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Chapter 49: Welfare

by D.M. BROOM

Introduction

Most of this book is directly relevant to the improvement of cattle welfare as it refers to the treatment or prevention of disease and the welfare of animals severely affected by disease is poor. There are often links between disease and other sorts of welfare problems (Gibson, 1988) both in the consequences of disease for welfare and in the increased susceptibility of animals to disease when their welfare is poor. Many welfare problems, however, are a consequence of inadequacies of management and housing and these will be discussed in this chapter.

Welfare definition

The welfare of an individual is its state as regards its attempts to cope with its environment (Broom, 1986). When conditions are difficult, individuals use various methods to try to counteract any adverse effects of those conditions on themselves. These attempts may be unsuccessful or they may succeed but the effects of lack of success and the extent of what is done to try to cope can be measured. Hence welfare varies on a continuum from very good to very poor and it can be assessed precisely. The assessment of welfare can be carried out in a scientific way without the involvement of moral considerations. The question which is asked after the measurement is made is: How poor must the welfare be before people consider the condition or treatment to be unacceptable? A moral decision must be taken here and different people will draw the line, marking what is unacceptable, at different levels in the welfare continuum. The moral decision depends upon the availability of evidence about welfare but the process of deciding about morality and the process of assessing welfare are quite separate.

Welfare problem areas

Whilst cattle management has been changing, our knowledge of cattle physiology and behaviour has been improving. It is clear that cattle have complex regulatory processes, elaborate social structure and sophisticated learning ability (Broom, 1981; Craig, 1981; Kilgour & Dalton, 1984; Stricklin & Kautz-Scanavy, 1984; Fraser & Broom, 1990). These results have made many animal scientists reconsider the effects of conditions and procedures on farms, both in terms of their efficiency as regards production and with respect to the welfare of the animals.

The general range of welfare problem areas is the same for cattle as for other farm animals (Table 49.1). Ill-treatment refers principally to physical abuse of animals. Neglect includes failing to give food and water, or to clean out, or to treat disease, or to assist as necessary at calving. Accommodation for animals may, for example, give insufficient space, poor flooring or poor food access and conditions indoors or outdoors may lead to risk of injury (Schlichting & Smidt, 1987).

Table 49.1 Possible causes of cattle welfare problems

Ill-treatment
Neglect: calculated, accidental, or due to lack of knowledge
Inadequacies in design of housing/furniture
Inadequate management system or poor husbandry on the farm
Unnecessary or poorly executed operations on the animals
Poor conditions and procedures
During transport
At market
At slaughterhouse

Management methods and husbandry include all aspects of feeding, moving of animals, grouping, milking, serving, etc. Farm operations require some special mention, both as regards the methods used and the consequences for the animals. Methods of handling and moving animals are of importance before and after transport, at markets and at lairage as well as on the farm. There are also special problems of transport vehicle construction and usage, market accommodation and procedures, and slaughter methods. Welfare problems that should be taken into account in cattle practice have been reviewed by Broom (1988).

Welfare and production

Improved welfare often leads to improved production. If the welfare of a dairy cow is improved there is often a greater milk yield and if the welfare of very young calves is improved, the resulting increases in growth rate and survival chances lead to economic advantages for the farmer. In other situations, however, improving welfare leads to reduced profits, for example when stocking density is decreased the benefit of welfare. Modern cattle husbandry systems do lead to some welfare problems, as discussed below. A general change in cattle management methods has been an increase in production pressure. Nutritional expertise has increased to the point where animals now convert feed to meat and milk very efficiently. If animals are pushed hard energetically, there need not be welfare problems and management difficulties but these are more likely and should be taken into account when advising farmers about which system to choose.

Ill-treatment and neglect

Human actions that can lead to poor cattle welfare include ill-treatment, neglect and inadequate production systems. Ill-treatment occurs most frequently when animals are being moved around the farm, when they are being loaded into or out of vehicles, or when they are at market or lairage. Those who do ill-treat animals can be advised of likely economic effects of their actions as well as being told about the laws on the subject. Neglect includes failure to provide an adequate diet, failure to treat disease and the lack of normal husbandry procedures. The diet may be inadequate in nutrient composition or in quantity. Cattle are sometimes undernourished for a period, whilst food is scarce or expensive, with the expectation that compensatory growth will occur when more food is provided. If the undernourishment amounts to starvation and this is clear from the condition of the animal, then this is serious neglect. Lack of knowledge on the part of the farmer may result in the provision of a poor diet or in failure to treat disease. This is poor husbandry, a very important cause of welfare problems. Advice on good husbandry methods can be an important veterinary service. If animals are diseased and require treatment there is a moral obligation upon the veterinarian to treat them. In the UK, the veterinary oath, which is sworn on admission to Membership of the Royal College of Veterinary Surgeons, includes the promise that 'my constant endeavour will be to ensure the welfare of animals committed to my care'. In certain circumstances, treatment without any prospect of payment may be necessary. In other circumstances it may be best to call in the State Veterinary Service, the police, or the RSPCA, even if to do so might mean losing a client.

Housing and management

General points

Feeding of housed cattle may lead to difficulties for the animals because the acquisition of food in housing conditions is very different from that when grazing. Physical difficulties may occur, as described by Cermak (1987), but social factors are also very important. Cattle synchronize their feeding to a large extent (Benham, 1982; Potter & Broom, 1987) so where group feeding is possible, enough feeding places for each animal are required (Metz, 1983; Wierenga, 1983). Those animals that cannot find a feeding place may not get sufficient food and it is likely that there are adverse effects on their welfare. The precise effects of the frustration that occurs when food is inaccessible because of competition remain to be determined. Competitive feeding situations where there are no individual feeding places pose extra problems for cattle. The subordinate individual has to attempt to obtain food

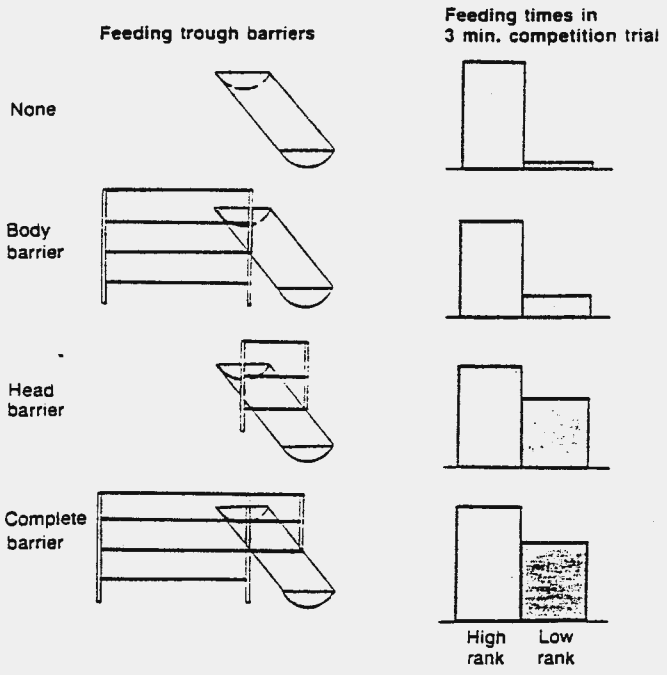

Fig. 49.1 Physical barriers affected feeding times by cows ranking high and low in a competitive order. With no barrier (a) the low ranking cows were scarcely able to feed. A body barrier (b) improved the situation slightly for the low ranking cows but a head barrier (c) and a complete barrier (d) had a much greater effect (redrawn after Craig, 1981; data from Bouissou, 1970).

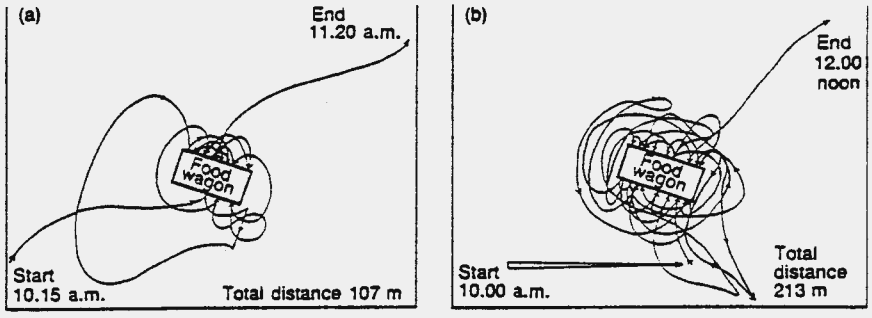

Fig. 49.2 The paths of two cows in a herd after food is provided in a food wagon are shown. Animal (a) was found to be high in a competitive order whereas animal (b), which was low in that order, walked further because of displacement at the food wagon and took longer to feed (after Broom, 1981; modified after Albright, 1969).

despite the attacks or threats of other individuals. Bouissou (1970) found that the greater the extent of the barrier between feeding places for cows, the fewer the attacks that occurred (Fig. 49.1). A trough that requires subordinate cows to come close to dominant individuals results in those subordinates walking greater distances and taking longer to obtain a meal (Albright, 1969; Fig. 49.2). Calves of low social rank obtain less of the favoured food if trough space is restricted (Broom & Leaver, 1978; Broom, 1982). In order to minimize such welfare problems, which are often associated with poor weight gain, farmers should provide feeding spaces for all individuals, preferably with barriers between the individual places. Adaptation to a single food source is possible for cattle, however, for a transponder-operated feeding stall can be quite successful (Albright, 1981), but certain individuals in a herd may have difficulties in such systems.

Another general problem for housed cattle is having to stand on floors that are wet, slippery, uneven, or hazardous because of sharp edges. Slippery slats can lead to difficulties in standing or lying (Andreae & Smidt, 1982; Fig. 49.3). These and other inadequacies of flooring can result in limb injuries, foot lameness, tail-tip necrosis and various diseases. Lameness is the greatest welfare problem of housed dairy cows and factors influencing its occurrence include floor quality and poor drainage, which results in cows standing in slurry (Wierenga & Peterse, 1987).

Calf welfare

In the first few days after birth the major calf welfare problems are enteric and respiratory diseases. The calves of dairy cows may fail to obtain sufficient colostrum for a variety of reasons (Edwards, 1982;

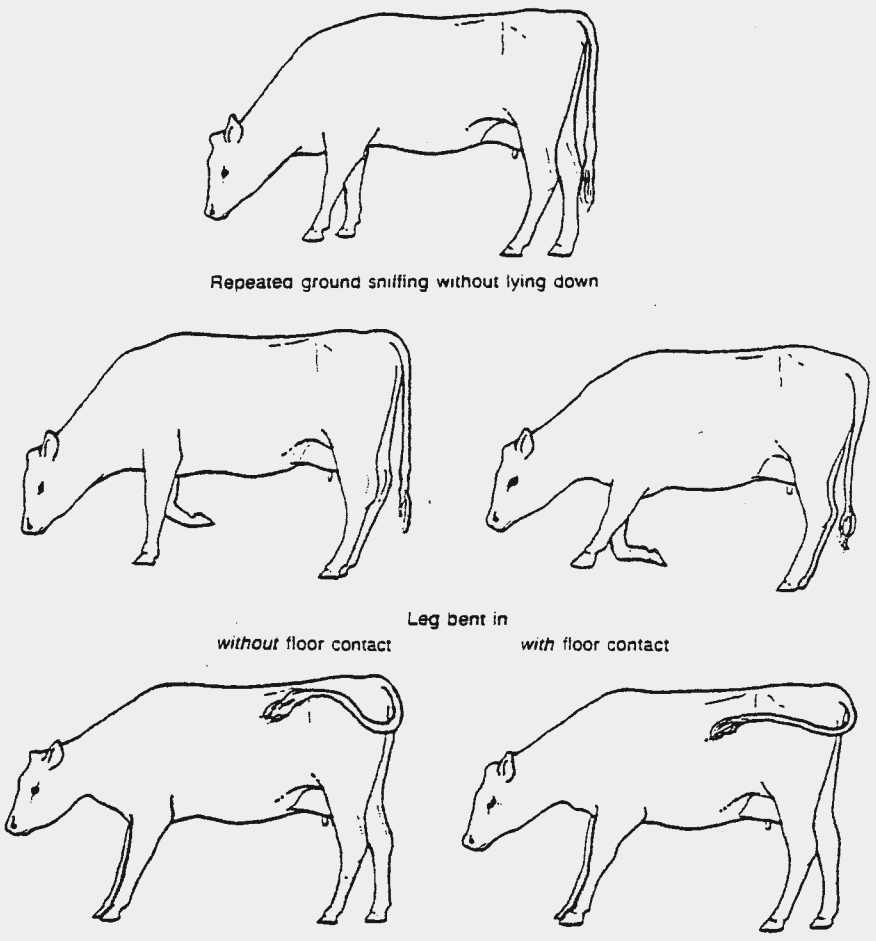

Fig. 49.3 Behavioural alterations in young cattle on a slatted floor (after Andreae & Smidt, 1982).

Edwards & Broom, 1982; Broom, 1983a). Management practices that maximize the chance that colostrum will be obtained and minimize contact with pathogens have important beneficial effects on calf welfare. If calves of dairy cows are normally left with their mother for the first 24 or 48 hours, the risk that the calf will not suckle early enough to obtain and absorb the immunoglobulin from colostrum can be minimized by the stockworker placing one of the mother's teats in the mouth of the calf as early as possible after the calf stands. Group-calving situations where several cows calve during a short period can lead to a cow's colostrum being drunk by a calf other than her own or to calves being rejected by their own mothers. Such occurrences can be prevented by providing separate calving boxes, which should ideally allow the cows some visual contact with other cows. The provision of soft bedding for the calf is also desirable and is easier where special calving accommodation is available.

Dairy calves are deprived of their mother from an early age and many are individually housed so that they are confined in a small space and deprived of all or most social contacts. In the EC, 7 million out of a total of 22 million calves per annum are reared for veal in small crates and fed on a diet with inadequate iron and roughage (Susmel, 1987). Many animals used as replacements for dairy herds are also individually housed. The welfare problems resulting from this rearing method are substantial. Calves housed for long periods in small pens (Fig. 49.4) that do not allow them to turn around are deprived in various ways. Firstly, the typical veal calf crate does not allow the animal to groom the hind part of its body. All calves do groom all of their body several times per day if given the opportunity to do so. The effects of being unable to groom a large part of the body are apparent in direct physical effects but the effects of the frustration that is likely to be associated with this inability is not known.

Fig. 49.4 Veal calf in crate with slatted floor. The front of the crate has been removed (after de Wilt, 1985).

The other effect on grooming when calves are housed in a small pen is that these calves show excessive amounts of grooming of those parts of the body which they can reach and this grooming often results in ingestion of much hair, with consequent formation of hair balls or bezoars in the rumen. These hair balls may on occasion block the exit from the rumen. Another restriction imposed by crates or other small pens is in the postures that can be adopted when lying. De Wilt (1985) reported that a common lying posture amongst group-housed calves involves turning the head backwards, whilst for 2–8 per cent of total lying time the hind legs are stretched out. Neither of these postures is possible in a crate so some frustration and discomfort is likely as a consequence. Stereotyped behaviours (Broom, 1983b) are shown by many crate-housed calves. Some licking is stereotyped but the commonest of such behaviours is tongue rolling. Table 49.2 shows the frequency of such behaviours in a large-scale study. Stereotyped behaviour is certainly abnormal and one of the behavioural responses to difficult conditions.

Other problems associated with close confinement include thermoregulatory difficulties and inability to escape from disturbing stimuli. In hot conditions calves stretch their limbs whilst lying but this is not possible in a small pen. An animal in a small pen may be frightened by human approach or by some sound but it is not able to avoid or retreat from the disturbing stimulus. There are no precise experimental data that allow the quantification of any adverse effects resulting from such restrictions on responses. Another major problem of individual housing is inability to show social behaviour. Young calves kept in groups interact with other calves frequently and associate closely. Individually reared calves cannot interact much with one another and long periods of social isolation lead to failure to develop normal social behaviour. When calves that were reared individually for many months were put in a social situation they failed to show some ear movements and other social signals and they did not retaliate if attacked. As a consequence they were unable to compete with animals reared in groups and they failed to grow as fast in a competitive feeding situation (Broom & Leaver, 1978; Broom, 1982).

Group housing can also lead to problems for some calves. Certain animals may show intersucking and urine drinking. This behaviour can lead to poor growth in those animals that drink urine and to soreness in the animals that are sucked. The problem is absent from many units and it is likely that current research will allow recommendations about management practices that will largely eliminate it. It is rarer in the UK, where dairy calves are usually left with the mother for 24 hours, than in countries like The Netherlands where bucket rearing from birth is common. In a study by de Wilt (1985) the use of teat buckets resulted in no preputial sucking whereas 48 per cent of calves given milk in open buckets did so but other studies in other conditions have not always given such results. Calves in groups sometimes fail to drink from teats connected to

Table 49.2 The incidence of oral stereotypies in calves kept in different conditions (per cent of time spent)

	Veal calves in crates	Veal calves in groups	Dairy calves in groups	Calves with suckler cow	Reference
Calves, 2 weeks	14	3	3	1	Webster *et al.* (1985a)
Calves, 10–14 weeks	10	4	2	0	

a milk reservoir but work by Barton (Barton, 1983; Barton & Broom, 1985) showed that in these young calves, aggressive behaviour was not the cause of this. Calves showed much social facilitation of feeding and for groups of 10 calves, the positioning of five milk supplying teats close together encouraged even the weaker calves to come to the teats and drink. Another group-housing system that can work well is an electronic feeder system triggered by transponders worn by the calves. This system facilitates rationing of milk but it allows only one calf to feed at a time. Straw-based group-housing systems are used extensively by commercial veal units in the UK and they result in low levels of disease and good economic returns (Webster *et al.*, 1986). With further refinement of management procedures such systems are likely to replace individual crate housing internationally as the normal method of calf housing.

Whether calves are kept in crates or in groups their diet has an effect on their welfare. The two commonest inadequacies are lack of iron and lack of roughage. The public demand for white veal results in many calves being fed an amount of iron that would inevitably result in their early death if they were not slaughtered whilst still young. The amount of iron needed to avoid anaemia and unnatural white meat is summarized in Fig. 49.5, which is taken from Webster *et al.* (1986). It is clear from Fig. 49.5 that some calves need more than 50 mg iron/kg dry food if they are not to be anaemic (haemoglobin <9 g/100 ml blood). As anaemia is a pathological sign it seems reasonable to assume that the welfare of anaemic calves is poor and hence that systems which produce white veal result in poor welfare for this reason as well as for other reasons stated above.

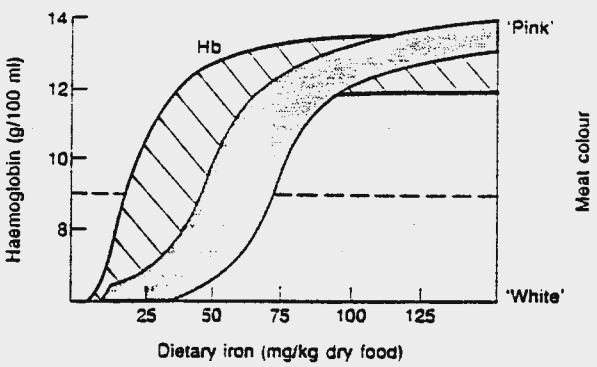

Fig. 49.5 Schematic relationships between dietary iron intake of calves and their blood haemoglobin concentration and meat colour (from Webster *et al.*, 1986).

Low roughage diets are also a consequence of white veal production. Calves are fed a diet that does not allow normal rumen development. Such conditions often result in ulceration of the abomasum. Diets that include adequate roughage have beneficial behavioural effects as well as permitting normal bodily development so all calves should be fed adequate roughage from two weeks onwards. Since white veal production is inefficient and there are inevitable welfare problems it is to be hoped that public demand for it will continue its rapid downward trend and such production systems will soon disappear.

Since young calves are so vulnerable to disease and are generally affected by adverse physical and social conditions their welfare is often poor when they are transported and taken to market. Despite this fact, a million young calves per annum are transported from France to Italy for veal production and many young calves are taken to market in the UK. The British calves should be more than a week old before marketing but many are not and even at one week the calves are ill-equipped to cope with the vicissitudes of vehicle and market conditions. In most European countries, calves are not marketed before weaning and the British practice is regarded as undesirable for production and welfare reasons. Calves should be sold from farm to farm, if movement at an early age is essential, or should be marketed after five weeks of age.

Beef cattle welfare

The housing conditions for calves destined for beef production are sometimes similar to those kept for veal production so they have similar welfare problems. Older beef animals are kept in small individual pens or are tethered in some countries and they then show much stereotyped behaviour. Riese *et al.* (1977) reported that stereotyped behaviour included tongue rolling, weaving movements and self-licking. Wierenga (1987) reported that one-third of young, individually housed bulls spent several minutes in every hour showing tongue rolling. Physiological responses to confinement also occur. Ladewig (1984) reported that tethered bulls showed more frequent episodes of high blood cortisol levels than did bulls able to interact socially in groups. Such abnormal behaviour and physiology is probably exacerbated by both social deprivation and inability to perform behaviours because of spatial restriction. Individual housing of beef animals is more frequent when they are bulls than when they are steers. In Germany 98 per cent of beef animals are bulls but in the UK 92 per cent were steers in 1987. The

UK situation is changing following the ban on growth promoters.

Fighting and mounting can lead to welfare problems when beef animals, especially bulls, are kept in groups. The most important way of minimizing such problems is to keep the animals in stable groups since social mixing leads to much fighting with consequent injuries, bruising and extreme physiological responses (Kenny & Tarrant, 1982). In stable groups, mounting may lead to more injury than does fighting (Appleby & Wood-Gush, 1986). Animals that are frequently mounted become bruised and may suffer severe leg injuries. Mounting can be greatly reduced by the use of overhead bars, which physically prevent it, or an electrified grid, which deters animals that wish to mount. The brief initial experience of an electric shock has a relatively small adverse effect on welfare as compared with the serious effects on animals that are repeatedly mounted.

The stocking density of beef animals and the flooring provided also have considerable effects on welfare. High stocking densities lead to more aggression, injury and bruising. Beef animals increase rapidly in body weight but they have little exercise if they are housed in small pens and their leg growth may not be able to keep pace with that of the rest of the body. The final weights reached are much higher now than they used to be so the legs are scarcely adequate to support the body. The consequence is cartilage damage, clear indications of limb pain and obvious difficulties in standing and lying (Dämmrich, 1987). Graf (1984) found that these problems were absent if fattening bulls were reared on deep straw and that such conditions also led to fewer behavioural problems.

Dairy cow welfare

The major welfare problems for housed dairy cows are lameness, mastitis and difficulty in gaining feeding and lying places. Most of these problems are associated with the design of the housing system but some are a consequence of poor husbandry. The causes of both lameness and mastitis are multifactorial and there is an interaction between the response of the animal to its conditions and the likelihood of clinical infection. A reduction in pathogen challenge will usually help to reduce disease incidence but changes in management methods, of the kinds that have other beneficial effects on welfare, can have an effect on minimizing disease that is as great or greater. Studies at the Institute for Animal Health, Compton have shown that there are positive correlations between lameness and mastitis incidence. High production increases the occurrence of both lameness and mastitis. Mastitis has declined in dairy herds where concentrate feeding has been introduced following the introduction of milk quotas, and in an experimental study Manson & Leaver (1986) found that the lameness incidence was higher in cows fed on a high-protein diet. The incidence of lameness can be reduced by the use of foot baths and by hoof trimming but much remains to be discovered about the conditions that lead to individuals being likely to become lame.

Space allowances are often quoted for housed dairy cows, for example Arave *et al.* (1974) quoted 2.3 m^2/cow, but house design and social stability must be taken into account when deciding on the best space allowance in any building. Social mixing leads to various behavioural and reproductive difficulties (Bouissou, 1976). Even when social disruption is minimal, cows need places to which to retreat so as to avoid confrontation with other individuals. Potter & Broom (1987) report that cows use cubicles and feed-barrier sections for this. If there is a shortage of feeding places, due to the highly synchronized behaviour of dairy cows (Benham, 1982; Wierenga, 1983; Potter & Broom, 1987) there are considerable effects on the cows. Metz & Mekking (1984) reported a dramatic increase in chasing and it is likely that the welfare of cows is poor when they are unable to get a feeding place because their herd mates are feeding. Narrow passageways in a cubicle house can cause problems for cows, for example Konggaard (1983) saw more contact, yielding, turning and waiting if passageways were 1.2 m wide than if they were 2 m wide. An inadequate number of cubicles, such that not all cows can lie at once, leads to more aggressive interactions and low-ranking animals having to lie in passageways where conditions are dirty and the likelihood of injury or disease is high (Kaiser & Lippitz, 1974; Friend *et al.*, 1977; Wierenga, 1987). Other welfare problems for dairy cows concern ill-treatment or neglect by the stockworker and producers when it comes to milking. The use of force is not conducive to good welfare or good milk production. Good stockworkers are consistent in their milking Parlour procedures and deal with the cows in a quiet predictable way.

Farm operations

Certain operations on cattle are performed on farms by staff with no veterinary qualification. In most cases, no anaesthetic is used. The most widespread of these operations are disbudding or dehorning, castration

and various sorts of individual marking. Some of the procedures used must also cause pain to the animals but there is little precise information about this. The use of caustic materials that remain in contact with living tissue for any length of time is likely to cause severe pain and should be avoided. Any use of hot irons on living tissue must also cause pain and hot iron branding is a painful and unnecessary form of marking. Castration is often carried out by applying a rubber ring around the testicles until the tissue in them dies and it seems likely that this is also very painful for a long period. Even the ubiquitous ear notching and punching must be painful for a few days and it would be better if alternative marking methods such as freeze branding or tattooing could be used.

More extensive operations should only be carried out under anaesthetic by qualified veterinarians and should be permitted only if the animal will benefit. Farm practices that necessitate the use of operations should be avoided. An example of a problem area is the breeding of cows such that their calf cannot be born normally. No animal should be made pregnant if there is a likelihood that caesarean section or a difficult birth will occur.

Handling, transport and slaughter of cattle

Every dairy farmer has to be able to move dairy cows in milk to and from the milking parlour. If the races and collecting yards that are used or the methods of moving the animals are inadequate and disturbing to some or all of the cows, there will be welfare problems. Such welfare problems will often be associated with reduced milk yield. Cows may be reluctant to enter a milking parlour because of the behaviour of the stockworker or because of design faults in the parlour that result in uncomfortable milking stalls or stray voltages. Such problems can lead to the use of excessive force by stockworkers in the collecting yard or to forcing animals towards the parlour entrance using gates or an 'electric dog'. The 'electric dog', which is a row of electrically live wires hanging downwards and moved towards the cows in the rear of the yard, has a large adverse effect on some cows so that their milk let-down may be prevented and they may become extremely unwilling to move towards the parlour.

The problems associated with the design of races for moving cows to the milking parlour are very similar to those of designing races used for other purposes, such as movement towards vehicles prior to transport. The most extensive study of how to design good races is that of Grandin (1983). She reported that cattle often balk if they encounter dark areas or areas of extreme lighting contrast. Races with sharp angular turns in them may also pose problems for cattle that are being driven and long straight races may result in animals being either reluctant to move or moving too fast. As a consequence of these observations, Grandin recommends that races should be evenly lit, have solid walls if animals unfamiliar with them have to use them and should be gently curved rather than having sharp corners or long straights (Fig. 49.6). Other studies also suggest that if animals are being loaded into vehicles, the ramp should be long, sloping (not more than 1 in 7), should allow a good grip for the feet of the cattle and should have solid sides, and the interior of the vehicle should be well lit.

Vehicles are often not well designed as regards flooring, ventilation and ease of subdivision. Just as important as vehicle design, as regards the welfare of animals during transport, is the behaviour of the transport staff. Problems arise because of rough treatment during loading, over or under stocking of compartments on the vehicle, inconsiderate driving or leaving the animals in conditions that are too hot or too

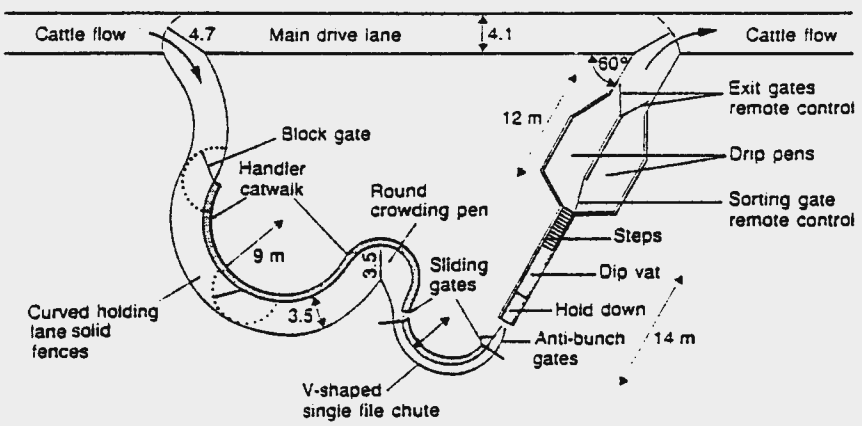

Fig. 49.6 Races for cattle should have no long straights or sharp corners so Grandin (1980) designed this race for movement to vehicles.

cold and windy for them. The other major transport problem is the effect of very long journeys, especially where there are no stops for food and water. This area has been reviewed in a Commission of the European Communities (CEC) Report (1984).

When cattle arrive at an abattoir they are often injured or bruised during unloading because of too much haste on the part of animal handlers or inadequate ramps. Grandin (1979, 1980) reported that 66 per cent of bruises of the loin area occurred during loading or unloading of trucks. At lairage, animals are often mixed with individuals that are strange to them. This causes much fighting amongst bulls and considerable emotional disturbance in other cattle. Studies of bulls by Kenny & Tarrant (1982) show that mixing at lairage causes much fighting, high levels of bruising and other injury and a great increase in the incidence of dark firm dry (DFD) meat. Both bruising and DFD meat are of economic importance as well as indicating severe welfare problems prior to slaughter.

In an efficient slaughterhouse the period during which animals are moved from pens to the point of slaughter can be very brief and the stunning and slaughter procedure itself can result in no pain for the animal. Welfare is worse if the animals are kept in a confined race for a period of more than one or two minutes before stunning, if stunning is carried out inadequately or if there is inversion before slaughter or no stunning. Poor equipment or lack of care by slaughter staff can result in extreme pain and discomfort for the animals. Extreme pain and discomfort is also inevitable if animals are not stunned, for example in the Jewish schechita or the Muslim halal ritual slaughter procedures. There is a period during which evoked potentials in the brain can still be produced after the throat is cut that may last for from a few seconds to two minutes during which the animal must be in great pain and distress. As the heart still beats after stunning and blood drains from the animal just as effectively whether or not the animal is stunned there is no logical reason why stunning should not be carried out before the throat is cut.

Welfare consequences of future developments in cattle management

Conventional methods of cattle breeding have changed the animals considerably during recent years and future changes are likely to be accelerated by new possibilities for genome manipulation. For example, selection for double muscling in beef cattle and the possibility of transferring genes that increase growth rate or modify final body form could both result in animals with larger, faster growing bodies. New growth promoters, if these are allowed to be used, could have the same effect. These techniques need not have any adverse effect on welfare but any increase in production pressure could lead to more problems. In addition, body weight increase without corresponding increase in leg size and strength could result in more lameness. Any modification of animals should be checked carefully to ensure that animals do not find it more difficult to cope with their environment. Some modifications of animals could result in improved welfare, for example if genes were implanted that increased the efficiency with which disease could be combatted by the individual.

The crossing of breeds of animals can lead to welfare problems for cows if a large breed of bull is crossed with a smaller breed of cow, resulting in increased calving difficulty. Similar problems can arise if embryo transfer is used. Multiple implantation of embryos could lead to other problems. The actual transfer of embryos could be a major operation that is traumatic for the cow but techniques which have only a minor effect are now possible. Any embryo transfer procedure should be such that cow welfare is not worse than that of cows undergoing a normal pregnancy.

A quite different development area that can have effects on welfare is the development of microprocessors and other electronic control units. Cows can already carry transponders that allow them to be fed individually and this methodology could be improved to minimize the chances that any individuals fail to obtain food. This system of feeding cows at a single or small number of feeding stalls can lead to problems because dominant individuals may attack others or deter them from feeding. Some very timid cows might be quite unwilling to approach a feeder when an aggressive individual is near it. Recent work by Wierenga & Hopster (1989) involves the use of an auditory signalling device on the cow's ear, which tells each individual when to come to feed. Animals that have already fed receive no food if they enter the feeder so this system provides a means for distributing feeding times for each individual throughout the day. Such a system should work well for all animals except for those that are stimulated to feed only when another animal is feeding. Electronic systems could also allow cattle greater control over their physical environment, for example by giving them the opportunity to regulate environmental temperature and air-flow rates. Lack of control is a major cause of welfare problems (Broom, 1985) so such possibilities could improve welfare. The development of robotics is likely to make possible in the near

future the automatic milking of cows. Cows would be recognized individually on entry to a milking stall and a computer that had been preprogrammed with their udder coordinates would attach a milking machine to them. Provided that this could be done without any discomfort to the cow it could improve welfare, since the cow could come to be milked whenever she chose to do so.

Summary

The major cattle welfare problem, apart from those resulting from ill-treatment and neglect, is the close confinement in small crates of calves and fattening bulls (Broom, 1987). In veal calf management there are also adverse effects resulting from low levels of iron and roughage in the diet. Amongst dairy cows, lameness and mastitis are serious welfare problems and certain housing systems lead to injuries or other difficulties for cows. For all cattle, transport and associated handling are traumatic experiences. These may be particularly bad for young calves that are taken to market before reaching weaning age and part of the welfare problem is often increased disease incidence. Bruising and other injuries are very frequent when bulls from different social groups are mixed at any time and yet this often occurs prior to transport or at lairage. Other welfare problems during transport of any cattle are the consequences of moving casualty animals, poor loading techniques or facilities, poor vehicle design, poor driving or very long journeys. Slaughter procedures are sometimes inadequate and stunning should always be carried out prior to slaughter. Farmers should be advised to give cattle: firstly, more control over their environment, secondly, predictable but diverse surroundings, and thirdly, rapid treatment if they contract disease.

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