(37°C), there were no differences in *Salmonella* at 0 or 1 h. However, by 2 h post-inoculation there was a 1.5 log decrease in the LAB-treated samples. By 4 h post-inoculation, there was a 2 log decrease in *Salmonella* recovery in the LAB-treated samples. Thus, our LAB cocktail appears to reduce growth of *Salmonella* in ground and whole turkey meat at refrigerated and elevated temperatures.

Key Words: *Salmonella*, Lactic Aid, Turkey Meat

445 Evaluation of serum as an indicator of antibiotic residues in edible poultry tissues. I. Reyes-Herrera*, V. Aguiar, M. L. Dirain, F. Solis de los Santos, J. H. Metcalf, P. J. Blore, and D. J. Donoghue, *University of Arkansas*, *Fayetteville*.

The FDA and USDA monitor food products, including poultry, to detect and prevent unsafe residues (e.g., drugs or pesticides) in the food supply. Monitoring procedures often require analysis of specific edible tissues (e.g., muscle). A potentially better option would be to evaluate blood samples collected directly from the processing line. Blood samples are usually easier to obtain and less expensive to analyze, do not require destruction of the carcass, and would represent any residue in the entire flock as opposed to an individual sample. However, it is unknown if residues in blood are correlated with residues in edible tissues. The objective of this study was to determine if antibiotic residue concentrations in blood are predictive of their concentrations in muscle tissues. The model antibiotic tested in this study was enrofloxacin. In this study, 5-wk-old broiler chickens (n = 156) were divided into two treatment groups and were dosed with either 25 ppm/3 d or 50 ppm/7 d of enrofloxacin (Baytril) in the drinking water. Blood and breast muscle samples were collected from six birds/group at 0, 1, 3, 6, 12, or 24 h during the first day of dosing and then every 48 h during the dosing period and every 12 h during the withdrawal period for up to 60 h post-withdrawal. Enrofloxacin was detectable within 1 h of dosing, reaching its plateau phase at 12 h (234 and 122 ppb for muscle and serum, respectively, for the 12-h sample from the 25 ppm/3 d dosing group), and was detectable for 36 h after drug withdrawal in both serum and muscle tissues. For all collection periods, enrofloxacin concentrations in blood (serum) were approximately half of those in muscle tissues. Because of this consistent relationship, monitoring blood samples may be an effective method to estimate antibiotic concentrations in edible tissues.

Key Words: Enrofloxacin, Edible Tissues, Poultry

446 Effects of blood in egg albumen on *Salmonella* survival and growth. D. P. Smith* and M. T. Musgrove, *USDA, Agricultural Research Service*, *Athens, GA*.

Two trials were conducted to determine effects of blood in table egg albumen on survival and growth of *Salmonella*. White-shell table eggs with blood spots were collected from a commercial egg processing plant after candling. In each trial eggs were broken out and approximately 4 mL of clear albumen (CLEAR) and 4 mL of bloody albumen (BLOOD) from each of 10 eggs were placed in sterile test tubes and inoculated with a nalidixic acid-resistant *Salmonella* Typhimurium. For inoculation, 0.1 mL of a *Salmonella* suspension (containing 2.9 log cfu/mL in Trial 1 and 7.1 log cfu/mL in Trial 2) was added to each tube. Tube contents were mixed and incubated at 22°C for 24 h. Immediately after inoculation and again after 24 h, 0.1 mL from each tube was plated onto brilliant green sulfa agar with nalidixic acid and incubated at 37°C for 24 h. Results were reported as log cfu/mL albumen. No differences ($P > 0.05$) in mean *Salmonella* counts were found for CLEAR or BLOOD samples in Trial 1 (averaging 1.6) or in Trial 2 (averaging 4.6) immediately after inoculation. In Trial 2, CLEAR samples had lower ($P < 0.05$) counts of *Salmonella* than BLOOD samples (4.8 vs 5.2) after 24 h. A vaild test was not appropriate for Trial 1 (24 h samples) because of reporting negative results due to the low inoculation level. Incidence of positive *Salmonella* samples in Trial 1 after 24 h was 3/10 for CLEAR samples and 8/10 for BLOOD samples. Results indicated that *Salmonella*, at the low inoculation level, appeared to survive somewhat better in bloody albumen than in clear albumen. At the high inoculation level, *Salmonella* numbers increased slightly in albumen without blood, but higher numbers were detected in bloody albumen. Thus, blood in the albumen of table eggs appears to support survival and growth of *Salmonella*.

Key Words: Table Eggs, Blood Spots, *Salmonella*

Forages and Pastures - Livestock and Poultry: Understanding Diet Selection in Temperate Biodiverse Pasture Systems

447 Dietary selection: The current state of knowledge. A. J. Rook*, *Private Consultant*, *Okehampton, UK*.

The current state of knowledge regarding dietary selection will be reviewed with particular emphasis on implications for temperate biodiverse pasture systems. It will be contended that dietary selection is not only key to optimising animal performance in these systems but also to minimising environmental impacts, whether through enhancing biodiversity and thus ecosystem functionality, minimising the impacts of animal excreta or reducing the carbon footprint of these production systems. Consideration will be given to progress made and key gaps in knowledge with respect to 5 questions. What do animals choose to eat? Where do they choose to eat? When do they choose eat? What mechanisms do they use to achieve these choices? Finally and most crucially, why do they make these choices? Methodological barriers to progress and the potential of new technologies to overcome them will be considered. Emphasis will be given to the importance of interdisciplinary collaboration and research at disciplinary interfaces. Key advances in recent years include the recognition of the importance of partial preferences, the complexity of spatial and temporal patterns in dietary choices, the role of social behaviour in modifying foraging decisions and the phenotypic plasticity in responses consequent upon learned behaviours from the dam or other conspecifics. However, most of this progress has been made using simple model and often artificial systems. In many cases we know the limits of the animals abilities in key traits but not how they interact in real world situations. Other key issues identified for further research include: 1) a better identification of the currencies that animals use to make their foraging decisions and the trade off between these currencies and with other behavioural needs; 2) a better understanding of the interplay between genetic, ontological and environmental factors influencing foraging behaviour; 3) the need to better understand and integrate spatial and temporal variation into practical systems. A key component in delivery of this knowledge will be further improvement in our capacity to model these complex systems based on multi-species swards.

Key Words: Dietary Selection, Biodiversity, Pasture Systems

448 Genetic control of dietary choice in farm animals: A combination of nature and nurture. R. M. Lewis*[1] and G. C. Emmans[2], [1]*Virginia Polytechnic Institute and State University*, *Blacksburg*, [2]*Scottish Agricultural College*, *Edinburgh, Scotland, UK*.

Dietary choices reflect an animal's physiological state, such as its degree of maturity or pregnancy. As genotype affects growth and body composition it is expected to affect dietary intake and choice. Experience also affects dietary choice. Genetic variation in state variables such as growth rate and fatness of gain, which is substantial, conditions dietary choice. Evolutionary theory predicts that animals that forage more effectively will also survive and reproduce more effectively. Thus, natural selection will favor those adaptations, that may be morphological, physiological or behavioral, that enhance an animal's fitness within the constraints of its feeding environment. In wild animals in natural environments, body homeostasis appears to be genetically controlled, in part mediated through the animal's feed choice and intake. Obesity and anorexia, extremes on the continuum of body composition, seldom if ever occur because of reductions in fitness. Farm animals no longer subsist within the conditions in which they originally evolved. In controlled environments, feed energy may be in abundance and diet choice limited or non-existent. Artificial selection for increased growth rate and, more recently, against fatness, may interact with the rules that govern diet selection. Poultry provide a striking example. Selection for rapid growth over the past 50 years has increased food intake relative to body mass, with broilers growing four times more quickly and reaching market weight (2.2 kg) at about 6 weeks. In broiler breeders, feed intake is routinely controlled to avoid reproductive difficulties and to enhance livability. Lines selected for human purposes still appear to use the pre-existing rules controlling feed intake. The evidence on the selection of diet composition, either in controlled circumstances or in grazing mixed swards, is far less clear. In ruminants, there are no satisfactory models for predicting diet composition for existing genotypes. The effects, if any, of genetic selection is also unclear.

Key Words: Dietary Choice, Genetic Delection, Intake Models

449 Learning and dietary choice. J. J. Villalba*, *Utah State University*, *Logan*.

Early studies of foraging assumed diet selection was genetically programmed, and livestock production systems have traditionally viewed grazing animals as ″machines″ whose nutritional needs had to be provided in a prescribed manner. However, physiological needs and behavioral responses are not fixed. Rather, they have a significant learned component that enables animals to balance their diets when allowed to select among alternatives. Genes affect morphology and physiology, creating the bounds within which animals can use nutrients and cope with toxins, but genes do not operate in isolation. They are expressed, beginning at conception, through the interplay with the social and biophysical environments where an individual is reared. These interactions allow individuals to learn through trial and error (individual learning) and from the experience of others (social learning). Individual learning is illustrated by food preferences, which emerge from the animal′s experience with the interrelationship between a food′s flavor and its postingestive consequences. The senses of smell and taste enable animals to discriminate among foods. Postingestive feedback calibrates preference for food with its homeostatic utility. This mechanism allows animals to avoid poorly nutritious foods and foods high in toxins and to prefer nutritious foods, substances with health benefits, or arrays of foods that complement one another biochemically. Social learning is manifest through mother and peers. Lessons learned early in life from mother create a dichotomy between the familiar and the unfamiliar (novel), which is essential for survival. Animals prefer the familiar to the novel, and they regard anything novel with caution. Understanding how learning affects animal behavior and performance can facilitate the design of sustainable grazing systems to improve the quality of land as well as the nutrition, health and welfare of animals. Incorporation of learning into grazing systems involves offering livestock diverse and biochemically complementary plant species, such that through individual and social experiences animals balance their consumption of nutritional and medicinal compounds.

Key Words: Diet Selection, Learning, Experience

450 Forage factors and dietary choice. D. F. Chapman*[1], A. J. Parsons[2], J. Hill[1], and K. Venning[1], [1]*University of Melbourne*, *Melbourne, Victoria, Australia*, [2]*AgResearch*, *Palmerston North, New Zealand*.

When offered a free choice between different forage species presented in a pasture association, ruminants will choose a mixed diet, even when one dietary component could meet all of their nutritional needs. Thus, preference and selection cannot be explained simply by the common measures of species nutritive or feeding value. The question then arises, what is the nutritional basis of the dietary choices that animals make? This review focuses on the forage composition factors that might be implicated in dietary choices made by grazing ruminants. The satiety theory is used to develop propositions about the physico-chemical attributes of forages that influence grazing behaviour. We present evidence that animals eating only clover (with relatively high rumen degradable protein content) take shorter meals than animals eating only grass (with relatively low rumen degradable protein content), or a mixture of grass and clover. Thus, total daily intake is reached by different combinations of meal length, meal number and intake rate on pure clover, pure grass, and mixed diets. We extend these observations by proposing that satiety in the case of the clover-only diet is related to the rate of release of ammonia from the soluble protein fraction of the forage, and subsequent uptake in the blood to levels that can approach toxicity if the ammonia is not removed by excretion as urea. Mixing grass with the clover allows animals to eat longer meals, perhaps because the better dietary balance of energy to soluble protein helps control ammonia accumulation rates. Rumen ammonia and gas profiles from in vitro studies suggest that digestive efficiency is optimal at a dietary clover: grass ratio of approximately 0.7:0.3, which corresponds closely to the partial preferences observed in free choice field experiments. Direct, real-time information on the relationships

between forage physico-chemical factors and meal initiation, cessation, and dietary switching is needed to further develop propositions about the control of dietary choices.

Key Words: Grazing, Intake, Dietary Choice

451 New approaches to grazing effects on pasture composition and productivity. E. A. Laca*, *Plant Sciences, University of California*, *Davis*.

Herbivory can have dramatic impacts on productivity, composition and functioning of grassland and pasture ecosystems. Yet, our ability to manage these effects has been limited, both by the traditional paradigms and by factors selected to manage grazing systems. These paradigms assume that grazing, plant growth, and ecological interactions are uniform and vary continuously over space and time. Management factors considered are total and seasonal forage demand, animal density, and duration of grazing. A typical analysis of grazing systems under this paradigm is a plot of herbage mass vs. time with various levels of stocking rate. Diet selection is represented as the proportion of each species grazed, which potentially affects the competitive interactions among pasture species across the pasture. These interactions are assumed to be constant over space and time. Further progress in grazing science and management requires implementation of a new and more complex paradigm that incorporates spatially and temporally distributed ecological interactions such as herbivory, growth, competition, and abiotic conditions. Although it is well established that grazing impact on a plant depends on its individual state, this has rarely been fully incorporated in the study and planning of grazing. The temporal and spatial dynamics of productivity and composition of pastures is sensitive to the initial state of the sward and to the spatiotemporal distribution of defoliation at scales much smaller than the typical paddock. Competitive dominance among plant species varies with ecological conditions. Thus, impact of defoliation on competition varies over space and time. I outline a model that shows the convergence of new ecological understanding of herbivory and pasture dynamics towards a new paradigm for researching grazing management tools. Technologies to monitor and control animal distribution are evolving rapidly and create management and research opportunities to experimentally address a new paradigm where there is a tighter link between manipulation of grazing and practical results.

Key Words: Grazing Systems, Plant-Animal Interactions, Spatial Ecology

Goat Species: Nutrient Requirements of Goats

452 Goat species: Nutrient requirements of goats - Introduction. J. E. Huston*, *Texas A&M University*, *San Angelo*.

The National Research Council recently released the first issue of *Nutrient Requirements of Small Ruminants* addressing the nutrient requirements for goats along with those for sheep and various cervid and camelid species. Specialists from various regions within the U.S., Australia, and Mexico were appointed in April 2004, and charged with gathering existing information and writing the report. The report was prepared to accommodate a broad readership that varied in both informational interest (species, physiological bases for nutrient requirements, tabular data, practical application, etc) and depth of training. Fourteen chapters summarize published information on comparative anatomy and gastrointestinal function, functions and requirements of nutrients, nutrient sources and intake, common deficiencies and deficiency symptoms, and other considerations as they pertain to the species considered. Usually, general discussion of the chapter topic is followed by discussions targeting the individual species. An extensive list of references is provided at the conclusion of each chapter. Individual tables list the nutrient requirements for the different species, and feed composition tables describe common feedstuffs, novel feedstuffs, and mineral supplements. The tables listing the nutrient requirements of goats provide separate entries for dairy, meat, and Angora goats as influenced by age, sex, body size, physiological stage (e.g., maintenance, growth, breeding, gestation, and lactation), and level of production (e.g., growth rates, litter sizes, and levels of milk production). Tables listing contents of common feedstuffs and mineral supplements are extensive and similar to those contained in other National Research Council reports. The table describing novel feedstuffs is unique to this publication and compiles information on feeds particularly important to small ruminants in their natural settings and managed by individuals of diverse cultures. The authors of this report are excited about its use in providing information to its readership and its role in stimulating discovery of new research information for subsequent improved issues.

Key Words: Nutrient Requirements, Small Ruminants, Goats

453 Energy and protein requirements of goats. M. Huerta Bravo*, *Universidad Autónoma Chapingo*, *Chapingo, México*.

The objective is to disseminate the new NRC recommendations about energy and protein for goats. Previous energy maintenance requirements were estimated as metabolizable energy (MEm) with a single equation for all goat types and conditions, with an adjustment for activity. Now, maintenance requirements (ME_m) are given for suckling or preweaning, growing, and mature goats. Also, goat breeds are grouped as meat, dairy, indigenous, and Angora. A 15 percent difference in ME_m among intact males vs females and wethers is assumed. An adjustment factor for body condition score and weeks after low nutritional plane stops and adequate nutritional plane starts may be included to estimate ME_m. Grazing activity considers grazing plus walking time, organic matter digestibility, and terrain score to calculate an adjustment for ME_m. Additionally, ME_m may be adjusted by environmental temperature. Metabolizable energy for gain considers suckling or preweaning, growing, and mature goats. For angora goats, requirements for gain are separated for nonfiber tissue gain (ME_{tg}) and clean mohair fiber gain (ME_f). Metabolizable energy requirements for