

ABSTRACTS
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SYMPOSIA AND ORAL SESSIONS

Keynote Symposium: Tomorrow's Poultry: Genomics, Physiology, and Well-Being

1 Breeding of tomorrow's chickens to improve well-being.

H. W. Cheng*, *Livestock Behavior Research Unit, USDA-ARS, West Lafayette, IN.*

Change is defined as 'becoming different' or 'modification'. Our world (natural environment) is continuously changing. In nature, the changing environment constantly puts selection pressure on animals for survival and reproduction (natural selection). Animals have the ability to change their behavior and physiology (plasticity) based on the costs and benefits in order to 'fit' the changing environment (adaptation). Through natural selection, the population preserves and accumulates traits that are beneficial and rejects those that are bad in their prevailing environments. The surviving populations are able to contribute more genes associated with traits for increased fitness to subsequent generations. Natural selection is slow but constant; accumulating over multiple generations, and generally the animals' change is silent and/or undetectable at a given point in history. Chickens were domesticated from the wild red jungle fowl. The principle of domestication of animals by humans is similar to that of natural selection: selecting the best animals with the highest survivability and reproducibility (artificial selection). Compared to natural selection, the process of artificial selection is motivated by human needs and acts more rapidly with more visible results over a short time period. This process has been further accelerated following the development of current breeding programs and the emergence of specialized breeding companies. A laying hen, for example, produces more than 300 hundred eggs a year, whereas a jungle fowl lays 4-6 eggs in a year. During the domestication process, chickens retained their capability to adapt to their housing environment, which is usually achieved by genetic changes occurring during each generation and over generations. Genes control animals' physiological, immunological, and psychological responses to stressors, including environmental stimulation. Genetic improvement of chickens will speed up breeding programs and has the potential to be used very successfully in selecting animals with high production efficiency and optimal welfare, resulting from resistance to stress, disease or both.

Key Words: chickens, breeding, selection, adaptation, well-being

2 Why using genetics to address welfare may not be a good idea.

P. B. Thompson*, *Michigan State University, East Lansing.*

Welfare of animals in livestock production systems is now widely defined in terms of three classes of measures: veterinary health, mental well-being (or feelings) and natural behaviors. Several well documented points of tension exist among welfare indicators in these three classes. Strategies that aim to improve welfare using genetics can increase resistance to disease, and may also be able to relieve stress or injury. One strategy is to reduce the bird's genetic proclivity to engage in behaviors that are frustrated in modern production systems. Another is to develop strains less prone to behaviors hurtful to other hens. Yet another is to make overall temperament a goal for genetic adjustments. These genetic approaches may score well in terms of veterinary and psychological well-being. Yet they also involve changes in behavioral repertoire and tendencies of the resulting bird. While it has seemed reasonable to argue that such animals are better off than frustrated or injured animals reflecting more species typical behaviors, there is a point of view which holds that modification of a species typical trait is ipso facto a decline in the animal's well-being. What is more, a significant amount of anecdotal evidence has been accumulated which suggests that many animal advocates and members of the public find manipulation of genetics to be an ethically unacceptable approach to animal welfare, especially when modifications in the environment could also be a response to welfare problems. Hence, though promising from one perspective, genetic strategies to improve welfare may not be acceptable to the public.

Key Words: animal welfare, public acceptability

3 Balancing act of welfare needs of broilers and productivity.

M. N. Katanbaf*, *Cobb-Vantress, Inc, Monticello, KY.*

Primary breeders are well aware that selecting for better health and welfare along with economic traits such as faster growth rate, higher levels of meat yield and improved efficiency of feed utilization are critical to balanced long term genetic progress of their pedigree pure

lines as well as to increased production efficiency of broiler products for the broiler industry. Cobb collects and selects on over 50 phenotypic observations per pedigree candidate at various ages. Over one half of these collections are more or less an evaluation of birds' health, welfare and fitness. Some examples of these traits are: various chick defects, various broiler age skeletal and leg abnormalities, feather cover, various physiological measures of heart and lung functions and various causes of mortality. Large pedigree populations, massive data collection infrastructure, integration of better technologies in evaluation of phenotypes and sophisticated data analysis capability have allowed geneticists to perform selections that are balanced for both economic and welfare traits. Cobb's internal as well as world-wide sponsored research has facilitated geneticists to make science based breeding decisions. Each pedigree line, per product available to primary breeders, exhibits its own unique characteristics that are enhanced by selective breeding and positioned in special mating schemes to produce the product and welfare performance that our customers demand. Additionally, most if not all primary breeding companies now offer different products for different markets which exhibit varying level of performance and behavior to fit customer needs. Future expansion of these products and creation of new products by breeding companies will be in large dictated by both our customers and consumers.

Key Words: broiler breeding, balanced selections, broiler welfare, sustained genetic progress

4 Genomics, physiology, and well-being: Layer industry breeder's perspective. N. P. O'Sullivan*, *Hy-Line International, Dallas Center, IA.*

The egg industry has been challenged by production system changes over the previous 75 years. Starting with extensive floor production systems, moving to adoption of cages, and returning, first in EU, followed by N. Am., with increases in use of enriched colony cages and floor and aviary systems. Thus a moving selection environment for breeders. Selection continues to evolve to meet systems of production needs. Selections of laying hen lines, have included evaluation of both purelines and crossbred daughters, the latter under group housing to amass data for egg production, sexual maturity, livability (in rearing, and adults), egg weight curve, and egg quality traits (shell strength, shell color, albumen height, and freedom from interior and exterior defects), adults body weight, feed efficiency, feather cover, and dry manure. In addition group evaluation, of livability without beak treatment and of nest laying behavior were adopted. All group evaluation is done with either full or half sibling groups. Genomics has been applied for simple single gene traits, such as MHC B bloodgroups, fast and slow feathering, recessive and dominant white, FMO3 mutant elimination have all become routine in breeding programs. More advanced use of validated markers for additive traits have improved with better marker density of Marek's disease alleles and complex curve traits like the egg weight curve with markers which differ between different points of the egg weight curve. Whole genome selection testing is currently being evaluated in Hy-Line lines with SNP panel developed for this specific purpose. While this technique is currently under experimental review, if it proves practical, feasible, and more effective than current industry practices, we will see a paradigm shift in laying hen breeding in the next five years. The results could yield a halving of generation interval, in addition to improved identification of males to select within full sibling families.

Key Words: laying hen genetics, selection traits, group selection, laying hen genomics, whole genome selection

5 Profitable turkey production and animal welfare are not mutually exclusive and can be selected for simultaneously. B. J. Wood*, *Hybrid Turkeys, Kitchener, ON, Canada.*

The aim of primary breeding companies focuses on maximising profitability for end users of their product. Consequently, selection pressure has been placed on traits such as growth rate, feed conversion and carcass yield that have an influence on profitability. Maximising profit does not necessarily mean that welfare is forgone, as the two are often positively correlated. When welfare and profitability are closely linked, consideration should be given to the balance between them as improving welfare can then improve profitability. For example, improving liveability decreases the financial loss incurred by feeding and housing birds that fail to achieve market age. Placing appropriate selection pressure on liveability improves both the returns and the welfare indicator. Other measures of welfare, like footpad score and behaviour, are not as easily linked so calculating a value relative to other traits is more difficult. There are observable differences in both litter wetness (correlated with footpad lesions) and behaviour in both pure-line and commercial crosses indicating the traits have a genetic basis and could therefore be used as selection criteria. Welfare indicators such as liveability and footpad scores can also be affected by management factors like growing density. Increasing floor space can improve both liveability and foot pad scores but fixed costs are then allocated across fewer birds which may lower the profit margin per unit. Decreasing the allowable density has been used to penalise producers with measurably poorer welfare. Conversely, producers with better welfare scores may be given the opportunity to increase bird density and hopefully subsequent profitability. From a primary breeding stand point, the rearing environment for pure line candidates should simulate the highest densities that their commercial progeny would likely experience. This effectively decreases the likelihood of a genotype x environment (GxE) interaction. These GxE interactions may occur when progeny are grown at a higher density compared with the selection environment.

Key Words: turkeys, welfare, foot pads, mortality, liveability

6 Animal welfare and the future of poultry genetics. S. Avendano*¹ and D. A. Emmerson², ¹*Aviagen Ltd., Edinburgh, United Kingdom,* ²*Aviagen Inc., Huntsville, AL.*

Welfare related traits such as leg and skeletal defects and metabolic disorders have long been important to primary breeders. These traits represent a challenge to breeders based on their relatively low heritabilities and unfavorable genetic correlations with broiler traits. Aviagen has included welfare related traits in breeding goals since the early 1990s making the improvement of both skeletal and metabolic traits its trademark. An inherent challenge to the introduction of welfare related traits into breeding goals is the actual definition of welfare. This can vary depending on the specific market, legal considerations and social perceptions and can be as specific as any trait compromising livability or as broad as any aspect related to bird well-being. In a global market where live performance of broiler products must be increasingly expressed in compromised environments, improvement of welfare will have a direct impact on profitability through their relationship with livability. Breeders record data on dozens of characteristics and have the opportunity to select for multiple traits in a balanced manner. Advanced statistical methods, including novel genomics information, can then be applied to provide accurate prediction of breeding values for both performance and welfare related traits. Medical technologies provide tools to dissect complex and lowly heritable welfare traits into more heritable components and to target underlying physiological systems. Alteration of the

selection environment can also be an important strategy to allow more effective selection for welfare by increasing trait heritabilities. Although genetic selection for improved welfare characteristics inevitably requires compromise and a delicate balance with other traits under selection, it is possible to improve welfare traits and economic performance simultaneously. As an industry it will be important to determine the optimal balance between genetic and non-genetic strategies to most effectively address welfare considerations.

Key Words: genetics, welfare, breeding objectives

7 The European experience in poultry welfare: A decade ahead.

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Farm animal welfare is a major issue in Europe, and has resulted in regulations and development of research dedicated to animal welfare, especially on standard poultry production which is often considered as resulting in a very poor welfare. The effect of selection is also often questioned. Indeed, capacities of adaptation have been very little considered during the first years of commercial selection and thus reduced. But nowadays, a much greater importance is given to welfare related traits and genomic selection should alleviate the need for their measurements in the short term. However the choice of the fittest selection criteria is still to be made. Since behavioural traits are highly dependant on environment, general propensity may be more efficient. For example, selection against undesirable behaviour such as feather peaking has been proven to be efficient (Kjaer and Sorensen, 1997) but selection for reduced mortality rates in collective cages proved to be preferable (Craig and Muir, 1996). The direction of selection is also to be considered: while social motivation appears to be important in large scale flocks, increasing it to a too large extent results in increased aggressivity (Richard et al., 2008). Moreover, a general propensity will not result in overall improvement: for example, while duration of tonic immobility is a general measure of fearfulness, selection on it does not modify response to social stress (Mills et al., 1993). Detrimental effects on other traits may also be observed: while genetic resistance to diseases should increase animal welfare, it may also result in increased frequency of silent carriers and in turn to human transmission. Studying lines selected for or against these traits will be of great help to choose the best strategy of selection. Another and longer term concern should be on links with other production traits but also on sustainability which will probably be of greater importance in the coming years.

Key Words: poultry, welfare, genetics, genomics, Europe

8 Molecular, neuroendocrine events during stress in poultry. W.

J. Kuenzel^{*} and A. Jurkevich, *University of Arkansas, Fayetteville*.

Over the past several years, two assays continue to be utilized as indicators of stress levels in poultry and objective markers of poultry welfare: the heterophil to lymphocyte ratio and plasma levels of corticosterone (CORT). The purpose of this review is to focus upon the second measure of stress to provide an understanding of how the neuroendocrine system responds to stress to regulate blood levels of CORT. Two key groups of neurons, corticotropin releasing hormone (CRH) and arginine vasotocin (AVT) project to the median eminence and are responsible for releasing the two neuropeptides into the portal system that bind to receptors found on corticotropes in the anterior pituitary to release ACTH. Two major receptor types, CRH-R1 and VT2-R, have been found co-localized in

the cell membrane of corticotropes. When the two peptides are injected centrally, each is able to stimulate release of CORT from the adrenal gland, however, concurrent administration does not result in significant increases in the stress hormone. In contrast, simultaneous, peripheral administration of the two neurohormones results in a synergistic increase in plasma CORT. Each of the two receptor types has a different signal transduction pathway and the one associated with the CRH-R1 (involves the second messenger cAMP) shows a greater than doubling of its release with co-administration of the two peptides in cell cultures transfected with both receptor types. It is hypothesized the two receptors, CRH-R1 and VT2R form functional complexes, heterodimers, that are responsible for augmenting the intracellular signal transduction mechanism. To date it is unknown whether acute or chronic stress results in augmenting intracellular signals. Data suggest the need to find another marker/s, e.g. cytokines, in the blood indicative of second messenger activation to complement standard plasma determinations of CORT to serve, perhaps, as a better combined measure of stress levels in birds. *Supported by National Res. Initiative Competitive Grant 2005-35203-15850 from USDA Coop. State Research, Education and Extension Service and NSF grant IBN 01111006.*

Key Words: CRH, AVT, corticosterone

9 Understanding stress-induced immunosuppression: Exploration of cytokine and chemokine gene profiles in chicken peripheral leukocytes.

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At present, the poultry industry has gained a lot of ground, being viewed as providing a healthy alternative to red meat. If this trend is to be maintained, solutions must be found to improve chickens' resistance to disease, which often is weakened by stressful conditions. In poultry, stress-induced immunosuppression (IS) is manifested with failures in vaccination and increased morbidity and mortality of flocks. The use of cellular and molecular markers of immunity could help to assess IS and improve stress-minimizing strategies. The full complement of cytokines and chemokines in the chicken genome has been recently characterised. Using quantitative reverse transcriptase-polymerase chain reaction (qRT-PCR) assays, a broad spectrum of avian cytokines and chemokines can be quantified in birds and then be used to examine the effects of stress on chicken immune competence. We are investigating immune and endocrine interactions in the chicken, in particular the cells and molecules of the immune response known to be involved in such interactions in mammals. We have evaluated the effects of stress, mimicked by administration of corticosterone (CORT) on peripheral lymphocyte and heterophil cytokine and chemokine gene profiles. In particular, there seem to be effects on cytokine and chemokine mRNA expression levels from both lymphocytes and heterophils, especially with expression of proinflammatory interleukin (IL)-1 β , IL-6, and IL-18, and chemokines CCLi2, CCL5, CCL16 and CXCLi1 initially being upregulated, and potentially modulating the adaptive immune response. Chronic treatment with CORT downregulates proinflammatory cytokines and chemokines suggesting that the delayed effects of chronic stress can hamper immune response. Gene expression levels of TGF- β 4 are also upregulated. It appears that the balance between Th1 and Th2/Treg cytokine production is altered in conditions associated with significant changes in CORT concentration. Experiments are underway to decipher the cytokine and chemokine responses to vaccination and bacterial challenge on the background of IS.

Key Words: stress, immunosuppression, cytokine, chemokine, gene expression

10 Genetics and genomic approaches to address both breeding and management issues of poultry well-being. W. M. Muir* and T. Nguyen, *Purdue University, West Lafayette, IN.*

Classical genetics and genomics can both be utilized to improve productivity. However, if applied to the wrong unit of selection (the individual), well-being can be compromised due to social interactions, while if applied at the production level unit (cage or pen), well-being will always be improved. For non socially induced issues, such as leg problems, direction selection is necessary; unfortunately such traits usually have low heritabilities and are difficult to quantify. Whole genome selection shows great promise to address these types of problems, both by increasing the accuracy of selection and by reducing the need to phenotype candidates. Unresolved issues are 1) how to quantify well-being and 2) which management practices necessarily compromise well-being. All physiological responses to the environment are mediated by genes interacting with other genes and/or environmental inputs. These interactions occur first at the RNA level, which are then translated into structural or regulatory proteins. Physiological quantification of well-being has usually occurred at the protein level or higher. But not all proteins can or have been quantified. An alternative is to quantify and profile the transcriptome through cDNA re-sequencing or microarrays. Quantifying the transcriptome profile in known conditions, or among questionable conditions, followed by supervised or unsupervised clustering respectively, and discriminant analysis, allows a scientific approach to combine or classify like management practices into states of well-being and thus offers a holistic metric for comparison. Finally, the physiological mechanisms that change as a result of genetic selection that impact well-being are not well understood. Again functional genomics comparing response of all genes in the transcriptome followed by gene ontology and path analysis allows us to uncover previously unsuspected mechanisms, which can in turn be used to modify management to address those mechanisms. Both genomic selection and functional genomics

approaches to address well-being are a direct result of sequencing the poultry genome.

Key Words: classification, welfare, breeding, stress, behavior

11 Modification of animals versus modification of the production environment to meet welfare needs. S. E. Aggrey*, *University of Georgia, Athens.*

The balance between genetic modification and welfare may be as old as “the chicken and egg debate”. Meeting welfare needs of farm animals has become an integral part of animal agriculture. Until recently, environmental and management modifications have been the methods of choice for meeting welfare needs of animals. While genetic selection over the past 50 years has improved growth, livability and general welfare, some aspects of welfare like metabolic disorders, susceptibility to some diseases and skeletal problems have increased. Several reports have demonstrated genetic variability in behavioral and physiological traits relating to welfare thus raising the possibility of selecting for welfare-related traits. Recent advances in molecular biology have also made it possible for the identification of quantitative trait loci for behavioral and welfare traits. Identification of causal or associative genes for welfare traits and improved biotechnology tools raises the possibility of either selecting for improved welfare or genetically modifying birds to suit commercial production environments. However, animal welfare is not only a scientific or commercial producers concern but public acceptance is equally important. Therefore, an integration of management, genetics and genome tools should be employed to genetically improve production and welfare traits with concurrent welfare risk assessments to address public and consumer concerns.

Key Words: welfare, genetic modification, environmental modification, selection, genomics

National Extension Workshop: What Is Needed to Improve University and Industry Collaboration

12 Washington update. R. D. Reynnells*, *USDA/CSREES/PAS, Washington, DC.*

The activities and observations of the author are reported. The 2009 Extension Special Recognition Award is presented to Jacquie Jacob, University of Kentucky, for her sustained, significant contributions to the PSA National Extension Workshop, National Poultry Waste Management Symposium, other extension programming, and the American Poultry Historical Society. The National Institute of Food and Agriculture has replaced the Cooperative State Research, Education and Extension Service, and the Agriculture and Food Research Initiative has replaced the National Research Initiative. Progress is being made in multi-state research committees: the Agricultural Bioethics (NCCC209) web site will facilitate writing collaborative papers on bioethics, and animal welfare or well-being (more participates are welcome); NE1022 is being rewritten as NEtemp1561, Optimization of Poultry Welfare and Production Systems for the 21st Century. Portfolio reviews are yearly (Knowledge Area (KA) 306, Environmental Stress in Animals; KA308, Improved Animal Products (Before Harvest); KA315, Animal Welfare), with a five year summary review due in 2009. The

2009 Southern Region (Quadrennial) Poultry Extension Workshop, will be in Raleigh, NC, November 9 - 12 (contact Ken Anderson for details). Proceedings are available for the 2008 National Poultry Waste Management Symposium. Edgar Oviedo (NC) will coordinate the 2010 symposium. The 2008 Future Trends in Animal Agriculture symposium provided a neutral and balanced forum for positive dialogue on animal welfare (AW) issues. The annual Animal Welfare Assessment Contest for students at Land Grant and other universities, held at Michigan State University, now includes components for veterinary students and for graduate students. The contest helps train students in AW and animal behavior areas, and emphasizes the importance of collaboration between disciplines and commodities to address AW issues. Bioethics are simply ethics as applied to biological systems, and are thus important in discussions of AW and animal rights issues. Discussions of bioethics help us understand value-driven societal perspectives, and restrictions or imperatives of animal use.

Key Words: Recognition Award, bioethics, animal welfare, assessment contest, extension workshop