

ANIMAL WELFARE AND MEAT SCIENCE

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Contents

<i>Preface</i>	vi
<i>List of Synonyms</i>	viii
1. Animal Welfare and the Meat Market	1
2. Livestock Presentation and Welfare before Slaughter	15
3. Solving Livestock Handling Problems in Slaughter Plants – by Temple Grandin	42
4. Physiology of Stress, Distress, Stunning and Slaughter	64
5. Muscle Structure, Exercise and Metabolism	93
6. Post-mortem Muscle Metabolism and Meat Quality	108
7. Cattle	123
8. Sheep	146
9. Pigs	165
10. Poultry	183
11. Fish	195
12. Processed Meats	213
13. Stunning and Slaughter	223
14. Stunning and Meat Quality	241
15. Caring for Animals and for Quality	254
<i>References</i>	265
<i>Student Assignments</i>	285
<i>Index</i>	287

Preface

The origins of an organized meat industry date back to the beginning of the 14th century. The first European public abattoirs were built at about that time and their purpose was to slaughter the large number of animals that became available in the late autumn and early winter months. Much of the meat was salted and stored in casks, whilst some was smoked or dry fermented. The animals arrived at the abattoirs on foot, and in some cases they walked long distances before reaching their destination. The traditional methods of meat production and slaughter at that time had some ugly features. For example, 400 years ago British butchers were required by law to bait bulls with dogs before slaughter. Bull baiting helped to make the meat more tender. Thankfully, that practice is now illegal. Society is now very sensitive to malpractices such as this, and there is increasing concern for those animals which are unable to protect themselves or improve their own conditions because of constraints imposed by farming, transport and abattoir conditions. There is concern about some practices which are done to improve product quality but may be considered unnecessary, such as force-feeding geese, castrating pigs and swimwashing sheep. There is also abhorrence for most forms of intentional injury to animals. The principle that underlies these concerns is one of being fair and reasonable to animals. It is held that we have a duty of care to animals that are under our control. At the other extreme some people take the view that life is not fair, and so whether they or anyone else are unfair to animals does not concern them.

The problem that faces modern society is in knowing, agreeing and deciding about what is fair and reasonable. There are widely differing views on whether it is fair to:

- remove baby chicks and calves from their mothers;
- breed animals with physical features that create problems with parturition, breathing, exercise and joint pain;
- confine animals in pens or cages;
- kill animals without any form of stunning.

It will take time before we come to agree on these issues, and there are three ways in which changes in attitude will come about. Legislation will force some changes. For example, legislators in the USA will probably soon decide that chickens should be stunned before they are killed in processing plants, and they will make the appropriate modifications to the law. Changes will also occur because people in charge of animals will modify their attitudes about what is fair and reasonable. Thirdly, changes will occur when it is recognized that there is profit in taking good care of animals. The profit motive is a particularly effective way of bringing about change. Part of the profit motive for being fair to animals rests in the assumption that good welfare is good for meat quality. This book brings together the evidence that lies behind that assumption.

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List of Synonyms

The meat and livestock industry uses many jargon words, and these are apt to cause confusion. Quite often there is more than one word which means the same thing. For example, in many parts of the world a hogget would be the term used for a two-tooth sheep, but in some English-speaking regions it would be known as a teg, gimmer or chilver. The following list summarizes some of the synonyms which crop up in this book.

Auction market – saleyard

Blood splash – ecchymoses, petechial haemorrhages

Cardiac arrest stunning – stun-kill, head-to-back stunning, head-to-leg stunning

Counting-out pen – count-out pen, unloading pen, first holding pen

Electric goads – electric prods, hot shots

Electric stunner – electrolethaler

Exsanguination – sticking, neck cutting, killing, bleeding out

Forcing pens – crowding pens

Haulier – trucker, lorry driver

Humane killer – captive-bolt gun

Lairage – holding pens, stockyards

Mob – group, flock, herd

Mustering – gathering

Rig – cryptorchid, short-scrotum castrate

Slaughterhall – killing floor, slaughterboard

Slaughterhouse – abattoir, freezerworks, meatworks, processing plant

Tenderstretch – hip suspension

Truck – lorry, transporter

Weasand – oesophagus, gullet.

Chapter 1

Animal Welfare and the Meat Market

The novelist John Galsworthy once wrote:

Butchers and slaughtermen perform a necessary task from which most of us would shrink, and it is unbecoming and nonsensical to suggest intentional cruelty on their part. I do not for a moment. But I do say that it is the business of the law so to control the methods of slaughter as to obviate, as far as possible, needless suffering, however unintentionally it may be inflicted.

Many of us would probably agree with these sentiments, and we would go further in saying that there should be effective control and prevention of needless suffering in almost all aspects of animal handling and husbandry (Rollin, 1997). This is the basic reason for studying and for being concerned about animal welfare.

WHAT IS ANIMAL WELFARE?

Animal welfare is a concern for animal suffering and for animal satisfaction. Animal welfare science is the science of animal suffering and animal satisfaction. Neither suffering nor satisfaction can be measured directly, but the consequences of different causes of suffering and satisfaction can be compared in various ways. For example, animal welfare scientists have found that it is more stressful physiologically for a lamb to have its tail docked with a knife than with a rubber ring (Lester *et al.*, 1996), and that it is more satisfying for a sow confined in a stall or farrowing crate to have snout contact with a neighbouring sow than to be in total isolation. One way of evaluating different causes of suffering is to measure the animal's stress responses. A *stress response* is a physiological reaction in an animal to threatening or harmful situations. *Distress* is the emotional state that is created by the threatening or harmful situations. For example, distress would

include the fear that causes some animals to shake uncontrollably when confronted with the novel sounds and situations at an auction market or abattoir. *Suffering* is a less precise term. Humans suffer in many different ways, including sickness, anxiety, fear, emotional deprivation, and through cold, heat, physical discomfort, pain, extreme thirst or hunger. No doubt animals also experience these feelings, which in extreme situations cause suffering.

Some people adopt the view that society is largely to blame for animal suffering. 'We have stuffed it up' is a phrase I hear from students. However, not all forms of suffering are caused by humans. We have no control over the weather, although we may be in a position to try to protect animals from adverse weather. We do not have good control over all diseases, and these are a major cause of suffering in livestock. In many cases, where humans are to blame for suffering it has not been inflicted on purpose. Instead, it has occurred as a by-product of some other motive or aim. For example, it was inexperience by the broiler breeding companies that led to leg disorders and lameness in the modern broiler chicken; it was not intentional.

In practice there are four situations where humans have some responsibility for animal suffering, and these are known as the *Four I's*. They are:

- **Ignorance** – not knowing what to do.
- **Inexperience** – knowing what to do but not knowing how to do it.
- **Incompetence** – inability to do it.
- **Inconsideration** – not caring.

In cases of cruelty it is unwise to bring a cruelty charge against a first-time offender where the cause was ignorance, inexperience and incompetence. Education or guidance can help to avoid or correct ignorance and inexperience. Incompetence is more difficult to correct, and often there is a human tragedy behind the situation. For example, the person in charge of the animals may be unstable, taking drugs or misusing alcohol. If it was a repeated offence which involved ignorance, inexperience and incompetence, it is likely there is inconsideration as well, and the offender should have taken steps to avoid its recurrence. In this case it would be more appropriate to raise a charge. Inconsideration is more difficult to tolerate and prosecution is more appropriate, especially where there has been callousness.

There are three *reasons for being concerned about animal welfare*:

- respect for animals and a sense of fair play;
- poor welfare can lead to poor product quality;
- risk of loss of market share for products which acquire a poor welfare image.

The first reason is a moral one, and each of us will differ in our values and outlook. Some feel that animals are less important than themselves or other humans and so they warrant less concern. For example, a well known behaviour scientist once gave a talk on hen welfare to a group of farmers.

At the end of the presentation one perplexed farmer stood up and asked, 'Do you mean to tell me that you care about what a chicken thinks?' Others take the view that animals deserve rights and freedoms comparable to those of humans. Most of us, however, fall between these two attitudes.

Society has grown to accept that, to satisfy the world's appetite for meat, animals must be farmed intensively as well as extensively, but some hold strong views about how the animals should be kept. As a guide to moral standards many countries have adopted the *Five Freedoms*. These are a set of goals towards which animal owners and handlers should strive. They are:

- freedom from thirst, hunger and malnutrition;
- the provision of appropriate comfort and shelter;
- the prevention or rapid diagnosis and treatment of injury, disease or infestation with parasites;
- freedom from distress;
- the ability to display normal patterns of behaviour.

Some countries go so far as to include freedom from fear as a goal instead of freedom from distress. This, perhaps, overstates the goal, as fear is an everyday occurrence and one that is needed, for example, in mustering animals together. The suffering associated with disease is one of the worst animal welfare problems that exists today (Gregory, 1998), and in some countries climatic stress is a common welfare insult (Gregory, 1995b). In overall terms these two forms of suffering receive insufficient attention simply because they are not sensitive politically.

The Five Freedoms (or, more correctly, the *Five Needs*), for animals are based on our perception of what animals need. We know what it feels like when we experience hunger, thirst, fear, cold and pain and we project these feelings on to animals. We cannot claim to have a complete appreciation of what animals feel, and we can only infer feelings by interpreting the animals' behaviour and physiology. To be precise, we must apply a different set of definitions for humans from those for animals. Take thirst, for example. Thirst in a human is the sensation that accompanies dehydration. In animals, the definition that would satisfy most people would be the tendency to seek and consume water when unimpeded and whilst experiencing dehydration. Physiologists would clarify the situation by determining whether dehydration was present. This could be done by measuring the concentration of total protein in the plasma, the packed cell volume or the plasma osmolality. For humans, we refer to sensations; for animals, we are more cautious and refer to behavioural and physiological experiences.

Livestock breeders have a particular responsibility to animal welfare because their actions can lead to genetic antagonisms which can affect a sizeable proportion of the population. *Genetic antagonisms* occur when genetic selection for particular traits results in unwanted traits emerging in the progeny. This can occur either because the wanted trait is genetically

correlated to the unwanted trait, or because insufficient attention is paid to removing unwanted traits that inadvertently start increasing – for example, through line breeding. Some examples of genetic antagonisms involving meat production traits and animal welfare are:

- dystocia, conformation and body size in particular cattle breeds;
- exercise stress disorders and muscularity in double-muscled cattle;
- osteochondrosis and growth rate in pigs;
- stress-induced deaths and muscularity in particular pig breeds;
- PSE meat and muscularity in particular breeds or strains of pig and turkey;
- leg disorders, lameness, conformation and growth rate in poultry;
- green muscle disease and muscularity in turkeys and chickens;
- ascites and genetic selection for breast meat yield and growth rate in chickens.

Poor welfare can lead to inferior meat quality (Gregory, 1993). In the fresh meat trade it results in loss of yield and loss of sales through rejection or downgrading of poor quality product. The links between poor welfare and downgrading apply to the following conditions in the fresh meat or carcass:

- abnormal meat colour;
- pale soft exudative (PSE) meat in pork and turkey;
- dark firm dry (DFD) meat in pork, beef and lamb;
- poor shelf life;
- dry meat;
- heat shortening in poultry;
- bruising;
- torn skin;
- broken bones.

In some situations poor welfare may also aggravate problems with:

- gaping in meat;
- boar taint.

It would be inaccurate to say that poor welfare always leads to poor meat quality. There are many instances where there is no effect at all. For example, cold stress during transport before slaughter does not usually have any detrimental effect on meat quality or yield. In some situations stress can even improve some quality features; for example, physical exhaustion before slaughter can make the meat more tender. However, animal welfare is in itself becoming a quality issue because some retailers are imposing animal welfare standards in their specifications for suppliers. The retailers want to have a *caring image* – for animals and for the company's customers. Some of the major supermarket companies are setting standards on animal welfare within the market. The specifications on welfare and product quality

are taken seriously by the meatworks which supply them because they need to secure the supermarkets' business.

Market forces created by the meat processing industry can also have a bearing on animal welfare. The industry is one of the major users of meat that is downgraded because of minor blemishes created by poor handling or stress. Sometimes there is a good market for meat from animals that have been ill-treated. For example, there is a well-established market for high pH_{ult} beef as hamburgers. This type of meat is unsuitable for the fresh meat trade because of its objectionable dark colour, but it is accepted by the processing sector because of its high water-holding capacity. With poultry there may be little difference in value in using a carcass for processed meat production in comparison with selling it as a whole bird. So, if the carcass is unfit for presentation as a whole bird because of an ante-mortem tear in the skin, the value of the carcass can often be maintained by sending it for further processing.

The meat quality features that are most important depend on the way in which the meat is used. For instance, a bone fragment (arising from a broken bone) might be disregarded in a whole chicken, but if it was present in a manufactured take-away product it could lead to a consumer complaint. Bruising and abnormal meat colour are important in the fresh meat trade, but less important in the ground meat trades. Hock burn in poultry is a serious appearance defect in the whole-bird market, but it is of little concern in the boneless meat market because it is trimmed out. Some meat processors run separate standards in their processing and quality control for different customers, but not all plants are sufficiently organized to know the destination of a batch of animals at the time they are slaughtered or when the carcasses are graded. In that situation a high standard in overall quality control has to be aimed for, or the plant has to concentrate on supplying a limited number of specialized outlets.

From the meat processor's and consumer's perspective, further processing fulfils seven functions:

- **Convenience** – ready-to-eat products, fast foods.
- **Preservation** – extending the storage life of meat.
- **Providing alternative products** – bacon or ham instead of fresh pork.
- **Adding value** – coated meat products, re-formed meats.
- **Upgrading low value meats** – buffalo wings, hamburgers manufactured from dark-cutting beef.
- **Spreads seasonal glut over the year** – salted meats, dried meats.
- **Allows distribution of meat over longer distances** – low water-activity meats.

It must be emphasized that only a small proportion of the total amount of meat that goes for further processing has in fact been downgraded because of a welfare-associated product quality problem.

Animal welfare is becoming more important in the *international trading*

of meat (Gregory, 1995c). Meat-exporting nations depend on agricultural produce for their livelihood. If sentiment goes against a country because it has unacceptable welfare, hygiene, environmental or sociopolitical standards, meat buyers may take their custom elsewhere. Consider the following example. Suppose that Country X exports beef to Country Y. There is a television programme broadcast in Country Y which shows hot-iron branding, and farmers in Country X are identified with this practice. The animal welfare pressure groups use the opportunity to lobby the public to stop buying beef from Country X. A sector of the public responds, but more importantly the supermarkets in Country Y decide to stop sourcing beef from Country X because of its tarnished image. The market forces that set this off originated with the animal welfare pressure group. Animal welfare pressure groups try to influence purchasing behaviour through their publicity. This may or may not have much effect on the way consumers spend their money, but it can influence the purchasing patterns of the major retail companies which try to promote the image of a reputable and caring business.

Animal welfare has not been used as an official barrier to trade between countries. This is because there are no provisions under the World Trade Organization (WTO) agreements for an animal welfare issue to become an acceptable technical barrier which one government could use as a reason for disallowing importations from another country. If a country did adopt an animal welfare issue as a technical barrier for trade, the matter could be taken before the WTO for arbitration. However, some EU meat-importing countries have argued strongly that transport duration for livestock should be limited by EU regulations to eight hours, whereas some of the meat-exporting countries have argued that there should be no limit on journey time. This is an example where an animal welfare issue could become a barrier to trade, assuming that a mutual agreement was reached. In practice, it is pressure from retailers, animal welfare pressure groups and consumers that is likely to have more influence on market positioning in animal welfare issues.

From the public's perspective the two least acceptable features of modern farming practice are close confinement of animals with limited ability to exercise, and mutilations without anaesthesia. These practices raise three recurring questions. Are they fair? Are they necessary? Are there alternatives? *Close confinement systems* which inevitably limit movement and exercise include:

- farrowing crates;
- dry sow stalls;
- sow tethers;
- battery hen cages;
- veal calf crates;
- rabbit, mink and quail cages.

Mutilations are procedures that involve removing or damaging part of an animal's body as a routine husbandry procedure. Many of them are done

without anaesthetic. Working from the front of the animal and moving backwards, they include:

- nose ringing;
- beak trimming;
- teeth clipping;
- antler removal;
- disbudding;
- dehorning;
- dubbing;
- desnooding;
- ear notching;
- wing and feather clipping;
- branding;
- pizzle dropping;
- mulesing;
- tailing;
- castration;
- toe clipping.

Disbudding, dehorning, toe clipping and turkey beak trimming are done to reduce the risk of damage to the animals and hence the final product. Castration is performed in pigs to ensure that the meat does not possess undesirable taints. Other procedures are done to prevent animals escaping (wing clipping); as a means of identifying animals (dubbing, desnooding, ear notching, branding); to reduce the risk of parasitism, body damage and disease (teeth clipping, pizzle dropping, mulesing, tailing); as a way of collecting a product (antler removal); or as a way of controlling damage to pasture (nose ringing and toe clipping). In the future there will probably be more pressure on farmers to move away from methods which involve close confinement and to farm without mutilations.

CHANGING PATTERNS IN MEAT CONSUMPTION

Over the past 25 years the world consumption of meat has been rising. The largest increases have been in countries where the standard of living has been improving. However, in many industrialized countries where the standard of living and economy have been stable, the consumption of red meats has been declining, whilst that of poultry meat has been increasing. For example, in the USA, Canada, Australia, New Zealand and the UK, beef consumption per capita has reduced by 24%, sheepmeat consumption has fallen dramatically by 45% and poultry meat consumption has increased by 96%. Pigmear consumption has not changed. In summary, the English-speaking countries in the world are in an era of reduced redmeat consumption and increased whitemeat consumption.

In order to understand the *reasons for reduced redmeat consumption* it is helpful to examine the attitudes and beliefs that vegetarians and semi-vegetarians have about meat (Gregory, 1997). Semi-vegetarians are people who eat some kind of meat but only on an occasional basis (e.g. once or twice a month), and they usually avoid red meats. Vegetarians do not eat any meat. In the UK during the 1980s and 1990s, between 2 and 5% of the population were vegetarian, and about 15% of the adult population are now semi-vegetarian. In Australia, 16% of adolescents (16-year-olds) are semi-vegetarian. Vegetarians represent only a small section of the meat-reducing public, but by studying their attitudes and those of semi-vegetarians we can identify more easily the key features which lead to more generalized reduced redmeat consumption. In addition, examining the attitudes and beliefs of young vegetarians and young semi-vegetarians is helpful in deciding whether consumption of red meats is likely to carry on decreasing in the next generation.

A familiar theme throughout human history is that things which are highly prized by some individuals are thought to be highly defiling by others. This applies in the case of the different meats we eat. Red meats, and in particular beef, have the highest status for meat eaters, and yet they are the ones which are first avoided by semi-vegetarians.

If one asked a vegetarian or semi-vegetarian what images they associated with meat or meat eating, the likely answer would be:

- animality;
- animal cruelty;
- depriving animals of the right to life;
- the consumption of dead flesh.

Many vegetarians believe that humans behave like animals when they eat animal flesh. It increases animality in humans. Along with this, meat eaters are thought to be more aggressive and they acquire animality through that particular food.

The full vegetarian is a morally motivated individual whose primary concern about meat eating is cruelty in modern farming systems and ethical concerns about animal slaughter. They see the health gains of being vegetarian as a bonus. There is a sense that the health gains are a symbolic reward for moral rectitude. Modern *semi-vegetarianism* is a diluted form of vegetarianism. The semi-vegetarian is also morally charged. In fact the primary concern amongst Australian semi-vegetarian women about eating meat is animal cruelty (Table 1.1). The negative sensory features of meat are an important additional deterrent, and about one-third of teenage semi-vegetarian and vegetarian women were reduced meat eaters principally because they thought that meat was fattening. It might be thought that the present trend toward reduced meat eating reflects a desire to live a long and healthy life. However, the evidence suggests that only 19% of full and semi-vegetarian adolescent women viewed meat eating as unhealthy, and this outlook existed in only 3% of non-vegetarians.

Table 1.1. Main concerns about eating meat amongst Australian adolescent women who were either vegetarian or non-vegetarian. (From Worsley and Skrzypiec, 1997.)

	Proportion of individuals (%)	
	Full and semi-vegetarian	Non-vegetarian
Animal cruelty	61	37
Sensory (bloody, smell, etc.)	44	5
Red meat is fattening	30	13
Meat is harmful to the environment	25	13
Meat eating is unhealthy	19	3

Most modern vegetarians and semi-vegetarians share the outlook that humans, as individuals, are not innately cruel to animals or disrespectful of the environment, but cultural values have forced society towards being cruel and wasteful. To some vegetarians and semi-vegetarians, applying logic in resolving such problems is less important than feeling at peace with the world and fellow creatures. For example, by denying themselves the right to eat animals they do not stop animal slaughter but they do quell any personal anxieties about being responsible for an animal's death. The mind and conscience are eased. Perhaps many of us are closer to this outlook than we realize. For example, when a large sample of meat eaters in the United Kingdom was confronted with the hypothetical prospect of having to kill animals themselves in order to eat them, the majority said that they would cease eating meat altogether (Richardson *et al.*, 1993).

Beardsworth and Keil (1992) held detailed interviews with 76 self-defined vegetarians in the United Kingdom, and some of the comments were revealing. In connection with animal welfare, one interviewee made the following point:

I've always been fond of animals and when you reach the age where it is blatantly obvious that meat is animals, I didn't want any more to do with it.

Another interviewee changed abruptly to vegetarianism after seeing a television programme, which:

showed them electrocuting pigs and I sat down in the canteen at work the very next day, and everybody was saying how awful this programme was, and they were all tucking into bacon cobs. I'd bought one of these cobs as well and I took one bite of it and it tasted awful and I thought, well if that pig's gone through all that for me ... and I've never touched it since. That was five years ago.

There are pronounced cultural differences in attitudes to animals and animal welfare. Kellert (1988) classified the attitudes people have towards animals into nine categories:

1. **Naturalistic** – an interest and affection for animals and the outdoors.
2. **Ecologicistic** – concern for the environment as a system, for interrelationships between species and their habitat.
3. **Humanistic** – interest and strong affection for individual animals such as pets or large wild animals, with strong anthropomorphic associations.
4. **Moralistic** – concern for the right and wrong treatment of animals, with opposition to presumed over-exploitation and/or cruelty towards animals.
5. **Scientific** – interest in the form and functioning of animals.
6. **Aesthetic** – interest in the physical attractiveness and symbolic appeal of animals.
7. **Utilitarian** – interest in the practical value of animals, or in subordination of animals for some practical benefit.
8. **Dominionistic** – interest in mastery and control of animals.
9. **Negative** – avoidance of animals due to indifference, dislike or fear.

Moral attitudes would equate most closely to concerns about livestock welfare, but animal welfare would also feature to some extent in humanistic attitudes towards companion animals. In a comparison of Japanese, Germans and US Americans it was found that the moralistic attitude was very strongly developed amongst the Germans (Fig. 1.1). The Japanese had a well-developed humanistic outlook and Americans varied according to the part of the country in which they were raised (Kellert, 1993).

In Australia, up to a third of teenage women experience difficulties in divorcing the image of the living animal and its production and slaughter from meat. Approximately half of the female interviewees said that they felt rearing animals to be killed was either 'cruel' or 'wrong'. In the same survey, it was reported that about one-third of the teenage women were in some way vegetarian, but only 21% of the women looked upon themselves as being vegetarian or semi-vegetarian. This indicates that either they did not like or wish to label themselves as vegetarian or that they took their abstention from meat consumption for granted without recognizing that it was synonymous with vegetarianism. Only 26% of all teenage females in the survey agreed with the statement: 'I think meat production is done humanely.' The majority of teenage Australian males had a different outlook: only 6% were semi-vegetarian and 65% agreed that they were not bothered that meat comes from animals. Their appreciation of eating meat was stronger than concerns about welfare. Nevertheless, fewer than half (46%) of all the teenage males agreed with the statement: 'I think meat production is done humanely' (Worsley and Skrzypiec, 1997).

The reduced meat eater would typically progress towards vegetarianism by giving up first red meats, then poultry and finally fish. The species of origin, the appearance of blood and the redness of the meat are thought to be key features which create this hierarchy (Twigg, 1979). An important issue for the pigmeat and veal industries is where their products fit within the hierarchy of meats. Are they white meats, in which case they may be

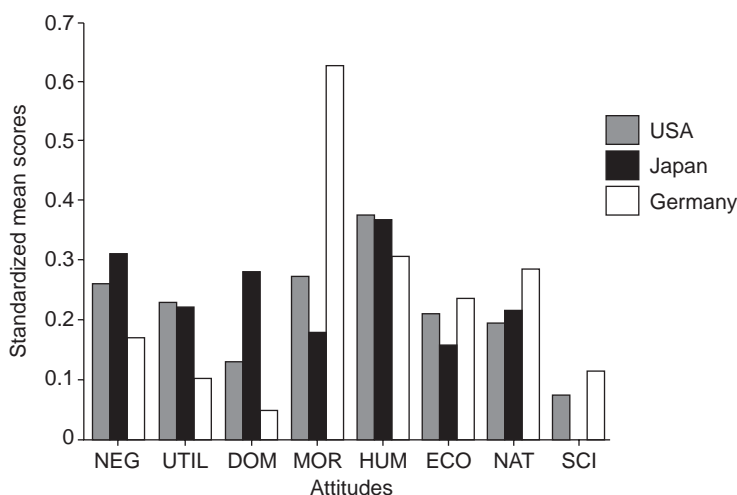


Fig. 1.1. Different cultures have different attitudes towards animals. NEG = negative; UTIL = utilitarian; DOM = dominionistic; MOR = moralistic; HUM = humanistic; ECO = ecologicistic; NAT = naturalistic; SCI = scientific.

acceptable to semi-vegetarians, or are they regarded as redmeats and so are likely to be rejected? Alternatively, do they share the live-animal images of beef and lamb as distinct from chicken and fish, in which case they would be avoided along with beef and lamb? A survey of Australian adolescents conducted by Worsley and Skrzypiec (1997) indicated that pork and veal are in fact ranked along with red meats (Table 1.2).

The vegetarian's outlook about vegetarian eating conjures up a different set of symbolic images:

- purity of lifestyle;
- healthiness;
- femininism;
- crispness;
- freshness;
- light eating.

The images of crispness, freshness and light eating fit well with heightened awareness about youthfulness and one's body shape. All these images help to influence an individual's attitudes and beliefs, which in turn helps to decide whether he or she is a meat eater.

Surprisingly, some vegetarians have a nostalgia and a craving for particular meats and especially for the taste and smell of bacon. Others find most cooked meats repulsive to the extent of causing nausea. Some people find preparing and cooking meat particularly offensive. The stickiness of

Table 1.2. Hierarchy of meats amongst 16-year-old Australian semi-vegetarians. (Adapted from Worsley and Skrzypiec, 1997.)

Meat	Number of semi-vegetarians who eat the respective meat for every meat eater who consumes the same meat
Beef sausages	0.41
Pork	0.43
Crumbed veal	0.46
Lamb	0.46
Steak	0.47
Bacon	0.47
Roast beef/veal	0.51
Casserole (not chicken)	0.55
Mince meat	0.56
Cold meats	0.65
Processed meats*	0.67
Chicken	0.82
Fish	1.05

* Sausage rolls, pies, hamburgers.

raw meat and the elasticity of meat when it is chewed can be objectionable. Notwithstanding this, the main reason people eat meat is because they enjoy it. It may be an acquired or habit-based enjoyment as other people live quite comfortably without it. For some, the taste of meat helps to reinforce that enjoyment and this is one of the main reasons why would-be vegetarians resist becoming vegetarian.

The meat and livestock industries have little to gain from trying to convert full vegetarians back to an omnivorous diet. Instead, they need to address the concerns that lead to reduced meat eating in would-be semi-vegetarians. Since animal welfare is one of the most important issues leading to semi-vegetarianism (Table 1.1), the contents of this book are pertinent to the long-term future of the industry.

It is not easy to know how the ethics of animal slaughter for meat consumption should be approached. Some take the view that in the long term it may be counterproductive to try to divorce meat from the living animal as this could create a greater reaction amongst adolescents and adults against meat eating when they realize where meat comes from. Others take the view that most meat eaters do not want to know where their meat comes from and there is a risk that frankness about animal slaughter may put them off altogether. A balance between these two would be to introduce society at an early age to the notion that we eat animals and that this is a normal activity. As such the image of meat eating needs to be promoted in a positive light, showing that it is part of the vital nutrition for normal, active, healthy people of both sexes.

It is worth asking how animal welfare problems have arisen in the first place. In some respects the meat and livestock industry has been a victim of its own efficiency. During the first 70 years of the 20th century the emphasis in farming was towards greater efficiency in terms of return for capital invested. This was achieved by increasing feed conversion efficiency, stocking density, growth rate through genetic selection, and reproductive performance. In some situations this striving for economic and biological efficiency has out-competed the welfare of the animal. Examples include:

- expansion in farm size leading to difficulties in handling stock because less time is spent familiarizing the stock with the handling procedures;
- overstocking livestock buildings, leading to respiratory disease, excessive dust and ammonia, and hockburn in poultry;
- genetic selection for growth rate, resulting in leg disorders in broiler chickens and pigs;
- confinement in dry sow stalls and stereotypic behaviours;
- insufficient space inside the abdomen, leading to diarrhoea in dairy cows, prolapses in broiler breeder hens and prolapses in twin-bearing ewes;
- inappropriate use of bulls from breeds of large mature size, and dystocia in heifers and cows.

It should not be overlooked that there have been many improvements in animal welfare standards during the 20th century. These include:

- more prescriptive legislation on animal welfare and cruelty;
- more effective prevention and control of infectious diseases;
- better understanding of how to avoid malnutrition and undernutrition;
- fewer male animals being castrated;
- better methods and standards in stunning and slaughtering in meat-works;
- in some countries, the abolition of some less humane practices and systems (e.g. sweatbox piggeries, tethered sow stalls, veal calf crates, hot-iron branding, surgical caponizing).

The methods used for slaughtering livestock species such as cattle, sheep and pigs have improved considerably in recent years. Unfortunately this does not apply to all farmed species. For example, a common method for slaughtering farmed frogs has been to chill the live animal and then cut off the hindlegs, which are the edible part, with a large pair of shears. On some frog farms, the live frogs are held in iced water containing 200 ppm chlorine before pithing with a spike in the head, and the chlorine at this concentration would undoubtedly have an irritant action before loss of consciousness.

There is a perception amongst some consumers that a product produced under natural or free-range conditions is inevitably better to eat. I was once told that 'a free-range hen is bound to produce tastier eggs because it has a happy life'. To biologists, the basis for this statement is not

immediately obvious. Is there a link between happiness in hens and flavour in their eggs and, if so, why? This book gives a scientific view of the possible relationships between welfare and meat quality.