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

± 0.2 kg) was similar among treatment diets. Calves fed the D2 diet had the greatest (P < 0.05) ADG (1.5 kg/d) and the calves fed the PC diet had the lowest (P < 0.05) ADG (1.1 kg/d). Likewise, the calves fed the D2 diet had the best feed conversion ratio (6.0) and the calves fed the PC diet had the poorest (P < 0.05) feed conversion ratio (7.9). Plasma nonesterified fatty acids levels in plasma were similar among treatments at the initiation of the experiment and lowest (P < 0.05) for calves fed the D1 diet at the termination of the experiment. This experiment demonstrates that maximizing the potential of DDGS in beef diets is dependent upon optimizing the level of DDGS and amino acid supply in the diet.

**Key Words:** Corn Distillers, Steer Performance, Pre-Condition

**217 Grazed forage supplementation with dried distillers grains, corn oil, or corn gluten meal.** J. MacDonald*, T. Klopfenstein, and G. Erickson, *University of Nebraska*, *Lincoln*.

One hundred twenty heifers (368 kg, SD=39 kg) grazing smooth bromegrass (IVDMD=65.8%, CP=20.8%, undegradable intake protein (UIP)=2.0%) were blocked by previous ADG and allotted to control or one of nine treatments in a three by three factorial design to determine effects of DDG supplementation on ADG and forage intake (FI), and determine effects of UIP and ether extract (EE) in DDG on ADG. Factors were supplement source and level. Supplements were: 1) dried distillers grains (DDG, UIP=15.8%, EE=9.67%), 2) 54.4% corn gluten meal, 34.6% corn bran, and 8.0% molasses (CGM, UIP=31.6%, EE=0.83%), 3) 18.4% corn oil, 73.6% corn bran, and 8.0% molasses (OIL, UIP=0.74%, EE=19.3%). Levels of DDG were 0.750, 1.50, or 2.25 kg while levels of CGM and OIL were 0.375, 0.750, or 1.125 kg. Control animals were fed 0.250 kg of 92% corn bran and 8% molasses. Heifers were individually supplemented daily via Calan gates. Treatments were separated by regressing response variables on g nutrient (DM, UIP, or EE) intake per kg body weight using GLM in SAS because several animals did not consume their allotment of supplement. Net energy equations from NRC (1996) were used to estimate FI. Supplemental DDG DM resulted in a linear increase in ADG (P<0.01) with slope 0.039 ± 0.011 kg and intercept 0.759 ± 0.085 kg ($r^2$=0.50), and a linear decrease in FI (P<0.01) with slope -1.62 ± 0.176 and intercept 24.2 ± 1.18 g FI per kg BW ($r^2$=0.727). When ADG response was expressed as g UIP intake per kg body weight, intercept was 0.810 ± 0.093 kg and slope for DDG was 0.257 ± 0.153 which was greater (P=0.10) than CGM slope 0.113 ± 0.048. Expressing ADG as g EE intake per kg body weight resulted in intercept 0.762 ± 0.102 kg and slope for DDG of 0.449 ± 0.259 which was greater (P=0.09) than OIL slope 0.256 ± 0.066. The CGM slope is 44.0% of DDG slope while the OIL slope is 57.0% of DDG slope. When summed, they equal 101% of DDG slope. Supplementation with DDG increases ADG and reduces FI. While increased ADG observed from DDG supplementation is not independently explained by UIP or EE contained in DDG, it is likely explained by their combination.

**Key Words:** ADG, Dried Distillers Grains, Forage Supplementation

**218 Effect of dried distillers grains plus solubles or sunflower meal on performance and body condition score on beef cows consuming poor-quality forage.** H. Doering-Resch*, C. Wright, K. Tjardes, and K. Bruns, *South Dakota State University*, *Brookings*.

Degradable intake protein (DIP) is essential when feeding poor-quality forages to cattle. Based on 1996 NRC recommendations, it would be necessary to feed in excess of 3.2 kg of dried distillers grains plus solubles (DDGS) per day to meet the DIP requirement of a gestating cow consuming poor-quality forage. However, since cattle recycle N, it may be possible to feed smaller amounts of DDGS, yet maintain rumen function. The objective of this experiment was to compare DDGS and sunflower meal as protein sources for cows consuming poor-quality forage. Ninety-six gestating beef cows (BW = 580.2 ± 22.2 kg; BCS = 4.7 ± 0.09) were stratified by BW and BCS and allotted to 15 pens (14.7 m × 34.7 m). The pens were then randomly assigned to one of three dietary treatments. Treatments consisted of ground cornstalks and mineral supplement provided *ad libitum*, plus one of three supplements: 1) 1.47 kg/d sunflower meal with soybean oil (SFM), 2) 0.79 kg/d sunflower meal with soybean oil and 0.73 kg/d DDGS (COMB), and 3) 1.43 kg/d DDGS (DG). The supplements were formulated to be iso-caloric and iso-nitrogenous but provide decreasing levels of DIP (304.2, 256.5, 206.8 g/d for SFM, COMB, and DG, respectively). Cows remained on the treatment diets for 70 d. Weights were taken on d -1, 0, 35, 69, and 70, and BCS and ultrasound measurements of rib and rump fat were determined on d 0 and 70. Dry matter intake of corn stalks and mineral supplement was not affected by treatment ($P < 0.05$). Weight changes (31.6, 21.3, and 21.8 kg for SFM, COMB, and DG, respectively) and BCS changes (0.15, 0.21, 0.20 BCS for SFM, COMB, and DG, respectively) were not affected by treatment ($P > 0.05$). Ultrasound rib fat change (0.00 cm for SFM, COMB, and DG) and rump fat change (0.03, 0.05, and 0.02 cm for SFM, COMB, and DG, respectively) were not affected by treatment ($P > 0.05$). These results suggest that DDGS can replace sunflower meal on a crude protein basis without sacrificing cow performance or BCS.

**Key Words:** Corn Stalks, Degradable Intake Protein

**219 Predicting forage intake of steers supplemented dried distillers grains while grazing native summer sandhill's range.** S. Morris*, T. Klopfenstein, and D. Adams, *University of Nebraska*, *Lincoln*.

Fifty six crossbred steers (BW= 311 ± 11 kg) were used in a completely randomized design experiment to predict forage intake, determine rate of replacement of forage, and determine effects on animal performance by increasing supplemental dried distillers grains plus solubles (DDGS) on steers grazing native summer Sandhill's range for 88 days. Supplement was fed at five levels, 0, 0.257, 0.514, 0.770, and 1.027 % BW six d/week. Levels of DDGS were adjusted throughout the trial to correct for weight gain. Initial and final BW were based on three consecutive day weights following a five d limit-fed period. Steers were stratified by weight and randomly assigned to a level of DDGS. Steers continuously grazed, except during the morning when they were gathered and supplemented their respective amounts of DDGS in individual feeding crates. Amount of DDGS offered and refused were weighed daily to determine DDGS intake. Three esophageally fistulated cows were used to collect diet samples monthly to determine TDN of the pasture. To predict forage intake, total TDN intake was based on ADG and BW, using an equation developed by Winchester and Hendricks (1953 U.S.D.A. Tech. Bul. No. 1071). In a previous growing trial, with known TDN intake, BW, and ADG, Winchester's equation was adjusted by the following equation, where adjusted TDN intake = 1.110(known TDN intake)-1.389 ($R^2$ = 0.781). Adjusted TDN intake establishes the total TDN consumed by the animal. The DDGS TDN was subtracted from the total TDN. The remaining TDN was divided by the diet TDN (66.85% TDN), resulting in forage DMI. Forage intake linearly decreased (P < 0.001) as level of DDGS increased, while ADG linearly increased (P < 0.01) as level of DDGS increased. Average daily gain and forage DMI were regressed on DDGS intake and regression equations were determined as follows: ADG = 0.049(DDGS) + 0.732 ($R^2$ = 0.773), and forage DMI = -0.942(DDGS) + 8.968 ($R^2$ = 0.969). Supplementing DDGS to steers in grazing situations appears to replace forage and increase ADG.

**Key Words:** Distillers Grains, Predicting Forage Intake

**220 A new equation to predict feed intake by *Bos indicus* cattle.** R. Almeida*[1,2], C. Boin[2], P. R. Leme[3], R. F. Nardon[4], G. F. Alleoni[4], G. M. Cruz[5], M. M. Alencar[5], and D. P. D. Lanna[2], [1]*UFPR & PUCPR*, *Brazil*, [2]*ESALQ/USP*, *Brazil*, [3]*FZEA/USP*, *Brazil*, [4]*IZ Nova Odessa*, *Brazil*, [5]*Embrapa São Carlos*, *Brazil*.

The NRC (1984 and 1996 Editions) developed predictive equations for DMI by growing and finishing beef cattle. The data was obtained mainly from *Bos taurus* cattle, implanted and fed low forage diets with ionophores. Previous data has shown that NRC equations overpredicted DMI for *Bos indicus*. The objective of this study was to develop and validate a predictive equation for DMI by Zebu

cattle. Meta-analyses methods were applied to 15 experiments with Nellore cattle. All trials recorded daily DMI from Nellore bulls and steers fed in individual pens, group pens or electronic Calan gate feeders. Only trials conducted in research centers were used to ensure an adaptation period that would minimize compensatory growth effects. Among the 176 experimental units, feeding periods varied from 62 to 277 d and $NE_m$ concentration ranged from 1.01-1.77 Mcal/kg (51.2-74.5% TDN). $NE_m$ intake per unit of shrunk $BW^{0.75}$ was analyzed using mixed model procedure from SAS. Random experiment effect, fixed sex effect (castrated and intact), and continuous variables (dietary $NE_m$ concentration, $NE_m^2$, and days on feed) were included in the model. The suggested new equation is:

$$DMI\ (kg/d) = (SBW^{0.75} * (0.2068 * NE_m - 0.03958 * NE_m^2 - 0.07553)) / NE_m$$

The sex effect was not significant (P>0.05), maybe because steers tended to be older than bulls. DMI predicted from the Zebu data and the NRC equations showed that at low dietary $NE_m$ concentrations (1.0-1.4 Mcal/kg), *B. indicus* have higher intakes than *B. taurus*. Conversely, *B. taurus* cattle showed increasingly greater DMI than *B. indicus* when $NE_m$ was above 1.4 Mcal/kg. Using an independent data set from Nellore young bulls to validate the new equation, we obtained less overprediction bias than the NRC 1984 and 1996 equations (1.3% vs. 6.1 and 3.2%). Also, actual intakes and the predicted estimates did not differ using *t* test (P>0.10). We conclude that our equation predicted DMI from *B. indicus* more accurately than NRC equations.

**Key Words:** Beef Cattle, Dry Matter Intake, Nellore

**221 Use of chromic oxide and alkane controlled release capsules to estimate intake and digestibility by beef steers.** I. Lopez-Guerrero*, J. Fontenot, and G. Scaglia, *Virginia Polytechnic Institute and State University*, *Blacksburg*.

Two digestion trials were conducted to evaluate chromic oxide and alkane controlled release capsule (CRC) technique to estimate DM fecal output (DMFO), intake (DMI), and digestibility (DMD) by steers. For the first trial, six Angus crossbred steers (BW = 328 ± 31 kg) were allotted at ramdom to individual pens and fed tall fescue hay at a level of 1.5% BW. Seven days before the collection period, the steers were dosed with two intraruminal CRC, one containing $Cr_2O_3$ and another containing a mixture of $C_{32}$ and $C_{36}$ alkanes. During the 7 d collection period, hay samples and feces were collected, mixed, and sampled twice per day. Statistical analyses were conducted using the mixed procedure of SAS. The results show that, actual DMI, DMFO, and DMD were 4.74 kg/d, 1.85 kg/d, and 61%, respectively. No differences were found among days in the recovery rate (RR) of alkanes ($P \geq 1.106$) or $Cr_2O_3$ ($P = 0.341$). There was no difference between the actual and the estimated values of DMFO ($P \geq 0.315$), DMI ($P \geq 0.381$), and DMD ($P \geq 0.161$), provided the RR of the respective marker was used as correction factor for the estimated values. However, estimates using $Cr_2O_3$ were more reliable than those obtained with alkanes. The second trial was conducted under grazing conditions. The procedures were basically similar to those used in the first trial. The main differences were that the steers (n = 5) were heavier (BW = 382 ± 16 kg) and grazed low-endophyte fescue pasture, and only $Cr_2O_3$ CRC was used to estimate DMFO and DMI. Forage allowance was between 12.48 and 14.81 kg of forage DM/100 kg BW. The RR of $Cr_2O_3$ was not different among days during the collection period, but the mean was unusually high (189%). Nevertheless, actual and estimated DMFO and DMI were not different ($P \geq 0.846$) when the RR was used to correct the calculations. Under the conditions of these trials, DMFO, DMI, and DMD can be reliably estimated using $Cr_2O_3$ CRC if an accurate RR can be obtained.

**Key Words:** Beef Steers, Markers, Dry Matter Intake

**222 The effect of silage microbial inoculant with and without additional preservatives on the aerobic stability of maize silage.** S. Hall[1], P. Moscardo Morales[1], J. K. Margerison*[1], D. Wilde[2], P. Light[2], M. Smith[2], and N. Adams[2], [1]*University of Plymouth*, *Plymouth, Devon, UK*, [2]*Alltech (UK) Ltd*, *Stamford, Lincs, UK*.

The effect of inoculating maize silage with Maize-all GS (inoculant) and Sil-all Fireguard (inoculant and preservative) on silage aerobic stability was measured. Forage maize (DM 29 (±1.29)) was divided into sub-samples (300 kg FM) and treated with; No additive (0), Sil-All fireguard (0.5g/100kg FM (SAFS), Maize All GS 1g/100kg FM (MAS). Nine experimental silos lined with polythene had 75 kg/m2 applied and were stored (17 to 20 ° C) for 30 days. On opening 20 holes were made (0.5 cm d), samples were wrapped in polystyrene. Lactic acid (g/kg) at 48 to 168 h 0 -37.2 b,SAFS -78 a, MAS -52.5 a (11.9) and 0 to 168 h -0 53.2 b,SAFS -72.4 a, MAS -64.2 a (5.56) reduced significantly more (P<0.05) with SAFS and MAS, while acetic acid (AA) (g/kg DM) at 0 to 48 h) declined more in 0 -8.2 c, least in SAFS 0.6 a, and -2.2 b in MAS (2.6) (P<0.05), but between 0 to 168 h AA were lowest in SAFS, 0 -14.6 b, SAFS -23.8 a, MAS -18.4 b (2.67) (P<0.05). Maximum pH was lowest in MAS, and not sigificatly different between SAFS and 0 (0 7.3 a, SAFS 6.7 b, MAS 7.4 a (0.22) and pH change 48 to 168 h was greatest in MAS, 0 3.3 b, SAFS 3.0 c, MAS 3.6 a (0.17) (P<0.05). Time to max. temp. (h) was greatest in SAFS (0 83.1 a b, SAFS 109.1 a, MAS 74.5 b (10.4) (P<0.05). Silage additives increased lactic acid and silage aerobic stability.

## Sheep Species: Management of Gastrointestinal Nematodes in Sheep

**223 Epidemiology of sheep gastrointestinal nematodes in the U.S.** R. Kaplan*, *University of Georgia*, *Athens*.

There are many important diseases of sheep, but none are as ubiquitous or present as direct a threat to the health and productivity of sheep as gastrointestinal nematode (GIN) parasites. Control of GIN is therefore of primary concern in any sheep health management program. Well designed worm control programs must take into account many factors, the most important of which is the epidemiology and transmission dynamics of GIN in the particular locale of the farm. Because epidemiology differs greatly between regions, it is not possible to formulate broad-scale recommendations that are valid in all regions of the United States. In order to develop rational control plans for GIN, it is important to appreciate that there are numerous worm species that can cause disease in sheep, and optimal control strategies will differ among species. Fortunately, only a few species are highly pathogenic and of primary concern. Major pathogens include *Haemonchus contortus*, *Trichostrongylus colubriformis*, and *Teladorsagia (Ostertagia) circumcincta*. Other less common and usually less important species/genera include *Trichostrongylus axei*, *Nematodirus*, *Cooperia*, *Oesophagostomum*, *Trichuris* and *Bunostomum*. In virtually all instances infections will be mixed, with climate and season being the major factors influencing the relative percentages of the different species. In the warmer regions of the country, *H. contortus* is by far the predominant species with *T. colubriformis* the next most important. In cooler regions, *T. circumcincta* will be more of a problem, and there is a greater potential to have a mixture of all 3 primary pathogenic species. The less common species usually are not present in numbers sufficient to cause disease on their own; however, in certain situations conditions may allow large infection levels to develop which can produce serious outbreaks of disease. In the cooler regions of the country, GIN transmission is highly seasonal, whereas in the warmer regions, transmission of GIN may occur year-round. In this presentation, epidemiology of the major GIN pathogens will be discussed in relation to how this impacts the development of worm control programs.

**Key Words:** Gastrointestinal Nematodes, Epidemiology