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Welfare

D.M. Broom

1. Public perceptions of the dairy and beef industries

Most members of the public who are asked about the dairy and beef industries think of cattle grazing in fields and cows living for some time whilst a series of calves are born and milk is produced. Milk products and beef are considered by the public in relation to their effects on human nutrition and health, their effects on the environment and their effects on animal welfare. If production is perceived to be bad in relation to any of these aspects, sales of the products could be severely affected. Bovine spongiform encephalopathy (BSE) resulted in substantial but sometimes brief decline in beef consumption. Some people may limit their intakes of milk products because of a desire to reduce cholesterol intake whilst certain aspects of the dairy industry, such as methane production, may be criticised in relation to pollution but it is animal welfare rather than these topics which is the subject of this paper. Until recently, the welfare of the dairy cow was not often perceived to be poor and it has been only in calf rearing that dairy production systems have been regularly criticised. However, the dairy industry has been changing. Evidence of poor welfare in cows is accumulating and has had influence on public opinion in several countries. It is important to the dairy industry that welfare problems should be addressed before there is any widespread public condemnation of breeding and management practices. Similarly, beef cattle production is not often criticised on welfare grounds. However, a few critical newspaper articles or television programmes which appear well founded can be very damaging to producers, processors and retailers.

Public concern about animal welfare manifests itself in actual product purchasing and in pressure applied to retailers and to legislators. Major supermarket and cooked food chains can be influenced rapidly by customer pressure and can cause changes to be brought about in the methods used by suppliers. Retailers may impose codes of practice on suppliers and the execution of these codes is checked because the retailers cannot afford public criticism of what they sell (Broom 1999). In several European countries, certain housing systems and farm practices have been changed by many farmers because of the standards required by the purchasing companies. For example the use of crates for calves, stalls and tethers for sows and castration of pigs slaughtered at 100 kg or less has ceased on many farms.

Effects of public pressure on legislation is usually slower but legislation makes for more equal constraints on producers. Legislation is becoming more and more international although it is clearly important that where there is legislation on wholly moral grounds, for example in order to prevent poor welfare in animals, there should be restrictions on imports from countries whose moral standards are lower and that such restrictions should be authorised by the World Trade Organisation.

2. The concept of animal welfare

Animal welfare has to be defined in such a way that it can be scientifically assessed and the term can be used in legislation and in discussion amongst animal users and the public. Welfare is clearly a characteristic of an individual animal and is concerned with the effects of all aspects of its environment on the individual. The welfare of an animal is its state as regards its attempts to cope with its environment (Broom 1986). This state includes the feelings of the individual, various physiological and behavioural responses and its health. The extent of the difficulty which the individual has in trying to cope with its environment, the extent of any failure to cope and the degree of happiness are all components of welfare. Hence welfare varies from very poor to very good and can be scientifically assessed (Broom and Johnson 1993, Broom 1998, 1999).

Indicators of animal welfare are listed in Table 1. These include disease prevalence and reduced ability to grow and breed. As explained by Broom and Johnson (1993), the welfare of a diseased individual is poorer than that of an individual which is not diseased and reduced ability to produce offspring given appropriate opportunities also indicates poor welfare. Individuals which are finding it difficult to cope with their environment, or which are failing to cope may be more likely to become diseased, less likely to produce embryos, less likely to carry young to term and more likely to die early.

Table 1 Indicators of animal welfare

Physiological indicators of pleasure
Behavioural indicators of pleasure
Extent to which strongly preferred behaviours can be shown
Variety of normal behaviours shown or suppressed
Extent to which normal physiological processes and anatomical development are possible
Extent of behavioural aversion shown

Physiological attempts to cope
Immunosuppression
Disease prevalence
Behavioural attempts to cope
Behaviour pathology
Self narcotization
Body damage prevalence
Reduced ability to grow or breed
Reduced life expectancy

(after Broom 2000)

3. 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 (Kilgour and Dalton, 1984, Stricklin and Kautz-Scanavy, 1984, Fraser and Broom 1990). These results have made many animal scientists reconsider the effects of conditions and procedures on farms, both in terms of their efficiency s 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 2). 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 and Smidt, 1987).

Table 2 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 mutilations of 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. Mutilations for the benefit of farming practice or of the animal 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).

4. 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.

5. Housing and management

5.1. 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 and 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 despite the attacks or threats of other individuals. Bouissou (1970) found that the grater the extent of the barrier between feeding places for cows, the fewer the attacks that occurred (Fig. 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 2). Calves of low social rank obtain less of the favoured food if trough space is restricted (Broom and Leaver, 1978: room, 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.

INSERT FIGS 1, 2 and 3.

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 and Smidt, 1982: Fig 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 and Peterse. 1987).

5.2. 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; Edwards and 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.

5.2.1. The needs of calves

A need is a requirement, which is a consequence of the biology of the animal, to obtain a particular resource or respond to a particular environmental or bodily stimulus. The needs of calves are described in detail by Broom (1991, 1996) and examples are given here.

The calf needs to ingest colostrum very soon after birth and milk thereafter. It also needs to show sucking behaviour and if a calf is not obtaining milk from a real or artificial teat, it sucks other objects (Broom 1982, 1991, Metz 1984, Hammell *et al* 1988).

Calves need to rest and sleep in order to recuperate and avoid danger. They need to use several postures which include one in which they rest the head on the legs and another in which the legs are fully stretched out (de Wilt 1985, Ketelaar de Lauwere and Smits 1989, 1991).

Exploration is important as a means of preparing for the avoidance of danger and is a behaviour shown by all calves (Kiley Worthington and de la Plain 1983, Fraser and Broom 1990). Calves need to explore and it may be that higher levels of stereotypies (Dannemann et al 1985) and fearfulness (Webster and Saville 1981) in poorly lit buildings are a consequence of inability to explore.

Exercise is needed for normal bone and muscle development and calves choose to walk at intervals if they can, show considerable activity when released from a small pen and have locomotor problems if confined in a small pen for a long period (Warnick *et al* 1977, Dellmeier *et al*, Trunkfield *et al* 1991).

Normal calf anatomical, physiological and behavioural development occurs only if the calves have some fibre containing material to eat (van Putten and Elshof 1978, Webster 1984, Webster *et al* 1985a) so it is clear that they need fibre in their diet after the first few weeks of life.

Grooming behaviour is important as a means of minimising disease and parasitism and calves make considerable efforts to groom themselves thoroughly (Fraser and Broom 1990). Calves need to be able to groom their whole bodies effectively.

A variety of nutrients are needed by calves. Sufficient iron is needed to allow normal activity and to minimise disease.

The needs of young calves are met most effectively by the presence and actions of their mothers. In the absence of their mothers, calves associate with other calves if possible and they show much social behaviour. The need to show full social interaction with other calves is evident from calf preferences and from the adverse effects on calves of social isolation (Broom and Leaver 1978, Dantzer *et al* 1983, Friend *et al* 1985, Lidfors 1994).

5.2.2. Comparisons of veal calf housing and management systems

The major housing systems which have been compared in studies of calf welfare are individual crates (Fig.) group housing on slats and group housing on straw. Where calves are housed individually, the size of the crate and whether or not the sides are solid have been varied. Any aspects of diet are important in relation to welfare. For example, if inappropriate proteins or carbohydrates are fed, the calf may be unable to utilise them and if milk is acidified too much, calves may find if very unpalatable. However, the two aspects of diet which have been of greatest concern in relation to calf welfare have been the amount of fibre and the amount of iron.

The incidence of disease in young calves is too high, for example 25% of veal calves had to be treated for respiratory disease in a study by van der Mei (1987). The use of antibiotics to prevent disease is also a problem. It is important for calf welfare and for farm economics that disease levels be lowered.

One aspects of management which causes problems is the practice of mixing calves from different sources. Webster (1984) found that calves purchased and brought into a unit were five times more likely to require treatment for disease. A second aspect is hygienic practice by farm staff and a third is early detection of disease. These variables seem to be more important than housing system in exacerbating disease.

As a consequence of the evidence of poor welfare in veal calves, the European Union passed a Directive in 1997 which required group-housing of calves after 8 weeks of age, individual pens

at least as wide as the height of the calf at the withers, no tethering of calves except for <1 h at feeding time, sufficient iron to ensure an average blood haemoglobin of 4.5 m mol l^{-1} and fibre in the diet increasing from 50 g per day at 8 weeks to 250 g per day at 20 weeks. Many E.U. calf producers have found group-housing of calves to be more successful economically than the old crate system and white veal can still be produced from systems which comply with the new law.

6. 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. Tethered animals lack exercise and have different patterns of muscle fibres from those free to walk (Jury *et al* 1998) and more osteochondrosis (de Vries *et al* 1986). Individual housing of beef animals is more frequent when they are bulls than when they are steers. In Germany almost all beef animals are bulls but in the UK most were steers before 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 and Tarrant 1982). In stable groups, mounting may lead to more injury than does fighting (Appleby and Wood-Gush 1986, Mohan Raj *et al* 1991). 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. Beef cattle have a strong preference for straw or other bedding.

All of these issues are reviewed in the E.U. Scientific Committee on Animal Health and Animal Welfare Report on the Welfare of Cattle Kept for Beef Production, 2001.

7. The welfare of dairy cows

The major welfare problems of dairy cows are lameness, mastitis, and any conditions which lead to impaired reproduction, inability to show normal behaviour, emergency physiological responses or injury.

Leg and foot problems

For a recent review of lameness, including the extent to which it is a welfare problem, see Greenough and Weaver (1996). Almost all animals which walk with a limp, or reduce walking to a low level, or avoid walking whenever possible suffer from some leg or foot pain. Their ability to carry out various preferred behaviours is generally impaired and there may be adverse consequences for various other aspects of their normal biological functioning. Lameness always means some degree of poor welfare and sometimes means that welfare is very poor indeed.

Measurements of the extent to which some degree of lameness occurs in dairy cows include 35 - 56 cases per 100 cows per annum in the USA, 59.5 cases per 100 cows per annum in the UK, and more than 83% of examined cows in the Netherlands. The actual figures depend upon the method of assessment and most of these cases were not treated by veterinary surgeons but there is no doubt that lameness is often a severe welfare problem.

Mastitis

Mastitis in mammals is a very painful condition. The sensitivity to touch of affected tissues is clearly evident and there is obvious damaging of normal function. Mastitis prevalence should have declined greatly with improved methods of prevention and treatment but it has not declined as much as it should have done. Webster (1993) reports 40 cases of mastitis per 100 cows per year as an average for the UK.

Reproductive problems

Reproductive problems in dairy cows have become very common in recent years with large numbers of cows being culled because of failure to get in calf. In a study of 50 dairy herds in England, Esslemont and Kossaibati (1997) found that farmers reported failure to conceive as the predominant reason for culling with 44% of first lactation, 42% of second lactation and 36.5% of cows in total being culled for this reason. However, mastitis, feet and leg problems, ketosis and other disease conditions can lead to reproductive problems and it is difficult to discover their initial cause from farmers' records. A report by Plaizier *et al* (1998) concerning Canadian herds indicated that reproductive culling risk varied between 0 and 30% with a mean of 7.5%.

Housing systems and welfare

The incidence of lameness is much worse in housed cows than in cows at pasture. Cows at pasture may have stone damage to hooves if they do not have a suitable place to walk but wet cubicle houses or poorly maintained straw yards can result in very high levels of lameness. Even the best cubicle housing systems seem to have some lameness problems which are exacerbated by social factors (1997). Since the best straw yards, with an abrasive area on which normal hoof wear occurs, have little lameness, these may be the best solution for housed cows. Mastitis incidence is affected by hygiene at milking and various other conditions of management. Poorly designed housing systems can result in a variety of welfare problems and these can be exacerbated by high stocking density. Most of these problems, such as those resulting from cubicles being too short for the length of the cows now occupying them or of poor design of cubicles which do not allow adequate movements in the cow, are well known so are mentioned briefly here. In general it seems that many dairy cow housing systems, and cubicles in particular, do not provide an environment to which cows can adapt easily, The best straw yards seem to be the most successful as they give the cows more opportunity to control their interactions with their environment.

Milk yield and welfare in dairy cows.

The dairy cow of 1998 could produce 18000l. or more of milk per annum with a peak milk yield of 75l. per day. This compares with UK figures of 6000l. and 30l. per day 10 years ago Webster (1993) and a beef cattle average of 1000 - 2000l. and 10l. per day. The dairy animal is producing considerably more than its ancestor would have. This raises questions of whether it is at or beyond its maximum production level and the extent of any welfare problems.

The peak daily energy output of the dairy cow per unit body weight is not very high in comparison with some other species such as seals or dogs but the product of daily energy output and duration of lactation is very high indeed. Hence long term problems are the most likely to occur (Nielsen 1998). This is what we see because, although some cows seem to be able to produce at high levels without welfare problems, the risk of poor welfare indicated by lameness, mastitis or fertility problems is greater as milk yield increases.

The steady increase in reproductive problems as milk yields have increased is well known. As Studer (1998) states, "despite programmes developed by veterinarians to improve reproductive herd health, conception rates have in general declined from 55-66% 20 years ago to 45-50% recently (Spalding et al 1975, Foote 1978, Ferguson 1988, Butler and Smith 1989). During the same periods, milk production has greatly increased."

Studies showing that milk yield is positively correlated with the extent of fertility problems have come from a range of different countries (van Arendonk et al 1989, Oltenacu et al 1991, Nebel and McGilliard 1993, Hoekstra et al 1994, Pösö and Mäntysaari 1996, Pryce et al 1997, 1998). Studer (1998) explains that high producing cows which are thin and whose body condition score declines by 0.5 1.0 during lactation often experience anoestrus. A loss of condition score of about 1.0 during lactation was normal in the review presented by Broster and Broster (1998). Data on the relationships between milk yield and reproduction measures from two large scale studies are presented in Tables 3 and 4.

In some studies, effects of health problems on reproduction are evident, for example Peeler *et al* (1994) showed how cows which were lame in the period before service were less likely to be observed as being in oestrus. The lameness could be more likely in high producing cows. Direct links between level of milk production and extent of disease conditions are also evident from a range of studies, positive correlations being reported by Lyons *et al* (1991), Uribe *et al* (1995) and Pryce *et al* (1997, 1998 see Tables 3, 4). In addition to mastitis and leg and foot problems, which are often measured in such studies, the occurrence of other clinical conditions can also be affected by production level. Modern, high producing cows with good body condition have a high incidence of milk fever, retained placenta, metritis, fatty liver and ketosis (Studer 1998).

Table 3 Positive correlations between milk production level and indicators of poor welfare (from Pryce *et al*, 1997).

Milk yield from 33,732 lactation records:

calving interval	0.50	±	0.06

days to first service	0.43	±	0.08
mastitis	0.21	±	0.06
foot problems	0.29	±	0.11
milk fever	0.19	±	0.06

Table 4 Positive correlations between milk production level and indicators of poor welfare (from Pryce *et al*, 1998).

Milk yield from 10,569 lactation records:

calving interval	0.28	±	0.06
days to first service	0.41	±	0.06
mastitis	0.29	±	0.05
somatic cell count	0.16	±	0.04
foot problems	0.13	±	0.06

The high yields of modern dairy cows are a consequence of genetic selection and feeding. Cows are adapted to high fibre, low density diets. The ways in which they have been modified genetically do not change these basic characteristics much. Cows do not adapt easily to high grain diets or to manufactured diets with high protein and low fibre. Genetic selection has not taken adequate account of the adaptability and welfare of cows. Current trends towards ever greater milk production and feed conversion efficiency should not be continued unless it can be insured that welfare is good (Broom 1994, Phillips 1997). Bovine somatotrophin (BST) results in high milk yields and higher levels of mastitis, lameness, reproductive disorders and other problems such as those at the injection site (Broom 1993, Willeberg 1993, Kronfeld 1997, Willeberg 1997, Broom 1998). Whether or not much of the effect of the genetically engineered hormone is a consequence of the milk yield, the poorer welfare caused by the BST is unacceptable.

The Report of the E.U. Scientific Committee on Animal Health and Animal Welfare on *Animal Welfare Aspects of the Use of Bovine Somatotrophin* concluded as follows.

"BST is used to increase milk yield, often in already high-producing cows. BST administration causes substantially and very significantly poorer welfare because of increased foot disorders, mastitis, reproductive disorders and other production related diseases. These are problems which would not occur if BST were not used and often results in unnecessary pain, suffering and

distress. If milk yields were achieved by other means which resulted in the health disorders and other welfare problems described above, these mans would not be acceptable. The injection of BST and its repetition every 14 days also causes localised swellings which are likely to result in discomfort and hence some poor welfare."

The Committee also made the following Recommendation.

"BST use causes a substantial increase in levels of foot problems and mastitis and leads to injection site reactions in dairy cows. These conditions, especially the first two, are painful and debilitating, leading to significantly poorer welfare in the treated animals. Therefore from the point of view of animal welfare, including health, the Scientific Committee on Animal Health and Animal Welfare is of the opinion that BST should not be used in dairy cows."

Farm operations

Certain mutilations of 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 mutilations should only be carried out under anaesthetic by qualified veterinarians and should be permitted only if the animal will benefit. Arm 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 cow 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, 2000). 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 5). 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 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% 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 and Tarrant (1982) sow 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.

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