarily should have bedding to allow for cow comfort and to insulate the udder against cold temperatures. When handled properly, many fibrous and granular bedding materials may be used (MWPS, 1995), including long or chopped straw, poor quality hay, sand, sawdust, shavings, and rice hulls. Inorganic bedding materials (sand or ground limestone) provide an environment that is less conducive to the growth of mastitis pathogens. Sand bedding may also keep cows cooler than straw or sawdust. Regional climatic differences and diversity of bedding options should be considered when bedding materials are being selected. Bedding should be absorbent, free of toxic chemicals or residues that could injure animals or humans, and of a type not readily eaten by the animals. Bedding rate should be sufficient to keep the animals dry between additions or changes. Any permanent stall surfaces, including rubber mats, should be cushioned with dry bedding (Albright, 1983). Bedding material added on top of the base absorbs moisture and collects manure tracked into the stall, adds resiliency, makes the stall more comfortable, and reduces the potential for injuries (MWPS, 1995).

Bedding mattresses over hard stall bases such as concrete or well-compacted earth can provide a satisfactory cushion. A bedding mattress consists of bedding material compacted to 8 to 10 cm (3 to 4 in) and enclosed in a fabric (heavy weight polypropylene or other similar material). Shredded rubber may be used and is recommended as a mattress filler (Underwood et al., 1995). Small amounts of bedding (chopped straw) on top of the mattress keep the surface dry and the cows clean (MWPS, 1995).

Tie Stalls and Stanchions

To avoid contamination of the teat and reproductive tract orifices, waste removal must be more regular and thorough when cows are housed in tie stalls than when cows are housed in free stalls, corrals, or pasture situations. Cow trainers and gutter grates are recommended for cleaner stalls and cows.

Free Stalls

One free stall is recommended for each lactating cow. The stall base and bedding provide a resilient bed for cow comfort and a clean, dry surface to reduce the incidence of mastitis. Because cows prefer to stand uphill, the stall base should be sloped forward 4% [1.4 cm/m (.5 in/ft) rise] from rear to front. Commonly used materials for the base include concrete, clay, sand, and stone dust. Hardwood planks tend to rot. Rubber tires, if not firmly imbedded, tend to come loose (MWPS, 1995). In an ideal free stall, the stall bed and partition should define the lying position of the cow and accommodate natural lying and rising behavior (McFarland and Gamroth, 1994; MWPS, 1995).

Key features of most free-stall accommodations are a leveled dirt base, clean bedding, and regular and effective cleaning of alleys. When dangerous pathogens or toxic or noxious substances are identified in the environment, they should be removed; the area should be cleaned and disinfected; and new, uncontaminated material should then be supplied. Good management procedures include the removal and replacement of contaminated bedding or soil and the disinfection of such areas with agents that are effective against the specific pathogen or pathogens present.

Special Needs Areas

Cows with special needs are associated with greater risk and thus require special consideration with respect to facilities:

- Preparturition. Cows that are near the time of calving (2 to 3 wk prepartum) benefit from a clean, dry environment and access to an appropriate dirt lot for exercise. Feeding facilities should be provided to prepare cows for the high energy ration they will receive upon entering the milking herd. Free-stall housing situated for frequent observation and proximity to the maternity area is a desirable option.
- Maternity. In preparation for calving, cows should be moved to individual pens that are separate from other animals, especially younger calves. The environment should be well ventilated, and the pens should be maintained to be clean, dry, and well bedded. Recommended pen size is 3.7 m × 3.7 m or 3 m × 4.3 m (12 ft × 12 ft or 10 ft × 14 ft). One maternity pen should be provided for every 20 cows. The maternity pen should have a stanchion on one side for cow restraint. A concrete curb between each stall aids sanitation. Deep bedding should be used on concrete floors to prevent cows from slipping. Grooved concrete (e.g., diamond pattern) is also recommended (Albright, 1994, 1995a). Provisions should exist for lifting downer cows. Devices to aid and promote standing include hip lifters (hip clamps), slings (wide belt and hoist),

inflatable bags, and warm water flotation systems. Pen location should permit access by a tractor or loader to allow removal of downed cows. Each pen should be provided with adequate feeding space and fresh, clean water. Depending on local conditions, a calving pen may not be necessary. Cows can calve in a pasture area with lighting situated for observation. A calving pasture should be well sodded and drained, should be large enough to allow cows to move away from others in the group before calving, and should contain an adequate sheltered area. Use of a pasture pen can eliminate footing and bedding problems associated with calving pens.

- Removing calf. Dairy calves are normally removed from their dams as soon as possible following birth. The cow and calf are more difficult to separate after 3 d (Albright, 1987). Therefore, early removal (before 72 hr) is recommended (Hopster et al., 1995).
- Postcalving. A cow that has recently calved (from 0 to 7 d postpartum) should be placed in a special area for frequent observation before rejoining the milking herd. Individual feed intake and milk production should be monitored to determine whether the cow is progressing normally. Milk must be withheld from shipment as required by regulations. Free stalls or large, well-bedded pens may be used in this special area. For a larger herd, a special hospital and maternity barn, possibly equipped with a pipeline or portable milker, could house cows in this management category as well as cows that are calving or that have other special needs.
- Treatment. A treatment area in the barn for confining cows for artificial insemination, pregnancy diagnosis, postpartum examination, sick cow examination, surgery, and for holding sick or injured animals until recovery is recommended.
- Dry-off. Cows recently dried off should be separated from the milking herd for feeding purposes. Recommended medical treatments should be performed, and cows should be observed frequently to ensure normal progress.

Table 6-2. Recommended Sizes[a] of Free Stalls as Related to Weights of Female Dairy Cattle Used in Agricultural Research and Teaching.

Target weight	Approximate age[b]	Free stall[c]	Tie stall[c]
	(mo)		
118 kg (260 lb)	4	61 × 122 cm (24 × 48 in)[d]	NI[e]
182 kg (400 lb)	6	69 × 122 cm (27 × 48 in)	NI
236 kg (520 lb)	8	76 × 137 to 152 cm (30 × 54 to 60 in)	NI
327 kg (720 lb)	12	86 to 91 × 152 to 168 cm (34 to 36 × 60 to 66 in)	NI
377 kg (830 lb)	16	91 to 107 × 168 to 198 cm (36 to 42 × 66 to 78 in)	NI
454 kg (1000 lb)	20	99 × 183 cm (39 × 72 in)	122 × 152 to 175 cm (48 × 60 to 69 in)
500 kg (1100 lb)	24	107 × 198 to 213 cm (42 × 78 to 84 in)	122 × 160 to 175 cm (48 × 63 to 69 in)
545 kg (1200 lb)	26	114 × 208 to 213 cm (45 × 82 to 84 in)	122 × 168 to 175 cm (48 × 66 to 69 in)
636 kg (1400 lb)	48	122 × 213 to 218 cm (48 × 84 to 86 in)	137 × 183 cm (54 × 72 in)
727 kg (1600 lb)	60	122 × 229 cm (48 × 90 in)	152 × 183 to 198 cm (60 × 72 to 78 in)

[a]Sizes are generally higher from midwestern sources than northeastern sources.
[b]Age of Holstein or Brown Swiss for target weights.
[c]Measurements are given as stall width times stall length. Length of stall is for the side-lunge free stall. For forward-lunge free stalls, add 30 to 45 cm (12 to 18 in) (MWPS, 1995). Where brisket boards are in use, the stall bed from curb to brisket board should be 168 cm (66 in).
[d]Free stalls are not recommended for calves less than 4 mo (Graves and Heinrichs, 1984) or 5 mo of age (Woelfel and Gibson, 1978; MWPS, 1995).
[e]NI = Not included in recommendations for dairy heifers (Woelfel and Gibson, 1978; Graves and Heinrichs, 1984; MWPS, 1985; Heinrichs and Hargrove, 1987).

Corrals

Corrals should be scraped as needed, and concrete alleys should be scraped or flushed regularly to clean them effectively. Feedbunk areas should be scraped regularly, and any leftover feed should be removed. Shades and corrals should be designed to minimize areas of moisture and mud.

Pasture

Pasture management and watering facilities have been implicated in a number of significant bovine diseases and zoonoses. Pasture should be managed to avoid disease transmission. Stocking rates should be managed to maximize production per head unless forage supplementation is provided or unless production per unit of pasture area is to be studied. This strategy minimizes the stress that may result from overgrazing and also minimizes ingestion of plants from areas immediately surrounding those areas contaminated with excreta, thereby reducing the challenge of potential pathogens and helminth parasites. Some pathogenic microbes may survive more than 6 mo in fecal deposits. Shade should be provided during hot weather.

Lighting

Lighting recommendations for dairy cattle housed in indoor environments are the same as those for beef cattle in intensive environments (see Chapter 5).

FEED AND WATER

Except as necessary for a particular research or teaching protocol, dairy cattle should be fed diets that have been formulated to meet their needs for maintenance, growth, production, and reproduction (see Chapter 2). Feed ingredients and finished feeds should be wholesome, carefully mixed, and stored and delivered to the cattle to minimize contamination or spoilage of feeds. To ensure freshness, feeds that are not consumed should be removed daily from feeders and mangers, especially high moisture feeds such as silage. Feed should be far enough from waterers to minimize contamination.

Space should be adequate for feed and water. Feeders or mangers should be designed with smooth surfaces for easy cleaning and increased feed consumption. The recommended linear space per cow at the feed bunk is 61 to 90 cm (2 to 2.5 ft), which should allow every animal uninterrupted feeding (Malloy and Olson, 1994). Feeder design should permit a natural head down grazing posture to promote intake, improve digestive function, and decrease feed-wasting behavior (Albright, 1993a). At least one water space or 61 cm (2 ft) of tank perimeter should be provided for every 15 to 20 cows in a group. At least two watering locations should be provided for each group of cows. Each cow in tie stalls and stanchions should have its own water bowl or drinking cup (Andersson, 1985; MWPS, 1995).

All calves should consume colostrum in amounts of 8 to 10% of body weight (or 2 to 3 L) within 4 to 5 hr after birth and another 2 to 3 L within 24 hr of birth for a 36- to 45-kg (80- to 100-lb) calf (Stott et al., 1979; Stott and Fellah, 1983; Hunt, 1990; Pritchett et al., 1991; Mechor et al., 1992). Colostrum should be monitored with a colostrometer for quality (protein and antibody content). Mixed high quality colostrum pooled from several cows can be better than low quality colostrum from a particular dam. Until calves can consume dry feed at an adequate rate, they should be fed liquid feed in amounts sufficient to provide needed nutrients at 10% of body weight at birth per day until weaned. Water should be given at times other than when milk or milk replacer is fed to avoid possible interference with curd formation. Calves being raised as replacement heifers or for beef should be fed enough dry feed with sufficient fiber preweaning to stimulate normal rumen development (McGavin and Morrill, 1976). Calf research guidelines have been reported that permit uniformity in measuring and reporting experimental data (Larson et al., 1977).

Water intake affects consumption of dry matter (Kertz et al., 1984; Milam et al., 1986) and is itself influenced by individual behavior, breed, production rate, type and amount of feed consumed, water temperature, environmental temperature, atmospheric vapor pressure, water quality, and physical facility arrangement (Atkeson and Warren, 1934; Murphy et al., 1983; Andersson, 1985; Lanham et al., 1986). Nonlactating cows consume 3 to 15 kg of water/kg of dry matter consumed, depending on environmental temperature. Lactating cows consume 2 to 3 kg of water/kg of milk produced plus that required for maintenance (Little and Shaw, 1978).

Water should be available at all times (NRC, 1989) and should be checked daily for cleanliness and also monitored regularly to ensure that it is free of contaminants that could potentially put zoonotic agents into the human food chain (Johnston et al., 1986). Water sources should be readily accessible to all stock. Underfoot surroundings in watering areas should be dry and firm. Cattle should not be able to wade in drinking water.

SOCIAL ENVIRONMENT

Dairy cattle are social animals that operate within a herd structure and follow a leader (e.g., to and from the pasture or milking parlor). Cows exhibit wide differences in temperament, and their behavior is determined by inheritance, physiology, prior experience, and training. Cattle under duress may bellow, butt, or kick. Cows are normally quiet and thrive on gentle treatment by handlers. Cows learn to discriminate between people and react positively to pleasant handling. Cows have higher milk yields if handlers touch, talk to, and interact with them frequently (Albright and Grandin, 1993; Seabrook, 1994). Cows should have visual contact with one another and with animal care personnel. Handling procedures are more stressful for iso-

lated cattle; therefore, attempts should be made to have several cows together during medical treatment, artificial insemination, or when cows are being moved from one group to another (Whittlestone et al., 1970; Arave et al., 1974).

Dairy cattle have traditionally been kept in groups of 40 to 100 cows (Albright, 1978), although specific research protocols may require smaller or larger group sizes. Variation in group size—small (50 to 99), medium (100 to 199), and large (200 or more)—does not cause a problem per se. Large herd size, however, can affect management decisions because overcrowding with insufficient number of headlocks or inadequate manger space per cow, irregular or infrequent feeding, and excessive walking distance to and from the milking parlor have a greater impact on behavior and well-being than does group size (Albright, 1995b).

HUSBANDRY

Vaccination schedules that are appropriate for the locality and the individual herd should be established with the advice of the attending veterinarian.

Certain dairy cattle behaviors (e.g., aggression and kicking) put at risk the health and well-being of herdmates as well as the humans handling the cattle. These behaviors can be reduced or modified by several devices and procedures, including stanchions, head gates, squeeze chutes, halters, and rope and tail hold. Nose tongs, hobbles, and electrical prods should be used sparingly, if at all.

Information about calving management is given by Albright and Grandin (1993). First-calf heifers should be bred to bulls with a reputation for siring easily delivered calves. Calf pullers should be used cautiously and only when necessary to prevent injury. If injury occurs during calving, the cow should be lifted into a standing position for rehabilitation. An apparatus with a wide belt and hoist may be used to lift a cow gently to her feet. Warm water flotation systems are also useful in rehabilitating cows.

Calves require special handling and care from the time they are born. Navels should be dipped in 7% iodine as soon as possible after birth. The newborn calf should be fed colostrum within the first 5 hr after birth. A calf should be given 8 to 10% of its body weight daily in fresh colostrum by bottle, bucket, or tube feeder. Colostrum is rich in nutrients and provides the calf with vital immunoglobulins. Good nutrition along with proper handling starts a calf on its way toward a healthy life.

STANDARD AGRICULTURAL PRACTICES

All animals should be individually identified (see Chapter 2). Heifer calves should have supernumerary teats removed at an early age (Moeller, 1981). Milking procedures should follow NMC guidelines.

Castration may be performed on male calves (see Chapter 5) except those being raised as veal calves (see Chapter 11) or kept as dairy bulls. Dehorning (disbudding) should be performed as described in Chapter 5.

Older calves and heifers close to calving should have supernumerary teats removed under local anesthesia by a qualified person. The removal of these extra teats is necessary because they can later disrupt the milking process and become infected. Removal may be performed in the first 3 mo of life with a scalpel or sharp scissors.

Tail-Docking

Docking of tails is a controversial, yet common practice performed on cows that are milked from the rear or that have filthy switches (Albright, 1972; Wilson, 1972; Ewbank, 1988; Jaquish, 1991; Ladewig and Matthews, 1992; Hemsworth et al., 1995; Phipps et al., 1995). Tail-docking has been prohibited in the United Kingdom (Ewbank, 1988) and some other European countries. Under conditions of high fly numbers, tail-docked heifers tail-flick more often and are forced to use alternative behaviors such as rear leg stomps and head turning to try to rid themselves of flies (Ladewig and Mathews, 1992; Phipps et al., 1995). More flies settle on tail-docked cows than on intact cows; the proportion of flies settling on the rear of the cow increases as tail length decreases (Matthews et al., 1995). Grazing and rumination are disturbed when fly attacks are intense (Ladewig and Matthews, 1992), and substantial losses to the United States cattle industry have been attributed to flies causing interference with grazing (Byford et al., 1992). Excellent fly control is therefore especially important for tail-docked cattle. A study of tail-docking in New Zealand (Matthews et al., 1995) found no difference in cortisol concentrations between docked and intact cows, but there were also no differences in milk yields, body weights, somatic cell counts, frequency of mastitis, or milker comfort among the treatments studied (intact tails, trimmed tails, and docked tails). Trimming switches with clippers or fastening the switch out of the way are preferred as alternatives to tail-docking in research or teaching herds. Further research is needed on the short- and long-term consequences of tail-docking in the United States herds.

Foot Care

Foot lameness is probably the single greatest insult to the welfare of the modern dairy cow. In a case-control study on lameness in dairy herds, the two factors found to be most influential in preventing lameness were maintenance of farm tracks (walkways) and patient handling of cows (Chesterton et al., 1989). Diet (acidosis) is also involved in the cause and control of lameness, especially lameness that is due to laminitis. Lameness may be controlled by foot bathing and foot trimming (Webster, 1993). A cow with properly trimmed hooves and healthy feet and legs will stand quietly and occasionally shift her weight. Cows with feet and leg problems are more restless, crampy, and uncomfortable; they appear to walk in place (Albright and Grandin, 1993). In situations in which the potential exists

for outbreak of infectious necrobacillosis of the hoof, hairy warts, or other foot infections, antiseptic footbaths or topical sprays are recommended (Blood et al., 1983). Properly designed and maintained footbaths should be placed in areas of heavy traffic flow (e.g., at exits from the milking area, but not at entrances). Predisposing causes of foot problems (e.g., sharp rocks or moist or muddy ground) should be removed. Topical spray application to the feet of individual cows is recommended (Shearer et al., 1995a,b).

HANDLING AND TRANSPORTATION

Loading and Shipping

Knowledge and utilization of the flight zone (see Chapter 5) are important during the moving of dairy cattle. See Chapter 2 for further information about handling cattle. Adequate space should be available for handling when dairy cattle are being loaded for shipping. Cattle need ample room to turn; the leaders will then move into the chute, and other cattle will follow.

Stair steps are recommended for loading ramps. Each step should be 10 cm (4 in) high with a 30-cm (12-in) tread width. Loading ramps for young stock and animals that are not completely tame should have solid sides.

Cows that become emaciated or too weak to stand must not be transported. If rehabilitation does not occur within a reasonable time, the animal should be euthanatized on the farm (LCI, 1992a).

Young dairy cattle or lactating cows should always be handled gently and allowed time to investigate their new environment and ease into it without outside distractions. Cows should be moved at a slow walk, particularly if the weather is hot and humid or if the flooring is slippery.

Attempts should be made to ship dairy cattle only under favorable weather conditions. In regions where temperature extremes are likely, consideration should be given to minimizing exposure of animals to such extremes during transport (Grandin, 1988, 1992, 1993; LCI, 1992a,b; Albright, 1993b; Malloy and Olson, 1994).

If young calves are to be marketed, individual care and colostrum should be provided for 2 to 3 d after birth. Calves should always have a dry haircoat, have a dry navel cord, and walk easily before being transported. A day-old calf can stand, but is unsteady and wobbly and is not ready for market. Calves should not be brought to a livestock market until they are strong enough to walk without assistance. To reach adequate strength and vigor, calves need to be a minimum of 5 d old (Grandin, 1990). In transit, calves must be handled carefully and receive protection from the sun and heat stress in the summer and from the cold and wind chill in winter.

Nonambulatory or downed animals must not be dragged (see Chapter 5). Recommendations by the LCI (1992a) address prevention, preparation, and prompt action. Nonambulatory cattle in research and teaching facilities must always be euthanatized using approved procedures.

EUTHANASIA

When necessary, euthanasia should be performed by trained personnel using acceptable methods established by the AVMA (1993). The approved methods for ruminants include barbiturates, penetrative captive bolt, gunshot, electrocution, and chloral hydrate (see Chapter 3).

SPECIAL CONSIDERATIONS

Milking Machine and Udder Sanitation

The milking facility should have a program for regular maintenance of milking machines and follow the comprehensive mastitis prevention and milking management program of the NMC. Because dairy cows may be studied and maintained in a variety of environments, various strategies for disinfection and sanitation are required. Appropriate equipment and competent personnel should be available for milking. Animal care facilities should be designed and operated to standards meeting or exceeding those of Grade A dairies (Pasteurized Milk Ordinance, 1993). The milking facility, whether stanchions or milking parlor, must have clean floors with good traction and proper illumination to be hygienic and safe.

Cows may be milked with portable milking equipment that is maintained to Grade A standards of efficiency and sanitation. Particular care should be taken not to undermilk or overmilk cows and to be attentive to a milking schedule (usually twice daily and regular intervals). Personnel who are trained or experienced in the husbandry and milking of dairy cows should be employed for this task. Written operating procedures should be established to control potential contamination of milk with antibiotics or other pharmaceutical agents.

Milking machine and udder sanitation are vital to an effective preventive program against mastitis. Water used to wash cows before milking should be of a high quality when manure and organic matter are present, because microbes in wash water have been implicated in mastitis outbreaks (Malmo et al., 1972). Care should be used to minimize the excessive use of water prior to and during udder preparation. Emphasis should be placed on ensuring that cows enter the milking parlor with clean, dry teats. Udders, especially teat ends, should be clean and dry when teat cups are applied for milking. Teat sanitation, predipping, and wiping immediately prior to machine attachment reduces udder infection caused by environmental pathogens (Bushnell, 1984; Pankey et al., 1987; Galton et al., 1988; Pankey, 1992; Malloy and Olson, 1994; Reneau et al., 1994). Another approach is to use a low water premilk-

ing preparation with recommended germicides (NMC) followed by wiping the teats and udder with a clean, dry towel. Postmilking disinfection of teats is an essential management practice that greatly reduces the incidence of mastitis (Neave et al., 1969; Philpot et al, 1978a,b; Philpot and Pankey, 1978; Pankey, 1992). Milkers handling cows should pay meticulous attention to their own personal hygiene and wash their hands thoroughly before milking and frequently during milking or wear clean rubber or latex gloves during milking to prevent contamination of the udder. Cows with contagious mastitis should be milked last to reduce the spread of mastitis throughout the herd. Udder hair removal is recommended as a means to improve milking hygiene and udder health.

Effective cleaning programs for milking machines include use of hot water; use of disinfectant solutions and other chemical agents effective for removing mineral, milk fat, and protein deposits from equipment between milkings; disinfection of teat cups between cows; and flushing of teat cups with warm water, cold water, boiling water, or chemical disinfectant solution.

Noise and Music

Changes observed in cows exposed to noise were well within the range of activity variation expected in a group of cows (Casaday and Lehmann, 1967; Head et al., 1993). However, disturbances by veterinarians and other visitors can reduce milk yield (King, 1976). Experimental results suggest that music can contribute to consistency in the environment of cows and can become part of a cluster of stimuli that condition the milk-ejection reflex (Whittlestone, 1960; Albright, 1981; Evans, 1984, 1990; Fox, 1984; Hart, 1985; Albright et al., 1992).

Stray Voltage

Numerous research studies have quantified the physiological and behavioral responses of dairy cattle to electric currents (Lefcourt, 1991; Aneshansley et al., 1992). The electrical currents required for perception, behavioral change, or physiological effects to occur are widely variable. Furthermore, symptoms associated with problems of stray voltage or electrical current are not unique, and many factors other than stray voltage and electrical current can cause similar problems in behavior, health, or production (Gorewit et al., 1992).

The sources of relatively small amounts of electrical currents passing through animals are often very difficult to locate. Stray voltage or electrical currents may arise because of poor electrical connections, corrosion of switches, frayed insulation, faulty equipment, or heavily loaded power lines.

Periodic evaluation of facilities for stray voltage is suggested. Solutions include voltage reduction, control of sources of voltage leakage, gradient control by use of equipotential planes and transition zones, and isolation of a portion of the grounding or grounded neutral system from the animals. Proper installation of electrical equipment and complete grounding of stalls and milking center equipment should help prevent stray voltage problems. Although stray voltages and electrical currents cannot be totally eliminated, they can be reduced (Albright et al., 1991; Lefcourt, 1991; Gorewit et al., 1992).

Bulls

The feeding and watering of growing and mature bulls should meet requirements of the NRC (1989). Bulls should be housed in clean, well-lit, and ventilated buildings or outside in facilities that protect them from inclement conditions. Young bulls kept in groups should be observed carefully as they mature to make certain that one or more individuals are not injured. Aggression increases with age. Smaller subordinate bulls should be removed from the group. Visual and vocal social interactions with other bulls may be stressful because free-ranging bulls do not live in groups (Hall, 1989). Space requirements for bulls are listed in Table 6-1.

The safety of humans and animals is the chief concern underlying management practices. By virtue of their size and disposition, bulls may be considered as one of the most dangerous domestic animals. Management procedures should be designed to protect human safety and to provide for bull welfare. Electroejaculation of bulls is sometimes necessary. It should be performed by a qualified person, preferably using the finger-electrode massage method (Ball, 1974; Weidler, 1978).

A program of annual self-regulation should be followed for (1) semen identification and sire health auditing service and (2) minimum requirements for health of bulls producing semen for artificial insemination (Certified Semen Services, 1992; Mitchell, 1992).

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