10 Nutrient synchrony: Sound in theory, elusive in practice. M. B. Hall*, *U.S. Dairy Forage Research Center, USDA-ARS*, *Madison, WI.*

The concept of improving animal performance through synchronizing ruminal availability of nutrients has been with us for at least 3 decades. Though theoretically appealing, research and field results have not supported this approach to diet formulation. Why? Essential to successful ruminal synchrony is the ability to predict available amounts and fates of diverse substrates. The substrates come from varied sources; their efficiencies of use and yields of products are affected by inherent properties, interactions, transformations, and passage. Substrate quality and availability is affected only in part by diet: for example, NPN, true protein, and peptides are contributed by diet and intraruminal recycling, with additional endogenous NPN contributions by the cow. Conversion of the ruminally degraded N sources to AA available to the cow depends greatly upon availability of fermentable carbohydrates and other nutrients that support microbial growth. However, changes in factors that alter rate or extent of substrate fermentation such as rate of passage or ruminal pH can alter nutrient yield from the rumen, and must be accounted for for synchrony to work. Yield of microbial protein from carbohydrate can be altered by type of N source available, but these may be available from intraruminal recycling and diet. Conversion of some carbohydrates such as sucrose and fructan to stored microbial α-glucan alters the prediction of carbohydrate available in the rumen. Our ability to estimate ruminally available substrate is also challenged by normal variation in feed composition and imprecision in component and digestibility analyses. To have any effect on performance, ruminal synchronization of nutrients needs to be in concert with specific nutrient demands of the animal. "Synchrony" implies a greater deliberate precision than may be currently possible to effect. Perhaps we should consider balance: Within the rumen and cow, can we generate conditions so that needed substrates or nutrients are concurrently available or accessible from endogenous resources to enhance productivity and efficiency? This approach brings a broader view than focusing on the rumen and feed we offer to the cow.

Key Words: Diet Formulation, Fermentation, Rumen

11 Nitrogen recycling and the nitrogen economy of ruminants – asynchronous symbiosis. C. K. Reynolds*[1] and N. B. Kristensen[2], [1]*The University of Reading*, *England*, [2]*University of Aarhus*, *Denmark*.

The extensive development of the ruminant forestomach sets apart their nitrogen economy from that of nonruminants in a number of respects. Extensive pre-gastric fermentation dramatically alters the profile of protein reaching the small intestine, largely through the transformation of dietary protein and nitrogenous compounds into microbial protein. This process is fueled primarily by carbohydrate fermentation, and includes extensive recycling of nitrogen between the body and gut lumen pools. Nitrogen recycling occurs via blood and gut lumen exchanges of urea and ammonia, as well as endogenous gut and secretory nitrogen entry into the gut lumen, and the subsequent digestion and absorption of microbial and endogenous protein. Factors controlling urea transfer to the gut from blood, including the contributions of urea transporters, remain equivocal. Ammonia produced by microbial degradation of urea and dietary and endogenous amino acids is utilized by microbial fermentation, or reabsorbed and primarily converted to urea. Therefore, microbial growth and carbohydrate fermentation impact on the extent of ammonia absorption and urea recycling and excretion. The extensive recycling of nitrogen to the rumen represents an evolutionary advantage of the ruminant in terms of absorbable protein supply during periods of dietary protein deficiency, or asynchronous carbohydrate and protein supply, but incurs a cost at higher nitrogen intakes, especially in terms of excess nitrogen excretion. Efforts to improve the efficiency of nitrogen utilization in ruminants by synchronizing fermentable energy and nitrogen availability through feedstuff selection, or the manipulation of urea or protein degradation, have generally met with limited success as regards production responses, but may influence nitrogen excretion. The microbial symbiosis of the ruminant is inherently adaptable to asynchronous nitrogen and energy supply. To synchronize, or not to synchronize: that is the question.

Key Words: Ammonia, Rumen Synchrony, Urea

12 Opportunities to enhance performance and efficiency through nutrient synchrony in forage-fed ruminants. M. J. Hersom*, *University of Florida*, *Gainesville*.

Increasingly, the need for optimized nutrient utilization to address increasing costs of production and environmental considerations will necessitate opportunities to improve nutrient synchrony. Historical attempts at synchronizing nutrient supply in ruminants, particularly in cattle consuming high-forage diets, has met with variable results. The success of nutrient synchrony has been measured primarily in ruminants by increases in microbial yield, microbial efficiency, nutrient utilization, and to a lesser extent animal performance. Successful synchrony of nutrient supply to cattle consuming forage-based diets faces several challenges. From a feed supply aspect, the challenges to nutrient synchrony include accurately measuring forage intake and consumed forage chemical composition. The issue of forage intake and chemical composition is perhaps the most daunting for grazing cattle. Indeed, for forage-fed cattle the availability of forage protein and carbohydrate can be the most asynchronous aspect of the diet. In most grazed forages, digestion rates of the carbohydrate fractions are much slower than that of the corresponding protein fractions. Additionally, the forage-supplement interaction exerts a large impact on the synchrony of nutrients. The supplemental feedstuffs comprise the component of the nutrient synchrony scenario that is most often manipulated to influence synchrony. The supplement type (starch vs. fiber, dry vs. liquid), nutrient profile (DIP vs. UIP), and degradation rates are often prime considerations associated with nutrient synchrony on high-forage diets. Other considerations that warrant attention include temporal intake patterns of the forage and supplement, increased use and types of co-product supplements, and an assessment of the success of nutrient synchrony. Synchronization of nutrient utilization by forage-fed ruminants has and will continue to encounter challenges for successful outcomes. Ultimately it is the improvement of animal performance and optimization of nutrient utilization efficiency that dictates whether nutrient synchrony is a successful strategy.

Key Words: Cattle, Diet Synchrony, Forage

13 Opportunities to enhance performance and efficiency through nutrient synchrony in concentrate-fed ruminants. N. A. Cole*, *USDA-ARS-CPRL*, *Bushland, TX*.

Synchronization of the ruminal degradation of carbohydrates and CP is projected to increase ruminal microbial protein synthesis, and improve N use efficiency. Attempts to synchronize the fermentation of dietary carbohydrates and CP have met with mixed results, suggesting that either ruminal nutrient synchrony is not important, or that N recycling to the rumen can offset a lack of synchrony. We hypothesized that in high-concentrate diets N utilization could be improved by synchronizing the supply of nutrients in one segment of the gut with those in another segment (i.e., synchronize a ruminal N deficiency with a lower gut N excess, etc.) via oscillating the dietary CP between deficient and adequate concentrations. With corn-based diets and oil-seed based natural protein supplements, N retention has been greater in lambs or steers fed oscillating CP concentrations (at 48-h intervals) than in animals fed a constant CP percentage. Effects of oscillating CP on cattle performance have been variable, and may depend upon the fermentability of the carbohydrate source (e.g., forage vs. grain, grain processing). In agreement with our hypothesis, Archibeque et al. (2007) reported that net portal uptake of urea was greater in lambs fed oscillating CP than in lambs fed constant CP concentrations. Nutrient intakes also need to be synchronized with the animal's requirements. One method to adjust nutrient intake with requirements is via phase- feeding. Results of studies with dry-rolled corn-based diets indicate that dietary CP concentrations can be decreased late in the feeding period with no adverse effects on animal performance; however, results of studies using steam-flaked corn-based diets are less consistent, possibly due to differences in the aggressiveness of the implant program used. In conclusion, ruminal nutrient synchrony is theoretically a sound principle; however, it seems that N recycling may mitigate effects of asynchrony. Thus, methodologies that increase N recycling and(or) increase the utilization of recycled N may benefit animal performance and the environment.

Key Words: Beef Cattle, Nutrients, Synchrony

Animal Behavior & Well-Being - Livestock and Poultry I

14 Does flavored sow's milk matched with the same flavored post-weaning feed improve performance, reduce post-weaning aggression, and establish an odor preference in piglets? N. Krebs* and J. J. McGlone, *Texas Tech University*, *Lubbock*.

Odor conditioning has been shown in utero and post-partum in rodents. The objective of this study was to determine the effects of post-partum conditioning of piglets to onion given in the sow diet (and through the milk) on behavior and performance of piglets weaned onto onion-flavored feed. Sows (n = 24) and piglets (N = 96) were assigned (N = 12 experimental units/treatment) to treatments: onion (ON), added to the sows′ diet before and after parturition (during lactation), or control diet (CON). Before weaning, the ON and CON piglets were tested in a Y-maze for 1 minute to determine if they were attracted to onion smell. Pigs were .more attracted to the left side than the right side (Preference Index: 55% ± 4.03 vs 38.6 ± 4.28) but there was no effect of the odor treatment ($P > 0.05$). At weaning, ON and CON pigs were kept in treatment groups and given an onion-flavored diet. Aggressive behavior was recorded by 5 min scan samples over 24h after weaning. Performance was recorded for 4 weeks post-weaning. Pigs on the east side (EA) of the room (regardless of the treatment) fought less than the pigs that were on the west side (WE) (3.13 % of the time based on 5 min scan samples over 24h ± 0.84 vs 6.43 % ± 1.10). CON pigs had a greater percentage time engaged in aggressive behaviors ($P < 0.05$) than the ON pigs (5.99 % of the time over 24h ± 0.767 vs 3.64 % ± 0.767). The weight at d 0 (day of weaning) significantly ($P < 0.0001$) affected the weight at d 1, 7, 14, 21, and 28 after weaning. Weight gain and feed efficiency were calculated. Treatments did not influence ($P > 0.10$) pig performance, although the treatment by barn-side interaction ($P < 0.05$) may have masked main effects. Odor conditioning had no effect on ON preference in a Y-maze, or on post-weaning performance, but odor conditioning reduced piglet post-weaning aggressive behavior.

Key Words: Pigs, Conditioning, Behavior

15 Sex differences in the septal-hypothalamo-pituitary-adrenal axis and distribution of arginine vasotocin and cortocotropin releasing neurons in the domestic fowl. F. N. Madison*, A. Jurkevic, and W. J. Kuenzel, *University of Arkansas*, *Fayetteville*.

Stress is a common stimulus faced by birds in the poultry industry and a better insight into a bird's response to a stressor could lead to improvements in productivity and well-being. In domestic fowl, males have been shown to have higher corticosterone (CORT) levels in response to acute stressors and to be more fearful than females. This suggests that males are more responsive to stress. Sexually dimorphic regions of the brain have been found in a few avian species, yet little is known about sex differences in the septo-hypothalamic region of the brain of the chicken, nor in the neuroendocrine release of stress hormones. We studied sex-related responses to intracerebroventricular injections of neuropeptides. Our past studies showed that male birds had significantly lower basal levels of plasma CORT than females, however males injected with arginine vasotocin (AVT) and corticotropin releasing hormone (CRH) had higher plasma CORT release than females (148% and 90% greater increase at peak response, respectively). Immunocytochemical studies were performed on sexually mature male and female chickens to determine the distribution of AVT and CRH anatomical profiles within the septo-hypothalamic region. Sexually dimorphic differences were observed in the medial bed nucleus of stria terminalis (BSTM), lateral septum (SL), and paraventricular nucleus (PVN). Co-localization of AVT and CRH neurons and fibers were present in the BSTM and SL of males, not females. There were more CRH perikarya in the PVN of female birds compared to males. A significant number of CRH fibers formed baskets around AVT neurons in the supraoptic nucleus of both males and females. Our results demonstrate that females have a higher number of CRH neurons in the PVN, higher baseline levels of plasma CORT, but are less responsive to ICV injections of CRH. Supported in part by NSF grant #IBN 01111006 and NRI grant #2005-35203-15850 from USDA, CSREES.

Key Words: Stress Response, Corticosterone, BSTM and PVN