mixer vs. post-pellet application). While it is clear that dietary phytase improves phytate phosphorus utilization by monogastrics, practical application of this technology for optimum efficacy and cost-effectiveness requires an integrated approach.

Key Words: Phytase, Phosphorus, Field application

216 Phytase does improve energy, protein, and amino acid utilization. Z. Mroz*, *Institute for Animal Science and Health, IDTNO Animal Nutrition, Lelystad, The Netherlands.*

Feeding phytate-rich diets with supplemental microbial phytase has often resulted in improved ADG and(or) feed efficiency of pigs. This implies that (1) not only minerals but also organic compounds from intrinsic phytate complexes could be "liberated" intraluminally; (2) de novo complexing/precipitation of dietary or endogenous protein with phytic acid in digesta could be diminished or prevented; (3) the activity of endogenous enzymes could be inhibited to a lesser degree with decreasing contents of phytic acid in digesta. The extent to which dietary protein and(or) energy digestibility/utilization from phytate-rich diets is improved by microbial phytase seems to be a result of such factors as (1) acidity/buffering capacity of individual ingredients, feeds, and intragastric/intraluminal contents; (2) sources and levels of dietary phytate, phytase, protein, and energy; (3) feeding regimen (restricted/ad libitum); (4) specific configurations and stability of phytate complexes; (5) the degree of synchrony of energy and nitrogen release in the small intestine with body protein/fat accretion patterns. Based on the available literature data it can be concluded for practical implications that corn- or cereal-soybean based diets supplemented with 500 FTU/kg microbial phytase (Natuphos) may have improved apparent ileal digestibility of CP/essential AA in the range from 1 to 3%-units, and DE from 32 to 46 kJ/kg of diet.

Key Words: Pigs, Microbial phytase, Protein and energy availability

217 Does supplemental dietary microbial phytase improve amino acid utilization?. O. Adeola*, *Department of Animal Sciences, Purdue University.*

Environmental concerns emanating from the excretion of large quantities of phosphorus in effluents from intensive animal production operations have led to the current routine use of microbial phytase. Following extensive investigations, microbial phytase supplementation of diet has been shown to consistently improve the utilization of phytate-bound phosphorus and a plethora of data is available in the literature to support this. The release of phosphorus from phytate during the digestion process is theorized to release other nutrients that may be bound in the phytate complex. Furthermore, hydrolysis of phytate is hypothesized to attenuate the inhibitory effect of phytate on digestive enzymes and consequently ameliorate the depression of nutrient absorption. While a limited pool of data exists on small increases in apparent amino acid digestibility in both swine and poultry literature, these have seldom translated into improved growth performance when the effect of enhance phytate-phosphorus utilization is factored out. Conversely, there are also data on a lack of response in amino acid utilization (both pre- and post-absorptive) to microbial phytase supplementation. Several factors may play important roles in amino acid utilization response to dietary microbial phytase supplementation. Identification of such factors and quantification of their effects on the magnitude of response to phytase would be important in ascribing meaningful "amino acid response factor" to dietary supplemental microbial phytase and moving the swine and poultry nutrition industry ahead.

Key Words: Swine and poultry, Phytate and phytase, Amino acid digestibility

Production, Management, and the Environment
Environmental Stress on Livestock and Economic Implications

218 The physiological response to stress. Robert Collier*[1], Wolfgram Alison[1], and Coppola Crista[2], [1]*University of Arizona, Department of Animal Sciences,* [2]*Colorado State University.*

Stress is an external event or condition which results in a strain on a physiological system. This strain can be measured on farm by reduced productivity or animal health. Under controlled laboratory conditions the strain can be measured as increased basal metabolic rate, increased adrenal axis secretion, reduced immune function or reduced reproductive performance. In future, gene expression technology will permit identification of specific genes which are turned on or off during periods of stress. This will allow researchers to identify markers for stress at the molecular level. Major stressors in animal production systems are associated with animal handling,housing and feeding practices. High productivity itself does not constitute a stress to animals. However, failure to alter management practices to accomodate higher production does impose a stress on animals. For example, doubling of average milk yield per cow in the last 50 years has increased dairy cattle cooling requirements in summmer and reduced heating requirements in winter. Failure to modify housing structures to accommodate this change results in stress on animals. It has been proposed that increasing milk production with exogenous somatotropin (bST) is stressful to cattle. However, bSt does not alter basal metabolism, adrenal axis or immune function and production is increased. Increased heat production associated with increased milk yield in bST treated cattle is accommodated with a concomitant increase in evaporative heat loss via increased sweating rate. Key to reducing stress in domestic animals is not to reduce production levels but to improve animal management practices

Key Words: stress, physiology, production

219 Environmental stress in beef cattle. T Mader*[1], [1]*University of Nebraska.*

The performance, health, and well-being of cattle are strongly affected by climate. While new knowledge about animal responses to climatic stress continues to be developed, managing cattle to reduce the impact of adverse weather remains a challenge. During the summers of 1992, 1995, 1997, and 1999, reported feedlot death losses in the Midwest averaged between 1,000 and 5,000 head each year as a result of severe heat episodes. In the winters of 1992-93 and 1997-98, feedlot death losses exceeded 50,000 as a result of snowstorms and/or extended periods of cold, wet weather. In the winter of 1996-97 reported cattle deaths (feedlot and cow/calf) in the Northern Plains approached 250,000 head due to excessive snowfall coupled with sustained periods of sub-zero wind-chills. More recently, feedlot cost of gains averaged 12% greater for cattle finished in February, March, and April of 2001 compared with the same period in 2000 (Feedstuffs data). Individual feedlots incurred deaths approaching 1,000 animals or over five times normal death losses. In many livestock operations, alternative management strategies are needed to mitigate climatic stress in cattle. Altering the microclimate by providing protection from the environment is one of the most useful tools helping animals cope with climatic conditions. However, changes in facilities and management strategies do not need to eliminate environmental stress completely, but rather minimize the severity of the environmental challenge and aid the animal in adapting to it. Inexpensive management alternatives, such as the use of bedding in winter or sprinklers in summer, need to be considered. When designing or modifying facilities it is important that changes made to minimize impact of the environment in one season do not result in adverse effects on animals in another season. Using permanent wind barriers to minimize cold stress in the winter may require that shade or sprinklers be provided in the summer to minimize heat stress. In addition to facility changes, dietary manipulation may be beneficial for feedlot cattle challenged by environmental conditions.

Key Words: Cattle, Climatic stress, Management strategies

220 The effects of environmental stress on the performance of dairy cattle. J.N. Spain*, M. Lucy, and D. Spiers, *Brody Environmental Center, University of Missouri - Columbia.*

Environmental stress reduces the productivity and health of dairy cattle resulting in significant economic losses. Heat stress affects animal performance and productivity of dairy cows in all phases of production. This effect in calves and growing heifers is due to repartitioning of energy necessary for maintenance of homeothermy. The outcomes include decreased growth, increased susceptibility of disease, and ultimately delayed initiation of lactation. Dry cows exposed to thermal stress during late pregnancy have reduced milk yield during the subsequent lactation period. Heat stress is most apparent in the lactating dairy cow that must dissipate excess heat resulting from increased metabolism. Dry matter intake and milk yield decrease as cows are exposed to ambient temperatures above the upper critical temperature of their comfort zone. Cow health is adversely affected as evidenced in the increased somatic cells in milk during summer months. Heat stress also negatively affects reproductive function. Normal estrus activity and fertility are disrupted in dairy cattle during summer months. Given the negative effects of heat stress, research has focused on means of improving animal performance by assisting the dairy cow in maintaining #normal# thermal balance. Research has focused on methods of reducing heat gain through dietary supplementation and environmental modification. Manipulations of the diet to reduce the heat of digestion and metabolism have been proposed as a way of reducing internal heat load. Supplemental shades and housing systems have been developed to reduce exposure to solar radiant heat load. To facilitate heat loss, supplemental and strategic cooling systems have been developed and proposed. With the ever-increasing genetic potential for milk synthesis and the concomitant increase in metabolic heat production, the methods used to describe, monitor, and alter the thermal balance of heat stressed dairy cattle must be studied further.

Key Words: Dairy Cattle, Heat Stress

221 Survival, performance, and productivity in swine as influenced by adverse environmental temperatures. J.A. Carroll*, *Animal Physiology Research Unit, Agricultural Research Service-USDA, Columbia, Missouri.*

The impact of thermal stress on survival, performance, and productivity is evident in all stages of swine production. Thermal stress is associated with reduced survival of the neonate, poor reproductive performance in sows and boars, and poor growth and carcass quality in finishing pigs. Thermal stress invokes numerous changes in the pig#s metabolism, behavior, and endocrine system. While the primary causes of neonatal mortality have been attributed to crushing, starvation, and disease, the actual causes of mortality may be more closely linked with one another than previously believed. We now know that interactions exist among thermal status, nutrition, and disease in pigs. Piglets with disease and nutritional problems experience chilling and express altered behaviors that increase the likelihood of being laid on by the sow. At birth, neonatal pigs have a limited ability to cope with environmental stressors (cold, disease, limited nutrition) that predispose it to relatively high rates of neonatal morbidity and mortality. In contrast to older animals, the early neonatal piglet does not increase its intake in response to cold temperature. Intake actually decreases during cold exposure, increasing the likelihood of starvation. Unlike the young pig, in which exposure to cold stress poses major health risks, in older pigs, exposure to heat stress hinders performance and productivity. At high ambient temperatures, sufficient feed intake by the sow is likely a greater concern for piglet survival and performance. Exposure to ambient temperatures greater than 25°C decreases intake in lactating sows, resulting in reduced milk production and associated piglet growth. In boars, heat stress has been shown to alter sperm cell count and quality, thus decreasing reproductive efficiency and capabilities. Finally, in finisher pigs, heat stress has been reported to reduce growth rate and alter carcass composition. Therefore, heat stress not only reduces overall productivity in finishing pigs, but also reduces the value of the final product. Given the associated economic losses due to thermal stress in pigs, continued research on the interactions among thermal stress, nutritional requirements, immunological status, and overall performance are undoubtedly needed and warranted.

Key Words: Pig, Environmental Temperature, Stress

222 Economic losses from thermal stress by U.S. livestock industries. N. R. St-Pierre*[1] and G. Schnitkey[2], [1]*The Ohio State University, Columbus,* [2]*University of Illinois, Urbana.*

Farm animals have well known zones of thermal comfort (ZTC). The range of ZTC is primarily dependent on the species, the physiological status of the animals, the relative humidity and velocity of ambient air, and the degree of solar radiation. Economic losses are incurred by the U.S. livestock industries because farm animals are raised in locations and/or seasons where temperature conditions venture outside the ZTC. The objective of this study was to provide estimates of the economic losses sustained by major U.S. livestock industries from thermal stress. Species (production) considered were: chicken (meat), chicken (eggs), turkey (meat), cattle (meat), cattle (milk), and pig (meat). Losses considered were: (1) decreased performance (growth, lactation, egg production), (2) increased mortality, and (3) decreased reproduction. USDA and industry data were used to estimate the population size of each species in each month of the year, for each of the 50 States. Weather data from the National Weather Service were used to estimate mean daily maximum and minimum temperatures and relative humidity, and their variances for each of the 50 States. A model based on a plateau and abrupt threshold leading to a linear decrease in performance and reproduction and a linear increase in mortality above and below the ZTC was used for each species. Solar radiation and air velocity were assumed negligible. Probabilities of exceeding the minimum or maximum values of ZTC were calculated from means and variances of weather data. Two losses were estimated. The total potential losses (TPL) were calculated as if no thermal stress abatement strategies were used by any of the animal industries. Clearly, this estimate is biased upwards but it sets a ceiling to the magnitude of the actual losses. Total abated losses (TAL) were calculated by the additional factoring of the prevailing management practices used by each industry to reduce the effects of thermal stress. Details of the results will be presented by species and for each of the major animal producing States.

Key Words: Thermal Stress, Economic Losses, Animal Production

Graduate Paper Competition
ADSA Production Division, ADSA Southern Branch, and Northeast ASAS/ADSA Section

223 Beta-Lactoglobulin as a facilitator of transcellular transport of IgG in Caco-2 cells. L. F. Sutton*[1], M. Worku[2], and B. Alston-Mills[1], [1]*North Carolina State University,* [2]*North Carolina A&T Universtiy.*

An earlier investigation suggested that Beta-Lactoglobulin (BLG) can facilitate IgG uptake in intestinal cells of neonatal piglets. The objectives of the present study were to use an in vitro model to corroborate in vivo data. Also investigated were properties of specific binding using competition at receptor sites, type of Fc receptors, and overall passage of the IgG molecule from apical to basolateral sides of the intestinal cell. The human intestinal cell line Caco-2 was used to investigate effects of BLG. Cells were grown in a porous transwell system, seeded at 4.6×10^4 cells/well, with a total of 18 wells. Media were added to both compartments in the transwell system with 2.5ml added to the basolateral side and 1.5ml to the apical. Media were changed every other day. Cells were cultured as a monolayer until confluency was reached (day 14) and the tightness of the monolayer was measured by determining the transepithelial electrical resistance (TEER). After apical projections and villi differentiations were observed, approximately day 21, several treatments were used to identify uptake and passage of IgG. Fluorescently labeled IgG was added with unlabeled IgA to determine specificity of binding at the receptor on the apical side. Labeled IgG was added alone in varying concentrations to determine levels of uptake. After a 2 hour incubation, BLG was bound to IgG as a complex. This complex was then added to the apical membrane compartment. Additionally, BLG and IgG were added separately but simultaneously. IgG transcellular transport was evaluated by fluorimetry and microscopically. Unlabeled IgA and labeled IgG competitively bound to the polymeric Ig receptor. Uptake of IgG was evident after incubation with the Caco-2 cells but