

470 Safety improvement of salmon using biopreservatives. H. Zuckerman*¹ and R. Ben Avraham², ¹Technion, Haifa, Israel, ²Milouda, Ashrat, Israel.

Presence of *Listeria monocytogenes* in fresh, or even in cold smoked, salmon has become a major concern for the salmon processing industry, government agencies, and consumers. The application of bacteriocins to inhibit foodborne pathogens in general, and *Listeria monocytogenes* in particular is of great interest in the food industry. The efficacy of Microgard™200 (10%) w/v combined with Novasin™ (nisin) (0.2%) w/v (Rhodia Inc. NJ) and sodium metaphosphate (10%) w/v and Novagard™ (lysozyme) (Rhodia Inc. NJ), to inhibit *Listeria monocytogenes* and to prolong shelf life of fresh salmon was evaluated. Chilled salmon were cut into 10x5 cm pieces and were randomly assigned to untreated controls and to treated samples. Treatments were carried out by dipping samples for 1 min into the respective solution, in 3 replications, control samples were dipped 1 min into water. The ratio of salmon samples to dipping solution was 1:4 (w/v). Samples were individually overwrapped with PVC film (15 micron) on polypropylene trays, and evaluated for surface pH, color, total and *Listeria monocytogenes* microbiological counts after 0,1,2,3,4 and 6 days of storage at 4°C. Samples treated with Microgard and Novasin reduced aerobic bacteria population by 2 log (p<0.05) and increased shelf life from 2 days to about 6 days and also, eliminated completely the growth of *Listeria monocytogenes*. Bacteriocin treatment neither affected surface pH values nor the color

of the fish. Novagard was effective against *Listeria monocytogenes* but did not prolonged the shelf life of fresh salmon and affected its color.

Key Words: Safety, *Listeria monocytogenes*, Bacteriocins

471 Fate of toxigenic contaminant and nontoxigenic fungi in blue-veined cheese. S. M. El-Gindy*, Assiut University, Egypt.

Eight (8) types of local and imported Roquefort cheese samples were collected from different Egyptian markets and examined for its mold content. Danish and French samples contained only *P. roqueforti*. The Egyptian sampled was contaminated with *Asp. niger* and *Rhizopus nigricans*. Roquefort cheese curd was inoculated with spores of *P. roqueforti*, and/or *Asp. fumigatus* or *Asp. flavus*. The resultant ripe cheese was morphologically examined. The body, texture, flavor and mold growth and distribution in cheese were judged. The examination of various cheeses showed similarity of all cheeses to the well-known blue cheese. Some of the judges preferred the blue cheese inoculated with *Asp. fumigatus*. The present investigation revealed that cheeses were found to be free from and detectable amounts of aflatoxins. This could be attributed to certain factors such as ripening at low temperature, higher salt concentration, and higher acidity. Moreover, the addition of cheese starter may prevent the production of aflatoxin in cheese.

FORAGES AND PASTURES

472 High population corn grain silage in a dairy operation: A field demonstration. GA Brown*¹, ¹University of Missouri Outreach and Extension, Columbia.

The objective was to do a field demonstration to determine if there was an economic benefit of multiple plantings of high population corn grain to be harvested as silage. The silage would be forage in a NW Missouri dairy operation. The total size of the area to be planted was 2.8 hectares (ha). The plant population was estimated at 395,376 plants per ha. Normal plant population for hybrid seed corn silage is 65,000 plants per ha. The first planting was on June 8, 1999 and harvested on July 26. Plant height was 1.1 to 1.4 meters at harvest and estimated yield was 17 metric tons (t) per ha. The second planting was done on August 2. Due to dry weather conditions there was no harvest of the second planting, but samples were collected for nutritional analysis. Total seed cost per planting was 28.98 dollars at the current corn grain market price. A total estimated seed cost for hybrid seed corn for silage was 195 dollars. Samples for nutritional analysis were taken at the first planting pre and post harvest stages and 8 weeks after the second planting. The average of the samples, sample variance and sample standard deviations (Std. Dev.) of Dry Matter, Crude Protein, Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), Net Energy of Lactation (NeL) and Relative Feed Value (RFV) are in the table below. Results showed that there was an economic advantage in seed cost to the high population corn grain silage. Nutritional quality and yields may not be an advantage over hybrid seed corn silage. More research is needed under different management styles and climatic conditions to determine if there is a benefit to using high population corn grain silage as forage in dairy rations.

oil RX 5888TC (HOC), Asgrow waxy RX 5888WX (WX), and Asgrow RX 5888 (Control). Diets contained 50% forage and 50% concentrate, except for one trt (BMRH) that contained 65% forage and 35% concentrate. The forage portion of the diets contained 75% corn silage and 25% alfalfa silage. Main ingredients in the concentrate were high moisture shelled corn, cotton seed, Soyplus®, and soybean meal. Diets were similar in NDF content (average: 30.5%), except for the BMRH, which was 34.5%. Dietary CP averaged 18.6%. Milk production was greatest with BMR and differed from the control, BMRH, and HOC trts (P < .04). FCM was greatest for the BMRH trt, reflecting the much higher fat test. Milk protein percent was lowest for the BMRH. Unreplicated estimates of silage and grain yields are presented.

Item	Control	BMR	BMRH	HOC	TMF	WX	P <
Milk, kg/d	34.9 ^c	36.0 ^a	34.9 ^c	35.1 ^{bc}	35.6 ^{abc}	35.8 ^{ab}	.04
Milk fat, %	3.29 ^b	3.15 ^b	3.77 ^a	3.29 ^b	3.15 ^b	3.31 ^b	.001
Milk CP, %	3.30 ^{ab}	3.27 ^{ab}	3.16 ^d	3.24 ^c	3.31 ^a	3.26 ^{bc}	.04
DMI, kg/d	21.1	21.0	21.1	21.0	21.3	21.5	NS
3.5% FCM, kg/d	33.8 ^{bc}	33.3 ^c	36.0 ^a	34.0 ^{bc}	33.1 ^c	34.6 ^b	.05
Silage yield, T/ha	21.7	21.0	...	23.0	20.9	23.9	...
Grain yield, kg/ha	11625	11050	...	10487	9524	12921	...

Key Words: Corn silage, Milk, Corn genetics

474 Effect of level of surface-spoiled silage on the nutritive value of corn silage diets. L. A. Whitlock*, T. J. Wistuba, M. K. Siefers, R. V. Pope, and K. K. Bolsen, Kansas State University, Manhattan.

Twelve ruminally cannulated crossbred steers were used to determine the effect of level of surface-spoiled silage on DM intake and nutrient digestibilities of whole-plant corn silage-based diets. Irrigated corn was harvested at the 80% milkline stage of maturity and chopped to a 10 mm particle length. A pilot-scale bunker silo, 0.9 m in depth, and a 2.8-m diameter AgBag® were filled with alternating loads of chopped forage. After 90 d, the bunker was sealed with a single sheet of polyethylene, and this silage was designated "spoiled". The silage in the AgBag® was designated "normal". The four experimental diets contained 90% silage and 10% supplement (DM basis), and the proportions of silage in the diets were: a) 100% normal; b) 75% normal:25% spoiled; c) 50% normal:50% spoiled; and d) 25% normal:75% spoiled. The diets were fed once daily at 0700, and the amount fed was adjusted so that approximately 10% of the as-fed diet was in the feed bunk at the end of each 24-h period. The metabolism study consisted of two, 17-d periods,

Key Words: Dairy Ration, Corn Silage, Economic

473 Effect of corn silage containing high oil, waxy, multileaf, or bm3 corn genetics on feed intake, milk yield, and milk composition of dairy cows. V. R. Moreira*¹, J. Jimmink¹, L. D. Satter¹, J. L. Vicini², and G. F. Hartnell², ¹US Dairy Forage Research Center, USDA-ARS, Madison, WI,, ²Monsanto Co., St. Louis, MO.

This trial was part of a larger three-site experiment to evaluate corn silage hybrids. This part of the experiment involved 144 cows in early lactation. Following a 2-wk covariate period, 72 cows were assigned to one of six treatments for a 28-d treatment period. A second group of 72 cows followed the same protocol. The five hybrids evaluated were Cargill brown midrib 3 (BMR), Mycogen multileaf-TMF99 (TMF), Asgrow high

and total fecal collections were used to determine nutrient digestibilities. The pH value, DM %, and NDF, ADF, and ash contents (% of the DM) were 3.90, 38.0%, and 42.6, 23.4, and 5.3%, respectively, for the normal silage and 4.80, 26.4%, and 49.0, 31.0, and 9.1%, respectively, for the surface-spoiled silage. Crude protein digestibility decreased ($P < .05$) in a linear manner as the proportion of surface-spoiled silage increased from 0 to 75% of the silage portion of the diet. Steers consuming the normal silage diet had higher ($P < .05$) DM intake and higher DM, OM, NDF, and ADF digestibilities than those fed the three diets that contain surface spoilage. The addition of surface-spoiled silage had large negative associative effects on DM intake and DM, OM, and fiber digestibilities; the largest decrease in digestibility occurred with the first increment of spoiled silage. Visual appraisal of the forage mat in the rumen indicated that its physical integrity was partially destroyed by even the lowest level of surface-spoiled silage in the diet.

Key Words: Silage, Surface spoilage

475 The effect of delayed filling and application of a buffered propionic acid-based additive on the fermentation of barley silage. J. A. Mills¹, A. G. Whiter¹, C. L. Myers², and L. Kung, Jr.¹, ¹University of Delaware, Newark, DE, ²Kemin Industries, Inc., Des Moines, IA.

Whole plant barley (early dough) was cut and wilted to 37% DM. Forage was chopped and immediately ensiled untreated (TRT 1), or treated (TRT 2) with KI-112 (0.1% of wet forage; buffered propionic acid, acetic acid, benzoic acid, and sorbic acid, Kemin Industries, Inc., Des Moines, IA). Portions of the chopped forages (untreated, TRT 3 and treated, TRT 4) were left in piles at about 25°C for 24 h before ensiling (delayed filling). A portion of untreated forage from TRT 3 was also treated with KI-112 as described (TRT 5), before ensiling. All treatments were ensiled in quadruplicate 20-l silos. Delayed filling increased the numbers of yeasts ($P < 0.05$) by more than 1000-fold (TRT 3-5), decreased ($P < 0.05$) water soluble carbohydrates ($> 50%$), increased ($P < 0.05$) NH₃-N ($> 40%$), and increased pH (> 1 unit). The changes in these later measurements were less ($P < 0.05$) in forage that was treated with KI-112 at chopping (TRT 4). After 60 d of ensiling, untreated (TRT1) and treated silages (TRT2) were similar in their concentrations of fermentation products, but DM recovery was greater ($P < 0.10$) in TRT silage (98.0%) than in TRT1 silage (91.3%). Silages that were delayed in filling (TRT 3-5) were higher ($P < 0.05$) in pH, lower ($P < 0.05$) in lactic acid content, higher ($P < 0.05$) in NH₃-N content, and lower in acetic acid content than silages that had been ensiled immediately after chopping (TRT 1-2). Delayed filling resulted in a clostridial fermentation as the butyric acid content was greater ($> 1.65%$, DM basis) in TRT 3 to 5 than in TRT 1 and 2 ($P < 0.05$). The increase in pH and NH₃-N was less in TRT4. Delayed filling of silos has severe negative consequences on the composition of forage before and after ensiling. Treating barley forage with a buffered propionic acid preservative immediately after chopping improved the DM recovery of silage and lessened, but did not prevent, the negative effect of delayed filling on some end products of fermentation.

Key Words: Silage, Propionic acid, Delayed Filling

476 The effect of varying doses of a buffered propionic acid-based preservative on the fermentation and aerobic stability of barley silage. J. M. Neylon¹, L. Kung, Jr.¹, C. L. Myers², N. K. Ranjit¹, and J. M. Robinson¹, ¹University of Delaware, Newark, DE, ²Kemin Industries, Inc., Des Moines, IA.

Whole plant barley (wilted to 39% DM) was chopped and treated with low application rates of a preservative (KI-126) that contained propionic acid, ethoxyquin, BHT, BHA, and calcium silicate (Kemin Industries, Des Moines, IA). Treatments at the time of ensiling were: 1) no additive, 2) KI-126, 0.1% of fresh forage weight, 3) 0.15% KI-126, and 4) 0.2% KI-126. At ensiling, addition of KI-126 increased the concentration of propionic acid from 0.02% in untreated forage to 0.18, 0.38, and 0.50% in treatments 2, 3, and 4, respectively. Triplicate 20-l silos were prepared for each treatment and forage ensiled for 87 d at 20 to 24°C. Addition of KI-126 resulted in a lower ($P < 0.05$) silage pH (average 3.93) than in untreated silage (4.03). These findings were supported by numerically higher amounts of acetic and lactic acids in silages treated with KI-126 than in untreated silage. The ammonia content was not different among treatments. Numbers of yeasts were more than 10-fold less ($P < 0.05$) in treated silages and was 4.97 (\log_{10} cfu/g of silage),

3.72, 3.61, and 3.86 for treatments 1, 2, 3, and 4, respectively. Aerobic stability was defined as the number of h prior to a 2°C rise in temperature of a 3-kg sample of silage after exposure to air (ambient temperature about 20 to 23°C). Aerobic stability was improved ($P < 0.05$) with the addition of all levels of KI-126 and was 58, 83, 89, and 95 h, for treatments 1 through 4, respectively. Aerobic stability was also determined on TMR comprised of 30% (DM basis) barley silages, 30% alfalfa haylage, and 40% concentrate. Combining treated barley silages into a TMR comprised of untreated alfalfa silage containing a high concentration of yeasts (5.44 \log_{10} cfu/g) did not improve the aerobic stability of the TMR. The data from this study shows that treating barley silage with low application rates of a propionic acid-based additive improved the aerobic stability of silages but not of a TMR containing untreated silage.

Key Words: Propionic acid, Aerobic stability, Silage

477 *Lactobacillus buchneri* and enzymes improves the aerobic stability of high moisture corn. C. C. Taylor¹, J. M. Neylon¹, J. A. Lazartic², J. A. Mills¹, R. M. Tetreault¹, A. G. Whiter¹, R. Charley², and L. Kung, Jr.¹, ¹University of Delaware, Newark, DE, ²Biotol Canada, Ontario.

The objective of this study was to evaluate the effect of various doses of *L. buchneri* (Biotol, Inc., Eden Prairie, MN) and the combination of *L. buchneri* (LB) with *L. plantarum* (LP) on the fermentation and aerobic stability of high moisture corn. High moisture corn (27% moisture) was ground and ensiled in lab silos with the following treatments: 1) no bacteria, 2) LB2 (final dose of 1×10^5 cfu/g of fresh corn), 3) LB3, (5×10^5 cfu/g of fresh corn), 4) LB4 (6.6×10^5 cfu/g), 5) LB5 (1×10^6 cfu/g), and 6) LBLP (5×10^5 cfu of LB and 1×10^5 cfu of LP per g of fresh corn). All treatments also supplied the following enzymatic activity (IU/ton of wet corn): β glucanase (63,636), α amylase (31,818), xylanase (34,545), and galactomannanase (5818). Inoculation had minor effects on the products of fermentation during the early stages of ensiling. However, after 92 d, LB treatments had numerically greater concentrations of acetic acid than did untreated corn. Specifically, corn treated with the highest dose of LB (treatment 5) had more ($P < 0.05$) acetic acid (0.78%, DM basis) than did untreated corn silage (0.45%). Numbers of yeast were 3.25 \log_{10} cfu/g in untreated corn and tended to decrease with increasing doses of LB to a low of 2.12 \log_{10} cfu/g ($P < 0.05$) in treatment 6. Total lactic acid concentration was lowest ($P < 0.05$) in corn treated with the highest concentration of LB (LB5) when compared to untreated corn. Dry matter recovery ranged from 96.5 to 98.9% and did not differ among treatments. Aerobic stability (number of h prior to a 2°C rise in temperature) was markedly improved by the addition of LB when applied at a dose of 5×10^5 or more cfu/g. Aerobic stability for d 92 corn was 47, 79, 333, 400, 372, and 306 h for treatments 1, 2, 3, 4, 5, and 6 respectively. Addition of LB did not affect the rate of fermentation in high moisture corn but after prolonged fermentation, increased production of acetic acid and markedly improved aerobic stability.

Key Words: *Lactobacillus buchneri*, Aerobic stability, High moisture corn

478 Effect of Maturity and Mechanical Processing of Corn Silage on Total Tract Starch Digestibility of Corn Silage Based Total Mixed Rations. L.M. Johnson¹, J.H. Harrison¹, D. Davidson¹, B. Mahanna², and K. Shinnors³, ¹Washington State University, ²Pioneer Hi-Bred Int'l Inc., Johnston, IA, ³University of Wisconsin, Madison.

Three total collection metabolism studies were conducted over two consecutive years to evaluate the effect of maturity and mechanical processing of corn silage on total tract starch digestibility in lactating Holstein cows. Experiments 1 and 2 were conducted using Pioneer hybrid[®] 3845 corn silage, and Experiment 3 was conducted using Pioneer hybrid[®] Quanta corn silage. During 1996 Pioneer hybrid[®] 3845 corn silage was harvested at three maturities (dough - 25% DM, 1/3 milkline - 28% DM, and 2/3 milkline - 28% DM). During 1997 Pioneer hybrid[®] 3845 and Pioneer hybrid[®] Quanta corn silages were harvested at three maturities (1/3 milkline - 27% DM and 34% DM, 2/3 milkline - 33% DM and 41% DM, and blackline - 38% DM and 47% DM, respectively). At all maturities, corn silage was harvested with and without mechanical processing (John Deere 5830 harvester with kernel processor). The experimental design was a 6 x 6 Latin square. The 18 TMRs consisted of similar

feed ingredients and composition (13.2% alfalfa hay, 13.6% whole cottonseed, 26.8% corn silage, and 46.4% grain mix) differing only in corn silage treatment. Starch content was measured on TMR, Orts, and feces. Starch apparently digested in the total tract was greater for cows fed processed corn silage in seven out of nine comparisons, and similar to unprocessed corn silage in the other two comparisons. At advanced stages of maturity processing enhanced starch digestion to a greater extent than with less mature silages (Experiment 2 - 2/3 milkline (P < 0.0003), blackline (P < 0.02), Experiment 3 - 2/3 milkline (P < 0.0073), blackline (P < 0.01).

Total Tract Starch Digestibility Estimates (%)

Maturity	Dough	1/3 Milkline	2/3 Milkline	Blackline	SE				
Proc	Un- Proc	Un- proc	Un- proc	Un- proc	Un- proc				
Exp. 1	98.2	97.4	97.6	96.7	97.7	97.9	...	...	0.42
Exp. 2	...	...	98.2 ^a	98.2 ^a	98.1 ^a	95.6 ^c	96.9 ^b	95.6 ^c	0.42
Exp. 3	...	...	97.5	97.1	97.4	96.4	97.6	96.6	0.28

^{a,b,c} P < .02

Key Words: Corn Silage, Starch Digestibility, Rations

479 Effect of two corn hybrids, with or without kernel processing, on milk production. V. R. Moreira^{*1}, L. D. Satter¹, and M. I. Endres², ¹U.S. Dairy Forage Research Center, USDA-ARS, Madison, WI,, ²Mycogen Seeds, Eagan, MN.

Two Mycogen corn hybrids (TMF2662 and TMF108) were chopped at 37-40% DM and a theoretical cut length of 9 to 19 mm. The longer cut silage was rolled through a processor mounted on the forage harvester with roller spacing of about 1 mm. Control and processed silages had similar particle size distribution. Sixty-four early lactation Holsteins were fed once daily with a TMR containing one of the four treatment corn silages. This completely randomized 2 x 2 factorial design was conducted for 124 d. Diets contained 37.5% corn silage, 12.5% alfalfa silage, 26.0% high moisture shelled corn, 11.6% roasted soybeans, 5.8% soybean meal, and other minor ingredients. Dietary NDF and CP averaged 27.1 and 18.0%, respectively. Grain contents (% DM) for TMF2662 and TMF108 silages were 43 and 48%. The TMF108 treatment resulted in a lower milkfat test. Processed TMF108 had the highest milk production. Processing tended to increase milk production and decrease grain in the feces.

Item	TMF2662 Control	Pro- cessed	TMF108 Control	Pro- cessed	P <
Milk, kg/d	40.6 ^b	39.6 ^c	40.5 ^b	42.4 ^a	.05
3.5% FCM, kg/d	36.9 ^b	36.9 ^b	33.9 ^c	37.9 ^a	.03
Milk fat, %	3.03 ^a	3.11 ^a	2.51 ^c	2.95 ^b	.05
DMI, kg/d	24.4 ^a	23.9 ^b	21.9 ^c	23.8 ^b	.05
FCM:DMI	1.52 ^b	1.54 ^{ab}	1.55 ^{ab}	1.57 ^a	.02
Digest. NDF, %	53.6 ^a	51.8 ^{ab}	53.7 ^a	49.0 ^b	.05
Corn kernels, % of fecal DM	3.37 ^a	.89 ^b	1.59 ^{ab}	.84 ^b	.001
SCM, kg/d	35.0 ^a	35.0 ^a	32.8 ^b	35.6 ^a	.008
Ruminal acetate, molar %	63.4	61.6	60.8	59.2	.05
Ruminal propionate, molar %	22.3	24.5	25.5	23.7	NS
Ruminal butyrate, molar %	9.8 ^b	10.1 ^{ab}	9.0 ^b	11.8 ^a	.04

Key Words: Corn silage, Kernel processing, Milk

480 Effect of Mechanical Processing of High Moisture Corn Silage on Loss of Effluent. J.H. Harrison^{*1}, D. Olson¹, J. Hay¹, and D. Davidson¹, ¹Washington State University, Puyallup.

Whole plant corn silage (Pioneer Hybrid 3845) was harvested at the dough stage of maturity (DM% = 23) as either mechanically processed or unprocessed forage. Forage was chopped at 19 mm TLC with a John Deere 5830 self propelled forage harvester equipped with a mechanical processor. The roller setting was set at a 1mm gap for processed forage. Forage was ensiled in duplicate 1.2m x 1.2m (hxd) cylindrical silos and

the top surface was weighted with 308 kg/m² of top surface. A hole of approximately 10 mm was made mid center and on the bottom of the silo for daily collection of effluent. The initial packed density of the forage as 610 kg/m³. Daily measures were made of effluent loss and DM of effluent. Data is summarized in the table below. No difference was observed in the DM % of the effluent and averaged 6.3% during the first 39 days of observation. Mechanical processing increased loss of effluent/909kg forage by 25 kg (through first 95 days of observation), and increased loss of DM/909kg forage in effluent by 1 kg (first 39 days of observation).

Treatment	%DM of effluent*	Kg Effluent loss/ 909Kg Forage**	Kg DM loss in effluent/ 909 Kg Forage*
Processed	6.03	67.55	2.25
Unprocessed	6.64	42.12	1.24
SE	.155	1.256	.0665
P <	.11	.005	.009

*Average of first 39 days of observation. **Average accumulative loss in first 95 days of observation.

Key Words: Corn Silage, Forage, Effluent

481 Relationship between NDF and hay intake in horses: A review of published studies. A. C. St. Lawrence^{*}, R. J. Coleman, and L. M. Lawrence, *University of Kentucky, Lexington.*

Forage is an important part of any horse feeding program and accordingly, it is important to be able to accurately predict the amount of forage a horse will consume. A review of the literature was undertaken to determine if a relationship exists between forage chemical composition and voluntary dry matter intake (VDMI) in mature horses.

Six studies representing VDMI of 21 different forages (4 alfalfa and 17 grass hays) were used. Grass hays included both cool and warm season varieties. The only forage chemical components that were consistently reported across all studies were CP and NDF. Because of this, the relationships of CP to VDMI and NDF to VDMI were examined. The CP content of the grass hays ranged from 8.0 to 17.5% while the legume hays ranged from 14.8 to 20.9%. The NDF content of the grass hays ranged from 59.5 to 74.9% while the legume hays ranged from 40.9 to 56.3%. All studies used mature horses that were allowed ad libitum access to long hay. Only studies that reported animal weights specific to each trial and measured intake over a minimum of 4 d were used. All reported VDMI values were converted to g/kgBW/d.

Crude protein was not strongly related to VDMI (R²=.14, grass hays; R²=.34, grass and legume hays combined). The relationship of NDF to VDMI for grass hays alone is expressed by the equation y=124.55+.0155x²-2.5742x (R²=.67) where x=%NDF and y=g/kgBW/d VDMI. The relationship for grass and legume hays combined is expressed by the equation y=18.377-.0051x²+.3895x (R²=.53). No equation was calculated for alfalfa hays alone because only four VDMI values were available. The lower correlation between NDF and VDMI when both grass and legume hays were analyzed may be related to differences in the structure and digestibility of grasses and legumes. The data reviewed from these papers suggest that, when compared to CP, NDF values will provide a better prediction of the dry matter intake of mature horses fed long stem hay.

Key Words: Horse, NDF, Intake

482 Effects of residual and reapplied biosolids on forage and soil mineral concentrations in North Florida. M.E. Tiffany, L.R. McDowell^{*}, G.A. O'Connor, H. Nguyen, F.G. Martin, and N.S. Wilkinson, *University of Florida, Gainesville.*

Effects of single applications and residual effects of exceptional quality biosolids to bahiagrass (*paspalum notatum*) pastures were studied from June to November in relation to beef cattle nutrient requirements. Thirty .8 ha pastures were assigned one of 11 treatments representing three sources of biosolids. Three biosolids (Baltimore, Tampa and Granulite) were applied at an "agronomic rate" (X) and 2X. Four of the treatments represented residual applications of the Baltimore and Tampa biosolids which had been applied to pastures as in the previous year. The control plot received NH₄NO₃. The highest Granulite treatment was higher (P<0.05) than the control in P and K at many

sampling times. Both Tampa reapplied treatments resulted in forage Ca higher than the control. Forage crude protein (CP) concentrations were high and met beef cattle requirements for all treatments, with Granulite treated forages consistently higher ($P < 0.05$) than the control. Forage receiving Tampa treatments had improved ($P < 0.05$) Zn concentrations over the control at most samplings, times, with this increase often seen in the Tampa residuals as well. Forage Mo concentrations were minute, and though some treatment effects were observed ($P < 0.05$), there was no threat of toxic accumulations observed at any time. Many biosolids treated pastures contained excess S, ($> .40\%$) and were greater ($P > 0.05$) than controls. All forage Cu levels were less than the requirement of 10 ppm, low Cu plus high S ($> .40\%$) increases the likelihood of Cu deficiency. In relation to grazing beef cattle requirements, all treatments resulted in generally adequate forage levels of Ca, P, Mg, K, and CP, however, Na, Co, Cu, Se and Zn concentrations were deficient.

Key Words: Biosolids, Forage, Minerals

483 The interrelationship of solar radiation and leaf area on growth of *Pennisetum purpureum* cv Mott. T. Clavero*¹, ¹La Universidad del Zulia.

The effects of fertilization on leaf area index, light interception, growth rate and the relationship between these parameters on dwarf elephantgrass (*Pennisetum purpureum* cv Mott) were evaluated. The study included four levels of nitrogen (0, 60, 120 and 180 kg N/ha). Treatments were replicated three times in a randomized block design. Plots were irrigated as necessary to maintain active growth. Dwarf elephantgrass growth for each season exhibited significant differences ($P < 0.05$) in mean live yield, leaf area index and light interception. Maximum live yield obtained during the rainy season was about 14.2 TN/ha. Critical leaf area index was approximately 8.0 - 8.4. Maximum mean growth rate for this season was about 315 kg/ha/day. During the dry season, dwarf elephantgrass attained a maximum live yield of about 10.5 TN/ha. Critical leaf area index was most likely around 5 - 5.5 with a maximum mean growth rate of about 250 kg/ha/day. This research showed significant differences between season growth. The results suggest that dwarf elephantgrass showed high growth rate due to high radiation and long days during the rainy season.

Key Words: *Pennisetum purpureum* cv Mott, leaf area index, growth rate

484 Effects of fertilization on biomass production of *Clitoria ternatea*. T. Clavero*¹, ¹La Universidad del Zulia.

A field experiment under tropical dry forest conditions was carried out in a dryland farming area in Venezuela in order to evaluate the biomass production of *Clitoria ternatea* under three levels of N (0, 100, 200 kg/ha) and three levels of P (0, 150, 300 kg/ha). A split-plot in randomized block design with four replications was used. Results obtained show that the N*P interaction affected ($P < 0.05$) the total biomass and composition of forage (stem and leaves production). Total dry matter yield of *C. ternatea* increased linearly with increasing N and P rate. The highest value for total biomass was 1.2 TN/ha when the legume was fertilized with 200 kg N/ha and 300 kg P/ha. Leaves and stem production ranged from 260 to 580 and 170 to 480 kg/ha respectively and were higher with a fertilizer of 200 kg N/ha and 150 kg P/ha. Dead material was not affected by fertilization which showed mean values of 0.18 and 0.12 TN/ha for heavy N*P doses (200-300 kg/ha) and lower N*P doses (0-0 kg/ha), respectively. It is concluded that fertilizer N and P benefits biomass production on *Clitoria ternatea*.

Key Words: *Clitoria ternatea*, biomass production, Fertilization levels

485 Effect of intensity and harvest frequency on dry matter yield of *Acacia mangium* Willd. A. Rodriguez-Petit¹, T. Clavero*², and R. Razz², ¹Centro de Transferencia de Tecnología en Pastos y Forrajes, ²La Universidad del Zulia.

A field experiment was carried out in Zulia State, Venezuela. The objectives were to evaluate the total dry matter yield (RMST) and its components (fine fraction, RMSFF and gross fraction, RMSFF); and also the growth rates (TCT, TCFF and TCFG) of *Acacia mangium* Willd under three intervals of cutting (42, 63 and 84 days) and three cutting heights (50, 75 and 100 cm). A randomized block design with treatments in split plot arrangement was used. The results showed that total dry matter yield and growth rate was affected by harvesting interval. The

maximum values were: 735.03, 588.31 and 146.75 g/plant for RMST, RMSFF and RMSFG, respectively, when the plants were harvested at 84 days. The same tendency was observed for growth rates (2.92, 2.33 and 0.58 g/plant/day for TCT, TCFF and TCFG, respectively). RMST and RMSFG was affected by the combined action of harvesting interval and cutting height. Maximum values was obtained with 84 day cutting intervals and 100 cm of height. *Acacia mangium* Willd shows highest yields with the least frequent and least severe defoliation.

Key Words: *Acacia mangium*, dry matter yield, growth rates

486 *Flourensia cernua* extracts decrease intake of alfalfa pellets by sheep. R. E. Estell*¹, M. R. Tellez², E. L. Fredrickson¹, D. M. Anderson¹, K. M. Havstad¹, and M. D. Remmenga³, ¹USDA/ARS Jornada Experimental Range, Las Cruces, NM, ²USDA/ARS Natural Product Research Center, University, MS, ³New Mexico State University, Las Cruces.

Our objective was to evaluate the effects of three extracts (hexane, ether, and ethanol) isolated from tarbush (*Flourensia cernua*) on intake of alfalfa pellets by sheep. In each of two experiments, 45 ewe lambs received one of five treatments for 5 d (randomized complete block, three lambs on each treatment per block). Treatments were alfalfa pellets (CON) or alfalfa pellets plus ethanol carrier (CAR), hexane extract (HEX), ether extract (ETH), or ethanol extract (ETOH). Treatments were isolated from tarbush leaves (36 kg) using a sequential extraction of hexane, diethyl ether, and 100% ethanol. Extractions (3 kg of leaves in 7 L of solvent, constant mixing, 22 h per solvent) were filtered, solvents removed using a rotary evaporator, and resuspended in ethanol. Lambs were offered 640 g of alfalfa pellets (DM basis) and intake was monitored during a 20-min interval each morning. Extracts were applied to alfalfa pellets at the same concentration as in tarbush in Exp. 1, and at 10-fold dilutions in Exp. 2. Lambs were adapted to handling and individual pen feeding for 10 d and maintained and fed alfalfa pellets (4.7% of BW, DM basis) as one group except during 20-min tests. All three extracts reduced intake by lambs in Exp. 1 ($P < .0001$) compared to CON or CAR. Mean intake during the 20-min period was 361, 393, 204, 212, and 228 g for CON, CAR, HEX, ETH, and ETOH, respectively (SEM = 28.9). Intake did not differ between CON and CAR, nor among HEX, ETH, and ETOH. Mean intake in Exp. 2 was not different (468, 455, 389, 381, and 431 g for CON, CAR, HEX, ETH, and ETOH, respectively; SEM = 30.5; $P = .187$). Three fractions containing mixtures of compounds of increasing polarity were equally effective in decreasing intake of alfalfa pellets at concentrations encountered in intact tarbush plants; thus, several compounds are probably involved in the low palatability and differential use of this shrub typically exhibited by livestock.

Key Words: Intake, Plant Extracts, Sheep

487 Introduction and cultivation of 5 grass varieties in Qinba mountain area. J. Luo*¹, S. H. Cao, X. F. Zhao, Q. Liu, and H. Y. Yang, Goat Research Institute of Northwest Agricultural University, Yangling, Shaanxi, China.

A study was conducted to compare the growth performance and nutritional values of 5 grass varieties which were introduced and cultivated in Qinba mountain area in south Shaanxi province in China and to select the most suitable varieties in the region. The 5 varieties, including *Medicago sativa* L., *Trifolium repens* L., *Bromus catharticus* vahl, *Lolium perenne* L., and *Amaranthus paniculatus* L. were chosen according to the specific climatic conditions of Qinba mountain area, and the characteristics of phenology, heat resistance, growth and development and nutritional value were recorded during the growth period. All grasses were planted in spring on the 10 m² plot with two replicates for each grass. The results indicated that the introduced spring planting grass germinated uniformly and grew fast in the early growth period because of appropriate temperature, in the hot and dry summer time, all forages grew slowly but demonstrated a good adaptability, drought and heat resistance. The wilting coverage score of 5 forages were between 3 to 4 points (5 point scoring system, 1 point means wilting grass percentage is greater than 80%; 5 point, less than 20%), and the white clover had the best resistance to heat and drought. The fresh forage yield of *Medicago sativa* L. and *Trifolium repens* L. was 20,000 and 34,000 kg/ha, respectively. In conclusion, all introduced forages were well adapted to the summer climatic conditions of Qinba mountain area, showing strong

drought and hot resistance, fast growth and high utilization values, and should be widely extended in Qinba mountain area of Shaanxi province.

Key Words: Grass, Introduction, Qinba mountain area

488 *Tripholium pratense*: Degradability and intestinal digestibility. M. de J. Marichal^{*1}, M. Carriquiry, A.I. Trujillo, and L. Astigarraga, ¹ *Facultad de Agronomía, Universidad de la República.*

Rumen nitrogen (N) and non-nitrogen organic matter (NNOM) dynamics and N intestinal digestibility (ID) were estimated to characterize and identify changes in nutrient availability of red clover spring forage. Forage was harvested in early (Sep 1, Oct 9) and late Spring (Nov 3, Dec 26). Degradability (*In sacco*) and ID (Mobile bag technique) were estimated in 3 Holstein dry cows fed alfalfa hay. Data were analyzed as a completely random design. Potentially degradable fractions (PDF) and degradation rates (kd) were compared by confidence intervals, and soluble fractions (SF) and ID by t-test. Effective degradability was estimated as $a + (bc/c+k)$, $a = SF(\text{zero-time})$, $b = PDF$, $k = \text{outflow rate, } 6\%/h$, and $c = kd$. PDF and kd originated from $a + b(1 - e^{-kt})$, $t = \text{time}$. Forage fermentable NNOM (FNNOM) and rumen degradable protein (RDP) appeared to be higher in early than in late Spring. Differences in rumen dynamics within each period and fraction were registered, with carbohydrates varying more than proteins. Cell wall and protein contents and characteristics, would explain these results. Differences in N digestibility may result from changes in protein fractionation (i.e. ADIN/NDIN-ADIN) associated with variation in forage morphological composition and phenological stage (PS). Results suggest fermentable carbohydrates would limit microbial protein synthesis. Consumed as only feed, forage RDP would exceed animal requirements and that UDP intake may meet animal requirements.

Harvest date	Sept	Oct	Nov	Dec
Chemical composition, %DM				
NNOM	58.7	55.7	69.7	61.7
NDF	24.7	27.8	39.8	37.9
ADF	17.4	17.2	26.9	29.2
ADL	5.9	5.8	6.2	8.3
CP				
NDIN	2.22	2.52	1.32	1.10
ADIN	0.36	0.36	0.35	0.39
PS	V	V	PB	PB-B
Plant height, cm	24	16	52	24
Leaf/Stem	2.1	5.1	1.1	0.8
Degradability				
NNOM, %				
SF	23a	13c	16b	15b
PDF	65e	79d	23f	58e
kd ¹	9e	8e	15d	4f
FNNOM	55.4	52.5	28.9	32.7
N, %				
SF	41c	41c	44b	54a
PDF	55d	57d	34e	35e
kd ¹	8e	8e	16d	2f
RDP	23	25	14	13
ID, %	48b	66a	68a	46b

a,b,c:P<0.05; d,e,f:γ =0.95; V=vegetative, PB=pre-bloom; B=bloom; 1=%/h

Key Words: red clover, degradability, intestinal digestibility

489 Agronomic and nutritional evaluation of commercial corn hybrids in Brazil. A.H. Fonseca, M.N. Pereira*, R.G. Von Pinho, and R.G.S. Bruno, *Federal University of Lavras, Lavras, Brazil.*

Corn is a major crop for the dairy industry in Southeastern Brazil. Our objective was to obtain environmentally specific data on the available hybrids and possibly establish genetic agronomic goals. Three replicates of 60 commercial hybrids were cultivated during the 1997/1998 rainy season. Plants were harvested at half milk line and ensiled in mini-silos. Agronomic variables considered were: Production of DM per hectare (PDM), plant DM content, plant and ears height, ears as a percentage of plant DM, stay green score, kernel texture, plant

population, prolificity, lodging, and incidence of *Phaeosphaeria maydis*. Silages CP, NDF, ADF, EE, ash and Klason lignin were chemically analyzed and 5 mm dried-ground samples incubated *in situ* at once in 10 non-lactating cows for 0, 12, 24 and 96 hours. Effective ruminal DM degradation (EFET) was calculated as the sum of the assumed instantaneously degradable DM fraction plus the slowly degradable DM times $[kd/(kd+kp)]$, kp at 0.04/h. NDF was 54.5 3.9 (mean SD), range:44.6-66.5% of DM. EFET was 54.3 2.5, range:47.6-58.5% of DM. PDM was 16.1 2.1, range:10.0-21.3 tons/hectare. Plant height was 2.45 0.20, range:1.94-2.97 m. Stepwise methodology was used for selecting agronomic and nutritional variables best predicting EFET. The best models containing one, two, three and four variables included: NDF ($R^2=0.54$), ADF and NDF ($R^2=0.57$), ADF, NDF, and stay green score ($R^2=0.61$), ADF, NDF, plant height, and stay green score ($R^2=0.64$). High fiber concentration, tall plants, and slow dry down were related to low EFET. Correlations between plant height and DMP and NDF were 0.46 and 0.35, respectively ($P<0.01$). The correlation between PDM and NDF was 0.04 ($P=0.73$). There is potential to improve nutritional quality without lowering production per area. Genetic goals should attempt to lower fiber content and decrease plant height, aiming at greater digestibility values.

Key Words: Corn silage, Digestibility, Agronomy

490 Effect of dietary sugarcane concentration on heifer growth. P.C.S. Gallo, M.N. Pereira*, and M.A.F. Andrade, *Federal University of Lavras, Lavras, MG/Brazil.*

Sugarcane is a viable alternative for raising Holstein heifers. However, an average daily gain of 1 kg was obtained when concentrate-feed intake was 1.1% of BW. This trial was an attempt to establish how low on concentrate a sugarcane-based diet could go and still provide adequate growth. Twenty-seven Holstein heifers (265.5 36.4 kg of initial BW) received one of three diets for 8 weeks, following a 2-week standardization period. Dietary sugarcane NDF concentration (54.2% NDF on a DM feed basis) was (% of DM): 33.4 (diet 33), 37.9 (diet 38), and 42.3 (diet 42). Crude protein was 16% of diet DM in all treatments. Protein sources were soybean meal, corn gluten meal and 11 grams of urea per kg of diet DM. Data obtained weekly was analyzed by repeated measures (SAS Mixed Model Procedure). The model included a covariate term (CV), which was a measurement of the same variable done during the last day of the standardization period. Increasing sugarcane concentration from 62 to 78% of diet DM, stimulated rumination plus eating time per kg of DMI, but tended to reduce intake. No differences were detected on heifer growth within this dietary sugarcane concentration range. ±

Trait	33	38	42	SEM	P for		Quad-ratic
					diet	Linear	
DM intake, kg/d	7.4	6.8	6.6	.3	.17	.07	.62
Body weight, kg	298	298	295	2.7	.26	.15	.43
Daily gain, g/d	1002	979	951	50	.94	.74	.98
Height at withers, m	1.19	1.20	1.20	.01	.30	.52	.18
Chew time, min/d	662	730	723	44	.50	.34	.49
Chew time, min/kg DMI	100	119	130	7.2	.03	.01	.63

Key Words: Sugarcane, Heifer, Chewing time

491 Feed resources and dairy animal productivity in Gangetic Plains of India. S. P. Singh*, C.S. Azad *University of Agriculture & Technology, Kanpur, India.*

The Gangetic Plains is a vast area that comprises the State of Punjab, Haryana, U.P. Bihar and Bengal rice-wheat is the predominant cropping system of this region. Buffalo is the main dairy animal followed by cattle of the region. Since rice, wheat and sugarcane are the main crops of this area, therefore, the animal population mainly depends upon their by-products, i.e., straws and sugarcane tops. These crop residues are characterized by high lignin & fiber content and low protein and mineral content. The animals consuming these feeds may suffer from

malnutrition, hence, their production and reproduction is often low. In the present study an attempt is made to divide this region in different zones, according to feed resources, and animal productivity and strategies to improve animal performance and milk yield of each zone.

492 Influence of pasture sward height and concentrate supplementation on intake, digestibility and grazing time of lactating beef cows. O. J. Gekara*, E. C. Prigge, W. B. Bryan, and E. L. Nestor, *West Virginia University, Morgantown.*

To establish the effect of sward height (SH) and concentrate supplementation on performance of grazing cattle, twenty-four crossbred Angus beef cows (535 kg BW) and calves (114 kg BW) were grouped by weight and calving date. They were randomly assigned to two SH treatments, either 4-8 cm or 8-12 cm, and fed three levels of supplement: high (H), low (L) or none (U) consisting of 6.24, 3.12 and 0 kg/head/day, respectively. The experiment was repeated over three 15 d periods in 1996: May (P1), June/July (P2) and August (P3). No SH x supplement level x period or SH x supplement level interaction ($P > .10$) were evident for responses tested. Cows on lower SH had greater ($P < .08$) DMI but spent an additional 1.3 hr/d ($P < .01$) grazing compared to cows on higher SH. Sward height had no influence ($P > .10$) on forage DMD and ADG of cows. Forage DMI, DMD and grazing time (GT) decreased ($P < .05$) as supplementation increased but ADG was not affected ($P > .10$). Nonetheless, supplemented cows consumed more total DM ($P < .08$) than non-supplemented cows. Cows consumed 2.4 kg/d more forage DM ($P < .01$) in P1 than in P2 and P3. Grazing efficiency (DMI/hr GT) declined as supplementation increased and grazing season advanced ($P < .01$). Cows gained 2.6, 0.2 and 0.8 kg/d ($P < .05$) and calves gained 1.4, 1.2 and 1.6 kg/d ($P < .10$) during P1, P2 and P3, respectively. Decreased forage DMI and grazing efficiency with supplementation suggests that supplemented cattle can optimally graze at SH lower than non-supplemented cattle.

Key Words: Pasture, Sward Height, Supplementation, Cattle, Intake, Digestibility, Grazing Time

493 Degradability of nitrogen in overseeded oat, wheat, and rye forages harvested on five dates in the spring. W. K. Coblenz*, K. P. Coffey, J. E. Turner, D. A. Scarborough, J. S. Weyers, K. F. Harrison, L. B. Daniels, C. F. Rosenkrans, D. W. Kellogg, and D. S. Hubbell, *University of Arkansas, Fayetteville.*

A study was conducted in northern Arkansas to evaluate the characteristics of N degradation for three cereal-grain forages (wheat, oat, and rye) harvested on five dates (March 24, April 15, May 4, May 26, and June 5) throughout the spring of 1998. Digestion kinetics of N were evaluated by the in situ procedure. Four (454-kg) ruminally cannulated crossbred steers were offered a basal diet consisting of alfalfa hay (50%) and concentrate (50%) to create a nutrient mixture similar to that consumed by a lactating dairy cow. For all cereal forages, the potential extent of N degradation declined ($P < .05$) with advancing harvest date and the associated advancement of plant maturity. The potential extent of N degradation was very high on the March 24 harvest date (>95%), but declined ($P < .05$) to < 80% in oat and wheat forage by the June 5 harvest date. The potential extent of N degradation for rye forage declined ($P < .05$) to < 60% on the May 4 and June 5 harvest dates. Rates of N degradation were very fast ($> 0.16/h$) initially; however, nonsignificant ($P > .05$) declines were observed for wheat and oat forages that reached a minimum (0.085 and 0.109/h, respectively) on the May 4 harvest date. Rates of N degradation increased sharply ($P < .05$) thereafter for both species to a maximum of 0.287/h for oat and 0.476/h for wheat. In contrast, decay rates for rye increased ($P < .05$) with harvest date to a maximum of 0.614/h. The rapid rates of N degradation at advanced growth stages are likely associated with grain fill. For all forages, the effective degradability of N declined ($P < .05$) with harvest date through May 4, but increased ($P < .05$) thereafter in association with grain fill. The degradation kinetics of N for cereal-grain forages are profoundly affected by the complex, concurrent processes of elongation and lignification of stem tissue and grain fill.

Key Words: nitrogen, degradation kinetics, in situ

494 Influence of supplemental protein degradability on nutrient utilization by beef cows on dormant, cool-season forage. M. Palmer* and K.C. Olson, *Utah State University, Logan.*

Multiparous crossbred beef cows ($n=25$, BW=611 kg) were randomly assigned to 5 treatment groups of 5 cows each using a completely randomized design to evaluate supplemental DIP:UIP effects on intake, forage utilization, and cow performance. The cows were group-fed tall fescue straw (NDF 73%, CP 5.9%) ad libitum and individually supplemented daily with blends of 2 soybean meal sources varying in ruminal degradability. The treatment supplements contained 28%, 34%, 40%, 45%, and 51% UIP. Two sampling periods were conducted: late gestation and early lactation. Total and forage DM intake as a percentage of body weight had a treatment by physiological stage interaction ($P < .01$). Total and Forage DM intake decreased with increasing UIP% during both gestation and lactation with the exception of 28% UIP in gestation and 51% UIP in lactation (cubic, $P \leq .02$). Dry matter digestibility did not differ among treatments, with an LSM \pm SE of 43.5 ± 0.94 %. Neutral detergent fiber digestibility decreased linearly ($P = 0.10$) as UIP % increased. Blood urea nitrogen displayed a treatment by physiological stage interaction ($P = 0.06$). It varied cubically ($P = 0.08$) during gestation and had no response during lactation. Calf weight at end of supplementation, at weaning, and adjusted 205-day weight did not differ ($P > .10$) among treatments, with overall LSM \pm SE of 95.7 ± 2.6 kg, 235.5 ± 4.9 kg, 249.6 ± 5.6 kg, respectively. However, calf ADG tended to increase linearly ($P = 0.11$) as cow supplemental UIP % increased. Milk production had a quadratic response to supplemental UIP %, with the highest level at 45% UIP. Cow weight loss, BCS loss and PPI were not affected by supplemental UIP% with LSM \pm SE of -2.421 ± 0.089 kg, -0.300 ± 0.048 , 46.2 ± 2.4 d, respectively. Because milk production and calf ADG were higher and forage intake lower at higher UIP %, increasing UIP % appeared to improve feed conversion to calf growth. However, increasing UIP % depressed forage utilization by the cow, with minimal effect on cow performance.

Key Words: Beef Cattle, Protein Degradability, Low Quality Forage

495 Effect of supplemental energy source and degradable intake protein amount on performance of spring-calving cows winter grazing stockpiled bermudagrass. C.R. Johnson*, D.L. Lalman, A.D. O'Neil, and J. Steele, *Oklahoma State University, Stillwater.*

Sixty-three mature spring-calving beef cows were used in a completely randomized design to determine the effects of energy source and DIP level on cow performance while grazing stockpiled bermudagrass pastures. Twenty-eight and thirty-five cows were allocated to one of four supplement regimes, at each of two locations (STW and HASK). A negative control (NEG) was imposed and supplement groups were either 1) soyhull based (SH); 2) corn-based with similar DIP to SH (LC); or 3) corn-based with double the DIP of SH. The SH and LC supplements were formulated to provide 63 g/d DIP and the HC supplement supplied 125 g/d of DIP. Pastures were grazed to approximately 7.5 cm in late August and fertilized with 56 kg N/ha. Grazing was deferred until November 15, upon which treatments were initiated and continued for 70 days. Methods for collecting forage samples for determination of nutritive value varied by location. At STW, masticate samples were collected using esophageally cannulated steers, at HASK, forage pluck samples were collected. Average forage CP (DM basis) during the trial was $17.2 \bar{n} .71\%$ at STW and $8.6 \bar{n} .87\%$ at HASK. Forage NDF (DM basis) averaged $52.7 \bar{n} 1.84\%$ at STW at $69.9 \bar{n} 2.14\%$ at HASK. Upon initiation of the trial all treatment groups and locations were similar ($P > .5$) in weight (WT; $547 \bar{n} 13.7$ kg) and body condition (BCS; $5.1 \bar{n} .11$). However, more forage was accumulated at HASK ($3253 \bar{n} 199$ kg DM/ha; $P < .0001$) compared to STW ($1588 \bar{n} 226$ kg DM/ha). Cow BCS change was unaffected by treatment ($P > .1$) and location ($P > .5$). Cow WT change was unaffected by treatment ($P > .2$), yet cows at STW gained $11.9 \bar{n} 3.7$ kg more ($P < .001$) than HASK. Due to the lack of change in body condition, mean weight gain ($73.5 \bar{n} 4.3$ kg) is attributed to change in fetal mass. This study demonstrates that during mild winters, supplemental energy and DIP is not required for maintaining body condition of spring-calving beef cows grazing stockpiled bermudagrass pastures.

Key Words: Stockpiled forage, Supplementation, Spring-calving cows

496 Performance of stocker cattle grazing bermudagrass and winter annuals under rotational or continuous stocking. K.A. Cassida*, C.B. Stewart, S.A. Gunter, and P.A. Beck, *University of Arkansas, Hope.*

We initiated a long-term evaluation of pasture management systems using stocker calves grazing common bermudagrass-dallisgrass overseeded with wheat-annual ryegrass-clover. Pasture treatments are a factorial arrangement of 2 grazing systems (C, continuous stocking; R, 6-paddock rotation) and 3 stocking rates (SR)(1998-3.7, 6.2, 8.6 animals/ha; 1999-4.9, 7.4, 9.9 animals/ha). Limousin-cross heifers grazed from May 18 to October 7, 1998, and Angus-cross steers and heifers grazed from Feb. 16 to Aug. 18, 1999. Calves received 0.45 kg/d of a corn-based mineral supplement and were fed hay if pasture availability was limiting. In 1998, animals performed similarly on C and R pastures. There was a linear effect of stocking rate on ADG (.57, .39, .35 kg/d, $P < .01$, for 3.7, 6.2, 8.6 head/ha, respectively) and gain/ha (300, 332, 426 kg/ha, $P < .05$). Hay feeding was not required in 1998. In 1999, type of forage influenced results. On winter annuals, ADG (.64, 1.01 kg/d) and gain (544, 831 kg/ha) were lower for C than R pastures ($P < .05$) at the highest SR and were similar at lower SR. In the transition period between winter annuals and bermudagrass, ADG (.64, .43 kg/d) and gain (270, 188 kg/ha) was higher on C than R pastures ($P < .01$) across SR. On bermudagrass, ADG and gain was similar for C and R. On winter annuals, ADG decreased linearly as SR increased. For transition and bermudagrass periods, gain/ha increased with SR, but ADG was similar across SR. In 1999, C pasture calves used more hay than R pasture calves at the two higher SR (0, 108, 142 and 0, 0, 30 kg DM/animal/year as SR increased, $P < .10$). Response of calves to R or C grazing systems depended on forage type and stocking rate.

Key Words: Stocker Cattle, Grazing Systems, Stocking Rate

497 Effects of Calendar Date and Summer Management on In Situ Nitrogen Degradation of Stockpiled Bermuda. D. A. Scarbrough*, W. K. Coblenz, K. P. Coffey, J. E. Turner, G. V. Davis, and D. W. Kellogg, *University of Arkansas, Fayetteville.*

Limited information is available concerning N utilization of dormant bermudagrass [*Cynodon dactylon* L. Pers.] by ruminant animals throughout winter. 'Greenfield' bermuda was stockpiled at two sites following either hay or pasture summer management; annual N fertilization rates were 345 and 215 kg N ha⁻¹ at the hay and pasture sites, respectively. Beginning on October 17, 1997, forage samples were taken from each site at four-week intervals under caged enclosures until January 9, 1998. The effects of calendar date and summer management on the kinetics of in situ N degradation were evaluated using five ruminally cannulated, cross-bred steers (mean BW = 387 \pm 18 kg). At the hay site, rates of N degradation did not differ ($P > .05$) on October 17 or January 9 (.056 h⁻¹) but were higher ($P < .05$) on November 14 (.064 h⁻¹). Potential extent of N degradation decreased ($P < .05$) between October 17 (747 g kg⁻¹ N) and January 9 (578 g kg⁻¹ N). Effective ruminal N degradability did not change ($P > .05$) between October 17 and November 14 or between December 12 and January 9, but decreased sharply ($P < .05$) from November 14 to December 12 (602 g kg⁻¹ N vs. 539 g kg⁻¹ N). At the pasture site, rates of N degradation were lowest on October 17 (.044 h⁻¹), but increased ($P < .05$) to .080 h⁻¹ on January 9. Potential extent of N degradation decreased ($P < .05$) from 790 g kg⁻¹ N on October 17 to 682 g kg⁻¹ N on January 9. Effective N degradability did not change ($P > .05$) over the first three sampling dates (590 g kg⁻¹ N) but was highest ($P < .05$) on January 9 (624 g kg⁻¹ N). The unusually high degradation rate (.080 h⁻¹) and effective degradability (624 g kg⁻¹ N) at the pasture site on the January 9 harvest date were likely due to the presence of winter annual weeds that were not present at the hay site. These data suggest that rumen availability of N in stockpiled bermuda decreases as winter progresses.

Key Words: Stockpiled Bermudagrass, In Situ, N Degradation

498 Dynamics of changes of feeding value and feed intake by sheep of two ryegrass species during primary spring growth. A. Ombabi, K.-H. Suedekum*, and F. Taube, *University of Kiel, Germany.*

This study evaluated the effects of maturity related alterations in the chemical composition of two grasses during primary growth on nutrient

digestibilities and feed intake by sheep. Pure swards of perennial ryegrass (*Lolium perenne* L., variety Gremie) and Italian ryegrass (*Lolium multiflorum* Lam., variety Lema) were harvested daily between April 23 and June 19 during primary spring growth 1991 and each grass was offered to a group of five sheep for *ad libitum* intake. A continuous digestion trial design was employed to measure daily intakes and fecal outputs of organic matter (OM) and OM constituents. The chemical composition of the grasses varied considerably with growth. Crude protein concentrations declined from 17.4 to 5.2% of dry matter (DM) for perennial ryegrass and from 15.6 to 3.7% of DM for Italian ryegrass, whereas concentrations of some cell-wall fractions markedly increased and partly more than doubled. Fiber content was slightly greater for perennial ryegrass than for Italian ryegrass over the whole growth period. The decline of feeding value with maturity was closely related to increasing concentrations of fiber components and their digestibility. Intake by sheep of Italian ryegrass was higher by 3 g/kg of body weight at the beginning and at the end of the primary growth period. Digestibility of the OM was greater than 80% at the start of the experiment and still around 70% after two months of grass growth. The decline in DM and metabolizable energy intake was much more pronounced than the decrease of OM digestibility, which could be due to a decline in feed intake capacity of non-lactating sheep caused by increasing body fat mass. Short-term fluctuations in OM digestibilities were related to alterations of chemical composition of the grasses caused by growth and maturation, in particular variations in water-soluble carbohydrate concentrations. Continuous digestion trials were effective in observing the dynamics of alterations in feeding value and feed intake by sheep as related to growth and maturation of two ryegrass species during primary spring growth.

Key Words: Grass, Digestibility, Intake

499 Effects of protein and energy supplements on changes in weight and body condition of gestating beef cows grazing bahiagrass during the fall. P. A. Davis*¹ and W. E. Kunkle¹, ¹*University of Florida, Gainesville.*

Protein and energy supplements for gestating beef cows grazing bahiagrass pastures were evaluated for effects on body condition score (BCS), ultrasound fat thickness over the rib and rump and shrunk weight (BW). Sixty Angus beef cows (435 kg initial average BW) were stratified by initial BCS (range from 4.2 to 5.8, 1 to 9 system) and randomly assigned to twenty predominantly bahiagrass pastures. Five supplementation treatments were arranged in a two by two factorial design plus an unsupplemented control (C) with four pastures assigned to each treatment. Supplement treatments were protein ([P], 33% CP, 68% TDN mostly from cottonseed meal) or energy ([E], 14% CP, 69% TDN, mostly soybean hulls and wheat middlings) with or without 150 mg/d monensin (M) added. Supplements were cubed (1.9 cm), P and P+M were fed on three days each week at .45 kg/d equivalent rate, and E and E+M were fed daily at 2.7 kg/d. Cattle were offered a vitamin-mineral mixture *ad libitum* and had adequate forage in all pastures during the 84 d trial started on September 21, 1999. Cows gained BW (.84 kg/d) during the 84 d trial and protein supplementation did not ($P > .2$) affect gain (.80 for P vs. .75 kg/d for C), BCS change (+.21 for P vs. -.01 for C), or ultrasound fat thickness change (+2.52 for P vs. +2.60 mm for C). Cows fed E tended ($P = .15$) to gain more than C (.94 for E vs. .75 kg/d for C), but differences were not found in BCS change (+.19 for E vs. -.01 for C), or ultrasound fat thickness change (+3.68 for E vs. +2.60 mm for C). Cows fed supplements with M had similar ($P > .10$) gains (.89 for M vs. .85 kg/d for C), BCS change and ultrasound fat thickness change compared to C. Cows with one unit lower initial BCS had .16 kg/d higher gains ($P = .039$) for the 84 d trial. Forage quality was excellent as evidenced by weight gains and increases in ultrasound fat during the trial and supplementation had little effect on performance.

Key Words: Body Condition Score, Protein, Energy

500 Effects of bypass sulfur amino acids on performance of growing cattle fed bermudagrass hay supplemented with molasses-based supplements. L. B. Davis*¹, W. E. Kunkle¹, D. B. Bates¹, and B. A. Reiling¹, ¹*University of Florida, Gainesville.*

This research investigated whether performance responses to protein supplements could be explained by total sulfur amino acids (TSAA, methionine plus cystine) in bypass (UIP) protein. Supplements were

formulated to provide 2, 4, or 6 g/d of TSAA in UIP from either corn gluten meal (CGM) or a rumen protected methionine (MEP, MEPRON M 85). These were compared to a molasses-corn (control) supplement. Supplements contained 84% fortified (urea, minerals, vitamins) sugar-cane molasses and 18% corn. CGM replaced corn in supplements containing CGM. Fourteen pens (5 head/pen) of crossbred steers and 14 pens of crossbred heifers were assigned within sex to the 7 treatments in 1998-99. Calves averaged 230 kg and body condition score averaged 5.2 at the start of the experiment (December 1, 1998). Bermudagrass hay was offered ad libitum and molasses slurries were limit fed at 2.2 kg DM/d (fed twice each week) during the 113-d trial. Animal data were averaged for each pen which was the experimental unit. Cattle gains increased linearly ($P = .004$) for increasing bypass TSAA supplied by CGM (23 gm increase in gain for each gm/d bypass TSAA) but cattle gains were similar at all levels of MEP (.66, .72, .64, .71 kg/d for 0, 2, 4, 6 gm/d bypass TSAA from MEP). Supplemental TSAA did not affect height change, body condition score change, or DM intake. Gain/feed was improved .0034 units (linear, $P < .018$) for each gram of bypass TSAA supplied by CGM but was similar for all levels of MEP. Cattle fed CGM supplements had increased BUN (9.9 to 13.2 mg/dl) as the bypass TSAA level and supplemental nitrogen intake increased, but cattle fed increasing TSAA levels from MEP had similar BUN (10.3 mg/dl) and similar supplemental N intake. Steers compared to heifers had .07 kg/d higher ($P = .0002$) gains, .44 kg/d higher ($P = .002$) dry matter intakes, similar gain/feed ($P = .23$), and .11 units (1 to 9 system) lower ($P = .08$) body condition score change. This research showed that supplemental CGM improved performance but that MEP did not improve performance. In contrast, previous research indicated that bypass TSAA from feed (CGM or blood-feather meal) or a different synthetic source had similar improvements in gain and gain/feed for growing cattle fed similar diets. Reasons for differing results were not apparent.

Key Words: Supplementation, Methionine, Molasses

501 Digestibility and ruminal parameters of endophyte-infected fescue at four stages of maturity in wethers. S. J. Paton*, B. T. Larson, D. L. Harmon, N. D. Paton, C. J. Richards, and K. C. Swanson, *University of Kentucky, Lexington.*

Eight ruminally and duodenally-fistulated Lincoln wethers (38.5 kg) were used in a 4 x 8 Latin rectangle to evaluate the influence of four maturities of endophyte-infected tall fescue on digestibility and ruminal parameters. Maturities of fescue included mid-season vegetative regrowth (V), boot (B), mature (M), and stockpiled (S). Intake of fescue was 2.25% BW (except M at 1.5% BW) in two portions at 0700 and 1900. Adaptation (d 1 to d 7) was followed by Co:EDTA dosing and subsequent ruminal fluid sampling (d 8 at 0800, 1100, 1400, 1700, and 2000; d 9 at 0200 and 0800), total fecal and urine collection (d 8 to d 11), duodenal samples (d 12 to d 14 every 6 h advancing two h/d), and ruminal fluid sampling (d 14 at 1000, 1300, 1600, and 1900) for pH, ammonia, and VFA analyses. Total tract apparent digestibility of DM, NDF, ADF, and CP and apparent ruminal digestibility of DM, NDF, and ADF was highest ($P < .05$) for B, intermediate for V and lowest for M and S. Apparent ruminal digestibility of CP was highest ($P < .05$) for V and B, intermediate for M and lowest for S. Ruminal liquid dilution rate (%/h) was not different between treatments ($P > .05$). Total VFA (mM) was greatest ($P < .05$) for B; V and S were greater ($P < .05$) than M. Ruminal pH was lower ($P < .05$) for B and S (6.4 and 6.5) than V and M (6.6). Molar percentages of propionate were higher ($P < .05$) for B and S (20.2, 18.3) compared to V and M (16.3, 14.5). Acetate was lower ($P < .05$) for M (44.9) than V, B and S (58.1, 61.1, and 56.5). Acetate:propionate ratio was higher ($P < .05$) for V (3.6) than B, M and S (3.2). Ruminal ammonia concentrations (mM) were greatest ($P < .05$) for V and B (9.4, 8.9) intermediate for M (7.8) and lowest for S (4.5). Maturity of endophyte-infected tall fescue has a significant effect on digestibility and ruminal parameters in wethers with vegetative and boot stages having overall better digestive effects than mature or stockpiled.

Key Words: fescue, maturity, rumen

502 Effect of stocking rate and season on performance of steers grazing endophyte infested tall fescue. M.A. Marsalis*, J.C. Waller, and H.A. Fribourg, *University of Tennessee, Knoxville TN/USA.*

Tall fescue (*Festuca arundinacea*) is one of the predominant and most important cool-season forages in Tennessee and the Mid-south U.S. Most tall fescue is infested with the endophytic fungus *Neotyphodium coenophialum*. This endophyte-tall fescue combination benefits the host plant but causes reduced performance, conception rates, intolerance to heat and reduced prolactin in cattle grazing the infected (E+) plant. This condition in cattle is known as tall fescue toxicosis. Annual production losses are estimated to be more than \$1 billion in the U.S. and over 100 million in Tennessee. A 4-year study was conducted to evaluate steer performance on pastures with different E+ levels ranging from <5 to >80 percent and three stocking densities (low, medium and high). Eighteen 1.2-ha pastures were grazed with a total of 96 newly weaned Angus and Angus Cross steers with initial weights of about 250 kg. Animal and available forage weights were measured at 21-d intervals. In each year, three grazing seasons from early November to March (fall-winter), March to July (spring) and July to early September (summer) were used. Average daily gain (ADG) and beef production (kg ha⁻¹) for each season were different ($P < .05$) and were 335 g d⁻¹ and 100.8 kg ha⁻¹ for fall-winter, 480 g d⁻¹ and 155 kg ha⁻¹ for spring, and 260 g d⁻¹ and 38 kg ha⁻¹ for summer respectively. Seasonal ADG for fall-winter, spring and summer were 475 g d⁻¹, 556 g d⁻¹, 297 g d⁻¹; 286 g d⁻¹, 496 g d⁻¹, 317 g d⁻¹; 242 g d⁻¹, 389 g d⁻¹, 166 g d⁻¹; for low, medium and high stocking densities, respectively. Results show that season and stocking density had a significant effect on ADG and beef production when steers grazed E+ tall fescue.

Key Words: Tall Fescue, Steer Performance, Endophyte

503 The relationship between digestibility and steer daily gain in tall fescue and birdsfoot trefoil pastures. L. Wen*, J. E. Williams, R. L. Kallenbach, C. Roberts, R. L. McGraw, P. R. Beuselinck, J. F. Thompson, L. Gebrehiwot, H. Benedict, and E. Navarro, *University of Missouri, Columbia.*

A grazing study and in situ experiment were conducted to compare the relationship between chemical components, forage digestibility, and steer performance. The experiment treatments consisted of tall fescue (TF) and TF + birdsfoot trefoil with (RBFT) and without (BFT) rhizomes in a continuous grazing system. The experimental pastures were established in 97 in a randomized complete plot design with 4 replicates (0.53 hectare) per treatment. In summer (May, 11-July, 1) and fall (Sep. 22-Nov. 17) 98 grazing season, steers were weighed every 14 days, while forage samples were collected from each plot every 28 days; they were freeze-dried and ground through 2mm screen. An in situ study was carried out in May, 99 with two ruminally cannulated heifers grazing TF + RBFT and BFT mixed pasture. Samples of dried forage were incubated for 0, 3, 6, 12 and 24 h to determine DM disappearance (DMD) and rate of DM degradation. The ADG for those grazing TF+BFT, TF+RBFT pastures (.92, .93 kg/d) were greater ($P \leq .05$) than that of TF (.64 kg/d) in summer; no differences ($P \geq .05$) existed in ADG of steers among the pastures in the fall. The ADG was correlated to 24-h DMD ($r = .55$, $P \leq .01$). The 24-h DMD was correlated to NDF ($r = -.89$, $P \leq .01$), to ADF ($r = -.96$, $P \leq .01$), to CP ($r = .67$, $P \leq .01$). In summer, NDF was 74.7, 72.7, 69.5% for TF, RBFT+TF and BFT+TF, respectively; CP was 9.1, 11.2, 12.5%, correspondingly. The 24-h DMD for BFT+TF and RBFT+TF (39.8, 40.5%, respectively) was greater ($P \leq .01$) than that of TF (36.7%). Throughout summer, DMD for each treatment decreased ($P \leq .01$) every 28 days. In fall, NDF was 69.1, 64.9, 63.0% for TF, RBFT+TF and BFT+TF, respectively; while CP was 10.9, 13.1, 14.9%, correspondingly. For the fall, the 24-h DMD for RBFT+TF (47.1%) and BFT+TF (46.6%) was greater ($P \leq .01$) than that of TF (37.8%). Interseeding birdsfoot trefoil in tall fescue pastures increased ADG and DMD in the summer, while differences in DM disappearance among pure TF and mixed pastures did not contribute to differences in ADG among treatments in the fall.

Key Words: ADG, DM disappearance, birdsfoot trefoil

504 Influence of corn silage fiber content and level of dietary concentrate supplementation on intake, digestion, and milk production by dairy cows. H. Al-Jobeile, M. A. Bal, R. D. Shaver*, and J. G. Lauer, *University of Wisconsin, Madison.*

Twenty-four multiparous Holstein cows (8 fitted with rumen cannulae) averaging 75 DIM at trial initiation were used in a replicated 4 x 4 Latin square design with 28 d periods. Treatments were low-NDF (LFCS; Cargill 3677) and high-NDF (HFCS; Garst 8751) corn silage each fed at two levels of dietary concentrate supplementation. Diets (DM basis) contained 53% forage and 47% concentrate with 19-21% NDF from forage at the high level of concentrate supplementation (HCD) and 61-67% forage and 33-39% concentrate with 24% NDF from forage at the low level of concentrate supplementation (LCD). The forage mixture was comprised of 67% treatment corn silage and 33% alfalfa silage (DM basis). Diets were formulated to contain 18% CP (DM basis) using corn-soybean meal based concentrates and were fed as TMR once daily. The corn silage treatments were harvested at one-third (HFCS) to one-half (LFCS) milkline stage of maturity using a crop-processing harvester set at 1.27 cm TLC and 2 mm roll clearance and stored in separate silo bags. The DM, NDF, and ADF contents (DM basis) of LFCS and HFCS corn silage treatments were 34.2%, 32.8%, and 18.9% and 36.7%, 39.2%, and 22.7%, respectively. Intakes of DM (27.2 vs. 26.7 kg/d) and NDF (7.7 vs. 7.0 kg/d) were higher ($P < 0.05$) for HFCS than LFCS diets. There was no effect of hybrid on milk yield or composition. Milk (44.9 vs. 42.5 kg/d) and FCM (41.1 vs. 39.9 kg/d) yields were higher ($P < 0.05$) for HCD than LCD. Milk fat content was lower (3.46 vs. 3.61%) but CP content was higher (3.14 vs. 3.06%) for HCD than LCD ($P < 0.05$). Total-tract NDF digestibility was higher (38.5 vs. 31.9%) and starch digestibility was lower (97.8 vs. 98.5%) for HFCS than LFCS diets ($P < 0.05$). Higher NDF digestibility for HFCS appeared to offset benefits of LFCS on lactation performance. Feeding diets containing 19-21% NDF from forage increased DMI, milk yield, and milk component yields over diets containing 24% NDF from forage.

Key Words: Corn Silage, Milk Production, Digestion

505 The effects of feeding processed or non-processed corn silage to lactating cows on dry matter intake, milk production, and milk components. C. M. Luhman*, *Land O'Lakes, Inc. and Cooperative Research Farms, Webster City, IA.*

Sixteen multiparous Holstein cows (average 65 DIM) were used in a replicated 4 X 4 Latin Square experiment. All treatments were based on corn silage variety and processing. Two treatments used were Croplan variety 534 that was harvested unprocessed and Croplan variety 534 with the chopped whole corn plant processed through a kernel processor before ensiling. Experimental periods were 21 days. The first seven days were used for transition to the new treatment and data was collected for the last 14 days of the period. Silages were allowed to ensile for at least 30 days before the bags were opened and the trial was started. Data was analyzed by using standard ANOVA procedures of SAS for replicated Latin Squares. In situ dry matter and starch digestibility was higher for processed corn silage than for non-processed corn silage. In this trial, cows fed processed corn silage produced enough additional milk to increase income \$0.54/cow/day over control fed cows when increased DMI was included (assumes milk price of \$12 cwt).

	Croplan 534	Processed Croplan 534	P=
DMI, kg/d	23.4	25.0	0.04
Milk, kg/d	40.7	44.4	0.10
FCM, kg/d	38.4	42.3	0.08
SCM, kg/d	35.7	39.3	0.08
Milk fat, %	3.23	3.26	-
Milk fat, kg/d	1.3	1.44	0.07
Milk protein, %	2.88	2.91	-
Milk protein, kg/d	1.17	1.29	0.08
Milk total solids, %	11.53	11.64	-
Milk total solids, kg/d	4.68	5.14	0.07

506 The effects of feeding potato leafhopper resistant or non-resistant alfalfa hay to lactating dairy cows. C. M. Luhman*, *Land O'Lakes, Inc. and Cooperative Research Farms, Webster City, IA.*

Thirty-one multiparous Holstein cows (average 110 DIM) were assigned to one of two treatments in a randomized complete block design. Treatments were a lactating cow ration containing a non-potato leafhopper resistant alfalfa variety (n=16) and an equivalent ration containing a potato leafhopper resistant alfalfa variety (n=15). Ration forage was an equal mix (DM basis) of corn silage and alfalfa hay. Hays were second cutting of first year spring sewn alfalfa. Hays were baled and then chopped immediately before inclusion into a TMR containing primarily corn and soy products. Trial length was 10 wk. Data was analyzed using the repeated measures option of GLM in SAS. Differences in milk production were highest when milk production was highest, i.e. weeks 1, 2, 3, 4, and 5 of trial ($P \leq 0.10$). Body weights and body condition scores of cows fed the two varieties were not different. Potato leafhopper resistant alfalfa hay apparently increased return 30.1 cents/cow/d at milk prices of \$12 cwt, especially at higher milk production (wk 1-5 of trial).

	Non-resistant	Resistant	P=
N	16	15	
Milk, kg/d	36.2	38.1	0.11
DM intake, kg/d	24.1	24.9	0.44
Milk fat, %	3.72	3.51	0.70
Milk protein, %	3.11	3.00	0.55

507 Effect of storage method, length of fermentation and days of aerobic exposure on dry matter consumption of native tropical grasses ensiled in large round bales in a tropical environment. G. Gonzalez¹, A.A. Rodriguez*¹, R. Macchiavelli², and E.O. Riquelme², ¹*Department of Animal Science, ²Department of Agronomy and Solis, University of Puerto Rico, Mayaguez Campus.*

An experiment was conducted to evaluate the effect of storage method, length of fermentation, and days of aerobic exposure on the voluntary dry matter intake of native tropical grasses (NTG) ensiled in large round bales (LRB; 350kg). Native tropical grasses (*Panicum maximum* and *Johnson halapense*; 37% DM %) were harvested at the Lajas Agricultural Experiment Station, University of Puerto Rico. The forage was ensiled in 12 LRB and was assigned to two treatments; storage with direct sunlight exposure (T1) and storage under shade area (T2). Three bales for each treatment were opened after two fermentation periods, 53 d (LF 1) and 111 d (LF 2), and were exposed to aerobic conditions for 4 days. Feed intake was determined for each treatment at each length of fermentation and day of aerobic exposure using six Holstein Friesian heifers (200 kg) assigned in pairs to three pens. Each pen was provided with double feeders. Water was offered at each pen ad libitum. The silage offered was weighed and given daily at 8:00 am, and the rejected material was weight after 24 hours. Forage preference (acceptability) was determined using the equation $TrI/TrI * 100$, where TrI = treatment intake, TI = total intake ($IT1 + IT2$). The voluntary intake was expressed as percentage of the offered material. Data were analyzed using a split plot over time model. The results indicate that storage method or length of fermentation did not affect ($p > 0.05$) the voluntary dry matter intake of NTG ensiled in LRB. However, for both treatments and length of fermentation, silage dry matter consumption decreased as length of aerobic exposure increased. In summary, under tropical environments storing NTG ensiled in LRB under roof did not improve the dry matter consumption of Holstein heifers, regardless of length of fermentation.

Key Words: Large round bales, Storage method, Silage intake

508 Effects of sampling site and silo type on fermentation and amino acid content of hay crop silages. M. J. Stevenson*¹, R. A. Patton², S. P. Crosby³, and J. Zmich³, ¹*Degussa-Huls Canada, Burlington, Ontario, Canada, ²Nittany Dairy Nutrition, Mifflinburg, PA, ³Fingerlakes Nutrition Service Inc., Genoa, NY.*

Previous work had demonstrated that degradation of lysine could occur during the ensiling of grasses and legumes. Because accurate prediction of lysine content in silages is critical for accurate prediction of flow to the intestine, it is important to quantify lysine content rapidly and economically. In order to investigate which parameters might be associated

with lower lysine content, 41 different haylages were obtained from 30 dairy farms from Ontario and central and western New York. Samples of each feed were obtained from the feeding surface and at a depth of approximately 0.6m. Factors investigated were sampling site and silo type. CP was numerically, but not significantly, lower for deep samples (20.2 vs 19.7%). Individual amino acids (% of CP) were not different between surface and deep samples although total amino acids were greater for interior samples (58.6 vs 56.7% CP, $P < .05$). Type of silo produced differences as below. Variables (%DM) with different superscripts differ significantly ($P < .05$).

There was no statistical difference in amino acid content between actual and that predicted with Degussa-Huls regression equations except for lysine and arginine which were predicted at higher levels ($P < .05$). Lysine was moderately correlated with pH ($R^2 = -.42$), propionic acid ($R^2 = -.52$), isobutyric acid ($R^2 = -.46$) and NH_3 ($R^2 = .54$). Arginine was correlated only with propionic acid ($R^2 = -.47$). It is of interest to note that silages with low values of lysine and arginine were identified, subjectively on farm by odor, as of poor quality. There was no significant correlation between butyric acid and either lysine or arginine.

Variable	Bunker	Tower	Oxygen Limiting
Titrateable acid	4.59 ^a	3.74 ^a	2.67 ^b
Lactic acid	5.01 ^a	4.53 ^a	3.02 ^b
Acetic acid	2.39 ^a	1.12 ^b	0.97 ^b
Propionic acid	0.24 ^a	0.02 ^b	0.02 ^b
Total VFA	8.54 ^a	5.72 ^b	4.03 ^c
Free NH_3	2.72 ^a	1.18 ^b	1.21 ^b
NDF-protein	3.23 ^a	2.81 ^a	3.97 ^b

Key Words: amino acids, haylages, silo types

509 Prediction of amino acid composition of grass silage and corn silage using near infrared spectroscopy (NIR). M.L. Swift^{*1}, J.A. Shelford¹, and L.M. Rode², ¹Faculty of Agricultural Science, University of British Columbia, Vancouver, Canada., ²Agriculture & Agri-Food Canada, Lethbridge, Alberta, Canada.

Samples of grass (102) and corn (102) silage were collected from the lower Fraser Valley region of British Columbia. Grass silage (GS) samples represented 4 crop years, 3 species (orchard grass, perennial rye, tall fescue), 5 cuts, 4 preservative treatments (none, acid, bacterial, enzyme) and 3 storage methods (bunker, sealed upright silo, Ag-Bag). The CP content of the GS samples ranged from 7.9% to 25%. Samples of corn silage (CS) represented 3 crop years, 6 varieties, 3 preservative treatments (none, acid, bacterial) and 3 storage methods (bunker, sealed upright silo, Ag-Bag). The CP content of the CS samples ranged between 6.9% and 11.9%. Amino acid composition (%DM) of GS was HIS 0.155(0.048-0.312), ARG 0.742(0.272-1.451), THR 0.412(0.085-0.87), VAL 0.59(0.251-0.993), MET 0.10(0.022-0.242), ILE 0.419 (0.171-0.685), LEU 0.745(0.287-1.39), PHE 0.472(0.167-0.94), LYS 0.341(0.098-0.707). Amino acid composition (%DM) of CS was HIS 0.0105(0.055-0.166), ARG 0.32(0.17-0.754), THR 0.243(0.101-0.383), VAL 0.322(0.242-0.514), MET 0.055(0.012-0.155), ILE 0.235(0.166-0.39), LEU 0.579(0.336-0.944), PHE 0.272(0.163-0.428), LYS 0.155(0.071-0.324). Subjecting spectral data to 60 different mathematical treatments developed preliminary equations. Resulting co-efficient of variation (RSQ) and standard error of cross validation (SECV) for amino acids in GS were HIS 0.77,0.03; ARG 0.83,0.16; THR 0.86, 0.08; VAL 0.83,0.09; MET 0.54,0.04; ILE 0.85,0.05; LEU 0.83,0.11; PHE 0.80,0.08; and LYS 0.67,0.10. RSQ and SECV for CS were HIS 0.80,0.01; ARG 0.86,0.05; THR 0.64,0.03; VAL 0.53,0.03; MET 0.33,0.02; ILE 0.50,0.03; LEU 0.77,0.06; PHE 0.74,0.03; LYS 0.64,0.03. Work is ongoing to develop equations based on the positive results from these preliminary equations.

Key Words: Amino acid, Forage, NIR

510 Performance of dairy cows fed corn silage differing in kernel texture or sugarcane as the dietary forage. C.E.S. Correa, M.N. Pereira^{*}, M.H. Ramos, S.G. Oliveira, and M. Ota, Federal University of Lavras, Lavras, MG/Brazil.

Kernels from a dented corn cultivar had greater ruminal *in situ* degradation and less decrease in digestibility with advanced maturity than flint corn. A flint cultivar (P 3041) was ensiled at half milk line stage and a dented cultivar (AG 4051) at black layer stage. Dry matter and

NDF content were 31.7 and 42.9% for flint corn silage (FCS), and 41.7 and 44.0%, for dented corn silage (DCS), respectively. Three primiparous and 6 multiparous Holsteins (616 kg) were fed FCS, DCS or finely ground fresh sugarcane (SCA, 33.0% DM and 43.2% NDF) in a triplicated 3x3 Latin Square design with 21-day periods. Dietary forage NDF content was 19.9, 20.1 and 19.6% of dry matter for treatments FCS, DCS, and SCA, respectively. The two non-orthogonal contrasts were: 1)(FCS+DCS) vs SCA. 2)FCS vs DCS. Sugarcane lowered intake and yield and had no effect on chewing activity. Sugarcane may be a viable forage alternative for lactating Holsteins in which nutrient demand is not at a maximum. Dented corn ensiled at a later stage of growth than the flint cultivar did not decrease performance when silage was at 45% of diet dry matter.

Trait	FCS	DCS	SCA	SEM	P for		
					forage 1	2	
Dry matter intake,kg/d	23.2	23.0	21.5	.6	.13	.05	.82
Milk yield, kg/d	34.6	34.2	31.9	.4	<.001	<.001	.82
Fat yield, kg/d	1.22	1.20	1.16	.02	.13	.06	.46
Fat %	3.57	3.54	3.64	.06	.44	.22	.73
Protein yield, kg/d	1.08	1.06	1.02	.02	.11	.05	.41
Protein %	3.13	3.10	3.22	.04	.06	.02	.61
Chewing time, min/d	710	704	687	23	.77	.49	.87
Chewing time, min/kg DMI	30.1	32.1	33.6	1.5	.29	.19	.37
Rumen pH (rumenocentesis)	6.02	6.01	6.08	.12	.92	.69	.96

Key Words: Corn silage, Sugarcane, Kernel texture

511 Effects of addition of *Acremonium* cellulase on tissue structure and ruminal digestion of alfalfa and timothy silages. K. Ataku^{*1}, A. Aniwaru¹, T. Watanabe¹, H. Terui¹, and L. Chase², ¹Rakuno Gakuen University, Hokkaido, Japan, ²Cornell University, Ithaca, NY.

The objective of this study was to characterize the effects of the addition of *Acremonium* cellulase on the tissue structure of both timothy and alfalfa silages. A scanning electron microscope (S-EM) was used to measure changes in structure of parenchyma tissue. Timothy *Phelum pratense* and alfalfa *Medicago sativa* forages were cut into 2-cm lengths and placed in nylon bags. Additives applied were lactic acid bacteria *Lactobacillus casei* at 8 ppm(LC), *Acremonium* cellulase at 0.01%(AC), both LC and AC(LC+AC) and formic acid at 0.3% for timothy and 0.5% for alfalfa(FA). Control forages were also ensiled. The additives were sprayed onto the forage, mixed and ensiled in 1-liter silos for 50 days. Each silo contained 8 replicate bags. At the end of the ensiling period, 4 bags from each silo were frozen for S-EM analysis. The other bags were used for a 48-hour *in situ* digestion, removed and frozen for S-EM analysis. Fresh, nonfermented (INRT) samples were also analyzed. Disappearance of the inner parenchyma tissue was observed in the control,LC,AC and LC+AC treatments for both silages. No changes in parenchyma tissue were observed in the FA samples. Samples from the *in situ* digestion had a decrease in inner parenchyma tissues in the INRT,LC,AC,LC+AC and FA treatments for the alfalfa silage. There was no apparent change in the inner parenchyma tissue in both control silages.

Key Words: Alfalfa silage, Timothy silage, Parenchyma tissue

512 Efficacy of cellulase/xylanase enzymes in a direct-fed application for dairy cows. T. R. Dhiman^{*1}, R. R. Gimenez¹, I. S. MacQueen¹, J. L. Walters¹, and R. Treacher², ¹Utah State University, Logan, ²Finnfeeds International Ltd. Wiltshire, UK.

A study was conducted to determine the yield response of dairy cows to cellulase and xylanase enzymes applied to the forage prior to feeding the diets. Fifty cows at the end of week 6 in lactation were blocked according to milk yield and randomly assigned to five treatments. Cows were fed a control diet during wk 7, 8, and 9 of lactation (pre-treatment). Starting week 10, cows were fed a control diet (CTL), or control diet

with enzyme 4011 applied to the forage at a rate of 1.30 L/ton of dry forage (E4011); or enzyme 4011 (1.30 L/ton of dry forage) plus enzyme X at the rate of 0.002 L/ton of dry forage (E4011+EXL); or enzyme X at a rate of 0.002 L/ton of dry forage (EXL); or enzyme X at 0.030 L/ton of dry forage mix (EXH). The required amount of enzyme was diluted with water to bring the volume to 10 liters/ton of fresh forage mix. Clean water was added in CTL. The diet contained 46% forage and 54% grain. The forage portion of the diet had 50% alfalfa hay and 50% corn silage on DM basis. Enzyme treated TMR was offered to the cows within 30 minutes after mixing. The experiment lasted until cows completed week 21 of lactation. Daily feed intake and milk yield were recorded. Once a week, milk samples were analyzed for composition. Feed intakes were 27.1^{ab}, 27.5^{ab}, 25.7^b, 26.3^b, and 28.9^a kg/d in CTL, E4011, E4011+EXL, EXL, and EXH treatments, respectively. Feeding enzyme treated feed did not alter the feed intake of cows. However, higher dose of enzyme X (EXH) increased the feed intake of cows compared with low dose (EXL). Fat-corrected milk yield was 39.0, 39.5, 40.6, 39.0 and 40.4 kg/d in CTL, E4011, E4011+EXL, EXL, and EXH treatments, respectively. Milk yield was not affected by enzyme treatment. Milk fat content, protein content and milk produced per kg feed intake were not different among treatments. Results suggest that treating the forage portion of the diet with cellulase/xylanase enzymes prior to feeding did not influence the performance of cows in this study.

Key Words: Forage, Cow, Milk

513 Effects of Stage of Maturity at Harvest and Kernel Processing on the Nutritive Value of Corn Silage Diets. T. J. Wistuba*, L. A. Whitlock, M. K. Siefers, R. V. Pope, and K. K. Bolsen, *Kansas State University, Manhattan.*

The nutritive value of the six whole-plant corn silage diets was determined using 12 ruminally cannulated, yearling steers in a Latin square metabolism study. All diets contained 90% silage and 10% supplement on a dry basis. The 180d periods consisted of a 10-d diet adaptation and an 8-d total fecal collection. The six silages were: 50% milkline, 80% milkline, and 7-d after-black layer (7BL), each was ensiled processed (Roskamp® roller mill) or unprocessed. The corn was grown under irrigation and the forage was chopped to a 10 mm particle length; and the DM content was 32, 38, and 42% for the 50 and 80% milkline and 7BL silages, respectively. Dry matter intake was not affected ($P>.05$) by either stage of maturity or processing. The only significant ($P<.05$) stage of maturity by processing interaction was for CP digestibility. Processing increased ($P<.01$) starch digestibility (95.9 vs. 93.9%), but it also decreased ($P<.05$) CP (74.6 vs. 76.4%) and NDF (51.6 vs. 53.5%) digestibilities. Steers fed the 7BL silage diets had the lowest ($P<.05$) DM, OM, starch, and ADF digestibilities.

Key Words: silage, kernel processing, stage of maturity

514 The effect of sample physical form on in situ digestion kinetics. K.J. Harvatine*, P.J. Kononoff, and A.J. Heinrichs, *The Pennsylvania State University, University Park.*

In situ techniques are commonly employed to study ruminal degradation of feed. It has been suggested that feed physical form regulates the rate and extent of rumen degradation. Typically samples are ground through small screens resulting in particles much smaller than those normally found in the rumen. The objective of this experiment was to develop an in situ method that best simulates digestion kinetics in vivo and could subsequently be used in experiments studying the effects of forage particle size. A composite sample of a haylage based TMR was prepared in two different forms. In first method, material was dried at 50°C then ground through a Wiley Mill fitted with a 1-mm screen. For the second method rumen digesta particle size was determined using a wet sieving process. Fresh material was then chopped using a food processor resulting in a sample composed of similar shaped particles as found in the rumen. Six rumen cannulated cows arranged in a completely randomized design were used to compare the effects of sample physical form on digestion kinetics. Samples of approximately 5 mg/cm² were placed into nylon bags of two different sizes. Dried and ground material was placed in 10 X 20 cm bags, conversely fresh and chopped was placed in 30 X 36 cm bags. Cows were fed a haylage based TMR and bags of both methods were incubated in replicate for 0, 1, 2, 4, 8, 12, 16, 24, 36 and 48 h in the rumen of each animal. Results indicated that OM of dried and ground samples had a significantly ($P<.05$) higher soluble fraction (37.6 % vs. 35.4 %), degradation rate (11.3 %/h vs. 8.1

%/h), and calculated effective ruminal degradability (65.4 % vs. 62.3 %). Matching sample physical properties to naturally occurring characteristics resulted in different digestion kinetics than conventionally prepared samples.

Key Words: In situ technique, particle size

515 Reed canarygrass management for dry cow forage. J.H. Cherney*, D.J.R. Cherney, and E. Mikhailova, *Cornell University, Ithaca, NY.*

Potassium (K) concentration of perennial grasses has been reported from as low as .1% K up to as high as 7.0% K. Potassium content of grass is critical when considering dry cow diets. Our objective was to evaluate the K content and forage quality of reed canarygrass managed for dry cow forage production. Reed canarygrass was established in 1992 and again in 1993 at two Ithaca sites. At these sites in 1995 and 1996, respectively, a two-harvest per season management was initiated in early June and late September and continued through 1999, with three rates of N fertilizer and three rates of K fertilizer. Crude protein averaged 16% for the spring harvest and 12% for the fall harvest at the high N fertilization rate in 1999. In vitro true digestibility declined with increased N fertilization, but remained above 70%. Neutral detergent fiber digestibility also declined with increased N fertilization, dropping to 62% in the spring and 50% in the fall at the high N fertilization rate. Neutral detergent fiber (NDF) increased from 61 to 65% with increased N fertilization in the spring and did not differ across N fertilization rates in the fall of 1999, averaging 58%. Withholding K fertilization reduced the available soil K to low levels in less than two years, resulting in minimized K uptake and very low forage K concentrations. With 112 kg actual N fertilizer per ha applied at spring greenup and after spring harvest in June, 1999, forage K content averaged 1.1% in June-harvested forage and .6% in September-harvested forage. Dry matter yields were influenced by year and N fertilization. In a droughty year, 1999, yields were 1,779, 4,000 and 6,522 kg DM per ha for N fertilizer rates of 0, 112 and 224 kg N fertilizer per ha, respectively. In a year with adequate moisture, 1998, yields were 4,356, 9,236, and 11,509 kg DM per ha for N fertilizer rates of 0, 112, and 224 kg N fertilizer per ha, respectively.

Key Words: Mineral, Hypocalcemia, Grass

516 Ruminal fermentation and in situ degradation of grazing dairy cows supplemented with full-fat roasted soybean or sunflower meal. F. Piñeiro*, D. Rearte, F. Santini, and F. Bargo, *Fac. Cs. Agr. UNMdP-EEA INTA Balcarce. Argentina.*

Four ruminally cannulated Holstein cows were used in a replicated 2 x 2 Latin Square with 21 d-periods to study the effect of feed full-fat roasted soybeans (RS) or sunflower meal (SM) supplementation on ruminal fermentation and in situ CP and NDF degradation of pasture and protein sources. Treatments were 2.2 kg DM/d of RS or SM. RS and SM had 32.6 and 35.8%CP, 23.5 and 38.3%Soluble CP/total CP, 23.0 and 3.4%EE, 71.6 and 71.1%in vitro DM digestibility (IVDMD), respectively. Cows grazed during 13-wk an annual winter pasture (*Lolium multiflorum* L., *Avena sativa*L.) during the day and a perennial pasture (*Lolium perenne* L., *Dactylis glomerata* L., *Trifolium repens* L.) during the night with in average 1140 kg DM/ha herbage mass, 19.7 %CP, 33.5 %NDF and 75.1 %IVDMD. Both treatments received 4.8 kg DM/d of dry ground corn, 4 kg DM/d of corn silage (59.1 %IVDMD). Neither pH (RS: 5.96 vs. SM: 5.97) nor NH₃-N concentration (RS: 19.2 vs. SM: 19.0 mg/dl) in ruminal fluid were affected by treatments ($P>.05$). Rate of degradation and effective degradability (ED) of CP were lower ($P<.05$) for RS. Protein sources did not affect ($P>.05$) CP degradation fractions of pasture, which had a high ED of CP (average 75.6%). RS tended ($P<.10$) to increase lag time and decreased ($P<.05$) ED of NDF of pasture. RS may be used as a low rumen degradable protein source to supplement cows on pasture but because of high content of polyunsaturated oil may affect ruminal NDF degradation of pasture.

	RS	SM	SEM	P<
Concentrate				
Soluble CP, %	4.2	17.8	3.40	0.10
Degradable CP, %	92.2	77.8	3.80	0.11
Rate, %/h	5.0	16.0	1.36	0.02
ED of CP ¹ , %	14.6	72.1	1.20	0.0001
Pasture				
Soluble CP, %	51.4	54.5	2.97	0.55
Degradable CP, %	41.7	38.7	3.05	0.63
Rate, %/h	7.2	8.5	0.47	0.19
ED of CP ¹ , %	73.9	77.3	0.88	0.11
Soluble NDF, %	30.9	36.9	1.29	0.08
Degradable NDF, %	49.1	45.4	1.97	0.31
Rate, %/h	10.1	9.6	0.50	0.26
Lag time, h	4.5	1.2	0.78	0.09
ED of NDF ¹ , %	50.7	60.4	1.02	0.02

¹rate of passage assumed: 6%/h

Key Words: roasted soybean, pasture supplementation, in situ degradation

517 Effect of full-fat roasted soybean supplementation on performance of grazing dairy cows. F. Piñeiro*, D. Rearte, F. Santini, and F. Bargo, *Fac. Cs. Agr. UNMDP-EEA INTA Balcarce, Argentina.*

Thirty-two Holstein cows (33 DIM, 580 kg BW, 4 primiparous) were used in a randomized complete block design to study the effect of replacement sunflower meal (SM) by full-fat roasted soybeans (RS) as protein supplement on milk production and composition, DMI, plasma metabolites, and BCS and BW change. Treatments were: 1. SM-based concentrate (SM-C), and 2. RS-based concentrate (RS-C). Cows received 7 kg/d of a 70 % ground corn and 30 % protein source concentrate. SM-C and RS-C had 16.8 and 15.8 % CP, 4.0 and 10.2 % EE, 82.4 and 82.6 % in vitro DM digestibility (IVDMD), respectively. Cows grazed during 13-wk an annual winter pasture (*Lolium multiflorum* L., *Avena sativa* L.) during the day and a perennial pasture (*Lolium perenne* L., *Dactylis glomerata* L., *Trifolium repens* L.) during the night with in average 1140 kg DM/ha herbage mass, 19.7 %CP, 33.5 %NDF and 75.1 %IVDMD. Both treatments received 4 kg DM/d of corn silage (55.5 %NDF, 59.1 % IVDMD). DMI, estimated in six cows per treatment using Cr₂O₃ as fecal marker, was not affected by treatments ($P > 0.05$). Milk yield and protein content tended ($P < 0.11$) to decrease and protein yield was lower ($P < 0.05$) in RS-C. Fat content and yield were similar ($P > 0.05$) between treatments. Plasma urea nitrogen (PUN) and glucose did not differ between treatments ($P > 0.05$). BW and BCS change were not different between treatments ($P > 0.05$). RS supplementation to dairy cows at pasture did not improve performance, probably because the high polyunsaturated oil content in RS affect fiber digestibility of forage, which represented 70 % of the total diet.

	SM-C	RS-C	SEM	P<
Total DMI, kg/d	20.80	21.47	1.98	0.82
Concentrate DMI, kg/d	6.95	6.95	0.09	0.99
Forage DMI, kg/d	13.85	14.52	1.95	0.82
Milk, kg/d	23.96	22.97	0.41	0.08
Fat, %	3.47	3.61	0.06	0.14
Fat, kg/d	0.83	0.81	0.02	0.64
Protein, %	3.29	3.24	0.02	0.11
Protein, kg/d	0.78	0.73	0.01	0.005
PUN, mg/dl	12.95	14.87	0.86	0.12
Glucose, mg/dl	64.02	65.13	1.34	0.55
BW change, kg	-3.00	1.00	7.69	0.71
BCS change	-0.25	-0.14	0.10	0.42

Key Words: roasted soybean, dairy cows, pasture supplementation

518 Modifications of the purine assay to increase accuracy and precision. K.W. Creighton*, R.A. Mass, and T.J. Klopfenstein, ¹University of Nebraska, Lincoln.

Due to poor repeatability in current purine assays, three experiments were conducted to investigate the combination of different modifications of the assay in an attempt to increase accuracy and precision. In Trial 1, ten brome and alfalfa omasal samples were used to evaluate the effect

of acid stringency on purine recovery. Hydrolysis was conducted with either 12 M or 2 M HClO₄ at 95°C for 1 h. Purine recovery with 2 M acid was higher (14.86 vs. 4.46 mg/g, $P < .001$) and more precise (3.14 vs. 14.87% CV, $P < .005$), suggesting that 2 M acid was more favorable. In Trial 2, buffer type and wash solution were investigated, using 2 M HClO₄ for hydrolysis. Buffers were .2 M ammonium phosphate (PO₄) solution or a .2 M acetic acid (AA) solution. During the wash procedure, a solution of .005 N H₂SO₄ plus .005 AgNO₃ (SN) or the initial precipitation solution (buffer+HClO₄+AgNO₃; PREC) was used. There was no interaction between buffer solution and wash solution for mean purine values; both PO₄ buffer (6.07 vs. 1.65 mg/g; $P < .0001$) and PREC (4.32 vs. 3.40 mg/g; $P < .003$) increased mean purine recovery. An interaction existed ($P < .02$) for CV values, as PO₄/PREC (2.84%) produced the lowest CV (most precise), with AA/SN (12.61%) having the worst precision and AA/PREC (6.87%) and PO₄/SN (9.85%) being intermediate. We conclude that for total purine recovery, a milder hydrolysis followed by precipitation in PO₄ buffer and washing with the original precipitation buffer yields the highest accuracy and precision. In Trial 3, the new procedure was used to determine microbial purine (P) to microbial N (N) ratios on NDF residues of five forages from in situ incubations. Bags were incubated for 12 h, washed, and residues were analyzed for microbial N (total N-NDIN) and purine. Values ranged from .28 for higher quality forages (alfalfa, brome, and high quality meadow hay) to .36 and .41 for low quality meadow hay and switch grass, respectively. These results imply that forage type has an effect on purine to total microbial N ratios and is a means of determining P:N ratio.

Key Words: Purines, Microbial protein, Ruminants

519 Evaluation of internal markers from fescue hay. E. S. Vanzant*, D. W. Bohnert, K. B. Combs, B. T. Larson, and D. L. Harmon, *University of Kentucky, Lexington.*

Four Angus steers (avg body weight = 440 kg) were fed a 100% fescue hay diet (15% CP; 77% NDF; 43% ADF; 4.8% ADL) at 95% of ad libitum intake. Markers evaluated included acid-insoluble ash (AIA), acid detergent lignin (ADL), and indigestible acid detergent fiber (IADF) analyzed by each of five procedures. All IADF procedures included acid/pepsin pretreatment of forage samples. For standard IADF (STD), samples were incubated in vitro individually for 144 h, extracted in acid detergent solution, and filtered through coarse Gooch crucibles. The other 4 procedures were arranged as a 2 x 2 factorial: batch incubation of samples for 168 h, either intraruminally (IS), or in an Ankom batch in vitro incubator (IV), in either standard in situ-type bags (Ankom # 1020) cut to 5.0 x 5.5 cm and heat sealed, or fiber filtration bags (Ankom #F-57, 5.0 x 5.5 cm), followed by batch acid detergent extraction. Fecal marker recoveries differed ($P < .10$) for all pairwise comparisons among AIA, ADL, and STD IADF (90.4, 110.5, and 100.1%, respectively). IADF concentrations of hay and fecal samples were affected by a sample type x treatment interaction ($P < .01$); differences between techniques were greater with fecal than with hay samples, although ranking of the techniques was similar between sample types. Average IADF concentrations for hay samples were 17.4, 10.4, 14.8, 13.4, and 16.7% and, for fecal samples, 37.4, 23.5, 34.3, 27.9, and 34.6% for STD, IS/1020, IS/F57, IV/1020, and IV/F57, respectively. For fecal samples, bag type had a larger influence (incubation procedure x bag type, $P = .02$) on IADF concentrations when samples were incubated in situ than in vitro, whereas the interaction was not significant ($P = .42$) for hay samples. Recoveries differed from STD (100.1%) for IS/1020 (105.6%; $P = .04$) and IS/F57 (107.5%; $P = .01$) but not for IV/1020 (97.1%; $P = .23$) or IV/F57 (96.2%; $P = .12$). Despite differences in absolute amount of IADF compared with STD, using bulk in vitro incubation with either Ankom #1020 or Ankom #F57 polyester bags resulted in acceptable fecal recoveries for cattle consuming fescue hay.

Key Words: Festuca arundinacea, Intake, Markers

520 In vitro fermentation patterns of individual and mixed major forage carbohydrates using a computerized gas monitoring system. J.J. Lee* and J.A. Shelford, *University of British Columbia, Vancouver, B.C. Canada.*

This experiment was conducted to study the fermentation profiles of individual major forage carbohydrates and to compare those results with that of their mixture. The prepared samples included starch, glucose, xylose, cellulose and the mixture comprising 25% of each carbohydrate. A modified version of a computerized gas monitoring system developed

by Pell and Schofield was used to measure the gas production up to 24 hr. Strained rumen fluid from two nonlactating cows was mixed and the mixture used as inoculum for the gas production measurements. About 150 mg of substrate was weighed in quadruplicate into flasks to which 12 ml of preheated phosphate-bicarbonate medium and reducing solution was added. Gas production rate and lag phase was estimated by an iterative least-squares procedure (PROC NLIN) with the SAS (1990) software package. Estimates generated for each substrate were analyzed using the General Linear Models Procedure of the SAS (1990). Gas production per 100 mg of substrate was 23.17 ml for glucose followed by 21.33, 19.14, 18.49, and 15.13 ml for xylose, starch, mixture and cellulose respectively. All values were significantly different ($p < 0.05$) except between mixture and starch. Starch showed longest (2.23 hr) lag time which was unexpected and lag times for xylose, cellulose, glucose, and mixture were 1.38, 1.08, 0.86, and 0.86 hr, respectively. They were significantly different from each other except between glucose and mixture ($p < 0.05$). Gas production rates differed significantly. Glucose showed highest value (0.31 ml/hr) followed by mixture, xylose, starch, and cellulose (0.2, 0.15, 0.06, and 0.05 ml/hr, respectively). Total gas production of mixture gave a similar pattern to that of cellulose which was the lowest and the lag phase for mixture showed strong similarity to that of glucose which was the highest. It is concluded that the fermentation pattern of mixture relates the individual carbohydrate sources.

Key Words: carbohydrate, fermentation, gas

521 The Accuracy of Using an Accepted Dry Matter Digestibility Prediction Equation on Alfalfa and Mixed Grass Hays. D. Chatman*, D. Miller, J. Spain, R. Belyea, and M. Eilersieck, *University of Missouri Columbia*.

The National Alfalfa Hay Quality Committees equation for predicting digestible dry matter of legumes, grasses, and legume grass mixtures from ADF is: $DDM = 88.9 - (.779 \times ADF\%)$. However, large differences in fiber-lignin complexes between grasses and legumes make it questionable to use the same prediction equation across a wide range of forage species. The objective of this study was to compare digestible dry matter as predicted by a universal equation to in situ measurements of the digestible dry matter of alfalfa and mixed grass hays. Forage samples used in this experiment were from the 1998 Missouri State Fair hay contest and included alfalfa and mixed grass hay samples. Representative samples were collected from two bales of each forage and composited. Samples were analyzed for DM, ADF, NDF, and CP using standard analytical procedures. Alfalfa ($n=16$) and the mixed grass hay samples ($n=8$) were dried, ground (2mm), and digested in situ in a ruminally fistulated cow fed a standard lactation diet. Incubation times were 0, 12, 24, and 36 hours. The 24-hour in situ incubation time was used as the estimated dry matter digestibility, and averaged 58.7% (SE= 1.8), and 56.0% (SE= 2.6), for alfalfa and mixed grass hay, respectively. Data were analyzed by analysis of covariance in which ADF was the covariant. Differences between treatment regression coefficients were tested to determine the rate of change in digestible dry matter as affected by changes in ADF. Regression coefficients of the alfalfa and mixed grass hay samples (0.88 and 1.90, respectively) differed significantly ($P = .02$). These results suggest that the current digestible dry matter prediction equation cannot be accurately applied to mixed grass hays. These results have important implications in the calculation of RFV for mixed grass hays.

Key Words: grasses, alfalfa, digestibility

522 Advances in bermudagrass research involving new cultivars for beef and dairy production. G. M. Hill*¹, R. N. Gates², and J. W. West¹, ¹*The University of Georgia, Tifton*, ²*USDA-ARS, Coastal Plain Exp. Sta., Tifton, GA*.

Bermudagrass (*Cynodon dactylon*) is a dominant warm-season perennial in the southern USA that is persistent on sandy, acidic soils of the region. Bermudagrasses are grazed or harvested for hay from April to October, and produce forage year around in tropical regions of Africa, Central America and South America. Coastal bermudagrass, released in 1943, was one of the first hybrid cultivars, and it remains the preferred cultivar grown on more than 5 million ha in the USA. Hybrid bermudagrasses are sterile and must be propagated vegetatively from roots and rhizomes, although some cultivars may be established using advanced maturity green top-growth. Seeded selections and varieties are being marketed, and some have been persistent over wide regions. However,

few have DM yields and forage quality comparable with hybrid cultivars such as Tifton 44', Tifton 78' and Tifton 85'. Tifton 85 (released in 1993) has become the premier hybrid for the lower South, exhibiting rapid establishment from rhizomes or top-growth, which allows hay production in the establishment year. In small plot and grazing trials Tifton 85 has consistently had higher DM yield and forage digestibility than Coastal or Tifton 78, resulting in improved grazing performance. In recent experiments, Coastal, Tifton 78 and Tifton 85 hays were evaluated for quality, using in vitro, in situ, and total tract digestibility techniques, and superior Tifton 85 hay digestibility was observed. Although ADF, NDF and hemicellulose were higher for Tifton 85 hays than other hays, Tifton 85 had lower concentrations of both lignin and ether-linked ferulic acid. This might explain why high-fiber Tifton 85 has higher digestibility than Coastal. Research with dairy cattle indicated that acceptable milk yields were achieved during late autumn and winter when Tifton 85 or alfalfa hay comprised up to 30% of the DM of the TMR. Future research challenges for plant geneticists will focus on improved forage quality, winter hardiness and broadened areas of adaptation for bermudagrasses.

Key Words: Cynodon, Forage, Cattle

523 In vitro digestion kinetics as influenced by forage species and harvest date. D.J.R. Cherney*, J.H. Cherney, and L.E. Chase, *Cornell University, Ithaca, NY*.

Dairy producers are incorporating more perennial grasses into their nutrient management strategies. Perennial grasses of similar chemical composition may vary in their digestion kinetics, which would alter intake potential by dairy cows. Objectives were to compare digestion kinetics of orchardgrass (1st and 2nd cutting, OG1 and OG2, respectively) and tall fescue (1st and 2nd cutting, TF1 and TF2, respectively) to a 1st cutting alfalfa (ALF1). The alfalfa was harvested at 37% NDF in late May. The OG1 and TF1, harvested a week later, analyzed 47% NDF, while OG2 and TF2, harvested in August, contained 52% NDF. Alfalfa in vitro true digestibility at 48h (82.6%) was intermediate between first cutting (86.7%) and second cutting grasses (77.3%). Lower in vitro digestion of second cutting grasses was attributed to higher lignin than in first cutting grasses. In vitro digestion was negatively correlated with lignin ($r = -.87$). Second cutting grasses had higher rates of digestion ($P \leq .05$) than first cutting grasses (.0530/h \pm .001 vs. .0233/h \pm .009). The ALF1 was intermediate with a rate of digestion of .0437/h. Indigestible residue of OG1 (12.5%), TF1 (13.4%) and TF2 (13.4%) were lower than for ALF1 (16.7%), but OG2 had the highest indigestible residue (22.65%). The OG2 also had lower potentially digestible fiber (28.8%) than the other grasses (33.3, 34.7 and 38.2% for OG1, TF1 and TF2, respectively). These results suggest that the intake potential of OG2 might be lower than for the other grasses. \leq

Key Words: Digestion kinetics, Grass, Fiber

524 Milk production of fall-calving cows during summer grazing. L. D. Satter*, Z. Wu, V. R. Kanneganti, and L. J. Massingill, *US Dairy Forage Research Center, USDA-ARS, and University of Wisconsin, Madison*.

Intensive rotational grazing of dairy cows can be an economic way for milk production, but usually does not allow milk yield in early lactation to be maximized. To better capitalize on the potential economic advantage of grazing, as well as the cow's milking potential in early lactation, a fall-calving strategy was evaluated for 2 yr. In each year, cows calved during September and October. After calving, cows were fed a TMR, then grazed from April to August for 11 wk in yr 1 and 18 wk in yr 2. At the beginning of grazing, cows averaged 220 DIM (SD 15) in yr 1 and 203 DIM (SD 17) in yr 2. In yr 1, the pasture had two distinct types of paddocks, one containing mixed grasses only and one containing mixed grasses, white clover, and red clover. The clover species accounted for 26% of the forage in the mixed paddocks. In yr 2 all paddocks were similar, containing almost all grass. A supplement mix consisting mainly of high moisture ear corn and roasted soybeans was fed during grazing at 6.2 kg/d in yr 1 and 7.9 kg/d in yr 2 (DM basis). This accounted for approximately 35 to 40% of total DMI. In each year, 40 cows (20 primiparous in yr 1 and 12 primiparous in yr 2) were grazed. In yr 1, 27 cows grazed the grass paddocks and 13 grazed the mixed paddocks. In yr 2, all 40 cows grazed grass paddocks as one group. Milk yield during the grazing season in yr 1 averaged 19.1 and 20.4 kg/d (SE .5, $P < 0.05$) for the all-grass pasture and the grass-legume pasture, respectively. The

yield declined 2.2 kg/d the first week cows were turned out to pasture for the two groups, with the decline being less with the grass-legume pasture than for the all-grass pasture. Milk yield averaged 21.4 kg/d (SE .6) during grazing in yr 2, with a decline of 4.2 kg/d occurring in the first week. Milk production for 308 d of lactation was: yr 1, 8873 kg for cows on all grass, and 9145 kg for the mixed grass-legume pasture; yr 2, 10055 kg for cows on all grass pasture. Production was markedly higher for these fall-calved cows pastured in late lactation compared to spring-calved cows pastured in early lactation under similar conditions (7114 kg, Dhiman and Satter, 1996). While milk production still declined in late lactation upon turning cows out to pasture, the cumulative loss was much less than with early lactation cows.

Key Words: Pasture, Clover, Grazing

525 Fermentation characteristics of alfalfa and whole crop barley round bale silage as influenced by bag type. G. R. Khorasani* and J. J. Kennelly, *University of Alberta, Edmonton, AB, Canada.*

Objective of this study was to evaluate the fermentation characteristics of round bale alfalfa and whole crop barley silage ensiled in different types of silage bags at two different dry matters (DM). Crops were ensiled at 60-70% and 35-40% DM. At ensiling, each crop was ensiled in three sets of silage bags (replicates) with three bales in each bag representing a treatment. For the silage bags, two different colors (white vs. black and white) and two different thicknesses (3.5 vs. 4.0 mil) were used as experimental treatments. After ensiling, samples were taken from each bag on day 1, 2, 3, 5, 7, and weekly for an additional 6 weeks. A repeated measurement design was used to determine the effects of forage type, forage moisture, and thickness and color of the bag on the fermentation characteristics of ensiled crops. The pH changes during the storage were very small and the effect of forage type, moisture and thickness were significant ($P < 0.05$). The temperature of silage was higher in the high moisture silage than in the low moisture silage. Crops ensiled in the thinner bags had a higher temperature than crops ensiled in the thicker bags (32.2 vs. 29.3 °C, $P < 0.05$). Color of the bag did not affect the ensiled temperature. The protein fractions for the high moisture silage were different from low moisture silage, but the thickness and color of the bag had no effect on the chemical composition of the silages. High moisture silage had a higher lactic acid content than low moisture silage (2.8 vs. 6.6 mg/g DM, $P < 0.05$), but no significant differences were observed due to silage type or bag color. Effect of bag type on acetate, ethanol, and methanol concentration of the silage was not significant, but forage type and forage moisture affected these parameters. We concluded that management factors such as DM content of ensiled forage significantly influenced the fermentation characteristics of ensiled crops, but the effect of bag type was relatively small.

Key Words: Silage Fermentation, Round Bale Silage

526 TascoTM: Influence of brown seaweed on antioxidants in forages and livestock. V. G. Allen*¹, K. R. Pond¹, J. P. Fontenot², K. E. Saker², C. P. Bagley³, R. L. Ivy⁴, R. R. Evans⁴, R. E. Schmidt², J. H. Fike², and D. B. Webster¹, ¹*Texas Tech University, Lubbock*, ²*Virginia Tech, Blacksburg*, ³*Sam Houston State University, Huntsville, TX*, ⁴*Mississippi State University, Prairie.*

Increased antioxidant activity in both plants and animals diminishes oxidative stress. Seaweed (*Ascophyllum nodosum*) is a known source of plant growth regulators and application of TascoTM-Forage (a proprietary seaweed-based product) to grasses increased activity of the antioxidants superoxide dismutase (SOD), glutathione reductase, ascorbate peroxidase, and vitamin precursors in several forage grasses. Tasco was applied to tall fescue (*Festuca arundinacea* Schreb.) pastures infected and non-infected with the endophyte fungus, *Neotyphodium coenophialum*. Both monocyte major histocompatibility complex class II expression and phagocytic activity were decreased ($P \leq .05$) in steers due to endophyte infection but this effect was reversed ($P \leq .05$) by Tasco application. Effects on immune function were measured after cross-country transportation to the feedlot and throughout the finishing period. Steers that had grazed the Tasco-treated pastures had higher ($P \leq .05$) marbling scores regardless of the endophyte and this was reflected in higher ($P \leq .15$) USDA quality grades. At slaughter, vitamin E in liver was increased ($P \leq .06$) in steers that had grazed the treated pastures. Color stability and beef shelf-life were enhanced. The mode of action may be at least in part through effects on antioxidant activity including vitamin

E. Direct supplementation of Tasco to beef, swine, and horses has provided further evidence of improved immune response and/or increased shelf-life. Tasco may provide opportunities to reduce oxidative stress in plants and animals.

Key Words: Immune function, *Ascophyllum nodosum*, Carcass characteristics

527 Alleviating tall fescue toxicosis with non-toxic endophytes. M.A. McCann*¹, J.A. Bondurant¹, L.L. Hawkins¹, N.S. Hill¹, C.S. Hoveland¹, F.N. Thompson¹, G.C.M. Latch², and J.H. Bouton¹, ¹*University of Georgia, Athens*, ²*AgResearch Grasslands, Palmerston North, New Zealand.*

The presence of a fungal endophyte (*Neotyphodium coenophialum*) in tall fescue has been shown to positively impact plant persistence and agronomic performance. However, previous studies indicate that livestock ingestion of endophytically derived ergot alkaloids in tall fescue forage results in poor animal weight gain and depressed reproduction, a condition referred to as "fescue toxicosis". The objective of the present study was to evaluate serum prolactin levels and animal performance in lambs on endophyte-infected (E+) tall fescue cultivars, endophyte-free (E-) cultivars, and cultivars after removal of their naturally occurring *N. coenophialum* endophyte and re-infection with nontoxic endophyte strains (NT). These NT endophyte strains had nil ergot alkaloid production. Jesup NT, Georgia 5 NT, and Kentucky 31 NT cultivars were compared to Jesup E+ and Jesup E- cultivars. Grazing trials were conducted at the Central Georgia Branch Station in Eatonton, GA in the spring and fall of 1998 and 1999. Lambs weighing approximately 23 kg were stocked on 930 m² paddocks. Put and take grazing was utilized to ensure similar forage availability among paddocks (2000 kg DM/ha). Animal weights and serum prolactin levels were measured along with available forage yield and forage ergot alkaloid concentration every two weeks. All cultivars with the NT endophytes produced none of the toxic ergot alkaloids in their forage and were similar to the E- paddocks in this regard. Serum prolactin was reduced ($P < .05$) in the lambs grazing E+ tall fescue as compared to lambs on E- forage. Animals consuming forage with NT endophytes showed blood prolactin levels similar ($P > .05$) to lambs on E- paddocks indicating a lack of toxicity. The lambs grazing NT paddocks also showed weight gains higher ($P < .05$) than lambs on E+ forage and similar ($P > .05$) to lambs on E- forage. These results indicate that infecting select tall fescue cultivars with NT endophytes is a promising strategy for alleviating the negative effects of fescue toxicosis.

Key Words: tall fescue, *Neotyphodium coenophialum*, nontoxic endophytes

528 Supplementation of Growing Heifers Grazing Stockpiled Fescue. M.E. Scott*, M.H. Poore, J.T. Green, S.P. Morgan, and H.K. Jones, *North Carolina State University, Raleigh.*

A two year 83-d winter grazing study was conducted to evaluate nutrient concentration of stockpiled fescue (98% endophyte infected), and performance of beef heifers stripgrazed with or without supplementation. Thirty-six AngusX heifers (initially 265 kg in yr 1 and 257 kg in yr 2) were managed as 6 groups, and half were given .33% of body weight (.9 kg dm) whole cottonseed plus a small amount (.2 kg dm) of concentrate per head. Fescue was fertilized with 76 kg N/ha on Sept 1, and initial forage mass was 4499 kg/ha in yr 1 and 5917 kg/ha in yr 2. Grazing and forage sampling started Dec 3 in yr 1 and Nov 25 in yr 2. Forage quality was higher ($P < .01$) in yr 1 {16.8% CP and 82.0% in vitro true organic matter digestibility, (IVTOMD)} than in yr 2 (12.6% CP and 71.9% IVTOMD). In yr 1, CP and IVTOMD declined until late winter when both recovered (Linear and Quadratic, $P < .05$). In yr 2, CP remained stable and IVTOMD declined (Linear, $P < .05$). Green and brown tissue were both higher ($P < .01$) in quality during yr 1 (green; 20.4 % CP and 90.5 % IVTOMD, and brown; 10.3 % CP and 63.9 % IVTOMD) than in yr 2 (green; 15.3 % CP and 87.2 % IVTOMD, and brown; 8.4 % CP and 61.7 % IVTOMD). Fescue was initially 79 % green and declined to 62 % in yr 1, and was initially 80 % green and declined to 54 % in yr 2. Heifers gained more in year 1 than year 2 ($P < .05$), responded to supplementation ($P < .01$), and displayed a supplement by year interaction ($P < .05$). Shrunken ADG for unsupplemented heifers was .46 kg/d in yr 1 and .22 kg/d in yr 2, and for supplemented heifers was .56 kg/d in yr 1 and .44 kg/d in yr 2. BUN was higher ($P < .01$) for supplemented heifers in both years (9.5 vs 10.5 mg/dl in yr 1 and 7.2 vs 8.6 mg/dl in yr 2). Forage organic matter intake (OMI) determined by

pasture mass difference was 3.29 kg/d in yr 1 and 3.79 kg/d in yr 2 and was not influenced by supplementation, while total OMI was increased ($P < .05$) by supplementation in both years. Pasture forage mass after grazing (2490 kg/ha) suggested that intake was not limited based on forage availability.

Key Words: Stockpiled fescue, Cottonseed

529 A novel system to estimate protein degradability in legume and grass hays. M.E. Dorshorst and P.C. Hoffman, *University of Wisconsin, Madison.*

Previous research from our laboratory has demonstrated that near-infrared reflectance spectroscopy (NIRS) has a utility in predicting RUP contents of legume and grass silages. This study was conducted to evaluate whether application of previous research techniques could yield a useful NIRS RUP prediction system for legume and grass hays. In 1998 and 1999, legume and grass hays ($n = 208$) from the north central region of the United States were collected. A portion of each sample was dried, ground (1 mm), and scanned on a NIR spectrophotometer and spectra saved. Center and select procedures using Infrasoft International® software (version 2) were implemented and 106 spectrally different legume and grass hays were selected for NIRS RUP equation development. The remaining portion of the legume and grass hay samples were dried, ground (2 mm) and evaluated for RUP using calibrated cow ($n = 4$) in situ procedures. Legume and grass hays were also evaluated for CP and NDF. The legume and grass hays ($n = 106$) were of desired variable quality with CP ranging from 10.7 to 29.7% of DM, and NDF ranging from 26.8 to 61.5% of DM. In situ RUP content ranged from 14.6 to 45.5% of CP, with a mean of 25.9% of CP. Development of an NIRS RUP equation for legume and grass hays proved to be fruitful. The R^2 and SE of calibration were 0.87 and 2.46% of CP, respectively. Validation procedures also indicated reasonably good performance of the equation with an r^2 of 0.83 and a SE of cross validation of 2.84% of CP. Data indicate NIRS can predict in situ RUP contents of legume and grass hays.

Key Words: Forage, Protein, Degradability

530 Genotypic differences in chemical composition and ruminal degradability of oat hulls. R. K. Thompson*¹, A. F. Mustafa¹, J. J. McKinnon¹, D. D. Maenz², and B. Rossnagel³, ¹University of Saskatchewan, Saskatoon, Canada, ²Prairie Feed Resource Center, Saskatoon, Canada, ³Crop Development Center, Saskatoon, SK, Canada.

A study, consisting of two trials, was conducted to determine differences in chemical composition and ruminal nutrient degradability of hulls derived from ten varieties of oat grown in western Canada. In trial one, chemical composition and IVDMD of the oat hull varieties were determined in a completely randomized design. Based on the results of the first trial, a second trial was conducted to compare in situ ruminal nutrient degradability of hulls from two of the oat varieties (AC Assiniboia and Calibre) with that of oat straw (Calibre) in a randomized complete block design. Results showed that relative to the other nine varieties, hulls derived from AC Assiniboia had a lower ($P < .05$) ADL and a

higher ($P < .05$) IVDMD. Relative to the average of the other nine varieties, AC Assiniboia had 79% less ADL and 44% higher IVDMD. There were no significant differences in ADF, NDF, and CP content between varieties. Results of the second trial showed that effective ruminal degradability of NDF and ADF for the AC Assiniboia hulls were similar to those of Calibre straw but higher ($P < .05$) than those of the Calibre hulls (22.5% vs. 11.8% and 22.3% vs. 12.5%, respectively). The higher effective degradability of the AC Assiniboia hulls relative to the Calibre hulls was due to a larger ($P < .05$) slowly degradable fraction. The results of this study show that due to their lower ADL content, hulls derived from AC Assiniboia oat have almost double the ruminal fiber degradability of Calibre hulls. The economic return for the oat milling industry may be increased by using an oat variety with a more valuable hull to sell into the feed market.

Key Words: Oat hulls, Chemical composition, Ruminal Degradability

531 Effect of undegradable intake protein supplements, forage protein level, and incubation time on *in vitro* fermentation. L.A. Richards*¹, M.K. Petersen², J.B. Richards², and M. Remmenga², ¹USDA-ARS Grazinglands Research Laboratory, El Reno, OK, ²New Mexico State University, Las Cruces.

High undegradable intake protein (UIP) supplements may interact with changing forage quality to affect ruminal fermentation. Two *in vitro* experiments investigated changes in OMD, NH_3 and VFA production when supplying UIP with range diet samples (3,8, or 13%CP) over 18 or 48 h. In Experiment 1, forage was not supplemented (NS); supplemented with wheat middlings (WM; 23%CP); WM + feathermeal (FM) at 7,16, or 23%UIP (32,44, or 55%CP); or CSM (16%UIP, 33%CP). In Experiment 2, forage was NS; supplemented with WM (17%CP); or WM + 9,12, or 15%UIP at 34%CP. Forage (F), supplement (S), and time (T) interactions were tested. In Experiment 1, OMD was increased by S vs NS (33 vs 40 ± .4%; $P = .01$), T at 18 vs 48 h (29 vs 48 ± .3%; $P = .01$), and F at 3,8, and 13%CP (31,40, and 45 ± .3%; $P = .01$). Higher NH_3 (SxT; $P = .01$) was detected as UIP increased at 48 h. Acetate:propionate decreased as forage CP increased, but increased with NS and higher UIP (SxF; $P = .01$). Total VFA were increased as forage CP increased, but decreased as supplemental UIP increased (SxF; $P = .01$). While UIP source did not change OMD ($P = .3$) or NH_3 ($P = .7$), FM increased VFA (65 vs 61 ± .8 mMol; $P = .01$) and decreased acetate:propionate (3.5 vs 3.7 ± .03; $P = .01$) vs CSM. In Experiment 2, supplementation increased OMD in lower CP forage (SxF; $P = .02$). NH_3 was lowest ($P = .01$) in NS and highest ($P = .01$) in WM+FM at 9%UIP. Acetate:propionate was decreased by higher WM and higher forage CP (SxF; $P = .01$). Lowest isovalerate, valerate, and isobutyrate were found in NS and highest in 8% CP forage (SxF; $P = .04$). Total VFA was decreased ($P = .01$) at 48 h in NS vs S (60 vs 75 ± 1.6 mMol) and increased ($P = .01$) at highest forage CP (68, 69, 79 ± 1.3 mMol). Higher UIP in a moderate protein supplement optimized *in vitro* forage fermentation. Nutrient availability had less effect on fermentation of higher protein forage. While forage degradation was consistently increased in the first supplemental increment, additional inputs which alter nutrient flow may improve animal performance.

Key Words: UIP, forage, fermentation

GOAT SPECIES

532 Effects of individual vs group confinement and forage access on performance of artificially reared, confined Alpine kids. A.L. Goetsch*, G. Detweiler, T. Sahl, L.J. Dawson, and S.S. Zeng, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

Forty Alpine kids (20 females and 20 males) were used to determine effects on performance of individual vs group confinement and access to forage during the suckling period. Kids began the experiment at 3 to 9 d after birth (3.6 ± .10 and 4.0 ± .09 kg initial BW for females and males, respectively). Treatments were: individual confinement in 91 × 91 cm cages (C1); confinement of two kids (one in the experiment and another older) in 182 × 91 cm cages (C2); group confinement (with at least two older kids present) in a 2.43 × 1.22 m pen (P); and P plus free access to alfalfa hay (PF). Milk was consumed ad libitum for 8 wk with free access to a concentrate-based starter diet, followed by a 4-wk post-weaning period, the first 5 d of which entailed restricted milk intake.

In the 8-wk suckling period, milk intake was similar among treatments (1.81, 1.80, 1.89, and 1.77 kg/d; SE = 34.8), whereas sex influenced the treatment response in ADG (interaction, $P = .02$) (female: 159, 154, 172, and 154 g/d; male: 175, 193, 162, and 182 g/d for C1, C2, P, and PF, respectively [SE = 6.3]). In the 4-wk post-weaning period, ADG was greater ($P < .05$) for P than for C2 and PF (75, 54, 112, and 49 g/d; SE = 16.4), although for the entire 12-wk experiment ADG was similar among treatments (137, 134, 149, and 128 g/d for C1, C2, P, and PF, respectively; SE = 6.7). In conclusion, housing two or more Alpine kids together vs alone and offering hay during the suckling period did not enhance performance during or shortly after suckling.

Key Words: Goat, Suckling, Performance