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

lactation (ME_l) are estimated as 1.25 Mcal for I kg of 4 percent fat corrected milk, and a value was given for mobilized tissue. Pregnancy requirements consider average birth weight per kid, day of gestation, and litter size. Previous protein requirements were given as crude (CP) or digestible crude protein. The new recommendation considers metabolizable protein (MP) for all functions. A conversion of MP to CP is given to facilitate its use. An estimate of rumen degraded intake protein is also given as a general guideline.

Key Words: Energy, Protein, Goats

454 Vitamin requirements of goats. B. W. Hess*, *University of Wyoming*, *Laramie*.

Vitamins are a group of complex organic nutrients that are essential for multiple metabolic processes but, unlike other organic nutrients, vitamins are required in minute amounts (µg to mg/d). Because estimates of endogenous vitamin losses are non-existent, vitamin requirements are based on animal responses during feeding trials. Recommendations for vitamin requirements are complicated by selection of the criteria by which the vitamins are judged adequate or inadequate. As in past NRC publications, vitamin requirements of goats are often derived from values for sheep. Unlike previous requirements for vitamin A, newly established requirements are based on the animal′s ability to maintain 20 µg of retinol/g of liver and are expressed as retinol equivalents (RE). Daily intake of 31.4 RE/kg of live BW is deemed necessary for animals at maintenance. Vitamin A requirements increase to 45.5 RE/kg of live BW for nannies during late gestation, 53.5 RE/kg of live BW for lactating nannies, and 100 RE/kg of live BW for growing kids. Due to insufficient data published to the contrary, the vitamin D requirements for all classifications of goats are comparable to previous recommendations. Daily vitamin E intake of 5.3 IU/kg of live BW is required to maintain blood α–tocopherol concentrations ≥ 2 µg/mL. Provision of 5.6 IU/kg of live BW during late gestation is recommended to increase serum α–tocopherol concentrations of the neonate. Vitamin E requirements increase to 10 IU of vitamin E/kg of live BW when the goal is to enhance immune response or extend the storage case life of meat. In general, vitamin K and water–soluble vitamin requirements of goats can be met by escape of dietary sources from ruminal metabolism and through endogenous synthesis (microbial or bodily). Although several studies have demonstrated production or health benefits when diets have been supplemented with water–soluble vitamins, the amounts of vitamins given to induce such responses are usually for specialized situations and may not necessarily reflect requirements for various production functions. Additional research is needed to establish recommendations for requirements of water-soluble vitamins for goats.

Key Words: Goats, Vitamins, Requirements

455 Revised guidelines for mineral requirements of goats. S. G. Solaiman*, *Tuskegee University*, *Tuskegee, AL*.

Mineral requirements of an animal largely reflect the nutritional demands during different physiological phases. Minerals are required for maintenance, growth, conceptus product formation, and milk production. Borderline mineral intake may compromise animal performance and longevity. Specific mineral deficiencies vary and animal may deplete the pool of tissue minerals before deficiency symptoms are exhibited. Inadequate mineral supplies may reduce production, prolong the duration of parturition, increase the number of stillbirths and result in a higher occurrence of skeletal problems. Many advances in mineral nutrition and metabolism have resulted in establishing guidelines for requirements of different species. However, there are relatively few original scientific research reported on mineral nutrition and metabolism of goats that can be used in establishing the guidelines for this species. Also most of the reported literature is largely speculation based on analogy with cattle and sheep, thus, made our task more challenging. However, few advances in recent years have allowed more specific recommendations for some macro and trace minerals based on goat data. The present report is an assessment of original research conducted on goats and where possible, mineral requirements are calculated by factorial methods using goats, cattle and sheep data. Therefore, the proposed requirements are generalizations and their application to specific breeds and conditions may vary.

Key Words: Goat, Minerals, Requirements

Growth and Development - Livestock and Poultry I

456 Specie and age effects on IGF mRNA expression in the amniotic and allantoic membranes and jejunum of developing avian species. D. M. Karcher* and T. J. Applegate, *Purdue University*, *West Lafayette, IN*.

Insulin-like growth factor (IGF) concentrations change in amniotic and allantoic fluids during development in the chicken, duck, and turkey. However, IGF contribution by the embryo has not been evaluated. This study investigated mRNA transcript abundance in the amniotic and allantoic membranes and jejunum throughout development and among three avian species. Eggs were set (540/specie) and 5 embryos were sampled every other day during incubation through 7 days post-hatch. RNA was extracted and mRNA transcripts for IGF-I, IGF-II, and IGF-R were evaluated by quantitative PCR at d -7, -4, 0 (hatch), 1, 3. Statistical differences were detected using proc mixed in SAS. The starting abundance of chicken IGF-I mRNA in the allantois increased 25-fold from d -7 of incubation to d -4. Within d -4, chicken IGF-I transcript abundance was 8.6 times greater than turkey ($P<0.05$) in the allantoic membrane. However, no differences were detected in membranes for IGF-II or IGF-R among species. The jejunum was evaluated prior to hatch and both jejunum and jejunum mucosa post-hatch. IGF-I transcript abundance was 3.4 fold higher ($P<0.05$) in the chicken compared to turkey at d -7. Turkey and duck were significantly lower ($P<0.05$) than chicken at d -4 in the jejunum. The chicken jejunum IGF-I transcript peaked at 1 d post-hatch versus ($P<0.05$) hatch and 3 d post-hatch. Chicken IGF-I mRNA in the jejunum was significantly higher ($P<0.05$) than both duck and turkey at 1 d post-hatch. The IGF-I mRNA in the duck's jejunal mucosa peaked at 3 d post-hatch and was significantly greater ($P<0.05$) than turkey and chicken at 3 d post-hatch. Chicken jejunum contained significantly ($P<0.05$) more IGF-I transcript when compared to the jejunum mucosa at 1 d post-hatch, while duck jejunum mucosa was statistically ($P<0.05$)