

capsule. Phagocytic index, percentage of neutrophils containing intracellular bacteria, and average number of intracellular bacteria per positive neutrophil were each greater for bacterial cells cultured in iron-replete medium compared with bacterial cells cultured in iron-deplete medium. Bacterial isolates positive for capsule were more resistant to phagocytosis than isolates that were capsule-negative. Iron availability in culture did not affect expression of a bacterial capsule. Culturing *E. coli* in iron-deplete medium increased resistance to phagocytosis by bovine neutrophils compared with culture in iron-replete medium.

Key Words: *Escherichia coli*, Opsonization, Iron

635 Oral glycerol as an aid in the treatment of ketosis/fatty liver complex. J.P. Goff^{*} and R.L. Horst, *USDA-ARS, National Animal Disease Center, Ames, IA.*

Glycerol can be converted to glucose in the liver of cattle. Glycerol enters the gluconeogenic pathway at the level of dihydroxyacetone phosphate and 3-phosphoglyceraldehyde. This is several biochemical steps closer to glucose than the traditional gluconeogenic precursors, propionate and propylene glycol. Use of glycerol as an aid in the treatment of ketosis was suggested during the 1960s but not adopted due to high costs. New sources of glycerol have reduced the cost. We examined the effect of glycerol administration on blood glucose in dry cows and did a dose titration to determine the maximal tolerable dose. Treatment groups consisted of 3 cows (one of which had a rumen fistula) which were given 1, 2 or 3 L of glycerol via esophageal pump. Blood samples were taken hourly for the next 8 hrs and also at 24 hrs. At 0.5 hr after treatment mean blood glucose increased 16, 20, and 25% respectively over pretreatment values. They remained elevated for the next 8 hrs. All cows had returned to baseline glucose values at 24 hrs. Two of three cows given 3 L glycerol exhibited staggering and depression; from which they recovered from within 4 hrs. Rumen pH was unaffected by treatment with glycerol. Two lactating cows with clinical ketosis, which had been previously treated for 2 or 3 d with IV glucose with little response suggesting fatty liver involvement, were treated with 1 L glycerol. In both cases ketone level in urine was reduced to trace amounts by 24 h and milk production increased 4-6 lb. In the first cow blood glucose increased from 48 mg/dl to 75 mg/dl 0.5 hr after treatment and was 109 mg/dl 5 hr after treatment. In the second cow blood glucose did not increase until about 4 hr after treatment when it increased from 48 mg/dl to 74 mg/dl and was just 64 mg/dl 8 hr after treatment. Glycerol offers another means of treating cows for ketosis which may have less toxic effects than propylene glycol.

Key Words: glycerol, ketosis, gluconeogenic

636 Economic consequences of Johne's disease control programs on dairy herds in Pennsylvania. H. Groenendaal^{*} and D.T. Galligan, *University of Pennsylvania, School of Veterinary Medicine, Kennett Square, PA, USA.*

A stochastic simulation model called JohneSSim has been developed to evaluate different Johne's disease control programs on their epidemiological and economic consequences. The model was applied to infected farms in the Pennsylvania dairy industry. Input data were collected from literature or obtained from experts. The results showed that none of the 'test-and-cull' strategies alone are effective in reducing the Johne's disease prevalence. 'Test-and-cull' strategies have an average benefit-costs ratio of around 0.85 (5% and 95% percentiles are respectively 0.00

and 1.30) and are therefore economically not attractive. However, improved management and hygiene for calves until 12 months of age, is much more effective in reducing the prevalence. This reduction will gradually start after 3-5 years because of the long sub-clinical period, but will result in a prevalence close to 0, after 15-20 years. In addition, the 'management improvement' strategies result in significant economic benefits. On average, the benefits increase from none (in year 1) to US dollar 11,000 in year 20 for a 100 cow dairy herd. Furthermore, 'heifer contract rearing' appeared to be an effective, simple, cheap and therefore attractive way of reducing the Johne's disease prevalence under Pennsylvania conditions with economical benefits, similar to 'management improvement strategies'. It was concluded that only a complete improvement of the calf management can reduce the prevalence effectively, and is therefore critical in any Johne's disease control program.

Key Words: Johne's disease, Simulation, Economics

637 Using *Solanum glaucophyllum* as a source of 1,25-dihydroxyvitamin D to prevent hypocalcemia in dairy cows. R.L. Horst^{*1}, J.P. Goff¹, S. Gill², E. Pawlak², and M.E. Dallorso³, ¹*National Animal Disease Center, USDA-ARS, Ames, IA,* ²*CAE, Buenos Aires, Argentina,* ³*Universidad Nacional de Lomas de Zamora, Buenos Aires, Argentina.*

Reducing cation-anion difference of diets (DCAD) fed just before parturition can prevent milk fever. However this dietary regimen does not entirely eliminate hypocalcemia. Milk fever can also be prevented by exogenous administration of the calcium regulating hormone 1,25-dihydroxyvitamin D. Unfortunately 1,25-dihydroxyvitamin D treatment remains expensive and the pre-parturient diets used in most trials would be classified today as high in cations. *Solanum glaucophyllum* (SG) is a plant which contains high levels of a glycoside form of 1,25-dihydroxyvitamin D. Could administration of SG leaves to cows that were already being fed a low DCAD pre-parturient diet further improve calcium status at calving? Nine multiparous Jersey cows were fed a low DCAD diet prior to calving. Urine pH of cows was maintained below 7.0 in all cows the week prior to parturition. Five cows were daily given 2 or 3 g SG leaves in gelatin boluses beginning 6 days (on average) before calving and continuing for the first 14 days of lactation. None of the four cows fed the low DCAD diet developed milk fever. Their blood calcium concentrations were 7.6, 7.0 and 8.0 mg/dl the day of calving and d 1 and 2 after calving respectively. Cows receiving SG in addition to low DCAD diet had significantly higher blood calcium concentration during the periparturient period with blood calcium concentrations of 7.8, 8.8 and 9.3 mg/dl the day of calving and d 1 and 2 after calving respectively. Control cows suffered an average of 3 days of subclinical hypocalcemia (blood calcium < 7.5 mg/dl) and the SG treated cows suffered 0.8 d of subclinical hypocalcemia the first 2 wk of lactation. Thus SG treatment improved calcium status in animals that were also being fed a low DCAD diet. Unfortunately, all cows receiving SG suffered 1-2 days of hypocalcemia (1 cow developed milk fever) between 6 and 8 days after SG treatment was ended. Mean blood calcium on d 22 of lactation of SG cows was 6.9 mg/dl compared with 9.2 mg/dl in untreated cows. It appears that SG treatment supplanted calcium homeostasis mechanisms in cows so that withdrawal of treatment left the cows temporarily unable to control blood calcium concentration.

Key Words: milk fever, *Solanum glaucophyllum*, hypocalcemia

ASAS/ADSA Forages and Pastures: Silages

638 Corn plant and silage nutritive value in different stages of maturity. Jorgelina Ferrero^{*1}, Oscar DiMarco², Enrique Rossi², and Daniel Valle², ¹*Fac. Cs. Agrarias U.N.L.,* ²*Fac. Cs. Agrarias UNMdP-INTA Balcarce.*

The nutritive value of corn "fresh cut" (FC) and ensiled (S) whole plant, stalk and leaf blade was evaluated in three stages of maturity: milking (A), half milk line (B) and physiological maturity (C). Chemical composition, *in vitro* DM digestibility (IVDMD) and *in situ* DM and NDF degradability (48 h) of whole plant, stalk and leaf blade, before and after ensiling, were evaluated. Three silos of each fraction were made in each stage of maturity in plastic containers (5 liters), which were stored for 45 days. In addition, samples of stalk and leaf blade were ensiled

in each container by placing them in nylon mesh bags inside the whole plant silage. Data from each plant fraction were analyzed by a two factorial analysis of variance (stage of maturity and ensiling). Whole plant (FC) chemical composition was: 52.2 % NDF, 3.2 % starch and 17.3 % soluble sugars (CNES) in A, and 43.9 % NDF, 21.6 % starch and 20.9 % CNES in C. The concentration of CNES diminished in stalk with maturity from 27.4 in A to 18.2 % in C. The IVDMD of whole plant did not differ between stages of maturity (average: 66.8 %). IVDMD of stalk diminished between B and C (50.6 to 48.8 %, P<0.01), due to a lower concentration of CNES, and in leaf blade IVDMD decreased between A and B (65.2 to 56.7 %, P<0.01), due to a decrease in NDF quality. The *in situ* NDF degradability decreased (P<0.01) with maturity (A and

B) in stalk (41.8 to 38.2 %) and in leaf blade (70.9 to 57.6 %) without affecting whole plant DM degradability (72.8 %). Ensiling depressed CNES but did not affect NDF concentrations in whole plant, stalk or leaf blade. Significant interactions between maturity and ensiling were found for IVDMD and degradability (MS and NDF) in whole plant, stalk and leaf blade. It was concluded that the increase in starch accumulation with maturity compensated for the decrease in stover quality; and that care should be taken in extrapolation of results between data of fresh cut and ensiled corn.

Key Words: maize, silage, maturity stage

639 Evaluation of the nutritive value of low moisture corn silage stored in Ag Bag® vs bunker silos. J. H. Harrison*, D. Davidson¹, and D. Linder², ¹Washington State University, Puyallup, ²Ag Bag®, Warrenton, OR.

Pioneer® hybrid 39K72 was harvested on 10-22 and 10-23 -1999 as alternating loads in to a 3 meter Ag Bag® or 4.2 x 2.4 x 45 meter bunker silo. Average DM of the whole plant corn was 37% at ensiling. Each silo contained ~ 150 tons of silage. Silage temperatures were monitored at two locations at .3 and 1 meter depths in each silo. After 6 months of storage the two silages were compared in a 2 x 2 Latin square design lactation study with 2 week periods. Each group of cows had 24 cows and was fed diets that contained 26 % corn silage, 13 % alfalfa hay, 13 % whole cottonseed, and 52 % grain mix. The fermentation profile of Ag Bag® and bunker stored corn silages were: pH, 3.9 and 4.2; acetate % DM, 0.9 and 0.9; lactate % DM, 2.9 and 2.8, and ethanol % DM, .2 and .1, respectively. Average silage temp was 0.8 to 2.0°C cooler during storage for Ag Bag® silage. Data shown below support the conclusion that low moisture corn silage stored in an Ag Bag® system had greater nutritive value.

Silo	Milk, kg	Milk fat %	3.5 FCM, kg	Milk protein, %	Milk protein, kg
Ag Bag®	38.1	3.80	39.4	2.89	1.08
Bunker	37.6	3.61	38.2	28.6	1.07
P<	.17	.05	.06	.17	NS

Key Words: dairy, nutrition, corn silage

640 Evaluation of the nutritive value of processed corn silage harvested at three chop lengths. J.H. Harrison*, D. Davidson, and L. Johnson, Washington State University, Puyallup, WA/U.S.A..

Pioneer® hybrid 3845 was harvested from 10-20 through 10-22-1999 at three chop lengths (16, 28, and 40 mm) with a John Deere 5830 harvester equipped with kernel processor and ensiled in 3 m Ag Bag® silos. After 3 months of storage the three silages were compared in a continuous design lactation study beginning three weeks pre-partum through 10 weeks postpartum. Each group had 5 cows and were fed diets that contained 26% corn silage, 13% whole cottonseed, and 52% grain mix. Data summarized below indicate a trend for a time x chop length interaction with long chopped corn silage sustaining a greater intake of DM, less loss of BW, and greater 3.5% FCM. Milk protein content was greatest for cows consuming long chopped corn silage.

Silage	3.5 FCM, kg		Milk fat, %	Milk protein, %	BW, kg	BCS
	Milk, kg	DMI, kg				
16 mm	39.3	20.6	42.6	4.01	2.97	599
28 mm	39.6	20.3	42.7	4.07	2.80	617
40 mm	40.3	22.0	44.5	4.27	3.02	609
P ≤ Chop length	NS	NS	NS	.34	.08	NS
P ≤ Chop length x week	.29	.13	.15	NS	.03	.27

Key Words: dairy, nutrition, corn silage

641 Production response of Holstein cows fed diets containing annual ryegrass and corn silage with either ground or steam-flaked corn. J. K. Bernard*, J. W. West, and D. S. Trammell, The University of Georgia, Tifton, GA USA.

Twenty-four lactating Holstein cows were used in a 6-wk randomized design trial with a 2 x 2 factorial arrangement of treatments to determine

the effects of feeding ground (GC) or steam-flaked corn (SFC) in diets based on either annual ryegrass silage (RS) or a 50:50 blend of annual ryegrass and corn silages (BLEND). Cows were fed a basal diet during the first 2-wk of the trial and data were collected for covariate analysis. Experimental diets contained 49.6% forage and were formulated to contain equal concentrations of CP, NDF and energy. There were no interactions of forage and processing of corn. The mean DMI, milk yield, milk fat percentage, milk protein percentage, and energy-corrected milk (ECM) yield was 19.7 kg/d, 30.8 kg/d, 3.28%, 2.85% and 27.6 kg/d for cows fed RS and 22.3 kg/d, 31.5 kg/d, 3.41%, 2.78%, and 31.2 kg/d for cows fed BLEND. Cows fed BLEND consumed more DM (P < 0.001) and tended to produce more ECM (P < 0.09) due to numerically higher milk yield and milk fat percentage than those fed RS. Efficiency of converting DM to milk was greater (P < 0.01) for the diet based on RS compared to BLEND, but no difference was observed for efficiency of converting DM to ECM. There were no differences in BUN and glucose concentrations (P > 0.10) between forages. The mean DMI, milk yield, milk fat percentage, milk protein percentage, and ECM yield was 21.5 kg/d, 29.8 kg/d, 3.59%, 2.84% and 28.8 kg/d for cows fed GC and 20.4 kg/d, 32.5 kg/d, 3.10%, 2.78%, and 30.0 kg/d for cows fed SFC. Cow fed diets containing SFC consumed less DM (P < 0.04), but had higher milk yield (P < 0.004) that tended to have lower concentrations of fat (P < 0.10). Yield of milk protein was higher (P < 0.01) for cows fed SFC (0.90 kg/d) compared with cows fed GC (0.83 kg/d). Efficiency of converting DM to milk was greater (P < 0.005) when cows were fed SFC than GC. No differences were observed in efficiency of converting DM to ECM. Blood glucose concentrations were similar for cows fed either GC or SFC, but BUN was lower (P < 0.03) for cows fed SFC (15.6 mg/dl) than GC (18.2 mg/dl). Results of this trial indicate that feeding a blend of annual ryegrass and corn silage supports greater milk yield than feeding all ryegrass silage and that steam-flaked corn improved milk yield and utilization of DM over ground corn.

Key Words: Ryegrass silage, Corn silage, Steam-flaked corn

642 The effect of Lactobacillus buchneri 40788 and enzymes on the fermentation and aerobic stability of barley silage fed to lactating cows. C. C. Taylor*, J. A. Mills, J. M. Neylon, and L. Kung, Jr., University of Delaware, Newark, DE.

We investigated the effects of adding a heterofermentative lactobacilli, *L. buchneri*, to whole plant barley on the aerobic stability and the nutritive value of silage. Chopped barley (40% DM) was either treated or not treated with a combination of *L. buchneri* (LB, 400,000 cfu/g of fresh forage) and enzymes (Biotal, Inc., Eden Prairie, MN) and ensiled in a bag silo. About 40 t of forage was prepared for each treatment. The average concentration of acetic acid in treated silage was higher (6.68%, P < 0.05) than in untreated silage (2.69%, DMB) during the first 16 wk of ensiling. After 7 mo of storage, both ends of the bag silo were opened simultaneously and untreated and treated silages were fed to sixteen multiparous and eight primiparous Holstein cows producing about 26 kg of milk/d (124 ± 52 DIM; mean ± SD). Cows were fed a TMR comprised of 35% untreated or treated barley silage, 15% corn silage, and 50% (DMB) of a pelleted concentrate. The experiment was a crossover design consisting of two 21-d periods; the last week in each period was used for collection of production data. During feedout, barley silage treated with *L. buchneri* had higher concentrations of acetic acid (5.92 vs. 4.02%, DMB, P < 0.06), fewer yeasts (2.63 vs. 4.89 log₁₀ cfu/g, P < 0.05), and took longer to spoil when exposed to air (>190 vs. 66 h, P < 0.05) when compared to untreated silage. The aerobic stability of the TMR was longer (P < 0.05) when it contained treated (77 h) rather than untreated (46 h) barley silage. Dry matter intake (18.6 kg/d), milk production (25.7 kg/d), and milk composition did not differ between treatments. These findings show that *L. buchneri* can improve the aerobic stability of barley silage in farm-scale silos and high concentrations of acetic acid in treated silage did not reduce DMI. The data also show that mixing silage treated with *L. buchneri* into a TMR, can improve the aerobic stability of that TMR even though it contained corn silage that had not been treated.

Key Words: Lactobacillus buchneri, Silage, Aerobic stability

643 Adding *Lactobacillus buchneri* 40788 to alfalfa silage increases the production of acetic acid in laboratory and farm-scale silos and has no effect on the dry matter intake of high producing dairy cows. C. C. Taylor, M. P. Lynch, J. M. Neylon, T. L. Ebling*, and L. Kung, Jr., *University of Delaware, Newark, DE.*

We applied a heterofermentative lactobacilli, *L. buchneri*, and enzymes (Biotol, Inc., Eden Prairie, MN), to alfalfa silage (38% DM) and studied its effects on silage fermentation in lab and farm silos. Alfalfa was chopped and treated with nothing, or *L. buchneri* to obtain a final application rate of 1×10^5 , 5×10^5 , or 1×10^6 cfu/g of fresh forage. After 56 d of ensiling in lab silos, treated silages had higher ($P < 0.05$) concentrations of acetic acid (6.00 versus 4.24%), propionic acid (0.18 versus 0.06%), and ammonia N (0.346 versus 0.289%) than did untreated silage. Yeasts and molds were less than $2.00 \log_{10}$ cfu/g in all silages. In a subsequent experiment, alfalfa (43% DM) was not treated or treated with *L. buchneri* (5×10^5 cfu/g) and enzymes and stored in a bag silo for 4 mo before feeding. Twenty four multiparous and six primiparous cows (86 11 DIM) were fed a diet comprised of 32% untreated or treated alfalfa silage, 11% corn silage, 5% chopped alfalfa hay, and 52% of pelleted concentrate (DMB) for a 6-wk treatment period. Dry matter intake (25.2 kg/d), milk production (40.3 kg/d), and milk composition were unaffected by treatment. During feed out, treated silage had a higher pH (4.66 vs. 4.36, $P < 0.05$) and higher concentration of acetic acid (5.69 vs. 3.38%, $P < 0.05$), but lower lactic acid (5.26 vs. 6.58%, $P < 0.05$) than untreated silage. Yeasts and molds were less than $2.00 \log_{10}$ cfu/g for both alfalfa silages but was 6.11 and $5.72 \log_{10}$ cfu/g in corn silage, respectively. Alfalfa silages, alone, did not heat but the TMR containing untreated silage heated after 69 h whereas the TMR containing the silage treated with *L. buchneri* did not heat until 100 h ($P < 0.05$). These data show that treating alfalfa silage with *L. buchneri* increases the concentration of acetic acid and when the silage mixed with other feeds, it can improve the aerobic stability of the TMR.

Key Words: *Lactobacillus buchneri*, Silage

644 Evaluation of nutrient composition and IVDMD of alfalfa and/or tropical grasses grown in Hawaii and harvested as round bale silage. D.T. Harauchi*, J.R. Carpenter, R.J. Early, and C.N. Lee, *University of Hawaii-Manoa.*

Currently, much of the nutritional composition data available in Hawaii has come from samples taken from outside the State. Since the current data from most forages have come from temperate climates, the objective of this study was to expand a database of nutrient composition for locally grown forages used for dairy rations. The samples consisted of alfalfa (*Medicago sativa*), guinea grass (*Panicum maximum*), green panic (*P. maximum* var. *trichoglume*), klein grass (*Panicum coloratum*), or a combination of these forages. The silage was grown in Wailua on the northern coast of Oahu and harvested between September 1997 and December 1998 at varying stages of regrowth. The ensiled samples were obtained from Dole Food Co. and CP, NDF, and ADF were determined using NIRs (NIRSystems Model 6500). DM, and ash were determined using AOAC techniques, and 48h IVDMD by Ankom procedures. A fistulated steer fed alfalfa cubes ad libitum was used as the source of rumen inoculum (4 h post-prandial). A total of 289 samples were separated according to forage type and different stages of maturity (<4, 4-5, 5-6, >6 weeks) to determine the effect of species and age of regrowth on digestibility. The mean DM was 47.1, and the % ash, CP, NDF, ADF and IVDMD for the 289 samples (DM basis) was 8.1, 17.4, 52.2, 34.4, and 76.6, respectively. NDF and ADF were lower ($P < .01$) for alfalfa (41.6 and 31.0%, respectively) than alfalfa/guinea (50.6 and 35.6%) and these were all lower than the other grasses (68.3 and 38.9%). 48h IVDMD, DM, and ash showed no significant difference between the grasses. The CP was highest ($P < .01$) for alfalfa (21.8%) followed by alfalfa/guinea mix (17.8%), green panic/guinea (13.6%), klein/guinea (10.9%) and other mixed grasses (9.3%). NDF values were higher ($P < .01$) with each increase in age of regrowth, and IVDMD was higher ($P < .01$) for the alfalfa and alfalfa guinea mix than the other grasses at all ages except for 5-6 wk where no differences were observed.

Key Words: Alfalfa and tropical grass silages, Nutrient composition, IVDMD

645 The effect of inoculation with *Lactobacillus plantarum* MTD1 and packing density on the fermentation of high DM alfalfa silage. M. P. Lynch*, J. A. Lazartic, J. M. Neylon, C. C. Taylor, M. A. Reddish, and L. Kung, Jr., *University of Delaware, Newark, DE.*

We investigated the effect of packing density and microbial inoculation on the fermentation of alfalfa silage with a high DM content. Alfalfa was wilted to 53% DM before chopping. Treatments were: 1) untreated, tightly packed (411 kg/m³, DMB) (UT), 2) inoculated with *Lactobacillus plantarum* MTD1 (Ecosyl Products, Ltd., Stokesley, England; 100,000 cfu/g of fresh forage), tightly packed (LPT), 3) untreated, loosely packed (205 kg/m³) (UL), or 4) inoculated, loosely packed (LPL) in laboratory silos. After 8 d of ensiling, LPT had higher ($P < 0.05$) concentrations of lactic acid, but lower ($P < 0.05$) concentrations of ammonia N and acetic acid than did UT. In contrast, UL had a higher pH (5.60 vs. 5.31, $P < 0.05$), a lower concentration of lactic acid (1.28 vs. 2.49%, $P < 0.05$), and fewer lactic acid bacteria (8.23 vs. 8.67 \log_{10} cfu/g, $P < 0.05$) than did UT. Adding homolactic acid bacteria to loosely packed silage (LPL) increased the concentration of lactic acid and decreased acetic acid ($P < 0.05$) when compared to UL, but the effect was intermediate ($P < 0.05$) to that of LPT. After 42 d of ensiling (see table), untreated, loosely packed silage (UL) had a higher ($P < 0.05$) pH, a lower ($P < 0.05$) concentration of lactic acid, and more ($P < 0.05$) yeasts and molds than did UT. Microbial inoculation overcame the detrimental effects of loose packing (LPL) by causing a more ($P < 0.05$) predominant homolactic acid fermentation. However, inoculation of loosely packed silage could not prevent the accumulation of yeasts and molds that were undetectable in tightly packed silage (UT and LPT).

Item	UT	LPT	UL	LPL	SE
pH	4.61 ^b	4.27 ^c	5.04 ^a	4.29 ^c	0.01
Lactic acid, %	4.19 ^b	5.63 ^a	3.24 ^c	5.36 ^a	0.14
Acetic acid, %	1.88 ^a	0.69 ^d	1.48 ^b	1.02 ^c	0.07
Ammonia N, %	0.11 ^a	0.05 ^c	0.08 ^b	0.05 ^c	0.01
Yeasts, \log_{10} cfu/g	0 ^c	0 ^c	5.71 ^a	5.72 ^b	0.34
Molds, \log_{10} cfu/g	0 ^c	0 ^c	6.19 ^a	4.43 ^b	0.25

^{a,b,c,d} Means in rows with unlike superscript differ ($P < 0.05$).

Key Words: Packing density, Inoculation, Silage

646 Why digestibility of alfalfa stems declines with maturity. H. G. Jung*¹ and F. M. Engels², ¹USDA-ARS, St. Paul, MN, ²Wageningen University, The Netherlands.

Development of an alfalfa stem internode from three genotypes was examined to determine why digestibility of alfalfa stems declines with maturity. The seventh internode from the stem base was collected from replicated field plots at five stages of development (12, 17, 21, 31, and 87 d of summer regrowth). Internode samples were preserved in alcohol for microscopic analysis and freeze-dried for cell wall (CW) and in vitro digestibility analysis. While minor genotypic differences were noted, the general pattern of development and digestibility was similar for the genotypes so only means are presented. Young, elongating internodes (12 and 17 d) had thin, nonlignified CWs in all tissues except primary xylem vessels which were already lignified. Internode elongation was complete by 21 d of regrowth, at which time there was some deposition of xylem fibers and this tissue was lignified. Further maturation (31 and 87 d) consisted of xylem tissue proliferation by cambial activity, and lignification of primary phloem and pith parenchyma tissues. CW concentration increased with maturity. Pectin (Pec) concentration in the CW declined while cellulose (Cel), hemicellulose (Hemi), and lignin (Lig) all increased with maturation. Major CW changes occurred when internode elongation ceased. All alfalfa stem tissues were completely digested in the two youngest maturity stages, except primary xylem vessels. Xylem fiber remained undigested after 21 d of regrowth and amount of undigested xylem increased with maturity. Some primary phloem and pith parenchyma tissues were undigested in the two oldest samples. CW polysaccharide digestion declined steadily from 17 to 87 d of regrowth. Xylem fiber was lignified as soon as it was formed and was almost completely indigestible. Proliferation of xylem fiber accounts for the increase in stem mass and reduction in alfalfa stem digestibility with maturity.

Trait	12 d	17 d	21 d	31 d	87 d
CW, % OM	37.1 ^a	50.2 ^b	65.3 ^c	71.1 ^d	72.4 ^d
Cel, % CW	33.9 ^a	34.5 ^a	40.1 ^b	42.1 ^c	40.2 ^b
Hemi, % CW	12.2 ^a	13.4 ^b	16.7 ^c	18.2 ^d	19.0 ^e
Pec, % CW	43.7 ^a	42.1 ^a	27.4 ^b	20.5 ^c	20.3 ^c
Lig, % CW	10.1 ^a	10.0 ^a	15.8 ^b	19.3 ^c	20.4 ^c
Polysaccharide Digestibility, %					
12-h	-	84.1 ^a	66.9 ^b	46.4 ^c	39.3 ^d
96-h	-	91.4 ^a	79.7 ^b	65.6 ^c	49.3 ^d

Means in the same row not sharing a superscript are different ($P < 0.05$).

Key Words: Alfalfa, Digestibility, Maturity

647 Nutrient composition of several brown midrib and non-brown midrib sorghum varieties. J. B. Banta*, F. T. McCollum, B. Bean, D. Pietsch, and M. Rowland, *Texas A & M University System*.

ABSTRACT: Nutritional constituents were compared in sorghum harvested for silage. The study included 17 brown midrib (BMR) and 48 non-BMR sorghum varieties. Varieties were randomly assigned to plots (four 0.762 m rows by 7.62 m long) in three replications. The varieties were planted on May 24, 2000, at a depth of 3.81 cm and 296,400 plants/ha. Fertilizer N was applied at 202 kg actual N/ha and Bicep II Magnum was applied immediately after planting. The soil type was a Pullman clay loam with a pH of 7.4. The varieties were grown under full irrigation. Harvest occurred on August 30, September 6, or September 27, when each entry was at the soft-dough stage. Forage samples were collected from 1 m of row in each plot, weighed, chopped and subsampled. Supsamples were immediately frozen and sent to the Dairy One Laboratory (Ithaca, New York) for analysis. The samples were analyzed using near infrared spectrometry and in vitro techniques. All varieties were ranked from most desirable (1) to least desirable (65) for each constituent. Mean nutrient values and ranks for BMR were more desirable than for non-BMR. However, based on individual variety data there was overlap between the two forage types. Hence, selection of a sorghum based solely on the BMR trait does not guarantee a more desirable nutrient profile.

	CP, %	ADF, %	NDF, %	Lignin, %	IVDMD, %
BMR					
mean	7.2	26.10	44.8	3.1	81.7
mean rank	27	26	26	15	16
non-BMR					
mean	6.7	28.4	48.1	4.4	75.4
mean rank	37	36	36	39	40
P-value	0.019	0.009	0.013	0.0001	0.0001

Key Words: Sorghum Silage, Digestibility

648 Performance of lactating dairy cows fed red clover based diets augmented with normal or brown midrib corn silage. P.C. Hoffman*¹ and L.M. Bauman¹, ¹*University of Wisconsin-Madison*.

Red clover (RC), normal corn silage (CS), and brown mid-rib corn silage (BMR) were harvested at recommended stages of maturity and ensiled. Eighteen early lactation (57±37 DIM) primiparous (N=9) and multiparous (N=9) Holstein cows were fed diets with forage bases of 100% RC, a 50:50 ratio of RC and CS, and a 50:50 ratio of RC and BMR. Concentrate mixtures were formulated for RC, CS, and BMR and fed at 56.0, 50.0 and 50.0% of dietary DM to yield isofibrous (NDF) and isonitrogenous diets. Lactation performance, feed intake, and milk protein fractions were evaluated. Numerically, RC contained more CP, NDF, and lignin than CS or BMR. The in vitro (IV) DM and NDF digestibility (D) of BMR was numerically higher than CS and was substantially higher than RC. There were no parity but treatment interactions, therefore data from primiparous and multiparous cows were combined. Cows fed CS and BMR produced more ($P < 0.07$) milk and consumed more ($P < 0.01$) DM than cows fed RC. Cows fed BMR consumed ($P < 0.05$) more DM than cows fed CS. Milk fat%, protein%, or casein% was not different between cows fed RC, CS, or BMR. Data suggested DM intake

and milk yield of lactating dairy cows fed red clover can be enhanced by addition of CS or BMR to the diet.

Item	RC	CS	BMR	SE	$P <$
Forage Quality					
CP, % DM	20.9	10.1	8.7	
NDF, % DM	53.7	39.8	39.0	
Lignin, % DM	6.2	2.6	2.2	
IVDMD, % DM	71.2	82.1	87.3	
IVNDFD, % NDF	46.2	55.0	67.5	
Performance					
Milk yield, kg/d	31.9	33.2	33.2	0.48	0.07
Milk fat, %	3.91	3.84	3.74	0.06	0.18
Milk protein, %	3.13	3.17	3.17	0.02	0.21
Casein, %	2.52	2.60	2.49	0.05	0.35
DMI, kg/d	20.6	22.1	23.3	0.30	0.01

Key Words: Red clover, Lactation, Corn silage

649 The effect of applying a buffered propionic acid-based preservative (Ki-112) alone or in combination with a mixture of homolactic acid bacteria (HAB) on the fermentation and aerobic stability of high moisture corn. J. M. Neylon*¹, C. L. Myers², C. C. Taylor¹, J. A. Lazartec¹, and L. Kung, Jr.¹, ¹*University of Delaware, Newark, DE*, ²*Kemin Industries, Des Moines, IA*.

The objective of this study was to evaluate the effect of applying Ki-112 alone or in combination with HAB on the fermentation and aerobic stability of ground, high moisture corn (29% DM) ensiled in lab silos. Treatments were: 1) no additive, 2) 0.1% (fresh forage weight) Ki-112 (a propionic acid-based additive, Kemin Industries, Des Moines, IA), 3) 0.2% Ki-112, 4) HAB, which was comprised of *Lactobacillus plantarum*, *L. bulgaricus*, and *L. acidophilus* to obtain 100,000 cfu/g of fresh forage weight (Kemin Industries), 5) 0.1% Ki-112 + HAB, and 6) 0.2% Ki-112 + HAB. The inoculant and chemical additive were applied separately in treatments 5 and 6. The addition of Ki-112 and HAB, alone or in combination, had few effects on the fermentation of high moisture corn during the early stages of ensiling. Similar to concentrations in freshly treated corn, treatments containing Ki-112 had greater concentrations of propionic acid than untreated corn after 120 d of ensiling. Numbers of yeasts were 4.16 log₁₀cfu/g in untreated corn and were less ($P < 0.05$) than 2.00 log₁₀cfu/g in corn that was treated with 0.2% Ki-112. HAB alone, did not affect the numbers of yeasts (3.92 log₁₀cfu/g) in high moisture corn. Corn treated with only 0.1% Ki-112 (161 h, $P < 0.10$) and 0.2% Ki-112 (218 h, $P < 0.05$) was more stable when exposed to air than untreated corn (122 h). Treatment with only HAB or HAB + 0.1% Ki-112 did not affect the aerobic stability of corn. However, treatment with HAB + 0.2% Ki-112 markedly improved the aerobic stability (> 400 h, $P < 0.05$) of corn. Data from this study indicates that application of Ki-112 at 0.2% of fresh weight is required to improve the aerobic stability of high moisture corn. A microbial inoculant, alone, had no effect on aerobic stability, but when combined with the 0.2% Ki-112, stability was markedly improved.

Key Words: Propionic acid, Aerobic stability, Silage

650 Evaluation of the replacement value of HMEC for steam rolled corn grain. J. H. Harrison*¹, D. Davidson¹, D. Linder², and F. Hosington³, ¹*Washington State University, Puyallup*, ²*Ag Bag® Int., Warrenton, OR*, ³*Dari-Tech Services, Kent, WA*.

Pioneer[®] hybrid 3489 was grown in George, WA in 1999 for harvest as high moisture ear corn (HMEC) or dry grain. The planting date was ~ April 23 and harvest date for HMEC (31% moisture) was October 26. The grain corn was harvested ~ 2 weeks later and artificially dried. The HMEC was harvested with a Claas 860 chopper equipped with a kernel processor. The HMEC was ensiled in a 3 meter Ag Bag[®] and treated with Pioneer[®] 1189 inoculant. The dry corn grain was steam rolled prior to feeding. The two forms of corn grain were fed in a 4 x 4 Latin square design trial with 14-day periods. Cows averaged 104 DIM at the onset of the experiment and all cows received rBST on day 4 of each period. The four dietary treatments were ratios of HMEC:steam rolled corn of: 1) 100:0, 2) 75:25, 3) 25:75, and 4) 0:100 to provide 25 % of diet DM. The

12 hr macro in situ digestibility of starch and NDF of HMEC and steam rolled corn grain was: 18, 77, 22, and 69, respectively. The data shown below supports the conclusion that 25 % of steam rolled corn could be replaced with HMEC.

Item	Ratio				P _≤
	100:0	HMEC:steamed 75:25	rolled corn 25:75	0:100	
Milk, kg	34.9	37.2	38.6	38.7	NS
Milk fat, %	3.46 ^c	3.69 ^{bc}	3.85 ^{ab}	3.73 ^b	.12
3.5 % FCM, kg	34.7 ^c	38.1 ^{bc}	40.8 ^{ab}	40.1 ^{ab}	.19
Milk fat, kg	1.21 ^c	1.36 ^{bc}	1.49 ^{ab}	1.44 ^{ab}	.12
Milk protein, %	2.99	2.97	3.00	2.92	NS
Milk protein, kg	1.04	1.11	1.15	1.12	NS

Key Words: dairy, nutrition, high moisture ear corn

ASAS/ADSA Ruminant Nutrition: Feedlot

651 Effects of supplemental phosphorus concentrations on inorganic phosphorus serum concentrations, growth performance, carcass characteristics, and cost of gain of finishing cattle. Wendy R. Flatt*¹, Tim Stanton¹, Jessica Davis¹, and Dave Schutz², ¹Colorado State University, ²CSU-Eastern Colorado Research Center.

ABSTRACT: The objective of this study was to evaluate the effects of dietary phosphorus (P) concentration on cattle growth, performance, blood serum levels and carcass characteristics. Two hundred and twenty-one beef cattle (119 heifers, 102 steers) with an average initial live weight of 296 ± 70.5 kg were used in a randomized experimental design. Calves were randomized by live weight, stratified by breed, and assigned to one of two treatments (four pens/treatment). Control (C) was fed at 0.34% (DM basis) for 147 days on feed (DOF). Low phosphorus (LP) cattle were fed at 0.34% P (DM basis) until day 85 at which time supplemental P was dropped to 0.24% until finish. Over the 147 d feeding period, feed intake was not affected (P > 0.05) by P level. Feed intake was 9.30 and 9.32 kg DM (± 0.02kg) of feed per day for C and LP, respectively. Average daily gain, although not significant (P > 0.05), was higher for cattle on C compared to cattle on LP (1.64 vs. 1.60 ± 0.04 kg/day). Feed efficiency was not affected by P treatments. No significant differences were determined between serum levels of inorganic P of cattle on C vs. LP. Dressing percent, hot carcass weight, muscling score, percent grading choice, and yield grade were not affected by the level of dietary P in the supplement. However, percent dark cutters for C and LP were significantly different as the percent not grading because they were dark cutters was 4.50% for cattle on C vs. 13.64% for cattle on LP. The calves on LP also had a higher (P < 0.05) incidence of morbidity than those calves on C, 13.51% vs. 4.50%, respectively. Reducing supplemental P from the diet at reimplant time may increase the incidence of morbidity and dark cutters.

Key Words: Phosphorus, Dark cutters, Feed efficiency

652 Effects of wet corn gluten feed and intake level on diet digestibility and rumen passage rate in steers. S. P. Montgomery*, J. S. Drouillard, E. C. Titgemeyer, J. J. Sindt, T. B. Farran, J. N. Pike, C. M. Coetzer, A. M. Trater, and J. J. Higgins, Kansas State University, Manhattan..

Twelve ruminally cannulated Jersey steers (534 ± 52 kg BW) were used in an incomplete Latin square design experiment with a 2 × 2 factorial arrangement of treatments to determine effects of wet corn gluten feed (WCGF) and total DMI level on diet digestibility and rumen passage rate. Treatments consisted of diets formulated to contain 40% WCGF or no WCGF, fed once daily either ad libitum or limited to 1.6% of BW. Two consecutive 24-d periods were used, consisting of 18 d for adaptation, 4 d for collection, and a 2-d in situ period. Chromic oxide (10 g/hd) was fed as a digestibility marker, and steers were pulse dosed with Yb-labeled alfalfa hay and a Co-EDTA solution via rumen cannula to measure solid and liquid passage rates. Dacron bags containing 5 g of either steam-flaked corn, WCGF, or ground (2-mm) alfalfa hay were placed into the rumens of all steers and removed after 3, 6, 12, or 48 h. WCGF increased total tract digestion of OM and NDF (P < 0.01), reduced total VFA concentration (P < 0.01), increased rumen NH₃ concentration (P < 0.01), increased rumen pH (P < 0.01), and tended (P < 0.06) to increase total tract digestion of starch. WCGF also increased rumen passage rate of solid digesta (P < 0.01). Limit feeding reduced (P < 0.01) total tract digestion of both OM and NDF, reduced total VFA concentration (P < 0.01), increased rumen NH₃ concentration (P < 0.01), and increased rumen liquid passage rate (P < 0.02). Total tract

digestion of starch was not affected by DMI level (P > 0.70). A DMI level × h interaction (P < 0.01) occurred for rumen pH. Limit feeding increased rumen pH at 0 and 12 h after feeding, but reduced rumen pH 4 h after feeding. WCGF or DMI level did not affect (P > 0.25) rate of in situ DM disappearance. This study suggests that WCGF increases OM and NDF digestion, and that limit-feeding high-energy diets once daily may depress OM and NDF digestion.

Key Words: Wet corn gluten feed, Limit feeding, Digestibility

653 Performance of beef heifers limit-fed growing diets containing alfalfa hay and wet corn gluten feed. S. P. Montgomery*, J. S. Drouillard, J. J. Sindt, T. B. Farran, J. N. Pike, C. M. Coetzer, H. J. LaBrune, A. M. Trater, and R. D. Hunter, Kansas State University, Manhattan..

Crossbred beef heifers (n = 339, BW = 277 ± 11.4 kg) were used in a randomized complete block design to determine optimum combinations of alfalfa hay (AH) and wet corn gluten feed (CGF) in limit-fed growing diets containing steam-flaked corn. Heifers were fed a common diet ad libitum for 15 d preceding the growing study to minimize differences in gastrointestinal tract fill. Heifers were then blocked by weight and allotted to pens containing four to seven head per pen, with six pens per treatment. Treatments consisted of diets containing 10, 20, or 30% ground AH, and 0, 40, or 68% CGF in a 3 × 3 factorial arrangement. All diets provided 33 mg/kg of monensin and were fed once daily at 1.6% of BW for 84 d. On d 8, 22, 37, 51, 64, and 79, unconsumed feed was removed from feed bunks 2 h after feeding, weighed, and returned to the respective feed bunk in order to measure rate of DMI. Prior to obtaining final weights, cattle were fed a common diet ad libitum for 15 d. An interaction occurred (P < 0.05) between level of AH and CGF level for both ADG and gain efficiency. ADG for the 99-d growing study were 1.03, .96, .90, .90, .88, .84, .85, .90, and .78 ± 0.02 kg/d and gain efficiencies were .196, .185, .175, .171, .172, .160, .163, .180, and .153 ± 0.004 kg gain/kg DM for 10AH/0CGF, 10AH/40CGF, 10AH/68CGF, 20AH/0CGF, 20AH/40CGF, 20AH/68CGF, 30AH/0CGF, 0AH/40CGF, and 30AH/68CGF, respectively. Increasing the levels of AH or CGF reduced cattle performance with the exception of 30AH/40CGF, which supported ADG similar (P > 0.10) to 20AH/0CGF or 30AH/0CGF, and improved gain efficiencies (P < 0.05) compared to 30AH/0CGF. DMI 2 h after feeding increased linearly (P < 0.01) with increasing AH, and decreased linearly (P < 0.01) with increasing CGF. This study suggests that 40% CGF can effectively replace steam-flaked corn in limit-fed growing diets containing 20 or 30% AH.

Key Words: Wet corn gluten feed, Alfalfa hay, Limit feeding

654 Wet corn gluten feed and alfalfa hay combinations in steam-flaked corn finishing diets. J. J. Sindt*¹, J. S. Drouillard¹, S. P. Montgomery¹, J. N. Pike¹, T. B. Farran¹, C. M. Coetzer¹, T. J. Kessen¹, and R. T. Ethington², ¹Kansas State University, Manhattan, ²Minnesota Corn Processors, Marshall, Minnesota.

A 153-d finishing experiment was conducted using 631 heifers (BW = 284 ± 7.9 kg) to determine optimum combinations of wet corn gluten feed (WCGF) and alfalfa hay in steam-flaked corn based diets. Heifers were randomly allocated to pens and stratified by weight to six treatments (2 pens per diet, 48 to 58 heifers per pen). Diets contained 25, 35, or 45% WCGF and 2 or 6% alfalfa hay (25/2, 25/6, 35/2, 35/6,