Improving Animal Welfare

A Practical Approach

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A Practical Approach

Edited by

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Preface

Animal welfare is an increasing concern all over the world. The World Organization for Animal Health (OIE) now has recommendations in the *Terrestrial Animal Health Code* for transport, slaughter and killing animals for disease control. In some countries, animal welfare is a new concept and this book will provide practical information which will enable veterinarians, managers and animal scientists to implement effective practical programmes to improve animal welfare. It will be especially useful for both students and training of animal welfare specialists. The emphasis is an international approach. Two of the authors worked on OIE animal welfare committees, and the most important parts of these guidelines are reviewed. The authors are from the USA, Canada, the UK and New Zealand, and they have extensive experience improving animal welfare in both the developed and the developing world. In addition to their work in North America and Europe, they have also worked in Brazil, Mali, western Africa, Uruguay, Chile, Australia, the Philippines, Mexico, China, Thailand, Argentina and New Zealand. *Improving Animal Welfare: a Practical Approach* covers how to both measure and assess welfare, plus 'how to' instructions on methods to improve practices in areas of major welfare concern such as animal handling, euthanasia, painful surgical procedures, transport, slaughter and treatment of draught animals. Another major area of emphasis will be how to use animal-based outcome measures such as scoring of body condition, lameness, lesions, behaviour and coat/feather condition. The use of numerical scoring to measure handling and stunning practices will also be covered. Measurement is essential because people manage the things that they measure. Key references to important scientific papers are included but this book is not intended to be a complete review of the literature. Additional chapters on the benefits of good stockmanship, economic factors, ethics and proven methods for motivating producers will also be helpful to bring about improvements. This book is aimed at the people who will be putting animal welfare programmes into practice to improve conditions for animals all over the world.

1 The Importance of Measurement to Improve the Welfare of Livestock, Poultry and Fish

TEMPLE GRANDIN

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There is a need for information on how to implement auditing programmes and other strategies that will improve animal welfare. Many excellent books and articles are available that review scientific research on welfare, statistics that outline the extent of animal welfare problems, philosophical issues, animal rights and legislation. However, there is a huge need for information on how to effectively implement programmes to improve animal welfare at the practical level. This is a hands-on 'how to do it' guide that provides practical information for veterinarians, animal scientists, producers, transporters, auditors, government agencies, quality assurance managers and others who work in the field with animals. Too often legislation will be passed to ban some terrible practice but it still continues because little is done in the field to implement change.

In this book, the authors will help bridge the gap between scientific research and practical application. Recommendations on implementing animal welfare programmes are based on over 10 years of the editor's experience developing and implementing welfare auditing systems for major retailers and restaurants (Grandin, 2003, 2005). During the last 35 years the author has visited over 500 farms and slaughter plants in 25 different countries. The information in this book will help the reader use the knowledge that can be obtained from many other sources in a more effective manner to bring about real changes that will improve the treatment of livestock, poultry and fish, on farms and transport vehicles and in slaughter plants. The principles of implementing an effective animal welfare programme are the same for all species. Animal welfare is now a worldwide issue (Fraser, 2008a). The World Organization for Animal Health (OIE) now has published animal welfare guidelines for slaughter of livestock and poultry and for the transport of livestock (Petrini and Wilson, 2005; OIE 2008, 2009a, b). The welfare of farmed fish is an emerging issue and the OIE will have guidelines for humane slaughter of fish (Hastein, 2007).

Large food retailers and restaurant chains are now requiring that their suppliers comply with their animal welfare standards. The economic incentive provided by these large buyers is a major force for improving animal welfare in both the developed and the developing world. Non-governmental (NGO) animal advocacy groups are also a major factor in developing animal welfare standards and legislation. When videos of animal abuses are seen around the world on the Internet, it makes people aware of the issue and they demand improvements.

The Importance of Measurement

In this first chapter, the importance of measuring animal welfare will be discussed. It will show you how to use numerical measurements to improve both animal welfare and productivity. In order to effectively manage and improve animal welfare it needs to be measured. There are two basic types of measurements. Simple ones that are practical for farm use and more complex or expensive measurements for research or diagnostic purposes. The more complex methods should be used to validate simple practical on-farm assessment methods. Another important purpose of research is to determine the effects of common commercial practices

on animal welfare. There are many fine books and journals that contain information on hundreds of research studies. Since the emphasis of this book is on the practical application of welfare programmes, the author will not attempt to do a complete review of all the research. It is also beyond the scope of this book to review all the differing animal welfare legislation around the world.

Goals of the Book

There are five main goals for this book:

1. To help people implement effective practical auditing, regulatory and assessment programmes that will improve the welfare and treatment of livestock, poultry and farmed fish.
2. To provide information that will directly improve welfare in critical areas such as slaughter, transport, handling, euthanasia and painful surgical procedures.
3. To help the reader understand the importance of animal behaviour in assessing animal welfare and its role in the design of housing and handling systems.
4. To discuss the role of ethics in animal welfare in a practical manner.
5. To understand how economic factors can be used to improve both welfare and reduce losses in farm animals. Improvements in husbandry, handling, stockmanship and transport will improve animal productivity, and reduce losses due to bruises, sickness, mortalities, lameness and other problems.

Since animal welfare is now a global issue, this book contains information that can be used by people in both developed and developing parts of the world.

Manage Things You Measure

Livestock producers routinely measure weight gain, death losses and sickness but they may not be measuring painful or distressing conditions such as lameness, bruises or electric-goad use, which severely compromises an animal's welfare. Lameness is one of the most serious welfare problems in many species of livestock and poultry. Lameness definitely causes pain because giving dairy cows the anaesthetic lidocaine reduces it (Rushen *et al*., 2006; Flowers *et al*., 2007). People often fail to be effective managers of conditions that they do not measure. Lameness in intensively housed dairy cattle is a good example. Over a period of many years, lameness in dairy cows housed on concrete has become steadily worse. One of the reasons why this happened was that nobody measured lameness until it became really bad. A recent British study showed that 16.2% of the dairy cows were lame (Rutherford *et al*., 2009). Cows housed in freestall (cubicle) barns had an average of 24.6% of clinically lame cows (Espejo *et al*., 2006). However, in the top 10% of dairies lameness was only 5.4% (Espejo *et al*., 2006). A British survey of 53 dairies indicated that in the best 20% of the dairies, only 0–6% of the cows were lame and in the worst 20% of the dairies, 33–62% of the cows were lame (Webster, 2005a, b). This shows that good management can reduce lameness. Lameness is also a huge welfare concern in sows. In sows, 72% of the breeding animals that had to be culled were due to locomotion problems. The major causes of locomotion problems were arthritis (24%) and fractures (16%) (Kirk *et al*., 2005).

The author observed a big increase in lame slaughter weight pigs between 1995 and 2008. A major breeder of lean rapidly growing pigs did nothing about it in the USA until in some herds 50% of the slaughter weight pigs were clinically lame. They also had very poor leg conformation. This breeder was selecting for leanness, loin-eye size and rapid growth, and over a 10-year period did not notice that there were more and more lame pigs. The increase in lameness was mainly genetic because the pigs were all housed on the same concrete slats that had been used for years. A recent US study indicated that 21% of the sows were lame (VanSickle, 2008). A study of sows in Minnesota indicated that risk of removal from the breeding herd increased when leg conformation was poor. Culling of breeding sows that was attributable to poor legs was 16.37% for the forelimbs and 12.90% for the hind limbs (Tiranti and Morrison, 2006). A study done in Spain showed that poor leg conformation was associated with higher sow culling rates (deSeville *et al*., 2008). Selecting breeding gilts with structurally correct feet and legs will provide better welfare and productivity.

Preventing 'Bad Becoming Normal'

How could dairy cows and pigs become so severely lame before anything was done to correct it? The

people who were breeding the pigs or managing the dairies were only looking at their own animals. They seldom saw other groups of pigs or cows to compare their animals to. Since the increase in lameness occurred slowly over a period of years, they failed to notice it because they were not measuring it. This is a prime example of a situation the author calls 'Bad Becoming Normal'. The reason the author noticed the increase in lame pigs when the pig breeders failed to see it was that the author had observed thousands of pigs in many different slaughter plants. Observations of slaughter weight pigs, from many different breeders, that were raised in similar buildings indicated that there were large differences between breeders in the percentage of lame pigs and leg conformation defects. To correct this problem, progressive dairy producers and pig breeders have incorporated formal lameness measurements and leg conformation evaluations into their programmes. Lameness is one of the most serious animal welfare problems. Figure 1.1 contains drawings of both correct leg conformation and different types of structurally poor legs in pigs. Charts like this can be easily made for all livestock species and poultry. They should be used when breeding stock is being selected.

Handling Practices Deteriorate Unless Measured

The author has observed that animal handling practices can slowly deteriorate and become rougher and rougher without anyone realizing it. Over the years the author has given many seminars on low-stress handling and quiet movement of pigs and cattle through corral systems on ranches, feedlots and slaughter plants. Many managers were eager to implement the new methods. Employees were taught to use behavioural principles of animal movement, stop yelling and greatly reduce the use of electric goads. A year later when the author returned to re-evaluate the handling practices, it was discouraging to observe that many employees had reverted back to their old rough ways. When the manager was informed that the animal handling methods were bad, he was surprised and upset. Because the regression back into old rough ways had happened slowly over the course of a year, the manager did not notice the slow deterioration of handling practices. Bad practices had become normal because the manager had not measured handling practices in an objective manner. In Chapters 3 and 9, an easy method to objectively measure livestock handling will be covered.

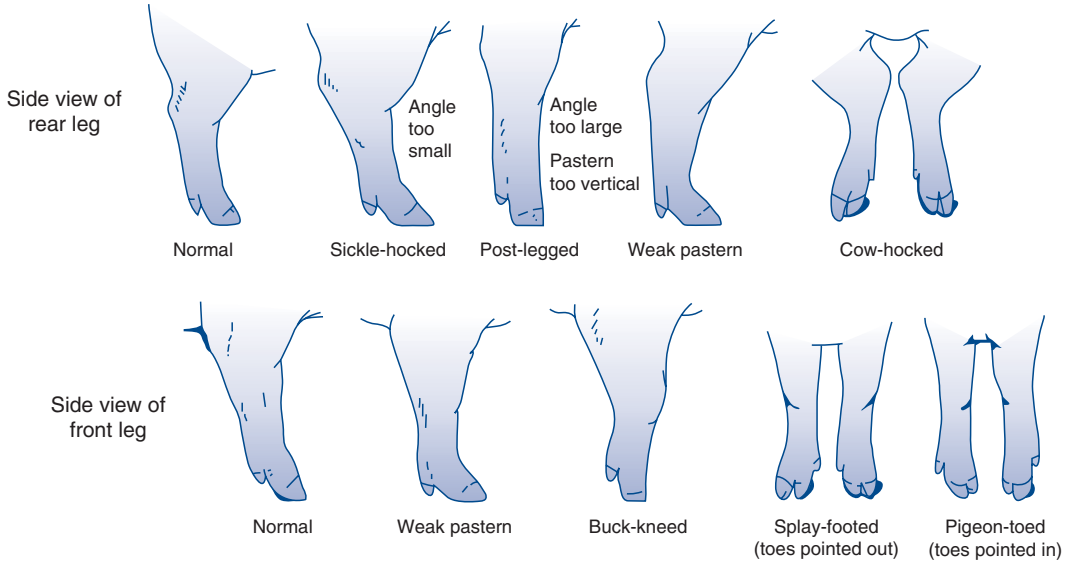

Fig. 1.1. Chart for scoring leg conformation in pigs. Plastic-laminated leg conformation charts should be used by producers when they select animals for breeding stock. Animals with poor leg conformation are more likely to become lame. The legs on the far left are normal and all the other legs are not normal. Other species such as cattle have similar leg and foot abnormalities.

The Power of Comparison Measures

When large numbers of farms are surveyed, practices and conditions can range from excellent to atrocious. Fulwider *et al*. (2007) surveyed 113 freestall (cubicle) dairies on the incidence of lesions and swellings on the dairy cow's legs. Figure 1.2 shows a cow that would be scored for a severe swelling. Table 1.1 shows the big differences between the best 20% of the farms and the worst 20%. The best 20% had 0% of the cows with swollen hocks and the worst 20% of the dairies had 7.4–12.5% of the cows had swollen hocks. In a Canadian study of 317 tie stall dairies, 26% of the dairies were well managed and cows had no open wounds on the hocks. However, 16% of the dairies

Fig. 1.2. Dairy cow with a severe leg lesion that has a diameter greater than 7.4 cm (size of a baseball). Photos like this should be put on laminated cards for scoring leg lesions on cows (photograph courtesy of Wendy Fulwider).

Table 1.1. Freestall (cubicle) dairies sorted by the best 20% to the worst 20% of farms for each welfare issue in 113 dairies (source: adapted from Fulwider *et al*., 2007).

	Percentage of cows on				
Well-being issue	Best 20% of farms	Second best 20% of farms	Middle 20% of farms	Second worst 20% of farms	Worst 20% of farms
Hock hair loss only	0–10	10.6–20	20.8–35.8	36.2–54.4	56–96.1
Hock swelling	0	0.7–1.7	1.9–4.2	4.2–11.9	7.4–12.5
Severe swelling[a]	0	0	0	0–1.5	1.8–10.7
Dirty cows[b]	0–5	5.3–9.8	10.3–15.4	16.8–28.9	29.4–100
Thigh lesions	0	0	0	0	0–28.8

[a]Cows were rated on having a severe swelling if the worst leg had a swelling more than 7.4 cm (size of a baseball) in diameter or open or oozing injuries.
[b]Cows were rated as dirty if there was dried or wet manure on their body, belly, udder or upper portions of the leg.

were really bad and 15% or more of the cows had open hock wounds (Zurbrigg *et al*., 2005a, b). In another study of 53 dairy farms in the UK, the best 20% had 0–13.6% lame cows and the worst 20% had 34.9–54.4% lame (Wray *et al*., 2003). A panel of dairy veterinarians agreed that lameness and swollen or ulcerated hocks were the most serious problems that needed to be corrected (Wray *et al*., 2003). It is likely that many of the dairy producers in the worst groups did not realize how bad they were compared to the other 80% of their colleagues. Research done in Ontario, Canada showed that 40% of the farms had 0% broken tails and the worst 20% had 5–50% of the cows with broken tails (OMAFRA, 2005).

A huge survey conducted by Knowles *et al*. (2008) in the UK showed that 27.6% of the chickens were lame with a score of 3 or higher on a six-point scale. The scores ranged from normal to down and not able to walk. A score 3 bird is mobile, but obviously lame. There was a big difference between five different chicken companies and there was also a lot of variation between the best and the worst flocks. The best flock had 0% with a score of 3 or worse lame birds, and the worst flock had 83.7% obviously lame birds. The standard deviation for data collected on 176 flocks was 24.3% for score 3 lameness. A high standard deviation indicates that there were huge differences between the best and the worst farms. Unpublished industry data in the USA from chicken farms that are being audited by major customers had only 2% obviously lame 3 kg chickens.

Numerical Scoring of Handling and Stunning

Grandin (2005, 2007) discussed the implementation of measurements of practices in slaughter plants as a method for auditing animal welfare. This measurement system is now used by McDonald's Corporation, Wendy's, Tesco, International, Burger King, Whole Foods and many other large meat-buying customers. Instead of an auditor subjectively determining whether a plant has good or bad practices, stunning and handling are evaluated with objective numerical scoring. Before the audits began, it was routine to use an electric prod multiple times on every animal and, in some plants, the stun guns were not kept repaired.

Baseline data prior to the audits indicated that only 30% of the plants could stun 95% of the cattle with a single shot from a captive bolt. After the audits began and the plants became concerned about losing a major customer, the percentage of plants that could achieve this rose to over 90% (Fig. 1.3). Both audit and survey data indicated that a lack of maintenance of the captive bolt was a major cause of poor stunning.

Similar dramatic results were obtained with the reduction of electric-goad use. Usage of electric goads dropped from multiple shocks administered to every animal to more than 75% of the cattle and pigs moving through the entire plant with no shocks (Grandin, 2005). Studies done on South American ranches have shown that training handlers and improved procedures resulted in a huge reduction in cattle trampling on top of another animal and lost vaccine. Carefully restraining each animal one at a time in the head stanchion and squeeze was compared to vaccinating a long line of animals held in a race. Restraining each animal individually reduced trampling from 10 to 0% and lost vaccine dropped from 7 to 1% (Chiquitelli Neto *et al*., 2002; Paranhos de Costa, 2008).

Measuring Improvements within a Farm or Plant

Objective measurements can also be used by the managers of farms and plants to quantify improvements and to do continuous internal audits to prevent practices from slipping back into old sloppy or rough ways.

Measurements every week or month make it easy to determine if handling practices are improving, staying the same or becoming slowly worse. Measurements on a regular basis of welfare-related issues such as lameness or leg lesions will enable farm managers to determine if their veterinary, bedding and husbandry programmes are improving or becoming worse.

Measurements can also be used to determine if a new piece of equipment, a new procedure or a repair has made an improvement. Figure 1.4 illustrates that a simple modification such as adding a light at the entrance of a race made it possible to greatly reduce electric-prod use due to pigs baulking and refusing to enter the race. The addition of a lamp reduces baulking and fewer pigs had to be shocked. Pigs have a natural tendency to approach illuminated areas (Van Putten and Elshof, 1978; Grandin, 1982; Tanida *et al*., 1996). Measurement also makes it possible to locate producers who

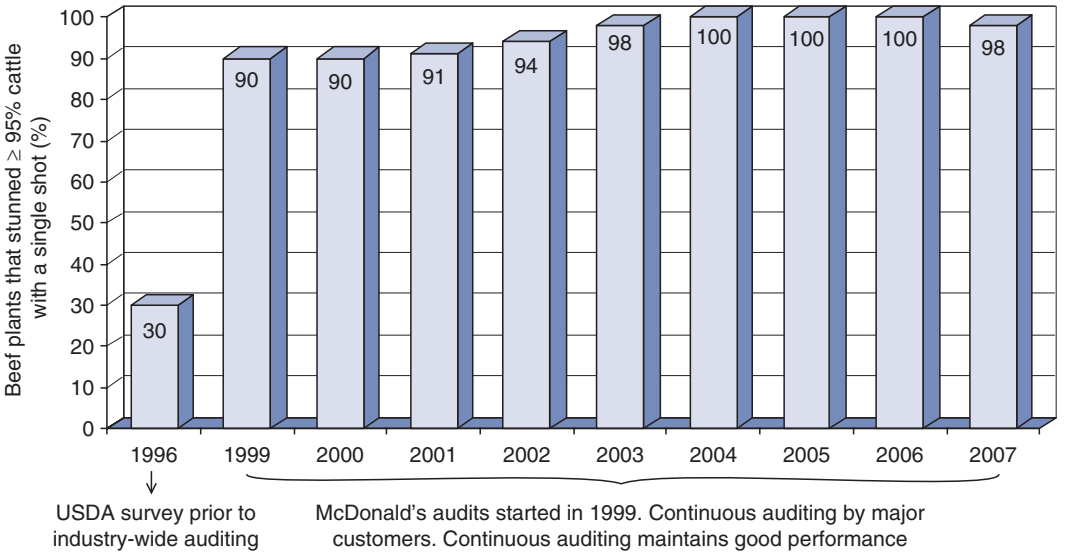

Fig. 1.3. Percentage of beef plants that stunned 95% or more cattle with the first shot. The baseline scores were measured in 1996 in ten US beef slaughter plants. After the restaurant audits started in 1999, the number of plants audited each year varied from 41 to 59. After the first 4 years of auditing, the scores further improved because the plants now had documented stunner maintenance programmes and test stands that measure the bolt velocity of the stunner.

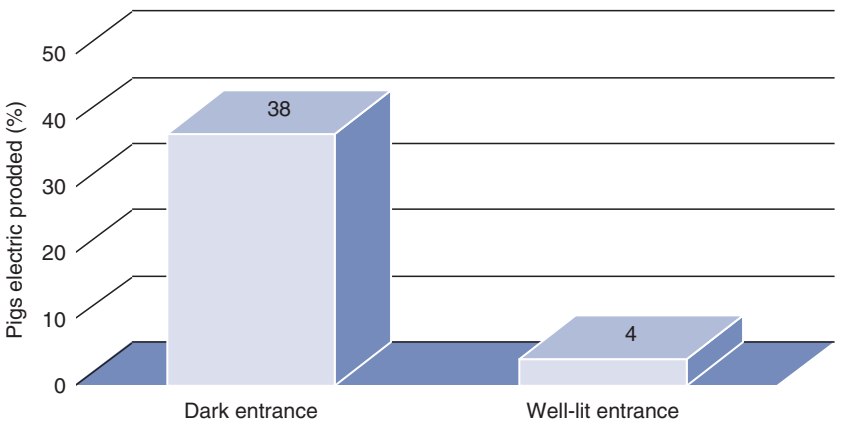

Fig. 1.4. Electric-goad use on pigs was reduced by adding lighting at the restrainer entrance. Simple changes such as placing a light at the entrance of a stunning race greatly reduced baulking and refusal to enter the race so less use of an electric goad was required. All handlers were well trained and only pigs that baulked or backed up were prodded.

have animals that are difficult to handle. Figure 1.5 shows that some groups of pigs are more difficult to drive and there is increased electric-goad use and squealing. In Chapter 3 the measuring tools that can be used to assess welfare will be covered in more detail.

Four Guiding Principles of Welfare

David Fraser (2008b) at the University of British Columbia in Canada states that from both an ethical and a scientific viewpoint, there are four guiding principles for good welfare:

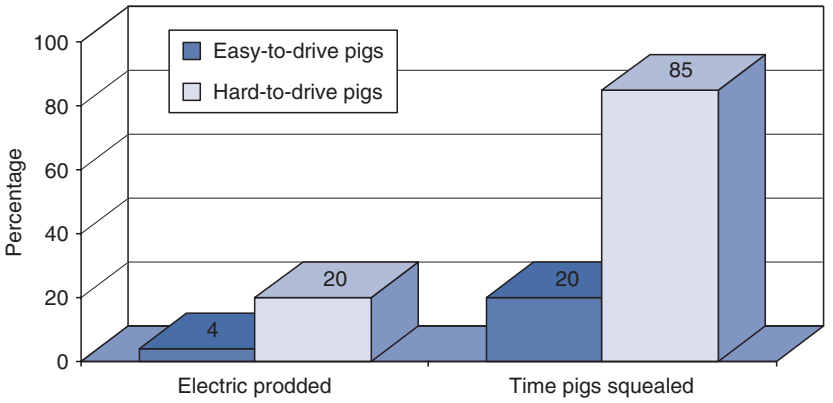

Fig. 1.5. Comparison of electric-goad use and squealing between easy-to-drive pigs and hard-to-drive pigs when moved by well-trained people who only used the electric goad on pigs that refused to move. Some pigs are more excitable and difficult to handle compared to other pigs. Measurement of each producer's pigs can be used to locate problem pigs, which baulk more and are more difficult to move through races. Squealing can be measured in small plants by counting the number of pigs that squeal. In large plants this is difficult, so the percentage of time the room was quiet was measured.

1. Maintain basic health – Examples: provide sufficient feed, water, vaccinations, housing and air quality to prevent disease and reduce death losses. Maintain the body condition and productivity of the animals or birds. Health is a major component of animal welfare but it is not the only factor.
2. Reduce pain and distress – Examples: use of anaesthetics for dehorning, preventing lameness, reducing bruises, preventing injuries and elimination of rough, stressful handling methods that cause fear or pain. Preventing hunger, thirst, heat stress and cold stress are also covered by the second principle.
3. Accommodate natural behaviours and affective states – Examples: provide a nest box for hens and straw for pigs to root in. The affective state is the animal's emotional state (see Chapter 8; Duncan, 1998).
4. Natural elements in the environment – Examples: outdoor access or natural sunlight.

A group of researchers from four European countries have proposed an alternative method for categorizing the four criteria for animal welfare (Botreau *et al*., 2007). They are:

1. Good feeding – absence of prolonged hunger and thirst.
2. Good housing – includes thermal comfort and ease of movement.
3. Good health – includes injuries, disease and controlling pain during surgical procedures.
4. Appropriate behaviour – includes expression of social behaviour and good human animal relationship.

In the next section, the author has categorized animal welfare issues in a series of tables that will make it easier for veterinarians and managers on farms and slaughter plants to implement improvements. The first two of Fraser's guiding principles of maintaining the animal's health and preventing pain and distress cover most of the worst problems, caused by either neglect or abusive treatment. The first two guiding principles outlined by David Fraser also cover four out of the five welfare freedoms in the Brambell Report and the OIE (2008) code. The OIE code (2008) states that the five freedoms are:

1. Freedom from hunger, thirst and malnutrition.
2. Freedom from physical and thermal discomfort.
3. Freedom from pain, injury and disease.
4. Freedom to express normal behaviour.
5. Freedom from fear and distress.

The ability of an animal to express normal behaviour is important, but in some parts of the world the first priority will be to correct obvious suffering that is caused by neglect, lack of knowledge or outright abuse.

Good Health Does Not Guarantee Good Welfare

Many people mistakenly assume that good health automatically means that an animal has satisfactory welfare. Good health is a key component for an animal to have good welfare. The OIE (2009a, b) code states 'Good welfare requires disease prevention and veterinary treatment'. However, there are some situations where an animal can be healthy but its welfare may be poor. For example, a dairy cow that is healthy, disease free and providing lots of milk could have painful lesions on her legs from lying in a poorly bedded stall that did not provide enough cushioning to prevent injuries. Fulwider *et al.* (2007) found that high-producing dairy cows had more leg lesions and a shorter productive life. Some genetic lines of chickens that have been bred to grow quickly have a high rate of lameness and leg abnormalities (Knowles *et al.*, 2008). Another example of poor welfare would be healthy laying hens that keep laying eggs even though the cages are so tightly stocked that the hens cannot all lie down at the same time without being on top of each other.

Some animals that have been bred for rapid weight gain are difficult to transport and handle in a manner that ensures good welfare. Certain genetic lines of pigs that have been bred for rapid weight gain become easily fatigued and weak when grown to heavy weights of 130 kg. The author has also observed healthy pigs that had been fed too much Paylean® (ractopamine) that were too weak to walk from one end of a lairage to the other. This is another example of bad conditions that some people perceived as normal. The author observed pigs 30 years ago that were strong enough to walk up long, steep ramps.

Healthy animals may also have abnormal behaviour if they are housed in an environment that does not allow them to express normal social and species-specific behaviours. Some examples of abnormal behaviour are pacing in a circle, bar biting in sows housed in gestation stalls, tail biting and pulling out feathers or hair. The behavioural needs of animals will be discussed in Chapters 8 and 15. There are also many excellent books on farm behaviour and ethology that review research on behavioural needs (Broom and Fraser, 2007; Fraser, 2008b).

Reducing Pain and Distress

Many welfare problems cause pain and distress. There are numerous scientific studies, review papers and books that document that livestock and poultry feel both pain and fear (Gentle *et al.*, 1990; Rogan and LeDoux, 1996; Grandin, 1997; Panksepp, 1998; Grandin and Johnson, 2005, 2009). Both rats and chickens will self-medicate for pain (Danbury *et al.*, 2000; Colpaert *et al.*, 2001). They will eat or drink bitter-tasting food or water containing painkillers when they are lame and have sore leg joints. To make it easier to implement a welfare programme, pain and distress items can be grouped into four categories:

1. Most severe problems with abuse or neglect that cause obvious suffering (Table 1.2) – these conditions must be corrected immediately.
2. Routine painful procedures (Box 1.1).
3. Fear stress during handling and transport – this stress can be reduced with good management (see Chapters 4, 5 and 7).
4. Overloading the animal's biological system (Box 1.2).

Painful routine procedures in livestock and poultry

The pain and distress category includes all of the painful procedures that producers routinely perform on animals (Box 1.1). Many of these procedures are done with no anaesthetics or painkillers. Numerous research studies on dehorning of livestock clearly indicate the need for pain relief (Faulkner and Weary, 2000; Stafford and Mellor 2005a). Cautery disbudding young calves is strongly recommended. Stafford and Mellor (2005b) report that removing the horns of an older animal causes greater increases in cortisol compared to disbudding calves. Other research has shown welfare benefits of providing painkillers for castration. There has been much controversy and discussion about whether or not certain procedures should be done at all. Further discussion of painful management procedures is in Chapter 6. Animal welfare legislation and animal welfare standards will vary greatly in different countries. However, most researchers and veterinary organizations agree that major surgery where the main body cavity is opened such as flank spaying a heifer requires the use of an anaesthetic.

Table 1.3 shows behaviours that are associated with pain that are easy for people to score and quantify. The behaviours in Table 1.3 occur AFTER the procedure has been done in cattle, calves, pigs and lambs. Animals should be scored

Table 1.2. The most severe animal welfare problems caused by abuse, neglect or bad management that cause obvious suffering. These conditions must be corrected immediately.

Handling and transport – prohibited practices and conditions[a]	Welfare problems caused by poor housing, environmental conditions, nutrition or health problems	Slaughter – prohibited practices[a]
• Beating, throwing or kicking animals • Poking out eyes or cutting tendons to restrain an animal • Dragging and dropping animals • Overloading trucks so tightly that a downed animal is trampled • Deliberating driving animals over the top of other animals • Poking animals in sensitive areas such as the eyes, anus or mouth • Breaking tails or legs • Overloading a draught animal and working it to exhaustion • Poking animals with pointed sticks • Conditions that cause animals to frequently fall or become injured or bruised during handling	• Starvation or allowing animals to become severely dehydrated • High ammonia levels that cause eye or lung damage • Death or severe stress from extreme heat or cold • Large swellings or other injuries caused by either a lack of bedding or poorly designed housing • Dirty animals covered with manure with no dry place to lie down • Failure to treat obvious health problems • Nutritional problems that compromise the animal's health • Conditions that cause many animals to become lame • Saddle or harness sores on a working animal	• Scalding, skinning, leg removal or other carcass dressing procedures performed on sensible, conscious animals • Immobilizing animals with an electrical current (Lambooy, 1985; Grandin *et al.*, 1986; Pascoe, 1986), not to be confused with effective electrical stunning • Puntilla method of immobilizing animals before slaughter by severing the spinal cord, which does not cause instantaneous insensibility (Limon *et al.*, 2008) • Highly stressful methods of restraining conscious animals. One example is hoisting cattle by one leg

[a]The items in the handling and transport and slaughter columns would be in violation of OIE (2009a, b) codes for slaughter and transport. The OIE standards for animal welfare are the most basic standards that everybody in both developed and developing countries should follow. To achieve a higher level of welfare will require some additional standards. Many countries have many additional standards. Disease control standards between different countries are easier to make uniform between countries than welfare standards that have more complex ethical considerations.

immediately after a procedure is done, for a minimum of 1 h, to detect signs of acute pain.

To detect signs of long-term pain, scoring can also be done over a period of days. These behaviours are associated with physiological measures of pain and stress (Molony and Kent, 1997; Eicher and Dailey, 2002; Sylvester *et al.*, 2004; Stafford and Mellor, 2005b; Vihuela-Fernandez *et al.*, 2007). The behaviours associated with different painful surgeries will vary depending on the procedure and the species. Quantifying pain-related behaviour provides an easy economical way to evaluate welfare in large numbers of animals. Animals often conceal pain-related behaviour when they see a person watching. To accurately assess the occurrence of pain-related behaviours, either the observer must be hidden from the animal's view or a remote video camera should be used.

Box 1.1. Routine painful management procedures.

- Beak trimming in poultry.
- Spaying female animals.
- Castrating male animals.
- Dehorning.
- Notching ears for identification.
- Removing tusks on boars.
- Clipping needle teeth on piglets.
- Docking dairy cow and pig tails.
- Mutilating and making big cuts in ears to identify animals.
- Mulesing sheep – cutting the skin on the rear end of a lamb to prevent flystrike.
- Wattling – cutting flaps of skin for identification.
- Tail docking.
- Hot iron branding.

Box 1.2. Welfare problems caused by overloading the animal's biological system.

- Lameness or leg abnormalities in rapidly growing pigs and poultry (Fernandez de Seville *et al.*, 2008; Knowles *et al.*, 2008).
- Increased aggression in some genetic lines of pigs or chickens (Craig and Muir, 1998).
- Future problems with animals that have been genetically modified (OIE, 2006).
- Increased excitability in some genetic lines of lean pigs bred for rapid growth.
- High rates of calving problems in cattle bred for large muscle mass (Webster, 2005a, b).
- Heat stress in cattle due to beta-agonists such as ractopamine (Grandin, 2007).
- Health problems caused by rBST (growth hormone given to dairy cows to increase milk production) in dairy cows (Willeberg 1993; Kronfield, 1994; Collier *et al.*, 2001).
- Stress gene in pigs that causes porcine stress syndrome which increases death losses (Murray and Johnson, 1998).
- Weak heavily muscled pigs due to either genetics or the use of beta-agonists such as ractopamine (Marchant-Forde *et al.*, 2003; Grandin 2007). These pigs may be reluctant to move.
- Cracks and hoof lesions in pigs fed ractopamine (Poletto *et al.*, 2009).
- High appetite drive and frustration in breeding animals selected for high weight gain when they are fed a restricted diet to prevent obesity.
- Metabolic problems that may increase death losses in poultry (Parkdel *et al.*, 2005).
- Lameness in cattle due to excessive use of beta-agonists such as ractopamine or zilpaterol.
- Increased bites from fighting in pigs caused by the beta-agonist ractopamine (Garner *et al.*, 2008).
- Lameness caused by poor leg conformation and over selection for a narrow range of production traits.
- Dairy cows that last only two lactations.

Table 1.3. Behaviours associated with pain that are easy to numerically quantify in lambs, cattle, calves, piglets and other animals. Evaluate these behaviours AFTER the painful procedure has been done (sources: Molony and Kent, 1997; Eicher and Dailey, 2002; Sylvester *et al.*, 2004; Stafford and Mellor, 2005a; Vihuela-Fernandez *et al.*, 2007).

Behaviours associated with pain	Species[a]
Time in contorted abnormal lateral or ventral recumbancy	Lambs, calves, cattle
Time in lateral recumbancy	Lambs, calves, cattle
Number of times foot stamped	Lambs, calves, cattle
Number of kicks	Lambs
Number of lip curls	Lambs
Number of ear flicks	Calves, cattle
Number of tail switches (wags)	Cattle, calves
Time standing still like a statue	Cattle, calves
Time walking (restless)	Cattle, calves
Time trembling	Calves
Time lying down in all positions	All species
Time huddling	Piglets
Time kneeling	Piglets

[a]The scientific studies were done in calves, lambs and piglets. Many of these behaviours may also occur in other species.

Vocalization scoring of painful, stressful procedures

Vocalization scoring of squeals, moos and bellows in cattle and pigs is a useful indicator that a procedure is stressful. Watts and Stookey (1998) recommend that vocalization scoring should be used to assess the stressfulness of a procedure across a group of animals and not for assessing the welfare of each individual. Watts and Stookey (1998) found that hot iron branding caused 23% of the cattle to vocalize and freeze branding caused vocalizations in only 3%. In cattle, vocalization

may be especially useful for evaluating severe stress (Watts and Stookey, 1998). When low-stress weaning methods were used for weaning calves, the number of vocalizations was significantly lower compared to abrupt weaning (Price *et al*., 2003; Haley *et al*., 2005). The calves weaned by the low-stress method also had better weight gains.

In another study, 98% of the cattle that vocalized during handling and stunning at a slaughter plant had been subjected to an obvious aversive event such as being poked with an electric goad, ineffective stuns or excessive pressure from a restraint device (Grandin, 1998b). Vocalization scoring works well for showing how improvements in equipment and handling procedures will lower the vocalization score (Grandin, 2001). Table 1.4 shows some data where the variable of restraining the animal in the squeeze chute was separated from the variable of the stressful procedure. It also shows how a less severe electro-ejaculation method reduced the number of vocalizations in Angus beef cattle.

Vocalization scoring should be done DURING procedures such as branding, castration, weaning, restraint or handling. Vocalization during painful or stressful procedures is correlated with physiological measures of stress (Dunn, 1990; Warriss *et al*., 1994; White *et al*., 1995). The neuropeptide substance P is involved in pain perception. It was higher in calves with more vocalization during castration (Coitzee *et al*., 2008).

Vocalization must not be used in sheep for scoring reactions to painful procedures or the stress of being restrained or handled. Cattle and pigs will vocalize when they are hurt or frightened, but sheep will usually remain silent.

Sheep are the ultimate defenceless prey species. They evolved to remain silent when they are hurt so they do not advertise their vulnerability to predators. However, lambs will vocalize loudly when they are separated from the mother at weaning. This is the only time that distressed sheep will vocalize. Vocalization scoring cannot be used if an animal is immobilized with electricity. Immobilization prevents vocalization. These devices are highly stressful and should not be used (see Chapter 5).

How to score vocalizations

There are two ways for scoring vocalizations that work really well in cattle and pigs. These methods can be easily used on a farm, ranch or slaughter plant. They are:

1. Score each animal as either silent or vocal to determine the percentages of animals that vocalized. This simple method works really well for assessing problems with excessive electric-prod use and other handling problems (Grandin, 1998a, 2005).
2. Score the total number of vocalizations in a group of animals. The number of vocalizations are counted and divided by the number of animals to determine an average vocalization score per animal.

Behavioural Versus Physiological Measures

Many scientists and veterinarians would prefer to use physiological assessments instead of behavioural measures. For research studies, it is recommended to use physiological and production measures combined with behavioural measures. The problem with physiological measures such as cortisol is that the lab tests are too expensive for routine farm use. The major advantage of behavioural measurements is that they can be easily implemented on the farm. Researchers should work to validate easily observable behavioural

Table 1.4. Average number of vocalizations per bull in response to restraint only or restraint plus electro-ejaculation (source: B.D. Voisinet and T. Grandin, 1997, unpublished data).

	Controls restraint in a squeeze chute with a stanchion headgate	High voltage electro-ejaculation machine	Low voltage electro-ejaculation machine
Average number of vocalizations per bull[a]	0.15 ± 0.1	8.9 ± 1.1[b]	3.9 ± 1.0[b]

[a]The total number of bellows for each treatment was tabulated and divided by the number of bulls.
[b]The difference between the high voltage and low voltage was significant at the $P \leq 0.001$ level.

measures. There is a huge need for research in species such as goats, camels, donkeys and many other animals. Research has been done that showed that the pitch of a vocalization is related to distress. Higher pitched vocalizations are associated with higher stress (Watts and Stookey, 1998). Unfortunately this method requires expensive equipment that is not practical for routine or farm use, but this research provides valuable insight into the emotional state of the animal.

Fear

Fear stress occurs when animals become agitated and excited during restraint and handling. Rough handling and multiple shocks from electric prods will increase fear stress. Stress from poor handling methods will greatly elevate stress hormones (Grandin, 1997). Pearson *et al.* (1977) found that sheep slaughtered in a small, quiet research abattoir had lower cortisol levels compared to sheep in a large, noisy commercial abattoir. Animals that are fearful of people or become agitated during handling will have lower weight gains and be less productive (Hemsworth and Coleman, 1994; Voisinet *et al.*, 1997). The fear circuits in animals' brains have been completely mapped. The literature on fear is reviewed by Rogan and LeDoux (1996) and Grandin (1997). Scientists were able to determine that the brain contains a fear centre called the amygdala. Destroying the amygdala will eliminate both learned and unlearned fear responses (Davis, 1992). Electrical stimulation of the amygdala in rats and cats raises corticosterone levels (Setckleiv *et al.*, 1961; Matheson *et al.*, 1971; Redgate and Fabringer, 1973). The amygdala is also the fear centre in humans (Rogan and LeDoux, 1996). Animals that are fearful will have poor welfare. There is a further discussion of fear stress during handling and restraint of both livestock and poultry. Chapter 4 reviews many research studies which clearly show the benefits of good stockmanship on reducing fear stress.

Tonic immobility looks calm but is really frightened

Some animals and birds will become highly agitated when they are frightened. However, others may go into tonic immobility and remain completely still and look calm. This phenomenon has been extensively researched in poultry. Tonic immobility can be induced by placing a chicken on its back in a U-shaped trough. It is held down lightly by a person for 10 s (Faure and Mills, 1998). If tonic immobility is induced, it will make no attempt to get up for at least 10 s (Jones, 1987). Poultry from genetic lines that are highly fearful will stay motionless for longer periods of time (Jones and Mills, 1982). The length of time a bird will remain motionless in a state of tonic immobility is used as an index of fear in chickens (Jones, 1984). Stimuli that are stressful to poultry such as electrical shocks or being kept in continuous light with no period of darkness increase the duration of tonic immobility (Hughes, 1979; Campo *et al.*, 2007). Many people mistakenly assume that chickens that go into tonic immobility are calm and relaxed. Tonic immobility testing can be used as one indicator of conditions that are stressful to poultry.

Do Fish Suffer?

Since the early 2000s, there has been an explosion of research on fish welfare. A search of the literature located many new welfare papers and lots of recent patents for equipment for stunning fish at the processing plant. The vast majority of this research has been on the teleost fish such as salmon, trout, tilapia and other finned fish that are farmed. Scientists in the UK, Canada, Norway, Brazil and other countries have recently written on the welfare of teleost fish (Chandroo *et al.*, 2004; Braithwaite and Boulcott, 2007; Lund *et al.*, 2007; Volpato *et al.*, 2007; Branson, 2008). Lund *et al.* (2007) state that fish can detect noxious stimuli and these authors conclude that 'farmed fish should be given the benefit of the doubt and we should make efforts to make sure that their welfare needs are met as well as possible'.

Research shows that fish respond to painful stimuli in a manner that is not just a simple reflex. The most convincing evidence that fish feel pain comes from the studies by Sneddon (2003), Sneddon *et al.* (2003a, b) and Reilly *et al.* (2008). Acetic acid was injected into the lips of fish to create a painful stimulus. Some of the fish engaged in weird rocking back and forth and rubbing the injected lip against the tank walls. Some individuals exhibited the behaviour and others did not. It is common in pain studies in all species to have big differences in the reaction between different individuals. There were also species

differences in the occurrence of this behaviour. Zebra fish did not do it (Reilly *et al*., 2008).

A study by Dunlap *et al*. (2005) showed that fish can be fear conditioned and that their reactions are affected in a complex manner by the presence of other fish. There is also evidence that fish react to handling stress with increases in cortisol. This would be similar to the increase in cortisol after stressful handling in mammals. The final experiment that needs to be done to verify that finned fish suffer from pain is the self-medication experiment that has clearly shown that rats and chickens will self-medicate for pain (Danbury *et al*., 2000; Colpaert *et al*., 2001).

From a practical standpoint, this research indicates that equipment such as a stunner should be used to render farmed fish insensible at the slaughter plant. Some of the behavioural indicators of distress that could be easily quantified on a fish farm are loss of equilibrium (fish is belly up), high respiration rate and agitated swimming (Newby and Stevens, 2008). Other researchers scored fish for fast-swimming escape responses and a tail-flip behaviour called the Mauthner-initiated startle response (Eaton *et al*., 1977). Fish is one area where more research will be needed to develop simple on-farm assessments. There are significant species differences in a fish's reaction to stress. Specific behavioural assessments will have to be developed for each species of farmed fish.

Invertebrates

During the literature search on this section of fish welfare, the author found only one paper on possible pain perception in invertebrates such as prawns. In this experiment, acetic acid was applied to the antennae. The prawns reacted by rubbing their antennae on the sides of the tank. The research was done by Stuart Barr at the Queen's University in Belfast (Barrett, 2008). Much more research will need to be done. At the time of writing this chapter, the author recommends that welfare programmes should be initiated for farmed, teleost fish and further research is required on invertebrates.

Overloaded Biology

Overloading the animal's biological system by either genetic selection for more and more production or use of performance-enhancing substances may also cause pain and distress. This includes welfare problems caused by over-use of beta-agonists, rBST growth hormone and other performance-enhancing substances. Many of these conditions may cause serious suffering. Box 1.2 lists conditions caused by either genetic selection for a narrow range of production traits or the indiscriminant use of substances such as hormones or beta-agonists such as ractopamine. All of the conditions listed in Box 1.2 are caused by pushing the animal's biology too hard to keep producing more and more meat, eggs or milk. It is the author's opinion that overloading of the biological system is the cause of many serious welfare problems. Overloading the animal's biology is a matter of degree. Selection for higher production will usually have no detrimental effects on welfare if it is done in moderation. Careful use of low amounts of performance-enhancing substances is probably not detrimental. It is just like revving up the rpm (revolutions per minute) in a car engine. A little revving up does no harm but if the engine rpm get too high, the engine will be ruined. The problem is that breeders and producers often fail to see problems until they become very serious.

Accommodate Natural Behaviours and Affective States

Fraser (2008b) maintains that affective states are a central animal welfare principle. An affective state is the animal's emotional state. The animal's affective state provides the motivation for many natural behaviours. Scientific research clearly shows that animals are highly motivated to perform certain species-typical behaviour. Pigs are highly motivated to explore and root in soft fibrous materials such as straw, cornstalks, wood chips or other bedding materials (Van de Weerd *et al*., 2003; Studnitz *et al*., 2007; Day *et al*., 2008; Van de Weerd and Day, 2009; see Chapter 8). The author has observed that fresh straw is rooted more by pigs than is old straw. After the straw is chewed up into little pieces, the pigs lose interest in it. Fraser (1975) found that providing small amounts of straw to tethered sows prevented abnormal stereotypic behaviour. Together these studies show that pigs should receive a daily ration of hay, straw or cornstalks to satisfy their rooting and chewing needs. Other behavioural needs that are strongly supported by scientific research are providing nest boxes and perches for laying hens (Duncan and Kite, 1989; Hughes *et al*., 1993; Freire *et al*., 1997; Olsson and Keeling, 2000;

Cordiner and Savory, 2001). A hen seeks a nest box to hide in so she has freedom from fear. Finding a secluded place to lay her eggs is an instinctual behaviour which prevented the wild ancestors of domestic hens from being eaten by predators.

Motivation can be measured in a very objective manner. Some of the methods that can be used to measure the strength of an animal's motivation to perform natural behaviours are: (i) the amount of time an animal is willing to go without feed so it can perform a behaviour; (ii) the number of times it will push a switch to get to something it wants; and (iii) weighted doors that become increasingly heavy (Widowski and Duncan, 2000; see Chapter 15).

Scientific research clearly shows that to give an animal a high level of welfare, the most highly motivated behaviours should be accommodated (O'Hara and O'Connor, 2007). Behavioural needs are important, but in places where conditions are really poor, the very serious animal welfare problems listed in Table 1.2 should be corrected first. Box 1.3 lists the most important behavioural needs.

Natural Elements and Ethical Considerations

The fourth principle about providing natural elements has little scientific basis compared to the first three principles of health, pain and distress, and natural behaviour. The first three principles are backed by many scientific studies. The fourth principle is mainly an ethical concern. Ethical concerns must not be ignored by the veterinarians, managers and other people who are in charge of implementing an animal welfare programme. Many organic programmes and large meat buyers specify that animals should be able to go outside or have daylight. A mistake that some people have made is to provide the natural elements but the animals have poor welfare due to neglect of principles 1 and 2. Health is an essential component of good welfare. The author has seen disgusting outdoor pig units full of sick pigs and excellent outdoor units with lots of healthy pigs. It is much easier to reach a consensus on welfare issues where science can provide clear answers compared to ethical concerns that have no clear answer. Ethical concerns are part of the decision-making process of legislators, animal advocacy groups and others who make policy. Lassen *et al*. (2008) provides a good summary: 'The main message of this paper for those who are professionally involved in animal production is that ethical assumptions and potential conflicts of view should be recognized and brought into the discussion of animal welfare.' Science cannot provide all the answers to ethical concerns. In some cases, ethics will overrule science. Sow gestation stalls are a good example. Research shows that sows can be highly productive in stalls, but confining a pig in a box where she cannot turn around for most of her life is not acceptable to two-thirds of the public. The author showed pictures of sow gestation stalls to passengers she sat next to on many flights. One-third of the passengers had no opinion, one-third said 'this does not seem right' and one-third hated them. One person said 'I would not keep my dogs in that'. Roughly two-thirds of the public disliked sow stalls. In 2008 in California, 63% of the voters decided to ban sow gestation stalls. Sow stalls are being phased out in both Europe and the USA. Farm animals are sentient beings and it is the author's opinion that people should provide both

Box 1.3. Basic behavioural needs that should be accommodated.

- Roughage feed for ruminant animals and equines.
- Animals should have sufficient space to be able to turn around, stand up and lie down in natural positions.
- Secluded nest boxes for poultry.
- Perches for poultry.
- Straw or other fibrous materials for pigs to root and chew on.
- Repetitive stereotyped behaviour in a barren cage or pen is an indicator of a poor environment that does not satisfy behavioural needs. Environmental enrichment should be provided to prevent abnormal repetitive behaviour (see Chapter 8).
- Opportunities for social interaction with other animals.
- An environment that helps prevent damaging abnormal behaviour such as feather pecking, wool pulling or tail biting (damage on animals can be easily quantified and measured).

food animals and working animals with a decent life that is worth living. Confining an animal for most of its life in a box in which it is not able to turn around does not provide a decent life.

Making Ethical Decisions

Scientific research shows that some behavioural needs are more important to the animal than others. For example, providing a secluded nest box is more important for a hen than providing a place to dust bathe (Widowski and Duncan, 2000). O'Hara and O'Connor (2007) state that there are priority behaviours that must be provided for in order to satisfy the minimum requirements for behavioural needs. The author recommends that the list in Box 1.3 would satisfy the minimum behavioural requirements for livestock and poultry. Higher welfare systems would provide for additional behaviours such as dust bathing in poultry or mud wallows for pigs.

Science can provide information to help people make good decisions about animal welfare. However, there are some ethical concerns that science cannot answer (see Chapter 2). To help make good decisions, many governments and large meat buyers have animal welfare advisory councils. The author has served on these councils for livestock industry associations, major retailers and restaurant chains. Most councils consist of scientific researchers in the field of welfare, animal advocacy groups and lay people. They provide advice and guidance. In Europe, advisory councils make recommendations on legislation. In the UK, the Farm Animal Welfare Council (FAWC) has been advising the government for many years. Another example is the Council on Animal Ethics at the National Veterinary Institute in Norway. It has both expert and lay members (Mejdell, 2006).

Measurements and Ethics

Numerical quantification of lameness, electric-goad use and feather pecking or other areas of welfare concern is a powerful tool for showing that practices or conditions have either improved or deteriorated. Some atrocious practices such as poking out an animal's eye or cutting leg tendons to restrain cattle should be banned. However, it is impossible to totally eliminate lameness. Chapter 3 will discuss practical ways to develop reasonable limits on the percentage of lame animals that would be permitted to pass a welfare audit. With good management, very low levels of lameness are possible.

From an ethical standpoint, interpretation of physiological measures such as cortisol levels or heart rate is more difficult. What level of cortisol should be permitted? The most practical way to help people make ethical decisions about physiological measurements is to compare the stressful or painful treatment to a control condition that most people find acceptable such as restraining the animal. It is best to evaluate physiological data by comparing them to a control condition within the same study with the same type of animals.

There are extreme levels of physiological measures that most scientific experts on an advisory council would be able to say 'This is absolutely not acceptable', for example, extremely high average levels of cortisol such as the 93 ng/ml average level reported by Dunn (1990) in cattle. The level is 30 units higher than cortisol levels due to poor handling. It is important to use the AVERAGE level of a physiological measure in a group of animals. Individual animals can have great variation in stress levels. More information on assessing stress has been reviewed in Grandin (1997). Another example of conditions that are absolutely not acceptable is the capture myopathy cases that are described in Chapter 5.

The Ethics of Animal Treatment Versus Treatment of People

The author went to Mexico and saw a man with a skinny, sickly donkey. When my host asked him about the poor condition of his donkey he pulled up his shirt to show us his skinny, bony chest with ribs that showed. He said 'I suffer too'. Obviously he cannot afford to feed his donkey because he cannot afford to feed himself. It would be unethical to ask the man to feed all his family's food to the donkey.

The most constructive way to implement improving animal welfare in this situation would be showing the man simple ways to help his donkey, to help him survive. Simple changes in the harness may prevent saddle sores, show the person how to take care of the animal's feet and work with people in the community on donkey husbandry (see Chapter 13). He cannot afford to feed it more, but some simple improvements in husbandry, such as providing plenty of water, could be taught to help the donkey live longer and be a more useful working

animal. Numerical scoring of lameness, injuries and deaths in many donkeys would help show the entire community that when you take care of your donkey's welfare and you do not overload it, it will last longer. Even in the poorest country, there is never any justification for beating animals up or torturing them.

Where in the Book to Find Important Animal-based Measures for Assessing Welfare

- Body condition scoring – Chapters 3 and 13
- Lameness scoring – Chapters 1 and 7
- Condition of coat and feathers scoring – Chapter 3
- Lesion and injury scoring – Chapters 1, 3 and 13
- Handling scoring – Chapters 3, 5 and 9
- Transport losses scoring – Chapter 7
- Scoring of stunning at slaughter – Chapter 9
- Animal cleanliness scoring – Chapter 3
- Behavioural measurements – Chapters 1, 8 and 15
- Assessing pain – Chapters 1 and 6
- Vocalization scoring – Chapters 1, 5 and 9
- Panting scoring for heat stress – Chapter 7
- Ethical issues – Chapters 1, 2, 8 and 12
- Condition of pastures – Chapter 3
- Lists of practices that should be banned – Chapter 1

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