

WellBeing International  
**WBI Studies Repository**

8-19-2008

## Understanding Animal Welfare

David Fraser  
*University of British Columbia*

Follow this and additional works at: <https://www.wellbeingintlstudiesrepository.org/assawel>



Part of the [Animal Studies Commons](#), [Other Animal Sciences Commons](#), and the [Other Anthropology Commons](#)

---

### Recommended Citation

Fraser, D. (2008). Understanding animal welfare. *Acta Veterinaria Scandinavica*, 50(1), S1.

This material is brought to you for free and open access by WellBeing International. It has been accepted for inclusion by an authorized administrator of the WBI Studies Repository. For more information, please contact [wbisr-info@wellbeingintl.org](mailto:wbisr-info@wellbeingintl.org).



Oral presentation

## Understanding animal welfare

David Fraser

Address: Animal Welfare Program, Faculty of Land and Food Systems, and W. Maurice Young Centre for Applied Ethics, University of British Columbia, 2357 Main Mall, Vancouver V6T 1Z4, Canada

Email: David Fraser - david.fraser@ubc.ca

from The role of the veterinarian in animal welfare. Animal welfare: too much or too little? The 21st Symposium of the Nordic Committee for Veterinary Scientific Cooperation (NKVet) Værløse, Denmark. 24–25 September 2007

Published: 19 August 2008

*Acta Veterinaria Scandinavica* 2008, **50**(Suppl 1):S1 doi:10.1186/1751-0147-50-S1-S1

This abstract is available from: <http://www.actavetscand.com/content/50/S1/S1>

© 2008 Fraser; licensee BioMed Central Ltd.

### Summary

In debates about the welfare of animals, different people have tended to emphasize different concerns. Some emphasize the basic health and functioning of animals, especially freedom from disease and injury. Others emphasize the "affective states" of animals – states like pain, distress and pleasure that are experienced as positive or negative. Others emphasize the ability of animals to live reasonably natural lives by carrying out natural behaviour and having natural elements in their environment. These concerns constitute different criteria that people use to assess animal welfare. The criteria overlap substantially but are sufficiently independent that the single-minded pursuit of any one criterion may lead to poor welfare as judged by the others. The different criteria reflect different sets of values that have been in conflict since the early debates about human welfare during the Industrial Revolution, with one side valuing a simple, natural life while the other values progress, productivity, and a life improved by science and technology. Scientific research on animal welfare has been based on the various criteria of welfare. Such research has helped to identify and solve animal welfare problems through improved housing and management of animals. However, the research has not resolved the differences attributable to the different criteria of animal welfare. Rather, the different criteria have provided the rationale for diverse approaches to animal welfare research. Thus, our understanding of animal welfare is both values-based and science-based. In this respect, animal welfare is like many other topics of "mandated" science such as food safety

and environmental sustainability where the tools of science are used within a framework of values.

### A dilemma

To understand animal welfare and its scientific assessment, let us begin with a dilemma that threatened to throw animal welfare science into disarray.

In 1997 a scientific committee of the European Union reviewed the literature on the welfare of intensively kept pigs. The committee asked, among other questions, whether welfare problems are caused by housing sows in "gestation stalls" where the animals are unable to walk, socialize, or perform most other natural behaviour during the majority of pregnancy. The review concluded that, "Some serious welfare problems for sows persist even in the best stall-housing system" [1], and with this review in hand the European Union passed a directive to ban the gestation stall as of 2013.

Not long after, a group of Australian scientists reviewed much the same literature and asked much the same question, but came up with essentially the opposite conclusion. They concluded that, "Both individual (i.e. stalls) and group housing can meet the welfare requirements of pigs." They also cautioned "public perceptions may result in difficulties with the concept of confinement housing" but that "the issue of public perception should not be confused with welfare" [2]. The swine industry in the United States has used that review, plus a similar one, to argue

that there is no scientific basis for eliminating the gestation stall.

Very accomplished and capable scientists did both of these reviews with great thoroughness, and both groups likely felt that they had done the best and most objective job possible. What, then, went wrong? How could two groups of scientists review the same scientific literature and come up with opposite conclusions? If we can solve this dilemma, the solution will take us a long way toward understanding animal welfare and its scientific assessment.

### Different views of animal welfare

To solve this problem, we need to go back to the debate that arose several decades ago when concerns were first expressed about the welfare of animals in the then-new confinement systems of animal production.

The first major criticism of confinement systems came in the book *Animal Machines*, by the English animal advocate Ruth Harrison [3]. She described cages for laying hens and crates for veal calves, and she claimed that these systems are so unnatural that they cause animals to lead miserable and unhealthy lives. She went on to ask:

"How far have we the right to take our domination of the animal world? Have we the right to rob them of all pleasure in life simply to make more money more quickly out of their carcasses? A decade later, in *Animal Liberation*, Australian philosopher Peter Singer [4] based his criticism of confinement production on the principle that actions should be judged right or wrong on the basis of the pain or pleasure that they cause. He claimed:

"There can be no moral justification for regarding the pain (or pleasure) that animals feel as less important than the same amount of pain (or pleasure) felt by humans."

In these and other quotations a key concern centred on words like "pleasure", "pain", "suffering", and "happiness". There is no simple English word to capture this class of concepts. They are sometimes called "feelings", but that term seems too insubstantial for states like pain and suffering. They are sometimes called "emotions", but emotions do not include states like hunger and thirst. Perhaps the most accurate, if rather technical, term is "affective states", a term that refers to emotions and other feelings that are experienced as pleasant or unpleasant rather than hedonically neutral.

In discussing confinement systems, however, some people put the emphasis elsewhere. A British committee that was formed to evaluate the welfare of farm animals concluded:

"In principle we disapprove of a degree of confinement of an animal which necessarily frustrates most of the major activities which make up its natural behaviour." [5]

Astrid Lindgren, the famous author of the Pippi Longstocking stories and a driving force behind animal welfare reform in Sweden, proposed:

"Let [farm animals] see the sun just once, get away from the murderous roar of the fans. Let them get to breathe fresh air for once, instead of manure gas." [6]

And American philosopher Bernard Rollin insisted that we need:

"... a much increased concept of welfare. Not only will welfare mean control of pain and suffering, it will also entail nurturing and fulfilment of the animals' natures." [7]

In these quotations, although affective states were often involved implicitly or explicitly, the central concern was for a degree of "naturalness" in the lives of animals: that animals should be able to perform their natural behaviour, that there should be natural elements in their environment, and that we should respect the "nature" of the animals themselves. All of the above quotations reflected the views of social critics and philosophers, but when farmers and veterinarians engaged in the debate, they brought a different focus. For example, one veterinarian defended confinement systems this way:

"My experience has been that ... by-and-large the standard of welfare among animals kept in the so called "intensive" systems is higher. On balance I feel that the animal is better cared for; it is certainly much freer from disease and attack by its mates; it receives much better attention from the attendants, is sure of shelter and bedding and a reasonable amount of good food and water." [8]

Or as the veterinary educator David Sainsbury put it:

"Good health is the birthright of every animal that we rear, whether intensively or otherwise. If it becomes diseased we have failed in our duty to the animal and subjected it to a degree of suffering that cannot be readily estimated." [9]

Here the primary emphasis is on the fairly traditional concerns of veterinarians and animal producers that animals should have freedom from disease and injury, plus food, water, shelter and other necessities of life – concerns that we might sum up as the basic health and functioning of the animals.

In these various quotations, then, we see a variety of concerns that can be grouped roughly under three broad headings: one centres on the affective states of animals, one on the ability of animals to lead reasonably natural lives, and one emphasizes basic health and functioning. These are not, of course, completely separate or mutually exclusive; in fact, they often go hand in hand. Harrison and Lindgren clearly believed that allowing animals to live a more natural life would make them more happy and healthy; Sainsbury clearly believed that unhealthy animals would suffer.

Nonetheless, the different areas of emphasis are sufficiently independent that the pursuit of any one does not necessarily improve animal welfare as judged by the other criteria. Fifty years ago the American psychologist Harry Harlow wanted to create a colony of disease-free monkeys for research purposes. To do this Harlow separated infant rhesus macaques from their mothers a few hours after birth, and raised them in individual cages where they could be isolated from pathogens. The monkeys could see and hear each other but they had no physical contact. The method produced monkeys with excellent physical health, but as the animals matured Harlow realized that they were, in his words, "emotionally disturbed":

"As a group they exhibit abnormalities of behavior rarely seen in animals born in the wild and brought to the laboratory as preadolescents or adolescents, even after the latter have been housed in individual cages for many years. The laboratory-born monkeys sit in their cages and stare fixedly into space, circle their cages in a repetitive stereotyped manner and clasp their heads in their hands or arms and rock for long periods of time." [10]

In this example, the single-minded pursuit of physical health led to animals that had very unnatural and seemingly unhappy lives.

What if we pursue only naturalness? Various studies of outdoor rearing systems show that animals may have plenty of fresh air and freedom to perform their natural behaviour, but may also be challenged by parasites, predators, and harsh weather that could be better controlled in more artificial conditions. Examples of problems include high neonatal mortality in outdoor pig units [11], and high levels of parasitism among chickens on organic farms [12].

Much the same is true of the pursuit of happiness. Well-fed Labrador Retrievers may never suffer from hunger but are likely to develop heart problems from being overweight [13], and human smokers may feel miserable when they try to stop smoking even though they accept that this painful process is good for their health.

Given this complexity, we are left with a conception of animal welfare shown in Figure 1 which provides a summary of three key points: that animal welfare involves different components that can be grouped roughly under three headings; that these involve considerable but imperfect overlap; and that the pursuit of any one criterion does not guarantee a high level of welfare as judged by the others.

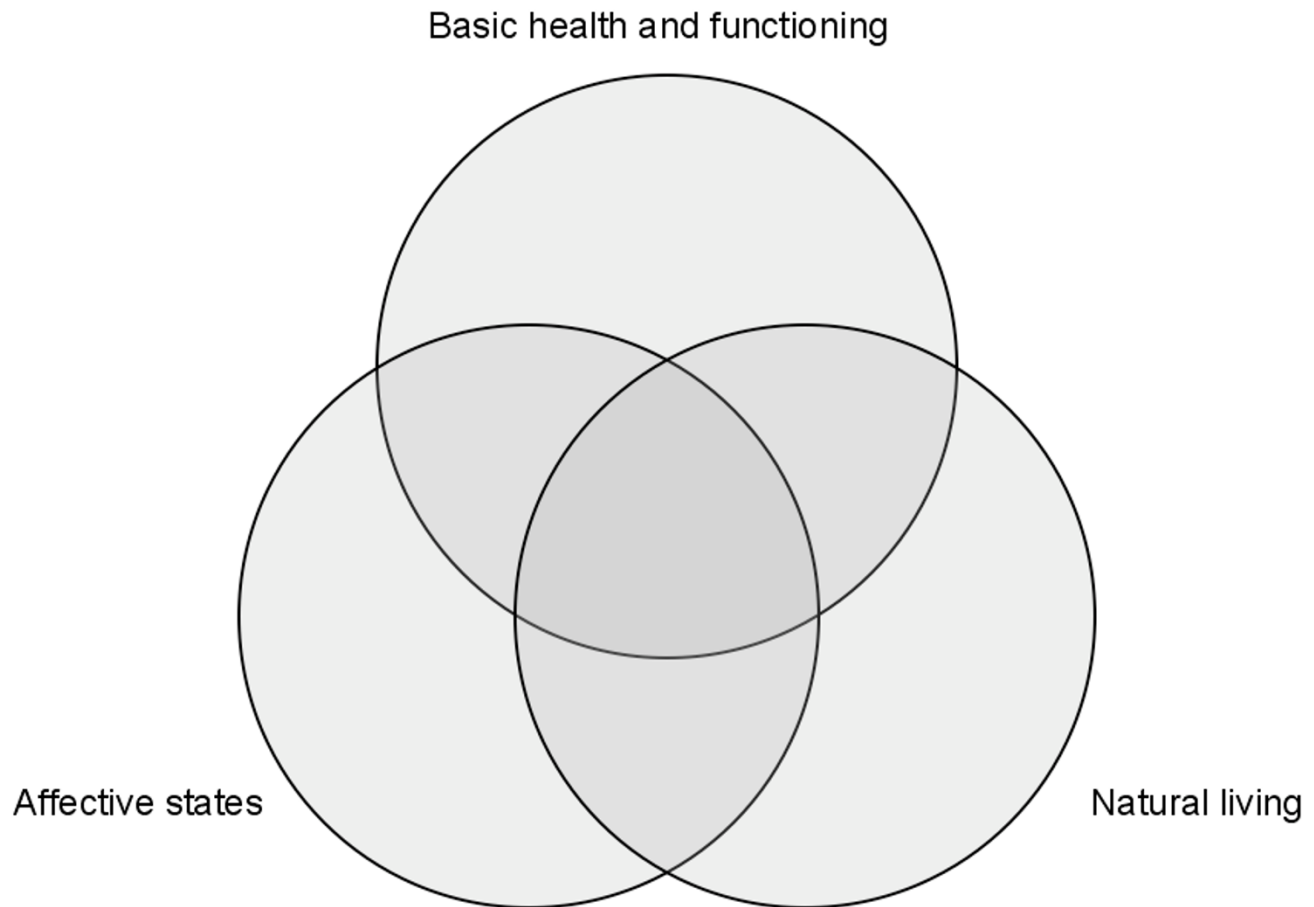
### **A debate about values**

The different views of animal welfare do not necessarily involve disagreements about facts. An intensive animal producer might conclude that welfare is good in a high-health confinement system because the animals are healthy and growing well; a critic might draw the opposite conclusion because the animals are crowded together in barren pens and develop abnormal behaviour. The two parties may agree on factual issues such as the amount of space per animal and the incidence of disease. Their disagreement is about values – specifically about what they consider more important or less important for animals to have good lives.

Why should people hold such different views about what constitutes a good life for animals? To understand this disagreement, it helps to review a debate that erupted over the welfare of humans. During the Industrial Revolution, the so-called "factory system" became the predominant way of producing textiles and other goods throughout much of Europe. Thousands of factories were erected, and they proved so efficient that traditional, hand production disappeared almost completely. Workers moved from villages and rural areas into cities; and instead of working at hand looms in their homes, people operated machinery in the factories. It was a profound social change, and it touched off an intense debate over whether the new industrial system was good or bad for the quality of human life [14].

On one side of the debate were critics who insisted that the factory system caused people to lead miserable and unwholesome lives. Critics claimed that the cities created cramped, unhealthy living conditions for the workers, and deprived people of contact with nature. The machines themselves caused many injuries, and (critics claimed) they often led to physical deformities because they placed an unnatural strain on the body. Perhaps worst of all, it was claimed that repetitive work with machines made the workers themselves like machines and led to an erosion of their human nature and moral character.

But the factory system also had staunch defenders. Instead of imposing unnatural strains, automation (the defenders claimed) relieved workers of much of the drudgery that manual handicrafts required. Far from being unnatural,

**Figure 1**

Three conceptions of animal welfare, adapted from Michael Appleby [21] and Vonne Lund [21].

the factory system represented a step in the natural progression from a time of human labour to a time when automation would make labour unnecessary. Moreover, the wise factory owner would take care to have healthy, happy workers because maximum productivity would not otherwise be achieved. In fact, the productivity of the system was seen as proof that the factories were actually well suited to human workers.

Because the effects of industrialization were so profound, the debate engaged some of the leading intellectuals of the day, and from their writing we can build up a picture of the very different values and world views that lay behind their arguments.

The world-view of the anti-industrial critics might roughly be called Romantic/Agrarian, and it reflects a set of values that we see extending from the rural poetry of the Latin author Virgil, through to the Pastoralist and Romantic

poets and painters of the 1600s to 1800s. This world-view values a simple, natural life. It sees nature as an ideal state that we should strive to emulate. It values emotional experience and the freedom of the individual. And it looks back to a Golden Age in the past when people lived in harmony with nature.

The world-view of the pro-industrialists was more a product of the Enlightenment when people looked to reason and science to replace superstition and ignorance. This world-view involved two concepts that were relatively new to Western thought.

One of these was productivity. Adam Smith opened his book *The Wealth of Nations* by claiming that the quality of life in a nation depends on the goods that are available to supply the citizens with what they need and want. Increasing the productivity of the work force, and thus increasing the supply of goods, should therefore improve the lives of

a nation's people. Hence the factory system, whereby automation and specialization lead to greater productivity, would ultimately make life better [15].

The second idea was progress – the idea that human history moves irreversibly in the direction of improvement. As historian Sydney Pollard points out, belief in progress began with science, because in science each generation was seen as building on the work of earlier generations so that knowledge constantly improves. But during the 1700s the idea of progress took wing, and by 1800, in the words of Pollard, "firm convictions had been expressed about the inevitability of progress in wealth, in civilization, in social organization, in art and literature, even in human nature and biological make-up." [16].

And a belief that change represents progress, and that we cannot "stand in the way of progress", has remained a common theme in Western thought ever since.

Thus, the Rational/Industrial world-view was very different from the Romantic/Agrarian world-view. Instead of valuing a simple, natural life, it valued a life improved through science and technology. It viewed nature not as an ideal state that we should emulate, but as an imperfect state that we should control and improve. It valued rationality rather than irrational emotion, and the productivity of the well organized enterprise more than the freedom of the individual. And instead of looking back to a Golden Age of harmony with nature, it looked forward to a Golden Age in the future when progress through science and technology would lead to a better life.

The debate over human welfare during the Industrial Revolution has obvious parallels with the debate over animal welfare during the intensification of animal agriculture. In fact, much of the disagreement over animal welfare can be traced to the continued influence of the contrasting world-views.

People who lean more toward a Romantic/Agrarian world-view will see a good life for animals as (primarily) a natural life, to be achieved by emulating nature through such means as free-range systems and access to the outdoors. They will emphasize the emotions of animals (are they suffering? are they happy?), and attach importance to their freedom. For these various reasons, people who favour a Romantic/Agrarian world-view are likely to see confinement systems as inherently incompatible with a high level of welfare, and they may look back to traditional, non-confinement systems as an ideal that we should try to return to.

In contrast, those who lean more toward a Rational/Industrial world-view will tend to see a good life for ani-

mals as (primarily) a healthy life, to be achieved by preventing disease and avoiding other vicissitudes of nature. They will value the rationality and scientific basis of the system more than the freedom of the individual animals, and they will see a high level of productivity as evidence that the animals are doing well. Thus, such people are likely to see confinement systems as a form of progress that improves both animal and human welfare, and they may look upon older, non-confinement systems as out-moded models that need to be improved upon.

### **Animal welfare and science**

When these value-based disagreements began to emerge in the debate about confinement production systems, many people thought that science would provide the way to decide among the different views of animal welfare and tell us which is right and which is wrong. However, scientists themselves are influenced by the different world-views that are present in our culture. In fact, when we examine the wide range of scientific methods used to study animal welfare, we can see that the different criteria of animal welfare provided the rationale for some of the different scientific approaches.

Some scientists have used the basic health and functioning of animals as a basis for assessing and improving animal welfare. As one classic example Ragnar Tauson and co-workers improved the welfare of laying hens by studying the basic health of birds in cages of different types and then developing cage designs that would prevent the various health problems they observed [17]. The scientists found that the birds developed foot lesions if the floor was too steeply sloped, and neck lesions if the feed trough was too deep and installed too high for comfortable access. There was often feather damage that could be reduced by using solid side partitions, and overgrown claws that could be prevented by installing abrasive strips. Thus, just by focusing on injuries it was possible to make large improvements in animal welfare, and these results formed the basis of regulations on cage design in Sweden and later in the European Union.

Other scientists have tried to improve animal welfare by focusing on natural behaviour and natural living conditions for animals. For example, as a basis for designing better housing for pigs Alex Stolba and David Wood-Gush began by observing pigs that they had released in a hilly, wooded area [18]. They found that the pigs showed certain characteristic types of behaviour: they rooted in the soil, exercised their neck muscles by levering against fallen logs, built nests in secluded areas before giving birth, and used dunging areas well removed from their resting areas. Stolba and Wood-Gush then designed a complex commercial pen that allowed the animals to behave in these ways. It included an area with peat moss for rooting, logs

for levering, and an activity area with a rubbing post, a separate dunging area, and secluded areas at the back where a sow could be enclosed to farrow. The authors claimed that the complex pen significantly improved the animals' welfare.

However, because some aspects of basic health (especially neonatal survival) were not as good in this system as in well-run confinement systems, some people disagreed with that conclusion.

In less radical approaches, scientists have incorporated simple elements of natural behaviour into existing rearing systems. On many commercial dairy farms, calves are separated from their mothers within the first day after birth, and are fed milk from a bucket, usually twice per day. With such infrequent meals the total intake has to be limited so that the calf does not receive too much milk at one time. Under natural conditions, cows stay fairly close to the calves for the first two weeks, and the calf will feed many times per day in smaller meals. Although it is normally not feasible to leave calves with the cow on a dairy farm, feeding systems can still be made to correspond more closely to the animals' natural behaviour. If the calves are fed more frequently (as they are by the cow), then they can drink more milk per day without developing digestive problems; and if the calves suck from an artificial teat rather than drinking from a pail, the action of sucking leads to a greater release of certain digestive hormones. As might be expected, therefore, calves fed frequently by teat gain substantially more weight than calves fed twice daily by bucket [19].

In other cases, scientists have based animal welfare research on the affective states of animals. Dairy calves are commonly dehorned by a variety of methods including surgical removal of the horn bud or the use of a hot iron to burn through the nerves and blood vessels that allow the horn to develop. In many countries these procedures are done without any form of pain management. A research group in New Zealand used plasma cortisol levels as an indicator of the pain caused by dehorning. They found that dehorning is followed immediately by a large increase in cortisol, but that the reaction is blocked if a local anaesthetic is used to freeze the area. In the treated calves, however, cortisol levels showed a marked increase several hours after the dehorning, probably because the injury remained inflamed and painful when the anaesthetic had worn off. If the calves also received an analgesic, the second peak in cortisol could also be eliminated. Thus the research showed that management of the pain of dehorning requires both a local anaesthetic and an analgesic [20].

All of the approaches described above have been useful for identifying and solving animal welfare problems. However, instead of the science providing a way to determine that one conception of animal welfare is correct and others are not, we see that the different scientists actually adopted the different value-based views of animal welfare – basic health and functioning, natural living, and affective states – as the rationale for different scientific approaches to assessing and improving animal welfare.

In summary, animal welfare is clearly a concept that can be studied scientifically, but our understanding of animal welfare, and even the science that we do to assess and improve animal welfare, is influenced by value-based ideas about what is important or desirable for animals to have a good life. Thus, we have a concept that is both science-based and values-based.

This situation may come as a surprise to scientists who have been taught to think of science as "value-free". During the 1800s, there was active debate about the boundaries of science and how science relates to matters of ethics and policy. Scientists like Max Weber rightly pointed out that science has a fact-finding role that helps to inform policy, but that research itself does not answer ethical or policy questions [21]. Such thinking obviously has merit, but in its crudest form it gave rise to the idea that values play no role in science. However, if a concept like animal welfare can be both science-based and values-based, then clearly we need a more nuanced understanding of the place of values in science.

The term "mandated science" refers to science that has been commissioned or undertaken in order to guide actions, decisions and policy. In this sense mandated science differs from science done simply to understand the natural world. Mandated science includes research on topics such as health, food safety, agricultural sustainability and animal welfare. In all these cases, the science is done to address concepts (health, safety, sustainability, welfare) that incorporate notions of merit or worth. To say that health or safety or sustainability or welfare has increased implies not merely a change but a change for the better. Hence, these concepts, while fully amenable to scientific research, are also rooted in value-based ideas about what people believe to be more or less desirable.

In the case of animal welfare, then, decisions can be based on a sound, scientific understanding of animals and how they are affected by housing, management procedures, and health care measures. However, the data that we choose to collect and consider when making decisions about animal welfare are determined by value-based ideas about what elements are important for animals to have a good life.

## Conclusion

Let us return to the dilemma that was created when two scientific reviews arrived at opposite conclusions about the welfare of sows in gestation stalls. If we look carefully at the reviews, we see that they were based on different conceptions of animal welfare.

The Australian reviewers based their analysis almost exclusively on the basic health and functioning of the animals, and they relied especially on what they called "widely accepted criteria of poor welfare such as health, immunology, injuries, growth rate, and nitrogen balance". They did not deny that affective states are involved in animal welfare, but they took the view that all significant risks to welfare would have effects on health and functioning variables. Thus, by presenting evidence that sows in stalls are generally no worse than sows in other types of housing in survival, weight gain, litter size, disease incidence and such variables, they concluded that, "Both individual and group housing can meet the welfare requirements of pigs".

The European reviewers used a conception of welfare that included affective states and natural living as well as basic health and functioning. Thus they included evidence of fear and frustration in their analysis of animal welfare, whether or not the basic health of the animals was affected. They also considered that the opportunity for "exploration of a complex environment, rooting in a soft substratum and manipulation of materials such as straw" is relevant to animal welfare because of its link to natural behaviour. Using such criteria they conclude: "Some serious welfare problems for sows persist even in the best stall-housing system".

In this example, what appeared to be a scientific disagreement – the sort of disagreement that might be resolved by better experiments – was actually due to a difference in values, specifically about what is important for animals to have good welfare.

Given that there are different conceptions of animal welfare that are not resolved by scientific research, and that these are based on values and world-views that have deep roots in our culture, how should we proceed in creating practical programs and policies to ensure high standards of animal welfare? I think the simplest message is that actions designed to improve animal welfare are not likely to achieve widespread support unless they take account of the different conceptions of animal welfare to at least some degree. Animal producers are not likely to convince their critics that high-health confinement systems are good for animal welfare if these systems cause frustration and prevent animals from carrying out most of their natural behaviour. Free-range producers are not likely to con-

vince their critics that seemingly natural systems are good for animal welfare if the animals suffer from harsh weather, parasites and have poor neonatal survival. For actions to be widely accepted as achieving high animal welfare, in addition to being based on good animal welfare science, they will need to make a reasonable fit to the major value positions about what constitutes a good life for animals.

## Acknowledgements

Portions of this paper have been reworked from: D Fraser: Assessing animal welfare at the farm and group level: the interplay of science and values. *Anim Welfare* 2003, 12: 433–443, and from the forthcoming book *Understanding Animal Welfare*, to be published by Blackwell. I am grateful to the publishers for permission to use some of that material here.

## References

1. Scientific Veterinary Committee: **The Welfare of Intensively Kept Pigs. Report of the Scientific Veterinary Committee.** European Union, Brussels; 1997.
2. Barnett JL, Hensworth PH, Cronin GM, Jongman EC, Hutson GD: **A review of the welfare issues for sows and piglets in relation to housing.** *Austral J Agric Res* 2001, **52**:1-28.
3. Harrison R: **Animal Machines.** Vincent Stuart Ltd, London; 1964.
4. Singer P: **Animal Liberation.** In (1st edition 1975) 2nd edition. Avon Books, New York; 1990.
5. Brambell FWR (chairman): **Report of the Technical Committee to Enquire into the Welfare of Animals kept under Intensive Livestock Husbandry Systems.** Her Majesty's Stationery Office, London; 1965.
6. Anonymous: **How Astrid Lindgren Achieved Enactment of the 1988 Law Protecting Farm Animals in Sweden.** *Animal Welfare Institute, Washington*; 1989.
7. Rollin BE: **Animal welfare, science, and value.** *J Agric Environ Ethics* 1993, **6(Supplement 2)**:44-50.
8. Taylor GB: **One man's philosophy of welfare.** *Vet Rec* 1972, **91**:426-428.
9. Sainsbury D: **Farm Animal Welfare. Cattle, Pigs and Poultry.** Collins, London; 1986.
10. Harlow HF, Harlow MK: **Social deprivation in monkeys.** *Scientific American* 1962, **207**:136-146.
11. Cox B, Bilkei G: **Lifetime reproductive performance of sows kept indoors and outdoors in Croatia.** *Vet Rec* 2004, **154**:569-570.
12. Lund V, Algers B: **Research on animal health and welfare in organic farming – a literature review.** *Livest Prod Sci* 2003, **80**:55-68.
13. Lawler DF, Evans RH, Larson BT, Spitznagel EL, Ellersieck MR, Kealy RD: **Influence of lifetime food restriction on causes, time, and predictors of death in dogs.** *J Amer Vet Med Assoc* 2005, **226**:225-231.
14. Bizup J: *Manufacturing Culture: Vindications of Early Victorian Industry* University of Virginia Press, Charlottesville; 2003.
15. Smith A: *The Wealth of Nations, Book 1, Chapter 5, 1776* Republished Dent and Sons, London; 1904.
16. Pollard S: *The Idea of Progress: History and Society* Penguin Books, Harmondsworth (UK); 1968.
17. Tauson R: **Health and production in improved cage designs.** *Poult Sci* 1998, **77**:1820-1827.
18. Stolba A, Wood DGM-Gush: **The identification of behavioural key features and their incorporation into a housing design for pigs.** *Annal Recher Vét* 1984, **15**:287-298.
19. Fraser D, Weary DM: **Quality of life for farm animals: linking science, ethics and animal welfare.** In *The Well-being of Farm Animals: Challenges and Solutions* Edited by: Benson GJ, Rollin BE. Blackwell Publishing, Oxford; 2003:39-60.
20. Stafford KJ, Mellor DJ: **Dehorning and disbudding distress and its alleviation in calves.** *Vet J* 2005, **169**:337-349.
21. Dahrendorf R: **Max Weber and modern social science.** In *Max Weber and His Contemporaries* Edited by: Mommsen WJ, Osterhammel J. Allen & Unwin, London; 1987:574-580.