Ruminant Nutrition Symposium: Update on Nutrient Requirements for Ruminants

861 Revising protein requirements of calves and heifers. T. M. Hill*[1], H. G. Bateman II[1], J. M. Aldrich[1], and A. J. Heinrichs[2], [1]*Nurture Research Center, Provimi North America, Brookville, OH,* [2]*Department of Animal Science, Penn State University, University Park.*

Research published since the dairy NRC (2001) relating to protein needs of calves and heifers was reviewed and compared with requirements from NRC (2001). The experiments used varied intakes or concentrations of CP or varied fraction or fractions of CP in the diet relative to an energy measure. Animal requirements were reviewed in 4 categories to identify advances in understanding of nutritional requirements since publication of NRC (2001). Categories included 1) calves less than 2 mo of age fed milk and starter, 2) calves to approximately 4 mo of age fed starter with limited forage, 3) pre-breeding age heifers, and 4) post-breeding age heifers. For calves in category 1, data estimating optimum ratios of amino acids for the milk-fed calf were identified. For calves in categories 1 and 2, data estimating optimum ratios of CP to ME were identified. For heifers in category 3, optimum diet CP:ME appeared similar to NRC (2001) but other differences existed. No experiments found tested the 70% RDP of CP recommendation for calves in category 3, however, approximately 65% RDP supported more typical dairy heifer ADG than lower amounts. Few differences from NRC (2001) were found for heifers in category 4. Precision or limit-feeding vs. more conventional ad lib fed programs appears to offer utility to save costs and reduce nutrient and fecal outputs with dietary adjustments to maintain protein intake relative to energy and DMI. The presentation will cite the literature since NRC (2001) found in the search. The new literature includes experiments measuring growth, rumen and whole animal metabolism, digestibility, tissue harvest, blood chemistries, and hormones. The focus will be on change in protein fraction consumed relative to growth and metabolism in calves and heifers with differences and similarities to recommendations from NRC (2001) highlighted.

Key Words: calves, heifers, protein

862 Revising energy requirements of dairy breed calves and heifers. M. E. Van Amburgh,* *Cornell University, Ithaca, NY.*

Work conducted over the last 15 years has provided a wealth of data on the maintenance and growth requirements of dairy calves and heifers. The data provide new insights and refines our ability to describe tissue requirements for energy, protein, amino acids, fatty acids and minerals for growth. Re-evaluation of the 2001 Dairy NRC maintenance requirements for calves (Diaz et al., 2001; Tikofsky et al., 2001; Blome et al., 2003) indicated the maintenance requirement is accurate for calves up to approximately 100 kg BW. Data from harvest studies have provided information that allows us to refine the efficiencies of energy and protein utilization for growth before weaning and post-weaning. For example, the 2001 NRC calf model uses an efficiency of metabolizable energy to net energy of 0.69 (Toullec, 1989) whereas a re-evaluation indicates a value of 0.60 for lighter, leaner calves. This partial efficiency is not fixed and is a function of body fat deposited by calves which is dependent on rate of growth, stage of maturity and before weaning, the amount of fat calories consumed above maintenance. Joost et al., (2007) and Tikofsky et al. (2001) directly and indirectly demonstrated that fat deposition does not come from carbohydrates in milk fed calves and Mills et al. (2010) showed that fatty acid profile impacts fat deposition. Tissue samples from various studies were used to update the values for amino acid composition (g/100 g of CP): methionine, 1.79; lysine, 6.26; histidine, 2.41; phenylalanine 3.65; tryptophan, 1.18; threonine, 3.83; leucine, 6.96; isoleucine, 2.94; valine, 4.28; and arginine, 6.75 and provides the opportunity to better formulate pre-weaned calf diets. Data now exist to describe the apparent energy supply to the animal from pre-weaning to full rumen function and this had been lacking from growth models and will be discussed. The study by Meyer (2005) from birth to 350 kg BW provides the ability to assess application of the mature body weight and target growth system implemented by the 2001 NRC. Evaluations of the current net energy equations indicate a 35% bias in energy required when mature body size is not accounted for.

Key Words: calves, heifers, nutrient requirements

863 Protein and amino acids for growth. E. C. Titgemeyer,* *Kansas State University, Manhattan.*

The Beef NRC (1996) predicts that all AA are used by cattle for growth with equal efficiency and that the efficiency decreases linearly with BW up to 300 kg. More recent data from Holstein steers (BW 132 to 228 kg) indicate that different AA are used for growth with different efficiencies. Efficiency of AA use for whole- body protein deposition (increase in AA deposition divided by the increase in AA supply) averaged 26% for Met (11 trials), 38% for Leu (4 trials), and 64% for His (2 trials). Efficiencies of Met and Leu utilization for growth were less than predicted by NRC. Energy supplementation improves efficiency of AA utilization. Analysis of data from 11 trials demonstrated that efficiency of Met use increases with supplemental energy but decreases with BW [Efficiency = 0.465 + 0.082 supplemental GE (Mcal) - 0.0028 BW (kg)]. Improvements in Leu utilization in response to energy supplementation appear somewhat less than for Met. Improvements in AA use in response to energy supply were similar when energy was provided as glucose, fat, or VFA, so energy source is not as important a factor as energy level. Supplementation of excesses of other AA improved efficiency of use of Met, Leu, and His; this may be due in part to energy provided as AA. Increases in ruminal ammonia absorption did not affect efficiency of Met use, but improved utilization of Leu. Efficiency of Met use was improved when Gly was supplemented, and this may be due to modulation of sulfur-AA metabolism. Despite the over-estimation by NRC of efficiency of AA utilization for growth, predicted total (maintenance plus growth) AA requirements in some situations are reasonable, reflecting that maintenance requirements are less than predicted by NRC or that AA are used for growth at much greater efficiencies when AA supplies are well below the requirement for maximal protein deposition. It is unknown if growth promotants impact efficiency of AA use. NRC (1996) provides a useful framework for estimating AA requirements of growing cattle, but modifications to predicted efficiencies and maintenance requirements areneeded to improve accuracy of the estimates.

Key Words: amino acids, cattle, utilization

864 Update on protein and amino acid requirements for lactating dairy cows. H. Lapierre*[1], L. Doepel[2], and D. R. Ouellet[1], [1]*Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada,* [2]*Faculty of Veterinary Medicine, University of Calgary, Calgary, AB, Canada.*

The Nutrient Requirements of Dairy Cattle (NRC, 2001) states that “current knowledge (on AA) is too limited to put forth a model that

quantifies AA requirements for dairy cattle." A decade later, have we gained enough information to move forward? This presentation assumes that 1) requirements (rqt) should be expressed as metabolizable protein (MP) and not CP; 2) for simplicity, MP rqt cover only maintenance and milk; that is, MP rqt = endogenous urine (EnU) + scurf + metabolic fecal protein (MFP) + milk; 3) duodenal endogenous proteins are not part of rqt (unlike NRC, 2001). To estimate total MP rqt, first the type and amount of proteins exported out of the cow need to be estimated and then divided by an efficiency of utilization of MP supply to synthesize these proteins or end products. From 217 treatments (Doepel et al., 2004 JDS 87:1279), MP rqt for EnU and scurf averaged only 6 and 1% of MP rqt (NRC, 2001): current estimations based on Swanson (1977. JDS 60:1583) can probably be kept. Our efforts focus on the greater contributors to MP rqt: milk and MFP. Milk protein is certainly an easy assessment, acknowledging that true protein needs to be used. Conversely, MFP is a challenging measurement. Estimations from Swanson (1977) are currently used by most models, but with different interpretations (e.g., NRC, 2001 vs. CNCPS v 6.1). Furthermore, this estimation of fecal protein excretion is not divided by an efficiency factor, unlike all the other functions, probably because it includes more than excreted proteins synthesized from AA. We therefore propose to use values of endogenous loss estimated in dairy cows using an isotopic dilution method (e.g., Ouellet et al., 2010 JDS 93:4252). Once the protein rqt is estimated for each function, AA composition for the function is needed to determine AA rqt. An update of milk AA composition, based on true protein output, is proposed. Similarly, estimation of the AA composition of endogenous loss is proposed to replace the currently used composition (whole empty body weight). In addition, based on measurements of liver and mammary AA uptake, it is proposed that the efficiency of utilization 1) varies with AA supply; 2) differs among AA; 3) is the same across the different functions. These refinements should improve estimations of protein rqt for dairy cows.

Key Words: amino acid, dairy cow, protein