[BPS]) was tested in a feeding trial with three hundred 1 d old broilers. These were allocated to 3 experimental treatments for 6 wk. Experimental treatments were: C (corn-soybean basal diet), PFW (basal diet containing BPS) and A (basal diet containing 2.5 mg avilamycin/kg). Overall BW in treatment A (2314 g) was higher ($P \leq 0.05$) than in treatment C (2216 g), but did not differ from treatment PFW (2276 g). The cecal microflora (log cfu/g wet cecal content) of probiotic treatment PFW had higher ($P \leq 0.05$) concentrations of bacteria belonging to *Bifidobacterium spp*., *Lactobacillus spp*. and Gram positive cocci respectively, compared to treatments C and A. Treatments PFW had numerically higher VFA concentrations in intestinal contents and also higher ($P \leq 0.05$) specific activities of α-galactosidase and β-galactosidase. The results showed that when the probiotic product was administered a growth promoting effect similar to the antibiotic avilamycin could be obtained. In addition Biomin®PoultryStar modulated the composition and the activities of the cecal microflora, resulting in a significant probiotic effect.

Key Words: Pathogens, Natural growth promotion, Probiotics

Forages and Pastures: Silages

277 Mastication and rumination effects on digestion and passage. M. R. Murphy* and K. E. Cowles, *University of Illinois*, *Urbana*.

Ruminants spend many hours per day chewing, including time spent eating and ruminating. Comminution of feed and digesta particles affects the kinetics of both digestion and passage. These, in turn, determine nutrient availability to the animal and its productive efficiency. Although large particles (i.e., those retained on a screen with 1.18-mm pores) often comprise 80 to 90% of alfalfa or corn silage dry matter, they account for only 5 to 10% of fecal dry matter. Large particles can be a minority of those in the reticulorumen at any given time; therefore, size is not the only criterion determining passage to the lower gut. Interactions of chewing during eating and rumination with other factors (diet composition and consumption, animal physiology, and microbial fermentation in the reticulorumen and lower gut) are important, although complex. Synergism apparently exists between animal and microbial effects; for example, mastication enhances microbial fermentation, which may increase the effectiveness of comminution during rumination. Copious salivation during mastication also affects rumen fermentation, fluid dynamics, and digesta passage. A quantitative understanding of factors involved in comminution, and the kinetics of their interactions, may allow digestion and passage to be manipulated for optimal production.

Key Words: Particle size, Comminution, Ruminant

278 Effect of forage particle length and sorting of dietary ingredients by lactating dairy cows on performance and health. L. Armentano*, *University of Wisconsin*, *Madison*.

Forage particle length and proportion of forage determine the mean particle length (MPL) and physical effectiveness of diets. Adequate physically effective fiber (PEF) is required to minimize displaced abomasum, milk fat depression and other negative production and health responses. Impact of low PEF may be reduced by reducing the fermentability of dietary carbohydrate, but some requirement for PEF remains. Excessive forage length negatively impacts stability of silage, diet mixing, and feed intake. Most cows sort somewhat against the longest particles in the diet so the diet consumed has a shorter MPL and less neutral detergent fiber (NDF) than the diet offered. Not only are long fibers sorted more than intermediate fibers, but long fibers are sorted more when diets contain more long fiber. Both these factors contribute to wider chemical and physical differences between the diet offered and consumed for diets rich in long particles, although increasing the proportion of long fibers in the diet offered will increase the MPL of the diet consumed. Dryer diets are more susceptible to sorting, but adding liquids to diets complicates measuring MPL. Increased NDF content in alfalfa did not increase sorting; however increased NDF in long particles will amplify the effect of sorting to reduce dietary NDF. Cow variation is large relative to the effect of diet on mean measures of sorting, and this complicates estimating risk associated with diet, especially for sporadic negative health events. Cows housed in groups can sort more on average than individually fed cows, but extreme sorting by a few cows may be difficult to measure in loose housing. MPL is obviously strongly correlated with the percentage of larger particles and it is not clear that either is a better predictor of PEF. It takes more added mass of moderate length fibers to increase MPL compared to if longer particles are added, however the former will provide a consumed diet closer in physical and chemical makeup to the diet offered.

Key Words: Sorting, Particle length, Physically effective fiber

279 Effect of brown midrib mutation and stage of development at harvest on chemical composition and in situ disappearance of millet forage. F Hassanat*, A. F. Mustafa, and P. Seguin, *McGill University*, *Ste. Anne De Bellevue, Quebec-Canada*.

A study was conducted to evaluate the effects genotype and stage of development at harvest on chemical composition and in situ disappearance of forage millet in a 2x2 factorial design. Regular (RM) and Brown midrib (BM) millet were harvested at vegetative (VS) or heading (HS) stage, and separated to leaves, stems, or whole plant. Concentrations of ADF and ADL were higher (P<0.05) for RM (39.8% and 3.5%) than BM (36.4% and 1.7% respectively) and were higher (P<0.05) at HS compared with VS. Level of CP was higher (P<0.05) for BM at VS and HS than for RM. Millet harvested at VS contained more (P<0.05) soluble CP and NPN and less (P<0.05) NDICP and ADICP than those harvested at HS. Differences in chemical composition of leaves and stems of RM and BM at VS and HS followed the same trend as the whole plants. Cell wall of BM leaves and stems contained more (P<0.05) xylose (31.4%vs. 15.9% for leaves, 29.2%vs. 24.4% for stems), but less glucose (49.9%vs. 56.7% for leaves, 45.2%vs. 53.1%, for stems) than that of RM. Arabinose concentration was higher (P<0.05) for leaves of BM compared with RM (9.6%vs. 5.5%), but was similar in the stems of both millet types. Arabinose and xylose levels increased (P<0.05) with advanced development, while glucose decreased in leaves of the two millet types, and in the stems of RM only. In situ DM and NDF disappearance of whole plant was higher (P<0.05) for BM (72.6% and 60.2%) compared with RM (64.9% and 53.8% respectively). In situ disappearance of all cell wall sugars in BM leaves was higher (P<0.05) than RM leaves. Stems of BM had higher glucose disappearance (47.5% vs. 38.5%) but less xylose disappearance (46.8%vs. 55.6% respectively, P<0.05) compared with

RM. In situ disappearance of most cell wall sugars was reduced (P<0.05) with advanced development. High NDF disappearance in BM could be related to increase in all cell wall sugars disappearance in leaves, and some in the stems. It could be concluded that the improved in situ disappearance of BM is attributed to reduction in ADL concentration and to alternation in cell wall structure.

Key Words: Millet, Brown midrib, Cell wall

280 Performance of dairy cows fed soybean silage. E. Vargas*, A. F. Mustafa, and P. Seguin, *McGill University*, *Ste-Anne-De-Bellevue, Quebec, Canada*.

The objective of this study was to determine the feeding value of forage soybean silage to dairy cows relative to a fourth cut alfalfa silage. Two isonitrogenous diets were formulated with 50:50 forage:concentrate ratio. Alfalfa silage (AS) or soybean silage (SS) comprised 72% of the forage in each diet, with corn silage comprising the remaining 28%.Twenty Holsteins cows in early lactation (DIM 68 d ± 113 d) were used in a Switchback design where each group of cows received both treatments and one treatment twice. The study consisted of three 21-d periods with the first 7 d for diet adaptation and the last 14 d for data collection. Relative to AS, SS contained 15% and 28% more NDF and ADF, respectively. Both silages had a similar CP level (average 21% ± 3.39%). Dry matter intake and milk yield were lower (P < 0.05) for cows fed SS than those fed AS. Dry matter intake and milk yield for SS treatment was 20.3 and 34.9 kg, respectively. The corresponding values for AS treatment were 25.4 and 38 kg, respectively. Milk protein, lactose and total solid concentrations were not affected by dietary treatments (average 3.0, 4.7, and 12.6%, respectively). However, cows fed SS produced milk with higher (P < 0.05) milk fat (3.7 vs 3.6%) and milk urea concentrations (15.6 vs 14.3%) compared with cows fed AS. It was concluded that forage SS used in this study had a lower feeding value for lactating dairy cows when compared with AS.

Key Words: Soybean silage, Alfalfa silage, Dairy cows

281 Effects of propionic acid-based additive (Solution Foin) on short-term ensiling characteristics of corn. T. Levital*, A. F. Mustafa, and P. Seguin, *McGill University*, *Montreal, QC, Canada*.

Silage is an important source of forage for ruminant animals. Forage shortage may force producers to feed unfermented ensiled forages, which are more susceptible to aerobic deterioration. Propionic acid-(PA) based additives can be added to ensiled forages to inhibit yeast and mould growth, and improve the aerobic stability of silages. The objectives of this study were to determine the effects of a PA-based silage additive (Solution Foin=SF) on short-term ensiling characteristics of corn silage, and on dairy cattle production. Chopped whole corn forage was left untreated or treated with SF (contains about 70% PA and 30% NH_4^+). The additive was added to forage prior to ensiling at a rate of 0.5% (wet basis). Treated and untreated forages were placed in six plastic silo bags (three each). Silo bags were opened one day after ensiling and daily samples were collected for 30 d to evaluate ensiling characteristics. Effects of feeding treated or untreated forage on animal performance were determined in a complete randomized design, using 30 lactating cows (DIM=178 ±55) fed TMR (50% forage and 50% concentrate) with the forage portion consisting of untreated or treated forage. Yeast and mold populations in the ensiled forages were reduced by SF (P<0.05) between d 5 and 15 post-ensiling. For example, yeast counts on d 10 were 4.35 and 7.85 $\log_{10}$ cfu/g for treated and untreated forages respectively (P<0.005; SE=0.17). Mould counts on d 10 were 0.0 and 2.51 $\log_{10}$ cfu/g for treated and untreated forages respectively (P<0.02; SE=0.24). Aerobic stability of ensiled forage was also improved (P<0.05) between d 0 to d 15; For instance, on d 5 treated forage was stable for 127.3 hrs compared with 20.7 h for the untreated one (P<0.0005; SE=1.69). The additive had minor effects on pH, temperature, lactic acid and water soluble carbohydrate concentration of ensiled forages. Dairy cows fed treated forage had similar DMI and milk yield to cows fed the untreated forage. It was concluded that SF can be used to improve the short-term stability of unfermented ensiled forages, likely by reducing yeast and mold populations.

Key Words: Solution Foin (SF), Silage additive, Corn silage

282 Genetic determinism and QTL mapping of plant parameters involved in the efficient and sustainable utilisation of forage maize in animal nutrition. L. A. Lethbridge[1], J. K. Margerison*[1], C. S. Brennan[1], M. Chrenkova[2], and L. Hentenyi[2], [1]*Massey University, Institute of Food, Nutrition and Human Health*, *Palmerston North, New Zealand*, [2]*RIAP*, *Slovakia*.

The objective was to measure forage maize (FM)composition (DM, CP, NDF, ADF, ADL, starch, water soluble carbohydrates (WSC), ash) and degradability (dg) for qualitative trait loci (QTL) mapping. Near isogenic lines (NILs) of FM (n=350) were produced from 3 parent varieties and grown in randomised block design in 3 EU countries. UK FM was harvested in mid October (27 % DM). Data from parental varieties (ANT, NKB) with 8 NILs (A to H) (in g/kg DM unless stated otherwise) were analysed (ANOVA) and compared (Tukey's test). DM: A 281.1, B 284.8, C 250.2, D 299.5, E 292.9, F 288.5, NKB 270.9, ANT 294.5, G 295.8, H 284.6 (sed 2.11, P<0.001). NDF: A 483.3, B 485.7, C 490.7, D 455.7, E 455.3, F 398.3, NKB 489.7, ANT 410.3, G 471.3, H 452.3 (sed 31.73). ADF, A 289.7, B 271.33, C 320.0, D 253.3, E 238.3, F 307.3, NKB 275.7, ANT 241.7, G 255.0, H 311.3 (sed 16.56, P,0.05). ADL: A 20.0, B 19.3, C 46.7, D 26.7, E 32.0, F 38.7, NKB 44.3, ANT 13.3, G 32.3, H 33.3 (sed 16.06). Ash: A 42.9, B 39.3, C 53.1, D 31.4, E 39.4, F 37.6 NKB 43.0, ANT 39.9, G 37.9, H 115.9 (sed 5.15, P<0.001). CP: A 73.5, B 63.0, C 72.1, D 67.7, E 57.7, F 57.5, NKB 59.2, ANT 63.5, G 55.3, H 59.2 (sed 1.22, P<0.001). Starch: A 159.5, B 247.7, C 98.3, D 201.8, E 507.0, F 324.0, NKB 122.0, ANT 434.9, G 464.9, H 148.7 (sed 88.69, P<0.001). WSC (mg/ml DM): A 5.00, B 13.3, C 15.0, D 10.0, E 9.8, F 5.0, NKB 2.9, ANT 8.1, G 4.1, H 17.8 (1.30, P<0.001). FM dg; quickly (a), slowly (b) and total dg rates, starch development, structure and relationship with protein varied significantly between NILs, pectin and amylopectin did not. Starch levels increased as DM increased, while NDF, ADF, ADL, CP and ash decreased. Genotype affected starch, ash and crude protein levels, starch and fibre degradability, starch structure and relationship with protein (P<0.001), but did not affect pectin and amylopectin. Distinct QTL were involved in FM composition, degradability and starch characteristics. QTL mapping can be used in genetic selection and breeding of FM to increase forage utilization efficiency and sustainability.

Key Words: Forage maize, Efficiency/sustainability, QTL mapping

283 Effect of multi enzyme cocktails on the digestion and fermentation of bahiagrass hay. N. A. Krueger* and A. T. Adesogan, *University of Florida*, *Gainesville*.

This study aimed to determine the effects of different combinations of ferulic acid esterase (E), cellulase (C), and xylanase (X) on the digestion of bahiagrass hay. A 12-wk regrowth of bahiagrass (Paspalum

notatum) hay was ground (1mm) and treated with nothing (Control), with a commercial esterase preparation (Depol (D) 740) containing all three enzymes, or with enzyme cocktails containing either 2% X, 2% C and 0% E (220) or 2% X, 2% C, 1% E (221) (DM basis). The 220 and 221 enzymes were more effective at improving the DM disappearance of the hay used in this study than various enzyme combinations in preliminary studies. Enzymes were dissolved in 1 ml of citrate-phosphate buffer (pH 6.0) and applied to 0.5 g of hay in triplicate in each of two runs. Samples were fermented in buffered, rumen fluid using a wireless automated gas production system for 24 or 96 h, and residues were analyzed for DM and volatile fatty acid concentrations. The kinetics of 24 h fermentation was determined by fitting a regression model to the data. A completely randomized design was used to analyze the data from 24 and 96 h incubations separately. Enzyme treatment did not increase ($P>0.05$) fermentation rate or 24 h DMD, but enzyme 221 increased ($P<0.05$) 96 h DMD. All enzymes decreased ($P<0.05$) the lag phase and enzyme 221 gave the shortest lag phase (4.92 h). Only enzyme 221 increased ($P<0.01$) the 24 h total gas production. After 24 hours of incubation, all enzymes had decreased ($P<0.001$) acetate concentration and increased ($P<0.04$) propionate and butyrate concentrations. Enzymes 221 and D740 decreased ($P<0.0001$) the acetate to propionate ratio and enzyme 221 was more effective than enzyme D740 in this respect. This study indicates that enzyme cocktails containing X, C, and E improved rumen fermentation. The 221 enzyme cocktail was the most effective treatment as it also increased 96 h DMD (2.36%), decreased the lag phase (57.5%) and increased the extent of gas production (13.4%) after 24 h of incubation.

Key Words: Ferulic acid esterase, Cellulase, Xylanase

284 Meta-analysis on the effect of main dietary forage on N excretion from dairy cows. V. R. Moreira[1] and C. Leonardi*[2], [1]*Lousiana State University AgCenter Southeast Research Station*, *Franklinton*, [2]*Lousiana State University*, *Baton Rouge*.

The objective of this meta-analysis was to evaluate the effect of primary forage source and nitrogen intake (NI) on N split between urine (UN) and feces (FN) in dairy cows. A dataset containing 187 treatment means obtained from 42 published N balance studies was assembled. Primary forage source was defined as 1) sole source of forage in the diet; 2) forage accounting for 60% or more of the dietary forage when 2 forages were fed; 3) forage accounting for 50% or more of the dietary forage when the diet contained 3 forages or more. A small number of observations that did not fit the criteria described above were not included in the analysis. Forages were categorized as alfalfa (A, hay or silage), corn silage (C), and grass (G, hay or silage). The effect of NI (kg/d) on the amount of excreted N was modeled utilizing the mixed procedure of SAS. Data were weighted by the inverse of the squared standard error of the independent variable divided by its own average. Linear, polynomial, exponential and power models were fitted for both UN and FN. The models chosen were linear for FN and power for UN. Each model included a fixed intercept and slope for NI, forage and its interaction with NI and a random intercept and slope clustered by study. The covariance among random intercept and slope was not different from 0 ($P > 0.30$) for both dependent variables; therefore only slope and intercept variance components were estimated. The FN excreted (kg/d) did not differ across forages ($P > 0.16$). The FN equation was: $FN = 0.077(\pm0.007) + 0.176(\pm0.016) \times NI$. The amount of UN excreted (kg/d) differed across forages ($P < 0.05$). The UN equation for A was: $UN = 0.39 \times NI^{1.30(\pm0.26)}$; for C was: $UN = 0.50 \times NI^{1.70(\pm0.14)}$; and for G was: $UN = 0.70 \times NI^{1.96(\pm0.11)}$. Urinary N surpassed FN when NI reached between 0.450 and 0.550 kg/d. Increasing the amount of NI above 0.550 kg/d is more likely to increase UN excretion on grass- than corn- than alfalfa-based diets, and thus increase the risk for N loss as ammonia.

Key Words: Forage, N-split, Dairy cows

285 Forage production and water use efficiency of 30 species used in the Australian dairy industry. J. S. Neal*[1], W. S. Fulkerson[1], and K. Greenwood[2], [1]*The University of Sydney*, *Camden, New South Wales, Australia*, [2]*Department of Primary Industries Victoria*, *Kyabrum, Victoria, Australia*.

The Australia dairy industry is the largest agricultural user of irrigation water. The recent drought and government policy to increase environmental flows in rivers have highlighted the importance of maximizing forage production from available water. Forage production accounts for up to 35% of variability in farm profit. The dominant forage used in Australia is perennial ryegrass (*Lolium perenne*); however its poor persistence has led dairy farmers to question its suitability and look for alternative species. In this context, thirty forage species suitable for dairy cows were evaluated to assess dry matter production (DM), water use efficiency (WUE) and forage quality. Besides an optimal irrigation treatment, to maximize DM, two other irrigation treatments were imposed to investigate how different species responded to increasing water stress. Irrigation was initiated once the optimum treatment had used 30mm of water from the soil profile. At this time the optimum treatment was refilled to field capacity (100%), the two water stress treatments received 66% and 33%, of the water applied to the optimum treatment. The WUE was calculated from the rainfall, water used from irrigation and changes in the soil moisture profile. Each species was harvested at the optimal stage of growth and was fertilized to replace nutrients removed. Annual DM ranged from 8 to 31t DM/ha, with maize (*Zea mays*) having the highest yield. The perennial grasses, tall fescue (*Festuca arundinacea*), perennial ryegrass, prairie grass (*Bromus wildenowii*) and kikuyu (*Pennisetum clandestinum*) had the next highest yields in the range of 27 to 28t DM/ha. WUE of the forages varied significantly from 12 to 59 kg DM/ha/mm, and depended on the season. In winter the WUE of perennial ryegrass was the highest at 37 kg DM/ha/mm, but it was one of the lowest in summer of only 20kg DM/ha/mm. Maize had the highest WUE during the summer of 59kg DM/ha/mm. The response to moisture stress differed significantly between species, the loss in yield in summer ranged from a low of 33% for lucerne (*Medicago sativa*) to a high of 82% for white clover (*Trifolium repens*).

Key Words: Forage, Pasture, Water use efficiency