cows. Pregnancy altered blood volume, pCO_2, and concentrations of nCa and Na during the ET.

Key Words: Exercise, Pregnancy, Dairy Cows

319 Profit maximizing calving interval with limited labor resources. C. C. Risch* and C. A. Wolf, *Michigan State University*.

Many dairy farms consistently exceed the industry benchmark calving interval of 13 months, instead having calving intervals of 14 to 16 months. Previous literature typically supports the 13 month benchmark but does not consider resource constraints (e.g., labor, capital, feed) common to dairy farms. This study examines the profit-maximizing calving interval decision when the managerial and skilled labor are limited. An optimizing linear programming model that explicitly considers managerial and skilled labor constraints was developed to identify the calving interval that maximizes net returns to a dairy herd. The model considered 13 to 18 month calving intervals in terms of lactation stage distribution effects on net returns and labor use. Revenues and expenses associated with calving interval and included in the model are milk, calf and cull revenues, as well as replacement and herd health costs. The model allowed various labor allocations in meeting the herd health and reproductive requirements needed to maintain a given calving interval. Results indicate that, although a 13 month calving interval is associated with the highest revenues, the profit-maximizing calving interval for a farm varies significantly with both managerial and skilled labor constraints. Further, labor allocation across reproductive and herd health activities is crucial in determining the profit-maximizing calving interval. Data from a 200 cow herd was used in the model, which resulted in an optimal calving interval of 14 months, achieved with hired labor contributing substantially to heat detection and breeding activities. Labor skill level and wage rate contribute significantly to the optimal calving interval for a given herd.

Key Words: Calving interval, Labor constraint, Linear programming

320 Dry matter intake of lactating dairy cows housed in freestall barns. D.M. Allen*[1,4], J.G. Linn[1,4], K.A. Janni[2,4], and S.C. Stewart[3,4], [1]*Department of Animal Science,* [2]*Department of Biosystems and Agricultural Engineering,* [3]*Department of Clinical and Population Sciences, College of Veterinary Medicine,* [4]*University of Minnesota*.

Data was collected from twenty groups of lactating dairy cows on three commercial farms from November 1999 to January 2001. All cows were housed in freestall barns. Groups for all three farms were managed based on stage of lactation, reproductive status and parity. Twelve groups had headlocks at the manger, 5 groups had rail-line feeding and 3 groups were fed in J-bunks. On average, 2075 lactating cows were represented in the milk and DM intake (DMI) data collected each month. Body condition score and body weight (BW) were determined on thirty-five percent of the cows in each group once per month. Feed DM offered each group daily was recorded using EZ Feed^{TM} software. Weighbacks, corrected to a DM basis, were recorded from each group and subtracted from feed DM offered to determine DMI. Group means for milk production and days in milk (DIM) were recorded daily by DairyComp 305^{TM}. Bulk tank milk composition was recorded daily from each farm. Group means and standard deviations (SD), categorized by DIM and parity, for BW, milk, and DMI are reported. DMI was predicted using the NRC 2001 equation for DMI from group mean data. The difference between actual and predicted DMI within farm and category is similar to the mean square prediction error reported for the DMI prediction equation in the NRC 2001.

	Farm A		Farm B		Farm C	
	Mean	SD	Mean	SD	Mean	SD
Lactating Cows/Farm	889		503		682	
Multiparous						
DIM 80 to 130						
Number of groups	2		1		2	
BW, kg	601.5	71.6	680.5	62.7	598.6	62.3
Milk, kg/d	45.2	4.8	52.1	2.8	42.2	7.3
DMI, kg/d	25.5	2.7	27.6	2.9	24.0	3.2
Predicted DMI, kg/d	26.9		30.2		25.7	
DIM 201 to 310						
Number of groups	3		1		2	
BW, kg	570.2	47.2	693.2	83.5	594.3	68.9
Milk, kg/d	32.2	2.0	33.9	2.9	31.3	5.8
DMI, kg/d	23.4	5.2	23.7	3.5	22.8	1.9
Predicted DMI, kg/d	22.5		24.7		22.6	
Primiparous						
DIM 80 to 130						
Number of groups	2		1		1	
BW, kg	530.8	61.7	581.9	64.7	514.0	46.8
Milk, kg/d	34.0	2.4	41.2	2.2	34.9	1.7
DMI, kg/d	19.9	3.9	23.1	2.5	19.5	1.5
Predicted DMI, kg/d	21.6		25.2		21.7	

Key Words: DMI, group, lactating dairy cows

321 Performance, health, and management of calves housed in a greenhouse barn (GHB) versus traditional wooden hutch (WH) during a Mississippi winter. M. L. Scott* and W. B. Tucker, *Mississippi State University, Mississippi State*.

The primary objective was to evaluate housing based upon management and health of young calves during wintry conditions. Forty dairy calves (32 Holstein; 8 Jersey) were randomly assigned at birth, blocked by breed and calving date, to a traditional WH or novel GHB (December 1997 to April 1998). Incidence and severity of scours, dietary intake, body weight changes, feed efficiency, respiration rate, rectal temperature, morbidity, and mortality were recorded from birth to 56 d. Calving assistance, Ig absorption, and calf vigor (birth to 1 h postpartum) were also recorded. Milk diet was 50% milk replacer (22% CP; 12% fat) and 50% waste milk. Gross energy were determined on daily samples composited by week. Dry feed (16% CP) was offered at 5d. Neither ADG (0.420±0.03, WH and 0.459±0.05 kg, GHB) nor feed efficiency (1.36±0.10, WH and 1.45±1.00 kg, GHB) were significantly different by housing. Weight gain was higher ($P<0.05$) for GHB than WH postweaning, 0.886±0.06 and 0.622±0.72 kg, respectively. Calves housed in WH consumed grain 1 wk earlier than GHB. Rectal temperatures at birth and overall were similar between housing. Fecal scores were 2.24±0.04 and 2.28±0.04 for WH and GHB, respectively. Observed health requiring medical attention were higher for GHB than WH (scours, respiratory and naval infection). Management and morbidity of GHB is similar to other barns. Nonetheless, GHB appears to be a suitable alternative to classical WH during winter, based upon growth.

Key Words: Greenhouse barn, Housing, Winter

ASAS/ADSA Ruminant Nutrition: Ruminal Fermentation

322 The effects of pH on acid resistance of cattle fecal *Escherichia coli* and O157:H7 in continuous culture or pure culture. C. J. Fu*, J. Porter, J. W. Lehmkuhler, E.E.D. Felton, D. Schmidt, M. Huck, and M.S. Kerley, *University of Missouri-Columbia, Columbia, MO 65211*.

Twelve single-phase continuous culture (CC) fermentors with a 0.045/hr dilution rate (D) and pure culture incubations were used to determine the effect of pH on acid resistance of fecal *E.Coli.* and *E.Coli.* O157:H7, respectively. The pH tested was 7.5, 7.0, and 6.5 in CC and 7.5, 7.0, 6.5, and 6.0 in pure culture. The basal diet fed to the CC was corn and soybean meal (95% + 5% on DM basis). The CC fecal inoculants were combined from 20 feedlot steers. The microflora samples were taken from the CC after 96 h of growth. The media used for the pure culture incubations was tryptic soy broth (TSB) without dextrose. Tubes were inoculated with *E.Coli.* O157:H7 (ATCC 43895) and then sampled after 24 h of incubation. The viable *E.Coli.* was enumerated by multi-tube method using lauryl sulfate trypticase broth (LST) as media. The viability of fecal *E.Coli.* linearly ($P < 0.01$) decreased (3.5, 0.7, and 0.007%) after extreme acid shock (pH = 2, 1 h) as the culture pH increased in CC. No *E.Coli.* O157:H7 was found in CC. The O157:H7 pure cul-

ture study indicated that the viability of the organisms was higher ($P < 0.01$) after extreme acid shock (pH 2, 4 h) when cultivated in pH 6.0 media than that in the other pH media (9.0 vs 2.4, 2.5, and 2.5%). This study demonstrated that culture pH affected acid resistance of *E.Coli.* as previously hypothesized.

Key Words: *E. Coli.* , Acid resistance, Acid shock

323 Effect of sampling frequency and schedule when determining dietary effects on ruminal pH. K. M. Krause* and D. K. Combs, *University of Wisconsin-Madison.*

Ruminal pH is often used as a response variable when assessing fiber adequacy of dairy rations. The optimal number of samples and the best time to sample in order to detect possible differences in ruminal pH are not known. In order to investigate this question a replicated 4 x 4 Latin square study with two forage particle sizes and two levels of corn grain moisture was used as an example. Ruminal pH was measured continuously for a five day period using indwelling electrodes and cows were fed twice daily. Feeding the cows twice daily caused diurnal variations in pH, so effect of feeding was included in the model along with day and hours post feeding. Data were analyzed as repeated measurements using proc mixed. In this study significant effects of the main variables forage particle size ($P<0.05$) and corn moisture ($P<0.001$) on pH were found using continuous measurement of ruminal pH. Also, the two forage particle sizes ($P<0.001$) and the two daily feedings ($P<0.005$) affected the decline in pH post feeding differently. Six alternative sampling schedules were investigated: 1) 4 h post am feeding on one day, 2) every 4 h for 24 h, 3) every 2 h for 12 h post am feeding, 4) 4 h post am feeding for five days, 5) every 4 h for five days, and 6) every 2 h for 12 h post am feeding for five days. The different sampling scenarios were simulated by using only the data points specified above from the data set collected using the indwelling electrodes. If sampling only on one day, sampling schedule 3 was the only schedule which detected effects of both dietary variables on pH. Sampling just once daily, but over a five day period (schedule 4), detected only a forage particle size effect on pH. Both sampling schedule 5 and 6 detected significant effects of both dietary variables and also interaction effects between dietary factors and hours post feeding. Based on the current data it can be concluded that when sampling on just one day, taking several samples between feedings is more useful than sampling across feedings. However, in order to detect dietary effects and effects of feeding on diurnal fluctuations in pH, data has to be collected across feedings and across several days.

Key Words: Ruminal pH, Sampling schedule

324 Effects of propionate supply on plasma vitamin B12 in growing lambs. CL Girard*[1], L Majdoub[2], and I Ortigues[2], [1]*Dairy and Swine R&D Centre,Agriculture and Agri-Food Canada,Lennoxville,Canada,* [2]*INRA,Unite de Recherches sur les Herbivores,Nutriments et Metabolismes,Theix,France.*

In sheep, up to 50% of glucose comes from propionate (Kennedy et al.1994. Internat.J.Vit.Res.64:270). Methylmalonyl-CoA mutase, a key enzyme in this metabolic pathway, requires vitamin B12 as a coenzyme. A lack of vitamin B12 induced by cobalt deficiency impaired propionate metabolism in sheep (Smith and Marston.1971.Br.J.Nutr.26: 41; Kennedy et al.1991.Biol.Trace Element Res.28:233).Within the framework of 2 trials aiming to study the influence of an additional supply of propionate on nutrient partition among tissues, the present work was undertaken to determine if changes in propionate supply modify vitamin B12 status in growing lambs. Four male lambs (32±2.2 kgBW) were fed frozen rye-grass (cut at grazing stage, chopped in 5cm length, frozen at -35°C and stored at -15°C) at an estimated level of 165 kcal ME per kg $BW^{0.75}$ in 12 equal meals daily.The treatments were applied in a cross-over design. In Trial 1, they consisted of 5d continuous intraruminal infusion of saline (C) or propionic acid representing 10% (P1; 0.54 mole propionate/d) or 16% (P2; 0.97 mole propionate/d) of daily ME intake from rye-grass, separated by transition periods of 7d. In Trial 2, the lambs were fed during 2wk the same basal diet than in Trial 1 supplemented or not with barley to increase the estimated absorption of propionate by 0.56 mole/d. At the end of each treatment period, blood samples were taken at 30min intervals during 4h for determination of vitamin B12 in arterial plasma. In Trial 1, plasma vitamin B12 decreased when propionate supply increased ($P=0.07$); 432.9±69.1, 236.9±33.4 and 276.8±68.7 pg/ml for C, P1 and P2, respectively. In Trial 2, feeding grass+barley decreased plasma vitamin B12 (551.9±87.5 pg/ml) as compared to grass alone (851.5±173 pg/ml)($P=0.08$). Therefore, it seems that increasing propionate supply decreased drastically plasma vitamin B12, probably through an increased demand for vitamin B12 by tissues involved in propionate metabolism.

Key Words: Vitamin B12, Propionate, Lamb

325 Assessment of phosphorus availability from different sources for ruminal fermentation. V. Fellner*, J. W. Spears, and S. J. McLeod, *North Carolina State University, Raleigh, NC.*

Two experiments were conducted using continuous cultures to (1) study the phosphorus requirements of rumen microorganisms and (2) determine the availability of phosphorus from different sources. Diets consisted of cottonseed hulls, corn starch, urea and an amino acid mixture. In the first experiment (n=2) daily additions of 28.3, 19.0, 9.4 and 0 mg of inorganic phosphorus (Pi) supplied as sodium phosphate resulted in culture soluble Pi concentrations of 13.9, 13.6, 8.2 and 2.0 mg/l, respectively. At Pi concentrations of 13.9, 13.6 and 8.2 mg/l total volatile fatty acids did not differ ($P > .10$) and averaged 42.4 mM. Reducing Pi concentration to 2.0 mg/l significantly reduced total volatile fatty acids; acetate and methane production also decreased by 8 % and 35 %, respectively. In experiment 2 (n=2), different sources of dicalcium and rock phosphate were evaluated for ruminal availability. Four fermentors were inoculated simultaneously, one received 9.4 mg of Pi (+ control; sodium phosphate) and one received 0 mg of Pi (- control). The other two vessels received 9.4 mg of either a dicalcium source or rock phosphate. Production of total volatile fatty acids averaged 57 mmol/d in the (+) and was reduced ($P < .10$) to 44 mmol/d in the (-). Concentration of Pi in cultures receiving the dicalcium sources averaged 7 mg/l compared with 1 mg/l for cultures receiving rock phosphate. Total volatile fatty acid production for all dicalcium Pi sources was similar ($P > .10$) to the (+) and averaged 61 mmol/d. However, addition of rock phosphate as the Pi source reduced volatile fatty acid production to 36 mmol/d. This was also true for acetate production that was higher for all dicalcium sources compared to rock phosphate. Our data indicate that 6 mg/l of soluble Pi concentration in ruminal cultures supported normal rumen fermentation. Rock phosphate had low phosphorus solubility and resulted in decreased ruminal fermentation compared with dicalcium phosphate.

Key Words: Phosphorus, Rumen microbes, Continuous cultures

326 Effects of natural plant extracts on nitrogen metabolism and fermentation profile in continuous culture. P. W. Cardozo, S. Calsamiglia*, and A. Ferret, *Universidad Autonoma de Barcelona, Spain.*

Eight 1.3-L dual flow continuous culture fermenters were used in two periods (10 d) to study the effects of natural plant extracts on N metabolism and fermentation profile. Fermenters were fed 95 g/d of a 60 to 40 forage to concentrate diet. Treatments (1.5 mg/d per fermenter) were: no extract (C), MX (a mix of all extracts), cassia (CA), garlic (G), anise (A), yucca (Y), marjoram (M) and capsicum (CA). Fermenters were maintained at constant temperature (39°C), pH (6.4) and solid (5%/h) and liquid (10%/h) dilution rates. Each day, a sample was taken 2 h after the morning feeding for the determination of ammonia (NH3) N and volatile fatty acids (VFA). During the last 2 days, samples were taken at 0, 2, 4, 6, and 8 h after feeding, and analyzed for peptide (Pep), aminoacid (AA) and NH3 N concentrations. Data were analyzed using the PROC MIXED (SAS, 1996) and significance declared at $P < 0.05$. Total VFA was similar across treatments (111.3 mM). Acetate concentration (mol/100mol) in A (57.8), M (56.6) and CA (57.4) were higher than C (53.4), and MX (52.4). Propionate concentration (mol/100mol) was lower in Y (26.3), A (25.3), M (25.6) and CA (25.0) versus C (28.4) and MX (28.4). Concentration of NH3-N (mg/100ml) in A (10.8) was higher versus C (7.9). The Pep-N concentration in hour 2 (mg/100ml) was highest for MX (8.9), CA (8.8), G (10.1) and Y (10.4), and lowest for C (3.3). The AA-N concentration in hour 2 (mg/100ml) was highest in C (12.4), and lowest in G (8.0) and CA (7.7). The NH3-N concentration in hour 2 (mg/100ml) was highest in A (10.0) and lowest in CA (6.3), G (5.6) and Y (6.0). The effect of individual extracts did not match the action of the MX. The accumulation on Pep-N in MX, CA, G, and Y suggested that peptidolysis was inhibited. The accumulation of AA-N, and the decrease in NH3-N in G suggested that

deamination was inhibited. Careful selection of these additives may allow to manipulate rate of protein degradation. Acknowledgment: Plant extract and financial support provided by Axiss France SAS.

Key Words: Microbial fermentation, plant extract

327 Comparison between Holstein and Jersey Cows in post-prandial Rumen pH and VFA Concentrations.

C.W. Cruywagen*, N. Strickland, and S.J. Schoeman, *University of Stellenbosch.*

The authors have previously reported that Jersey cows on high concentrate diets appeared to be more efficient than Holsteins to digest fibre in the rumen. The reasons for breed differences were not apparent. A study was done under the same conditions to compare post-prandial rumen pH values and volatile fatty acid concentrations in an attempt to explain previously observed differences between breeds. Eight ruminally cannulated cows (4 Holsteins and 4 Jerseys) were used in the trial. All the cows were non-lactating but received a lactating cow TMR from two weeks before, until the end of the trial. The TMR was fed at 08h00 daily (12 kg for Holsteins and 10 kg for Jerseys) and supplementary wheat straw was available *ad libitum*. Samples of rumen liquor were taken at 08h00, 12h00, 16h00, 18h00 and 20h00 on the first day of the trial, representing 0, 4, 8, 10 and 12 hours post-feeding. Initial pH (0h) did not differ between breeds and was 7.48 for Holsteins and 7.72 for Jerseys. A sharp decline in post-prandial rumen pH was observed for Holsteins and pH reached a minimum of 6.08 at 4h post-feeding, which was significantly lower ($P<.01$) than the 6.62 observed for Jerseys at the same time. Values at 8h, 10h and 12h post-feeding did not differ between breeds ($P>.05$) and were 6.18 and 6.2, 6.25 and 6.31 and 6.40 and 6.43 for Holsteins and Jerseys, respectively. Post-prandial molar proportions of acetic acid and propionic acid did not differ between breeds ($P>.05$), but total VFA concentration was higher at 4h ($P<.01$) and 8h ($P<.05$) post-feeding for Holsteins than for Jerseys. Higher total VFA concentrations for Holsteins at 4h post-feeding corresponded with lower pH values. It was observed that the Holsteins ate at a faster rate than the Jerseys and always finished their TMR long before the Jerseys. This could explain the differences observed between the breeds in post-prandial pH profiles. Fibre fermentation in the rumen is suppressed at low pH levels and it was concluded that the lower fibre digestibility values observed earlier for Holsteins could be due to lower pH values observed for at least 6h of the day which was probably caused by a difference in feeding behaviour.

Key Words: Dairy Cows, Rumen pH, Rumen VFA

328 Meta analysis of the acidogenicity of ingredients.

S. Giger-Reverdin and D. Sauvant, *UMR INRA - INAPG Physiologie de la Nutrition et Alimentation.*

Several studies stressed the large variations in the ability of ingredients to depress rumen pH in vitro. The aim of this work was to study the consistency of the ranking of acidogenicity of ingredients between experiments. A meta analysis was performed on a base including data of four already published papers and our own data. All the ingredients studied by at least two authors were retained. Methods differed between teams: the ratio (volume of incubation/sample mass) varied from 10 to 150 ml/g, the percentage of artificial saliva was comprised between 50 and 80 For the 14 most studied ingredients, the ranking was established on adjusted means of pH (lsmeans) which was accompanied for each feed by its standard error. It was the following one from the more acidogenic to the less one: Cassava (5.70, 0.10), Barley (5.77, 0.06), Citrus pulp (5.82, 0.07), Wheat (5.84, 0.06), Corn gluten feed (5.86, 0.07), Oats (5.87, 0.08), Wheat bran (5.87, 0.08), Beet pulp (5.89, 0.06), Rapeseed meal (5.95, 0.08), Coconut meal (5.98, 0.08), Soybean hulls (6.00, 0.07), Soybean meal (6.01, 0.07), Corn (6.04, 0.06), Sorghum (6.10, 0,06).As stressed by the precision of the model, the hierarchy between feeds hardly differ between teams and was conserved through incubation duration. Thus, these values could be included into feed formulation to take into account the potential acidogenicity of compound feeds formulated with these ingredients.

Key Words: Acidogenicity, Formulation, Ingredients

329 Rates of production of the major rumen volatile fatty acids in lactating cows given normal and milk fat depressing diets.

J.D. Sutton*[1,3], M.S. Dhanoa[2], S.V. Morant[3], D.J. Napper[3], and E. Schuller[3], [1] *University of Reading, UK,* [2] *IGER, Aberystwyth, UK,* [3] *formerly NIRD, Shinfield, UK.*

To examine the relation of the production rates of the 3 major rumen VFA to milk fat depression, 5 rumen-fistulated Friesian cows in mid-lactation were given two contrasting diets supplying similar digestible energy (DE) intakes. Cows were fed, in a 2-period cross-over design, a Normal diet of 9.0 kg concentrate (82% rolled barley (RB), 16% soyabean meal (SBM)) and 6.0 kg long hay (total 12.9 kg DM and 161 MJ DE/d) and a low-roughage diet (LR) of 12.9 kg concentrate (87% RB, 11% SBM) and 1.4 kg long hay (total 12.7 kg DM and 171 MJ DE/d) in two equal portions at 12-h intervals. Rates of VFA production were measured by 22-h intra-ruminal infusions of 0.5 mCi 1-^{14}C-acetic acid (A), 2-^{14}C-propionic acid (P) or 1-^{14}C-n-butyric acid (B) at 4-6 d intervals with sampling over the last 12 h. Results were calculated using a 3-pool, non-steady state model. Rumen fluid volume changes were included in the model and were measured by a 2-marker system and also by rumen emptying but were found to have little influence on calculations of VFA production. On Normal and LR respectively, milk yield was unaffected at 17.8 and 19.6 kg/d but fat content was severely depressed by LR at 34.5 and 22.0 g/kg ($P<0.001$). Net production rates (mol/d) on Normal and LR were 56.8 and 48.3 for A ($P<0.10$), 16.3 and 36.4 for P ($P<0.01$), and 6.5 and 4.7 for B ($P>0.10$). Molar proportions (%) of net VFA production were 71.3 and 54.2 for A ($P<0.001$), 20.8 and 40.5 for P ($P<0.001$) and 7.8 and 5.4 for B ($P>0.10$) and were broadly similar to molar proportions of rumen concentrations at 68.1 and 51.5 for A ($P<0.001$), 19.2 and 39.2 for P ($P<0.001$) and 12.7 and 9.3 for B ($P<0.01$). Net production of these 3 VFA provided 89 and 108 MJ/d, equivalent to 55 and 63% of DE. The milk fat depression was associated with a small reduction in acetic acid production, doubling of propionic acid production, and a small but non-significant reduction in n-butyric acid production.

Key Words: Rumen VFA Production, Milk Fat Depression, Dairy Cows

330 Gas and VFA production during the in vitro fermentation of selected organic acids and sugars.

D.O. Molina*, A.N. Pell, and P. Schofield, *Cornell University. Ithaca, New York.*

The study aimed to examine gas and VFA production and microbial yield from fermentation of selected organic acids (OA) and sugars. Citric, malic and lactic acids were included in *in vitro* medium at three concentrations, 10, 25 and 40 mM. The experiment was repeated twice: in the first experiment, ruminal fluid was filtered through four layers of cheesecloth and one layer of glass wool. In the second experiment, the ruminal fluid was centrifuged and the resulting pellet was resuspended in fresh medium prior to inoculation. In a third experiment, the same OA and two sugars, glucose and arabinose, were included in the standard *in vitro* medium (40 mM), using an inoculum of centrifuged ruminal fluid. In all cases, fermentations were conducted with the appropriate OA or sugar as the substrate either with or without 25 mg of soy hulls. Differences in fermentation among the OA are clear. Citric acid produced the highest gas volumes but did not always have the highest rate of gas production. It also produced the highest acetate and lowest propionate concentrations. More purines were detected in the lactic acid fermentations although the dry weights of the pellets from the lactic acid were not higher than that of the other acids. Fermentation of sugars resulted in more gas production than OA but the rate of gas production from arabinose was similar to that from lactic acid. It is concluded that significant differences ($P < 0.05$) in fermentation exist among various OA and between OA and sugars.

Acid	Citric	Malic	Lactic	Citric	Malic	Lactic	SE
Variable	No Soy hulls			Soy hulls			
Rate/h	0.11^a	0.07^b	0.12^a	0.08^a	0.05^b	0.05^b	0.01
Vfinal, mL	10.2^a	5.9^b	7.4^c	15.3^a	12.3^b	12.9^c	0.2
Acetic, mM	48.6^a	8.9^b	5.4^c	62.1^a	18.2^b	12.1^c	1.3
Propionic, mM	2.3^a	6.7^b	7.0^b	4.5^a	12.4^b	9.5^c	0.3
Pellet, mg	7.7^a	8.3^a	9.6^a	28.9^a	23.2^b	23.3^b	0.7
Purines, μg	45.1^a	49.0^a	82.7^b	137.1^a	136.7^a	163.4^b	3.3

Substrate	Glucose	Arabinose	Citric	Malic	Lactic	SE
Variable			No Soy hulls			
Vfinal, mL	19.8^a	20.1^a	13.3^b	6.6^c	7.7^d	0.2
Rate/h	0.69^a	0.17^b	0.12^c	0.07^d	0.20^b	0.01
			Soy hulls			
Vfinal, mL	28.2^a	25.6^b	17.6^c	12.8^d	13.5^e	0.2
Rate/h	0.47^a	0.10^b	0.16^c	0.05^d	0.09^b	0.01

Key Words: Organic acids, Sugars, *In vitro* fermentation

331 Interaction between Fermenten™ or soybean meal and fermentability of carbohydrate source on microbial yield and efficiency in continuous culture.

W.H. Hoover*[1], T.M. Miller[1], J.E. Nocek[2], and W.E. Julien[2], [1]*West Virginia University,* [2]*Biovance Technologies Inc.*.

A continuous culture study was conducted to evaluate the effect of protein and carbohydrate sources on rumen microbial yield and efficiency. Within the dual flow continuous culture system, liquid and solids dilution rates were 0.13 hr $^{-1}$ and 0.05 hr $^{-1}$ respectively. Culture pH was not controlled and feeding frequency was 2x/d. The design was a 2 x 2 factorial with protein and carbohydrate as the main effects. There were three replications with eight d fermentations per replication. The forage:concentrate ratio of the basal diet was 56:44. Treatments were: 1) ground corn and SBM, GC-SBM; 2) ground corn and Fermenten™ (Biovance Technologies Inc. Omaha, NE), GC-F; 3) steam-flaked corn-barley and SBM, SF-SBM; and 4) steam-flaked corn-barley and Fermenten™, SF-F. Microbial growth (g N/d) and efficiency (g microbial N/kg OM fermented) were 2.36 and 45.4, 2.28 and 43.8, 2.51 and 48.6, 2.78 and 51.6 for GC-SBM, GC-F, SF-SBM and SF-F respectively. Substituting steam flaked corn-barley for ground corn resulted in increased microbial growth and efficiency (P<0.02). There was a carbohydrate x protein interaction for microbial growth (P<0.05) and efficiency (P<0.15) whereby the combination of steam flaked corn-barley and Fermenten™ increased microbial N production by 11% compared to steam flaked corn-barley/SBM and 17 and 22% more than ground corn with either SBM or Fermenten™ respectively. These data suggest that the combination of steam flaked corn-barley and Fermenten™ acted synergistically in enhancing microbial protein yield and efficiency compared to any other combinations tested.

Key Words: microbial protein synthesis, rumen

332 Selection of *Propionibacterium* strains capable of utilizing lactic acid from *in vitro* models.

T.D. Parrott*[1], T.G. Rehberger[1], and F.N. Owens[2], [1]*Agtech Products, Inc., Waukesha, WI,* [2]*Oklahoma State University, Stillwater, OK*.

Forty-four strains representing four species of *Propionibacterium* were screened for lactic acid utilization to examine their potential for use in a direct-fed microbial to prevent lactic acidosis in cattle consuming large amounts of highly fermentable carbohydrate. Strains were tested for utilization of lactic acid and growth in a nutrient broth supplemented with 80 mM lactic acid at two different pH values - one representing the pH of an acidic rumen (5.0) and the other that of a forage-fed ruminant (7.0). No differences (p>.05) in growth and lactic acid utilization were detected among strains at pH 7.0. Data from pH 5.0 experiments showed *P. freudenreichii* strains P49 and P99 utilized 76.90 mM and 78.59 mM of lactic acid respectively, which was significantly (p<.05) more compared to other strains. Compared with strains of *P. acidipropionici*, *P. jensenii* and *P. thoenii*, *P. freudenreichii* strains reached higher cell densities and utilized more lactic acid at pH 5.0. Rumen fluid simulation models were used to examine the ability of fifteen selected propionibacteria strains to survive and utilize lactic acid produced by native ruminal microorganisms. Eleven of the fifteen propionibacteria strains tested utilized lactic acid in the rumen model. Compared with other strains, P42 had the highest rate of pH increase (.0377 units/h), but was not different (p>.05) from strains P63, P54, P25, and P41. Strain P42 also had the highest rate of lactic acid utilization (1.61 mM/h) compared to others, but was not different (p>.05) from strains P63, P54, P25, P41, P111, P81, and P104. Gompertz non-linear curve fitting equation revealed that strains P54 and P63 increased (p<.001 and p<.01 respectively) the lag time for lactic acid accumulation and suppressed the rate of H+ concentration. These results suggest that *Propionibacterium* may be able to utilize ruminal lactic acid, thus preventing ruminal pH decline in cattle consuming high concentrate rations.

Key Words: *Propionibacterium*, Rumen, Lactic acid utilization

333 Quantitative analysis of *in situ* starch degradation in the rumen.

A. Offner*[1], D. Sauvant[1], P. Chapoutot[1], J. Van Eys[2], and A. Bach[2], [1]*INRA - INA PG, Paris,* [2]*Agribrands International, St. Louis*.

The objective of this study was to predict ruminal starch degradation for various feedstuffs. The equation ED = a + b × c / (c + k) was generally used to calculate starch effective degradability. The parameters a, b and c represent the rapidly degradable fraction, the potentially degradable fraction and the degradation rate of fraction b, respectively. The passage rate (k) was considered to be equal to 6%/h. A database on starch degradation including the parameters (a, b, c) and also the kinetic values was built from 47 references (291 observations). Data were analyzed using the GLM procedure. The model took the effects of laboratory (lab) and raw materials (rm) into account, these two factors being significant ($P < 0.001$). This model predicted the effective degradability with an R^2 of 82% (rsd=7.9, sd_{lab}=16.2 and sd_{rm}=32.5). A similar model predicted starch "a" fraction with an R^2 of 72% (rsd=16.0, sd_{lab}=40.2 and sd_{rm}=41.6). The least squares means were collected and results with at least 3 observations are presented. This approach can be used to predict ED with standard deviations ranging from 1.8 to 4.9%.

Ingredients	a, %starch*	Starch ED, %*
Corn	22.1 (27, 3.7)	60.2 (28, 1.8)
Ground Corn	32.5 (6, 7.5)	71.6 (5, 4.1)
Extruded Corn	39.4 (3, 10.3)	77.5 (4, 4.4)
Pelleted Corn	21.0 (3, 9.9)	64.9 (3, 4.9)
Corn Gluten Feed	53.3 (6, 7.4)	86.5 (6, 3.7)
Corn Silage	54.0 (14, 5.4)	83.8 (14, 2.7)
Sorghum	25.4 (8, 6.3)	59.5 (9, 3.0)
Barley	46.1 (25, 3.9)	88.7 (26, 1.9)
Ground Barley	62.9 (3, 11.6)	99.8 (3, 5.7)
Wheat	66.2 (12, 5.5)	95.1 (12, 2.7)
Wheat by-products	78.5 (9, 6.2)	98.2 (9, 3.0)
Oats	73.7 (5, 7.7)	97.4 (5, 3.8)
Ricebran	12.7 (5, 8.0)	74.3 (5, 3.9)
Potato	47.3 (7, 6.7)	79.4 (7, 3.3)
Faba beans	42.1 (5, 8.2)	77.6 (5, 4.0)
Toasted Faba beans	35.7 (11, 6.2)	65.7 (11, 3.1)
Peas	41.0 (8, 6.6)	79.3 (8, 3.3)
Toasted Peas	26.6 (10, 6.4)	61.6 (10, 3.2)

*Mean (number of observations, standard deviation)

Key Words: Starch, Degradation, In situ kinetics

334 Influence of post-ruminal partially hydrolyzed starch and casein on pancreatic α-amylase expression in calves.

K. C. Swanson*, J. C. Matthews, C. A. Woods, and D. L. Harmon, *University of Kentucky, Lexington*.

The objective of this experiment was to examine the effects of post-ruminal partially hydrolyzed starch (SH) and(or) casein on the expression of pancreatic α-amylase mRNA, protein, and enzyme activity in calves. Twenty-four Holstein calves (88 ± 3 kg), fitted with abomasal infusion cannulas, were randomly assigned within block (wk of infusion) to one of four abomasal infusion treatments. Calves were fed an alfalfa-based diet to supply 1.2 × NEm requirement and to exceed requirements for ruminally degradable intake and metabolizable protein for a steer gaining 0.33 kg/d. Abomasal infusion treatments (3000 mL total volume infused/d) were control (water), SH [4 g/(kg BWd)], casein [0.6 g/(kg BWd)], and SH+casein. Treatments were infused abomasally for 10 d

before tissue collection. Casein infusion increased pancreatic weight by 74% and α-amylase mRNA expression by 69% in the absence of SH, but did not influence pancreatic weight and α-amylase mRNA expression in the presence of SH (SH × casein, P < 0.10). Infusion of SH decreased (P = 0.02) pancreatic α-amylase protein expression by 67% and activity (U/g pancreas) by 63%. Casein infusion did not influence pancreatic α-amylase protein expression and activity (U/g pancreas). Casein infusion increased total α-amylase activity (kU/pancreas) by 148% in the absence of SH, but did not influence total α-amylase activity (kU/pancreas) in the presence of SH (SH × casein, P = 0.05). These data suggest that increases in small intestinal SH decrease pancreatic α-amylase expression largely by post-transcriptional events. Increases in small intestinal protein increase pancreatic weight and total α-amylase activity, whereas small intestinal SH inhibits these increases.

Key Words: calves, α-amylase, post-ruminal nutrients

335 Abomasal infusion of casein enhances abundance and activity of Na+/glucose cotransporter along the small intestine of lambs. S. J. Mabjeesh*, D. Guy, and D. Sklan, *The Hebrew University.*

The purpose of this study was to determine the effect of abomasal casein infusion on glucose uptake and abundance and activity of the Na+/glucose cotransporter (SGLT1) in brush border membrane vesicles (BBMV) prepared from mucosa in different regions of ovine small intestine. Lambs (body weight 35 ± 1.0 kg) were surgically fitted with abomasal infusion catheters and were fed diets containing equal portions of wheat hay and cracked corn. Lambs were infused with either 500 g/d water or with 500 g/d water containing 35 g casein. The infusion period lasted 10 d, after which lambs were slaughtered, exsanguinated, and eviscerated. Intake and total tract digestibility of nutrients were similar between treatments and averaged 1134, 1142 and 486 g/d, and 67, 70, 94% for dry matter, organic matter, and non-structural carbohydrates. Crude protein digestibility was higher by 15% in the casein infused lambs. Glucose uptake to BBMV ranged from 101 to 337 pmol.mg protein-1.sec-1 along the small intestine and was highest in the mid section of the small intestine. In the mid jejunum glucose uptake was higher ($P < 0.07$) in lambs infused with casein and averaged 120 compared to 68 pmol.mg protein^{-1}.sec^{-1} in the control group. SGLT1 affinity was similar in the different segments of the small intestine of lambs infused with casein and averaged 106 mM. In contrast in the control group a scattered range of values was found in the control group with lowest values in the duodenum. SGLT1 protein abundance correlated positively with glucose uptake in the BBMV in the casein treated lambs, but not in the control group. These data suggest that glucose uptake along the small intestine of lambs is directly influenced by casein or its derivatives in the small intestine via SGLT1 affinity at the brush border membrane. SGLT1 activity may be regulated by post-translational events affected by amino acids and peptides.

Key Words: Sheep , Starch digestion, Glucose transporter (SGLT1)

ASAS/ADSA Ruminant Nutrition: Transition Cow

336 An overview of dietary factors influencing dry matter intake and milk protein yield in early lactation dairy cows. A. N. Hristov*[1], W. J. Price[2], and B. Shafii[2], [1]*Department of Animal and Veterinary Sci.,* [2]*Statistical Programs, College of Agriculture, University of Idaho, Moscow, ID 83844.*

The objective of this meta-analysis was to determine the factors mostly responsible for the variation in DMI and milk protein yield (MPY) in lactating dairy cows. Diets (467) from feeding trials conducted in the U.S. and Canada involving Holstein cows less than 100 DIM published in J. Dairy Sci. (volumes 73 through 82) were analyzed for nutrient composition (CPMDairy program). The average DMI of the cows involved in this study was 22.1 kg/d (varying from 16.0 to 29.9 kg) and the average milk yield was 33.0 kg/d (varying from 20.1 to 46.0 kg). The relationships between DMI and MPY with variables representing the chemical composition of the diet and ruminal fermentability of carbohydrate (CHO) and nitrogen fractions were investigated. Principle component analysis (PCA) was used to reduce the dimension of the underlying data and identify specific sources of variability. More than 80% of the data variability was accounted for by the first three components representing starch, fiber and protein intakes. Dominant variables contributing to these axes were non-structural CHO, CHO fraction B1 and fermentable CHO fraction B1 for starch, NDF, CHO fractions B2+C and fermentable CHO fractions B2+C for fiber, and soluble and degradable protein intakes for protein. A subsequent regression analysis was carried out to investigate the relationships between these dietary attributes and the response variables DMI and MPY. A three-parameter model involving CHO fraction B1, NDF, and soluble protein intakes was deemed appropriate for DMI, accounting for 91% of the response variability. Whereas, CHO fraction B1, degradable protein, and NDF intakes were the best explanatory variables for MPY, accounting for 41% of the response variability. In conclusion, during the first 100 days of lactation, starch and NDF intakes were the most important variables in determining DMI, while starch intake was the important variable in determining MPY.

Key Words: Dairy Cows, Dry Matter Intake , Milk Protein Yield

337 Dry period protein nutrition and glucose and protein metabolism in transition cows. W.S. Burhans*[1], R.M. Slepetis[1], P.J. Reeds[2], and A.W. Bell[1], [1]*Cornell University, Ithaca, NY,* [2]*USDA-ARS CNRC, Houston, TX.*

The effect of protein nutrition during the dry period on periparturient glucose flux and protein metabolism was assessed in multiparous Holstein cows. Cows (n=12) were dried off at -67 days from expected calving date and fed a common diet (HIGH) containing 157g/kg CP, 40.9% NDF, 34.8% NFC, and 1.59 Mcal/kg NEl. At -60 d and -20 d before expected calving and +3 d after calving cows were infused with a complete mix of ^{15}N labeled amino acids (AA) and [6-^{2}H] glucose for 8 h (AA) and 4 h (glucose) respectively. Hourly blood samples were taken to determine plasma isotopic enrichment. After infusion for 8h a liver biopsy was taken for determination of protein fractional synthesis rate (FSR) from hepatic incorporation of ^{15}N AA. After the infusion 6 cows were assigned to a diet (LOW) containing 7.9 g/kg crude protein, 40.9% NDF, 46.2% NFC, and 1.56 Mcal/kg. Cows remained on HIGH or LOW diets until calving, when a common lactating diet was fed containing 175 g/kg CP, 31.1% NDF, 38.9% NFC, and 1.74 Mcal/kg. Tabulated results suggest minimal effects of dry period dietary protein concentration on periparturient glucose or AA metabolism. High dry period DMI and inclusion of additional corn starch to the LOW diet may have ameliorated potential negative effects of low dietary protein concentration. Increased glucose flux postcalving is consistent with increased glucose demand immediately postpartum. Additional work is needed to assess the significance of low dry period protein concentration when intake is low or restricted or when diets are less glucogenic.

	Far Dry	Close Dry		Lactation				*P*	
	Cov.	H	L	H	L	SEM	Prot	Time	PxT
Body weight, kg	692	754	711	660	613	18	NS	<.001	NS
DM Intake, kg	12.7	11.0	11.8	13.0	10.0	0.7	NS	NS	NS
Glucose Kd, g/kg.d	3.62	3.53	2.97	3.91	4.32	0.18	NS	<.05	NS
Glucose Kd, g/d	2472	2651	2081	2536	2637	97	NS	NS	NS
Prot Kd, g/kg.d	5.11	5.13	5.07	5.76	6.25	0.38	NS	NS	<.1
Prot Kd, g/d	3485	3813	3600	3752	3758	239	NS	NS	NS
Liver FSR	0.172	0.184	0.172	0.238	0.314	0.027	NS	<.1	NS
N bal. d2-d7				- 49	- 63	17	NS		

Key Words: Transition cow, metabolism