Animal Welfare Forum: Sow Housing and Welfare

November 5, 2004, Hoffman Estates, Illinois

The following papers were submitted by speakers at the 2004 AVMA Animal Welfare Forum, which was held at the Chicago Marriott Northwest, Hoffman Estates, Illinois. These papers have not undergone peer review; opinions expressed are those of the authors and not necessarily those of the American Veterinary Medical Association.

During the Forum, the 2004 Animal Welfare Award was presented to John New, DVM, MPH.

The Animal Welfare Forum is an annual event planned by the Animal Welfare Committee, under the direction of the Executive Board. For additional information about the Forum or the Animal Welfare Award, please contact the AVMA Communications Division.

Table of Contents

Welcome

Henry Childers, DVM, DABVP
AVMA 2004–2005 President-Elect

Good morning. It is my pleasure to welcome you to the 15th annual Animal Welfare Forum on behalf of the more than 71,000 members of the American Veterinary Medical Association. The Animal Welfare Forum is held each year as the highlight of Animal Welfare Week, which is a public awareness program designed to promote the welfare of animals. For more than a decade, the Forum has served as a useful platform for highlighting and exploring important animal welfare concerns affecting a variety of species. This year, the AVMA is pleased to present "Sow Housing and Welfare."

Animal welfare assessment and assurance is always a complex issue. The debate over how to best house pregnant sows is no exception. Today's speakers will share science-based information and their perspectives regarding the 2 basic types of housing systems for pregnant sows—individual and group. Within these systems, factors such as enclosure design, feeding practices, environmental exposures, behavior, and stockmanship will be addressed. While paying due attention to the science, we also recognize that human concern for animal welfare has its root in ethics and is affected by social mores. Technological advances, urbanization, social movements, trends in marketing, and business consolidation have all played a role in shaping the realities and belief systems of producers, veterinarians, and consumers. These influences, too, will be considered as we move through today's program.

Attempting to critically analyze every approach to the housing of pregnant sows during a 1-day Forum is ambitious. Although we don't pretend to have all the answers, the AVMA's Animal Welfare Committee has assembled an excellent panel of speakers to educate and stimulate discussion about how we can assess and improve the welfare of pregnant sows.

Our goal for this Forum, as it has been for all previous Forums, is to promote the well-being of animals. The AVMA is proud of the vital role veterinarians have played in advancing the welfare of animals used for food production.

Animal agriculture and the welfare of animals

Paul B. Thompson, PhD

Taking proper care of one's animals has always been understood as an ethical responsibility. It is a responsibility that has traditionally been accepted by producers and largely taken for granted by the general public. In the past, producers never thought of the ethical responsibility to care for their animals as being in any sort of conflict with good business practice, and the public never thought much about the welfare of farm animals at all. This is not to say that consumers in the past did not care about the welfare of farm animals. Rather, I think that people who reflected on the well-being of livestock tended to think that farm animals were living lives well suited to the kind of creatures they were and that the producer's self-interest in healthy animals served as a check against cruel treatment.

Times have changed, however. Some of the changes reflect new attitudes toward animals, but others reflect changes in animal agriculture itself. There is now a substantial social movement committed to changing the way that humans use animals. This movement had its roots in protests over the use of laboratory animals, but has now spread to many other areas, including animal agriculture.[1] Arguably, general public ignorance about animal agriculture provides an opportunity for such activists to have influence beyond what their numbers would suggest. But one should not underestimate the importance of public expectations, nor should producers ignore the way that the swine industry now differs from what it was in the past. Some of these differences have important implications for the way we should understand the ethics of animal husbandry.

The ethical responsibilities of animal husbandry have been thought of as duties that individual people—farmers and farmhands—must perform on behalf of the animals in their care. Any practice that resulted in ill health or poor treatment of a farm animal has been thought of as a fault for which the individual producer should be held accountable. Although it is still true that animal husbandry imposes ethical duties

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on those who practice it, animal agriculture has changed dramatically in scope and complexity over the past few decades. New technologies pose challenges to the way that we understand how animals fare in a given production system. New methods may seem to enhance one dimension of animal health and well-being while seemingly causing a decline in another. New scales of production can provide opportunities for improvements in overall herd health, reproductive success, and profitability while reducing the amount of care and attention that can be given to individual animals. Emerging trends in marketing and contracting constrain producers' flexibility and introduce powerful new actors into decision-making that affects animal health and well-being. This means that although the ethical responsibilities of the individual producer are still important, there is a growing need to examine the ethics of animal care on an industry-wide basis.[2]

In a technologically complex world in which a producer's choices are sharply limited, it is no longer appropriate to place the entire burden of ethical responsibility on the shoulders of individual producers. Above all, consumers must not expect individual producers to undertake practices that will make them uncompetitive in the marketplace. Livestock producers will do what is necessary to compete, or they will not be livestock producers for very long. But it is not unreasonable for consumers to expect that the industry as a whole should continue to recognize an ethical responsibility for proper animal care. This means that the ethics of farm animal welfare must come to be seen as a collective responsibility that falls on those organizations that have the means to influence the care of animals on an industry-wide basis. The ethical responsibilities of husbandry must be reflected in industry standards, market structures, and government regulations, as well as in individual producers' husbandry of their animals.

We are entering a time when the public's demand for ethical treatment of farm animals is starting to register in the form of price premiums and special contracting requirements, as well as in increased pressure for government action. It is very difficult to measure or characterize what public expectations are at any given time, much less how they will change in the future. Although public opinion research can tell us that more people are expressing concern about the treatment of animals or that more people are choosing vegetarian diets, a number of plausible interpretations for such data remain viable at any given time. Thus, for example, it may be that groups with extreme views about animal use are having a significant influence on public expectations. It may also be that public attitudes about appropriate animal use have changed little, but that people are looking for new ways to ensure that producer incentives line up with their own understanding of animal ethics. It may also be that diet, health, and the pocketbook are having far greater influence on consumer behavior than anything having to do with animal welfare.

One consequence of the difficulty in sorting out these questions of the underlying bases for public attitudes is that it will continue to be possible for people to selectively choose whichever interpretation happens to suit their mood. This means that it will be possible for a number of competing claims about public attitudes to be bandied about. Clearly there is a danger that the emerging system will serve neither animal nor human interests well. I believe that the swine industry should not be tempted by interpretations that lay all the blame at the feet of extremists. One problem with such a view is that it can make very reasonable and needed steps seem as if they are concessions. One digs in one's heels and refuses to do the right thing for fear that doing anything will give momentum to a movement seeking unreasonable change. Although I cannot prove it with statistics, my belief is that the mainstream public wants to believe that farm animals lead reasonably contented lives and is prepared to think that farmers want that too. As such, I think that the most reasonable course of action is to focus on the pigs themselves, to be resolute in finding industry-wide standards to address any welfare problems that exist, and to let the public reaction take care of itself to a substantial degree.

One of the key responses has been to rely on scientific measures of how animals fare under conditions typical of alternative production methods. This type of work has been undertaken internationally for many years, although the United States is only now starting to take appropriate cognizance of research that has been done in other countries. The 1997 Council for Agricultural Science and Technology report[3] on animal well-being acknowledged this work and pointed the way toward a scientifically informed approach to the welfare of livestock in production settings. Recently, 3 leading animal welfare scientists published an overview paper[4] documenting a number of ways in which existing production conditions throughout North America should be regarded as problematic given current research. Recently, the Federation of Animal Science Societies has led a process to collect the existing, state-of-the-art scientific knowledge on animal welfare and to begin thinking about species-based guidelines for farm animal care and use.

Scientifically validated and ethically grounded industry standards can provide an alternative to rules and regulations imposed from without, but only if 3 key conditions can be met. First, it must be clear that the ethical goals and principles place appropriate weight on the welfare and interests of the animals themselves at the same time that they recognize the role of animal agriculture in satisfying vital human needs. Second, consumers must have confidence that standards are taken seriously and that livestock producers faithfully follow recommended practices. Third, producers themselves must believe that standards are fairly established and administered. Although some mix of market incentives, government regulation, and self-administered industry standards may eventually emerge to address the new challenges of ethical husbandry, only a system that meets all 3 of these criteria can truly be said to be ethically justified.

Who will take the lead in formulating and implementing such a system? One response has been the

USDA's creation of the Western Region Coordinating Committee 204 on animal ethics. This effort to bring together interdisciplinary researchers, including ethicists, is an important first step. But there is only so much that a group of professors or government officials can do. Producers themselves should take the initiative, either through existing commodity groups or through some yet-to-be-formed organization that would be 1 step removed from the day-to-day concerns of farm policy and profitability. They will need to work with scientists and government, as well as find new partners among nonfarm groups with an interest in animal care. The eventual organizational response to the new ethics of animal husbandry will probably not look exactly like anything that we have today.

One thing is certain. If producers undertake a new effort to provide assurances that animal interests are being taken into account in contemporary husbandry, they can be certain that people from outside will be watching carefully, even skeptically. Fortunately, there are several well-organized animal-protection groups that have a clear commitment to the continuation of animal production for our food supply. Yet any proactive coalition will almost certainly meet opposition from people whose view of animal protection leaves no room for animal agriculture. At present, the broader public is caught between these extremists on the one hand and a farm community polarized by extreme views and reluctant to take any coordinated action on the other. As Bernard Rollin has long argued,[5] the new social ethic for animals demands that animal interests be given due consideration in a system that still provides healthy and economical products for consumers. Producers can and should accept the challenge of ending that gridlock, for no one is truly served by it, and public confidence in the food system is its greatest casualty.

You may notice that my remarks have focused on animal agriculture rather than swine production. On the one hand, we must be sensitive to the fact that different species of animals have very different capabilities and very different needs. In addition to this, the various sectors of animal production face somewhat distinct structural and marketing challenges, and these economic realities will certainly affect the nature of any organized effort to change industry practices. Thus, it will be necessary for pig producers to work together in addressing the needs of their animals, and there will be many specific issues where expertise in the welfare of pigs, as well as the economics of pig production, becomes absolutely critical. On the other hand, there is an important sense that animal welfare needs to be addressed more broadly. It will be important for the public to see that all animal producers are responsive to the needs of their livestock; hence, there will be a number of policy and procedural issues on which it will be important for each of the species groups to work together.

As science and technology advance, we have come to expect that standards for husbandry will evolve and that periodic updating and revision will be the norm. The complex trade-offs between animal welfare, consumer prices, and producer profitability will also be affected by shifting social values and technical change. This points, again, to the need to go beyond the view that ethical responsibilities fall solely on individual producers and animal caregivers. Ethics itself must come to be seen in terms of responsiveness to change and to what we have learned. The ethics of husbandry will consist as much in how animal industries adapt to new knowledge and altered circumstances as in the individual performance of the age-old duties of animal care. The most recent guide to swine care reflects what we have learned most recently about responsible husbandry, but it also represents a commitment to continue in the search for better knowledge and better practices. Producers can meet their responsibility for ethical husbandry only by practicing what they believe to be right today and by resolving to test those beliefs, to learn, and to improve in the future.

References

1. Rudacille D. *The scalpel and the butterfly: the war between animal research and animal protection*. New York: Farrar, Straus and Giroux, 2000.
2. Thompson PB. Animal welfare and livestock production in a postindustrial milieu. *J Appl Anim Welf Sci* 2001;4:191–205.
3. *The well-being of agricultural animals*. Ames, Iowa: Council for Agricultural Science and Technology, 1997.
4. Fraser D, Mench J, Millman S. Farm animals and their welfare in the year 2000. In: Salem DJ, Rowan AN, eds. *The state of the animals 2001*. Washington, DC: Humane Society Press, 2001;87–99.
5. Rollin B. *Farm animal welfare: social, bioethical and research issues*. Ames, Iowa: Iowa State University Press, 1995.

My responsibilities as a swine caregiver

John Kellogg

I am John Kellogg, of Yorkville, Ill. I am a husband, father, pork producer, professional businessperson, and member of the community. At the national level, I served as vice president of the National Pork Board for 2 years and as president from July 1999 through July 2001. I currently serve on the National Pork Board's Animal Welfare Committee. At the state level, I served on the Board of Directors for the Illinois Pork Producers Association from 1986 through 1991. I also have served on the Kendall County Pork Producers Association for many years, 6 of those as president. Throughout my service to the industry, I have received many awards, including Illinois Pork All-American, Illinois State 4-H Alumni, and Prairie Farmer Master Farmer.

My brother David, my wife Jan, and I are partners in Kellogg Farms, which was homesteaded by our great, great grandfather in 1846. Over time we have been involved in raising pigs, cattle, and grain, but since the 1970s, we have focused on pigs and grain. Jan and I manage the farm operation, including 1,200 acres of corn and 100 acres of soybeans.

The commercial pig operation is located in Yorkville, Ill, 35 miles southwest of Chicago and literally on the edge of urban development. The farm is in a designated agricultural area, which, with the approval of the local county board, is protected for farming purposes. Under the 1980 Illinois Agriculture Area Conservation and Protection Act, this designation may help farmers protect their land from encroachment and possible complaints from new residents to the rural area. Not many livestock producers are left in the area; in the past 4 years, 5 to 10 pig farms have closed their operations. Two miles east of the farm, there is a new high school and housing development.

Our farm has 1,450 breeding sows and since 1993 has been a closed herd. That means no animals have entered the farm; new genetics enter via semen used for artificial insemination of gilts and sows. We do this to reduce the risk of introducing diseases into our herd. We produce gilts from pure Landrace and York grandparent stock; this cross results in females with good maternal traits, such as milking ability and calm demeanor. Gilts are bred to terminal Duroc-Hampshire sires to produce commercial pigs.

In Illinois, we raise weaned piglets and feeder pigs that are transported to 8 contracted production sites in Iowa to be finished. We process our animals at a producer-owned plant in Rantoul, Ill, and market our product through Meadowbrook Farms.

Changing Gestation Systems

Over the course of 30 years, we have had many different gestation housing systems on the farm. We have managed gestation in pens with open-front sheds and in pens in enclosed buildings. Pens with open-front cattle sheds worked well in the spring and fall, but were difficult to manage in extreme weather. We lived through winter storms that covered the sows with snow. In the summer, heat and humidity were also difficult to manage. Floors were not appropriate, and routine activities, like pen cleaning, were difficult to perform. We observed feet and leg injuries among the sows that were caused by the equipment used to clean these sheds. Building design did not allow us to observe animals and offer individual care or feeding. This translated into great variation in sow body condition scores. Aggression was also a problem. We observed fighting between the sows, which resulted in sows being scratched or injured. In retrospect, we feel that the sows' welfare was compromised in these adapted facilities.

We now house all sows in individual gestation stalls inside totally enclosed buildings. We can now offer individual sow care, we can monitor individual feed intake, and we can dispense individual treatments. We are now able to control the environment. Routine activities, like manure removal, are easier and safer for the caretaker to accomplish. Because animals receive their full, intended rations, we have improved the herd's overall body condition. We have also reduced the number of treatments administered to animals injured in fights, and injuries caused by mounting behavior during estrus have completely disappeared. Although space is limited in these stalls, the sows can stand, sit, and lie down comfortably in every stall. We provide enough space and have designed our stalls such that sows do not have to rest their heads on feeding troughs or injure themselves with the back gate or lateral bars. The slatted floors allow us to keep stalls free of manure and dry. Protection from the weather, individual feeding, individual management, and individual housing have improved our herd's welfare, and evidence of this is the herd's productivity.

Our reproductive parameters have improved substantially since we moved our sows and breeding from pens to stalls. Fifteen years ago, we averaged 9.3 pigs weaned/litter and 19 pigs weaned/sow/y. Today, our farrowing rate is 87%; the farm's average litter size (ie, number of pigs born alive) is 11.3 piglets; we wean an average of 10.9 piglets/litter and wean 26 pigs/sow/y.

Replacement gilts are identified in the farrowing house and raised on the farm. After the nursery phase, these gilts are raised in totally enclosed buildings. Some are in pens with partially slatted concrete floors, and some are in pens with totally slatted concrete floors. The buildings are naturally ventilated by means of tilt doors and a ridge vent. Supplemental heat is provided with gas heaters. Designated hospital pens for ill or injured gilts and sows are available in each building. Pens are equipped with self-feeders and a nipple

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drinker. Twenty-five gilts are housed per pen until they are bred at approximately 8 months of age and 300 lb.

Breeding and gestation facilities house females in individual stalls with partially slatted floors. The buildings are naturally ventilated with sidewall curtains and a ridge vent. Gas heaters provide supplemental heat; a drip or evaporative cooling system aids in cooling animals in the summer. Heating, ventilation, and cooling systems are thermostat controlled. Females are provided with individual drop-tube feeders, and a nipple drinker provides a continuous source of clean and high-quality water to each stall.

Farrowing is in stalls with plastic slat floors. Plastic floors are easy to clean; hygiene is important in the farrowing stalls because piglets are born with a limited immune system and require a clean environment to thrive. Plastic can be easily washed and disinfected and is stable when treated with commonly used disinfectants. Plastic slatted floors dry fast and, because of this, maintain a good environment for the pigs. The low temperature conductivity of plastic floors also benefits piglet welfare. Young piglets have low glycogen reserves, leaving them prone to hypothermia. With low temperature conductivity, plastic floors do not modify piglet body temperature as much as other materials would. Finally, plastic is less abrasive than concrete, reducing the risk of injury to sows and piglets.

Buildings are ventilated with sidewall exhaust fans. Supplemental gas heaters are provided in the room, and drip coolers are available in each farrowing stall. Ventilation, heaters, and coolers control the macroclimate inside the farrowing facility. Each farrowing stall is equipped with a sow feeder and nipple drinker. The sow is confined to the center of the stall and limited by creep bars. These allow free movement for the sow to stand, sit, and lie down fully on her side, while offering additional protection for the piglets, preventing them from being stepped on or lain on. The bars do not limit piglet suckling activity in any way. Piglets can move freely and safely around the sow. They have space to rest away from their mother in areas called creeps that are supplemented with heat lamps. Sows and piglets have different thermal needs during the lactation period, and supplemental heat sources provide piglets with their own adjustable microclimate to avoid hypothermia, especially during their first days of life. We take animal welfare seriously on our farm, and reducing environmental stress for pigs of all ages is an important part of this.

Piglets are moved into nurseries or directly into finisher facilities as the buildings become available. Nursery barns house piglets in pens of 25. Piglets entering the area are sorted by size; this routine practice has clear welfare implications for the piglets. It gives all of them the same opportunity to access feeders and drinkers and reduces injuries to smaller, weaker piglets. Pens have plastic slat flooring. Buildings are enclosed with sidewall exhaust fans and pits. Supplemental heat is provided with gas and radiant heaters. There are self-feeders and nipple drinkers in each pen. Hospital pens are reserved for piglets that need to be treated and separated from their penmates to aid in their recovery.

Growing-finishing facilities house pigs in groups of 25. Floors are partially or totally slatted. Sidewall curtains control ventilation, and heat is supplemented with gas heaters. Self-feeders and nipple drinkers are provided in each pen. Hospital pens are available for pigs that require treatment. Pigs are processed at approximately 145 days of age and 265 to 270 lb.

We manufacture 95% of the feed on farm with the aid of our consulting veterinarian and nutritionist. We consider this to be ideal, as it allows us to make batches of feed for individual buildings or groups of pigs on the farm; this way, we can meet our sows' and pigs' needs and requirements and maintain excellent body condition scores.

Employees

We employ 12 full-time people at our farm. All of them are very important in the day-to-day operation of the farm; their experience working on the farm varies from 1 to > 25 years. Our consulting veterinarian and area managers developed the training program used on the farm.

All employees are certified in the National Pork Board's Pork Quality Assurance Level III program[1] (Appendix) and involved in the Swine Welfare Assurance Program (SWAP).[2] Our drivers are all certified in the Trucker Quality Assurance program,[3] and certification is required for all truckers delivering at our Meadowbrook Farms plant. These programs help us reinforce our animal welfare policies with all employees and are an important part of our training.

We are committed to being a responsible party in our community. As a part of this, we actively work to be good environmental stewards. We participate in programs developed by the Soil and Water Department of the USDA and follow the guidelines included in the National Pork Board's Comprehensive Nutrient Management Plan.[4]

I encourage employees to attend workshops organized by extension specialists, the National Pork Board, and our consulting veterinarian. To reinforce this, we have adopted an incentive program based on training, experience, and goal achievement. This program has been very rewarding for our employees, providing them with opportunities to learn and advance within our company.

Farm Activities

We work 7 days a week, and at least 1 person is at the farm from 6 o'clock in the morning to 5 o'clock in the afternoon, every day. Employees stagger their days off so no area in the farm is ever left unattended. All areas are monitored by an alarm system after hours. The system can detect problems such as a loss of electrical power and contact a central telephone forwarding station in case of an emergency. Calls are forwarded to a list of contact numbers belonging to farm personnel. A written contingency action plan exists and is known by every employee. The plan includes a detailed list of actions to be taken in case of an emergency and the names and telephone numbers of people to call in specific emergencies. For medical emergencies, we use 911.

The farm maintains a written herd health program developed with the help of our consulting veterinarian and the herd manager. The consulting veterinarian

monitors herd health during quarterly visits to the farm and is available by telephone at all times. He conducts the SWAP assessments on our farm. His SWAP report has helped us set priorities regarding animal welfare. We give priority to any maintenance problems or repairs needed to equipment or facilities, especially if they have the potential to hurt our sows, pigs, or workers. Training or retraining opportunities have also been discovered through SWAP and have been resolved. For example, after our first SWAP assessment, we retrained all farm personnel in neonatal piglet processing.

We maintain strict biosecurity guidelines that are known by all of our employees. Our employees shower in and shower out of our facilities and are provided with clothing and shoes or boots for on-farm use. They are not allowed contact with other pigs, and for any one of us who has contact with pigs outside our farm, we require 48 hours of downtime before entering the facilities again. We adopted these measures to reduce the risk that diseases would be introduced to our herd. Visitors to our facilities follow our guidelines as well.

We maintain written and electronic production records at the farm. Each area has a set of forms that are filled out on a daily basis. Sows in gestation and farrowing have individual sow cards that identify them and the stage of production they are in. This helps us individualize their care, feeding, and management. Records are essential for managing the farm. They allow us to identify changes in production that can indicate health or welfare opportunities in our facilities.

Our daily activities at the farm are, I consider, standard for the industry. Sows in the gestation and farrowing barns are fed, and their water system is checked. We walk through the buildings assessing temperature, ventilation, and air quality of the barns, as well as the state of equipment and floors, noting repairs, if any are needed. Gestation barns are pressure washed twice a year. Throughout the rest of the year, routine cleaning includes manure removal, cleaning alleys, and removing old feed from feeders and troughs.

In the farrowing house, sows are hand-fed so that we can record intake. Sows that have farrowing problems are checked, and interventions and treatments are dispensed as needed. Piglets are treated as needed and their microenvironment adjusted, if required. The farrowing house is cleaned and disinfected between farrowing groups.

We monitor the health status and welfare of all sows in gestation and in the farrowing house every day. We look for animals that don't stand to be fed; those with wounds, scratches, or abscesses; and those that show signs of discomfort. We take this opportunity to note each sow's body condition score and adjust the amount of feed the sow will receive. Sows being treated are checked to determine their health status and response to treatment. Our caregivers, managers, and laborers are trained to understand and recognize abnormal behavior. Any problems are documented, and the farm manager and attending veterinarian are consulted as needed.

Our growing pigs are also monitored daily. We walk through the building assessing temperature and air quality and making sure feeders are in working order and water is available. All equipment, floors, and pens are checked to see whether they are in need of repair or present a risk to animals or workers. At the same time, we observe the animals, separating and treating those that might be sick or injured. All barns are cleaned and disinfected between groups of animals.

We feel we have a responsibility to keep our animals healthy and comfortable. If their well-being is compromised and treatment or other intervention is not successful or represents more discomfort to the animal, we choose to euthanatize the animal humanely. We have a euthanasia action plan as described in the booklet *On farm euthanasia of swine—options for the producer*.[5] The plan was developed with the help of our consulting veterinarian and herd manager. All euthanasia is done with methods that are humane and approved by the American Association of Swine Veterinarians. Employees are trained to perform these functions correctly and humanely under a manager's supervision.

Animals moved within the farm are moved with rattle boards and panels. We have trained our staff to minimize stress when moving gilts and sows and to recognize behavioral signs indicating that pigs are frightened. We understand that this not only improves the pigs' well-being but facilitates our work. We do not use hot shots (also known as electric prods) to move or load gilts and sows. Pigs requiring transport within the farm or to outside facilities are moved in hydraulic trailers, a modified school bus, or a flat-floor semitrailer. Before animals are moved, we walk through the transport vehicle, loading and unloading ramps, and receiving facilities to make sure they are safe for our pigs. We make sure that floors are clean and dry, that loading ramps are steady and not slippery, and that receiving pens have water and feed available.

We take pride in our facilities, and we understand that the community's impression of our farm depends on how visually appealing and clean our facilities look from the outside. We keep all outdoor areas clean and mowed. Exterior building appearance is constantly maintained.

As a pork producer in such close proximity to the urban sprawl, it is my responsibility to help my neighbors understand agriculture and the livestock industry. Our farm has hosted 1,200 visitors in a special event called Farm/City Day. For 15 years, we have also hosted a program called "Teachers on an Agriscience Bus," during which teachers visit agriculture-related businesses to learn about them. Through this program, we have reached over 60,000 students. During their visits, our guests will ask many questions, some of which are directly related to animal welfare. I feel it is our responsibility to answer these questions truthfully and professionally. If we cannot answer, we always offer to refer the questions to the people who can.

Conclusion

I have been a pork producer for more than 30 years. My family and I are proud to be pork producers, and we understand that a successful operation requires that animals be healthy and comfortable. Every employee on our farm understands this. Just as we approach other important issues in the industry, we approach animal welfare as an opportunity to improve the life of our animals, our farm, and the swine industry.

References

1. Pork Quality Assurance Level III. National Pork Board Web site. Available at: www.porkboard.org/PQA/default.asp. Accessed Nov 5, 2004.
2. Swine Welfare Assurance Program. National Pork Board Web site. Available at: www.porkboard.org/SWAPHome/default2.asp. Accessed Nov 5, 2004.
3. Trucker Quality Assurance. National Pork Board Web site. Available at: www.porkboard.org/TQA/intro.asp. Accessed Nov 5, 2004.
4. Comprehensive Nutrient Management Program. National Pork Board Web site. Available at: www.porkboard.org/environment/Programs/cnmp.asp. Accessed Nov 5, 2004.
5. American Association of Swine Veterinarians and National Pork Board. *On farm euthanasia of swine—options for the producer*. Available at: www.aasp.org/aasv/euthansia.pdf. Accessed Nov 5, 2004.

Appendix

Description of programs sponsored by the National Pork Board.

Swine Welfare Assurance Program (SWAP)
Major concern: Animal welfare.
Program description: The SWAP is an assessment program that benchmarks animal welfare practices. Individual production sites are assessed by a Certified SWAP Educator for adherence to 9 principles of swine care and well-being; the facilities, individual animals, and record-keeping practices are all evaluated. Assessment results are used to identify opportunities for improvement.

Pork Quality Assurance (PQA) Program
Major concerns: On-farm animal welfare, animal health, and public safety.
Program description: Individuals enrolled in the PQA program review the 10 good production practices with a PQA instructor. These practices focus mainly on managing herd health, hazard analysis and critical control points, and issues related to public safety. Individuals completing the program can be certified by the National Pork Board. The goal is to ensure production of quality pork products. The PQA program includes reviews of health plans, euthanasia plans, and the administration and recording of treatments.

Trucker Quality Assurance (TQA) Program
Major concern: Animal welfare during transport.
Program description: Individuals enrolled in the TQA program review the importance of proper handling, loading, and transporting of pigs, with a focus on animal welfare and biosecurity issues, with a TQA instructor. Individuals completing the program can be certified by the National Pork Board.

Comprehensive Nutrient Management Program (CNMP)
Major concern: Environmental issues.
Program description: The CNMP represents a technical guide for incorporating environmental conservation practices on the farm. It results in a comprehensive plan that allows a producer to choose the most appropriate manure-handling practices for that producer's farm.

Sow housing: opportunities, constraints, and unknowns

John Deen, DVM, PhD, DABVP; Sukumarannair S. Anil, BVSc, PhD; Leena Anil, BVSc, PhD

The provision of adequate housing for gestating sows needs to be part of an overall program of care for swine on pig farms. Although the discussion has often been reduced to the question of whether to use gestation stalls, this is far from the place where such discussions should begin.

The proper provision of adequate welfare for sows, pigs, farmed animals, and even people is an unending challenge. There are innumerable opportunities for improvement that are constrained by ignorance, lack of intent, and limited resources.

The provision of welfare, particularly as it relates to policy, is thus a classic economic problem. It is a problem of trying to meet unlimited needs with limited resources. Optimization models are often created to answer such complex questions, even as they relate to welfare concerns.[1] The problem with creating such models is not in identifying the resources and capabilities of farms. It is in identifying the objective function or, in other words, identifying the components of welfare and determining how much various changes contribute to the well-being of pigs.

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Elements of Welfare

A number of approaches have been used to summarize the basic elements in the delivery of welfare. The most commonly quoted approach involves what are called the 5 freedoms. These freedoms were derived

from a review[2] (commonly called the Brambell report after its lead author) performed in England into the welfare of farmed animals in intensive farming systems. The 5 freedoms are commonly listed as follows:

- Freedom from thirst, hunger, and malnutrition.
- Freedom from discomfort.
- Freedom from pain, injury, and disease.
- Freedom to express normal behavior.
- Freedom from fear and distress.

Interestingly, there have often been reactions to the use of the term freedom in relation to farmed animal welfare, and it has been suggested that these 5 freedoms would be better presented as the 5 needs.[3] This reaction is particularly common in the United States, where freedom has been treated as an absolute in many discussions. As veterinarians, however, we recognize that absolute freedom from these conditions is impossible. On a daily basis, farms are faced with starvation of young piglets due to inadequate access to milk, dehydration due to diarrhea, and chilling due to inadequate heat sources, and they face constant challenges associated with infectious and metabolic diseases. Dr. John Webster,[4] one of the authors of the 5 freedoms, suggests the following:

> "When put to work by comparing different housing systems, the 5 freedoms are an attempt to make the best of a complex situation. Absolute attainment of all 5 freedoms is unrealistic. By revealing that all commercial husbandry systems have their strengths and weaknesses, the 5 freedoms make it, on the one hand, more difficult to sustain a sense of absolute outrage against any particular system, such as cages for laying hens or stalls for sows, and easier to plan constructive, step-by-step, routes towards their improvement."

In comparison, when the National Pork Board listed its comprehensive goals in swine care, there was an expansion on the 5 freedoms, with a focus on the responsibilities of the caregivers[5]:

- Providing facilities to protect and shelter pigs from weather extremes while protecting air and water quality in the natural environment.
- Providing well-kept facilities to allow safe, humane, and efficient movement of pigs.
- Providing personnel with training to properly care for and handle each stage of production for which they are responsible with zero tolerance for mistreatment of swine in their care.
- Providing access to good-quality water and nutritionally balanced diets appropriate for each class of swine.
- Observing pigs to make sure basic needs for food and water are being met and to detect illness or injury.
- Developing herd health programs with veterinary advice.
- Providing prompt veterinary medical care when required.
- Using humane methods to euthanatize sick or injured swine not responding or not likely to respond to care and treatment in a timely manner.
- Maintaining appropriate biosecurity to protect the health of the herd.
- Providing transportation that avoids undue stress caused by overcrowding, excess time in transit, or improper handling during loading and unloading.

Such a list suggests that there is a body of knowledge that is continually being refined and that the proper application of that knowledge in a consistent and careful manner constitutes welfare. To measure compliance with these goals, the National Pork Board has created a formal assessment program called the Swine Welfare Assurance Program (SWAP).[6] This program measures compliance with specific goals in the areas of herd health and nutrition, caretaker training, animal observation, body condition score, euthanasia practices, handling and movement, facilities, emergency support, and continuing assessment and education.

In the SWAP, these 9 areas are called the care and well-being principles, and measures are provided for each area. Programmatically, assessors are trained to work with producers and assess the level of compliance with the principles outlined in the program. The program has identified shortcomings specific to farms and to the industry as a whole. Important concerns, such as the rapid and skillful use of methods of euthanasia, have been identified for further emphasis in training.

Creating Models for Allocation of Resources

A major problem is that there are differences between researchers, farmers, and the general public in regard to the importance assigned to the various components of welfare. Moreover, maximizing any 1 component while ignoring the rest is inherently wrong. Additionally, there is a law of diminishing returns for most components. As a result, the first aim is typically to avoid extremes for factors such as ambient temperature and feed, space, and water allocations. Maximizing the availability of each factor sequentially creates a ridiculous and unsustainable method of caregiving. In other words, not only are there multiple factors that are difficult to compare, but the effects of each are curvilinear.

It is always attractive to simplify such equations and assume that the resulting answers are correct. We can lessen the number of variables that are considered to be components of welfare. We can assume that the factors that are most easily classified and visualized are the most important. In fact, it is quite evident in discussions concerning the welfare of swine, and particularly sows, that visual measures are overemphasized. Interestingly, many measures of human welfare policy are quantifiable. We measure infant mortality rates, longevity, availability of food, and distribution of health care. However, we do not see equivalent measures discussed in farm animal welfare, and it may be that we as veterinarians are to blame, in that we rarely

discuss concerns such as high mortality rates in terms of the welfare of animals.

Even worse, we often assume a causality that extends the benefits of certain changes in caregiving to other concerns. An example is the argument that restricting gestation stalls would also restrict the creation of industrialized hog factories.[7] In fact, there is no evidence that the adoption of stalls is scale dependent or that their use is common in the industry across different sizes of farms.

We have a real, complex model of animal care that needs real expertise. We have a swine population that has pigs that are dying from the primary or secondary effects of starvation, contend with painful conditions such as lameness, die from the secondary effects of chilling, are exposed to agonistic behaviors when populations are mixed, are infected with pathogens, and are exposed to innumerable other factors that affect their well-being. There is a primary expert on the judicious allocation of resources to meet these competing and sometimes conflicting needs. That expert is the farmer, who needs to be empowered to do the correct things, to treat conditions as they occur, and, even more importantly, to prevent conditions before they occur. It is essential that these caregivers remain empowered to address complex matrices of demands and resources as they are presented on the individual farm.

Housing Gestating Sows

Housing gestating swine is 1 element of that swine care matrix. A criticism of SWAP is that it does not measure the use of gestation stalls. This, in part, is due to the lack of a definitive housing system that addresses all welfare concerns.[8] There is considerable variation in the results seen across different housing systems, and there is a need for continued refinement in alternatives to stalls. Housing for gestating sows has a number of requirements. The first requirement is to keep sows protected from the environment, whether it be heat, precipitation, or cold. The second is to protect sows from aggressive acts from other sows. Mixing of sows, particularly after weaning, can result in lameness, skin wounds, infertility, and exhaustion. Sow housing must also include a feeding system that avoids excessive competition for feed, resulting in obesity in some and starvation in others. Moreover, employees should be protected from aggressive behaviors. Finally, there are a number of financial costs associated with each housing system involving building, bedding, heating, and feed costs. For the sows themselves, there are also costs in terms of hunger, weight control, exposure, and irritation. Identifying and prioritizing the needs of sows is an area of considerable controversy. It is interesting that boredom is often defined as a concern by public critics,[9] although rarely identified in the same manner by farmers. As a generalization, it appears that aberrant behavior identified by researchers as being caused by boredom is identified by farmers as being caused by an unacceptable environment. This difference identifies a reliance on anthropomorphism in some theories of causation that may have more direct associations.

Although anthropomorphic evaluation of stalls results in an obvious answer, evaluation of stalls in comparison to other housing methods results in a less defined answer. Results are inconsistent, in part because there are different emphases on various measures of welfare and in part because there is no single model of stalls or group housing.[8] Studies of housing systems should first be used for refinement, rather than differentiation.

One example is recent work that we performed on injury levels in sows in stalls versus sows in a group housing system that used an electronic sow feeding system. Although total injury scores were lower for sows in stalls than for sows in the group housing system, the important finding was that how injuries were generated differed substantially between housing systems.[10] Injuries to the skin of the shoulder region and neck after mixing and to the vulva during late gestation were the major injuries seen among sows in the group housing system. Injuries to the skin of the shoulder region and neck were a result of fighting, and the vulvar injuries were associated with jockeying among sows as they attempted to enter the feeding station. Our findings, therefore, point to the need for better methods for socialization and to prevent queuing for food among sows in group housing systems. Conversely, sows in stalls had injuries that were best predicted by the height of the sow relative to the width of the stall.[11] As sows grew larger, the number of injuries increased, showing that a standard-size stall does not fit the whole population of sows. Different stall sizes thus would prevent injuries but add a layer of complexity to operations on swine farms.

Thus, a simple condition of prohibiting gestation stalls will not have straightforward results. If the aim is to induce farmers to improve the well-being of sows, there must be discussion and, often, a model of improvement across multiple rearing stages and multiple measures of well-being. Success must be measured in such a manner, and successes are seen daily, as are areas for improvement.

Summary

As Webster[4] has stated, we have real opportunities to provide incremental improvements to a whole range of welfare factors. We need a disciplined approach that takes into account the skills of farmers, veterinarians, and the whole range of other specialists involved in animal agriculture. Improvement is best based on a model of discovery, transparency, and dialogue. Combative models impede discovery and dialogue, and the animals are the most likely to suffer when we create such a scenario. Veterinarians have a real opportunity to aid swine farms in identifying opportunities and allowing for a transparent portrayal of activities on the farm.

References

1. Huirne R. Farm animal welfare in an economic context, in *Proceedings*. Sustainable Agriculture Production Workshop. Available at: agriculture.de/acms1/conf6/ws5aeconom.htm. Accessed Nov 1, 2004.

2. Brambell FWR. Report of the technical committee to enquire into the welfare of animals kept under intensive livestock husbandry systems. Command Paper 2836. London: Her Majesty's Stationery Office, 1965.

3. Gregory NG. Animal welfare and meat science. New York: CAB International, 1998;1–14.

4. Webster J. Assessment of animal welfare: the five freedoms. Alberta Farm Animal Care Web site. Available at: www.afac.ab.ca/fivefreedoms.htm. Accessed Nov 1, 2004.

5. Swine welfare fact sheet. Vol 1(1). Des Moines, Iowa: National Pork Board, 2002.

6. Swine Welfare Assurance Program. Des Moines, Iowa: National Pork Board, 2003.

7. Abolishing gestation crates and farrowing stalls. The Animals Voice Web site. Available at: www.animalsvoice.com/PAGES/features/pigs1.html. Accessed Nov 1, 2004.

8. McGlone JJ, von Borell EH, Deen J, et al. Review of scientific literature comparing housing systems for gestating sows and gilts using measures of physiology, behavior and productivity. *Prof Anim Scientist* 2004;20:105–117.

9. The serious welfare problems associated with housing sows in gestation stalls and the immediate need for implementation of group-housing systems. Available at: www.avmahurtsanimals.com/gest.html. Accessed Nov 1, 2004.

10. Anil L, Bhend KMG, Baidoo SK, et al. Comparison of injuries in sows housed in gestation stalls versus group pens with electronic sow feeders. *J Am Vet Med Assoc* 2003;223:1334–1338.

11. Anil L, Anil SS, Deen J. Evaluation of the relationship between injuries and size of gestation stalls relative to size of sows. *J Am Vet Med Assoc* 2002;221:834–836.

Welfare challenges in sow housing

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In most of our interactions with animals, there is at least some overlap between our interests and theirs. For instance, it is to the benefit of both farmers and their stock if the latter are healthy. Many of the practices involved in pig keeping are based on this mutual benefit, and recognition of this can be thought of as enlightened self-interest on the part of the farmer. Rollin[1] has suggested that good husbandry can be summed up by the maxim "I take care of the animals, the animals take care of me." However, Rollin goes on to say that "[i]ndustrialized, high-technology agriculture has given us the ability to move beyond our implicit contract with the animal, to move beyond keeping square pegs in square holes. We can now ... fit animals into environments which are good for us without necessarily being good for them."

There is increasing public concern in many countries about this tendency and its implications for farm animal welfare. This includes concerns about the welfare of pregnant sows and their housing, especially the use of individual crates or tethers throughout gestation. Yet many pig producers and their representatives dismiss such concerns. The National Pork Board,[2] for example, says that "[b]ecause the welfare of their animals directly affects their livelihood, pork producers work to ensure their animals are treated humanely. Anything less would be self-defeating."

The present article considers the welfare challenges of sow housing and the basis for such diverse opinions.

Challenges

Crates and tethers do offer challenges to sow welfare, as they considerably restrict movement, particularly foraging, which is an important component of behavior in these food-restricted animals. Frustration of foraging instincts often results in stereotypic behaviors,[3] which are generally interpreted as indicators of reduced welfare.[4] There are also welfare problems in group housing, such as aggression between sows, but these problems are mostly amenable to management, whereas the problems of crates and tethers are more integral to those systems.

The welfare implications of sow housing offer challenges to all the people involved in decisions about such housing. Those most immediately involved include producers (eg, farmers, companies, workers, and contractors), intermediaries (eg, packers, processors, transporters, and retailers), and the consumers purchasing the produce. Others with an input, including input on issues such as social and environmental impacts, include legislators, extension agents, inspectors, auditors, production researchers, other researchers, veterinarians, meat inspectors, and food safety specialists. Yet others more peripherally involved include economists, philosophers (including ethicists), sociologists, educators, animal advocates, other advocates, media, and public health specialists. Indeed, all citizens have some involvement in and responsibility for animal agriculture, a role that may be distinct from their role as consumers and independent of whether they actually purchase meat products. Lastly, consideration must be given to 2 other categories of stakeholder, although these must be represented by individuals: communities affected by pig production and the environment.

Approaches to Welfare

One reason for the diverse opinions on the welfare implications of sow housing is that attitudes toward animals and their welfare vary widely. Among people who give consideration to animal welfare, there are 3 common approaches to the question of what welfare actually is, and individuals may believe any 1 of these or a mixture of 2 or 3.[5,6]

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First, animal welfare may be seen to concern physical health and fitness so that problems such as disease and injury are the most important challenges to welfare. Second, welfare may be seen to concern mental feelings such as pleasure and suffering. Third, welfare may be seen to concern the ability of animals to express their intrinsic nature by, for example, living in natural conditions.

Many producers tend to emphasize the physical aspects of welfare, such as health and growth. The same is true of veterinarians and many scientists working to increase agricultural efficiency. The general public, by contrast, tends to emphasize both the mental aspects, such as suffering, and the aspects concerned with naturalness. Not surprisingly, these groups form correspondingly different conclusions about animal treatment. For example, interviews in the Netherlands showed that farmers who housed their livestock in intensive systems felt they treated their animals well because the animals were healthy. However, consumers felt that welfare was poor because the animals lacked freedom to move and to fulfil their natural desires.[7] Producers are more affected by the economics of animal production than are other members of the population, so the balance they strike between human and animal interests is likely to be different. However, even the attitudes of the public are constrained by other factors, such as food prices.

Individuals and Groups

There is a second important exception to the rule that benefits to animals and farmers are mutual. Farmers are generally concerned with animals as a group. For many farmers, the main criterion is not the growth rate of each particular animal and the profit gained from it, but the performance of the herd as a whole and the economic balance sheet of the entire herd. So farmers are likely to increase stocking density, for example, because they can then keep more animals in the same pen. Crowding usually reduces the growth rate of each animal—as well as its welfare—but the total profit from the pen will be more.

Other aspects of the drive for efficiency in animal agriculture that affect the relationship between farmers and their animals are the increase in herd size and the restrictions placed on the amount of time spent in husbandry. Together, these result in farmers having less opportunity to get to know individual pigs, if they wish to do so, and much less time to give individual care to each animal.

Ethics and Economics

Turning to the relationship between economics and sow welfare, there are many instances when improvements in welfare (eg, measures to reduce disease and mortality rates) will reduce the costs incurred by farmers. However, there are other instances when improving welfare (eg, increasing space allowances for sows) would increase costs. Sometimes increased costs can be offset by increased income, as, for instance, when price premiums are paid for products that are perceived to be associated with high welfare, such as free-range meat. More usually, however, reducing cost has taken priority over increasing welfare. An important point to recognize is that profits achieved by cutting costs are short term, as they are constantly pared away by competition on prices. Yet some such cuts—including those achieved by reducing space allowances—have produced long-term reductions in welfare.

Despite the relationship between cost and welfare on farms, it turns out, surprisingly, that major improvements in pig welfare could be achieved with only minor increases in the price paid for food by consumers. As an illustration, the capital costs of pork production (housing and so on) typically account for about 10% of production costs. Suppose we double the space and facilities provided for the pigs, increasing production costs by 10%, and introduce new disease control measures at a cost that also amounts to 10% of the original total. Cost of production has then been increased by 20%. When a consumer buys a pork meal in a supermarket or restaurant, the cost of meat products in that meal accounts for only about 5% of its purchase price. So increasing the cost of production by 20%, with considerable improvement in pig welfare and food safety, need only add 1% to the price of the meal. Most consumers would not even notice such a change and would support it if asked.

A real example is provided by the United Kingdom ban, for welfare reasons, on the use of stalls and tethers for pregnant sows, which took effect in January 1999. McInerney[8] estimated that this would increase pork production costs by 5%, but retail prices, which include transport, packing, and marketing, by only 1%. Householders might buy slightly less pork than hitherto, so their expenditures on food would be unchanged or decrease by perhaps 0.03%. Meanwhile, it should be possible for farmers to maintain their profits, offsetting increased costs with increased selling prices.

An obstacle to such change, however, is what may be called economic inertia. Producers tend to resist legislation and pressure from intermediary buyers to improve conditions for animals because in existing price structures, buyers continue to expect low prices. Any increased cost of production would therefore be borne by producers, and they would suffer losses or reduced profits, at least short term. But if these short-term effects can be avoided, by making changes gradually or deploying public subsidies, a new situation with increased costs and increased income from increased food prices need not be disadvantageous for producers.

As it is true that sow welfare could be increased with only minor effects on food prices, ethical considerations suggest that mechanisms should be sought to achieve this. As such, the welfare challenges of sow housing are primarily matters of communication and consensus. If farmers, veterinarians, retailers, consumers, and the government talk to each other about how to produce the sort of food people actually want, we should be able to agree on how to improve the welfare of pigs.

References

1. Rollin BE. Animal production and the new social ethic for animals. In: Baumgardt B, Gray HG, eds. *Food animal well-being: conference proceedings and deliberations*. West Lafayette, Ind: USDA and Purdue University, 1993;3–13.

2. National Pork Board. Animal care: overview. Available at:

www.porkscience.org/dispTopicOverview.asp?topic_id=3&TID=3&level=1&TPID=3&tier2ID=. Accessed October 2004.

3. Appleby MC, Lawrence AB. Food restriction as a cause of stereotypic behaviour in tethered gilts. *Anim Prod* 1987;45:103–111.

4. Lawrence AB, Rushen J. *Stereotypic animal behaviour: fundamentals and applications to welfare.* Wallingford, UK: CAB International, 1993.

5. Duncan IJH, Fraser D. Understanding animal welfare. In: Appleby MC, Hughes BO, eds. *Animal welfare.* Wallingford, UK: CAB International, 1997;19–31.

6. Fraser D, Weary DM, Pajor EA, et al. A scientific conception of animal welfare that reflects ethical concerns. *Anim Welf* 1997;6:187–205.

7. Te Velde H, Aarts N, van Woerkom C. Dealing with ambivalence: farmers' and consumers' perceptions of animal welfare in livestock breeding. *J Agric Environ Ethics* 2002;15:203–219.

8. McInerney JP. The economics of welfare. In: Michell AR, Ewbank R, eds. *Ethics, welfare, law and market forces: the veterinary interface.* Wheathampstead, UK: Universities Federation for Animal Welfare, 1998;115–132.

Experiences with alternative methods of sow housing

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The housing of gestating sows is one of the most controversial issues in farm animal welfare and swine production. The welfare status of animals housed in the various systems that are currently available is widely debated among swine producers, consumer and animal interest groups, and scientists. The approaches taken by different jurisdictions to implement changes in commercial production practices also differ widely and sometimes confuse the primary issue of ensuring animal welfare. In this presentation, I will outline what I perceive to be the key welfare issues concerning housing of gestating sows and my experiences with various alternatives to conventional stalls.

Key Welfare Issues

Although freedom of movement is generally cited as the key welfare issue for gestating sows, this freedom is itself open to some interpretation, and several other welfare issues must also be considered when recommending a housing system.

Freedom of movement—A review[1] (commonly called the Brambell report after its lead author) of the welfare of farmed animals in intensive farming systems stated that "[a]n animal should at least have sufficient freedom of movement to be able, without difficulty, to turn round, groom itself, get up, lie down, and stretch its limbs." This statement refers to what is often termed dynamic space, or that space necessary to change postures and perform certain behaviors in place. Although this statement was made in the context of a discussion on natural behavior, the emphasis arising from this listing of freedoms was on postural changes.

The Farm Animal Welfare Council[2] later expanded on this concept of space by stating that an animal should have the "freedom to express normal behavior by providing sufficient space, proper facilities, and company of the animal's own kind." It is important to note the shift from postural changes to a more comprehensive expression of behavior. I have suggested that the importance of freedom of movement arises from 3 needs of the animal: a sense of control over the environment, the opportunity to select the most comfortable microenvironment, and the benefits arising from increased exercise.[3] Marchant and Broom[4] demonstrated the latter by examining specific muscles and bones in sows housed for several parities in stalls or group pens. The muscles of sows kept in stalls were smaller than the muscles of sows housed in pens, which provided for freedom of movement, and their bone breaking strength was lower.

Freedom from aggression—Housing systems that do not involve stalls generally require pigs to live in groups and to be regrouped with unfamiliar pigs several times during their lifetime. Aggression among sows arises for 3 major reasons. The first form of aggression is aggression associated with regrouping. Pigs to a greater degree than other farmed animals will fight with unfamiliar animals in an attempt to either exclude them from the social group or establish dominance over them. The second form of aggression is aggression related to competition over limited resources, specifically feed. Sows are restricted to a limited amount of feed each day, and competition can be severe. The third form of aggression is the continuing low level of aggression within a group as animals maintain social order within the pen.

Aggression associated with regrouping and feed competition is a major concern for producers. To a large degree, the industry adopted gestation stalls to eliminate these types of aggression. Sows are frequently injured, usually in the form of scratches, during these aggressive episodes, but the damage is typically short-lived. Studies typically demonstrate that a high number of scratches occur among sows in group housing systems for several days or weeks after regrouping,

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but that these scratches heal by mid gestation. Aggression associated with competition for feed will result in mild injuries throughout the gestation period, but, more importantly, will affect access to feed.

Control over individual feed intake—Over the past few decades, we have amassed a considerable amount of knowledge on how to best feed sows. To achieve both high productivity and longevity, it is necessary not only to limit the amount of feed that sows consume, but also to maintain a certain level of body condition. Both fat and thin sows create problems. To achieve the desired level of body condition, typically expressed in terms of back-fat thickness, animals are periodically assessed and levels of energy and protein intake adjusted.[5]

To avoid the aggression associated with feeding and to achieve control over individual feed intake in sows, the industry moved first to feeding stalls and then to gestation stalls. Producers remain committed to the importance of controlling feed intake, perhaps even more so with the high levels of productivity expected on today's farms. Overly thin sows are recognized as a welfare problem. To be acceptable, a housing system must ensure that timid animals are able to access sufficient feed.

Environmental enrichment—The European Union has issued a directive that pigs should have access to manipulable material.[5] In most instances, this is straw. There are many benefits to providing straw or other forms of bedding to pigs, including thermoregulation, reduced hunger, protection from the floor, and increased activity. Had the European Union not already required an end to stall housing, the need to provide environmental enrichment would have shifted the industry in that direction.

Much of the North American pig industry exists in regions with little straw. Corn is the most common feed grain in North America, but stover (ie, the mature cured stalks of corn with the ears removed) is a poor bedding substrate. As a result, the industry has moved to liquid manure systems, which preclude the use of substantial amounts of bedding. To incorporate environmental enrichment in the form of bedding into sow housing would involve both developing a reliable supply of bedding material and a change in manure handling.

Static space—The Food Marketing Institute and National Council of Chain Restaurants have reintroduced the concept of static space as a welfare requirement.[7] Although they advocate freedom of movement as outlined earlier, they also state requirements in terms of space for sows to lie comfortably and safely. Specifically, they indicate that sows in stalls should be able to lie on their sides without their udder extending into the adjacent stall.

During their productive life, sows may double in body weight. They also increase in size as their pregnancy progresses. Narrow stalls may be sufficient to meet the static space requirements suggested for early-parity sows and sows in the first part of gestation, but be insufficient to meet static space requirements as sow size increases.

Alternative Housing Systems

Suggesting that we can classify housing systems as stalls versus group pens is overly simplistic. Various housing systems have been developed to address the previously described issues. Stalls are able to meet the needs associated with controlling aggression and feed intake, but fail in terms of providing space for natural behaviors. All group housing systems are challenged by their inability to completely eliminate aggression, but some types will accommodate the need to control intake and provide enrichment. There are 4 major systems for providing feed to sows in group housing systems. If you include management options such as floor type (slatted, partial slatted, and bedded), social grouping strategy (static vs dynamic groups), and timing of regrouping (weaning, prior to implantation, and after implantation), there are 72 combinations to consider. These should not be lumped together as "group systems" in any analysis of sow housing options.

Floor feeding—Many producers assume that group housing means floor feeding, as this was the system they remember from before stalls. The group of animals is fed by spreading their feed on the floor or ground. This is a very competitive situation, with dominant sows able to monopolize the feed and subordinate animals encountering both social and nutritional stress. Control over individual feed intake is never very good, but some management procedures can be used to improve the situation. Forming groups of similar-sized animals will result in more even competition for and distribution of feed. It is therefore important that all animals have similar feed requirements as well. To achieve these conditions, it is necessary to allocate animals into several groups, with each group being relatively small. Groups fed by means of floor feeding are generally managed on a static basis (ie, animals are not added to already existing groups). Providing more space in the feeding area and ensuring that the feed is widely spread will make it more difficult for sows to claim a disproportionate amount of the feed. However, this additional space increases the cost of the system, and low cost is the greatest advantage of floor feeding.

A recent article[8] described a floor feeding system used on a large commercial farm. Some of the key components were that the sows were kept in stalls for about 5 weeks before entering the group pens. This ensured that embryonic implantation was complete before regrouping occurred and allowed the manager to feed the animals individually for several weeks. The animals were penned in groups of 5 animals sorted by size and parity to minimize the negative aspects of feed-associated aggression.

The competition involved in feeding can be intense, and 10% to 15% of the sows may need to be pulled from such a system. European legislation is already suggesting that highly competitive systems will not be acceptable.[6] Our industry has embraced the importance of good sow nutrition, and this can only be achieved when control over individual feed intake is possible. If we are required to adopt group housing, then floor feeding will be used by producers who are concerned about capital costs in the transition. But in

the long run, systems that provide better control over feed intake will be necessary to achieve the productivity that we have come to expect on modern farms.

Short feeding stalls or trickle feeding—In trickle feedings systems, sows are fed in partial stalls that provide protection for their head and shoulders, but do not extend further into the pen area. This arrangement conserves space, compared with feeding stall systems, yet still attempts to achieve uniform distribution of feed among sows in a pen. In each feeding space, feed is supplied at a set rate representing the eating speed of the animals in the pen. Because feed is distributed at the same rate that the sows can eat it, no feed accumulates and it does not benefit a sow to move from space to space, attempting to steal from other animals. The system may be operated with a single drop of feed, in which case it is called a short-stall system. Animals must be sorted by eating rate, as sows eat much faster than gilts, and by feed requirement. The result is a number of small, uniform groups. Trickle feeding depends on social management of the animals. It has not been used extensively on large farms. Although popular for a time in the United Kingdom, it is not widely used in Europe. Conventional stall barns have been renovated to incorporate an inexpensive, modified trickle feeding system. It is not clear that such modified systems can adjust the rate of feed drop among groups, and the importance of this with this feeding system has yet to be determined.

Individual feed stalls—Before the swine industry adopted gestation stalls, many farms used feeding stalls as a means to control individual feed intake. Although sows were housed in a loafing area for most of the day, they were moved into stalls for feeding. Such a system can easily achieve uniform intake among all members of a group, and sows requiring additional feed can be topped up by hand. Traditionally, sows have been housed in relatively small groups, and the feeding stalls have been located in each pen. Larger groups are feasible, although provisions must then be made for individual supplementary feeding. The greatest drawback to the use of individual feeding stalls is the requirement for both stall and loafing space. With indoor production systems, this added expense can be substantial.

A feeding stall system can be made more efficient in terms of space and capital costs by time-sharing the feeding stalls among several groups of sows. Once a day, each pen of sows is released from their loafing area in rotation and given access to the feeding stalls. Although some mechanization of sow movement is possible, essentially one trades space and capital costs for labor costs. Sharing feeding stalls in this way allows stockpersons to observe each group of animals as they move from the loafing to the feeding area, and various procedures, from treatment to pregnancy checking or breeding, can be easily accomplished while the sows are confined. Large herds can be managed in this way through the use of static social groups. However, sow movement to the feeding stalls resembles a stampede, and facilities must be designed for both animal and stockperson safety. Preliminary results from studies[9,a] that used large social groups and time-shared feeding stalls indicate that sows in groups had fewer lameness problems and abrasions than did sows in conventional stalls, but had more scratches. It is not clear whether the reduction in lameness problems was a result of the daily movement to the feeding area or the use of bedded loafing areas.

Electronic sow feeders—Electronic sow feeders provide the greatest control over individual feed intake among all group housing systems. Each pen of animals has 1 or more feeding stations that the animals cycle through to obtain their specific daily allowance of feed. Each animal can be fed a different amount of feed, a different diet, or a blended ration of 2 basal diets. Daily feed allowances can be programmed to change as each sow progresses through pregnancy. Theoretically, therefore, all size and body condition combinations could be housed together, as each sow could have its own feeding program.

Electronic sow feeding systems are technically complex, involving computer programming, electronic identification, and the mechanics of station gates and feeders. Early systems had many problems, but most companies have now developed reliable equipment and support services. Nevertheless, a producer who is not adept at computer records should recognize that he or she would have to develop those skills to operate such a system effectively.

The relative cost of an electronic sow feeding system is highly dependent on the number of sows fed from each station. The larger the number of sows, the lower the cost per sow. It is recommended that sufficient feeders be provided that the entire group of animals can complete feeding in 14 to 18 hours. For mature sows, this limits the number of animals per station to 55 to 65. Gilts eat more slowly than sows, and the number of animals may have to be reduced if a group contains a large number of gilts. Increasing the number of sows beyond this point may result in increased competition and aggression at the feeder entrance, with the result that more animals will miss a feeding. Attention must be paid to training the animals to use the system and to the daily checking of feed records to detect animals going off feed.

We operate an electronic sow feeding system with sows housed on partially slatted floors without bedding. We are comparing static and dynamic (ie, new animals added to existing groups every 5 weeks) groups. We also add animals to the pens either before (within a week after breeding) or after (6 weeks after breeding) embryonic implantation. We have found few differences between the static and dynamic group management options. However, it should be noted that dynamic groups do not have new animals added weekly, as is the case with some commercial operations, but rather at 5-week intervals to reduce the frequency of regrouping prior to implantation.

In our experience, grouping sows prior to implantation reduced farrowing rates by about 5%, compared with rates when sows were grouped after implantation. Overall productivity, combining farrowing rate and litter size, was reduced among sows grouped prior to

implantation, but did not differ between sows housed in stalls and those grouped after implantation. There has not been any interaction of these main factors with parity of the sow, indicating that young animals were not at a disadvantage with an electronic sow feeding system.

Wider stalls—Conventional gestation stalls are criticized for denying freedom of movement to sows. Although it may seem obvious that stalls will never provide freedom of movement as defined by some welfare advocates, as an industry we have done little to avoid criticism. When a turn-around stall was developed in the 1980s,[10] the industry failed to adopt it. Yet this stall did allow animals to turn around without difficulty. Also, even though mature sow size has increased over the years, until recently, the industry has narrowed gestation stalls rather than widened them.

The Canadian Code of Practice suggests that sows should be housed in wider stalls as they increase in size with each parity,[11] but few producers manage their sows in this way. I suspect that many studies involving stalls have examined only gilts and young sows. Are we confident that productivity in older sows is not limited by stall size?

We are studying the relationships between sow size, stall size, and sow behavior and have initiated a long-term project looking at stall size and productivity this past summer. In the first part of this project, we observed females from gilts to mature sows in stalls ranging from 55 to 70 cm (22 to 28 inches) in width. Using the criteria suggested by the Food Marketing Institute and National Council of Chain Restaurants that sows should be able to lie on their sides without their udder extending into the adjoining stall,[7] we assessed the posture of sows during the 14th week of gestation. We found that sows spent 50% to 60% of the time lying laterally, that is, on 1 side. The proportion of that time that their udder protruded into the adjoining stall was dependent on both sow size and stall width. No definitive guideline has been given on the criteria for determining whether the udder was protruding into the adjoining stall, but if we used a value of 50% of the time that a sow was lying laterally, then a 70-cm-wide stall would be sufficient for all animals, but a 65-cm-wide stall would only be sufficient for gilts and small (ie, first-parity) sows. Whatever percentage is used as a criterion of acceptability, it is clear that larger sows would require wider stalls.

Our project will continue to examine productivity, behavior, and stress levels in sows in different-width stalls, but the industry should consider what it must do if it wants to retain gestation stalls in a high-welfare environment. Increasing the width of stalls, particularly for larger sows, would seem to be an appropriate action.

Importance of Management

We experienced a number of management problems with our electronic sow feeding system. Our sows were developing lameness problems at an unacceptable rate, and we identified the problem as being slippery floors. We made some changes to the pens that shifted the dunging patterns away from the solid area of the pen and installed sprinklers to facilitate cleaning of the slats. The problem was not directly related to the electronic sow feeding system, but to our management of the partially slatted floor.

We also encountered problems ensuring that gilts were adequately trained to use the electronic sow feeding system prior to breeding. Our solution, taking into account pig flow in our unit, was to wait until after implantation had occurred before gilts were trained to use the electronic sow feeding system. These 2 experiences demonstrate that implementing a new system is often accompanied by other problems. Problems need to be analyzed, and the appropriate changes must be made. The problems are often not with the group system per se, but with some peripheral component of the system.

Systems and Issues

None of the systems outlined completely address all of the issues identified. If freedom of movement were considered essential, trumping all other concerns, then a nonstall system would be required. Similarly, if freedom from aggression were considered to trump other issues, then stalls would be the only satisfactory solution. Basing the selection of a housing system for gestating sows on a single welfare issue may lead to substantial reductions in welfare because of other issues. Some 37 characteristics of housing systems that relate to sow welfare have been identified, and weighting factors for these have been proposed to allow comparisons of different systems.[12] However, these weighting factors are very dependent on the values of the scientists and experts setting them, and there will be considerable disagreement. Some modifications within a system may be appropriate to better address critical issues for that system, such as the use of wider stalls to allow greater freedom of movement or the use of social management to decrease aggression with electronic sow feeding systems.

The Future

Concern about the welfare of farm animals will ebb and flow with other societal issues. But it will not disappear. It would be prudent to thoroughly investigate alternatives and remain open to new systems that prove themselves to be both economical and welfare friendly. A consensus among interested parties (eg, producers, animal advocate groups, and consumers) will be needed. Not all group housing systems are equal, and the industry should be careful not to accept single-issue solutions.

a. Karlan GA, Hemsworth PH, Gonyou HW. Incidence of sow lameness in two gestating housing systems (abstr), in *Proceedings*. Int Soc Appl Ethol 2004;38:142.

References

1. Brambell FWR. *Report of the technical committee to enquire into the welfare of animals kept under intensive livestock husbandry systems*. London: Her Majesty's Stationery Office, 1965.

2. Webster AJF. The challenge of animal welfare, in *Proceedings*. World Conf Anim Prod 1993;513–524.

3. Gonyou HW. Design criteria: should freedom of movement be retained? *Acta Agric Scand A Anim Sci* 1996;27(suppl):36–39.

4. Marchant JN, Broom DM. Effects of dry sow housing conditions on muscle weight and bone strength. *Anim Sci* 1996;62:105–113.

5. Young MG, Tokach MD, Aherne FX, et al. Comparison of three methods of feeding sows in gestation and the subsequent effects on lactation performance. *J Anim Sci* 2004;82:3058–3070.

6. Council of the European Union. Council directive 2001/88/EC of 23 October 2001 amending directive 91/630/EEC laying down minimum standards for the protection of pigs. *Off J Eur Communities* 2001;44:L316/1–L316/4.

7. Food Marketing Institute and National Council of Chain Restaurants. June 2002 report. FMI-NCCR Animal Welfare Program. Available at: www.nccr.net/download/0602ANIMALWELFAREREPORT.doc. Accessed Nov 2, 2004.

8. Miller D. Sows flourish in pen gestation. *National Hog Farmer* 2004;49(3):10–14.

9. Karlan GA, Hemsworth PH, Gonyou HW, et al. The welfare of gestating sows in conventional stalls and in deep litter systems. In: Paterson JE, ed. *Manipulating pig production IX: proceedings of the ninth biennial conference of the Australasian Pig Science Association*. Werribee, Victoria, Australia: Australasian Pig Science Association, 2003.

10. McFarlane JM, Boe KE, Curtis SE. Turning and walking by gilts in modified gestation crates. *J Anim Sci* 1988;66:326–333.

11. *Recommended code of practice for the care and handling of farm animals: pigs*. Publication 1898/E. Ottawa: Agriculture and Agri-Food Canada, 1993.

12. Bracke MBM, Spruijt BM, Metz JM, et al. Decision support system for overall welfare assessment in pregnant sows. A: model structure and weighting procedure. *J Anim Sci* 2002;80:1819–1834.

Sow housing: science, behavior, and values

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The most common method of housing gestating sows involves the use of individual gestation stalls. In Europe, 70% of gestating sows are individually housed,[1] and in Australia and New Zealand, 63% and 50% of sows are individually housed.[2,3] In the United States, 69% to 70% of sows are housed in stalls throughout gestation.[4] Although gestation stalls have certain advantages that enhance animal welfare, such as preventing aggression, individual feeding, and general ease of management,[5] they provide minimal space and prevent sows from performing many of the behavior patterns that pigs would perform in more natural or less restricted conditions. The barren environment, the restrictions to movement, and the limited social interactions characteristic of gestation stall housing are all thought to negatively impact sow welfare.[6]

Concern over animal welfare has resulted in gestation stalls being banned in the European Union as of 2013. In the United States, attempts to ban gestation stalls have been initiated in numerous states. In 2002, gestation stalls were banned from use in Florida. One might assume that these actions are based on an objective analysis of the scientific evidence and that there is agreement within the scientific community regarding the interpretation of sow housing data. Unfortunately, this is not the case. Animal welfare is a value-laden concept,[7,8] and when assessing the welfare of farm animals, different scientists select different criteria reflecting different value-dependent views.[9] In fact, the various scientific viewpoints on the gestating sow housing issue exemplify fundamental issues that animal welfare scientists and veterinarians must consider when trying to assess animal welfare. In this report, I hope to clarify some of the value-dependent issues inherent in animal welfare assessment and suggest an approach to evaluating sow housing that addresses the most important aspect of animal welfare: those things that matter to the animal.

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Animal Welfare: Assessment, Measurement, and Values

Contrary to popular notions, science is neither value free nor ethics free.[9] One of the first value-oriented issues faced by scientists is the issue of whether animal welfare can be measured objectively or only subjectively assessed. Fraser[10] outlined 3 concepts that reflect how various scientists may conceptualize animal welfare. The first concept is that animal welfare is a single attribute that can be measured objectively. The second concept is that animal welfare is a single attribute in principle that although not measured directly, can be objectively estimated by integrating contributing variables. The third concept is that animal welfare involves multiple attributes linked by their involvement in the quality of life of animals and interpreted by use of value position, rather than integrated objectively.

Scientists that consider animal welfare to be a type 1 concept may use a single objective measure, such as longevity or stress hormone concentrations, to evaluate welfare. Regardless of how objective the measurement is, the selection of 1 such measure over another requires a not purely objective judgment about the relative importance of the measure in regard to animal quality of life.

The idea that a single measure can be used as an indicator of welfare is no longer accepted.[10-12] Scientists have developed numerous objective measures (ie, physiologic, biochemical, immunologic, and behavioral) to use as indicators of welfare. Scientists who use

these various measures tend to treat animal welfare as a type 2 concept. The challenge of this approach is that of integration.[13] How should these various measures be integrated to reflect animal welfare? Should health measures be weighted more than behavior or physiology more than production? One solution may be to use experimental studies of animal preferences and motivation as an objective way to weight different attributes. This approach, although technically difficult and not without fundamental challenges,[10,14-16] has the potential to provide important information about animal welfare, but will not provide an objectively correct weighting of the various attributes being used by the animal.

Fraser[10] argues that animal welfare should be treated as a type 3 concept, whereby various attributes can be objectively measured, but their integration and interpretation is value based. This approach will lead to disagreements, but these are disagreements about values rather than scientific theories. Although the variables in question are studied objectively, there is no objective means by which science can achieve consensus on what variables are more important or how they should be weighted.[12] The implications of this approach are substantial, as it implies an inevitable limit to how science can be used to compare and evaluate the welfare of animals in different complex systems.

Another set of value frameworks[17] describes 3 different views of animal welfare[18] (**Figure 1**). These views impact the manner in which the public perceives animal welfare research, the types of criteria emphasized by different animal welfare scientists,[9] and ultimately the overall assessment of an animal's welfare. The first value framework emphasizes affective states of the animal, such as pain, suffering, and other emotions. The second emphasizes the biological functioning of the animal as measured by indicators of health and productivity. The third suggests that animals should be allowed to live in environments where they are able to express natural behaviors.

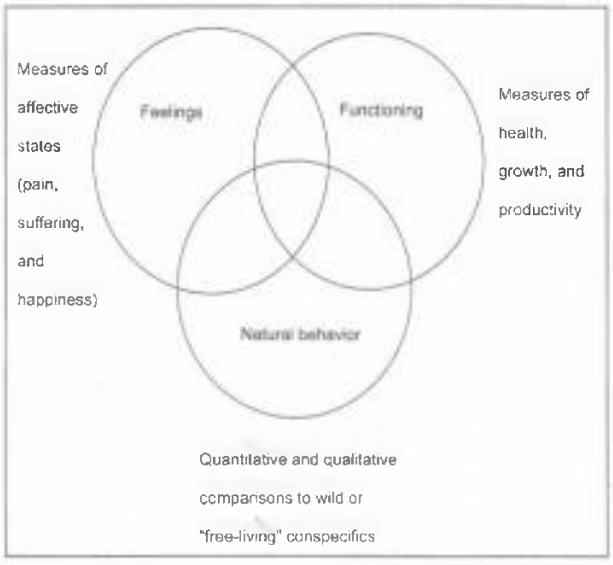

Figure 1—Value frameworks emphasizing 3 different views of animal welfare.

Three recent reviews[4-6] of gestating sow housing systems provide an excellent example of the impact that different value frameworks can have on animal welfare assessments. One of these reviews[6] emphasized affective states and natural behavior and concluded that serious animal welfare problems occur in even the best stall systems. The other 2 reviews[4,5] emphasized the biological functioning of the animals, with particular emphasis on indicators of health and productivity. Both of these reviews concluded that individual stalls and pens can meet the welfare requirements of sows, which is essentially the opposite of the result of the first review. This difference occurs not because of different scientific theories but because of different value frameworks used to emphasize different attributes of welfare.

Behavioral Needs and Animal Welfare

In 1964, the Ruth Harrison book *Animal machines—the new factory farming industry* was published and exposed the manner in which farm animals were being cared for and handled in postwar industrialized agriculture. In response to the public outcry caused by *Animal machines*, the British Government appointed the Brambell committee to "examine conditions of livestock kept in intensive husbandry systems, advise about whether standards should be set in the interests of their welfare, and what the standards should be."[19]

The Brambell committee was comprised of the leading veterinarians, animal scientists, and biologists of the time. The Brambell report acknowledged that confinement may offer some advantages for animals, such as protection from predation and adverse weather conditions. However, it also concluded that agricultural animals had behavioral needs that were not likely to be satisfied in barren environments and that not meeting these needs may cause animals to suffer.

The Brambell report was an insightful, progressive document of expert opinion that has had considerable influence in developing the study of animal welfare. For example, the Farm Animal Welfare Council, using the principles implicit in the Brambell report, subsequently developed a list of 5 freedoms[20] (**Appendix**). These 5 freedoms have been used to develop guidelines and codes of practice for various organizations in numerous countries.

The concept of behavioral needs is implicit in both the Brambell committee report and the 5 freedoms. Animal needs are dictated by the basic biology of the animal. The term need refers to requirements that are essential for survival or substantially important to the animal. Historically, needs have been divided into ultimate and proximate needs.[21,22] Ultimate needs were defined as those needs that, if not met, would result in death or loss of reproductive function. In contrast, a failure to meet proximate needs would not result in death or loss of reproductive success, but may cause animals to suffer.

Behavioral needs can be short term, such as hunger or predator avoidance, or long term, such as exercise. Behavioral needs can be internally motivated (ie, arising from changes within the animal itself)

or externally motivated (ie, arising from changes in the animal's environment). Although some authors claim that animal welfare tends to be more severely compromised if behavioral needs that are internally motivated are not met,[22] this may not always be the case.[23,24] Regardless of whether needs develop from internal or external stimuli, it is clear that certain animals at certain times are highly motivated to perform specific behaviors. For example, just prior to farrowing, sows will become restless and initiate nest-building behavior even when nesting material is absent.[25] Preventing nest-building behavior is thought to compromise animal welfare[23] and has been reported to cause increased heart rates and an increase in stereotypic behavior.[26] Another complexity of behavioral needs is determining whether animals need to perform the appetitive stage or the consummatory stage of a behavior or both. For example, does a sow need to perform nest-building behavior, or is just having the end goal of a nest sufficient? Research suggests that providing the goal alone is insufficient to decrease the motivation to perform many behaviors in a variety of species.[27-29]

Substantial research efforts have been made in trying to precisely identify and rank various behavioral needs. However, the current inability to objectively rank such variables combined with the ambiguity of the term need has resulted in limited success. Recently, Dawkins[14] has suggested that the confusion and ambiguity that result from asking what animals need may be clarified by asking 2 basic questions: Are the animals healthy?, and Do the animals have what they want?

Sow Housing and Measurements of Welfare

Although gestation stalls are the most common form of sow housing, there are a variety of housing systems that are being successfully used by producers, including electronic sow feeder (ESF) systems, trickle feeder systems, small group systems, and pasture-based systems. Clearly, these different systems will meet some needs but fail to meet others. Each system will have advantages and disadvantages for animal welfare. Assessing animal welfare in these systems has involved measuring the physiology, behavior, and productivity of the animals.

Physiologic measures of stress have yielded contradictory findings, although mostly negative. Some studies have reported higher basal cortisol concentrations in sows housed in stalls than in sows housed in small groups without straw,[30,31] but others have found no difference.[32-34] No difference has been found in the cortisol response to ACTH injection[33,35] or in the status of the immune system.[35]

Studies[32,36-38] have consistently reported a higher incidence of stereotypy in sows housed in stalls than in sows housed in small groups without straw, but this finding is difficult to interpret. Stereotypies develop when animals are frustrated,[39,40] but it is not clear that physical confinement is the cause of the frustration. Lawrence and Terlouw[41] have argued that hunger is the motivation underlying the development of stereotypy in sows, while physical confinement merely shapes the sows' behavior into a few simple and highly repetitive routines.

Sow productivity is often raised as a concern by producers, but few differences are reported in the scientific literature. Similar production levels have been reported for sows housed in gestation stalls versus alternative systems, including ESF systems,[42,43] outdoor production units,[44] small pens,[45,46] large pens,[47] and hoop barn systems.[48] In a major review,[4] Barnett et al wrote that "[t]he data on individual versus group housing are equivocal, on the basis of weaning-to-mating interval and mating, conception, or pregnancy rates."

The evidence obtained through traditional measures of physiology, behavior, and productivity indicates that the welfare of sows in groups is equivocal. Some measures of welfare have yielded contradictory findings, while others have proved difficult to interpret. An alternative approach that is in principle linked to behavioral needs—the 5 freedoms and the Brambell committee findings—is to measure the motivation of the sow for various housing systems.

Motivation

Measurement of motivation is a widely used approach in animal welfare science.[16] The technique has been used in the development of housing for many domestic species, particularly poultry, but has so far been used in only a single study,[31] and in a very limited way, involving gestating sows.

Motivational strength is a measure of how badly an animal wants to do something. If an animal is strongly motivated to obtain a resource or to perform an activity, but its environment prevents it from doing so, its welfare will be poor in this environment.[15,23] Conversely, if an animal is unmotivated, or only weakly motivated, to obtain a resource or perform an activity, its welfare will not be substantially affected by an inability to do so, unless negative health consequences develop in the long term.

Motivational strength is measured through the use of choice tests and operant tests. In choice tests, animals are required to choose between alternative resources, and the one that is chosen most often is said to be preferred. These tests are well suited to comparing resources that satisfy the same motivation (eg, different floor substrates for lying comfort), but they are typically unable to establish how strong a preference is and hence how important it is that an animal have access to a particular resource. In operant tests, an animal is generally given access to only 1 resource at a time and is required to perform a task, such as pressing a panel, to obtain the resource. To begin with, only a single panel press is required. The number of presses required is then gradually increased until the animal fails to earn access to the resource. The greatest number of presses the animal is prepared to perform is often used as a measure of motivational strength.[49,50] However, although number of panel presses is a measure of how hard an animal is prepared to work, it is difficult to interpret on its own. The number of panel presses the animal will perform for access to a particular resource must be compared with the number of

panel presses it will perform for access to another resource of known value (a comparator) to establish how important the resource of interest is to the animal.

For the operant approach to work, it is important to choose a good comparator. Food is a suitable comparator because its value varies in a reliable way from very high to very low, depending on how much has already been eaten. If work done for access to the resource of interest is equal to or greater than work done for access to food when hungry, the resource must be of substantial value to the animal. Conversely, if work done for access to the resource is equal to or less than work done for access to food when close to satiation, the resource must be of little value.

This approach has been used recently to compare the strength of a dominant sow's motivation for access to a group of familiar and subordinate sows.[51] Preliminary results provide little evidence that sows are highly motivated to spend time in a group pen. This may be attributable to a number of factors, including quality of group space and the amount of time spent away from the group.

Measures of motivational strength complement other approaches to the assessment of welfare. Many behavioral, productivity, and physiologic welfare indicators are really indirect measures of motivation, signs that an animal has been prevented from doing something that it wants to do. Their disadvantages include that it is not clear how to assess motivational strength (eg, how much time must an animal spend performing stereotypic behaviors before we can conclude that the animals is suffering?) and that it is sometimes difficult to tell which motivation has been frustrated. Their main advantage over direct measures of motivational strength is that they evaluate motivation when the animal has no access to the resource in question. Direct measures of motivation reveal the importance of resources when they are available, but do not demonstrate that animals miss them when they're unavailable (ie, out of sight might be out of mind). Physical indicators of welfare (eg, health, productivity, and injury) reveal nothing about motivation, but assess the physical consequences of housing animals in a particular environment. The things that animals want are not always good for them, and sometimes animals benefit from things they are indifferent or averse to.

Conclusion

Animal welfare is clearly entwined with values. Scientists, veterinarians, and animal activists must be willing to clarify their value positions when discussing animal welfare issues. Traditional measures of animal welfare provide a limited interpretation of the welfare of sows in different housing systems. Although motivational techniques are currently limited, refining this approach will greatly improve our understanding of animal priorities. Combining traditional, direct measures of animal welfare with measures of motivation and preferences can yield a balanced picture of animal welfare: a quantitative assessment of how badly animals want access to a resource, a confirmation that they miss it when it is absent, and an assessment of whether access to the resource is good for their health in the long term.

References

1. Hendricks HJM, Pedersen BK, Vemeer HM, et al. Pig housing systems in Europe: current distributions and trends. *Pig News Inf* 1998;19:97N–104N.

2. Patterson R, Pointon A, Cargill C. *Sow wastage in the Australian pig herd—degree, cost and prevention*. Canberra, Australia: Pig Research and Development Corp, 1997.

3. Gregory NG, Devine CD. Survey of sow accommodation systems used in New Zealand. *N Z J Agric Res* 1999;42:187–194.

4. Barnett JL, Hemsworth PH, Cronin GM, et al. A review of the welfare issues for sows and piglets in relation to housing. *Aust J Agric Res* 2001;52:1–28.

5. McGlone JJ, von Borell EH, Deen J, et al. Compilation of the scientific literature comparing housing systems for gestating sows and gilts using measures of physiology, behavior, performance and health. *Prof Anim Sci* 2004;20:105–117.

6. Scientific Veterinary Committee. *The welfare of intensively kept pigs*. Brussels, Belgium: European Commission, 1997. Available at: europa.eu.int/comm/food/fs/sc/oldcomm4/out17_en.pdf. Accessed Oct 1, 2004.

7. Tannenbaum J. Ethics and animal welfare: the inextricable connection. *J Am Vet Med Assoc* 1991;198:1360–1376.

8. Rollin BE. Ideology, "value-free science" and animal welfare. *Acta Agric Scand Sect A Anim Sci* 1996;27(suppl):5–10.

9. Fraser D. Assessing animal welfare at the farm and group level: the interplay of science and values. *Anim Welf* 2003;12:433–443.

10. Fraser D. Science, values and animal welfare: exploring the inextricable connection. *Anim Welf* 1995;4:103–117.

11. Dawkins MS. *Animal suffering*. London: Chapman & Hall, 1980.

12. Broom DM. The scientific assessment of animal welfare. *Appl Anim Behav Sci* 1988;20:5–19.

13. Mason G, Mendl M. Why there is no simple way of measuring animal welfare. *Anim Welf* 1993;2:301–319.

14. Dawkins MS. Using behaviour to assess animal welfare. *Anim Welf* 2004;13:S3–S7.

15. Dawkins MS. From an animal's point of view: motivation, fitness, and animal welfare. *Behav Brain Sci* 1990;13:1–9, 54–61.

16. Fraser D, Mathews LR. Preference and motivational testing in animal welfare assessment. In: Appleby MC, Hughes BO, eds. *Animal welfare*. Wallingford, UK: CAB International, 1997;159–173.

17. Brunk CG, Haworth L, Lee B. *Value assumptions in risk assessment: a case study of the Alachlor controversy*. Waterloo, ON: Wilfred Laurier University Press, 1991.

18. Fraser D, Weary DM, Pajor EA, et al. A scientific conception of animal welfare that reflects ethical concerns. *Anim Welf* 1997;6:187–205.

19. Brambell FWR. *Report of the technical committee to enquire into the welfare of animals kept under intensive livestock husbandry systems*. London: Her Majesty's Stationery Office, 1965.

20. Farm Animal Welfare Council. *Second report on priorities for research and development in farm animal welfare*. Tolworth, UK: MAFF, 1993.

21. Dawkins MS. Battery hens name their price: consumer demand theory and the measurement of ethological "needs." *Anim Behav* 1983;31:1195–1205.

22. Petherick JC, Rushen J. Behavioural restriction. In: Appleby MC, Hughes BO, eds. *Animal welfare*. Wallingford, UK: CAB International, 1997;89–105.

23. Jensen P, Toates FM. Who needs "behavioural needs"? Motivational aspects of the needs of animals. *Appl Anim Behav Sci* 1993;37:61–81.

24. Hughes BO, Duncan IJH. The notion of ethological "need", models of motivation and animal welfare. *Anim Behav* 1988;36:1696–1707.

25. Jensen P. Nest building in domestic sows: the role of external stimuli. *Anim Behav* 1997;45:351–358.

26. Damm BI, Lisborg L, Vestergaard KS, et al. Nest-building, behavioral disturbances and heart rate in farrowing sows kept in crates and Schmid pens. *Livest Prod Sci* 2004;80:175–187.

27. Hughes BO, Duncan IJH, Brown MF. The performance of nest building by domestic hen: is it more important than the construction of a nest? *Anim Behav* 1989;37:210–214.

28. Arey DS, Petchey AM, Fowler VR. The preparturient behaviour of sows in enriched pens and the effect of pre-formed nests. *Appl Anim Behav Sci* 1991;31:61–68.

29. de Passille AMB, Christopherson RJ, Rushen J. Nonnutritive sucking and postprandial secretion of insulin, CCK and gastrin by the calf. *Physiol Behav* 1993;54:1069–1073.

30. Barnett JL, Cronin GM, Winfield CG. The effects of individual and group penning of pigs on total and free plasma corticosteroids and the maximum corticosteroid binding capacity. *Gen Comp Endocrinol* 1981;44:219–225.

31. Barnett JL, Hemsworth PH, Newman EA, et al. The effect of design of tether and stall housing on some behavioural and physiological responses related to the welfare of pregnant pigs. *Appl Anim Behav Sci* 1989;24:1–12.

32. Barnett JL, Hemsworth PH, Cronin GM, et al. Effects of design of individual cage-stalls on the behavioural and physiological responses related to the welfare of pregnant pigs. *Appl Anim Behav Sci* 1991;32:23–33.

33. Nicholson RI, McGlone JJ, Norman RL. Quantification of stress in sows: comparison of individual housing versus social penning. *J Anim Sci* 1993;71(suppl 1):112.

34. Pol F, Courboulay V, Cotte JP, et al. Urinary cortisol as an additional tool to assess the welfare of pregnant sows kept in two types of housing. *Vet Res* 2002;33:13–22.

35. Von Borell E, Morris JR, Hurnik JF, et al. The performance of gilts in a new group housing system: endocrinological and immunological functions. *J Anim Sci* 1992;70:2714–2721.

36. Jensen P. Diurnal rhythm of bar-biting in relation to other behaviour in pregnant sows. *Appl Anim Behav Sci* 1988;21:337–346.

37. Morris JR, Hurnik JF, Friendship RM, et al. The behavior of gestating swine housed in the Hurnik-Morris system. *Appl Anim Behav Sci* 1993;71:3280–3284.

38. Vieuille-Thomas C, Le Pape G, Signoret JP. Stereotypies in pregnant sows: indications of influence of the housing system on the patterns expressed by the animals. *Appl Anim Behav Sci* 1995;44:19–27.

39. Mason GJ. Stereotypies: a critical review. *Anim Behav* 1991;41:1015–1037.

40. Lawrence AB, Rushen J. *Stereotypic animal behaviour fundamentals and applications to welfare*. Wallingford, UK: CAB International, 1993.

41. Lawrence AB, Terlouw EMC. A review of behavioral factors involved in the development and continued performance of stereotypic behaviors in pigs. *J Anim Sci* 1993;71:2815–2825.

42. Gonyou HW. Management and alternatives with electronic sow feeder, in *Proceedings*. Leman Swine Conf 2004;31:158–160.

43. Bates RO, Edwards DB, Korthals RL. Sow performance when housed either in groups with electronic sow feeders or stalls. *Livest Prod Sci* 2003;79:29–35.

44. Johnson AK, Morrow JL, McGlone JJ. Behavior and performance of lactating sow and piglets reared indoors or outdoors. *J Anim Sci* 2001;79:2588–2589.

45. Harris MJ, Sorrells AD, Eicher SD, et al. Effects of production and health of two types of housing for pregnant gilts. In: *Purdue swine research reports*. West Lafayette, Ind: Department of Animal Sciences, College of Agriculture, Purdue University, 2001;115–119.

46. Pajor EA. Group housing of sows in small pens: advantages, disadvantages and recent research, in *Proceedings*. Symp Swine Housing Well-Being 2002;37–44.

47. Morrison R. Large group systems for gestating sows, in *Proceedings*. Symp Swine Housing Well-Being 2002;53–54.

48. Honeyman MS. Sow well-being in extensive gestating sow housing: outdoor and hoop barn system, in *Proceedings*. Symp Swine Housing Well-Being 2002;45–51.

49. Olsson IAS, Keeling LJ, McAdie TM. The push-door for measuring motivation in hens: an adaptation and a critical discussion of the method. *Anim Welf* 2002;11:1–10.

50. Mason G, McFarland D, Garner J. A demanding task: using economic techniques to assess animal priorities. *Anim Behav* 1998;55:1071–1075.

51. Kirkden RD, Pajor EA. Motivation for group housing in gestating sows, in *Proceedings*. 6th North Am Reg Meet Int Soc Appl Ethol 2004;6:20.

Appendix

The 5 freedoms of animal welfare.[20]

1. Freedom from thirst, hunger, and malnutrition—by ready access to fresh water and a diet to maintain full health and vigor.

2. Freedom from discomfort—by providing a suitable environment, including shelter and a comfortable resting area.

3. Freedom from pain, injury, and disease—by prevention or rapid diagnosis and treatment.

4. Freedom from fear and distress—by ensuring conditions that avoid mental suffering.

5. Freedom to express normal behavior—by providing sufficient space, proper facilities, and company of the animal's own kind.