

The Science behind the Issues in Animal Welfare

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■ Introduction

Making decisions about animal welfare is not easy. It involves considering the issues, gathering the facts, weighing the choices and calculating the economic implications. When faced with tough decisions, we (humans) often expect science to provide us with clear-cut answers, and similarly we want "science-based" decisions about animal welfare. But science is only part of the process. Science provides an empirical method for obtaining knowledge; it gives us the facts about how different aspects of housing or management can affect a pig's health, physiology or behaviour. The next step in decision-making involves assessment - integrating all of the current knowledge, weighing its importance and interpreting it in terms of animal welfare (Fraser, 2003). This is a step that involves ethical values and requires consensus. With some of the more complex welfare issues, for example sow housing, this step can be one of the most difficult to accomplish, even within the scientific community. In this paper I will review some of the current thinking about what and how science contributes to decision-making about animal welfare and where our current state of knowledge is at with regards to some of the major animal welfare issues in the pork industry.

■ Different Viewpoints on Animal Welfare Lead to Different Scientific Approaches

Animal welfare science has become a well-established field of study over the last thirty years, but it is unique compared to other disciplines in animal science. Unlike areas of study such as genetics or reproductive physiology, the term animal welfare does not describe a scientific concept per se but arose in response to ethical concerns about the quality of life that animals

experience (Duncan and Fraser, 1997). The science of animal welfare allows application of the scientific method to address those concerns. Different people (including scientists, veterinarians, producers and consumers) define animal welfare in different ways, because our notions of quality of life are shaped by cultural and personal values. As animal welfare science developed over time, three overlapping viewpoints emerged in the way that animal welfare is considered (Fraser et al., 1997; **Figure 1**). These different viewpoints have been the basis for the various animal welfare issues in the pork industry worldwide and have shaped the ways that the welfare of animals is measured during scientific experiments and the way it is assessed in practical situations.

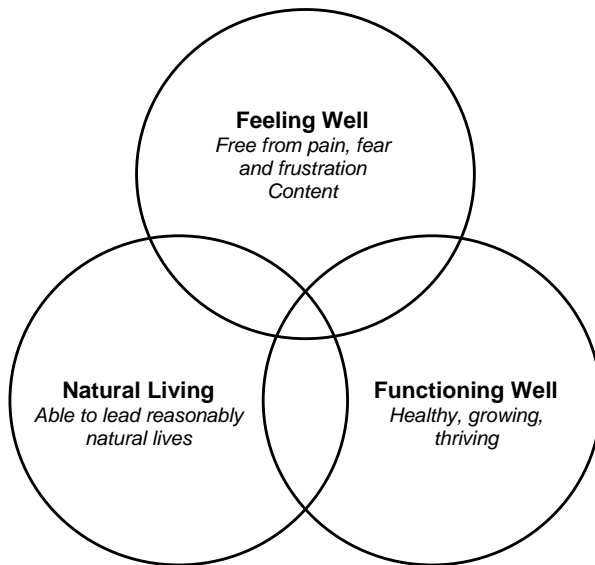


Figure 1. Three overlapping viewpoints for how animal welfare is defined (adapted from Appleby, 1999 and Fraser, et al., 1997). These viewpoints lead to different approaches for assessing welfare in scientific studies and in practice.

Biological Functioning

One viewpoint is that animal welfare reflects an animal's functioning in the biological sense. This means that animals should be kept in conditions in which they are healthy, growing and reproducing well and in which they show few physiological or behavioural disruptions. This viewpoint covers many of the basic provisions such as food, water, comfortable temperatures, good air quality, sufficient space and health care. The parameters used to measure biological function include biological endpoints such as rates of illness, injury and mortality, body condition and measures of productivity such as growth or

farrowing rates. Some of these parameters are used as animal-based measures for on-farm welfare assessment. In controlled studies, measures of the stress response, such as heart rate and hormone levels (e.g., cortisol), and measures of immune function are often used as indicators of biological function.

Feeling Well

Another viewpoint is that animal welfare reflects an animal's feeling well. This means that animals should be housed and handled in ways that prevent negative feelings such as pain, fear and frustration and that may even promote positive feelings such as pleasure or contentment. Although an animal's feelings cannot be measured directly, a variety of experimental techniques have been developed and refined so that we now have well-established measures of some animals' emotions. Some techniques rely on preferences or the knowledge that an animal will work very hard to obtain something that it finds rewarding or to escape from something that it finds aversive. Other techniques use postures or vocalizations that we know signal fear or pain. For example, detailed sound analyses of the calls of piglets have shown that while all restrained piglets vocalize to some degree, those experiencing pain give calls of a higher pitch (Weary and Fraser, 1995), and we can use these measures to assess the painfulness of different procedures. In laboratory studies, behavioural techniques are often combined with physiological measures, since many negative emotional states can result in a stress response. A few of these parameters, such as vocalizations or postures are readily recognized and used in day to day practice by knowledgeable stock people, but they are more difficult to apply to on-farm welfare assessment schemes. Most often, measures of animals' feelings are determined from laboratory studies and then used to make recommendations on housing or management practices.

Natural Living

A final viewpoint concerning welfare is that animals should be able to lead relatively natural lives or behave in ways that are consistent with the nature of their species. According to this viewpoint animals should be kept in conditions that allow them to express normal behaviour and may be taken to varying degrees. Some proponents of this viewpoint suggest that at the very least all pigs should have freedom of movement and the opportunity for exercise and social interaction, while others suggest that they should additionally be provided the space and materials for rooting and building nests or even be allowed to live part (or all) of their lives outdoors. Compared to the biological and feeling-based viewpoints, there are relatively fewer scientific approaches for assessing welfare that are derived from the natural living viewpoint. However, studies of pigs in natural or semi-natural environments have been

used to determine what the natural behaviour of the modern pigs is like - how they organize their social groups, how they spend their time and how behaviour in more confined systems compares. Information from these types of studies are used to identify what aspects of the environment might be important to pigs, for example nesting material, and then other approaches are used to determine whether pigs experience frustration or increases in stress hormones when deprived of it.

Integrating Viewpoints and Approaches

For most animal welfare concerns there is at least some degree of overlap among the different viewpoints. When measures arising from different viewpoints lead to the same conclusions it is much easier to reach consensus in interpretation. This is especially true when reduced productivity corresponds with other measures, since the evidence also provides economic incentive for alleviating a welfare concern. Most recommendations for floor space allowance for growing-finishing pigs, for example, are based on measures of productivity (Gonyou, et al 2006). However, productivity rates do not always correspond with other measures of welfare - for example when a lame sow who finds it painful to stand or walk delivers and weans a large, healthy litter of piglets. In many respects, intense selection for high levels of production has created a mismatch between productivity and other aspects of biological fitness. For example, breeding sows have to be feed-restricted in order to maintain high reproductive rates, yet they show signs of chronic hunger on the diets commonly provided. There are also examples where selection for fast lean growth has also led to producing pigs that may be more aggressive, more difficult to handle or are more susceptible to handling stress. Disagreements among the viewpoints, especially when different scientific measures conflict lead to the most contentious debates concerning animal welfare.

■ Science and the Sow Stall Debate

In the past ten years four major scientific reviews of the literature have been published (Borell et al., 1997, Barnett et al., 2001; McGlone et al., 2004, AVMA Task Force, 2005). One of those reviews provided the evidence behind the banning of sow stalls in the European Union while others have been used to defend the housing of sows in gestation stalls (Fraser, 2003). How can such opposing conclusions both be 'science-based'? One of the problems is the validity of the notion that the welfare of 'sows in stalls' can be directly compared to the welfare of 'sows in group housing systems'. If we look at the different group housing systems used in various studies we see they comprise different feeding systems (floor feeding, electronic feeding, individual feeding stalls), different group management strategies for groups (dynamic versus static) and different group sizes (for example, small < 10 sows; medium 10-40

sows; large > 40 sows). Considering those three variables alone we have $3 \times 2 \times 3 = 18$ combinations of management schemes, not including differences in time of mixing sows into groups, space allowances or floor types. Even when considering data from sows in stalls, these data are derived from sows kept in stalls of different sizes, of different parities and under different breeding or nutritional management.

Table 1. Overview of measures used to assess the welfare of gestating sows in different housing systems (AVMA Task Force Report, 2005)

Measure	General Findings
	Stalls vs. Group Housing
Physiologic measures of chronic stress	No difference between systems; In groups low ranking sows have higher cortisol than high ranking sows
Immune function	No difference between systems
Productivity	No difference between systems
Social interactions	Sows in groups can form social order; In groups aggression can be high; In stalls conflicts remain unresolved
Stereotypic behaviour (repeated sequence of movements, i.e. sham chewing, bar biting; considered indicator of reduced welfare)	Higher in stalls Thought to be due to limit feeding so some is observed in both systems
Freedom of movement	Restricted in stalls Some stalls do not accommodate body size of sows
Muscle tone and bone strength	Reduced in stalls
Opportunities for control over environment	Sows in groups can adjust location with regard to drafts and other pigs and can establish dunging area
Injuries	Scratches, injuries from fighting higher in groups Vulva biting is higher in groups

Probably more important with regards to disagreements in the sow stall debate is that scientists and veterinarians approach their interpretation of the data from different ethical and scientific viewpoints and use their viewpoint to conclude which system is better or worse (Fraser, 2003). The most recent comprehensive review on the housing of pregnant sows published by a Task Force put together by the American Veterinary Medical Association (AVMA Task Force, 2005) concludes that all sow-housing systems have some advantages and some disadvantages in terms of animal welfare (**Table 1**). Group housing systems provide sows with freedom of movement and opportunities for social interactions but can also result in problems such as stress or injury due to aggression or uneven body condition. Stall housing restricts the behaviour of sows, which may lead to frustration, but prevents aggression and facilitates individual feeding. In their summary the Task Force acknowledged the limitations of science in making the final decision regarding sow housing:

There is no scientific way, for example, to say how much freedom of movement is equal to how much freedom from aggression or how many scratches are equal to how much frustration. In such cases, science can identify problems and find solutions but cannot calculate and compare overall welfare in very different systems.

When considering all three of the ethical and scientific viewpoints concerning animal welfare, group housing systems in general have *the potential* to provide for better welfare for sows compared to gestation stalls. They do require a high level of management, and therefore they also have the potential to result in poorer welfare. Therefore, on-farm assessment schemes will be critical for ensuring sow welfare as the industry moves toward adopting alternative housing systems.

■ **Where the Science is at with some Other Issues in the Pork Industry**

Castration and Piglet Processing

Until fairly recently, surgical procedures were performed on very young animals because it was assumed, although largely untested, that their nervous systems were not fully developed and therefore they had a reduced ability to feel pain. This led to recommendations to perform surgical procedures on animals at a very young age. However, the methods used to assess pain have advanced considerably and we now know that neonates do in fact feel pain. Consequently, the routine performance of surgical procedures without the use of some form of pain relief has come under scrutiny in all of the livestock industries. There have been a number of studies conducted to determine

whether castration, tail docking and teeth clipping cause pain and to assess the long-term effects of those procedures on the welfare of pigs (see Widowski and Torrey, 2002).

Castration

There is substantial evidence that castrating piglets causes acute pain. Castrated piglets have significantly higher heart rates and higher levels of stress hormones compared to piglets that are restrained or sham-castrated. Most piglets vocalize a great deal during handling, but spectral analyses of their vocalizations indicates that during castration their calls change - they produce significantly more high frequency calls (>1000Hz). Castrated piglets also show behavioural changes including reduced nursing, increased lying time away from the heat lamp, lying with legs tucked up under their body and trembling that are not observed when piglets are sham-handled. The use of local anesthetic significantly reduces heart rates and behavioural changes, which indicates that the behavioural changes following castration, are, in fact, due to pain. Although comparisons of the responses of piglets to castration at different ages indicate that it is a painful procedure at any age, castrating piglets after weaning and during the first few days of life has been shown to result in reduced growth rates compared to piglets castrated during the second or third week of life.

Tail Docking

Tail docking is the most common method used to prevent tail biting which is a serious welfare and economic problem. Although tail docking does not eliminate tail biting, results from large surveys conducted in abattoirs in the UK indicate that pigs with docked tails have significantly lower incidence of tail biting compared to pigs with intact tails. There have been relatively few studies assessing any acute or long-term pain caused by tail docking or comparing the techniques used to dock tails. We do know that peripheral nerves can be traced to the tips of the tails of day-old piglets suggesting that the entire tail is sensitive at birth. Recent work showed that piglets undergoing tail docking and ear notching vocalized at a higher rate and produced more high frequency calls than sham-handled piglets (Torrey et al, 2007). Processed piglets also jammed their tails between their legs and tended to tremble more when processed on day 1. Nursing behaviour and growth rates were not affected by processing. In another study, using a cold analgesic spray reduced tail jamming.

Teeth Clipping

Routine teeth clipping has become less common in the pork industry yet the costs and benefits of this procedure are still often debated. Teeth clipping is clearly effective at reducing facial lesions on littermates and may reduce injuries to teats and 'udder-protective' behaviour of sows in farrowing crates.

The needle teeth of piglets are lacteal (baby) teeth that undergo resorption and replacement by adult teeth at around 50 days of age. The pulp cavities of needle teeth are innervated, richly vascularized and presumably sensitive to pain. It has been shown that fully clipping teeth can lead to infection from exposure of the pulp cavity or shattering of teeth, and in one study examination of the gums and palates of piglets indicated signs of inflammation even at 55 days after clipping. However, few studies have investigated whether teeth clipping causes either acute or long-term pain.

The decision whether to dock tails and clip teeth involves some trade-offs for the welfare of the pig. Teeth clipping provides obvious benefits in terms of reducing facial lesions but the degree of pain and long-term consequences are unclear. Tail docking appears to cause at least some short-term pain but benefits the pig by reducing chances of being tail bitten over the long term. Castration is clearly a painful procedure with little or no benefit to the pig but a large economic benefit to the producer. For these reasons, some countries have placed restrictions on these practices or are prohibiting them altogether. Developing alternatives to these practices or adopting effective means for pain alleviation are likely to be challenges for the future.

Weaning

A variety of evidence indicates that weaning is highly stressful for piglets (Widowski et al, 2008). For the first few days after weaning, piglets are restless, give distress calls, and often try to escape their pens, presumably in attempt to regain contact with the sow. These behavioural changes are associated with increases in stress hormones and reduced immune function. In addition, many piglets have difficulty in initiating feeding and consequently experience reduced growth rates. These same piglets are prone to developing behavioral problems such as belly nosing and belly sucking over the next few weeks. All of these problems are more pronounced when piglets are weaned at younger ages, which led to particular concern for the welfare of piglets in Segregated Early Weaning systems (Robert et al., 1999). Weaning near or after four weeks of age results in fewer problems and better overall performance, which is probably what is leading the trend toward later weaning in the industry. However, weaning later than four weeks may compromise the welfare of sows when sows and their litters are confined to farrowing crates.

Handling and Transport

The importance of good handling techniques at all stages of production is well established in the scientific literature. A number of studies have shown that rough handling results in increased fear and avoidance responses towards humans, increased measures of stress hormones, reduced growth rates of nursery and grower-finisher pigs and reduced conception and farrowing rates

of sows (Table 2). Therefore, the training of stock people in proper pig handling techniques is considered to be critical for ensuring pig welfare.

Table 2. Effects of handling treatments on the level of fear of humans, stress hormones and productivity of pigs (adapted from review by Hemsworth et al., 1993). The time a pig takes to interact with a person is measured during a standardized "Human Approach Test".

Experiment	Handling Treatment		
	Pleasant*	Minimal	Unpleasant*
Finishing pigs (Hemsworth et al, 1981)			
Time to interact with a person, sec	119	-	157
Growth rate from 11-22 weeks, g/day	709	-	669
Free corticosteroid concentrations, ng/ml	2.1	-	3.1
Growing pigs (Gonyou et al, 1986)			
Time to interact with a person, sec	73	81	147
Growth rate from 8-18 weeks, g/day	897	888	837
Growing pigs (Hemsworth et al, 1987)			
Time to interact with a person, sec	10	92	160
Growth rate from 7-13 weeks, g/day	455	458	404
Free corticosteroid concentrations, ng/ml	1.6	1.7	2.5
Breeding gilts & young boars (Hemsworth et al, 1986)			
Time to interact with a person, sec	48	96	120
Pregnancy rate, %	88	57	33
Age of full mating response by boars, days	161	176	193
Free corticosteroid concentrations, ng/ml	1.7	1.8	2.4

*Unpleasant handling involved brief use of electric prod. Pleasant handling involved stroking pigs when they approached.

The use of electric prods has been shown to be particularly detrimental (Benjamin, 2005). During pre-slaughter handling, electric prodding can increase the incidence of non-ambulatory pigs during transport and cause reductions in meat quality at the slaughter plant. Physiological responses to stress directly effects muscle pH and temperature leading to changes in colour and drip loss in the meat.

The transport of animals for market is a major welfare concern worldwide. In addition to the stress associated with handling during loading and unloading, transport often involves the mixing of unfamiliar animals, extremes in temperatures, crowding, and other physical stressors such as noise and vibration. We know that these conditions can and often do lead to injury, non-ambulatory animals (downer pigs) and death loss. However, until very recently, most of the research on transport of pigs has been conducted in Europe where vehicle design, road conditions, climate and transport distances differ from those in North America. Even within Canada, there are regional differences in transport distance and climatic conditions. A number of recent and ongoing transport projects in Canada are addressing the transport conditions of both market hogs and iso-weaned piglets. One ongoing collaborative study in Canada involving scientists at the Prairie Swine Centre, University of Saskatchewan, University of Manitoba, University of Guelph and Agriculture and Agri-food Canada is investigating the effects of handling, truck design, season and climatic conditions on welfare and meat quality of market hogs through trials conducted in Quebec and western Canada. This project will provide detailed information about the behaviour, stress response, body temperature and meat quality of market hogs under different transport conditions and will offer solutions that are appropriate for the Canadian industry.

■ Conclusions

When faced with difficult decisions, a common response is to call for a review of the scientific literature or to conduct more research. For many of the major animal welfare issues facing the pork industry, we already have the scientific knowledge to draw conclusions about how management practices affect pig welfare. We now need to make the decision as to if and how to apply that knowledge to make improvements. For some issues, we do need more research, not necessarily to refute the welfare concerns, but rather to find solutions to problems and to identify the best affordable management practices that address those concerns. In the end, decisions regarding animal care practices will be based on balancing scientific knowledge that comes from different viewpoints with professional judgment and societal values.

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