ABSTRACT
People feel that they have obligations to the animals that they use and show some degree of care behavior toward them. In addition, animal welfare is an aspect of our decisions about whether animal-usage systems are sustainable. A system that results in poor welfare is unsustainable because it is unacceptable to many people. The quality of animal products is now judged in relation to the ethics of production, including impact on the animal’s welfare on immediate features and on consequences for consumers. Because genetic selection and management for high productivity may lead to more disease and other aspects of poor welfare, consumers demand some major changes in animal-production systems. In teaching animal welfare, a clear definition that can be related to other concepts such as needs, health, and stress is needed. The methodology for the scientific assessment of animal welfare has developed rapidly in recent years and has become a major scientific discipline. No veterinary degree course should be approved unless a full course on the science of animal welfare and relevant aspects of ethics and law have been taught. Each country should have a national advisory committee on animal-welfare science, made up of independent scientists, including veterinarians, who can write impartial reviews of the state of scientific knowledge.

Key words: animal usage, sustainability, product quality, animal welfare, veterinary teaching, national committee

THE MORAL BASIS OF ANIMAL USAGE
Humans, and other animals living in social groups throughout much of their lives, will compete with one another, but most of their interactions will involve tolerance of others, avoiding harming them, or cooperating with them. If this were not so, social groups would not be stable. As a result of natural selection, moral systems have evolved in humans and other species.1–5 People consider that they have obligations to other people and to other animals that they use. As a consequence, they show care behavior toward individuals. Although the care is most likely to be shown to the people and animals most frequently encountered, it is addressed to all to some degree. It is widely accepted that each person has a duty of care toward individuals. Although the care is most likely to be shown to the people and animals most frequently encountered, it is addressed to all to some degree. It is widely accepted that each person has a duty of care toward the animals they keep, whether used as companions, sources of food, means of transport, subjects of experimental studies, or for other purposes. The concern here is the welfare of the living animal. A different ethical concern is whether animals should be killed.

SUSTAINABILITY
Although in some difficult situations, people may think in a short-term way, when decisions are made about whether a system for exploiting resources should be used, a central question is whether the system is sustainable. A system or procedure is sustainable if it is acceptable now and if its effects will be acceptable in the future, particularly in relation to resource availability, consequences of functioning, and morality of action.6,7 There are several possible reasons why a system, for example an animal usage system, might not be sustainable. It could involve so much depletion of a resource that this resource will become unavailable to the system. A product of the system could accumulate to a degree that prevents the functioning of the system. However, in each of these cases, and in the case of some other aspects of systems, the earliest effect that renders the system unsustainable is one that impinges on the general public’s values in a way that the members of the public find unacceptable. Where there is depletion of a resource or accumulation of a product, the level at which this is unacceptable, and hence the point at which the system is unsustainable, is usually considerably lower than that at which the production system itself fails. Unacceptability is often the result of effects on other systems.

A system could be unsustainable because of one of the various harms that result (Table 1). There might be harm to the perpetrator, to other humans, or to the environment of present or future humans. There might also be harms to other animals. No system or procedure is sustainable if a substantial proportion of people find aspects of it now, or of its consequences in the future, morally unacceptable. The people referred to here are the public everywhere. They may be in a local community, in a nation, or in the world as a whole. Hence, each of the examples in Table 2 is unsustainable.

The consequences of unacceptable practices in manufacturing, animal production, or other human activities have become more wide ranging in the world because of increased efficiency of communication. Adverse effects on people or animals can be reported by the media around the world. Examples of events in this category that led to headline news in world newspapers and television include people poisoned by insecticide in China,
The pollution of a river by manure in Thailand, people catching new-variant Creutzfeldt-Jakob disease by eating beef in the United Kingdom, sheep on an Australian ship dying in large numbers en route to Saudi Arabia, slaughterhouse cruelty and consumer health risk from slaughtered sick cattle in the United States, and chickens killed by inhumane methods during avian influenza control in Indonesia.

As a result of media reports of activities or events that the public find unacceptable, consumers in many countries may refuse to buy animal and other products from the companies or countries involved. There are now many examples of events that led to consumers refusing to buy products. The sales of tuna dropped sharply when it became known that dolphins were being killed in the nets set for tuna. This effect was long term and resulted in a permanent change in fishing practices. In the United Kingdom, reporting of the poor welfare of calves kept in small crates for veal production in France resulted in a drop in the sales of all French products, including unrelated products such as wine. For most consumers, this was temporary, but for some it continued until the introduction of European Union legislation banning the production of veal using crate housing and low-iron and -fiber diets. The deaths of the sheep on the ship to Saudi Arabia caused a temporary drop in sales of Australian products. Individual retail food companies have been affected, for some consumers permanently, by reports of rainforest destruction for beef production, very low payments to poor coffee farmers in third-world countries, and cruelty to poultry by suppliers. A few people respond to information about poor welfare in animals by becoming vegetarian, but a much larger number make some changes to their food-purchasing practices.

Consumers drive legislation and retail company codes of practice for animal production. Legislation on animal welfare has developed in the European Union and in many countries because of pressure from voters. The codes of practice of food companies often have international impact. For example, pig producers in Brazil have to comply with the animal-welfare standards of UK markets, and egg producers in Thailand have to rear their birds according to the standards of US markets.

FOOD AND OTHER PRODUCT QUALITY

The concept of the quality of goods that people buy has been changing in recent years. At one time, quality referred only to immediately observable aspects. For an animal food product, this might be its visual qualities and taste, which continue to be important. Expectations about taste are tending to become more refined, but other factors are now being incorporated into what constitutes good quality. First, more of the consequences of consumption are now considered. If a food causes people to become sick, quality is considered to be poor. For some consumers, if a food makes them more likely to become fat, quality is considered to be poor. For others, if food has added nutrients, quality is considered to be better. Second, the ethics of the production method are taken into account. Factors considered by purchasers include (a) the welfare of the animals used in production; (b) any impact on the environment, including conservation of wildlife; (c) ensuring a fair payment for producers, especially in poor countries; and (d) the preservation of rural communities so that the people who live there do not move to towns.

Consumers of food demand that it be safe, that is, without damaging levels of toxins or pathogens. Although individual food production companies are expected to be responsible for this aspect of food quality, the public also expects the government to ensure that adequate standards and adequate checking systems exist. To achieve this in the European Union (EU), the European Food Safety Authority (EFSA) has been set up. Part of the work of the scientists who sit on its panels and working groups is the assessment of risks and benefits. All of these scientists are appointed because of their scientific expertise; they do not represent countries or interest groups. The subject area covered by EFSA is wide, reflecting the public’s concern. One panel deals with animal disease and animal welfare. The EU member states, like the United States, have extensive checking schemes for animals before and after slaughter as well as for other food products.

To take account of the ethics of the production method, products must be traceable. If foods can be traced, it is less likely that they will contain toxins, other poor-quality materials, or pathogens.

If animals can be traced, the sources of animal-disease outbreaks are more likely to be found and places where injuries, or other causes of poor welfare, occurred are more likely to be located. Legislation and industry initiatives ensuring traceability are important.

SUSTAINABILITY AND QUALITY TOPICS

Consumers purchasing animal products and evaluating what is sustainable and what has good product quality consider topics such as human health; human diet; acceptability of genetic modification; animal welfare; environmental effects such as pollution, conservation, and carbon footprint; efficient use of world food resources;
fair trade, that is, considering poor producers; and preserving rural communities. These factors are considered briefly here, with the exception of animal welfare, which is considered in more detail in the following section.

Some examples of human health issues that affect views of product quality are salmonella in eggs and meat, Campylobacter in chicken carcasses, avian influenza (H5N1 or H1N1), and bovine spongiform encephalopathy in beef products. One consequence has been the development of the risk assessment approach.

Concern about human diet has large effects on animal production. In particular, saturated fats increase risks of heart disease, and farm livestock are a major source of saturated fats. As a consequence, fish production is increasing rapidly. The production of fish that consume vegetable matter, rather than of predators like salmonids, which have to be fed mainly fish products, is likely to increase the most. Farmed fish production is already larger than open-water fish production and will overtake it in weight of fish within a few years.

Genetically modified plants are not accepted in some countries because of ethical concerns, the issue being modification of living things in the laboratory as opposed to genetic changes that occur naturally. There is also concern because protein changes can cause allergies. Genetic modifications in animals can benefit the animals (e.g., confer disease resistance), help to treat human disease (e.g., a blood clotting factor in a sheep’s milk), develop new products for other purposes, or increase efficiency of animal production. Some people accept none of these modifications, and many people do not accept the last two as sufficient justification for genetic modification. A big reason for this is that, in some cases, animal welfare may be poorer as a result of the modification. Many people have concluded that any production of genetically modified animals should occur only if it has been demonstrated by scientific studies that the welfare of the animals is not poorer than that of unmodified animals as a consequence.

One major reason why animal production systems may be regarded by the public as unacceptable, and hence become unsustainable without some modification, is the welfare of the animals used in the production system. For example, members of the European Parliament receive more letters about animal welfare than about any other subject. However, substantial variation exists within and between countries in the degree of public concern, and most people think about animal-welfare issues infrequently unless their attention is drawn to it by media exposés. There is a point at which the welfare of the animals becomes so poor that most of the public may consider the system to be unacceptable. Hence, animal welfare and public attitudes toward it must be considered wherever the sustainability of an animal production system is evaluated.

Agriculture generally reduces biodiversity. Where wild or semi-wild areas are cleared for animal production, substantial harm can be done to populations of animals and plants. Hence, some animal production is not considered acceptable, and people do not buy these products because these harms have been done. In most countries, the public demands the creation of significant areas of nature reserve, and preservation of wildlife can sometimes result in greater income through eco-tourism than would have been possible by farming. The purchase of land to conserve natural resources can often stimulate local economies and lead to a sense of regional pride that would not have existed if low-level animal production had continued. A further example of a possible...
The adverse impact of animal production on conservation is the inappropriate use of antimicrobials and other medicines. The population of several species of vultures in India has declined by 96.8% to 99.9% in the past 15 years as a consequence of poisoning by the painkiller Diclofenac, and the Indian government has recently banned its use.\textsuperscript{13}

Another cause of unsustainability is mismanagement of resources and effluents that can result in contamination of water supplies, loss of plant nutrients, greenhouse gas production, and increased human disease. The animal producer should pay any costs of pollution, and, wherever possible, animal waste should be efficiently recycled.

Many regard the inefficient use of world food resources as unsustainable. What can be done to change animal-production activities so as to better exploit existing resources? One important use of animals for food production is that some can eat food that humans cannot. In this regard, raising grazers will often be more advantageous than raising pigs or poultry because the latter may compete with humans for food. Great energy loss results when people eat animals that consume food that they could have eaten. Greenhouse gas production is also affected because carbon dioxide and other greenhouse gases are emitted in the course of production of animals such as poultry and pigs, for example because of the combustion of materials in the course of food production and the transport of food and animals. This advantage of using grazers can be weighed against any adverse consequences of methane production by ruminants.

Animal agriculture is associated with many traditions and ways of life for people. Many human communities exist as they do as a consequence of particular animal production systems. If that production system is changed so that the number of farms is greatly reduced in the original areas, or the whole production system is moved away from those areas, social and environmental consequences result. The destruction of rural communities is thus another factor that is taken into account by those considering whether animal production systems are sustainable. Within the European Union, for example, a central aim of the Common Agricultural Policy was to preserve rural communities and to reduce the number of people who leave country areas and move to large cities, thus increasing the cities’ size. That policy has been successful in minimizing such movement, and some US government agricultural policies have also had this effect. In many other countries, in contrast, cities have become much bigger, and rural communities have declined or disappeared. Similar destruction of rural communities has occurred when the number of people employed on farms has been drastically reduced by their replacement with machinery, often resulting in high energy consumption. When all of the costs of agriculture related to the welfare of agricultural animals, energy usage, conservation, natural environments, and human consumers and agricultural workers, rural communities, and so forth are properly evaluated, major changes will ensue. Sustainable agriculture is the only way forward.

\section*{TEACHING ANIMAL WELFARE}

\textit{Welfare} is a term that refers to animals, including man. It requires strict definition if it is to be used effectively and consistently. A clearly defined concept of welfare is needed for use in precise scientific measurements, in legal documents, and in public statements or discussion. If animal welfare is to be compared in different situations or evaluated in a specific situation, it must be assessed in an objective way. \textit{Welfare} refers to a characteristic of the individual animal rather than something given to the animal by man. The welfare of an individual is defined as its state as regards its attempts to cope with its environment.\textsuperscript{14} This definition refers to a characteristic of the individual at the time, that is, how well it is faring.\textsuperscript{15,16} The concept refers to the state of the individual on a scale ranging from very good to very poor. Welfare is a measurable state, and any measurement should be independent of ethical considerations. When considering how to assess an individual’s welfare, it is necessary to start with knowledge of the animal’s biology and all of its needs. An animal’s feelings are an extremely important part of its welfare.\textsuperscript{17–20} They are adaptive aspects of an individual’s biology that must have evolved to help in survival just as aspects of anatomy, physiology, and behavior have evolved. In the fastest acting urgent coping responses, such as avoidance of a predator attack or the risk of immediate injury, fear and pain play an important role. In longer time-scale coping procedures, where various risks to the fitness of the individual are involved, positive and negative feelings and other brain processes that involve no affect are among the causal factors determining what decisions are made. In attempts to deal with very long-term problems that may harm the individual, aspects of suffering contribute significantly to how it tries to cope. In the organization of behavior so as to achieve important objectives, pleasurable feelings and the expectation that these will occur have a substantial influence.

It is important to be aware that needs have a biological basis, but this does not mean that degree of naturalness is a part of the definition of welfare. Some events that occur in nature, such as starvation or predation, result in very poor welfare. The needs of individuals will vary according to genotype and will be affected by conditions during development. \textit{Health} is that part of the individual’s state that has to do with pathology and attempts to cope with it. It refers to body systems, including those in the brain, that combat pathogens, tissue damage, or physiological disorder. All of this is encompassed within the broader term \textit{welfare}, so health is an important part of welfare, not separate from it.

The word \textit{stress} should be used for that part of poor welfare that involves failure to cope; for example, the common public use of the word refers to a deleterious effect on an individual.\textsuperscript{19} A definition of \textit{stress} as just a stimulation that could be beneficial (e.g., eustress) or as just an event that elicits adrenal cortex activity is of no scientific or practical value. One indicator of adversity is whether there is an effect on biological fitness. \textit{Stress} can be defined as an environmental effect on an individual...
that overtaxes its control systems and reduces its fitness or seems likely to do so.\textsuperscript{16,21} Using this definition, the relationship between stress and welfare is very clear. First, although welfare refers to a range in the state of the animal from very good to very poor, whenever there is stress, welfare is poor. Second, stress refers only to situations in which there is failure to cope, but poor welfare refers to the state of the animal both when there is failure to cope and when it is having difficulty coping.

There has been rapid refinement of concepts in animal-welfare science and development of a wide range of sophisticated measurements of welfare. The education of veterinary, animal science, and biology students has not kept pace with these developments, so there is an urgent need for animal-welfare courses to be designed and taught in universities. Professionals such as veterinarians also need continuing veterinary education courses in animal welfare.

Animal welfare should be taught to veterinary and animal-science students in a separate course because, first, the scientific subject is interdisciplinary so integrated lectures are needed; second, students need guidance on the interrelations of the ethics and the science, for example to understand deontological and utilitarian approaches; and, third, because it is necessary to separate scientific evaluation from ethical judgment because animal welfare science is not an evaluative discipline.

What is the best sequence for animal-welfare courses? Most well-structured courses on animal welfare include:\textsuperscript{22,23}

1. An early introduction to some of the problems—year 1, first term.
2. Basic science courses, including sensory, adrenal, brain function, behavior, immune system function, pathology, animal husbandry systems, and the concept of sentience.
3. An animal-welfare course including
   - concepts
   - ethics
   - scientific assessment—the wide range of physiological, behavioral, and other measures of welfare including pain, fear, and other positive and negative feelings referring to a range of animals, wild and domestic
   - integration of measures, long and short term, magnitude of good or poor welfare
   - species housing, handling, transport, disease, mutilations, slaughter topics
   - effects of genetic selection or human contact
   - possibilities for practical monitoring on farm or otherwise in situ.
4. Legal and social aspects, animal welfare in relation to sustainability and ideas of product quality.

NATIONAL ANIMAL-WELFARE SCIENCE COMMITTEE
Key areas of animal management that affect animal welfare are the genetic selection of animals, housing and management, transport and handling, stunning and slaughter, and mutilations or operations carried out on the animals. One consequence of heightened sensitivity to animal well-being is that producers, consumers, and government agencies are requesting scientific information about animal welfare.

In the United States, the rapidity with which various segments of the animal-use industries have moved to address related issues has varied considerably. For example, within the food industry, retailers have been quicker to react than producers, in large part because of consumer pressure that has a direct impact (or potential impact) on their business. Producer organizations have sometimes just asserted that there is no animal-welfare problem in their industry with the consequence that many disbelieving consumers are alienated. Useful standards have been set, but the disparities in those standards are significant. The animal-protection societies have sometimes done a good job in trying to obtain and share information. In making videos of real events, they have raised appropriate questions and have aggressively sought answers. However, some of their activities have been more effective at slingling mud than creating constructive dialogue. The government (US Department of Agriculture) provides a good source of information and has promoted a small amount of good-quality research. It is important that any scientific study of animal welfare be carried out in an unbiased way and published whatever its results. The research must be conducted independently of industry and of animal-protection societies. No sponsor of research should ever be able to suppress the results because they are not in line with policy or economic interest. No animal-welfare scientist should ever accept money for research if the sponsor could prevent publication.

One way to address the need for independent scientific review is to appoint a national animal-welfare committee made up of an impartial group of scientists, including veterinarians, who can provide unbiased information. Such committees can have a role in guiding legislation and in checking on codes of practice. An important role for a national organization that standardizes veterinary education is to encourage the teaching of animal-welfare science and ethics in veterinary schools, such as the animal-welfare policy espoused by the American Veterinary Medical Association (www.avma.org/issues/animal_welfare/default.asp). In Europe, no veterinary degree can be awarded unless animal-welfare science is taught in the course. In my opinion, this subject area should be part of the validation of veterinary courses in every country. Animal-welfare courses should also be required for animal-science degrees and animal-health technology.

CONCLUSIONS AND RECOMMENDATIONS
In relation to animal production throughout the world, consumers will increasingly demand the avoidance of adverse effects on human welfare, animal welfare, the environment, and fair trade and maintenance of the viability of human communities. All of these aspects are now part of product quality.
1. One suggested approach for increasing the efficiency of production in a socially responsible way is to develop systems in which animals consume plant material rather than animal feed that could be food for humans. The feeding of animal material, such as farmed fish, to animals is inefficient and may damage the environment.

2. Genetic selection and management for high productivity needs to be evaluated carefully to ensure it does not lead to more disease and other aspects of poor welfare.

3. All aspects of sustainability and product quality in its wider sense should be part of teaching to veterinary, animal-science, and biology students.

4. No veterinary degree should be awarded unless a full course has been taught on the science of animal welfare and relevant aspects of ethics and law.

5. Each country should have a national advisory committee on animal-welfare science, consisting of independent scientists, including veterinarians, who can write impartial reviews of the state of scientific knowledge.

REFERENCES


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