

# **The Science and Ethics Behind Animal Well-Being Assessment**

One in a Series of Educational Programs Presented by the  
**Future Trends in Animal Agriculture**

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## PREFACE

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The Future Trends in Animal Agriculture (FTAA) offers a series of educational meetings dealing with various animal well-being issues and related areas of concern. For example well-being is often tied to ethical considerations, environmental issues, food safety concerns, consumer demand, and rural infrastructure considerations. These examples are perceived by some to be directly and negatively related to commercial agricultural interests, while others recognize a greater complexity of these issues. This greater complexity demands more than a simplistic approach to effectively dealing with these intertwined issues.

The program is provided as Appendix A. The primary audience is comprised of agency decision makers and other personnel, animal advocacy organization personnel, professional and agricultural industry representatives, and congressional staffers. All FTAA events are open to the public.

The purpose is to briefly present discussions and updates of how animal welfare is assessed in directed research by U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) personnel, in cooperation with Land Grant University (LGU) researchers. Linkages between behavior and welfare are explored, including the use of specific examples of research being conducted by ARS and LGU researchers. This research is often tied together by multi-state research committees administered by the LGU. Ethical considerations of animal based research are discussed with the intent to create an opportunity for dialogue in this area. Speakers are primarily from the USDA/ARS and LGU's.

The presentations will help ensure audience participants have a clearer understanding of animal welfare research and the cooperative role played by USDA, LGU and other personnel. USDA and LGU's have been very involved in animal welfare research, and take into consideration the ethical ramifications of this work.

The FTAA organization is comprised of an informal committee, Co-Coordinated by David Brubaker, Agri-Business Consultant, Michael Appleby, Humane Society of the United States, Ken Klippen, United Egg Producers, and Richard Reynnells, USDA Cooperative State Research, Education and Extension Service. The FTAA organizing committee is composed of representatives from several animal welfare and industry organizations, universities, and USDA/CSREES. These individuals represent moderate views on animal production and the desire to work together to bring about positive benefits to animal agriculture and to society.

The Mission of the FTAA is to foster and enhance balanced and enlightened public dialogue on topics related to the nature and future of animal agriculture. The Vision is: to develop programs

that are inclusive and national in scope, with the committee consisting of individuals from organizations representing academia, agribusiness, animal welfare, environmental, university, government and others. The FTAA the Committee seeks to present timely issues in a balanced, innovative and thoughtful manner. The Committee also seeks to enhance public dialogue and understanding about the nature and future direction of animal agriculture, and the impact of their personal decisions on this process.

FTAA Goals are: 1. To facilitate genuine collaboration and the ability of farmers to produce food for society while improving animal well-being. 2. To provide opportunities for dialogue and understanding of animal well-being, environmental and other issues in an atmosphere of mutual respect of consumers, farmers, advocates, commodity organizations, and others. 3. To provide information to identify critical animal production issues and enhance greater understanding of societal desires and trends that impact production agriculture.

We hope that you find the proceedings enjoyable and educational. Feel free to contact any committee member for more details of future programs.

October 17, 2003

Note that corrections were provided by Dr. Eicher for her paper, but they were not included in previous printings. That oversight has been corrected.

# Assessing Animal Welfare: Strategies

## Summary of Assessment Strategies

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The goal and desire to be able to reliably determine if an animal is in a state of poor or good well-being, is not new. This goal has been illusive due to the nature of those characteristics that are important in determining the state of well-being in both humans and other animals. The characteristics of emotional states, states such as being fearful, anxious, happy; and other subjective states such as pain sensation, perception, etc. are such that they can never be precisely and accurately measured. Thus the quantification of well-being has eluded scientific endeavor. However, the need understand animal well-being has been so great that efforts have continued toward this end. Currently, efforts are concentrating on assessing well-being which is very different than measuring animal well-being. Assessment means to estimate the value of something, as opposed to measure something, which means to compare it to a standard. Because we have no standard of animal well-being, efforts to assess well-being allow us to place the level of well-being, as best as we can access this state, on a continuum from good to poor well-being. Then by placing other animals in other situations on this same continuum we can start to separate, with reasonable assuredness, the relative level of well-being that different environments provide.

Recent efforts at assessing well-being are concentrating on trying to create an 'index' of well-being, thus being able to add a quantitative aspect to a subjective state. Typically these indexes are created by listing many relevant variables that may impact an animal's well-being. Relevant variables include: space per animal, type of food, availability of shelter, quality of the stockmanship, quality and type of social contact, type and cleanliness of flooring, ability to ambulate, ability to perform normal behaviors, etc. Then these variables are scored with a low to high value. The cumulative score provides a specific location on the scale from good to poor well-being that allows policy makers, farmers, and the general public to then make decisions in relation to animal well-being in that specific circumstance. These models may also include set levels for absolute minimums and maximums, such as minimum floor space allowance and maximum number of pen mates. Additionally, it is also common for these indexes to include weighting factors, which give more value (as measured in index score) to specific criteria. For instance, if it is decided that amount of floor space is more important than the number of animals sharing that space, then a multiplier which increases the index score more for floor space as compared to number per group, will be provided to increase the contribution of floor space to the final index score.

In contrast to an indexing method, one group of researchers (Wemelsfelder et al. 2001) is currently working to develop methods to assess well-being by using a 'free choice profiling' approach. This approach uses observers, from farmers to animal activists, to describe in qualitative means, using terms such as calm, nervous, excitable; the state of an animal that is being observed (in their current model the animals are swine). They have found that the observers are in a high degree of agreement with one another as to the state of the pig. Their hope is that formal and systematic analysis of our perceptions of animal well-being will guide future efforts to develop models of well-being.

Many efforts are currently under way to assess well-being in farm animals. Two international conferences held in 1999 and 2001 were well attended and had approximately 20 speakers each. Speakers provided advice and related their experiences on their efforts to develop models to reliably assess an animal's state and to design a system of aggregating the various scores. Conclusions from the first conference (second has not yet been published) state '...that much remains to be done.' And, that the way forward will be based on: a clear idea of the goal of animal welfare measurement, selection of measures that will enable attainment of the goal, validation of these measures, and pragmatic consideration of what is possible given practical and economic constraints.

Our efforts at the Livestock Behavior Research Unit are concentrating on the assessment of sow well-being, starting with a comparison of sows housed in gestation stalls as opposed to group housed sows. Our specific objective is to: develop a relative ranking of animal well-being of sows in gestation stalls compared to pens, based on the factors: physical, physiological, and mental state. We will start this effort in a very small but significant step. We will first evaluate the usefulness of typical 'stress' measures and rank their import against one another in their ability to indicate when a sow is in a state of poor well-being. We will use characteristics of sows which few would argue indicate poor well-being, factors such as pathology, injury and poor reproductive performance. Then we will determine if typical measures of well-being, such as behavior, cortisol, or immune function, that give values which are indicative of the sows expressing pathology and provide evidence of a state of poor well-being. And, we will determine the robustness of these measures.

The current status of assessment methods are progressing forward. Currently it is critical that multiple measures of physiology and behavior are used in assessing animal well-being. Probably the most important and critical step in reliably assessing well-being will require the future development of valid measures of the mental states the animal is experiencing. Measurements of physiology and behavior are merely reflective of the animals mental state, the real determinant of well-being. And although it is easy to criticize the current efforts of assessing well-being by saying we don't know precisely what the animals state of being is, this attitude does not move us in a forward direction. Thus, these efforts need to be considered a 'work in progress'.

### **Reference**

Wemelsfelder, F., T. E. A. Hunter, M.T. Mendl, A. B. Lawrence. 2001. Assessing the 'whole animal': a free choice profiling approach. *Animal Behavior*. 62:209-220.

## **Animal Welfare in Modern Animal Agriculture**

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Animal welfare is a controversial topic in modern animal agriculture because of a discrepancy of opinions regarding how animals should be maintained and treated. Opinions range the entire spectrum, and people tend to become very emotional and vocal defending both sides. Part of the controversy over farm animal welfare issues is related to an apparent conflict of interest, as some management practices that increase farm profitability may negatively impact welfare (e.g. increased stocking density). Logically, the industry has been reluctant to address animal welfare issues, fearing that the discussion would trigger a burden of regulation as has happened in Europe where legislation is increasing the requirements for the rearing of laying hens was enacted (Council Directive 1999/74/EC; L 203/56). In spite of the industry's concerns, the recent minimum welfare standards imposed by McDonald's (Smith, 2000) to their food suppliers (due mostly to the actions of extremist animal rights movements) has pushed the topic forward more quickly and strongly than any governmental actions. In addition, international pressure to insure animal welfare is increasing, particularly from the European Union (EU), where concern has been expressed, for example, about the impact of feed restriction and partial amputations (viewed as mutilations) on the welfare of broiler breeding stock (European Commission, 2000). These concerns have led the EU to request that animal welfare issues be included in future international trade talks (<http://trade-info.cec.eu.int/europa/2001newround/agr.htm>). Consequently, animal welfare has jumped to the forefront of the discussion in modern agriculture, and will likely be here to stay.

In the coming years, it is expected that U.S. animal agriculture will have to face the challenge of addressing welfare issues, a new challenge to add to the restrictions and regulations already in place. Many producers fear the economic impact that this may have on their business, and many reasons can be given as to why the industry should not be concerned about the welfare of domestic animals. The primary reason is that producers DO, of course, care about the welfare of their animals. An efficient production system cannot be based in keeping unhealthy, underfed animals. The industry in the U.S. has done an excellent job at improving health and maximizing efficiency, which has resulted in meat and poultry products that are affordable for all sectors of the society. However, welfare comprises many aspects aside from animal health, such as those related to an animal's behavioral needs, pain, fear, and suffering (Broom and Johnson, 1993). These factors have not been previously considered by the industry. At the present time the question is not whether the industry is going to deal with these issues, but how it is going to successfully and efficiently incorporate these new welfare considerations into the production system.

In addition to animal welfare, the current trend in animal agriculture is towards sustainable production systems that minimize environmental impact, reduce pollution and soil erosion, improve the working environment for animal caretakers, and/or minimize resource utilization while maximizing animal performance. Animal welfare is also considered to be an integrative part of an ideal sustainable system. The impact that these challenges will have on the animal



industry will strongly depend on the strategies adopted by each of the companies. Basing management strategies on good **scientific information** and proactive attitudes will be key to successfully passing the test. It will be fundamental to understand, or even to become an “expert” on animal welfare (Steward-Brown, 2001) and to minimize controversy and emotionality when engaged in public discussion.

### **Defining and measuring animal welfare**

Animal welfare is a “state” (Broom, 1986) that encompasses many complex aspects of the animals and includes biological, psychological, and ethical components. The biological components can be further divided into physical, physiological and behavioral. Hence, one should take notice that welfare and behavior are not synonymous terms, as is commonly believed. Behavior is merely one of the many aspects to consider when evaluating animal welfare. Most of the physical components of welfare are easy to determine, as it includes parameters traditionally used by the producers to evaluate performance and health (e.g. growth rate, body weight, comb color, and feathering condition). Behavior is frequently (if not always) used by experienced farmers to determine potential problems in animals, although perhaps this behavioral evaluation is done in an “instinctive” manner. For example, farmers can determine if chicks are under an optimal brooding temperature by simply observing how the birds are distributed in the space. In addition, farmers can recognize early disease symptoms of some diseases if the animals are unusually inactive, or unusually silent. Many other behavioral measures, such as occurrence of stereotypies, feather pecking, all forms of cannibalism, unusually high levels of aggression, and duration of tonic immobility (Kostal and Savory, 1994; Bilcik et al., 1998; Gunnarsson et al., 1999) can be excellent welfare indicators for ethologists. Physiological parameters, which include hormone levels such as cortisol or corticosterone (Craig et al. 1986a), heart rate (Price and Sibly, 1993), or immune status (Gross and Siegel, 1983; Patterson and Siegel, 1998) are frequently used as reliable indicators of the welfare status as well.

As indicated above, animal welfare also involves a psychological component as to “how the animals feel” (Duncan and Petherick, 1991), and an equally important ethical component “their quality of life” (Duncan and Fraser, 1997). These two aspects have been responsible for much of the controversy surrounding welfare discussions because they are more vague, and can only be addressed *scientifically* through well-controlled experiments designed for such a purpose, and they are usually more difficult to evaluate in farm settings than are the behavioral, physical or physiological components. As indicated by Dawkins (1980), “animals are unable to talk, but they can express their preferences by their choices”. One of the best methods to scientifically address animal motivation, or, of knowing the relative importance of different resources to the animals, is based on the principles of *demand theory* which is routinely applied by economists to determine the relative importance of different commodities to consumers (Dawkins, 1983). Demand theory methodologies have proven successful to determine motivational states and preferences (feelings?) in poultry (Gunnarsson et al., 2000).

In addition, cost benefit models can be helpful in decision making when trying to determine the right balance between productivity and welfare. For example, as the rearing density in poultry houses increases, the health and performance of the birds will start to deteriorate slowly and

almost imperceptibly. If density continues to increase it is likely that it will reach an inflection point where further density increments will produce a more severe reduction in performance or health status of the birds. It would make sense to determine “welfare standards” at the inflection points, that theoretically will allow maximum farm returns at minimum “welfare cost” for the animals.

It is clear that science has developed methods to determine the impact of rearing conditions on the physical, physiological, biological and even the psychological aspects of welfare. However, the main problem regarding the successful analysis of welfare is, not the measurement of welfare *per se*, but where to establish acceptable limits for variables that are measured on a continuum scale. “From where to where in the scale” should we consider an animal in a good welfare state, and beyond which point must be considered to be simply acceptable, or poor? Contrary to some opinions it does not matter whether we use biological or psychological parameters, the scale problem is similar for all types of measurements. Where we decide to put the cut-off point of what should be considered good vs. poor welfare is an ethical decision. Ethical questions cannot, and should not, be addressed in the scientific forum, simply because it is not science and they can only be answered by philosophers, the society, and ultimately by the consumers. The questions are simple. Is it ethically correct or acceptable to grow animals under current rearing conditions or do we need to incorporate changes? And, how much are we (consumers) willing to pay for the suggested changes to occur? The answer to these questions would probably depend on the education, current moral values, and last but not least, on the economical development of the society.

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## Physiological Indicators of Stress

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Although both the sympatho-adrenal system (SA) and the hypothalamic-pituitary-adrenal (HPA) system are the corner stone of stress research today, it is critical to remember that both systems are not specific to reacting to stress, as the hypothalamic-hypophyseal-gonadal (HHG) axis is to acting on reproductive function. The SA and HPA systems are always working in the body to maintain homeostasis. Because of this, simply measuring plasma cortisol, an increase in heart rate, or blood pressure can not tell us that the animal is in a state of distress. However, when values for these parameters are significantly out of the norm for the specific species and exact situation under which the sample was taken, then these values would raise a flag that the animal is likely being challenged with a stressor. Herein lies the differentiation between 'stress', 'distress', and 'eustress'. Stress can simply be referred to as normal deviations from homeostasis, to which the body invokes the SA and HPA systems to bring itself back to a steady state. Whereas, distress pushes the body so far away from homeostasis that the body is more significantly taxed in its attempts to bring the body to a steady state. And eustress, stress perceived as pleasurable also pushes the body past normal physiology. Therefore, there is no clear physiological distinction between the states of stress, distress and eustress, it is merely a matter of degree. For this reason, it has been and continues to be, a difficult task to determine when the amount of stress imposed upon an animal is excessive, and therefore, a production and a well-being concern.

A very critical issue that is often not emphasized enough is the variation among animals within a group in whether a stressor elicits an adrenal response and in those individual animals in which a response is elicited, and the variation in the degree of response (Ingram et al., 1980). Additionally, physiologic status (i.e., gestation) of the animal can influence its perception of distress, if not cognitively, at the level of the physiological measures of distress (Cook, 1996; Komesaroff, 1998). This is more than an impediment to clear interpretation of experimental data, and poses an important fundamental problem both in the validation of physiological indicators of distress as well as the use of said indicators in assessing the well-being implications of particular production systems and research methods. We are currently still searching for robust, repeatable physiological indicators of distress for use in the assessment of production procedures and environments. The next, or potentially emerging concurrent, question that must be addressed is not only what physiological indicators are best and what their critical values are, but in what proportion of animals must a critical value be attained in order to be of concern from a well-being perspective.

Our pursuit of understanding the physiological changes that occur in livestock is due to our desire to both increase livestock production and to increase livestock well-being. As evidence of this importance, multitudes of researchers, creating voluminous amounts of literature on stress physiology, are employed to this end. As we struggle toward our goal, it is important to remember that our measurements are reflections of the perception of the animal in question. These animal perceptions are shaped by mood, past experiences, temperament, personalities, and cognitive ability. Therefore, our physiological measurements are indirect measures of a

more important question – how the animal feels. It is the individual animal's perception, cognitive ability and feelings that determine whether its well-being is adequate. Our physiological measures can lead us astray in this assessment. For example, using impaired reproductive function as a measure of poor well-being we would conclude that highly trained female athletes that become amenorrheic have a poor well-being. However, upon questioning they would likely indicate that they have a superior well-being as they pursue their goal to be an Olympian. To prevent such a misinterpretation of animal well-being, future research needs to move forward in its assessment of livestock cognition in order to determine how the animal actually perceives the situation to which it is subjected.

Since Claude Bernard, Walter Cannon and Hans Selye delved into the complicated study of stress physiology, a great deal has been learned. Researchers have discovered a multitude of effects on the immune system, shown that the stress and immune responses are highly integrated, and recently discovered new hormones of the stress response, stresscopin and stresscopin-related peptide – members of the CRH/urocortin family (Hsu and Hsueh, 2001). However, much more needs to be learned in order to adequately answer questions on livestock well-being. Research on stress physiology has produced data which shows 'stress' hormones, heart rate, and immune function increasing when the animal is in an apparent state of good well-being, such as during copulation, and it has failed to produce data indicating the animal is in a state of poor well-being, even when the animal is showing behavioral signs indicative of poor well-being.

Therefore, it is important that interpretation of research data does not fall into the trap of circular reasoning, measuring physiology to measure stress, but when the physiology doesn't indicate a stressful situation concluding that the measures are flawed – as opposed to concluding that the situation is not stressful. Until we are confident that we have defined objective measures of distress this will be a consideration of priority. This is important when we consider that dependant upon which measures of immune function we choose to measure a stressor could be either enhancing them, depressing them or having no effect. Often, we see research that finds a difference in physiology and because the difference is attributed to a situation that was pre-conceived to be poor, that difference is used as an example of an indicator of poor well-being. Different does not necessarily indicate that a situation is distressful. An animals physiology indoors can be expected to be different than one housed outdoors, but both may be appropriate for the situation and both physiologic states can indicate good well-being. A great deal of the literature on stress can produce data that conflicts. These variations are likely due to animal perception, past experience, species/genetic variation, handler ability, etc. An understanding of these discrepancies will greatly enhance our understanding of stress physiology.

Because of the above mentioned concerns, with conflicting data, animal variation, etc., researchers typically try to measure a multitude of factors to be sure that the data agrees, indicating a stressful or non-stressful state. However, what invariably happens is that from the multitude of data collected only one or two parameters will be different from control animals. Three points are important in this area. First, when a multitude of measures are collected and only one or two indicate a stressful, or non-stressful situation, care should be taken to not over-interpret the meaning of such findings. As with any standard statistical test, the more parameters that are analyzed for statistical differences, the more likely it is to find such a difference in one of the parameters. Therefore, the level of significance when making such multiple comparisons should be increased to avoid such an error. Secondly, multiple measures

does not mean more information. A great number of the parameters that are being measured are subsequent effects of another parameter. For instance, we know that CRH causes the release of ACTH, which causes the release of cortisol. By measuring all three of these variables we do not have three times as much information, only a confirmation of what we already know. And finally, more often than not, when multiple measures are taken it is found that one physiological parameter indicates good well-being while another indicates poor well-being. Without a true objective measure, and power of that measure, to indicate stressful situations, the researcher is left to somehow justify this finding, usually with a preconceived idea of what should have happened. And often, researchers will use behavioral data to direct their conclusions in this situation. Indeed, research by Hicks et al. (1998) administered multiple stressors and examined the social status of pigs, while measuring a great deal of physiological parameters, immune parameters, and behavior. These authors concluded that the only consistent, specific response to a stressor was a behavioral change, not a physiological change. Developing objective, reliable measures of stress, distress, and eustress, will aid in our understanding of the physiological consequences of distress

The study of stress physiology, although started more than fifty years ago, is still in the early stages of development and needs to develop objective, quantifiable measures of stress, distress, and eustress. Although research can easily quantify differences in physiology in response to presumed stressful events, it is the animals perception of these events that dictate if its state of well-being is adequate. Therefore, future research needs to further develop these physiological measures and pursue research into the physiology of the mind of livestock in order to understand how production practices and environments influence the amount of distress to which they are exposed. Without an objective evaluation of the stress state of an animal, assessment of animal well-being can not be made.

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# Assessing Animal Welfare: Specific Research Approaches

## Immunological Measures of Animal Well-Being

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Part of a multi-disciplinary approach to animal well-being must include immune status. The basic definition of immunity is the ability to resist a particular disease through preventing development of a pathogenic micro-organism or by counteracting the effects of its products. However, we now know that the mechanisms of immunity are broader than that definition. The immune response is comprised of two branches. The adaptive immune response is specific to a priorly experienced pathogen or antigen. This is in contrast to the innate immune response that does not require prior exposure to the antigen. Among the cells that are essential to a robust innate immune response are neutrophils. They are phagocytic cells that are responsible for the earliest containment of pathogens. Because of the importance of the innate immune response for neonates and lactating cows, this is the branch that is the focus of the studies in this review.

The first immune responses to stressors include an increase in circulating neutrophils, changes in lymphocyte phenotypes, changes in cell activation or suppression, and activation of the acute phase response. The acute phase response is initiated by toll-like receptor (TLR) interaction with an antigen. Toll-like receptors are pattern recognition molecules that identify a pathogen and initiate an appropriate immune response. Then a cascade of cell signals results in the release of acute phase cytokines (cell signals) such as interleukin (IL)-1, IL-6, tumor necrosis factor-alpha (TNF) and interferons. These cytokines along with glucocorticoids stimulate the release of acute phase proteins from the liver that have a variety of physiological homeostatic functions. The end results of the actions of these proteins on neutrophils is phagocytosis and killing (measured by chemiluminescence) of pathogens. The toll-like receptors play an important role in the recognition of the pathogen and stimulating the appropriate immune response resulting in the containment of the pathogen.

Toll-like receptors are a recent discovery that explain the capability of cells to recognize a diversity of pathogens. Two TLRs of particular interest in this research are TLR2 and TLR4 for their ability to recognize gram positive cell components and yeast cell wall components (TLR2)

and lipopolysaccharide (LPS), the antigenic portion of gram negative bacteria (TLR4). The acute phase cytokines that they stimulate include IL-1 and TNF which act on a number of physiological functions resulting in altered memory, growth and development, somnolence, anorexia, and glucocorticoid functions.

This cascade of the innate immune response has been applied to answer research questions of dairy cattle well-being. Tail-docking in dairy cattle, pre-partum milking, and transport of dairy cattle are among the management practices under investigation. Dietary immune modulators are being studied in housing and transport stress models of dairy calves. The efficacy of acute phase proteins as early predictors of lameness of dairy cows in confined housing is being tested. Four studies of tail-docking showed adult animals increased eating behavior when tails were banded and haptoglobin increased when the necrotic tail was removed. Fly avoidance behaviors and fly counts increased on the rear of docked cows. This held true for young calves as well. Infrared thermography was used to demonstrate prolonged elevated temperatures of the tail following several stimuli, suggesting increased sensitivity may be present. This series of experiments showed that tail-docking directly and indirectly alters behavior of neonatal and adult cattle and should be avoided.

Transport of dairy cattle is increasing because of the necessity to move the calves from the dairy to be grown on separate farms until just prior to calving. This results in multiple transports of the heifers before their first calving. Whole herds are also being relocated because of urban squeeze and environmental regulations. The veal and dairy beef industries also require multiple and early (neonatal) movement of dairy cattle. Early transport studies showed that therapeutic subcutaneous electrolytes following transport caused a shift in lymphocytes toward cytotoxic T-lymphocytes and gamma delta T-cells. Other experiments using a dietary immuno-modulator demonstrated a synergistic effect of beta-glucan (a cell-wall component of yeast) and vitamin C on weight gain for calves raised in mildly stressful indoor calf crates. The weight gain benefit was not evident following a transport stress, but feed efficiencies were improved by the beta-glucan and vitamin C combination at 4 weeks post-transport. However, the particulate and soluble forms were divergent in their effect on neutrophil function at 4 weeks post-transport. The percentage of calves that were positive for *E. coli* O157:H7 tended to be greater for the beta-glucan and vitamin C fed calves. It appears that the combination may be a potent immuno-modulator for keeping neonatal calves healthy during and after housing and transport stress, but the mechanisms are not clear.

Because of 1) the age effect that was evident in the experiments, 2) subjective accounts of four-day-old calves succumbing to greater morbidity, and 3) the European literature that suggested that morbidity and mortality were inversely related to age-at-transport, we designed an experiment to investigate the age of transport effects on health, growth and innate immune functions. The calves transported at six to eight days-of-age had improved fecal scores (less diarrhea) while the calves transported at four to five days-of-age had the worst fecal scores. The calves that were transported at two to three days-of-age had more days of nasal discharge, indicative of virus infection or irritation. However, weights and gains were not different among treatments. Testing the age effect with in vitro stimulation of the cells with the beta-glucan vitamin C showed no differences in the expression of the LPS receptor (CD14) nor the adhesion molecule (CD18) except at day 21. The neutrophil's phagocytosis and kill (measured by chemiluminescence) of bacteria were lowest for the two treatments containing the particulate



beta-glucan. When the cells were examined for RNA expression of IL-1 and its receptor antagonist and TLR 2 and 4, both the cytokine and its antagonist and both toll-like receptors were increased with the combination of beta-glucan and vitamin C. These studies indicate that transportation stress has discrete effects that are dependent on the age at which the calves are transported within the first week of life. This provides evidence of times at which the calves may need additional therapy to cope with transportation stress or may need stressors reduced by altering times of transport.

Based on these results, studies of the efficacy of this dietary combination to reduce morbidity and mortality during a *Salmonella dublin* challenge and its economic feasibility in field trials are underway. The use of a fluorescently labeled beta-glucan is planned to track the beta-glucan movement through calves. This will allow us to ascertain if the effects of the combination are local in the intestine or if they become systemic.

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Note that corrections were provided by Dr. Eicher for her paper, but they were not included in previous printings. That oversight has been corrected.

## **Neurophysiologic Regulation and Animal Well-Being in Poultry Laying Hens**

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The modern intensification of the farm animal industry has led to widespread public concern regarding animal well-being and public health. Animal well-being is an indistinct concept and is affected by multiple factors. Factors include both internal and external events, which are regulated at different levels by different stress buffering systems, including the nervous system. The genetic basis of different mechanisms of regulating neuroendocrine changes in response to different stressors were studied in chicken lines divergently selected for high (HGPS) or low (LGPS) group productivity and longevity resulting from changes in cannibalism and flightiness in multiple-hen cages. Compared to HGPS hens, LGPS hens had greater blood concentrations of dopamine and epinephrine ( $P < 0.01$ ). Blood concentrations of norepinephrine were not significantly different between the lines but the ratio of epinephrine to norepinephrine was greater in the LGPS hens ( $P < 0.01$ ). The blood concentration of serotonin was also greater in the LGPS hens compared to the HGPS hens ( $P < 0.01$ ). These results indicate that genetic selection for group productivity and longevity altered the chickens' physiological homeostasis that produced the line's unique coping ability with domestic environments.

Stress susceptibility in farm animals is a major problem in the modern intensified industry, and many managerial practices subject animals to stress. Animals' inability to adapt to those stressors results in changes of behavioral and physiological homeostasis that cause a greater effect on animals' emotional and physical well-being, such as susceptibility to disease and increase in frequency of abnormal behavior. A major goal of husbandry management strategies is to reduce stress and increase adequate adaptation to stressors in farm animals.

One solution to reach the goal is through genetic adaptation. There are inherent differences in the capability and coping styles for maintaining behavioral and physiological homeostasis in response to disease and stressful stimuli. Selectively breeding farm animals for genetic or phenotypic features associated with specific behavioral and physiological characteristics has become a major tool for improving animal well-being (Buchenauer, 1990, Mench & Duncan, 1998; Newman, 1994; Swanson, 1995). However, selection programs based on measurement of specific behaviors are either difficult to implement or result in an unacceptable rate of inbreeding. An alternative is to directly select against genes that result in unacceptable behaviors, such as locating genes related to abnormal behavior. It would be of great value to know how genes and genetic-environmental interactions control behavior and regulate

physiological homeostasis. However, before genome scans can be attempted to locate genes associated with abnormal behavior, objective and reliably quantitative assessments of stress and well-being are needed.

Chickens offer a good animal model for studying the effect of genetic-environmental interactions on animal well-being. Within a 60-week period, a hen can have more than two hundred offspring with similar genetic characteristics. In addition, the function of the avian neuroendocrine system in response to stress is analogous to that of humans and other mammals (Covelli et al., 1981; Ferrari & Giuliani, 1993; Harvey et al., 1984; Wambebe, 1986); and there are homologous distributions of neuroendocrine hormonal receptors in both the central and peripheral nervous systems of birds and mammals (Cardinaud et al., 1997; Dietl & Palacios, 1998; Ferrari & Giuliani, 1993; Jiao et al., 2000; Richfield et al., 1987). Furthermore, chickens have proven to be effective models in various clinical and psychopharmacological studies.

In order to examine the effects of genetic-environmental interactions on the animal's well-being, two genetically selected lines of White Leghorn chickens were developed at Purdue University using a program termed "group selection" which emphasized high (HGPS) or low (LGPS) group productivity and survivability that resulted from changes of cannibalism and flightiness in colony cages (Cheng et al., 2001a; Craig & Muir, 1996a, b; Muir, 1996; Muir & Craig, 1998). The HGPS line, compared to the LGPS line and Dekalb XL commercial strain, has been shown to improve rate of lay, survival, and feather score as well as reduced cannibalism and flightiness (Craig and Muir, 1996; Cheng et al., 2001). The HGPS line also has better and faster adaptations to various stressors such as social, handling, cold and heat in multiple-hen cages (Hester et al., 1996a, b). In addition, the HGPS hens display a greater cell-mediated immunity with a higher ratio of CD4:CD8, whereas the LGPS hens exhibit eosinophilia and heterophilia and have a greater ratio of heterophil:lymphocyte (H/L) in the single-hen cage (Cheng et al., 2001). Collectively, genetic selection has created the lines with significantly different phenotypes, each of which has unique characteristics in physical indexes, behavioral styles and resistance to stressors, which could account for the differential stress adaptation of the stress buffering systems including the nervous systems in response to stress.

The nervous systems, peripheral and central systems, collect, distribute and integrate information from both internal and external stimulation, then, transport signals, i.e., releasing of neurotransmitters, to the target cells or organs, resulting in behavioral and physiological changes in animals. Neurotransmitters are regulated by neuronal activity that is affected by changes in the morphological and physiological properties of the CNS neurons. Changes of neurotransmitter system, including alterations in biosynthesis, densities of receptors and gene expression, have been used as indicators of central neuronal plasticity in response to stimuli, which directly and/or indirectly regulate the animal's behavior and production in response to stress and directly impact well-being (Popova et al., 1997; Ferris et al., 1999). In rodents and humans, abnormal regulation of biogenic amines and hormones, such as serotonin (5-HT) and dopamine (DA) concentrations and their derivatives or both have been associated with abnormal behavior (Bell & Hepper, 1987; Dillon et al., 1992; Popova et al., 1997; Berman & Coccaro, 1998), change of coping capability (Driscoll et al., 1998) and altered reproduction (Sirotkin & Schaeffer, 1997). Although the function of the avian neuroendocrine system in response to stimulation is analogous to that in rodents and humans (Harvey et al., 1984) and there is similar distribution of neurotransmitter receptors in birds and mammals (Richfield et al.,

1987; Walker et al., 1991), the effect of genetic-environmental interaction on neuroplasticity and its effect on well-being has not been studied in chickens.

The genetic basis of different regulatory mechanism of neuroendocrine changes in response to differ LGPS hens had greater blood concentrations of dopamine and epinephrine ( $P < 0.01$ ). Blood concentrations of norepinephrine were not significantly different between the lines but the ratio of epinephrine to norepinephrine was greater in the LGPS hens ( $P < 0.01$ ). The blood concentration of serotonin was also greater in the LGPS hens compared to the HGPS hens ( $P < 0.01$ ). The present data showed that, as in mammals, there are measurable changes in the neuroendocrine and immunological systems in response to stress. These changes can be used as physiological indicator(s) of an animal's well-being and responsiveness to housing environments.

The results indicate that genetic selection for group productivity and survivability with reduced cannibalism and flightiness alters the regulation of the neuroendocrine systems. The differential regulations of the neuroendocrine systems are correlated with the line's unique coping ability to novel environments and resistance to stressors. The data suggest that the present lines could be used as models to investigate the molecular and cellular mechanisms underlying effects of genetic factors on physiological functions of neuroimmunoendocrine communication in controlling responsiveness to stress, including housing environments. And, the alterations of physiological parameters could be used as indicators in the evaluation of animal well-being.

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## **The Effects of Ractopamine on Behavior and Physiology of Finishing Pigs**

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The feed additive ractopamine, a  $\beta$ -adrenergic agonist, acts as a repartitioning agent, promoting lean tissue deposition. It has been shown to give substantial improvements in average daily gain, feed conversion efficiency, dressing percent and carcass lean content. The FDA formally approved its use in swine in 1999. However, the production advantages of ractopamine are relatively brief. Performance measures peak and then decline and may even reverse if fed for more than 4 weeks. There have also been anecdotal reports of behavioral hyperactivity and increased reactivity in stressful situations but there is no scientific evidence to support this. The hypotheses to be tested in this study, therefore, were that pigs fed a diet including ractopamine showed hyperactivity during normal daily routines, and increased reactivity during handling and transport.

To test these hypotheses, we set out to examine behavioral time budgets, ease of handling during routine weighing, heart rate response to human interaction, heart rate response to transport and stress hormones response to transport. We used 72 gilts housed in pens of 3, with the pen as the experimental unit. The pens had slatted/perforated floors and pigs had access to food and water ad libitum. Dietary treatments were imposed over a 4 wk period prior to slaughter, during which the feed in 12 pens contained ractopamine and the feed in the other 12 pens contained no ractopamine. The pigs' behavior was video-recorded for one 22h period per week and scan sampled every 5 min, to record each pig's location within the pen, its posture and its behavior. Once per week, the pigs were subjected to a behavioral disturbance test where they were all made to stand up and the latency to lie back down was recorded.

Also once per week, the pigs were routinely weighed. During this process, a pen gate was opened and the pigs either exited the pen voluntarily or were forced out by a handler. Once in the corridor, an individual pig was driven by one handler towards the weighing crate, using a solid board as a guide and hands and legs to push, where necessary. The other handler stood to the side of the crate and closed the door once the pig was inside. After weighing, the crate handler opened the crate door and the pig either reversed out voluntarily or was tapped on the head by the crate handler, using her hand. Once all 3 pigs had been weighed, they were herded back into the home pen and the gate was shut. The weighing process was video-taped using a hand-held camcorder for later analysis.

Physiologically, heart-rate responses to an unfamiliar human kneeling in one corner of the pen and interacting with the pigs for 10 min were measured in all pigs once during the 4<sup>th</sup> week of the trial. Heart rate was also measured during transportation to the campus slaughter facility. During this, the pigs were released into the central corridor, and herded onto a hydraulic trailer. Once the pigs were on the trailer, it was pulled outside to a flat-bed truck. The pigs were then

herded off the trailer onto the truck and the truck departed immediately for the slaughter facility. Loading took approximately 2 min. and journey approximately 18 minutes. Once at the slaughter facility, the pigs were off-loaded straight into a lairage room and the heart rate equipment removed, which took about 2 min. Blood was taken once during the 4<sup>th</sup> week of the trial and analyzed for catecholamine and cortisol concentrations. An additional post-slaughter blood sample was taken during exsanguinations and analyzed for cortisol concentrations only.

## RESULTS

During weeks 1 and 2, pigs fed ractopamine spent more time active, more time alert, more time lying in sternal recumbency and spent less time lying in lateral recumbency. There were no differences in time budgets in any of the behaviors measured during weeks 3 and 4. Following behavioral disturbance, pigs on ractopamine took longer to settle than control pigs, but only during weeks 1 and 2.

At the start of the trial, there were no differences in behavioral responses to handling. However, over the next 4 weeks, on average, 51% fewer pigs fed ractopamine exited the home pen voluntarily compared with control pigs. Ractopamine-fed pigs also took 136% longer to remove from the home pen, 83% longer to handle into the weighing scale and needed 52% more pats, slaps and pushes from the handler to enter the scales.

In response to the presence of the experimenter, at the end of week 4, pigs fed ractopamine had higher mean heart rates overall during the test ( $144.6 \pm 3.2$  bpm vs  $136.4 \pm 2.7$  bpm,  $P < 0.05$ ). When separated into 1 min periods, heart rate showed similar temporal patterns and was initially not different between the two treatments. However, it became and remained significantly different from 3 min onwards. During transport, again pigs fed ractopamine had similar mean heart rates overall ( $P > 0.1$ ). When separated into 2-min periods, heart rate showed similar temporal patterns and was not different between treatments when heart rate was highest during loading and unloading.

At the end of week 4, pigs fed ractopamine had increased circulating concentrations of epinephrine ( $253.0 \pm 55.0$  pg/ml vs  $101.5 \pm 15.0$  pg/ml,  $P < 0.05$ ) and norepinephrine ( $991 \pm 150$  pg/ml vs  $480 \pm 58$  pg/ml,  $P < 0.01$ ) than control pigs. Circulating cortisol concentrations did not differ between treatments either before or after transport.

The results indicate that ractopamine did affect the behavior and physiology of finishing pigs in this study. Pigs fed ractopamine were more difficult to handle and had elevated heart rates and catecholamine levels after 4 weeks of administration. Pigs that are more difficult to move are more likely to be subjected to rough handling and increased stress during transportation. Further research is needed to determine why ractopamine-fed pigs are more difficult to handle and to elucidate ways to ameliorate adverse behavioral responses to handling.

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## **Research Program - Summary**

Animal Physiology Research Unit (APRU)  
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### **ORGANIZATIONAL BACKGROUND INFORMATION**

The Animal Physiology Research Unit (APRU) operates under a single CRIS project entitled "Physiological Mechanisms of Stress and Growth in Pigs". Research conducted within the APRU is directly associated with National Program 105 (Animal Well-Being & Stress Control Systems). The APRU is staffed with one permanent SY, two postdoctoral research associates, three technicians, and a quarter-time secretary. Research conducted by the APRU has received the Innovation Award for Basic Research by the National Pork Board on three separate occasions (1999, 2000 and 2002) and received the Omega Protein Innovative Research Award in 2002.

#### **Overall Research Direction**

Research in the APRU is directed toward understanding the complex interactions between stress, immunology, nutrition, and productivity in young pigs. Highly significant production losses continue to occur in the young pig, despite previous long-standing attempts to solve the problem. Approximately 15% of newborn piglets die soon after birth. In addition, the surviving piglets are susceptible to depressed growth performance due to numerous factors including environmental and managerial stressors, pathogen exposure, nutritional stressors, etc. Therefore, the overall goal of the APRU is to optimize survival, performance and overall well-being of swine during the pre-weaning and early post-weaning periods. The problem is highly complex, however, requiring an integrated multi-disciplinary approach involving research in the areas of neuroendocrinology, endocrinology, immunology, nutrition, stress physiology, thermoregulation, and behavior.

### **RECENT RESEARCH ACCOMPLISHMENTS**

#### **Stress Physiology**

A series of studies were conducted to evaluate the effect of perinatal stress on subsequent growth, performance, and overall well-being of the neonatal pig. The research began with the establishment of a unique caesarian-section birth model in the pig to determine if the stress associated with the natural birth process was necessary for post-natal development and function of the neuroendocrine, endocrine, and immune systems. Additional studies evaluated the effect of providing exogenous glucocorticoid therapy to neonatal pigs at the time of birth. Results from the initial research indicated that the periparturient events associated with the natural birth process are necessary for the proper development and function of the growth and stress axes during the postnatal period and most likely dictate the magnitude of an animal's response to stress later in life. Additionally, the results indicated that perinatal stress may be the trigger which signals the transition from a fetal growth mode to an adult growth mode. The

glucocorticoid therapy research demonstrated that providing exogenous glucocorticoids during the perinatal period can enhance postnatal growth of the pig. Collectively, this research provides compelling evidence that pre-programming of an animal's stress response and growth axis is within our reach.

### **Nutritional Immunology Research**

The APRU has been involved in collaborative research with swine nutritionists at the University of Missouri for several years evaluating the use of nutritional supplements such as plasma protein and fish oil as a means to enhance immune function in weaned piglets. Weaning is a period of acute stress for pigs and is often associated with decreased performance and increased susceptibility to stress and disease. Enhanced production and/or decreased morbidity and mortality of neonatal pigs may be achieved if a more thorough understanding of this acute stress response to weaning were available. Thus, the APRU has led a collaborative research effort with nutritional scientists at the University of Missouri to elucidate the mechanism(s) by which plasma protein and fish oil supplementation improves neonatal pig performance following weaning. Research efforts are directed toward alterations in the hypothalamic-pituitary-adrenal axis and immune system that arise when these supplements are included in the diet of weaned pigs. Unique alterations in the stress response and immune systems of pigs fed plasma protein and fish oil have been identified through this research. This information provides important insight into our future ability to enhance neonatal pig performance and improve the immunological status of pigs during the acute stress of weaning.

### **Immunology Research**

The APRU has been involved in collaborations with scientists from the College of Veterinary Medicine to evaluate alternatives to antibiotic use in swine production at certain stages of development. In order to accomplish this task, initial efforts have been directed at elucidating and understanding the neuroendocrine, endocrine, immune, and physiological responses to a live disease challenge. Initial results from these studies have demonstrated that the acute phase inflammatory response associated with a live bacterial immune challenge differs from that associated with the typically used endotoxin model. Therefore, current research is being directed towards the understanding of developmental changes which are associated with disease susceptibility in the weaned pig.

### **Environmental Stress Research**

Neonatal pigs often succumb to disease due to stress and an associated diminished immune function during the first two weeks of life. A large portion of these losses is due to chilling of the neonatal pig. The APRU has pursued an area of research to evaluate the effects of environmental temperature on pig health and performance. This research specifically targeted the effect of environmental temperature on the neonatal pig's response to an endotoxin challenge. Results from this research were the first to demonstrate that environmental temperature can be effectively utilized to lessen the severity of a neonatal pig's response to an endotoxin challenge. This research has highlighted the importance of managerial strategies which can help prevent the development of hypothermia (i.e., chilling) in the neonatal pig which can lead to death.

## **Managerial Stress Research**

The age at which castration least affects performance and well-being of male pigs continues to be an area of scientific debate due to dissimilar conclusions in prior studies. Previous studies have reported that performance of pigs castrated at 14 days was greater than that of pigs castrated at 1 day of age. However, the authors reported similar behavioral changes for pigs castrated between 1 and 20 days of age. In another study, heart rate and vocalization data indicated that castration-induced stress was greater for pigs castrated at 8 days of age or older. And finally, another study reported that pig age had no effect on behavioral responses when castration occurred at 3, 10 or 17 days of age. Therefore, the APRU conducted a study to evaluate the effect of age at castration on the pig's acute growth and cortisol responses post-castration. Data from this study indicated that castration between 3 and 12 days of age does not influence the acute growth performance of pigs. However, the cortisol data did indicate that the stress response lengthened as the pig age. Additionally, the cortisol data also indicated that after 3 days of age, pigs have a greater stress response to being handled.

## **Overall Impact and Effectiveness**

Research conducted by the APRU spans the scientific realms of basic laboratory analysis to on-site commercial farm studies. Data are presented at local, national and international meetings. Research manuscripts are published in various peer-reviewed scientific journals such as the *Journal of Animal Science*, *Domestic Animal Endocrinology*, *American Journal of Veterinary Research*, *Journal of Swine Health and Production*, *Journal of Applied Physiology*, and *Livestock Production Science*. Additionally, research conducted by the APRU has been highlighted in the media and appeared in the following trade/popular press articles:

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## **Behavior: Recent and On-Going Research**

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Research in our lab focuses on: a) evaluating the effects of various management practices on animal welfare, and b) understanding animal behavior and its development.

### **Gestation housing: small groups vs crates**

The swine industry practice of housing sows in small individual stalls limits the expression of natural behaviors and is considered a serious animal welfare issue. Although group housing systems are being developed in Europe, few studies have investigated group housing in the US. Previous studies have often compared different housing systems on different farms. These results are difficult to interpret since different farms use different management practices. In addition few experiments have included measures of behavior, physiology and production. The objective of this experiment was to compare small group housing with gestation crates. In this experiment both housing systems were located in the same room, and experienced similar levels of management. Measures included behavior, physiology and production variables.

Gilts grouped for one gestation showed more skin injuries and lameness but fewer stereotypic oral behaviors than stalled gilts. There were no other behavioral time budget, physiological or production differences. Little fighting occurred among group members after the immediate post-mixing period. Housing gilts in groups of four does not appear to reduce their welfare, and may increase it, by providing more freedom of movement and reducing the exhibition of repetitive oral behaviors. However, housing effects may emerge after several parities, and effects of group systems will vary with design, space allowance and group size

### **Gestation Housing: measuring sow motivation for group housing.**

Most previous research on alternative housing systems has focused on European production and husbandry methods. In addition, no studies to date have attempted to quantify the strength of sows' motivation to be in a group pen. Previous studies have instead assessed the effects of housing in groups versus stalls upon the sows' health and productivity. Both types of measure are important. Measures of motivation tell us how an animal feels about its environment, which is a very important aspect of welfare (Broom & Johnson 1993, p. 80). Measures of motivation include the level of abnormal behavior, such as stereotypy, performed when a desired goal is unavailable (possibly reflecting the level of frustration), and the quantity of time, effort, or some other valued commodity that an animal is prepared to give up to obtain a goal. Many studies have compared the level of stereotypy between groups and stalls, but the relationship between stereotypy and motivation is far from straightforward (Mason 1991) and motivational strength cannot be quantified in this way. Far fewer studies have investigated what sows will give up to gain access to a group, or some aspect of group living, such as social contact. Barnett et al. (1989) observed how sows allocated their time in a test pen between food and a social partner,

to ascertain whether sows previously housed in stalls were more strongly motivated for social contact than those previously housed in groups. However, different experiments yielded contradictory findings and the procedure was in any case unable to quantify motivational strength.

The objective of this experiment is to measure how strongly motivated stall-housed sows are to be in a group pen. Furthermore, the study will discriminate between sows of different social status. By quantifying the motivation of stall-housed sows to gain access to a group pen, the present study will provide a new sort of data on the welfare of sows in groups versus stalls. Furthermore, by discriminating between sows of different social rank, the study will address the important question of whether all sows, or only some, are better off in groups. Intermediate ranking sows have been shown to exhibit higher levels of physiological stress and lower productivity than dominant and subordinate sows in groups (Mendl et al. 1992; Nicholson et al. 1993) and than stall-housed sows (Nicholson et al. 1993), but it is not known whether they would prefer the group to the stall on balance, or how strong their preference would be.

### **The effect of co-mingling litters on social behavior, performance and temperament**

A great degree of variability exists among individuals of the same species in terms of physiological and behavioral responses. Such differences have been neglected and treated as noise around the "true estimate", the mean. Recent investigations have revealed the importance of understanding such variability, especially in production systems. Individual variation in behavior can have serious economic effects in farmed species, with animals that are less well adapted to their environment often having reduced productivity, health and welfare (Seaman et al. 2002).

Understanding individual variation and its development in animal may have a significant impact on animal production. For example, understanding individuals could either be the first step in selecting animals that are better adapted to their artificial production environment, or in developing better environments (housing systems) for the animals. Studies on alternative housings, such as the communal farrowing system, suggest certain production and welfare advantages for piglets. Weary et al. (1999) demonstrated that early mixing of piglets involves little conflict and provides piglets with a socially enriched pre-weaning environment. The importance of a socially enriched environment has also been shown by Hillmann et al. (2003), who found that piglets reared in group farrowing systems are better adapted to social and non-social challenges and show less aggression at weaning compared to piglets reared in an enriched single farrowing system. However, both systems may allow for the occurrence of cross suckling and an increased variation in growth rates among other problems. By understanding and looking at individual variation in response to communal housing systems we may be able to find ways to minimize associated production/management challenges, and reduce possible problems associated with it on an individual basis.

Individual variation in behavior can have serious economic impacts in swine production. The present experiment has several objectives. First, we will describe individual characteristics of piglets based on their suckling behavior, social interactions, time budget, growth and performance, neuron development in terms of dendritic branching and responses to temperament tests, such as the backtest, isolation test and social challenge. Second, we will

examine the extent in which temperament correlates with individual characteristics by comparing test outcomes to behavioral observations cited above. Third, we will examine the degree in which piglet's individual characteristics explain the variation in growth and behavior known to occur in two systems for housing lactating sows and litters: communal housing and standard farrowing crates. Finally, we will examine the effect of different levels of social experience on piglet behavior. By understanding individual variation, one may be able to predict responses to challenges imposed by production systems and eventually develop an environment that suits diverse individuals' needs thus reducing the incidence of some welfare problems.

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# Assessing Animal Welfare: Applications and Challenges

## Regional Meetings W-173, NCR-131, WCC-204

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### INTRODUCTION

There are many efforts by individuals and groups within the Land Grant University (LGU) system and Federal government related to improving the well-being of animals. Part of these efforts are represented by persons conducting research, some by educational and training programs, and some by other collaborative programs and networking to improve the understanding of welfare issues.

The impetus for this meeting was by United States Department of Agriculture (USDA) Agricultural Research Service (ARS) personnel who realized the Future Trends in Animal Agriculture proposed Round Table discussion on ethical issues related to animal production was behind schedule. Lew Smith (ARS, Beltsville, MD) saw this opportunity to highlight some of their projects, and Don Lay (ARS, West Lafayette, IN) organized the speakers. The ARS has several animal welfare related research programs in various locations. The thought was to use ARS programs and involvement in LGU multi-state research committees as the basis to attempt to answer questions related to the ethical assessment of animal well-being issues.

There are many dedicated personnel in the agricultural system that view animal well-being and ethical issues as critical to the long term success of that system, and as an obligation to society. For example, Jeff Goodwin, University of Idaho, several years ago created a "Just do the Right Thing" program that included videotapes and other educational material for youth and youth leaders. This program was initiated while at Texas A&M University, and in cooperation with the Livestock Conservation Institute (now the National Institute for Animal Agriculture; NIAA). The NIAA also has led several educational programs for youth, and for personnel at fairs and exhibits where there are livestock and poultry competitive events for youth. Other industry organizations have education and training programs dealing with animal well being. USDA and LGU personnel attempt to network with industry and activist groups to gain a better understanding of these issues and to create opportunities for dialogue.



## MULTI-STATE RESEARCH COMMITTEES

The LGU's are organized according to regions in the United States. The Experiment Station Director in a LGU receives an allocation of Federal funds each year intended to support research at that university. A portion of these funds are to be spent on multi-state activities. The precise allocation of these funds to support research related expenses is at the discretion of the Director. Some states pay few travel expenses, while others pay expenses for one or more persons for each committee. Research support is also at the discretion of the Director.

There are two types of multi-state research committees: full, and coordinating. It is the prerogative of the administrative council in each region to approve and designate a committee as full or coordinating, depending on their collective desire to support specific areas of research. They may or may not approve of an initial petition to form a committee, or its renewal. Thus, an emerging concept may languish as a coordinating committee or be immediately incorporated as a research emphasis.

Each committee has an administrative liaison from the region, who helps guide the committee through the initial approval process and reauthorization approvals. This reauthorization occurs approximately every five years. The USDA Cooperative State Research, Education and Extension Service (CSREES) provides a liaison to each committee. This person may actively participate in the committees with insight into research questions or work on subcommittees, or may simply attend the meeting to provide updates and answer questions about policy. The CSREES liaison provides an update of important events or policy changes that occur in CSREES at the annual meeting and helps the committee if they have questions or concerns about USDA policy.

Multi-state research committees were previously known as Regional Research committees. This name change reflects the change in participation in these committees that is in large part the result of reduced faculty at the Land Grant University in each region. Government agencies such as the USDA/ARS also have personnel who actively participate on these committees. Previously, persons from other regions may have participated in these cooperative research initiatives, but today they are generally more simply administered in a region with participation encouraged on a national level. For example, WCC-059 (Western Region Coordinating Committee), Poultry Water Quality for Production and Processing was on the verge of elimination due to the few persons available in the region. The team revised the renewal proposal to reflect the objectives of a full committee and recruited throughout the USA. This committee is now W-195.

The precise alphanumeric designation of these committees is determined by the administrative council for each region. Full committees are identified using the regional letter abbreviations W (West), NE (North East), S (South), and NC (North Central). For example, the full committee, W-173 is the Western Region project number 173. It is not clear the source of the specific number. The Coordinating Committee is identified in other ways such as NCR-131, Animal Care and Behavior, for North Central Region-131, with no specific identification as a coordinating committee. Others, such as WCC-204, Animal Bio-Ethics, is identified as Western (Region) Coordinating Committee.

The claim is made that faculty can do as much as a coordinating committee as a full committee, but that is not perceived as accurate by many faculty members. The reason for this opinion is that full committee members have the potential for research funding, and travel support to participate in the multi-state research committees. The potential for this happening for a person who is a member of a coordinating committee is greatly reduced. For example, faculty members for coordinating committees may have great difficulty obtaining travel funds to participate in the annual meeting. The attitude of support at the Federal level may also be greatly reduced. Federal personnel have had travel authorization rescinded the day prior to travel to the annual meeting of a coordinating committee that was struggling to survive (the team later created W-195). For even a full committee, travel support may well only apply to the single faculty representative on a committee. Some of these decisions are strictly based on the available budget, that trumps a desire to support various research projects and travel.

These reasons support the absolute need to move the NCR-131 from a coordinating committee to a full committee. Likewise, the WCC-204 is being revised to achieve approval as a full committee. The WCC-204 and NCR-131 committees are critical to the long term success of the LGU and animal industries because in their separate ways, they address societal issues of increasing importance. The areas of animal well-being are also becoming increasingly important trade issues. Having credible voices of reason that educate the public, decision and policy makers, and the industry regarding these issues are of utmost importance. Having the capacity to train USA students in the areas of animal behavior and stress responses to management is likewise of great importance.

### **Committee Functions**

The purpose of multi-state research committees is roughly the same for all specialty areas. The primary purpose is to enhance and expand the capabilities of research stations. By cooperating on research projects, sharing resources, as well as networking to share ideas, the ability of LGU personnel to use increasingly sophisticated technology and techniques to meet the emerging needs of clientele is enhanced. The specialization of researchers has increased over the last few decades, particularly, but not entirely, due to the influence of an increased emphasis on biotechnology. Genomics and other areas such as immunology and physiology has delved deeper into the minutia of cells and their interactions. At the same time, the number of available faculty to work in the numerous areas in which we provide research has dwindled. Thus, faculty members who in the past would have had a single or at most two way appointment with teaching now have a two- or three-way appointment that includes extension. The same would be true for extension faculty who now have two- or three-way appointments.

At the Federal level, the Cooperative State Research Service was combined with the Extension Service to form the Cooperative State Research, Education and Extension Service, which diluted work in extension leadership areas. This situation has likewise complicated the ability to coordinate some research activities, but also opened the door for persons normally engaged in extension to participate in research at the university versus field research. These new views of current and emerging research areas have the potential to alter the composition and direction of multi-state research committees.

Of great importance is the opportunity for enhanced synergy between researchers that results in their ability to accomplish more collectively than as individuals. This is true regardless of the type committee, but there is greater potential for this to occur with those members of full committees because coordinating committee members often do not have financial support for research or for travel to meetings. This situation reduces the capacity for networking and planning collaborative research projects or outreach to disseminate results. The reduced travel option is particularly true for members who are not the primary representative of the university to a committee. This situation has greatly inhibited the NCR-131 members from creating widespread knowledge of this area in American students, and why positions at USA universities are being filled by persons from other countries. While outstanding personnel from other countries have been attracted to teach in our universities, and to work at ARS stations and non-government organizations, the point is that we need to have USA students trained in this area. There is general agreement that USA students need to fill research positions that include behavior as a component of research. Attendance at the NCR-131 has been sporadic and usually low, with the same situation being the case for the WCC-204. Progress has been and will be very difficult if we can not find ways to get people to attend the meetings and to use these committees to further our understanding in these critical areas.

Productivity is increased by the sharing of resources and ideas. This is particularly true for those universities that have the potential to interact with ARS station personnel. In most cases, sharing of resources means that fewer animals are needed for research because animals can be used in more than one phase of coordinated research. Behavior data can be collected on animals used to answer management questions related to stress, while tissues, reagents and laboratory techniques and equipment can be used in other cases. Video equipment can be used at more than one facility. These opportunities for sharing reduce the potential for duplication of efforts, and enhance the possibility of wider distribution of results. Rather than results being disseminated through individual station reports, this will be done in several states, with perhaps regional reports being prepared. Projects such as symposia result in national and international distribution of results. These scientific reports can be important in providing input to the decision making process for public policy and answer specific questions about societal issues. Results are submitted as part of the peer review process for professional publications, book chapters, trade journal articles and workshop proceedings. Individuals also provide important input to questions involving societal concerns, such as the guidelines developed by corporate fast food restaurants and grocery chains for their suppliers.

## **Justification**

The following information was taken from the documentation for the W-173 committee, but it applies to the other research committees. One justification for these committees is the significant societal concern about animal well-being issues. More importantly is the underlying need for producers and processors to treat animals in the best manner possible. Farmers have traditionally been considered to be good stewards of their land and animals. Also, farmers have traditionally been influenced by biblical mandates, one of which is that they properly use the resources provided to them. With the advent of increasing consumer demand for cheap food, research did an admirable job in providing science-based information to increase the efficiency and productivity of plant and animal resources. Competition contributed to the whirlwind of increasing knowledge that was unencumbered by traditional values and which swept away the

traditional ways of housing and caring for animals. And it eliminated many good farmers that were perhaps not as good at marketing their products. But consumer demand for cheap food was met and exceeded.

Animal well-being is a societal concern, the extent of which is difficult to evaluate using monetary terms, or other single issue factors such as farm size. Today, consumers say they want to return to the more traditional methods of raising animals, yet their market choices indicate otherwise. Actual or true consumer demand (marketplace expenditures) says they want cheap, safe, attractive, plentiful food in a wide variety of forms, but their responses to surveys say they want the old fashioned or traditional food sources. This is not an easy time of transition. Multi-state committees such as W-173 can help answer questions related to these changes. Complicating the situation are the changes in the structure of society and the rural community that have been forever altered by the last 50 years of meeting consumer demands. Labor availability and rate of pay/benefits, plus equipment, housing, environmental, marketing and other costs impact the capacity of smaller family farms to survive. Demands presented by corporate fast food chains and grocery chains as voluntary supplier guidelines, under the guise of consumer demand, may be seen as improving the welfare of animals in conventional systems. They do not necessarily improve the lot of farmers, and certainly not the small and medium size farmer. This is because the corporate marketplace does not pay cost-plus for animal products to all suppliers, which creates a greater difference between large and small producers. Also, quantity purchases leave out most small or medium size farmers. Activists then tie corporate or industrial farming techniques to conditions perceived to be less than adequate for animal well-being. The corporate retailer guidelines that exist do not appear to solve this puzzling situation (how you can have your cake and eat it too). The WCC-204 committee can help us understand the complexity of the situation.

Significantly more animal well-being research is needed to define how animals interact with production environments, and specifically how they respond to what are perceived by some persons to be better housing and management practices. After determinations are made regarding the effects of the environment on animals, society can better make informed demands for the animals' care and housing. These informed choices should come in the form of consumer demand at the marketplace. Forced changes in management are open to manipulation and politicization that may well not account for anthropomorphic considerations, such as battery cages having a large space per hen versus range, floor, or aviary production of table eggs. Biases against all use of cages for hens may well not be scientifically valid as evidenced by food safety concerns for eggs from cage-free hens.

Animal well-being research using stress and behavior indicators can also reduce animal health care costs, and increase the assurance of well-being. Assessment of research by committees such as WCC-204, allows researchers and society a better understanding of the philosophical nature of our demands and how they relate to positive, neutral or negative animal well-being situations is essential. Obvious abuse and conditions of negative well-being with no redeeming qualities should be presented as such, while neutral or positive management options should likewise be identified. It is possible that science will identify what are intuitively considered as negative management options are actually neutral or even positive in an overall evaluation. Multi-state research committees such as W-173 offer a mechanism for tracking broad regional research problems having national and international implications. The latter would particularly

be true for the NCR-131 and WCC-204 committees. These and other committees are vehicles for sharing and disseminating the most current information on livestock stress, health, welfare, behavior, and environmental management.

### **W-173, Stress Factors of Farm Animals and their Effects on Performance**

Objectives for W-173 are: 1. Identify appropriate measures of animal stress and well-being and characterize factors affecting the biology of the stress response (e.g., measure respiration rate versus body temperature); 2. Evaluate management strategies that minimize the detrimental effects of animal stress (e.g., use of shade, and/or water mist and fans to create air flow). The team expects that cooperative efforts will identify management practices that will improve animal environments and reduce animal stress. Response measures will predict if an animal is under stress/distress and if there is a need for intervention.

W-173 is similar to S-299 in that both projects have objectives related to environmental and physiological stress of domestic animals. S-299 focuses on reproductive performance of heat stressed dairy cattle under hot, humid conditions. While W-173 looks at heat stress under hot, dry conditions, which are a very different range of circumstances and indicated actions. Also, NE-127 (Bio-physical Models in Poultry Production and Processing) includes relief of stress as part of their objectives, with such projects as ventilation innovations and water-cooled perches for broilers.

The justification for W-173 is that in addition to animal well-being concerns, environmental and management stressors erode the efficiency and profitability of farming or ranching operations. Heat stress recently cost the dairy industry \$5-6 B in one year. Swine neonatal mortality is a significant problem for farmers to the extent that saving one piglet per litter will boost profit \$400 M/year. Cattle feeders in Iowa alone lost \$28 M in 1995 to heat related losses. The experiments in W173 are often of an applied nature and have been effective in offering alternatives to ranchers and farmers that have improved the health and well-being of animals and improved the profit picture for the owners.

It is important to realize that we all work on a profit motive. Activists have too often used profit as a negative component of animal welfare discussions...such as, profit is obtained from the suffering of animals at the hands of corporate agriculture. While this may or may not be accurate, profit is not the driver of this negative attitude, rather the scape goat. All organizations require income to exceed expenses, (profit) or they could not continue to be functional. Likewise, individuals sell their expertise for financial rewards and other benefits, and this income must in the long run be in a positive balance (profit). None of us are working for free, and neither should farmers. Consumers hold the key to a livable profit for farmers, and their preferred management option for animals. That key is their market choices. When farmers can earn at least an equivalent profit by using management systems preferred by some in society, then it is likely that some will convert to these systems. And, when farmers can earn more net money, given equivalent management inputs, all will convert. It bears repeating that farmers are good stewards of their land and animals and do the best job possible given the constraints under which they operate. They have increased in size for many reasons, one of which is the need to reduce their costs or improve their profit margin. That is possible when fixed costs are spread over more units of output, and when variable costs are reduced by being able to buy in

bulk, and other savings. In this regard it is also important to remember that size is relative to the time period under discussion. Today's medium or even smaller size farm would have been huge 50 years ago, and one person in the family would not have had to work off the farm to make a living. By meeting consumer demands for cheap food as stimulated by retail outlet competition, farms had to increase in size. It seems obvious that cheap food and small/medium size farms are mutually exclusive concepts.

The W-173 committee has a long history of accomplishments. In the last five year period, they authored 97 full-length scientific publications and 185 abstracts, numerous book chapters, several non-technical reports, dissertations, etc. They sponsored an international symposium, partially funded by a USDA/NRI grant, titled "The Biology of Animal Stress" that resulted in a hard cover publication, "The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare". Members were fundamentally involved in the organization and presentations for the American Society of Animal Science and American Dairy Science Association 2000 Annual Meeting symposium, "Livestock Transport: Industry Issues and Research Challenges". Team members are active on national committees that are developing management guidelines for retail outlets such as corporate grocery and restaurant chains, as well as providing information that impacts policy for government agencies.

### **NCR-131, Animal Behavior and Welfare**

There is a growing concern among the general public, retailers, special interest groups and the scientific community regarding the use of animals in food or fiber production and in research. The NCR-131 focuses on evaluating behavioral responses to stressors and the cognitive ability of farm animals, which will help resolve welfare issues and help provide a better environment for the animals. This in turn may increase productivity and profit. Thus, NCR-131 is logically tied to some W-173 activities. Team members are key spokespersons on the topic of food animal welfare in the USA and internationally. As for W-173, members are active on national committees that are developing management guidelines for retail outlets such as corporate grocery and restaurant chains, other organizations that provide auditing programs, as well as providing information that impacts policy for government agencies.

Scientific data that describe the impacts of management systems and practices on animal welfare may not be adequate for the development of guidelines for farm animal workers and others. There is a significant amount of information in other countries, some of which would be appropriate for use in the USA. However, it is imperative that we have personnel trained in the USA to meet these needs. The preponderance of university personnel and specialists in non-government organizations, and even some government personnel, are from Europe or Canada. There is absolutely nothing wrong with having these personnel working in the USA, and they offer considerable expertise and insight into animal well-being related problems. However, to move these issues forward and to create sufficient data on which to make decisions appropriate to the USA, our agricultural students must have an appreciation for these issues. Many more need to be trained to independently or collaboratively incorporate animal behavior and well-being into their research protocols. The use of behavior adds an important dimension to the evaluation of production related research. This training is important to correctly assess well-being situations and properly advise the public and government agencies when questions arise.

The objectives of the NCR-131 are: 1. To increase student, researcher, and public awareness and understanding of the intricate relationships between animal behavior, production and well-being; 2. To identify factors associated with behavior (including social behavior) that influence animal productivity, reproduction, and well-being; 3. To investigate the behavior and correlated physiology of farm animals under existing housing and management systems, and determine the efficacy of alternative systems and practices with respect to improving their production and well-being; 4. To improve the understanding of the consequences of social isolation and crowding through development and utilization of approaches to the study of animal cognition, which includes perception, awareness, and learning; and, 5. To investigate indicators of pain and suffering in domestic animal species. There is agreement that there is a continuing need for basic and applied animal behavior research, that is multi-disciplinary or individual discipline based, to increase knowledge and understanding of these issues. This need requires greater involvement in these committees by LGU faculty and USDA personnel.

NCR-131 members carry out research in several diverse areas that include: 1. Alternative production and housing systems (e.g., how animal responses and systems interact to affect social behavior; use ethology and knowledge gained to devise production systems that will create an optimal social environment for farm animals); 2. Social behavior (e.g., determine responses to social challenges; determine how spacing behavior is affected by various social interactions); 3. Animal cognition and motivation (e.g., develop approaches to define how animals feel about conditions under which they are kept and procedures to which they are subjected; define motivational states under various housing and management conditions); 4. Animal transportation (e.g., understand farm animal basic responses to animal handling and transportation; suggest ways to minimize stress and ensure well-being).

NCR-131 members represent the core individuals at LGU who are involved in teaching undergraduate and graduate students the principles of domestic animal behavior and animal welfare in this country. Committee members have in numerous ways helped educate the public regarding animal well-being issues, advised government agency personnel or testified at hearings regarding regulations or other questions, and served on animal care panels. Networking is essential to members' ability to participate in these activities.

The primary outcome of this committee is the exchange of ideas and information such as new techniques, behavior and welfare issues, and sharing of data. The contributions members have made on national scientific advisory committees has been substantial. Their work has created an increased understanding of alternative production and housing systems.

Results have been consistently high quality and quantity over the several revisions since 1981. There is a diversity of research topics and there is leadership in developing educational material for LGU and industries. Accomplishments include the following items:

1. The "Encyclopedia of Farm Animal Behavior" is intended for research and teaching, but could also be used in consumer education settings. This important work standardizes the definition of behaviors which currently may be subject to widely differing views of what actions, or their duration, constitute a given behavior. The Internet site is <http://www.liru.asft.ttu.edu/EFAB/efabinfo.htm>.

2. Symposium on "Transportation, Stress and Animal Welfare", held at the 2000 American Society of Animal Science and American Dairy Science Association Annual Meeting.
3. Interaction with group members on the development of species-specific assays.
4. Networking among members for the benefit of developing or responding to public policy and regulations at state and federal levels.
5. Development of an Animal Welfare Judging Team competition for college students. The suggestion has been made to transfer this concept to the 4-H and FFA level to encourage student involvement when they attend college.
6. Distance education graduate level course on animal welfare.
7. Studies on fence line contact between beef cows and calves to reduce negative effects of separation on behavior and growth.
8. Review of the scientific data on tail docking of dairy cattle.
9. Study of rest intervals needed during transport.
10. Alternative housing systems for sow housing.
11. Studies to determine whether imprint training of foals is efficacious in reducing stress and the time required to conduct training sessions.
12. Evaluation of field tests routinely used by veterinarians to assess dehydration and fatigue in transported horses.

#### **WCC-204, Animal Bio-ethics**

This important multi-state research committee was initially approved in 2000. Social concerns about the use of animals continues to evolve, often with information provided by activist groups that promote a certain agenda. There is also confusion between the terms animal rights, welfare, or well-being. The intentional mislabeling of the ultimate goals of rights groups that provide animal welfare related information to the public further confuses these concepts. This confusing situation is detrimental to the desire of many in the industries to enthusiastically explore options in this area. Scientific advances, not tempered by open discussions and individual responsibility of all parties, have possibly led to negative consequences, both from societal and animal well-being standpoints. Misinformation spawns polarization of views and destroys cooperation, while respectful and honest interactions and disagreements provide opportunities for progress.

The objectives of this coordinating committee are:

1. Create a forum in which animal scientists and non-animal scientists (philosophers, social scientists, etc.) may work together to examine and discuss contentious social issues.
2. Provide a means of encouraging the development and coordination of activities that support research projects dealing with bioethics of the animal sciences.
3. Develop mechanisms of outreach that would allow animal scientists to respond directly to consumers and our critics who may question our science and/or production methods.
4. Provide the means for ongoing critical analysis of the animal science profession in the context of its ability to address moral and socio-political issues.

Note: this coordinating committee was not developed to become an advocacy group for animal science or animal agriculture. Rather, the research and other activities conducted under its umbrella will be done in an honest attempt to search for truth. Thus by implication, the group



will also not be an advocate for the philosophies of animal rights or welfare organizations (noting the difference between the two concepts).

This committee attempts to bring individuals from differing points of view together to find common areas of concern which can be used to initiate common areas of support. At the least, the intent is to allow persons of different philosophies the opportunity for honest communications that may lead to mutual respect for differences and ways to cooperate when possible. Science is a social practice and supports cultural agendas that determine socio-political structures that determine who has access to goods, services, liberties and power. Scientists must evaluate their work in a context that is broader than just the scientific or technical...because something is possible does not mean it should be done. Society must also be educated to the fact that if they create demands then they must be willing to pay for those demands. This brings up the point that some make about the hidden costs of food production, which require payment through taxes, societal structural issues, or other means.

Animal scientists have been mostly silent on the subjects related to animal bio-ethics, partially out of: insufficient knowledge of the subject matter; ignorance of the “language” of philosophy that leaves their arguments unstated or readily invalidated; possibly the incapacity to justify some practices on ethical (versus efficacy grounds); an inability to understand the concerns of society who demand cheap food then demand changes that increase food costs. These increased costs are expected to be absorbed by the farmer. The WCC-204 is designed to help initiate a dialogue among members of the animal science community about what are the questions, and potential answers, and so help members discuss these concerns in a meaningful manner.

Accomplishments of these LGU professionals began before formal authorization of the committee. They worked with the American Society of Animal Science in 1997 to sponsor a symposium called “What Should Animal Science Departments be doing to Address Contemporary Concerns?”. There, Thompson recommended several approaches to develop a new professional ethic, which include:

1. Create a forum in which contentious issues in animal science and agriculture may be vigorously debated.
2. Increase the number of undergraduate and graduate courses that deal with the ethics of animal sciences and animal agriculture (Contemporary Issues; this has been done at several LGU).
3. Create “renewed attention to the philosophy of science within the animal agriculture and veterinary disciplines”.
4. Sponsor workshops/symposia which would “cover the basic patterns of argument used to justify an action in light of its consequences, in light of claims of right, consent and respect...”.
5. Establish a new regional coordinating committee on animal bioethics to encourage the development of active interdisciplinary research projects and outreach programs.

It is because of this last recommendation that the WCC-204 committee petition for authorization was submitted, and through which the other recommendations could be addressed. In 1993, Swanson and Thompson discussed several actions needed to address

increased social concerns about animal sciences and production. These actions included development of educational material and curricula, conduct research that will support the development of alternative policies and methods of production, and create sources of funding for these actions. Cheeke published a review of the problems facing contemporary animal scientists and animal agriculture. Shillo has addressed the diversity of the animal science profession and the need to develop a professional ethic that reflects this diversity in order to make the profession more empirically relevant.

The WCC-204 also provided symposia to members of the American Society of Animal Science in the years following 1997. In 2002, a representative presented a paper at the Extension Workshop at the Poultry Science Association Annual Meeting. In 2003 the WCC-204 will provide a symposium, "Bio-ethical Considerations in Animal Production" to the Poultry Science Association membership. The proceedings of this symposium will be published in "Poultry Science". In addition, this committee has resulted in increased credible dialog between science and other communities about contentious social issues, increased cooperative research, and communications. To stimulate work and collaboration in this area, it is important that animal science faculty be given credit in promotion and tenure, and other areas of evaluation for research using social science techniques and presentations in other than animal science venues.

### References

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## **Development of the ARS:Purdue Animal Welfare Program**

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Animal welfare is an important issue for the agricultural industry. Public interest, awareness and examination of agricultural practices, is increasing due to concerns over issues such as genetically modified organisms and environmental impacts. As a result, concerns over specific animal husbandry practices are receiving more scrutiny. The issues are complex and multi-dimensional dealing with animal behavior, production, health, and ethics. There is a clear need for an objective, scientific voice, in the public debate over animal welfare issues. The animal welfare program aims to be that voice and addresses animal welfare in all areas of a Land Grant Universities mandate; research, education, and extension.

Research is the major activity of the animal welfare program. Animal welfare research is the focus of the USDA's Livestock Behavior Research Unit. The mission of the Livestock Behavior Research Unit is to develop scientific measures of animal welfare that will allow an objective evaluation of animal agricultural practices. USDA scientists have expertise in stress physiology, immunology, neurosciences and behavior. Combining efforts with the Purdue faculty's expertise in behavior, physiology, genetics and animal production, results in a broad multi-disciplinary approach to researching animal welfare issues. In the past 4 years, 16 Purdue faculty have collaborated with 3 LBRU scientists on animal welfare issues involving swine, poultry and dairy cattle. The topics studied have included the welfare implications of genetic selection, transportation, physical alterations, and various housing methods. In addition to the direct collaboration with Purdue faculty, USDA scientists, train graduate students and serve on graduate student committees through their role as adjunct Purdue faculty.

Curriculum concerning animal welfare is of increasing importance in animal agriculture and our society at large. All members of the animal welfare team are involved with undergraduate and graduate course instruction, some as primary instructors and others as guest lecturers. Within the Department of Animal Sciences, there are three courses currently available which directly address animal welfare. Animal Behavior (ANSC 303) and Animal Welfare (ANSC 404) are currently available to all undergraduates across campus. These courses are designed to introduce students to basic concepts in animal behavior and welfare, and their application in addressing challenges facing the animal agricultural industry. Graduate students and senior students can presently enroll in a distance education graduate level course, "Recent Advances in Animal Welfare Science" which is offered in collaboration with Michigan State University (MSU). Two additional courses, an animal welfare assessment course and a graduate level animal

behavior course (to be offered in collaboration with the Purdue School of Veterinary Medicine), will be offered in the very near future.

Public education, extension, and outreach, is another main focus of the animal well-being team. Members of the animal welfare team provide expertise to industry and government. Team members were involved in the revision and implementation of welfare guidelines for the United Egg producers and McDonald's corporation. Members also serve in scientific advisory roles to organizations such as the National Pork Producers, Federation of Animal Science Societies, Certified Humane, and the Indiana Board of Animal Health. Purdue Agriculture in collaboration with the USDA and the School of Veterinary Medicine established the Center for Food Animal Productivity in 1997. The Center's objectives include: (1) the development of a multi-disciplinary graduate education program on animal well-being. (2) extending livestock well-being expertise to industry; and (3) developing a program of adult education

The USDA-ARS:Purdue team in animal welfare: 1) conducts basic research to develop measures of animal well-being, 2) conducts applied research to address existing, and to prevent future, animal welfare problems, and 3) educates students, producers and the public at large about animal welfare issues and solutions.

Purdue 's efforts, in partnership with the USDA-ARS, Livestock Behavior Research Unit aims to be an objective scientific voice and provide the necessary scientific information to the animal industry to ensure appropriate animal practices and a viable agriculture industry in the future

Additional information on the animal welfare program at Purdue can be found at the Center for Food-Animal Welfare's website, [www.ansc.purdue.edu/CAWB/](http://www.ansc.purdue.edu/CAWB/) Information about the Department of Animal Sciences can be found at [www.ansc.purdue.edu](http://www.ansc.purdue.edu)

## **Assessment of Animal Welfare: A Matter of Ethics**

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### **BACKGROUND AND OVERVIEW**

Assessment of animal welfare is ultimately a matter of ethics. To support this statement, I feel it necessary to provide some definitions. I am not proposing that these definitions be universally adopted or that they supercede those previously presented by other persons. Rather, I provide them only to state what I mean when I use the terms within this presentation – and ultimately, to clarify why I assert that assessment is inextricably tied to ethics.

First, I contend that animal welfare, from an individual animal's viewpoint, has to do with all components, functions and life experiences of that animal. Thus, animal welfare is inclusive of factors related to genes, reproduction, physiology, health, nutrition, behavior - and every other sub-discipline of animal science. Additionally, the composite of traits commonly referred to as production (growth, lactation, egg production, etc.) are tied to the individual's welfare, as are the subjective mental state and feelings of the animal – which arguably are ultimately the most important of all. Both the immediate stimuli being experienced and all of the animal's past experiences, of course, influence these subjective states. Nothing that is of the animal, or of its past, can be said to be without influence on the animal's welfare. However, the relative importance of these different factors to an animal's well-being spans an enormous range. For example a single nucleotide substitution in DNA can have an infinitesimal impact, while another single substitution can cause the brain function to be grossly abnormal. Similarly, a given stressor might have a major impact on an adult animal, but negligibly affect a neonate. Regardless, without giving consideration to genetic composition, background and developmental experiences, nutritional status, etc., one could not contend that a true determination of an animal's welfare has been made. This of course presents an enormous challenge to persons attempting to assess the welfare of animals.

Science, unquestionably, has played a major role in adding to the understanding of each of the above-mentioned aspects of animal welfare. As an example, the tools of science have been used to specifically define the nutritional needs of animals in terms of energy, protein, vitamins, minerals, etc. Stress physiologists have similarly defined the critical temperatures for animals. Behavioral scientists have measured - or can measure - the amount of space needed by a hen to perform different behaviors including standing, turning around, grooming, stretching wings, dust bathing, engaging in courtship and mating, flying, roosting in a tree, etc.

Science can be said to be the human endeavor associated with gaining a rational understanding of the universe, including its many components. In short, science deals with questions about "what is." Above, the nutritionist, physiologist and behaviorist each were answering questions about "what is" in regards to meeting a given requirement of the animal. Science is generally

viewed as being a process that avoids the use of subjective topics and methodologies. (I should note that for the sake of brevity and clarity, in this discussion I have drawn a sharp line of distinction between ethics and science. In truth, this is not the case. Science is a process conducted by humans. Thus, it is not possible to eliminate ethics from science as a process because every action taken by a scientist involves value judgment starting with deciding what research topic to investigate.)

Assessment by definition falls outside of science. Specifically, to assess is to appraise or to determine the importance, worth or value of something. In short, assessing has to do with making value judgments. Value judgments imply, or have to do with, “what ought to be.” As was mentioned, science can measure how much space a hen needs to perform a given behavior, but science cannot define whether or not a hen “ought to be” able to roost in a tree, for example. Assessing the welfare of a given animal thus has to do with how much value the person making the assessment assigns to the resource in question, i.e., enough space to fly and roost in this example. The majority of scientists contend that their work, through the scientific process, does not involve ascribing value, especially to entities such as subjective mental states. However, ethicists have acknowledged the importance of value judgments and attempted to objectify the process. Therefore, some discussion of ethics will be presented.

## **ETHICS AND ANIMAL WELFARE**

The term ethics is usually applied in reference to professional behavior, while the term morality is more commonly used in reference to personal behavior. Accordingly, it is appropriate to mention that animal scientists – and others, even animal protection advocates - do have professional ethical obligations. For animal scientists I would propose that we have obligations to producers, citizens, animals, and the environment, as well as to each other in ensuring that the integrity and trust of our group as a whole is maintained. We, animal scientists, commonly state that our purpose is to serve at least some, if not all, of these groups and entities.

A fair question to ask is – Do animal scientists actually serve producers? And I will discuss dairy in this example, but one could just as well use poultry or pork. The USDA-NASS May 2001 report indicates that from 1990 to 2000, there was: 1) a 21% increase in the pounds of milk per cow and 2) a 14% increase in total milk produced. However, there was: 1) a 6% decrease in the number of milk cows and 2) a 41% decrease in the number of milk cow operations! In truth, can we say that we have helped the collective group we commonly refer to as producers when 41% of them went out of business during the decade of the 1990's?

Now, let us address the question: What is the impact of continuing to increase the amount of milk produced per cow? We know that higher producing cows have more mastitis, more feet and leg problems, and lower fertility, all contributing to shorter longevity in the herd. Yet, we continue to conduct research whose goal is to increase efficiency – which in fact is a term we use for nothing more than more milk per cow. Is there no upper limit to the amount of milk we will ask of one cow? How can we say we serve the interests of producers knowing that increased production per cow will force more producers out of business? And can we honestly say that our mission is to improve animal welfare if we endorse increased levels of production per animal when we know that this results in cows experiencing greater stressors? Maybe these negative consequences could be justified if we were confronting food shortages, but

instead, we have a surplus of milk! I have encountered animal scientists who respond to these questions with an answer common to most all sciences, “I am only a research scientist. It is not my job to consider how the knowledge and technology I develop is used.” At some point animal scientists should also ask, “How much does the continued research focus on increasing production per animal unit serve the continuance of my job and my professional interests – to the detriment of other interests?”

I contend that statements of denial by animal scientists of responsibility for the consequences of their work are, in fact, in direct contradiction – maybe even unconsciously hypocritical – when viewed in the context of the mission statements of their home institutions and scientific societies. Most all of these mission statements include, often begin with, a claim that the overall objective is to serve producers. How can animal scientists honestly contend they are serving producers when a large percentage of them have been forced out of business? I suggest that this is one of a number of issues that should be carefully examined in the context of professional ethics by animal scientists.

Acknowledging the level of conformity forced upon its membership is also an area of professional ethics that I think is in need of recognition. I believe there are sometimes penalties associated with speaking out within the animal science community. In preparing for this presentation, I felt a certain level of pressure to conform or not go too far, but after some thought I decided that I had some obligation to attempt to act consistently with my message – and speak openly about what I considered to be right and wrong. Striving for consistency, in both reasoning and action, is in fact a principle in moral philosophy. Regardless of our job, we all have professional pressures that force us toward compromise. If our job is to bring about legislation on animal welfare, then salary and peer evaluations become tied to getting a bill passed and signed. Without consideration of ethics, one can lose sight of the long-term consequences of the legislation and end up serving one’s own self-interest, i.e., simply getting a bill passed. I give this example to demonstrate that it is not scientists alone who have need of consideration of ethics in their professional behavior. Everyone has this obligation regardless of profession, and I call for all animal scientists to take on this responsibility.

Animal welfare falls into a category of philosophy commonly referred to as applied ethics. Applied ethics also deals with other moral issues such as abortion, capital punishment, euthanasia – all of which have to do with determining what is right and wrong. Moral issues can be said to be concerned with “what ought to be,” and thus, addressing these topics is often fraught with difficulties and angst. However, we humans are moral agents, meaning that we have the ability, within some bounds, to choose between right and wrong and to act accordingly. This ability separates us from the other animals. Ethics is built upon the premise that because humans have the ability to do what is right, then we also have an obligation to behave accordingly – and not simply to act as animals. In short, it is ethics – not science – that has resulted in our transcendence from the animal state. Accordingly, one could argue that it is science and ethics acting in concordance that has the best prospect of ultimately producing a just and sustainable society.

The field of ethics that involves statements about what is considered right and wrong is also called normative ethics. Normative statements can be built from either a consideration of the consequences of the action in question or based on existing, specific rules. We in agriculture

tend to base our justification for using animals on a consequentialist argument. We contend that even if harm is done to animals, then a greater good is served because people do not go hungry. This type of reasoning is called utilitarianism, which ironically, is the type of argument Peter Singer used in his book, *Animal Liberation*. On the other hand, Tom Regan presented an argument based on rules; it is wrong to harm or kill others. Regan's argument is truly a rights-based argument, while Singer's is not – even though most scientists commonly and mistakenly view him as arguing on the basis of rights for animals. Instead, what Singer argued in *Animal Liberation* was that modern production systems cause such great harm that the benefits that accrue are not enough to balance the pain and suffering. Theoretically, if one could demonstrate that the benefits of animal agriculture were greater than the negatives then to be consistent in his utilitarian philosophy, Singer would have to accept the use of animals in the production of food – which in fact was acknowledged by Singer originally. However, because Regan bases his argument on the rule that it is wrong to kill, then no matter how much good one might be able to demonstrate that results from using animals for any purpose, he would still contend that it violates the rule against causing harm to other sentient beings.

There are many normative principles that should be used in making decisions about right and wrong including the following (after the Internet Encyclopedia of Philosophy):

- Personal benefit – acknowledge the degree of gain for one's self.
- Social benefit – consider the benefit to society.
- Benevolence – help others who need help.
- Paternalism – engage in parenting, mentoring, shepherding, etc.
- Harm – do not harm others, or do the least harm.
- Honesty – do not be deceitful.
- Lawful – do not violate laws and statutes.
- Autonomy – acknowledge the right of freedom over one's actions and body.
- Justice – acknowledge one's right to due process, compensation, etc.
- Rights – acknowledge one's right to life, information, privacy, safety, etc.

The first two listed above, again, have to do with consequentialist principles (or utilitarianism) and the others are considered to be non-consequentialist and are rule-based (or deontological) principles. Also the deontological group can be further divided into duty-based and rights-based theories, with the last three listed above being rights-based and the others duty-based in theory.

Ethics ultimately has to do with doing the right thing. Doing what is right necessitates both introspection and considering the views of others. Doing the right thing for animals necessitates that there be an ongoing dialogue, review and changes in attitudes and practices. I propose that this process is best done through a type of democracy wherein the views of animals, producers, citizens (consumers), the rural communities, the environment, etc. are taken into consideration. Traditionally, animals used for food production have been considered to be "live stock" meaning nothing more than property. Polls taken over the past 35 to 50 years (HSUS; Herzog et al.; *The State of the Animals 2001*) document that no increase in vegetarianism has occurred, and the public wishes to continue to eat animal products. However, these polls also clearly indicate that a huge majority of the public wants assurance that their food is coming from animals that have had a reasonable quality of life - and that the animals have not suffered unnecessarily. I believe the implication of these two views (providing appropriate welfare but



continued use for food) is that it is necessary for discussions be initiated regarding how the ownership of the animal as a food product is to be uncoupled from the ownership of the animal's life. This has already occurred with research animals through a process wherein all research institutions must form a committee that has responsibility for making decisions about the life and treatment of animals while the researcher still "owns" the animal as a research subject. It is not practical to consider using this exact system for privately owned production animals, but I believe that it is important that persons in animal agriculture increase the level of discussion and action on this topic. If animal agriculture does not take the initiative then at some time in the future, it is almost certain that others will take action that will dictate how this uncoupling will be done.

There are already many groups and individuals clamoring for legislation governing the housing, treatment and care of food animals. In many of the proposed laws, the desire to inflict punishment onto animal owners makes it easy for most any critic to attack and defeat the proposed bills. Legislation, I believe, should be the last resort. As an educator, I very much wish to see persons change because they recognize that change is the right thing to do – as opposed to bringing about change in behavior because the power of government has been brought to force upon them. Additionally, there is a plethora of examples where government intervention has resulted in huge, expensive bureaucracies that in some cases can be shown to have exacerbated the very problem they were intended to solve. Unwise legislation could easily drive the animal industries outside the borders of the USA and into other parts of the world, which could possibly make it difficult or maybe impossible to ensure proper treatment for animals.

Having expressed my opposition to legislation, I must again state, however, that animal agriculture should give all due consideration to the importance of addressing the concerns of the public. "Educating the public" on many of these issues is not the answer. When animal agriculture says that the public must be educated, this is paramount to saying, "We are right and you are wrong." While it is true that the public is not informed about many practices in animal agriculture, the same can be said for many animal scientists. It is near impossible for one person today to be informed on the vast range of production systems and practices across the different animal species-production groups. Very few animal scientists have been inside a veal barn for example. Typically, poultry scientists are not familiar with the red meat production systems and vice versa. This ignorance of animal production systems has not stopped animal scientists from expressing opinions outside their area of expertise or even engaging in writing guidelines – as I, and several others, have done. Similarly, a person does not have to be fully informed about the science associated with egg production to have an opinion about how crowded the hen should be that lays their breakfast egg. We need to stop contending that the public does not understand us as animal agriculturalists, and start seriously listening to what is being said and begin working toward making the necessary changes.

At the 2002 Pork Academy, I proposed that it could be a wise choice for pork producers to join together and voluntarily ban the building of new gestation crates. I believe that if done with planning, it could be possible for crates to be phased out over 20 to 25 years. Additionally, I believe that tax incentives, low interest loans, direct subsidies, etc. could be obtained in support of development and implementation of alternative systems, if producers seriously moved as a group on this issue. And again, not taking the initiative will at some time in the future most likely

mean that pork producers will have the terms of eliminating stalls dictated to them. A voluntary move by the industry itself could have a huge positive public relations benefit – in addition to this being the right thing to do for the animals.

## **CONCLUSIONS**

Assessment involves value judgment but should be done consistent with scientific knowledge. However, it can be argued that assessment, because it involves subjective valuation, is ultimately a question of ethics. Similarly, it can be argued that ethics is an inevitable part of all science. Science and technology have added much to our quality of life, with readily available, safe and inexpensive food being one of the benefits. However, we have attained a level of food production in this country that is one of oversupply and now we are looking outside our borders for markets for our meat. There are some serious ethical issues associated with developed world countries dumping food into under-developed countries. It would be a mistake to attempt to limit science in its pursuit of new knowledge because increasing world population may someday require that we produce more. However, I suggest that at this time, we should consider stopping the funding of research that has as its specific goal the increase of production of milk, growth rate, eggs, etc. per animal unit. At least we need to start talking about what we consider to be the upper limit that we consider to be ethical. Funding research that demands production per animal unit continues to add to the problems of American animal agriculture – not solve them. The major problems and issues that confront animal agriculture are related to the environment in general, nutrient concentration from animal waste, decreasing farm numbers and the decline of the rural community, food safety, food healthfulness and consumer acceptance, biodiversity as both a natural issue and one related to bioterrorism, and of course, animal welfare. Animal agriculture, even animal science research, has become focused on short-term profit. This approach is not one that is sustainable. Developing a healthy, long-lasting animal agriculture is rooted in striving to do the right thing for producers, the environment, the public, and animals.

# APPENDIX A

## AGENDA

8:30 AM      **Introduction:** Dr. Lew Smith, USDA/ARS, Beltsville, MD

### **Assessing Animal Welfare: Strategies**

Moderator: Dr. Alan Grant, Purdue University

8:35 AM      **Summary of Assessment Strategies** Dr. Don Lay, *USDA/ARS, Livestock Behavior Research Unit*, Purdue University

8:45 AM      **Animal Welfare in Modern Animal Agriculture** Dr. Inma Estevez, *University of Maryland Department of Avian and Animal Sciences*

9:00 AM      **An Introduction to Stress Physiology Applications** Dr. Michael Toscano, *USDA/ARS, Livestock Behavior Research Unit*, Purdue University

### **Assessing Animal Welfare: Specific Research Approaches**

9:15 AM      **Immunology** Dr. Susan Eicher, *USDA/ARS, Livestock Behavior Research Unit*, Purdue University

9:30 AM      **Neurophysiology** Dr. Heng wei Cheng, *USDA/ARS, Livestock Behavior Research Unit*, Purdue University

15 Minute Break

10:00 AM      **Behavior** Dr. Jeremy Marchant-Forde, *USDA/ARS, Livestock Behavior Research Unit*, Purdue University

10:15 AM      **Stress Physiology** Dr. Jeff Carroll, *USDA/ARS, Animal Physiology Research Unit, Columbia, Missouri*

10:30 AM      **Behavior** Dr. Ed Pajor, *Purdue University, Department of Animal Sciences, Purdue University*

10:45 AM      **Round Table Discussions**

11:15- 1:00 PM      LUNCH BREAK

## **Assessing Animal Welfare: Applications and Challenges**

Moderator: Dr. Don Lay, *USDA/ARS, Livestock Behavior Research Unit, Purdue University*

- 1:00 PM      **Regional Meetings W-173, NCR-131, WCC-204** Dr. Richard Reynnells,  
*USDA/CSREES/PAS, Washington, DC*
- 1:20 PM      **Program Development** Dr. Alan Grant, *Purdue University, Department of  
Animal Sciences*
- 1:40 PM      **Assessment of Animal Welfare: A Matter of Ethics** Dr. Ray Stricklin,  
*University of Maryland, Department of Avian and Animal Sciences*
- 2:10 PM      **Comparison of Industry Guidelines: The Role of Values** Dr. Janice Swanson,  
*Kansas State University, Department of Animal Sciences and Industry*
- 2:40 PM      **Round Table Discussions**
- 3:10 PM      **Meeting adjourned**

9/15/03