

Husbandry and Animal Welfare

1

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Key Concepts

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1.1 Introduction

The broad aim of this book, as in earlier editions, is to provide an introduction to the management and welfare of farm animals through the practice of good husbandry within the context of an efficient, sustainable agriculture. Successive chapters outline these principles and practices for the major farmed species within a range of production systems, both intensive and extensive. This chapter is an introduction to this introduction. It opens with concepts in animal welfare that may be applied to any sentient farm animal, then progresses to general principles that may be applied to their management. These general principles are illustrated by specific examples relating to animal species and production systems (e.g. broiler chickens, dairy cows). For those of you who are new to the study of animal management and animal welfare, some of these examples may only make sense when you have read the chapter on the species to which they refer. I also suggest that, when you have read, learned and inwardly digested a chapter on a particular species, you could refer back to this opening chapter and consider how well (or not) current management practices for that species meet the general criteria for good husbandry and welfare within the categories outlined here.

The purpose of farming is to use the resources of the land to provide the people with food and other goods. The successful farmers are those who have the best idea of what it is the people want and need. Successful livestock farmers are those who also have the best understanding of what it is their animals want and need. Successive chapters will consider the special needs of different farmed species and provide practical advice as to how to meet these needs within the context of viable production systems. The aim of this opening chapter is to introduce principles of husbandry and welfare as they apply to the feeding, breeding, management and care of animals throughout their lives on farms large and small, and in times of special need such as during transport and at the point of slaughter. Most of the meat, milk and eggs for sale to the public in the developed world comes from highly intensive systems in which very large numbers of animals are confined and 'managed' by very few people. However, most of the people who actually work with farm animals in most of the world do so within traditional communities where animals are more likely to be cared for on an individual basis. Within the developed world, there is a growing movement to reject industrialized farming methods and return to systems that appear to afford more care and respect to farm animals as individuals. This applies both to those who seek organic, high-welfare or trusted local produce in the shops and to those who wish to farm, whether full- or part-time, to such standards. Of course the fundamental welfare needs of an animal such as a chicken are the same, whether it is scavenging for food in an African village or confined in a controlled environment building containing 100,000 birds. The ethical challenge in either circumstance is how to reconcile the welfare needs of the animals, the needs of the farmers to obtain a fair return for their investment and labour, the needs of the people for safe, high-quality, affordable food and last (but not least) the need to preserve the quality of the living environment.

1.1.1 Traditional agriculture

Agriculture, past, present and future, can be defined by four eras, traditional, industrial, value-led and one-planet. Traditional agriculture, as practised for most of history, and still practised in much of the world today, was low output but sustainable, not least because most of the animals looked after themselves. Sheep and goats consumed fibrous food, unavailable to humans, commonly grazing land the farmer did not own. Chickens and pigs (where culturally acceptable) were fed or scavenged leftovers, and food that humans failed to harvest or elected not to eat. In many traditional communities chickens also fulfilled a valuable community service, consuming ticks and other pests of humans and animals. A dairy cow justified more attention from the farmer (or more likely his wife) who would cut, cart and conserve her feed since she (the cow) was a source of real income through sale of milk. The system seldom generated great riches but it was usually sustainable, partly because it imposed a minimal drain on capital reserves such as fossil fuels, but mainly because nothing was wasted. The use of food and other resources by humans and farm animals was complementary rather than competitive.

1.1.2 Industrial agriculture

It is easy for the well-educated, well-fed citizen of the developed world to paint a rosy picture of traditional agriculture. However, it provided little more than subsistence for most farmers, most of the time, and could not meet our modern expectations for a wide variety of good, safe, cheap food in all seasons. This has been achieved through an industrial revolution in farming that began only about 70 years ago, and only in the industrialized world. In undeveloped countries, it has hardly started. The key distinction between the traditional and the factory livestock or poultry farm is that most or all of the inputs to the latter system – power, machinery and other resources (e.g. food and fertilizers) – are bought in. Thus output is constrained only by the amount that the producer can afford to invest in capital and other resources and the capacity of the system to process them.

The key objectives of industrialized livestock production can be summed up in a single phrase: to control the environment. Feeding involves provision of a nutritionally balanced ration in optimal quantities and at least cost. Housing is designed partly to provide animals with comfort and security, but mainly to maximize income relative to the costs of building and labour. Control of health is achieved through attention to biosecurity and hygiene. These general principles will be developed below and applied to the various species of farm animals in successive chapters.

Figure 1.1 outlines the genealogy of the intensive livestock farm, as typified by modern intensively housed pig and poultry units (Webster, 2005). Some feed for pigs and poultry (e.g. cereals) may be grown within the farm enterprise, but this, along with purchased feed supplements to ensure a balanced diet, is trucked onto the unit and dispensed to animals in controlled environment houses by mechanical feeding systems. Mechanical and electrical power is used to control temperature and

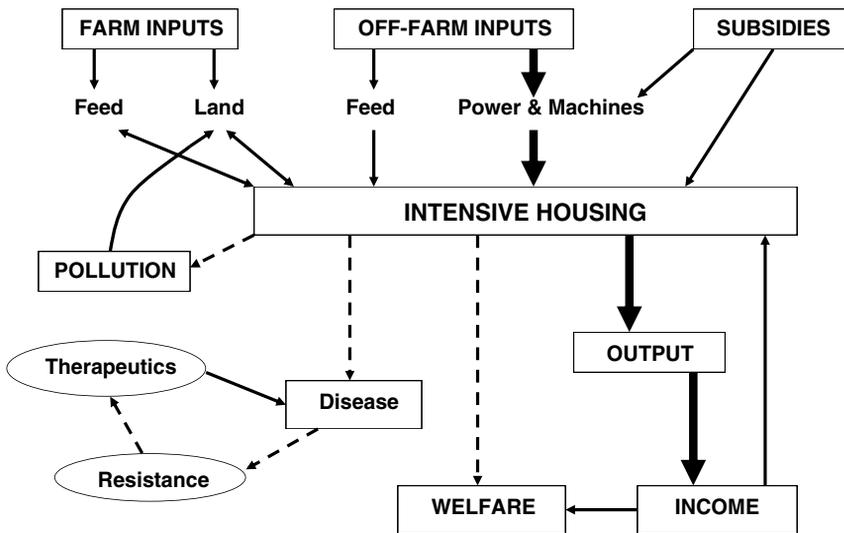


Figure 1.1 Factors influencing the development of industrialization in livestock farming. Potentially adverse effects are indicated with broken lines (from Webster, 2005).

ventilation, to dispense feed and to remove and disperse the manure. Factory farming was born when it became cheaper, faster and more efficient to process feed through animals using machines than to let the animals do the work for themselves. Once the high set-up costs had been met, the input of cheap energy and other resources from off-farm was able to increase output and reduce running costs. In consequence, poultry meat from chickens and turkeys, once the food of family feasts, is now the cheapest meat on the market.

Potential (although avoidable) harmful outputs from intensive livestock systems (hatched lines in Figure 1.1) include increased pollution, infectious disease and abuse of animal welfare. Bringing animals off the land and into close confinement inevitably increases the risks of infectious disease. To combat this increased risk it has been necessary to introduce strict new strategies to eliminate, or at least reduce, exposure to infection. The key to elimination in an intensive pig or poultry unit is biosecurity. This requires strict controls on the movement of animals and stock-keepers who shower and don protective clothing before entering the unit. This will normally ensure the health of the animals (one essential element of welfare) but there are obvious limits to the expression of natural behaviour in a large isolation hospital. The key element of hygiene is to minimize contact between animals and their excreta.

Where exposure to infection cannot be eliminated through exclusion or hygiene, it is necessary to develop routine disease control measures through the use of vaccines, antibiotics and antiparasitic drugs. If access to cheap power had been all that was necessary for the success of intensive livestock farming, then this industrial revolution would have happened in the 1920s. In fact the greatest rate of expansion only

occurred in the 1950s when antibiotics effective against the major endemic bacterial diseases of housed livestock became cheap and freely available. Alternative, subtler approaches to disease control, such as the development of specific vaccines and strains of animals genetically resistant to specific diseases, have also contributed to the commercial success of intensive systems, especially in the case of poultry. However, it is fair to claim that industrialized farming of pigs and poultry has, for the last 50 years, been sustained by the routine use of antibiotics, coccidiostats and other chemotherapeutics to control endemic diseases. In some cases these diseases could be life threatening. In most cases, however, chemotherapeutics have been used routinely to increase productivity by reducing the effects of chronic, low-grade infection.

In Europe there is now a ban on the routine use of antibiotics and many other chemotherapeutic 'growth promoters', mainly on the basis of concern that the development of microbial resistance to antibiotics used as growth promoters will pose an increasing risk to human health. The scientific evidence in support of this legislation is inconsistent. However, on balance, and in time, it has to be a good thing, both for the animals and ourselves, to restrict the routine use of antibiotics in livestock agriculture. It is an unequivocal insult to the principle of good husbandry to keep animals in conditions of such intensity, inappropriate feeding or squalor that their health can only be ensured by the routine administration of chemotherapeutics.

Although the industrial farming of livestock and poultry does present opportunities, assessed in terms of animal health and welfare, it also presents inherent threats. It is obviously impossible to care for each chicken as an individual within a poultry house containing over 100,000 animals. Any individual that falls behind the average by virtue of ill health, impaired development or reluctance to compete at the feed trough has little chance of being nursed back to normality through sympathetic stockmanship.

1.1.3 Value-led agriculture

The main impact of industrial agriculture has been to provide an ample supply and wide, year-round choice of food that is reliable, safe and cheap, and looks and tastes good. This is what most of the people have wanted most of the time. However, in recent years and within societies that can afford such morals, consumers have begun to display an increasingly compassionate concern for other, less tangible, elements of food quality, especially animal welfare and the quality of the environment. Farmers and retailers involved in livestock production have responded to this demand by developing alternative husbandry systems that give increased attention to animal welfare and environmental sustainability through developments and improvements to husbandry. The development of such alternative systems will be a feature of this book. It is however, necessary to point out at the outset that the amount of care that farmers can give to the welfare of both their animals and the land is constrained by what they can afford. If society wishes to give added value to such things as animal welfare and the environment, then society must pay for it.

1.1.4 One-planet agriculture

The aim of good husbandry has always been twofold: to provide a good food and other goods for humans, while at the same time sustaining the quality of the land and the life of the land. In the future, the pressure on agriculture throughout the world, intensive and extensive, will increasingly be driven by the need to sustain the living environment. This may challenge our current, comfortable feelings of compassion for other sentient creatures, farm animals, wildlife and poor people. The challenge will be to sustain improvements in animal welfare within the context of animal production systems that are efficient in use of resources, do not pollute the soil and waterways, and restrict the production of greenhouse gases, especially from ruminants. This book outlines the basic principles that define our duty of care to farm animals and the practices that contribute to their management. However, these principles and practice can never be divorced from the primary need to ensure the economically competitive production of food and other goods, while sustaining the productivity and quality of the living environment. This being so, compromise is inevitable. An ethical approach to such compromise is presented in the closing section of this chapter.

1.2 Concepts in Animal Welfare

The expression ‘animal welfare’ has two distinct meanings. The first is a description of the physical and mental state of an animal as it seeks to meet its physiological and behavioural needs. It is a measure of welfare as perceived by the animal itself and something that we can study through careful observations of animal behaviour and the disciplines of welfare science. The second concept of animal welfare is as an expression of moral concern. It arises from the belief that animals can experience feelings that we would interpret as pain and suffering, thus we have duty to protect animals in our care from these things. A concern for animal welfare is obviously a virtue. It is good that we should care about animals. *Caring for* animals, however, involves more than virtue; it requires a sound understanding of the principles of husbandry and welfare and these things can only be acquired through education and practical experience. This book is aimed mainly at those who will have direct responsibility for the care of farm animals. However, the moral responsibility to provide a duty of care does not apply only to those directly involved with animals on the farm, in transport and at the place of slaughter. The responsibility must be shared by all who, directly or indirectly, derive any value from the exploitation of animals to suit their ends, whether for food, clothing, sport or companionship. These responsibilities may be outlined as follows:

1. to acknowledge and understand the concepts of welfare, sentience and suffering in farm animals;
2. to breed and manage farm animals so as to promote good welfare and avoid suffering throughout their working lives;

3. to increase public awareness of the welfare needs of farm animals, within a context that also recognizes the needs of farmers to produce good food and maintain a decent living through the practice of good husbandry: the competent and caring management of the land and the life of the land;
4. to work towards improved standards of farm animal welfare through the parallel development of improved husbandry systems and increased public demand for food and other goods produced to these higher standards.

1.2.1 Sentience, welfare and wellbeing

Animal welfare has been defined as ‘the state of an animal as it attempts to cope with its environment’ (Fraser and Broom, 1990). The definition may be applied to any animal from an ant to an ape. Farm animals, however, have been classified, at least within the European Union, as ‘sentient creatures’, a definition that acknowledges that their welfare is defined by their success in meeting both their physiological and behavioural needs. For farm animals therefore the definition of welfare becomes ‘the state of body and mind of a sentient animal as it attempts to cope with its environment’. This definition covers the full spectrum of welfare from healthy to sick, pain to pleasure. The aim of the sentient animal is to achieve a state of good welfare, or *wellbeing*, defined simply as ‘*fit and happy*’ or ‘*fit and feeling good*’ (Webster, 2005). This, too, is a state of body and mind. For the body it implies sustained health; for the mind it implies, at least, an absence of suffering from such things as pain, fear and exhaustion. Ideally it should embrace a sense of positive wellbeing (*feeling good*) achieved by such things as comfort, companionship and security.

Animal sentience involves feelings. It also implies that these feelings matter. Marian Dawkins (1990) has pioneered the study of motivation in animals by seeking to measure how hard animals will work to achieve (or avoid) a resource or stimulus that makes them feel good (or bad) (see Chapter 2). So far as animals are concerned, sentience may therefore best be defined as ‘*feelings that matter*’ (Webster, 2005). This definition recognizes that the behaviour of animals is motivated by the emotional need to seek satisfaction and avoid suffering. Many of these emotions are associated with primitive sensations such as hunger, pain and anxiety. Some species may also experience ‘higher feelings’ such as friendship and grief at the loss of a relative, and this may expand the nature of their sentience. However, we should not assume that the distress caused to animals by the emotions of hunger, pain and anxiety is any less intense because they are primitive.

Figure 1.2 illustrates how sentient animals perceive their environment and how this motivates their behaviour (Webster, 2005). The ‘control centres’ in the central nervous system (CNS) constantly receive information from the external and internal environment. Much information, e.g. the perception of how an animal stands and moves in space, is processed at a subconscious level. However, any stimulus that calls for a conscious decision as to action must involve some degree of interpretation. Motivation scientists observing the response of sentient animals may define

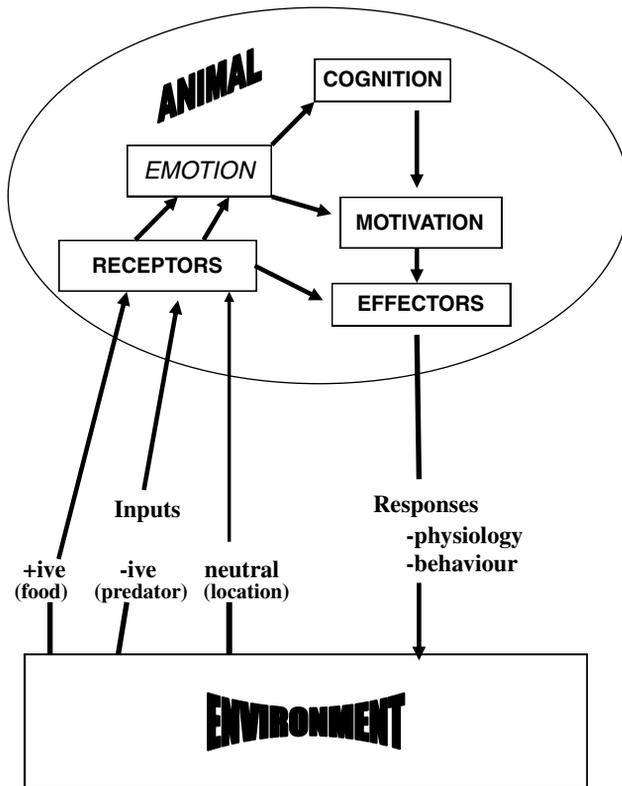


Figure 1.2 Animal sentience; pathways involved in the conscious perception of sensations and information, motivation and behavioural response.

a stimulus as positive, aversive or neutral. In simpler words, the animal, when presented with the stimulus, will experience feelings that are good, bad or indifferent. This is an emotional (i.e. sentient) response to the stimulus. The sentient animal (within which category we must include *Homo sapiens*) may or may not also interpret the incoming information in a cognitive fashion, i.e. apply reason. However they, and we, are usually and most powerfully motivated by how we feel.

This psychological concept of mind makes a clear distinction between the reception, categorization and interpretation of incoming stimuli. Although it may appear abstract it is soundly based in neurobiology. Kendrick (1998) has made recordings from nerve centres involved in these processes. When a sheep is presented with grain or hay (or photographic images of these things) this triggers signals in a family of neurones that convey the generic information 'food'. A second set of stimuli or images, e.g. dogs and men, form another generic category of information that we may call 'predator'. The information 'food' then proceeds to a second processing centre where it stimulates a family of neurones that transmit a positive emotion

(good). The information 'predator' passes to another centre that transmits the negative emotion (bad). However, if the sheep is now presented with a picture of a human carrying a sack of food, two categories of information (food and predator) are passed to the emotion centre, evaluated together and in this case passed on as a single, unconfused emotional message, namely 'good'.

The sentient animal is then motivated to respond according to how it feels (good, bad or indifferent) about the information it has received. Moreover, the interpretation is not a simple yes/no decision. The intensity of its feelings will vary. It will, for example, feel more or less hungry, more or less afraid, and this will determine the strength of its motivation to respond in positive or negative fashion. By studying the strength of motivation of an animal to seek or avoid the feelings it associates with certain sensations and experiences, we can measure not only what an animal sense as good and bad but also how much these feelings matter.

Having behaved in a way designed to achieve a satisfactory emotional state, the sentient animal will then review the consequences of its action. If it has been effective, it will feel better and it will gain the assurance that it knows what to do next time. If its action fails, either because the stress was too great, or because it was constrained in such a way that it was unable to do what it felt necessary in order to cope, then it is likely to feel worse and be more anxious for the future. Thus a sentient animal does not live only in the present: its mood and understanding are modified in the light of experience.

1.2.2 Stress and suffering

The fact that the emotional response of an animal to stimuli is governed by its past experience carries obvious survival advantages in a challenging environment, and forms an essential contribution to the survival of the fittest. The interpretation of past experience is equally important to a domestic animal since it is a key indicator of the animal's success, or otherwise, in coping with stress. To illustrate this point, consider the difference between fear and anxiety (Figure 1.3). Fear is an emotional response to a perceived threat that acts as a powerful motivator to action designed, where possible, to evade that threat. It is also an educational experience since the memory of previous threats, the action taken in response to those threats and the consequences thereof ('was it less bad than I feared or worse?') will obviously affect how the animal feels next time around. Thus fear, like pain, is an essential part of sentience. These emotions have evolved as key elements for survival. An animal that has no sense of pain or fear, for itself or its offspring, is at a profound disadvantage in the struggle for existence. So too is an animal that cannot remember what gave rise to pain or fear in the past and how well or badly it coped.

Stress and suffering are not the same. Animals are equipped to respond and adapt to challenges in circumstances that permit them to make an effective response. If so, then they learn that they can cope. An animal is likely to suffer when it fails to cope (or has extreme difficulty in coping) with stress:

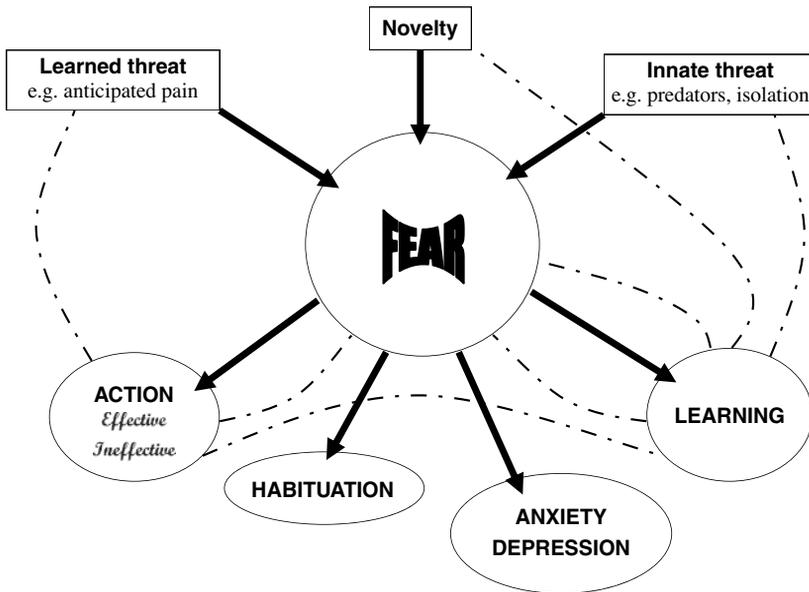


Figure 1.3 Causes and consequences of fear (from Webster, 2005; for further explanation see text).

- because the stress itself is too severe, too complex or too prolonged (e.g. a dairy cow worn out by the sustained complex stresses of metabolic overload and chronic pain from lameness); or
- because the animal is prevented from taking the constructive action it feels necessary to relieve the stress (e.g. a sow in the extreme confinement of an individual pregnancy stall).

1.3 Principles of Husbandry and Welfare

1.3.1 The five freedoms and provisions

The essence of good farm animal husbandry is to provide the resources and management necessary to ensure the economic production of food and other goods in a way that does not compromise the health and welfare of the animals (and the environment). Since wellbeing has been defined as ‘fit and happy’, provision must be made to promote both the physical and psychological elements of good welfare. These aims have been expressed according to the principles of the ‘five freedoms and provisions’ (Farm Animal Welfare Council, 1993) as set out in Table 1.1. The ‘five freedoms’ identify the elements that define an ideal state of wellbeing as perceived by the animals. The ‘five provisions’ define the husbandry and resources required to

Table 1.1 The five freedoms and provisions. Source: Farm Animal Welfare Council (1993).

1	<i>Freedom from thirst, hunger and malnutrition</i> – by ready access to fresh water and a diet to maintain full health and vigour
2	<i>Freedom from discomfort</i> – by providing a suitable environment including shelter and a comfortable resting area
3	<i>Freedom from pain, injury and disease</i> – by prevention or rapid diagnosis and treatment
4	<i>Freedom from fear and distress</i> – by ensuring conditions which avoid mental suffering
5	<i>Freedom to express normal behaviour</i> – by providing sufficient space, proper facilities and company of the animal's own kind

promote, though possibly never achieve, this ideal state. This requires proper attention to physiological needs through good nutrition, good housing, and attention to health and hygiene. It also requires attention to the psychological needs of sentient animals to avoid fear and stress and achieve satisfaction through the freedom to express normal, socially acceptable behaviour. The five freedoms should not be interpreted as a counsel of perfection but as a set of standards for compliance with acceptable principles of good welfare and a practical, comprehensive checklist from which to assess the strengths and weaknesses of any husbandry system, whether within the context of international standards for production systems or at the level of the individual farm.

Application of the five freedoms to the evaluation of standards for production systems is illustrated by Table 1.2, which considers alternative husbandry systems for laying hens: the conventional barren battery cage that constitutes the environment for most hens worldwide, the ‘enriched’ cage, that will become the minimum standard for Europe in 2012, and the ‘free range’ system. These systems are reviewed in detail in Chapter 7. Here they are briefly compared using the evaluation structure provided by the five freedoms. Thus:

Table 1.2 An outline comparison of the welfare of laying hens in the conventional battery cage, in the enriched cage and on free range. Source: Webster (2005).

Factor	Conventional cage	Enriched cage	Free range
Hunger and thirst	Adequate	Adequate	Adequate
Comfort, thermal	Good	Good	Variable
Comfort, physical	Bad	Adequate	Adequate
Fitness, disease	Low risk	Low risk	Increased risk
pain	High risk (feet and legs)	Moderate risk	Variable risk (feather pecking)
Stress	Frustration	Less frustration	Aggression
Fear	Low risk	Low risk	Aggression, agarophobia
Natural behaviour	Highly restricted	Restricted	Unrestricted

- Adequate freedom from hunger and thirst can be achieved in all systems.
- Thermal comfort can be maintained in all cage systems. On free range it will be variable. However, since hens can choose whether to be indoors or out, then thermal comfort is likely to be satisfactory most of the time.
- Physical comfort is unacceptably bad in the conventional barren battery cage when the floor space allowance for hens is only 450 cm². To give two examples only: the birds damage their feet on the wire floors and they are unable by virtue of restricted space and the barren environment to perform natural comfort behaviours such as wing flapping, grooming and dust bathing. In the enriched cage, which provides a perch, a scratching surface and more space, some of these comfort behaviours become possible. Outdoors, on free range, the bird has both the freedom and the resources necessary to perform comfort behaviour.
- Control of bacterial and parasitic infections is easier in cages, mainly because the birds are kept out of contact with their own excreta, and that of passing wild birds. This assumes great importance when there is a risk of their contracting a disease such as bird flu, especially strains that may also infect humans.
- Osteoporosis leading to chronic pain from bone fractures is likely to be a problem with all laying birds in the extreme confinement of the barren cage stocked at 450 cm² per bird. This is because one of the major predisposing factors to osteoporosis is extreme, enforced inactivity. The enriched cage permits more movement and some increase in bone strength. Active birds on free range have denser bones but are at greater risk of damage, e.g. to the sternum or keel bone as they fly to roost.
- There is good evidence that laying hens experience extreme frustration in the barren cage, most especially the frustration associated with their inability to select a suitable nesting site prior to laying their daily egg. The enriched cage and the free-range unit are both equipped with nest boxes.
- A laying hen may be less likely to experience fear when confined in a group of three or four birds within a caged system, than when in a group of 10,000 birds on a free-range unit. Fear in free-range birds may result from experience of aggression, or it may simply involve agoraphobia, i.e. fear of open spaces. Note, however, that while fear may be a stress, it may lead to adaptation rather than suffering if the birds learn to cope. On free range, birds have greater freedom of action and opportunities for education. They can take action (e.g.) to avoid the consequences of aggression. They can also habituate to the experience of being outdoors, i.e. learn that it is not a cause for alarm but a source of satisfaction.
- According to the fifth of the freedoms, the freedom to express normal behaviour, the free-range unit wins by a distance.

Application of the five freedoms and provisions to the evaluation of animal welfare on an individual farm is illustrated in Table 1.3. In this example, the five provisions create a structure for the identification of risks and hazards, and thus the application of a programme for the monitoring and control of animal welfare at farm level

Table 1.3 Application of the 'five provisions' to the identification of risks and hazards to farm animal welfare.

Provision	Hazard	Risk	Examples
1. Nutrition	Under-feeding	Hunger	Out-wintered sheep
	Unbalanced diets	Metabolic disease	High-yielding dairy cows
2. Housing	Concrete floors	Discomfort	Lameness in cows and pigs
	Cages	Injury and pain	Bone fractures in hens
3. Health care	Poor hygiene	Infectious disease	Mastitis in cows
	No vaccination policy		Respiratory diseases in poultry
	Lack of foot care	Pain	Lameness in cattle, sheep
4. Security	Barren environment	Injury	Tail-biting in pigs
	Poor stockmanship	Anxiety	Rough handling
5. Choice	Extreme confinement	Frustration	Sow stalls
	Barren environment	Learned helplessness	Barren cages for hens

according to internationally recognized HACCP (hazard analysis and critical control point) principles. This approach is considered in more detail in Chapter 18. Hazards characterized as inadequate provision of nutrition include underfeeding, e.g. in out-wintered sheep, creating a risk of hunger, possibly amounting to starvation. The category also includes the feeding of nutritionally imbalanced diets creating a risk of metabolic disease, e.g. in high-yielding dairy cows. The other hazards and risks within the categories of housing, health care, security and choice should now be self-explanatory. As one further example, I would cite freedom from fear and stress, here expressed by the single word, security. Hazards include barren environments for growing pigs that can increase the risk of tail-biting and aggression, and poor stockmanship, especially rough handling, that can provoke increased anxiety in farm animals when in the presence of humans.

These examples are presented here in brief to illustrate the central logic of the five freedoms. The welfare of animals in any system must be assessed according to all the paradigms. It is not sufficient to claim that the free-range system is superior simply because the birds are free to express normal behaviour. If mortality, preceded by a period of malaise (i.e. feeling unwell) on a free-range unit is shown to be significantly greater than in a caged system, then this must be taken into account, not just on economic grounds, but also because it is an important measure of poor welfare. Different individuals and different societies rank the importance of the five freedoms differently when passing judgement in matters of animal welfare. For example, the long-term housing of pregnant sows in individual stalls is prohibited within the European Union but currently permitted in the USA by federal law.¹ The fact that legislators within the two communities reviewed the same scientific

¹ Individual states within the USA (e.g. California, Maine, Michigan) have passed state laws to ban pregnancy stalls for sows and barren cages for laying hens.

evidence but came to opposing conclusions reflects the fact that, while such decisions may claim to be based on science, they are in fact value judgements reflecting belief in the current will of society. However, whatever may be the overall judgement on animal welfare on an individual farm or within a production system; it must include reference to all the freedoms. The best judgement is likely to be that which assesses the importance of the different freedoms in a way that most closely approximates to the animal's own measure of these things. This requires a profound understanding of the nature of animal motivation and animal behaviour (Chapter 2).

1.3.2 Good feeding

So far as the animals are concerned, the first provision of good husbandry is to ensure freedom from hunger and thirst. Freedom from thirst is achieved by provision of water fit for drinking from natural sources, containers (e.g. water troughs) or dispensers (e.g. nipple drinkers) that allow each individual to satisfy its needs. Provision of food for farm animals is a much more complex affair. In most livestock production systems animal feed is the major cost to the farmer. Thus the first essential for economic production is to maximize the efficiency of conversion of animal feed into saleable animal produce (meat, milk or eggs). The terms 'food conversion efficiency' (FCE) and 'food conversion ratio' (FCR) are used both by farmers and throughout this book. FCE is the proper description of efficiency (i.e. output:input). However, FCR (input:output) is in more common use. A broiler production unit may report an FCR of 1.56. In this case it is the ratio of total of feed consumption by a flock of birds relative to the weight of birds sold for slaughter.

Figure 1.4 outlines the steps involved in the conversion of animal feed to animal product as seen by both the animal and the farmer. Consider the case of intensive pig and poultry systems where machines are used to mix and dispense a 'compound' ration usually based on a cereal such as barley combined with a protein source (e.g. soya bean meal) and other supplements to provide a balanced supply of nutrients. This feed mixture (illustrated for simplicity in Figure 1.4. by ingredients A, B and C) is broken down in the digestive tract to supply nutrients available for metabolism: energy, protein (as amino acids), minerals and vitamins to meet the animals' requirements for maintenance and production of saleable produce such as meat, milk or eggs. Feed required to sustain maintenance of body tissues generates no output (i.e. FCE at maintenance is zero). As output increases relative to maintenance FCE increases, although as nutrient supply approaches the genetic capacity of the animal to produce milk, meat or eggs, increasing amounts of energy will be stored as fat in adipose tissue. These fat reserves can, of course, be called on in times when nutrient demand exceeds supply. This can occur when supply of digestible nutrients is restricted, as is the case for grazing animals during the winter in higher latitudes or during the dry season in the tropics. It can also occur when the productive capacity of the animal exceeds its capacity to consume and digest feed, as is the case for many high-yielding dairy cows in early lactation.

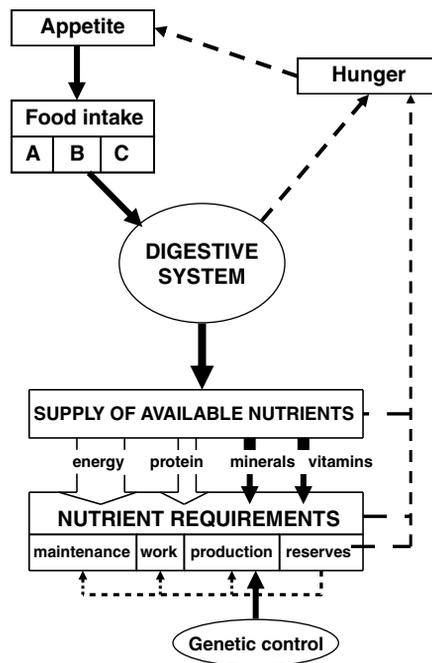


Figure 1.4 Factors affecting the supply and demand for digestible nutrients in animals.

An animal's motivation to eat is driven by hunger and appetite. These two things are not quite the same. The conscious appetite of an animal may be stimulated by the sight or smell of good food, or the foreknowledge that feeding time is approaching. If it has not eaten for some time its appetite will be increased by a sense of hunger. If it has recently eaten a large meal, it will be satiated and its appetite will be less. The internal sensations of hunger and satiety are determined partly by sensations from the digestive tract (e.g. a full stomach) and partly by a sense of 'metabolic hunger' stimulated (e.g.) by a low blood concentration of an essential substrate such as glucose. An animal that is unable to meet its dietary requirements for maintenance and production will experience metabolic hunger. As indicated above, this can occur in a sheep kept outside over winter where the quantity and quality of the food are insufficient to meet maintenance needs. It can also occur in a high-yielding dairy cow when her nutrient requirements for lactation exceed her capacity for digestion. In these circumstances she can be both 'hungry and full-up'. She experiences the simultaneous discomfort of metabolic hunger and digestive overload.

A 'good feed' for farm animals should meet four criteria:

- It should provide a balanced supply of nutrients for the needs of maintenance and production (work, growth, pregnancy and lactation).
- It should promote efficient, healthy digestion.

- It should provide oral satisfaction.
- It should do no harm.

The provision of a ration containing a balanced supply of nutrients has been introduced already. It is equally important that the feed should be provided in a form that matches the digestive function and digestive capacity of the animal. This is particularly important when feeds are prepared for natural grazers such as ruminants. The rumen of cattle and sheep has evolved to permit the anaerobic microbial digestion of cellulose and other fibres within a large well-stirred fermentation vat. Most compound rations for ruminants at high levels of production (e.g. the dairy cow) supply energy from a mixture of fibrous grasses, fresh or conserved as silage or hay, and starchy cereals. If the ratio of starch to digestible fibre is too high, fermentation may proceed too rapidly, leading to indigestion and acidosis within the rumen, with complications such as painful inflammatory laminitis within the feet. If the ratio of highly digestible starch to less digestible fibre is too low, the dairy cow will be unable to consume and digest enough feed to meet her nutrient requirements for lactation. She will then draw excessively on her body reserves, leading to loss of body condition, infertility and increased predisposition to injury and disease.

The feed should provide oral satisfaction. This is particularly important in housed adult animals such as horses and pregnant sows fed rations well below the limits of their appetite and given little to occupy their time. It is natural for a grazing animal such as the horse to nibble at food for 8–10 hours a day. It is natural for a pig to root in the ground for nuts, worms and other attractive food sources. Offered only a highly digestible, high-energy diet, a horse or pig may be able to consume enough nutrients to meet its needs within 10 minutes. It is then likely to become hungry and frustrated for the rest of the day. This frustration can lead to profoundly disturbed, stereotypic behaviour (Chapter 2) such as bar-chewing in sows, crib-biting and wind-sucking in horses. The oral satisfaction provided by a diet that includes hay or chaff for a horse, or by an environment that allows a sow to root in the earth, can prevent these behavioural disturbances and the frustration that they reveal.

The fourth essential of a good diet is that it should do no harm. It should not contain poisonous weeds or other toxic substances such as heavy minerals. Furthermore, it should be free from infectious agents, such as pathogenic bacteria or fungal toxins acquired during improper storage. Any feed of animal origin must be demonstrably free from prions responsible for the transmission of spongiform encephalopathies (TSEs), most notably responsible for ‘mad cow disease’.

1.3.3 Housing and habitat

Farm animals are housed mainly for the convenience of the farmer. Pigs and poultry are confined in houses to save land and reduce the cost and labour involved in feeding and handling. Cattle are brought off pasture in the winter more to protect the pasture than to protect the animals. It is however good husbandry, and usually good economics, to design housing and other facilities so as to meet the environmental

Table 1.4 Major environmental requirements of farm animals (adapted from Webster, 1995).

Comfort, thermal	Neither too hot nor too cold
Comfort, physical	A suitable resting area Space for grooming, limb-stretching, exercise
Security	Of food and water supply From death or injury due to predation, aggression, floods etc. From fear of predation or aggression
Hygiene	To reduce the risk of disease To avoid the discomfort of squalor
Choice	To permit coping behaviours To allow animals to acquire security through experience and adaptation to the normal sights and sounds of farm activity

requirements of the confined animal. The four most important environmental requirements of farm animals are comfort, security, hygiene and freedom to perform behaviours intended to achieve these things. In Table 1.4, freedom of behaviour is described by the single word, 'choice'. Freedom from thermal discomfort is achieved by providing an environment that is neither too hot nor too cold, where hot and cold cannot be defined simply by air temperature but must take into account all factors that determine heat transfer between an animal and the environment; especially air movement, precipitation and solar radiation. Provision of an optimal thermal environment is dealt with on a species-by-species basis in subsequent chapters. As a general rule, most intensively farmed pigs and poultry are kept in controlled environment buildings, mainly to minimize feed energy requirement for maintenance and so maximize FCE. For most grazing animals, shelter from excessive sun, wind and rain is usually sufficient to ensure both adequate welfare and efficient production. For a fuller description of factors affecting the heat exchanges of farm animals, see Wathes and Charles (1994).

The most important requirement in terms of physical comfort, security and hygiene is a good resting area. The relative importance of the different criteria necessary to define a suitable resting area is summarized in Table 1.5. Poultry, for example, do not require a soft bed or a yielding mattress. They prefer to rest on perches. Chickens are motivated to perch at night by an innate fear of predators operating at ground level. This has been essential to their survival in the wild. Although there be may no real risk of predation in a controlled environment poultry house, the innate fear persists, so their selection of resting area is driven primarily by the need to experience a sense of security. The need to achieve a real (rather than imagined) degree of security is important for laying hens, who can and will injure one another, but not for young broilers, who do not.

The requirements of the large, bony, heavy dairy cow may be placed at the opposite end of the spectrum from those of the laying hen. Her greatest need is for a bed that is soft and yielding when she lies down, but does not impede her movement

Table 1.5 The relative importance of the different criteria necessary to define a suitable resting area for farm animals (adapted from Webster, 1995). Importance is ranked from 0 (unimportant) to *** (highly important).

	Hygiene	Dryness	Softness	Warmth	Security
Poultry, broilers	*	***	0	*	0
Poultry, layers	*	**	0	0	**
Pigs, weaners	**	**	*	**	*
Pigs, dry sows	*	**	**	**	***
Cattle, young calves	**	***	**	**	0
Cattle, dairy cows	**	**	***	0	**
Sheep, adult ewes	*	**	*	0	*
Horses, adult	**	**	**	0	*
Neonates, general	***	***	*/0	***	***

when in the act of standing up and lying down. Bare concrete fails on both counts. Rubber mats are barely adequate. Deep straw is comfortable but may fail on grounds of hygiene and increase the risk of mastitis. Deep, dry sand is close to ideal both in terms of comfort and hygiene (see Chapter 3). Most of the other rankings in Table 1.5 should now be self-explanatory and all will be considered in more depth in subsequent chapters. However, note all the reasons why it is important to provide a suitable resting area for neonates, especially when they have been removed from their mothers. Hygiene and warmth are particularly important, the former to reduce the risk of exposure to infection, the latter to reduce the risk of thermal stress leading to a loss of resistance to infection.

The last, but not the least, environmental requirement listed in Table 1.4 is defined as ‘choice’. Sentient animals make decisions that enable them to cope with environmental challenges and improve the way they feel. As explained earlier, an animal such as a sow in the extreme confinement of an individual pregnancy stall may suffer because it is prevented from taking any constructive action it feels necessary to relieve its frustration. This is an extreme example (and in Europe, illegal). However, as a general rule, farm buildings and confinement areas should be designed and managed so as to allow the animals to acquire a sense of security through experience and adaptation to the normal sights and sounds of farm activity. This requirement is clearly stated in the UK *Codes of Welfare for Farm Animals* (<http://www.defra.gov.uk/foodfarm/farmanimal/welfare/onfarm/index.htm#we>) (DEFRA, 2003).

1.3.4 Fitness and health

The third of the five freedoms (Table 1.1) is ‘freedom from pain, injury and disease, by prevention or rapid diagnosis and treatment’. The aim of good husbandry should go beyond this: it should be to breed, feed and manage farm animals so that they can sustain productivity and maintain physical fitness throughout a profitable working

life. Since most animals reared for meat are killed at a very young age, this concern relates mostly to adults, breeding sows, laying hens and lactating cows. Here physical fitness implies more than just freedom from pain, injury and disease; it includes the maintenance of fertility and body condition. To give an extreme example, too many emaciated dairy cows are culled for infertility after a working life of less than three lactations. This is not only a measure of poor welfare for the cows, it also represents a loss to the farmer from animals that might have been highly productive at the start of their first lactation but failed to achieve an economically satisfactory lifetime performance.

Farm animals are susceptible to a wide range of diseases for which the primary cause is infection with pathogenic viruses or bacteria, or infestation with parasites. Farm animals may also act as carriers of infections that cause them little or no harm but can cause serious diseases in humans. The most important of these are bacterial infections with certain strains of *Campylobacter*, *Escherichia coli*, *Salmonella* and *Listeria* species. Thus control of infection and disease on farms is essential not only for the health and welfare of the animals but also for the protection of the general public. The strategies adopted for the prevention and control of farm animal diseases are outlined in Table 1.6. The surest way to protect farm animals from a specific pathogen is to adopt a strategy of total exclusion: i.e. ensure that the animals never come into contact with the infectious agent. This strategy can operate at national level, e.g. the UK policy to exclude and eliminate foot and mouth disease. It can also operate at farm level. Many pig farms are designated as carrying Minimal Disease, or Specific Pathogen Free (SPF) herds. In this case, the animals are protected from infection by a rigid programme of biosecurity. Animals live in controlled environment buildings protected from contact with possible disease carriers such as wild animals and birds. Stock-keepers have to wear protective clothing and shower in and out. Any new animals brought onto the site (e.g. breeding sows) must come from a farm operating to the same standards of SPF control. The exclusion approach is

Table 1.6 Strategies for the prevention and control of infectious diseases in farm animals.

Strategy	Examples
Exclusion	National exclusion and eradication: e.g. foot and mouth disease Biosecurity at farm level: e.g. swine pneumonia
Vaccination	Poultry: Newcastle disease, coccidiosis Sheep: clostridial diseases
Hygiene	Dairy cattle: contagious and environmental mastitis Sheep, horses: parasite control through pasture management
Drug therapy	Pigs: antibiotic control of post-weaning diarrhoea Sheep, horses: parasite control through routine worming
Natural immunity	Calves: controlled exposure to endemic infections Pigs: reducing weaning stresses

highly effective so long as it works. However, if there is a breach of biosecurity and disease enters the country, or the farm, the next step is draconian: slaughter all animals infected or exposed to infection, disinfect, leave the buildings unoccupied until safe to re-enter, then start again.

For many infectious diseases of farm animals, the most effective means of prevention is to promote a lasting immunity through vaccination. Poultry in controlled environment buildings are vaccinated *en masse* against Newcastle disease (fowl pest), an infection that would otherwise cause catastrophic losses in an environment where so many birds are confined in a small space. Vaccination is the only effective method for control of clostridial diseases (see Chapter 5) in sheep at pasture because the bacteria that cause these diseases can survive for many years in the soil. Unfortunately many diseases of farm animals are not controlled by vaccination, because the vaccine does not exist, is limited in its effect or is too expensive.

Prevention of infectious disease through exclusion or vaccination is highly effective but only for those diseases for which such a strategy is possible. Since these methods are effective, these diseases are usually under control. It follows that most of the infectious disease problems on modern commercial farms are those associated with endemic organisms that cannot be eliminated from the environment and where absolute immunological protection is unfeasible. Examples include parasitic infections in grazing cattle and sheep, mastitis in dairy cows, and many respiratory diseases. With this category of diseases, it is not possible to exclude the possibility of infection. Indeed, infection is the natural state: the aim of the farmer must be to create an environment wherein the balance between the challenge from the pathogens and the immune and other defence mechanisms of the animal is shifted in favour of the animal.

The three strategies for control of endemic diseases where vaccination is not an option are hygiene, use of chemotherapeutics (antibiotics and antiparasitic drugs) and promotion of natural immunity. In each case the aim is not to eliminate infection but to reduce the risk that infection will proceed to disease. Hygiene is designed to reduce the magnitude of the challenge. Examples presented in Table 1.6 include the control of mastitis in dairy cattle through good hygiene in the milking parlour, and the control of parasitic worm infestation through pasture management. These practices are admirable but not infallible. It is customary, and usually good husbandry, to reinforce the practice of good hygiene with the controlled use of chemotherapeutics (antibiotic or antiparasitic drugs) to keep the pathogen burden under control. However this approach can be abused. To take but one example: it has been common practice to dose growing pigs routinely and regularly with antibiotics. This was done initially to prevent catastrophic losses from diarrhoea and pneumonia. However, it was discovered that animals that were apparently healthy (to a casual eye) grew more efficiently (FCE was improved) when dosed regularly with antibiotics, which then acquired the name of 'growth promoters'. The reasons for this are complex but one of the reasons was a reduction in low-grade infection. This practice gave rise to public concern, mainly relating to the public health risks of increasing antibiotic resistance in bacteria pathogenic to humans. The use of

antibiotics as growth promoters for farm animals is now banned in Europe. However, it is still possible for veterinarians to prescribe antibiotics for all the animals in a piggery when only a few appear to be sick. Thus the practice has not gone away. The use of chemotherapeutics for the prevention of disease in populations, rather than the treatment of individuals, is something that has to be considered on a case-by-case basis and in accordance with fundamental principles of good husbandry. It is, for example, good practice to incorporate regular worming of horses and sheep (especially the young animals) as part of an overall strategy for parasite control. It is good practice to control mastitis in dairy cows through dry cow therapy (Chapter 3). It is *not* good practice to rely on antibiotics as a strategy for keeping calves, pigs or poultry alive in conditions of squalor.

Last but not least among the strategies for prevention and control of infectious disease is to design systems that enhance natural immunity and so reduce the risk that exposure to infection will proceed to losses and ill thrift due to clinical disease. Natural immunity can cope with many infections when the challenge is not too severe and the immune mechanisms are not impaired by stress. Weaning is a particularly stressful time for young animals and can precipitate outbreaks of diarrhoea in pigs or pneumonia in calves. The aim should be to minimize weaning stresses and ensure that these do not coincide with increased exposure to infection (e.g. not moving weaned calves directly into a building containing older animals who are likely to be carriers of respiratory viruses).

Some of the most important diseases and disorders of farm animals are described as 'production diseases'. This description acknowledges that the prevalence and severity of these diseases are profoundly influenced by the standards of feeding, housing and hygiene imposed by the husbandry system. Table 1.7 lists some of the more common production diseases. These include infertility, mastitis and lameness in dairy cows, diarrhoea and wasting in weaner pigs, osteoporosis and bone fractures in laying hens, and lameness and hock burn in broiler chickens. Diarrhoea in weaner pigs, and mastitis and digital dermatitis in dairy cattle involve infectious agents but their cause and control are largely down to management. Other conditions such as lameness in broiler chickens and osteoporosis in laying hens can be attributed entirely to the way the animals are bred, fed and housed.

Table 1.7 Some common production diseases of farm animals.

Animal	Disease
Dairy cattle	Infertility, mastitis, claw lameness, digital dermatitis
Beef cattle, finishers	Rumen acidosis, liver abscess, laminitis
Pigs, weaners	Diarrhoea and wasting
Laying hens	Osteoporosis, bone fractures
Broiler chickens	Lameness, hock burn

Infectious diseases and injuries that cause pain and lameness compromise both the success of the farm enterprise and the welfare of the affected animals. The aim is to control these things, ideally by prevention, but when they occur, by early diagnosis and treatment. The first aim of treatment is to attack the causative agent, e.g. by administration of an appropriate antibiotic in the event of bacterial infection. It is also necessary to address the welfare of the sick or injured animal through symptomatic treatment and nursing. To give two examples: the welfare of a lame cow will be improved if she is not required to stand on concrete but can be moved to a box with a comfortable straw bed. The welfare of a calf or foal suffering the chills of a pneumonic fever will be improved if it is allowed to lie under a heat lamp.

1.3.5 Freedom from fear and distress: the art of stockmanship

The aim of good husbandry is to promote freedom from fear and distress by ensuring conditions which avoid mental suffering (Table 1.1). In all but the most extensive farming systems (e.g. hill sheep) the animals come into regular contact with humans. The essence of good stockmanship is therefore to do all that is possible to avoid causing fear and distress and to strive to instil in the animals a sense of security. The principles of good stockmanship as applied to the different farm species are excellently set out in the DEFRA *Codes of Recommendations for the Welfare of Livestock* (<http://www.defra.gov.uk/foodfarm/farmanimal/welfare/onfarm/index.htm#we>). Daily routines should be carried out calmly and consistently with the aim of accustoming the animals to the normal sights and sounds of farm activity. Farm animals, in common with most sentient creatures, are neophobic; they have an innate fear of novelty (Figure 1.3). Once the sights and sounds become routine, they habituate and acquire a sense of security.

There are, however, some occasions when the imposition of fear and distress is inevitable. These include procedures such as castration, de-horning, foot trimming, sheep dipping, transport and the routine administration of medicines. The use of anaesthetics is required by law for many painful procedures such as castration. Even procedures unlikely to cause pain (e.g. foot trimming, loading on to a lorry) can cause distress because they are novel, and because the animals are severely restrained, or forced in a direction they don't want to go. These procedures are likely to cause the most distress to extensively reared animals like sheep coming off the hill for the first time. The best way to minimize distress in animals that need to be moved or handled is through the design of facilities that permit the animals to move naturally with minimal disturbance and in the company of their own kind. The best exposition of the principles and practice of good livestock handling and management is that of Temple Grandin (1993).

1.4 Breeding for Fitness

Evolution through natural selection involves the survival of the fittest. Those animals whose genetic make-up is better suited to a particular environment are those more

likely to breed successfully and pass on their genetic superiority (in that environment) to their offspring. By domesticating animals and controlling their breeding to suit our own purposes, we have redesigned their phenotypes to produce more of the things we want and at greater efficiency: more milk per cow, more eggs per hen, faster growth and leaner carcasses in pigs and poultry, improved FCE. Controlled breeding of farm animals has been conspicuously successful at achieving these aims and, in the case of growth rates, milk yields and FCE, the evidence would suggest that the rate of progress can be sustained.

If a trait, such as growth rate, is heritable, then that trait can be 'improved' through genetic selection at a rate that is determined by its heritability. However, the consequences of selection are not limited to the trait or traits included in the selection programme, and some of these correlated responses to selection may compromise fitness and welfare. Thus, selection for increased milk yield in dairy cows has led to correlated increases in infertility (Simm, 1998); selection for increased growth rate in broiler chickens has led to an increase in the prevalence of limb disorders (Kestin *et al.*, 1992). The principles and practice of genetic selection in farm animals are too complex to consider here in any detail: for an excellent introduction see Simm (1998). There is, however, one general truth that needs emphasis. The traits that carry the highest heritability, such as coat colour, growth rate, and proportion of meat in the most expensive cuts, tend to be those which carry little or no benefit to the animals themselves within the Darwinian context of fitness. The traits that really matter to the animal, like mothering ability and viability of the offspring, carry a very low heritability.

The impact of genetic selection on production and production efficiency has been most conspicuous in the intensive poultry and pig industries. This does not automatically imply that these industries are more advanced. The first reason for the high response to selection is that these animals are kept securely in controlled environment houses with all the high-quality feed they need. The second reason is that selection has been directed almost entirely at 'improved' traits in animals destined directly for slaughter (e.g. growth rate, carcass quality, FCE) with little regard for traits that may affect the fitness of the breeding animals. Table 1.8 outlines some of the key factors that determine the efficiency of production in meat animals and their implications for genetic selection. The most important single factor is the prolificacy of the breeding female. A broiler breeder that produces 250 chicks/year, slaughtered for meat at an average weight of 1.5 kg, can produce 120 times her own weight in the form of saleable meat per annum. At the other extreme, a ewe that produces 1.6 lambs per year yielding on average 18 kg of saleable meat/lamb only yields 32% of her own weight. In the case of broilers, 96% of feed is eaten by the slaughter generation; in pigs it is 80%, in sheep only 32%, i.e. 68% of feed is eaten by the breeding generation. Thus the improvements in efficiency (output: input) achieved through genetic selection in the pig and poultry industries reflect the fact that the slaughter generation dominates both outputs and inputs. Where the requirements of the breeding generation are relatively high (e.g. suckler beef cattle and sheep) then

Table 1.8 Factors affecting the efficiency of meat production: allocation of food energy to the breeding and slaughter generations in broiler chickens, pigs, sheep and suckler beef cattle. Source: Webster (2005).

Inputs and outputs	Broilers	Pigs	Sheep	Beef cattle
Weight of breeding females (kg)	3	180	75	450
Progeny/year	240	22	1.6	0.9
Carcass yield from each meat animal (kg)	1.5	50	18	250
Total carcass yield/weight of dam	120	6.2	0.38	0.50
Proportion of feed energy/year				
to slaughter generation	0.96	0.80	0.32	0.48
to breeding generation	0.04	0.20	0.68	0.52

selection based on simply on growth rate, FCE, and so on can drive efficiency in the wrong direction. It would, for example be extremely unproductive to stock the hills of Scotland with Suffolk sheep. In these circumstances breeding policy is typically based on the principle of ‘divergent selection’. In sheep this might involve selection for ‘meaty’ traits in the sire breeds (e.g. Suffolk or Texel) and hardy, low-maintenance traits in the breeding females (e.g. Scottish Blackface). A fuller explanation of breeding strategies in the sheep industry is given in Chapter 5.

Within the global poultry, pig and dairy industries, the phenotype of the ideal production animal is determined by a small number of international companies who constitute the nucleus breeders. They provide the ‘superior’ male genes (usually in the form of semen) and breeding females and market these products either direct to commercial farms or through ‘multiplier’ units (Chapter 6). The superior genotypes are developed on the basis of a ‘selection index’ that nominates multiple traits relating both to productivity and fitness and weights them with the aim of achieving the most efficient compromise, measured in strictly economic terms. This will inevitably put greatest weight on production traits such as growth rate in broilers, even if it leads to a deterioration in the leg strength of growers and the fitness of broiler breeders (Chapter 8). However, breeding companies have, in recent years, come to place increased emphasis on fitness traits, in response to criticism from both producers and consumers that so-called high genetic merit animals were becoming increasingly unable to sustain fitness throughout their productive lives. Thus dairy cow selection in the USA is now based on an ‘index of lifetime merit’ that still gives 62% weighting to milk fat and protein yield but now allocates 38% to fitness-related traits such as reduced somatic cell count in milk and increased productive life.

In summary, the overall aim of controlled breeding in farm animals is to produce a superior animal, measured mainly in terms of production and productive efficiency. However, genetic superiority is not an absolute concept: it can only be measured in the context of a specific environment and in relation to the criteria used to define superiority. The ‘superior’ lines of pig or broiler chicken generated from the nucleus

breeders for intensive, controlled environment production systems all tend to be very similar because both the selection criteria and the environments for which they have been selected are all much the same. Moreover, traits that may be defined as superior in commercial terms may not be consistent with fitness, especially in breeding adults. One sees the most genetic diversity within extensive livestock systems, where animals have to fend for themselves in a wide range of environments. Where environmental control is not an option, it makes more sense to exploit natural selection and genetic diversity to match animals to the environment, rather than vice versa, and this inevitably implies giving added weight to fitness traits. Paragraph 29 in the Welfare of Farmed Animals (England) Regulations (2000) states: *'No animals shall be kept for farming purposes unless it can reasonably be expected, on the basis of their genotype or phenotype, that they can be kept without detrimental effect on their health or welfare.'* The intention of this regulation is admirable but it has yet to be tested in the form of a challenge as to whether any current breeding programme might be detrimental to animal health and welfare.

1.5 Transport and Slaughter

The procedures involved in the transport of farm animals and their handling in abattoirs up to the point of death will inevitably involve some degree of stress. Recent UK orders, the Welfare of Animals (Transport) Order 1997 and the Welfare of Animals (Slaughter or Killing) Regulations 1995, based on European Council Regulations, acknowledge that these procedures are inherently stressful and are designed to minimize the risk that animals will suffer physically as a direct consequence of any of these procedures, or suffer mentally in anticipation of them. The Transport Order sets out regulations concerning vehicle design, journey times and rest periods. The Slaughter Regulations state that 'No person engaged in the movement, lairaging, restraint, stunning, slaughter or killing of animals shall: (a) cause any avoidable excitement, pain or suffering to any animal; (b) permit any animal to sustain any avoidable excitement, pain or suffering.'

This legislation recognizes the range of potentially stressful experiences that an animal might encounter from the moment it is taken from the relative security of the farm environment to the point of death. The humanity of processes involved in the transport and slaughter will be determined by how well these principles are put into practice. Once again the five freedoms may be used as a comprehensive structure that can identify the major problems and point to solutions (Table 1.9).

Pigs and poultry are much more susceptible to thermal stress (especially heat stress) than cattle and sheep, mainly because of their limited ability to regulate heat loss by evaporation. Pig and poultry transporters are designed, ventilated and sometimes air-conditioned to minimize the risk of thermal stress for the sound commercial objective of preventing animals from arriving dead at the abattoir. Sheep and cattle are unlikely to be killed as a direct consequence of heat stress but it can

Table 1.9 Application of the 'five freedoms' to identify welfare problems for farm animals in transport and at the place of slaughter. Source: Webster (2005).

	Poultry	Pigs	Cattle	Sheep
Hunger and thirst			Thirst	Thirst
Physical discomfort	Overcrowding ** Shackling	Overcrowding*	Exhaustion	Exhaustion
Thermal discomfort	Heat stress *** Cold stress*	Heat stress ***		
Pain and injury	Bone fractures		Bruising	Smothering
Infection	Day-old chicks		Young calves **	
Fear and stress		Fighting	Fighting	Neophobia

exacerbate their suffering from severe thirst and physical exhaustion when they are transported long distances. European regulations state that journey times for cattle, sheep and goats should not exceed 14 hours and must be followed by a rest period of at least 1 hour (Council Regulation (EC) 1/2005 on the Protection of Animals during Transport). This recognizes that the main problem for these animals will be exhaustion because they are likely to remain standing throughout the journey for reasons of security. Journey times for pigs may be up to 24 hours provided they have continuous access to liquid. This is because they lie down. Fighting, and injuries caused by fighting, constitute one of the main sources of stress in pigs and cattle, especially in lairage. All farm animals are likely to experience the stress of neophobia when exposed for the first time to the procedures involved in loading and unloading from vehicles. This problem is likely to be greatest for animals such as hill sheep that have had little or no previous experience of contact with humans and hardware. I repeat, the most effective way to minimize stresses in transport and at the place of slaughter is to design facilities that minimize human contact and encourage animals to move naturally and with a sense of security (Grandin, 1993). This assumes particular importance when handling animals such as red deer (Chapter 10) where overexcitement and fear can also lead to serious injuries.

This is not the place to review in any detail the methods used for the stunning and slaughter of farm animals. For more information see Gregory (1998) and publications produced by the HSA (<http://www.hsa.org.uk/>). Regulations state that 'animals should be slaughtered instantaneously or rendered instantaneously insensible to pain until death supervenes'. In most cases animals are first stunned to render the animal insensible, then 'stuck' and bled to death. The most common stunning method for cattle involves concussion, using a captive bolt pistol or percussion bolt gun. Pigs and poultry have conventionally been stunned by application of electric currents to induce an epileptic seizure. However, in recent years there has been increasing use of the gases carbon dioxide, argon or mixtures thereof to create insensibility prior to bleeding out.

The 1995 Slaughter Regulations recognize two key stages essential to ensure the humanity of the slaughter process:

- The stunning process should ensure that animals are rendered (almost) instantaneously insensible to pain (and fear) until death ensues.
- All abattoir procedures from the time of the animals' arrival to the time of death should be designed and executed in such a way as to avoid excitement, pain or suffering to any animal.

Incorporation of these principles into abattoir design and management is a complex business but vital in terms of both animal welfare and meat quality, since the two are related (Gregory, 1998). The key principle must always be compassion. At an excellent abattoir in Scotland, there is written above the point of animal entry the words 'Quality control starts here. Treat all animals with care and kindness.' That says it nicely.

1.6 Ethics and Values in Farm Animal Welfare

Ethics, or moral philosophy, is a structured approach to examining and understanding the moral life: right thought and right action. There are two classic approaches to addressing moral issues, conveniently abbreviated as 'top-down' and 'bottom-up'. The classical 'top-down' approach asks the question: 'What general moral norms for the evaluation and guidance of conduct should we accept, and why?' The drawback to this approach is that practical issues tend to be given little emphasis or ignored. The alternative 'bottom-up' approach is first to identify a specific practical issue, then construct an analysis of relevant moral issues by a process of induction. Beauchamp and Childress (2001) have developed a powerful and widely adopted 'bottom-up' approach to addressing problems in biomedical ethics which builds upon well-established principles of 'common morality'; i.e. those principles and norms identified as relevant and important by reasonably minded people. These principles have been adapted by Mepham (1996) to livestock farming. The three pillars of common morality are all based on the central principle of respect:

- *beneficence*: – a utilitarian respect for the aim to promote the greatest good and least harm for the greatest number;
- *autonomy*: – respect for the rights of each individual, e.g. to freedom of choice;
- *justice*: – respect for the principle of fairness to all.

Any ethical evaluation of the use of animals by humans is complicated by the fact that the animals cannot contribute to the debate, and no benefit accrues to the individuals used in the process. This applies particularly to the principle of justice. Humans are moral agents and carry moral responsibilities. The animals are 'moral patients'.

In this context, therefore, the concept of justice demands that we should always seek a fair and humane compromise between the likely benefits to humans and our moral duty to respect the welfare and intrinsic value of any animal in our care. Respect for the general welfare of individuals and populations is a utilitarian principle; respect for the intrinsic value of every farm animal is in accord with the principle of autonomy. However, no moral judgement regarding animal welfare, nor any action consequent upon this moral judgement, can be made in isolation. It must also consider the farmers who produce our food, consumers, especially those with little money to spend on food, and the overall impact of any decision on the living environment.

The three principles of respect and the four parties commanding respect are brought together in Table 1.10 in the form of an ethical matrix (after Mepham, 1996). Farmers and all who work in the food chain have a duty to provide the public with safe, wholesome, affordable food. The utilitarian principle commands that we, the general public, have a duty to help farmers to promote the welfare of their animals and the living environment through our actions and our laws. This help may take the form of financial rewards for food produced to high welfare standards and subsidies for conservation of a living environment that can sustain biodiversity, wildlife and the beauty of the living countryside.

Our moral duties to farmers and their animals may be explained largely in utilitarian terms. They are also motivated by self-interest. Even the duty to sustain the living environment reflects not only our human respect for beauty but our long-term need to preserve the planet for our own ends. The matrix however recognizes that utilitarianism alone is not enough: our actions should also be motivated by the principles of autonomy and justice. The principle of autonomy commands respect for other living creatures and for the living environment by virtue of their very existence. It is most simply expressed by the maxim: 'Do as you would be done by.' In this context, the most important element of autonomy is equal freedom of choice, for us and for them. Individual consumers should have the right to select their food on the basis of knowledge (or at least trust) of those things that matter to them – price, quality, safety and maybe (if they wish) production methods. Farmers should have the freedom to adopt, or not adopt, production methods of which they may or may not approve, such as hormone implants in beef cattle, or genetically engineered crops.

Table 1.10 The ethical matrix as applied to the production of food from animals (adapted from Mepham, 1996).

Respect for	Beneficence Health and welfare	Autonomy Freedom/choice	Justice Fairness
Farm animals	Animal welfare	<i>Telos</i>	Duty of care
Producers	Farmer welfare	Choice of system	Fair trade and law
Consumers	Safe, wholesome food	Choice/labelling	Affordable food
Living environment	Conservation	Biodiversity	Sustainability of populations

Respect for the autonomy of the moral patients, farm animals and the living environment is a more difficult concept since it cannot be reciprocated (we may assume that animals feel no moral obligation to us). Nevertheless, the principle encourages us to recognize the ‘*telos*’, i.e. the fundamental biological and psychological essence of any animal; in simple terms ‘the pigness of a pig’. A pregnancy stall for sows that denies them the freedom to express normal behaviour is an insult to *telos*, even if we cannot produce evidence of physical or emotional stress. If you disagree with this concept (and many do), consider two more extreme possible manipulations of farm animals in the interests of more efficient production: breeding blind hens for battery cages, or genetically engineering pigs to knock out genes concerned with perception and cognitive awareness (in essence, to destroy sentience). A strictly utilitarian argument could be marshalled to defend both practices since it could be argued that blind hens would be less likely to damage one another, and less sentient pigs would be less likely to suffer the emotional effects of discomfort and frustration. I offer these examples in support of the argument that, even when considering non-human animals, utilitarianism is not enough.

The principle of justice implies fairness to all parties. In the context of farm animal welfare the principle of justice imposes on us the duty of care. All those who keep farm animals and all those who eat their products should accept that these animals are there to serve our interests. Their ‘purpose’ is to contribute to our own good. It is therefore only fair to do good to these animals in a way that is commensurate with the good they do for us. We owe them a duty of care.

This chapter has introduced the major elements of good farm animal husbandry and welfare. Successive chapters describe the practical application of these principles to the management of farm animals in the major production systems. Our understanding of good husbandry is founded on science, technology and, most important of all, generations of practical experience and it is these things that that make up most of this book. Nevertheless, our duty of care to farm animals and to the living, farmed countryside cannot be measured in scientific terms. It can, and should, be informed by science, but it is defined by our sense of *values*. Ethics has been defined as the ‘science of values’: it offers justification and guidance for right action. The ethical matrix (Table 1.10) has something in common with the ‘five freedoms’ in that it can operate in practice as a checklist of concerns and an aid to diagnosis in matters of value. I invite you to use both frameworks when evaluating the welfare of farm animals within different production systems. The five freedoms will help you to assess how the animals feel (‘fit and happy?’); the ethical matrix will help you to assess how well we meet our duty of care.

References and Further Reading

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Animal Husbandry & Welfare. Animal Species & Commercial Insects. Animal Health & Disease Management.Â Animal Species & Commercial Insects. Cattle (new with animal welfare standards). Cattle breeds and Breeding. Donkeys (new, with animal welfare information). Chicken (new, with animal welfare information). Camels (new, with animal welfare information). Sheep (new, with animal welfare information). Fish farming (new, with animal welfare information). Rabbits (new with animal welfare information). Goats (new with animal welfare information). Pigs (new, with animal welfare information). Poultry: Geese (New with animal welfare information). Mulberry Silkworm. Beekeeping. Pets: Dogs (new). Pets: In animal husbandry management decisions that need to be done daily are configured according to the correctness of the decisions to be made. At this point, smart systems give many opportunities to farmers. Milking, feeding, environmental control, reproductive performance constitute everyday jobs most affected by correct management decisions. Human errors in this works and decisions made big effect on last product quality and profitability are not able to be risked. This chapter deal with valuable information on the latest challenges and key innovations affecting the animal husbandry.Â Our team is growing all the time, so weâ€™re always on the lookout for smart people who want to help us reshape the world of scientific publishing. Open access peer-reviewed chapter.