313 Growth and subsequent productivity of dairy replacements. M. E. Van Amburgh*, *Cornell University, Ithaca, NY.*

The growth of heifers for dairy replacement purposes is unique in that the animal's potential for growth is never achieved nor desired due to the well-documented effects on future productivity. To optimize production, growth rates are chosen that minimize fat deposition, and based on extensive research data, are designed to minimize deleterious effects on pre-pubertal mammary development. One of the concerns related to dairy heifer growth is a thorough understanding of the net tissue requirements for a particular rate of gain. The body composition database currently available and in use contains little Holstein and no Jersey breed information and does not represent slaughter data for cattle less than 250 kg body weight. This is a critical deficiency if concerns over absolute growth rates and mammary development during the pre-pubertal period are relevant to discussions of future productivity. Recent studies have illuminated differences among the predicted composition of slaughter animals and the observed values. The growth model published in the Nutrient Requirements for Dairy Cattle, 7th ed., requires the inputting of the mature size of the cattle to generate energy and protein requirements. The use of this input factor across diverse dairy cattle populations increases the precision with which energy and protein requirements are met and might help explain variation in subsequent milk yield based on composition of the gain at a particular stage of development. In addition, few data sets exist that describe both the development of the mammary gland at puberty and the associated milk response. Four data sets will be discussed that allow for a critical examination of this relationship. Further, data generated from calves demonstrated significant changes in body composition based on diet composition, suggesting the potential for long-term carry-over effects on body composition. In addition, data are available that indicate level of nutrient intake and growth rate in early life affects lactation milk yield. The overall objective of this paper will be to integrate body composition, nutrient requirements and supply, and mammary development on milk yield with additional reference to early life effects.

Key Words: Heifer, Body composition, Growth

314 Effect of plasma protein and form of diet in meal fed calves. J.A. Booth*[1], J.D. Quigley[2], and T.M. Wolfe[2], [1]*Iowa State University,* [2]*American Protein Company.*

Calves fed starter rations containing highly fermentable carbohydrates often experience dramatic changes in rumen and blood metabolites. It is not clear if these changes affect the immune competence of these animals. Our objective was to compare the performance and immune response of calves fed two different forms of starter rations (coarse vs. finely ground) supplemented with either spray-dried animal plasma (SDAP) or an isonitrogenous combination of spray-dried red blood cells and whey protein concentrate (RBCW). Holstein bull calves (n = 28) were randomly assigned to one of four treatments in a replicated 4 x 4 Latin square design. Treatments consisted of coarse or finely ground commercial calf starter supplemented with either 5% SDAP or 5% RBCW. The trial consisted of 4 two-week treatment periods and a 21- day pre-experimental period. During days 8-14 of each period, calves were limited to 90% of calculated average intake of the treatment diets from days 1-6. Body weight was measured on the last day of each treatment period. At the same time, jugular blood samples were also taken prior to (0 hour) and post feeding (8 hours) and analyzed for urea N, NEFA, BHBA, WBC, RBC, hemoglobin, and hematocrit. Plasma urea N increased at 0 and 8 hours in the calves fed SDAP ($P<0.01$ and $P<0.04$ respectively) and also in the calves fed the finely ground diets ($P<0.07$ and $P<0.03$ respectively). Concentrations of BHBA and NEFA were not affected by treatment. Concentrations of RBC were higher at 0 and 8 hours in calves fed SDAP ($P<0.05$ and $P<0.16$ respectively). Hemoglobin concentrations ($P<0.14$) and hematocrit ($P<0.13$) tended to be higher in calves fed SDAP at 0 hours. Concentrations of WBC were not affected by treatment, yet populations of specific white blood cells differed. This data suggests that the form of diet presented and the addition of spray dried animal plasma does influence blood metabolites associated with rumen function.

Key Words: Dairy Calves, Rumen Function, Spray Dried Animal Protein

315 Performance of Jersey bull calves fed whole milk or milk replacers with varying fat/protein ratios. S. S. Bascom*, R. E. James, M. L. McGilliard, and E. P. Hovingh, *Virginia Polytechnic Institue and State University.*

The objective was to compare growth, feed efficiency, and health of Jersey bull calves fed diets with varying ratios of fat and CP. Week old Jersey bull calves (n=33) were assigned to one of four diets. Calves assigned to diet MM received a 21%CP:21% fat milk replacer(MR) fed at 15% of body weight. Calves assigned to diet HH (n=8) received a 27% CP:33% fat MR. Calves assigned to HL (n=9) received a 29% CP:16% fat MR. Calves assigned to diet JM (n=8) received whole milk (4.7% fat:3.2% true protein). Calves on diets HH, HL, and JM were fed 180g/day CP to support 650g ADG. Calves were fed three times daily for four weeks. Weight, hip height, wither height, heart girth, body length, were measured weekly. Gains averaged 0.110±0.0335 g/d, 0.357±0.034 g/d, 0.368±0.033 g/d, 0.496±0.034 g/d for diets MM, HH, HL, and JM. Hip height, heart girth, wither height, and body length were not different. Average number of days scouring/calf were 2.1, 6.2, 6.6, and 4.4, for MM, HH, HL, and JM. The average number of daily respiratory scores (1=healthy, 2=nasal discharge, 3= fever) greater than 2 per calf were 1.2, 0.1, 0.6, 0.3, respectively for MM, HH, HL, and JM. Feed efficiencies (g of gain/g of DM) were 0.26±0.039, 0.5±0.039, 0.52±0.038, 0.75±0.040, for MM, HH, HL, and JM. Calves fed MM had lower feed efficiency and calves fed JM had greater feed efficiency than calves fed other diets. Calves fed HH and HL had similar feed efficiencies. ADG and feed efficiency were greater for calves fed JM than MM, HH, or HL. Calves fed MM had the fewest scour days but also had lower ADG, feed efficiency, and more respiratory problems than the calves fed HH, HL, or JM. Performance of calves fed HH and HL was similar. Feeding 180g of CP in the MR was beneficial to calf performance when compared to diet MM.

Key Words: Calves, Milk, Milk Replacer

316 Contemporary issues in applied dairy replacement heifer research. P.C. Hoffman*[1], [1]*University of Wisconsin, Madison.*

The principal objective of rearing dairy replacement heifers is to minimize rearing cost while optimizing heifer growth and future lactation performance. One management strategy that reduces heifer rearing cost is to increase the rate of heifer growth thereby reducing days on feed and age at first calving. Complexities and dynamics of accelerating heifer growth have been the focus of replacement heifer research. Studies have investigated prepubertal growth regimes, mammary development, optimum growth, intensified calf feeding and early calving strategies. Accelerating calf and heifer growth and its biological idiosyncrasies can be academically consumptive yet is not the only management strategy available to achieve the principal objective of rearing replacement heifers. In field application, restrictions are made on dairy heifer growth. Despite restrictions, management strategies can still be employed to minimize rearing cost and/or optimize future lactation performance. For example, research data from beef feedlots suggest precision feeding as compared to ad libitum feeding results in modest improvements in feed efficiency (> 10 to 15%). Similarly, new intensified calf feeding strategies have been demonstrated to improve calf feed efficiency (20 to 40%). Feed efficiency of dairy replacement heifers is commonly overlooked in both application and research. Recent research has also defined protein requirements of dairy heifers and can be applied avoiding necessity for luxury protein feeding. Research has identified that dairy replacement heifer diets are over-supplemented with minerals as compared to NRC, 2001 requirements. In addition, plant genetics developed for lactating dairy cows may not be suitable to optimize replacement heifer nutrition. Finally, new NRC, 2001 requirements improve the capability to target feed heifers, and more ably define dietary energy and protein requirements which likewise can improve precision in rearing dairy heifers. This paper will explore current and future research that may aid decreasing dairy heifer rearing cost and improve future lactation performance without inference to altering heifer growth.

Key Words: Heifers, Growth, Feed Efficiency

317 Evaluation of the Hipometer® and Heart Girth tape for estimating body weight in Holstein heifers. K.E. Leslie*[1], M. Wallace[1], R.T. Dingwell[1], C. Leslie[1], C.J. McLaren[1], and B. Dow[2], [1]*University of Guelph, Department of Population Medicine,* [2]*University of Guelph, Kemptville College.*

Monitoring growth of dairy replacement heifers is useful to ensure that a goal of average age at first calving of approximately 24 months can be met. Standard growth curves have been established. Heart Girth Tapes are available to estimate body weight. The Hipometer® is a new tool for weight estimation using external width between the greater trochanters of the left and right femurs. Holstein heifers at four research herds were used, ranging in age from birth to immediately prior to calving. The objective of this project was to evaluate the Hipometer® and the Tape for estimating body weight of Holstein heifers compared to the actual weight recorded by an electronic scale. At each weighing event, each heifer was weighed by all three methods. The Hipometer® and Tape were each compared to the actual scale weight by calculating the age-adjusted Pearsons Correlation Coefficient (R^2). In addition, the sensitivity and specificity for the ability of each method to determine if the growth rate was normal were calculated using the scale weight and the standard Pennsylvania Growth Curve ($\pm$ 1 standard deviation) as the gold standard. Data was used from 242 heifer measurements. There was no significant difference in the average weight of animals recorded between the three methods. The R^2 values for the correlation of scale weight and the Hipometer® and Tape were 0.88 and 0.91, respectively. These heifers had a mean age of 10.1 $\pm$ 4.5 months of age and weighed an average 277.9 $\pm$ 125.9 (55-714) kilograms. The sensitivity and specificity of the Hipometer® and Tape for correctly classifying a heifer as being in the normal range were 89.7 % and 75.0%, and 84.6% and 56.7%, respectively. In conclusion, the Hipometer® is an easy, rapid method of estimating the body weight of heifers. The Hipometer® has similar R^2, sensitivity and specificity to the Heart Girth Tape for estimating the weight of Holstein heifers.

Key Words: Body weight, Hipometer®, Holstein Heifers

318 Increasing energy and protein intake of Holstein heifer calves increases mammary development. E.G. Brown*, M.J. VandeHaar, K.M. Daniels, J.S. Liesman, L.T. Chapin, and M.S. Weber Nielsen, *Michigan State University, East Lansing, Michigan.*

The objective of this study was to determine if increased energy and protein intake decreases mammary development in Holstein heifers less than 4 mo of age. At 2 wk of age, purchased heifer calves (n=42) were assigned randomly to 1 of 4 treatments in a 2 X 2 factorial arrangement with 2 levels of energy intake (low, L; high, H) and with 2 periods of development (2 to 8 wk of age; 8 to 14 wk of age). Treatments were LL, LH, HL, and HH, indicating energy intake during the first and second periods. The L diet was standard milk replacer (20% CP, 20% fat) at 10% of body weight (BW) and an 18% CP grain mix at restricted intake to promote 400 g of BW gain/d. The H diet was a high protein milk replacer (28.5% CP, 15% fat) at 15% of BW and a 22% CP grain mix fed ad libitum. Calves were gradually weaned from milk replacer by 7 wk and slaughtered at 14 wk. In period 1, gains averaged 379 g/d for L calves and 666 g/d for H calves. In period 2, gains averaged 439 g/d for L calves and 1095 g/d for H calves. Final BW for LL, LH, HL and HH were 80, 106, 87 and 121 kg (SEM = 4), respectively. Total mammary gland weights were 253, 391, 266 and 512 g/100 kg BW (SEM = 33); total parenchymal tissue 16, 15, 22 and 23 g/100 kg BW (SEM = 4), and total extra-parenchymal fat 53, 99, 62 and 153 g/100 kg BW (SEM = 15) for LL, LH, HL and HH, respectively. Total parenchymal DNA and RNA for LL, LH, HL and HH were 45, 42, 79 and 86 mg/100 kg BW (SEM =14) and 140, 132, 194 and 219 mg/100 kg BW (SEM = 32), respectively. Treatment did not alter percent parenchymal protein (P = 0.65) or parenchymal fat (P = 0.29). Groups HL and HH had 32% more parenchymal mass and 47% more parenchymal DNA than LL and LH. However, no difference was observed in parenchymal mass, DNA and RNA from 8 to 14 wk of age within L and H, nor were there any interactions between feeding level and period. Increasing energy and protein intake from 2 to 8 wk of age increases mass and total DNA of mammary parenchyma in heifer calves.

Key Words: heifers, mammary, calves

319 Potential role for leptin in mammary development of heifers. M.J. VandeHaar*, L.F.P. Silva, B.E. Etchebarne, and M.S. Weber Nielsen, *Michigan State University, East Lansing, MI.*

Mammary gland development is impaired when prepubertal heifers are fed high energy diets that promote body growth rates greater than 1 kg/d. Leptin, a protein produced by adipocytes, may help explain this phenomenon. High energy intake increases IGF-I concentrations in serum of prepubertal heifers but, despite IGF-I's potent mammogenic effects in vitro and in vivo, high energy intake decreases mammogenesis, indicating other factors also regulate mammary development. High energy intake also increases adipose deposition, and heifers that gain the most fat have the least mammary parenchyma. Moreover, proliferation of bovine mammary epithelial cells was reduced when co-incubated with bovine adipose tissue, indicating adipose tissue secretes an anti-mammogenic compound. Adipose tissue produces leptin, and high energy diets increase blood leptin. Leptin reduces IGF-I-stimulated proliferation of MAC-T mammary epithelial cells. At 5 ng/ml, IGF-I increased DNA synthesis to 300% that of cells in basal medium, but ovine leptin at 64 to 160 ng/ml inhibited IGF-I-induced DNA synthesis by 20% ($P<0.05$). Fetal bovine serum at 1% increased DNA synthesis to 1200% that of cells in basal medium, but ovine leptin at 10 to 1000 ng/ml inhibited DNA synthesis by 25% ($P<0.05$). Leptin did not inhibit basal cell proliferation. Based on trypan blue exclusion, leptin was not cytotoxic at the concentrations used. Transcripts for Ob-Rb (the long form of the leptin receptor) exist in epithelial cells of mammary tissue from prepubertal heifers and in MAC-T cells; Ob-Rb is the only Ob-R isoform with a complete intracellular domain and likely is responsible for leptin signaling in cells. In addition, Ob-Rb is closely related to the interleukin-6 (IL-6) receptor, and IL-6 at 50 ng/ml also reduced bovine mammary epithelial cell proliferation by 30%. Some elements (e.g., MAP kinases) of the intracellular signaling pathways for leptin and IGF-I overlap, suggesting possible mechanisms for interactions of the two factors. Studies are ongoing to examine this interaction in vivo and to elucidate the intracellular pathways for such an interaction.

Key Words: Leptin, Mammary gland development, IGF-I

320 Mitogenic effects of parenchymal tissue extracts from different regions within the heifer mammary gland. L. E. Davis*, J. L. Liesman, M. J. VandeHaar, and M. S. Weber Nielsen, *Michigan State University, East Lansing.*

Our objective was to examine the proliferative response of mammary epithelial cells to extracts of parenchymal tissue from different regions of the mammary gland of dairy heifers. Mammary extracts were prepared from parenchyma collected from proximal and distal regions within the mammary glands of prepubertal heifers (n = 3, BW = 213 $\pm$ 16 kg). "Proximal" was defined as the 1/3 region closest to the teat and "distal" was defined as the 1/3 region farthest from the teat. MAC-T bovine mammary epithelial cells were cultured in collagen gels in serum-free medium with or without 3% mammary extracts, in three separate assays. After 40 h incubation with treatments, total cellular DNA was measured. Mammary extracts of tissue from proximal regions stimulated cell proliferation more than extracts of tissue from distal regions (proximal = 3.74, distal = 3.38 μg of DNA/well, SEM = 0.11, $P<0.02$). Addition of mammary extracts stimulated total DNA 108% compared to serum-free medium. Concentrations of IGF-I in extracts did not differ between regions ($P=0.67$). However, higher abundance of IGFBP-2 ($P<0.001$) and a 28-kD BP ($P<0.005$) was noted in extracts of tissue from proximal regions than from distal. A tendency existed for IGFBP-3 to be greater in distal than proximal regions ($P<0.06$). Abundance of IGFBP-1 did not differ by region ($P=0.77$). We conclude that extracts from proximal regions contain more mitogenic activity than those from distal regions of the developing mammary parenchyma in prepubertal dairy heifers.

Key Words: mammary, IGF-I, heifer