repro, health, etc.) is a tool we use to evaluate management within a given period of time. In an expansion mode, usually voluntary culling takes a lower priority compared to involuntary issues. Culling rate for any given category can become camouflaged by ?real? management reasons for culling (i.e., cow comfort can be the rea-son for many culling categories including low production, lameness, and injury). Beef prices also play a critical role in some culling activities, especially for cows targeted to cull for reproductive reasons. Death loss is a culling category that most farmers choose to avoid but is a real number that oftentimes exceeds 8%. Culling is a reflection of many events that transpire in a static and expanding herd. Culling reflects management; therefore, our philosophy is culling is a tool with which our management can be measured.

Key Words: Culling, Management, Dairy

Ruminant Nutrition: Exploring the Boundaries of Efficiency in Lactation

210 Metabolic relationships in supply of nutrients in lactating cows. H. Tyrrell*[1] and K. Cummins[2], [1]*USDA/CSREES*, *Washington, DC*, [2]*Auburn University*, *Auburn, AL*.

The work reported in this symposium represents the current activities of members of the NC-1009 Multi-State Research Committee, an activity which has continued for nearly thirtyfive years and several project numbers and revisions. Members of this series of projects have been the core of National Academy of Science Subcommittees responsible for the revision of the Nutrient Requirements of Dairy Cattle published by the National Research Council. It was recognized a number of years ago that the conventional additive methods for the determination of nutrient requirements and the nutritive value of a ration fed to lactating cows was too simplistic a model to permit significant improvements in our ability to develop improved feeding systems for high producing dairy cows. This is particularly true for meeting energy and protein requirements of the high producing cow. The other presentations in this symposium will focus on current concepts of nutrient supply for lactation. It is critical, however, to not lose sight of established boundaries of efficiency in lactation. It was demonstrated clearly in the development of the Net Energy for Lactation System that the majority of the variation in the Net Energy Value of a ration is associated with pre-absorptive metabolism (85%) compared to variation in post-absorptive processes. The modern high producing dairy cow is significantly more efficient in the conversion of dietary energy to energy in milk produced. However, metabolizable energy required for maintenance and for each calorie in milk is remarkably similar to the cow a century ago. Improvement in gross efficiency of milk production is the result of dilution of maintenance.

Key Words: Lactation, Efficiency, Nutrients

211 Integration of ruminal metabolism in dairy cattle. J. L. Firkins*[1], A. N. Hristov[2], M. B. Hall[3], and G. A. Varga[4], [1]*Ohio State University*, *Columbus*, [2]*University of Idaho*, *Moscow*, [3]*USDA*, *Madison, WI*, [4]*Pennsylvania State University*, *University Park*.

Objective 1 of the NC1009 Cooperative Regional Research Project is to integrate various aspects of ruminal metabolism that affect the secretion of milk protein. Our overall aim is to quantify properties of feeds that determine the availability of nutrients critical to milk production. Specific goals are to integrate carbohydrate and nitrogen metabolism to provide fuel and precursors for metabolism by the digestive tract, mammary gland, and peripheral tissues to improve the efficiency of milk production while minimizing the loss of dietary nutrients to the environment. Thus, the current objectives of this paper are to review past research and highlight need for future research related to aspects of microbial population changes, feed degradability, microbial metabolism of dietary nutrients, VFA production, and flow of microbial protein (and AA) to the duodenum. Improved procedures for analysis of carbohydrate fractions are needed to better predict ruminal degradation of structural and non-structural carbohydrates and efficiency of microbial protein synthesis. Differences in concentrate and forage composition and particle size among studies are variables that influence these results. New procedures and data will be discussed to assess manipulation of bacterial and protozoal populations in vivo, with future goals being to better explain differences among animals fed similar diets and to integrate data to predict how production of milk components will vary among different dietary conditions. Whenever possible, current perspectives will be addressed to improve the integration of ruminal metabolism in dairy cattle for improved parameterization or better evaluation of computer models such as Molly, CPM, or NRC.

Key Words: Ruminal Metabolism, Microbial Protein Synthesis, Models

212 Regulation of key metabolic processes in lactation. S. Donkin*[1], J. Knapp[2], M. VandeHaar[3], and B. Bequette[4], [1]*Purdue University*, *West Lafayette, IN*, [2]*University of Vermont*, *Burlington*, [3]*Michigan State University*, *East Lansing*, [4]*University of Maryland*, *College Park*.

Research conducted under the NC-1009 multi-state project focuses on quantifying the properties of feeds that determine nutrient availability for milk production and on identifying the metabolic interactions among nutrients and tissues. Knowledge from these complementary research areas is integrated to challenge and refine nutrition systems for dairy cattle in a multi-faceted, quantitative manner using mechanistic models. The overall objective for this work is to provide information for the dairy industry that will improve the accuracy of feeding systems to predict the metabolic, production, and health responses of dairy cows in an environmentally responsive, profitable, and sustainable manner. An understanding of glucose and amino acid metabolism is central to this mission as they are critical metabolic commodities for milk synthesis. Often the metabolism of these nutrients within tissues and exchange among tissues dictates their availability for milk synthesis. Liver and portal drained viscera collaboratively dictate the availability of nutrients for use by muscle, storage in adipose tissue, and use in mammary metabolism and milk synthesis. Metabolism of these nutrients is sensitive to the rate of their appearance in blood, changes in hormone profiles, and responsiveness of tissues to hormonal changes. The net metabolism of absorbed nutrients in tissues is the combination of fluxes through individual reactions which comprise classical metabolic processes and pathways. These processes and their integration are described and the limiting elements identified with respect to nutrient use for milk production. Information pertaining to molecular events and key metabolic reactions is highlighted with regards to glucose and amino acid metabolism. Limitations for input and output relationships and the application of current biochemical and molecular knowledge to predictive models of nutrient metabolism in dairy cattle are identified.

Key Words: Lactation, Metabolism, Modeling

213 Nutrient supply for milk production by splanchnic tissues in dairy cows. C. Reynolds*[1], B. Bequette[2], and J. Knapp[3], [1]*The Ohio State University*, *Wooster*, [2]*University of Maryland*, *College Park*, [3]*J.D. Heiskell & Co.*, *Tulare, CA*.

A major focus of the NC-1009 regional project is the quantification of nutrient supply and utilization for production in lactating dairy cows. These data are integrated with measurements of fermentative and digestive processes through mathematical representations, with the overreaching goal of improving the nutritional management of dairy cows, thereby improving the efficiency and profitability of the dairy enterprise, and the health and longevity of the dairy cow. Together, the tissues of the portal-drained viscera (PDV; the gastrointestinal tract, pancreas, spleen and associated adipose) and liver determine the quantity and pattern of the nutrients available for production through their central roles

in diet digestion, nutrient absorption and assimilation, and the integration of nutrient supply with requirements for milk synthesis, maintenance and reproduction. The exogenous supply of most carbon-based nutrients in arterial blood is determined by amounts absorbed from the lumen of the gut, as well as the extent to which those nutrients are metabolized during their passage through absorptive cells and the liver. On a net basis, nutrient metabolism by the PDV and liver includes a substantial utilization of nutrients from arterial blood, as the splanchnic bed receives as much as 40% of cardiac output. A clearer picture of this metabolism is emerging through the strategic integration of measurements of net nutrient flux across the splanchnic tissues, in vitro measurements of metabolic processes, and their regulation, and isotopic labelling to assess tissue utilization and intermediary metabolism. Ultimately, the efficiency of nutrient utilization in the lactating dairy cow is determined by nutrient supply relative to the requirements of the mammary gland and other body tissues, and their propensity for productive nutrient utilization. Integration of research in these areas highlights progress in our understanding of intermediary metabolism of dairy cattle, and limitations to our ability to predict nutrient utilization.

Key Words: Nutrient Supply, Portal-Drained Viscera, Liver Metabolism

214 Metabolic models of ruminant metabolism: Recent improvements and current status. M. D. Hanigan*, H. G. Bateman, J. G. Fadel, and J. P. McNamara, *Land O' Lakes, Inc.*, *St. Paul, MN*.

The NC-1009 regional research project has two broad goals of quantifying the properties of feeds and the metabolic interactions among nutrients that influence nutrient availability for milk production and that alter synthesis of milk; and, to use those quantitative relationships to challenge and refine computer-based nutrition systems for dairy cattle. The objective of this paper is to review progress in modeling. Significant progress has been made in model refinements over the past 10 years as exemplified by the most recent NRC (2001) model and work on the model of Baldwin et al. (1987). These models have different objectives yet share many properties. The level of aggregation of the NRC model (2001) does not allow detailed analyses of specific metabolic reactions that affect nutritional efficiency. The Baldwin model is aggregated at the pathway level and is therefore amenable to assessment with a broad range of biological measurements. Recent improvements to that model include the addition of an ingredient based input scheme, use of in situ data to set ruminal protein degradation rates, and refinement of the representation of mammary cells numbers and activity. Although the Baldwin model appears to be appropriate structurally, several parameters are known to be inadequate. Predictions of ruminal nitrogen metabolism and total-tract starch digestions have similar accuracy as the NRC model. However the NRC more accurately predicts total-tract fiber digestion and both models significantly over-predict total-tract lipid digestion. These errors contribute to over-predictions of weight retention when simulating full-lactations with the Baldwin model and may result in performance prediction errors with the NRC model. Additional improvements in accuracy occur if a non-integral value for ATP production is adopted. Limitations remain in the descriptions of metabolism and metabolic regulation of the splanchnic viscera, adipose tissue, body muscle, and mammary tissue. Integration of genetic control mechanisms can expand these efforts to assist genetic selection as well as feeding management decisions.

Ruminant Nutrition: Beef—Feedstuffs and Predicting Feed Intake

215 Feedlot performance of a new distillers byproduct (Dakota Bran) for finishing cattle. V. Bremer*[1], G. Erickson[1], T. Klopfenstein[1], M. Gibson[2], K. Vander Pol[1], and M. Greenquist[1], [1]*University of Nebraska*, *Lincoln*, [2]*Dakota Gold Research Association*, *Sioux Falls, SD*.

Three hundred crossbred yearling steers (BW = 384 ± 20 kg) were utilized in a randomized complete block design to evaluate the effect of level of Dakota Bran (DB) on feedlot performance and carcass characteristics. Dakota Bran is a new distillers byproduct feed produced as primarily corn bran plus distillers solubles (53% DM) containing 14.9% CP (DM basis). Dietary treatments consisted of 0, 15, 30, and 45 % DB and 30% dried distillers grains plus solubles (DDGS), replacing corn (DM basis). Basal ingredients consisted of high-moisture corn and dry-rolled corn, fed at a constant 1:1 ratio (DM basis), plus ground alfalfa hay and dry supplement each fed at 5% of diet (DM basis). Steers were blocked by weight, stratified by weight within block, and assigned randomly to pen. Pens were assigned randomly to treatment within block with five/treatment and 12 steers/pen. Steers were fed for 116 d and slaughtered on d 117 at a commercial abattoir. There was a significant linear increase ($P < 0.01$) in final BW, ADG, and G:F, as level of DB in the diet increased and a significant quadratic response ($P < 0.01$) for DMI as level of DB in the diet increased. With the exception of HCW, there were no significant differences ($P > 0.05$) for carcass characteristics. These results indicate the new DB byproduct has feeding performance similar to DDGS at the same inclusion level. Feeding Dakota Bran in this trial, up to 45% of the diet, resulted in improved performance compared to feeding high-moisture/dry-rolled corn, suggesting energy value equal to or greater than corn.

Treatment[a]:	0 DB	15 DB	30 DB	40 DB	30 DDGS	SE
Final BW, kg[b]	583	596	601	609	595	4
DMI, kg/d	11.5	12.3	12.4	12.4	12.0	0.1
ADG, kg	1.71	1.83	1.86	1.94	1.82	0.03
G:F	0.149	0.149	0.150	0.157	0.152	0.002

[a]DB = Dakota Bran, DDGS = dried distillers grains plus solubles [b]Calculated from HCW divided by a common dress of 63%

Key Words: Byproduct Feed, Corn, Distillers Grains

216 Optimal level of corn distillers dried grains in no roughage diet for pre-conditioned calves. J. Williams*, F. Farias, and M. Kerley, *University of Missouri*, *Columbia*.

A study was conducted to determine the optimal level of dried corn distillers grains with solubles (DDGS) in a corn-soyhull-wheat midd diet for weaning calves. Seventy-two Angus Simmental crossbred calves (38 steers and 34 heifers; BW 249 ± 13.5 kg) were used in a 42 d growth and feed efficiency experiment. The first seven d after weaning calves were group fed ad libitum smooth brome hay and 2 kg per hd basal supplement. Calves were allotted by weight to eight pens and randomly assigned to one of five treatment diets. Diets were a control (C) containing the basal ingredients of all diets (38% corn, 40% soyhulls, 20% wheat midds, and 2%minerals/vitamins premix), a diet containing soybean oil (PC) added to lipid equivalency of the high DDGS diet, and three diets with increasing levels of DDGS (D1, D2, and D3). The D2 diet was formulated to optimize the amino acid to energy ratio. Individual intakes were measured using the GrowSafe Feed Intake System and weights were taken on consecutive days at initiation and termination of the experiment. Dry matter intake (avg 8.1