metagenomics to describe relationships between dairy-associated isolates and isolates from other sources and elucidate the ecology of pathogens in dairy farm environments. Genome analysis of 118 *Salmonella enterica* serotype Kentucky (*S.* Kentucky) isolates from dairy, poultry, and humans identified some of the poultry and bovine isolates as sequence type (ST) 152, but there was a phylogenetic distinction between the poultry and bovine isolates. The human isolates were primarily distantly related ST198 strains. Three of the dairy isolates were ST198, suggesting that dairy animals are a potential reservoir of this human pathogen. We further compared the fecal microbial communities of *S.* Kentucky-shedding and non-shedding cows to search for potential shifts in community composition associated with *S.* Kentucky carriage. No significant differences between the two groups were observed, suggesting that *S.* Kentucky is a transient commensal gut inhabitant. For *L. monocytogenes*, we sequenced the genomes of 128 isolates from dairy cows and bulk tank milk and compared them to human-associated *L. monocytogenes* isolates. Phylogenetic inference revealed a high level of diversity among the isolated strains. Multiple sequence and virulence types were identified, including at least four virulence types known to be responsible for large outbreaks. Based on a whole genome phylogenetic analysis, several isolates were closely related to human clinical isolates, such as the strain isolated in the 2011 cantaloupe outbreak that was responsible for multiple deaths. Decreased cost and increased access to WGS is radically changing the understanding of the ecology of bacterial populations. With WGS data, much more subtle changes are readily accessible compared with historic methods of distinguishing strains.

Key Words: *Salmonella*, *Listeria*, dairy

FORAGES AND PASTURE II

0609 Influence of forage diversity on feeding behavior and diet digestibility in lambs. S. Lagrange*[1,2], and J. J. Villalba[2], [1]*INTA EEA, Bordenave, Argentina,* [2]*Utah State University, Logan.*

Diverse combinations of forages with different nutrient profiles and classes of plant secondary compounds (PSC; tannins, saponins) may improve intake and nutrient utilization by herbivores. We tested the effects of increasingly diverse combinations of PSC-containing legumes on intake and diet digestibility in lambs. Freshly-cut birdsfoot trefoil (TRE), sainfoin (SAN), and alfalfa (ALF) at the early flowering stage were offered in ad libitum amounts to forty-two lambs in individual pens assigned to 7 treatments ($n = 6$): single species, a choice of all possible 2-way combinations, or a 3-way choice of the legumes. Composited forage and fecal samples and acid detergent lignin were used to determine in vivo DMD. The change in concentration of BUN from the beginning to the end of the study (24 d) (ΔBUN) was also assessed. Dry matter intake (DMI) and digestible DMI (DDMI) were analyzed as repeated measures designs with lambs (random effect) nested within treatments. A complete random design was used for the remaining variables with treatment as a fixed factor. Lambs preferred ALF > SAN > TRE in 70:30 and 50:35:15 ratios for 2- and 3-way combinations, respectively ($P < 0.05$). Average DMI and DDMI were 10% greater for 2- and 3-way choices than for single species (Table 1). Digestibility values of tannin-containing legumes (SAN and TRE) and their combination were greater than those recorded for the saponin-containing legume (ALF) or ALF/TRE (Table 1). Feeding SAN in a single diet or in combination had lower ΔBUN and greater fecal N/N consumed ratio (Table 1) than ALF, TRE, or ALF/TRE, suggesting a shift in the site of N excretion from urine

Table 0609.
Table 1.

Items	Treatments							SEM	CHOICE vs Single Diets P-Value
	ALF	SAN	TRE	ALF SAN	ALF/ TRE	SAN/ TRE	ALF/ SAN/ TRE		
DM,%	19.7^{a}	18.2^{ab}	16.6^{b}					0.67	
CP,%	16.5^{b}	13.4^{c}	19.3^{a}					0.42	
ADF,%	31.1^{b}	39.3^{a}	31.6^{b}					1.13	
DMI, gr/Kg BW/d	35.9^{ab}	32.4^{b}	27.4^{c}	37.8^{a}	34.3^{ab}	33.5^{ab}	36.0^{ab}	1.88	0.0217
DMD,%	59.3^{d}	68.1^{a}	65.7^{b}	64.2^{b}	61.6^{c}	68.4^{a}	64.6^{b}	0.67	0.5450
DDMI, gr/Kg BW/d	21.3^{b}	22.1^{ab}	18.0^{c}	24.3^{a}	21.0^{b}	22.9^{ab}	23.2^{ab}	1.12	0.0087
Fecal N/N consumed	0.33^{cb}	0.38^{a}	0.28^{d}	0.35^{b}	0.32^{c}	0.35^{b}	0.34^{cb}	0.01	0.3390
ΔBUN, mg/dL	-1.0^{bc}	-4.2^{d}	2.3^{a}	-1.7^{dc}	1.7^{ab}	-0.3^{abc}	0.0^{abc}	1.18	0.3457

Means in a row with different superscripts differ (P < 0.1).

to feces. Combinations of PSC-containing legumes have the potential to enhance intake and digestibility while shifting N loses to feces relative to some legume monocultures.

Key Words: diet mixing, plant secondary compounds, intake

0610 Nutritive quality and forage yield of three *Brassica* varieties for use in livestock grazing systems.

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Brassicas are gaining popularity as high-quality forage for pasture-based livestock producers due to their use to extend the fall grazing season and during the summer forage slump. Little research has been conducted to evaluate forage yield and nutritive value of brassica species. A study was designed to compare forage yield and nutrient composition of 'Barsica' rapeseed (*Brassica napus*), 'Inspiration' canola (*B. napus*), 'Appin' turnip (*B. rapa*), and 'KB Supreme' annual ryegrass (*Lolium multiflorum*). The study was conducted as a completely randomized block (n = 4) design at The Pennsylvania State University Russell Larson Agricultural Research Farm in Rock Springs, PA. Plots were drilled (Wintersteiger Plotseed XL, Salt Lake City, UT) into a prepared seed bed in August 2015 and fertilized with 71 kg N/ha. Potash, P, and lime were added according to soil tests. Forages were sampled biweekly during October and November using a 0.1-m^2 quadrat and clipped to 4 cm. Samples were dried at 60°C using a forced-air oven for 48 h, ground to 1 mm using a Willey Mill (Thomas Scientific Inc., Philadelphia, PA), and submitted to Dairy One Laboratories (Ithaca, NY) for wet chemistry analysis. Statistical analysis was conducted using Proc GLIMMIX (SAS Inc., Carey, NC) with $\alpha = 0.05$. Forage yield was not different among brassicas (1023 ± 108.5 kg DM/ha), which were greater ($P \leq 0.0001$) than ryegrass (242 ± 108.5 kg DM/ha). Although CP was greater ($P < 0.032$) in ryegrass than the brassicas (33.1 vs. 29.2 ± 1.44%), degradable and soluble protein fractions were lower ($P < 0.032$) in ryegrass than all brassicas (76 vs. 84 ± 0.71% and 49 vs. 53 ± 1.12%, respectively). Brassicas contained similar NDF and ADF concentrations (18.7 ± 0.94 and 14.4 ± 0.77%, respectively) but were lower ($P < 0.0001$) than ryegrass (35.4 ± 0.94 and 17.5 ± 0.77%, respectively). Both canola and rapeseed had greater ($P < 0.001$) NE_M and NE_L (1.65 ± 0.02 and 1.72 ± 0.01 Mcal/kg, respectively) than turnip or ryegrass (1.45 ± 0.02 and 1.54 ± 0.01 Mcal/kg, respectively). Inclusion of brassicas in a cool-season pasture rotation has the potential to increase animal productivity and reduce the need for stored feed during periods of perennial cool-season forage shortages, including mid-summer and late fall.

Key Words: *Brassica*, forage, grazing

0611 Effect of early intensive grazing of Kentucky bluegrass on animal performance.

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Kentucky bluegrass (*Poa pratensis* L.), a perennial, cool-season grass, is increasingly dominating pastures in the northern Great Plains, compromising pasture quality due to declining forage quality in the summer months when compared with native forages. Timed grazing can impact plant species and can shift plant communities to a more desired state. A grazing study was conducted at the Central Grassland Research Extension Center, North Dakota, to compare the effect of early-intensive grazing with season-long grazing on Kentucky bluegrass production and on grazing animal performance. Six pastures were assigned to one of two treatments: early intensive grazing and season-long grazing. All pastures were stocked with yearling beef heifers (340 ± 35 kg) at a moderate stocking rate before Kentucky bluegrass reaching the two-leaf stage. The early intensive treatment was grazed for 1.2 mo with a stock density of 0.39 animal units per hectare (AU · ha^{-1}), equivalent to a stocking rate of 0.46 animal unit months per hectare (AUM · ha^{-1}). The season-long treatments were grazed for 4 mo with a stock density of 0.12 AU · ha^{-1}, which is also equivalent to a moderate stocking rate of 0.46 AUM · ha^{-1}. Heifers were removed from the early-intensive treatment when 30% of native vegetation had received some grazing. Due to the shortened grazing time period, stocking density was more than three times higher on the early-intensive treatment. Heifers gained more ($P \leq 0.05$) in season-long pastures, with a corresponding weight loss on the early intensive treatment (0.16 vs. −0.45 kg · d^{-1}, respectively) in 2015. Results from this study show that early intensive grazing negatively influenced animal performance through weight loss and overall lower average daily gains when compared with season long grazing. The production of *P. pratensis* can vary widely in the northern Great Plains, depending on soil and spring moisture conditions; therefore, additional research on utilizing yearling beef cattle to spring graze *P. pratensis* will continue to document animal performance in response to this grazing treatment.

Key Words: early intensive grazing, grazing, heifer, invasive, Kentucky bluegrass, yearling

0612 Frequency of feeding distillers dry grain with solubles as a supplement to beef cows grazing corn residue.

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This study was conducted to evaluate the effects of delivery frequency of distillers dried grains with solubles (DDGS) as a supplement to cows grazing corn residues in the northern

Great Plains. The 36-d study was conducted in the fall of 2015, with 80 first and second calf cows (520 ± 34.5 kg BW). Ten cows were assigned to one of eight paddocks (4 ha each) of corn residue. Four applied treatments with two replications per treatment were no DDGS supplementation (control), DDGS fed daily, DDGS fed every third day, and DDGS fed every sixth day. The DDGS was fed at 0.35% BW per day. Body weight and body condition scores were recorded on two consecutive days at the beginning and end of the study. All cows had ad libitum access to water and a mineral supplement. After corn harvest, corn grain drop was estimated by counting the number of ears on the ground in three 30.5 m rows. Gusty winds in excess of 90 km · h^{-1} before harvest resulted in approximately 1004 kg · ha^{-1} of corn grain on the ground. Above normal temperatures were encountered through the six week course of the study. Average daily gain was greater ($P < 0.05$) following daily (1.57 ± 0.12 kg) and every third day supplementation (1.62 ± 0.12 kg) relative to control (1.22 ± 0.12 kg) or every sixth day supplementation (1.19 ± 0.12 kg). Body condition score change was greater ($P < 0.05$) following daily supplementation (0.7 ± 0.08) relative to every sixth day supplementation (0.4 ± 0.08). There was no difference ($P > 0.05$) in BCS change among control cows and cows supplemented daily or every third day. These results show that under certain conditions, such as mild weather and high grain drop, cows grazing corn residue may not require supplementation. Dried distillers grains with solubles can be supplementally fed every third day to reduce winter labor costs, with no detrimental effects to animal performance.

Key Words: beef cattle, corn residue, dried distillers grains with solubles

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0613 Development of an automated system for measuring supplement intake of grazing animals.

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The objective of this research was to develop and test an automated supplement intake measurement system (SmartFeed, SF), which can be used to measure individual animal supplement intake, behavior, and allow for control of supplement intake to grazing animals. The SF was developed by C-lock Inc., Rapid City, SD, and was designed using a stainless steel feed bin (79 by 71 by 86 cm) that included two weigh cells suspending the bin at two points, an RFID reader and antenna, an adjustable metal framework to limit access to animals at one time, and a data acquisition system that recorded RFID tags and feed bin weights at 1 Hz. A locking door can be added to future SF to control access for individual animals, but the prototype tested in this research did not limit supplement intake. The SF weighs about 100 kg and is self-contained and portable. Over a 14-d test period, 16 RFID-tagged steers (256 ± 31 kg mean BW) grazing dormant native range pasture in Oklahoma had ad lib, 24-h access to SF. The supplement provided in SF was 55% supplements (80% soybean meal and 20% soybean hulls, as-fed basis) and 45% fine mixing salt (as-fed basis) as an intake limiter. During testing, it was determined that SF must be placed on level ground and firmly anchored because the animals will move it if possible. The herd tended to visit SF as a group and exchanged places at the feeder frequently rather than spacing visitation over the day and/or consuming supplement in series. The major considerations for data processing included accounting for rapid animal exchanges at the feeder and weigh scale noise that resulted from animals pushing on the feed bin. Mean daily supplement intake was 1.15 ± 0.50 kg per animal (as-fed basis). The high CV (43%) indicated that considerable variation in daily supplement intake among group-supplemented steers exists. However, the Pearson correlation coefficient between mean daily intake during wk 1 vs. 2 was 0.84, indicating that the ranking of supplement intake was somewhat consistent between weeks. Overall, SF has the potential to measure and, in the future, control individual animal supplement intake in grazing experiments. These capabilities can improve design flexibility and statistical power of experiments, and may have application in nutritional management of range livestock.

Key Words: automation, grazing, supplement intake

0614 Sampling corn silage in bags from the sides.

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Because composition variation in silo bags is expected along the tube, and as nutritionists need to know forage composition before it is consumed, it is necessary to collect representative samples from the sides of the tube. The aim of the study was to determine if the composition of the side samples was similar to that of the face samples. Seven corn silage bags in dairy farms in Cordoba and Santa Fe provinces (Argentina) were sampled. Duplicate samples were taken from 5 different areas of the face of the bag (F1) with a core sampler. Then, 2 to 4 samples from both sides, 2 m forward in the bags, were taken (S). When the front achieved the same place where the side samples were taken, the newly exposed face was sampled again as in F1 (F2). After sampling, samples were stored in a refrigerated box for the rest of the day and sent to the same commercial laboratory to determine percentages of DM, NDF, ADF, CP, and ash by NIR. Nutrient composition of corn silage in F2 and S was compared using a mixed procedure of InfoStat, with silage bag as a random effect and sampling site as a fixed effect. Mean DM percentage (31.8 ± 4.0%) was inside the recommended range for corn silage, although the 80% range is lower than recommended, indicating early cuttings compared to optimum. The other nutrients were in accordance to typical values of corn silage. When evaluating different areas in both F1 and F2, no

Table 0614.

Table 1: Effect of sampling site on nutrient composition in corn silage

Nutrient	F2		S		*P*-value
	Mean	SE	Mean	SE	
DM (%)	32.0[a]	1.65	31.7[a]	1.66	0.3241
NDF (%)	46.6[a]	2.02	46.3[a]	1.94	0.7690
ADF (%)	27.6[a]	1.48	28.1[a]	1.53	0.4415
CP (%)	8.2[a]	0.46	7.8[b]	0.47	0.0001
Ash (%)	5.6[a]	0.27	5.6[a]	0.28	0.8948

Means within rows followed by the same letter are not significantly different (P ≥ 0.05).

differences were found for nutrient composition accounting for the silage bag and type of face (F1 and F2) as random effects. No differences between F2 and S were found in DM, NDF, ADF, and ash content, although CP levels showed different values in the side samples (Table 1). Our results showed that side samples are representative comparing them with the front of the bag regarding most nutrients. Nevertheless, more research is needed to determine a complete side sampling methodology for bagged silage.

Key Words: bagged corn silage, nutrient composition, sampling

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0615 Survey of temporal variation in pasture mineral concentrations and total dietary mineral intake in pasture-based dairy herds. F. Curran*[1,2], D. Wall[3], P. Lonergan[2], and S. Butler[1], *[1]Animal & Grassland Research and Innovation Centre, Teagasc Moorepark, Fermoy, Co. Cork, Ireland, [2]School of Agriculture and Food Science, University College Dublin, Dublin, Ireland, [3]Teagasc Crops, Environment and Land Use Program, Johnstown castle Co., Wexford, Ireland.*

In grass-based dairy production systems, grazed pasture represents the sole feed for long periods. Mineral concentrations in pasture vary depending on region, season, plant variety, and fertilization strategy. The objectives of this study were to: (i) benchmark the seasonal variation in pasture mineral concentrations, and (ii) determine the mineral nutritive value of both grazed grass and the total diet for lactating dairy cows. Spring calving dairy farms (n = 44) were selected based on region and soil type and enrolled on the study. Each farm was visited once in March, May, August, and October 2013. These visits were selected to coincide with expected changes in the grass morphology and growth rate from the start (March) to the end (October) of the grazing season. During the week before each visit, pre-grazing grass samples were cut daily for 7 d to a stubble height of 4 cm. At each visit, the grass samples and samples of any other feeds being consumed (silage, concentrate, and other miscellaneous feedstuffs) were collected, and the proportion of each feedstuff in the diet was recorded. The daily grass samples were then mixed to form one composite sample, representative of grass offered to the herd during the preceding week. All samples from each farm were analyzed for mineral concentrations using inductively coupled plasma mass spectrometry (ICP–MS). The mean, range, and standard deviations for each sample analyzed were calculated across the study farms at each time-point. Pasture mineral concentrations did not vary greatly over the four sampling points, with the exception that mean Se concentration was greater at the first sampling time point (0.21 ± 0.18 mg/kg) compared with all other sample collection times (0.04 ± 0.03, 0.07 ± 0.04, 0.03 ± 0.04 mg/kg on visits 2, 3, 4, respectively). On average (range in parentheses), a pasture-only diet would have provided 90% (45–130), 80% (30–125), 50% (8–190), 65% (30–77), and 30% (3–108) of the requirements for lactating cows (National Research Council, 2001) for P, Cu, I, Zn, and Se, respectively. When total dietary mineral intakes were estimated, on average, the diet provided 96%, 153%, 359%, 109%, and 58% of the lactating cow requirements for P, Cu, I, Zn, and Se, respectively. We conclude that, on average, pasture grown on Irish dairy farms is inadequate for P, Cu, I, Zn, and Se to meet cow requirements when fed as the sole feed.

Key Words: minerals, pasture, dairy

0616 Observations of forage yield and steer average daily gain when double cropped forage following crop harvest. K. M. Ulmer*[1], R. G. Bondurant[1], J. L. Gramkow[1], G. W. Lesoing[2], M. E. Drewnoski[1], and J. C. MacDonald[3], *[1]University of Nebraska, Lincoln, [2]University of Nebraska, Auburn, [3]University of Nebraska-Lincoln, Lincoln*.

Two experiments were conducted to evaluate yield of annual forages planted after harvest in cropping systems and to determine the grazing potential. In Experiment 1, a brassica-based 5-species mix was drilled following wheat harvest on August 17 in yr 1 and August 15 in yr 2. Aboveground forage production measured in late October was 2,257 ± 270 and 3,991 ± 270 kg DM/ha in yr 1 and 2, respectively. In both years, land was split into three 2-ha paddocks and stocked according to aboveground forage yield at 909 kg DM per steer. In yr 1, 15 steers (initial BW = 205 kg [SD 16]) were divided into 5 hd groups and grazed for 48 d. In yr 2, 26 steers (initial BW = 266 kg [SD 4]) were divided into 8 to 10 hd groups and grazed for 52 d. Grazing began in mid November and ADG was 1.00 ± 0.019 and 0.70 ± 0.073 kg/hd in yr 1 and 2, respectively. In Experiment 2, half of a corn field was harvested as corn silage (CS) and half as high-moisture corn (HMC). In yr 1, a mix of oats and turnips was drilled on September 9 after CS harvest yielding 1,047 ± 65 kg/ha, and on September 18, the same mix was drilled after HMC yielding 487 ± 117 kg/ha in late October. In yr 1, there was no grazing of the oat–turnip mixture due to herbicide restrictions. In yr 2, oats were drilled on September 3 after CS harvest yielding 3,200 ± 93 kg DM/ha whereas oats drilled on September 17 after HMC harvest yielded 586 ± 95 kg DM/ha. In yr 2, grazing began in mid November with 2 groups of 10 steers per treatment (initial BW = 212 kg [SD 74]) grazing for 62 d. Steers grazing after CS were allocated 795 kg oat forage DM/hd. Steers grazing after HMC were allocated 181 kg oat forage DM and 1,229 kg corn husk and leaf DM per hd. Steer ADG did not differ ($P = 0.27$, SEM = 0.12) among treatments, 0.50 and 0.33 kg for CS and HMC, respectively. Gain per hectare of HMC (109 kg) and CS (153 kg) did not differ ($P = 0.15$, SEM = 1.07). Fall forage production after grain harvest is sufficient to provide cover and adequate forage for growing calves.

Key Words: average daily gain, brassicas, cover crop forages

0617 Banana tree (*Musa sapientum*) forage in sexed Guinea pig (*Cavia porcellus*) fattening. A. R. Sanchez*, *Universidad Tecnica Estatal de Quevedo, Quevedo, Ecuador*.

This research was performed in La Mana canton, in the southeast of Cotopaxi province, whose geographical location is 0°45′35″ S and 7°09′32″ W at an altitude of 240 m above the sea level. The objectives were 1) to determine the effect of Savoie grass (*Panicum maximum* Jacq.) and banana tree leaves (*Musa sapientum*) consumption on guinea pig productive behavior, 2) to determine the effect of sex on guinea pig productive behavior, and 3) to determine treatment yield. A factorial arrangement 2 (forages) × 2 (sexes) within a complete randomized block design with six repetitions was applied. To determine rate differences, a Turkey test ($P \leq 0.05$) was applied and the cost–benefit relationship served as a basis for the economic analysis. Forage consumption, food consumption, live weight (LW), weight gain (WG), food conversion index (FCI), carcass weight (CW), carcass yield (CY), and rent were evaluated. The highest forage consumption (55.40 g MS animal^{-1} d^{-1}), LW (841.11 g.), WG (8.78 g. animal^{-1} d^{-1}), FCI (7.96), CW (598.06 g), and CY (71.0%) were registered for savoie-based treatments. The male guinea pig reported the highest LW (826.00 g.), WG (8.57 g animal^{-1} d^{-1}), FCI (7.96), and CW (576.25 g.), whereas differences among treatments ($P < 0.05$) were shown: savoie per male interaction was significant ($P < 0.05$) for LW (881.0 g.), WG (9.63 g animal^{-1} d^{-1}), FCI (7.01), CW (639.00 g.), CY (72.5%), and 48.3% profitability. Results demonstrate that using tropical forage resources contributes to guinea pig fattening in the studied zone.

Key Words: forage, grasses, feeding, nutrition, guinea pigs

0618 Effect of frame size and season on enteric methane (CH_4) and carbon dioxide (CO_2) emissions in Angus brood cows grazing native tallgrass prairie in central Oklahoma. J. P. S. Neel*, K. E. Turner, P. H. Gowda, and J. L. Steiner, *USDA-ARS-PA-GRL, El Reno, OK*.

A reduction in enteric CH_4 production in ruminants is associated with improved production efficiency. Enteric CH_4 and CO_2 production associated with the livestock industry is of interest due to the impact these emissions might have on global climate change. Our objective was to evaluate the effect of cow frame size (FS) and season on enteric CH_4 and CO_2 production in cattle grazing during summer and fall. Twenty-eight Angus cows (545 ± 49 kg BW) of either medium ($n = 14$) or large FS ($n = 14$) and grazing simultaneously within a native tallgrass prairie pasture in central Oklahoma were used to estimate individual animal enteric CH_4 and CO_2 production daily (via a commercially available breath analyzer) over the summer and fall seasons. Cow FS was categorized based on frame scores generated from individual hip heights. Summer and fall season designations were based on summer and winter solstices and the fall equinox. Statistical analyses were conducted using GLM of SAS. The model included class effects of FS and season and their interaction. As measured at the beginning of the experiment, large-FS cows were heavier ($P < 0.001$) and had a greater frame score ($P < 0.001$) compared with medium-FS cows (609 vs. 480 kg and 6.8 vs. 4.6, respectively). As measured during the experimental period,

large-FS cows produced calves with heavier ($P < 0.01$) 205-d adjusted weaning weights (261 vs. 222 kg). There were no frame size × grazing season interactions with regard to enteric gas production. Large-FS cows produced greater ($P < 0.001$) enteric CH_4 (280 vs. 248 g/d) and CO_2 (9,065 vs. 8,021 g/d) than medium-FS cows. Cows produced higher ($P < 0.001$) amounts of enteric CH_4 and CO_2 in summer than in fall (292 vs. 236 g/d and 9,065 vs. 8,021 g/d, respectively). When expressed as total production (over the entire summer and fall seasons) of CH_4 or CO_2 per weight unit of weaned calf, enteric gas production did not differ between large- and medium-FS cows (0.20 vs. 0.21 kg/kg and 6.4 vs. 6.6 kg/kg, respectively). Further research is needed to relate enteric gas production to herbage nutritive value and animal DMI.

Key Words: beef cows, enteric methane, native prairie

0619 Grazing management: milk production and composition of dairy cows grazing elephant grass.

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The objective of this experiment was to evaluate the effects of strategies of rotational grazing management on milk yield and composition of dairy cows grazing elephant grass (*Pennisetum purpureum* Schum. cv. Cameroon) from December 2015 to February 2016. Treatments corresponded to management strategies characterized by the pregrazing targets of 95% and maximum canopy light interception during regrowth (equivalent to 100 and 135 cm; $LI_{95\%}$ and LI_{Max}, respectively). The postgrazing target was the same and corresponded to 50% of the pregrazing height. Midlactation Holstein × Jersey cows were separated into two groups according to BW, days in milk, age, lactation number, and daily milk yield. The 2.5-ha experimental area was divided up into two sets of 18 paddocks (700 m^2). Twenty-two cows (487.5 ± 13.1 kg) were used as testers and a variable number was used to adjust stocking rate. Milking was performed twice a day at 0500 and 1530 h, milk yield was measured in a daily basis, and milk composition was measured at 10-d intervals. The amount of concentrate mix fed to cows was based on the average milk production for the groups (1 kg of concentrate:3 kg of milk) and offered in two daily individual meals just before milking. The effective values of pre- and postgrazing heights were 100.8/50.5 and 135.6/68.6 cm with average stocking rates of 9.2 and 6.0 cows/ha for $LI_{95\%}$ and LI_{Max}, respectively. The results were analyzed using the PROC MIXED of SAS ($\alpha = 0.05$). Management based on the $LI_{95\%}$ target resulted in an 18.5% increase in milk production (19.2 vs. 16.2 kg of 3.5% fat corrected milk cow^{-1} d^{-1}), lactose (854 vs. 710 g d^{-1}), protein (578 vs. 519 g d^{-1}) and fat yield (677 vs. 569 g d^{-1}), despite no difference in fat content. Protein content was higher for LI_{Max} (3.28 vs. 3.07%) and urea N was higher for $LI_{95\%}$ (13.17 and 11.83 mg dL^{-1}). The results suggest that the $LI_{95\%}$ pregrazing target correspond to a better management strategy because it resulted in increased milk and milk solids production per cow and stocking rate, resulting in increased productivity.

Key Words: light interception, tropical grass, grazing management

Table 0620.

Table 1. Effects of traditional pasture (control) or spring available annual forage crops (SpAFC) on animal performance, plasma metabolites, and ruminal fermentation profile

	Treatments			
Item	Control	SpAFC	SEM	*P*-value
Pasture intake, kg/d	8.10	7.49	0.45	0.20
TMR intake, kg/d	10.9	10.7	0.13	0.13
Total DMI, kg/d	18.9	18.1	0.44	0.08
ADG, kg/d	0.56	0.77	0.14	0.15
Milk yield, kg/d	25.2	23.1	1.24	0.23
Milk fat, %	4.15	3.89	0.26	0.50
Milk fat, kg/d	1.02	0.92	0.09	0.45
Milk true protein, %	3.53	3.63	0.12	0.54
Milk true protein, kg/d	0.86	0.85	0.05	0.83
MUN, mg/dL	13.1	14.7	0.55	0.06
Plasma urea-N, mg/dL	11.9	12.2	0.79	0.66
Plasma NEFA, mEq/L	176	174	5.12	0.72
Ruminal total VFA, m*M*	73.1	75.1	6.40	0.77
Ruminal acetate, mol/100 mol	70.0	69.8	0.79	0.74
Ruminal propionate, mol/100 mol	16.2	16.5	0.50	0.66
Ruminal butyrate, mol/100 mol	11.3	11.1	0.42	0.64

0620 Performance and rumimal metabolism are not changed in lactating dairy cows offered spring available annual forage crops during a short-term grazing experiment. K. A. Juntwait*, A. F. Brito, K. S. O'Connor, R. G. Smith, K. M. Aragona, C. P. Ghedini, and A. B. D. Pereira, *University of New Hampshire, Durham*.

Spring available annual forage crops (AFC) can potentially be used to extend the grazing season by increasing pasture production. We aimed to determine the impact of spring available AFC on pasture production and animal performance during a short-term grazing experiment. Fourteen multiparous and 2 primiparous lactating organically certified Jersey cows were randomly assigned to either a traditional legume–grass pasture mix (control treatment; $n = 8$ cows) or a spring AFC mix of wheat, triticale, barley, cereal rye, and hairy vetch strip-tilled into a traditional pasture (SpAFC treatment; $n = 8$ cows). The botanical composition (DM basis) for the control averaged 70% grasses, 17% legumes, and 13% other (broadleaf, weeds, and dead), whereas that for SpAFC averaged 60% grasses, 14% legumes, 13% AFC grasses, 4% AFC legumes, and 9% other. Cows averaged 433 ± 48 kg of BW and 83 ± 50 DIM for the control group and 416 ± 46 kg of BW and 86 ± 43 DIM for the SpAFC group. A 14-d adaptation period was followed by a 7-d sampling period. Pasture nutrient composition during the sampling period averaged 16.0 and 15.1% CP, 53.3 and 56% NDF, and 34.6 and 32.1% ADF for the control and the SpAFC, respectively. Pasture biomass averaged 3,038 ± 303 and 4,052 ± 353 kg of DM/ha for the control and SpAFC, respectively. Cows were fed a total mixed ration (TMR) and milked twice daily and had access to a new strip of pasture after the afternoon milking. Pasture intake was estimated using chromium oxide and IVDMD. Ruminal fluid was sampled using an esophageal tube immediately after the morning milking with samples analyzed for VFA. Results are shown in Table 1. There were no significant differences in pasture and TMR intake comparing the control with SpAFC, but a trend ($P = 0.08$) was observed for increased total DMI (+0.8 kg/d) in cows fed the control treatment. Contents and yields of milk and milk fat and protein and ADG did not differ between treatments. A trend ($P = 0.06$) for greater MUN was observed with feeding the SpAFC rather than the control treatment. No significant differences were observed in the plasma concentrations of urea N and NEFA or in the ruminal concentration of total VFA. Strip-tilling spring available AFC into a perennial grass–legume pasture mix increased herbage biomass production and did not affect animal performance of lactating Jersey cows in the Northeastern United States.

Key Words: annual forage crops, dairy cows, grazing

0621 Performance and ruminal metabolism in lactating dairy cows offered summer available annual forage crops during a short-term grazing experiment. K. A. Juntwait*, A. F. Brito, K. S. O'Connor, R. G. Smith, K. M. Aragona, C. P. Ghedini, and A. B. D. Pereira, *University of New Hampshire, Durham*.

Summer available annual forage crops (AFC) have the potential to increase pasture production during times of heat and drought in the Northeastern United States. The objective of this study was to determine the impact of summer available AFC on pasture production and animal performance during a short-term grazing experiment. Sixteen multiparous and 4 primiparous organically certified lactating Jersey cows were randomly assigned to 1 of 2 treatments: traditional legume–grass pasture mix (control; $n = 10$ cows) or a summer AFC

Table 0621.

Table 1. Effects of traditional pasture (control) or summer available annual forage crops (SuAFC) on animal performance, plasma metabolites, and ruminal fermentation profile

	Treatments			
Item	Control	SuAFC	SEM	*P*-value
Pasture intake, kg/d	8.26	8.75	0.73	0.51
TMR intake, kg/d	11.2	11.6	0.38	0.32
Total DMI, kg/d	19.6	20.3	0.82	0.41
ADG, kg/d	0.65	0.57	0.22	0.71
Milk yield, kg/d	17.1	17.0	0.60	0.86
Milk fat, %	4.43	5.02	0.14	<0.01
Milk fat, kg/d	0.78	0.93	0.04	0.02
Milk true protein, %	3.49	3.73	0.08	0.05
Milk true protein, kg/d	0.61	0.69	0.03	0.05
MUN, mg/dL	11.8	10.8	0.39	0.09
Plasma urea-N, mg/dL	10.6	8.92	0.49	<0.01
Plasma NEFA, mEq/L	174	168	6.88	0.34
Ruminal total VFA, m*M*	5.34	5.07	7.37	0.95
Ruminal acetate, mol/100 mol	71.8	71.8	0.81	0.92
Ruminal propionate, mol/100 mol	15.5	15.6	0.31	0.71
Ruminal butyrate, mol/100 mol	10.6	10.5	0.40	0.93

mix of millet, teff, buckwheat, oats, and chickling vetch strip-tilled into a traditional pasture (SuAFC; n = 10 cows). The botanical composition (DM basis) for the control averaged 69% grasses, 11% legumes, and 20% other (broadleaf, weeds, and dead), whereas that for SuAFC averaged 61% grasses, 13% legume, 1% AFC grasses, 2% AFC legumes, 12% AFC broadleaf, and 11% other. Cows averaged 434 ± 46 kg of BW and 146 ± 61 DIM for the control and 449 ± 53 kg of BW and 140 ± 57 DIM for the SuAFC. A 14-d adaptation period was followed by a 7-d sampling period. Pasture nutrient composition during the sampling period averaged 12.9 and 14.8% CP, 53.1 and 50.1% NDF, and 35 and 38.8% ADF for the control and SuAFC, respectively. Pasture biomass averaged 2,774 ± 275 and 2,588 ± 272 kg of DM/ha for the control and SuAFC, respectively. Cows were fed a total mixed ration (TMR) and milked twice daily and had access to a new strip of pasture after the afternoon milking. Pasture intake was estimated using chromium oxide and IVDMD. Ruminal fluid was sampled using an esophageal tube immediately after the morning milking with samples analyzed for VFA. Results are shown in Table 1. There were no significant differences in pasture, TMR, total DMI, ADG, and milk yield between the control and SuAFC. Milk fat and protein concentrations and yield were all significantly greater in cows offered SuAFC than in cows offered the control. A trend (P = 0.09) for lower MUN in cows fed SuAFC vs. cows fed the control treatment was observed. Cows offered SuAFC had less (P < 0.01) concentration of plasma urea N than those offered the control. Ruminal concentrations of total VFA and plasma NEFA did not differ between treatments. Strip-tilling summer available AFC into perennial grass–legume pasture mix did not change pasture biomass production compared with the control but increased the concentrations and yields of milk fat and protein.

Key Words: annual forage crops, dairy cows, grazing

0622 Fluctuation of soil carbon dioxide emission in agrosilvopastoral system managed with sheep.

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The burning of fossil fuels and the misuse of land in the agricultural sector has been raising the concentration of carbon dioxide (CO_2), which causes global temperature rise causing climate imbalance. The use of integrated systems such as agrosilvipastoral is vitally important in mitigating this gas. This research aimed to evaluate the CO_2 in soils intercropped with corn and Massai grass with subsequent implementation of a silvopastoral system with sheep grazing. The experiment was performed at Sao Paulo State University in Brazil from April to May 2012 and February 2013 to September 2014. Carbon dioxide emissions were assessed weekly from soil on intercropping corn and Massai grass 15 d before the corn harvest and 1 mo after. Carbon dioxide assessments were also performed every 15 d in three different treatments: silvopastoral Massai grass with eucalyptus spacing by 6.0 by 1.5 m with grazing assess, silvopastoral Massai grass with eucalyptus spacing by 12.0 by 1.5 m, and Massai grass without eucalyptus system with grazing assess in a completely randomized design with repeated measures with two longitudinal factors (2 yr of evaluations and two seasons: dry and rainy season). The CO_2 emission on intercropping corn and Massai grass remained constant a week after harvesting of maize with an average of 2.43 μmol CO_2 $m^{-2}{\cdot}s^{-1}$. Two weeks after the harvest, there was reduction in CO_2 emissions of 34.98% or 0.85 μmol CO_2 $m^{-2}{\cdot}s^{-1}$. The average flux of CO_2 emission in the silvopastoral system did not differ between treatments (P > 0.05). In the summer (rainy season), there were higher CO_2 emission values compared with the winter (dry season) (P < 0.05), with a reduction of 44.46%, or 2.33 μmol $m^{-2}{\cdot}s^{-}1$, in the CO_2 emissions. Comparing the years of measure, we can denote that in the first year, there was the highest values of CO_2 emissions compared with the second year of measure (P < 0.05), with a reduction of 16.44%, or 0.73 μmol CO_2 $m^{-2}{\cdot}s^{-1}$. Therefore, the corn harvest reduces the emission of CO_2 in the soil. However, the introduction of trees in the pastoral system did not change the CO_2 emissions. The CO_2 emission was modified only by climatic factors. These results can be explained because the silvopastoral system was in an implementation phase when the eucalyptus trees had an average height between 1.7 and 4.7 m in first and second year, respectively, and were not providing the expected shading as the silvopastoral system.

Key Words: intermittent stocking, climatic changes, tropical pasture

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0623 Yield and quality evaluation of ensiled Johnsongrass as a potential forage for beef cattle.

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Johnsongrass (*Sorghum halepense*) is a nonnative invasive species that is commonly used for hay production. Johnsongrass could be ensiled to avoid long drying times associated with hay production. The objective of this study was to examine the nutritive value and digestibility of Johnsongrass conserved as silage when harvested at four maturity levels: 3-wk, boot, flower, and dough. A preexisting stand of Johnsongrass was split into 16 plots in May 2015 at the J. Phil Campbell Research Station at the University of Georgia in Watkinsville, GA. Each plot was then randomly assigned to one of the four treatments. After reaching the proper stage, botanical separation and growth stage data were collected before harvesting to obtain DM yield. During the growing season, two harvests were designated for ensilage. After these harvests, forage was allowed to

wilt to approximately 50% DM. Wilted forage was packed into mini-silos constructed with 90-cm lengths of 10-cm diameter polyvinyl chloride pipe. Forage was packed to a density of 2.4 kg/L. The silos were sealed and allowed to ferment for 10 wk. After fermentation, all samples were frozen until subsequent nutritive value and fermentation characteristics could be determined. Statistical analysis was performed in JMP (SAS Inst. Inc., Cary, NC) with treatment as a main effect and harvest date as a random variable. Treatment did not have a significant effect on DM yield ($P = 0.09$). Neutral detergent fiber, ADF, and lignin increased ($P < 0.001$) as maturity at harvest increased from 3-wk (52, 35, and 6.0%, respectively) to dough (62, 41, and 7.9%, respectively). However, CP and relative forage quality decreased ($P < 0.01$) as maturity at harvest increased from 3-wk (108 and 14.9%, respectively) to dough (86 and 12.2%, respectively). Forage maturity did not affect nonstructural carbohydrates ($P = 0.06$). After fermentation, pH was similar ($P = 0.06$) across maturities; however, total VFA and ammonia was greater ($P < 0.03$) for forage harvested at 3 wk (7.7 and 1.4%, respectively) compared with dough (5.7 and 0.9%, respectively). These data indicate that Johnsongrass can provide high-quality forage if not allowed to mature past the boot stage and can be ensiled, providing an alternate method of conservation.

Key Words: Johnsongrass, silage, digestibility

0624 Evaluation of warm-season annual forages on forage production and stocking rate.

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A 2-yr study was conducted to evaluate four warm-season annual forages in a southeastern forage-finishing beef production system. Forage treatments were brown midrib sorghum × sudangrass (*Sorghum bicolor* var. *bicolor* × *bicolor* var. *sudanense*) (BMR; Honey Graze/AS6201), sorghum × sudangrass (SS; Sugargrazer/AS5201), pearl millet [*Pennisetum glaucum* (L.) R. Br.] (PM; Tifleaf III), or pearl millet planted with crabgrass [*Digitaria sanguinalis* (L.) Scop.] (PMCG; Tifleaf III + Red River) planted at a seeding rate of 22.4, 22.4, 16.8, and 11.2 + 5.6 kg ha^{-1}, respectively. Sixteen pastures (0.81 ha) were assigned to one of four forage treatments in a randomized complete block design. Pastures were subdivided into two 0.405-ha paddocks for rotational grazing. British-cross beef steers ($n = 32$; 438 ± 49 kg) were stratified by weight and randomly assigned to 1 of the 16 pastures for forage finishing. Put-and-take grazing was used to maintain a forage allowance of 1,600 to 4,500 kg ha^{-1}. Pastures were grazed in 2014 and 2015 for 70 and 63 d, respectively. Forage yield was measured by clipping, in triplicate, a 4.3-m^2 area with a plot harvester on d 0 and every 14 d thereafter, whereas metabolic BW were measured on d 0 and every 34 d thereafter until termination of the trial. Statistical analysis was conducted using the MIXED procedure in SAS 9.4 (SAS Inst. Inc., Cary, NC) with main effects of treatment, year, and the interaction. Analysis of main effects revealed that DM yield in 2014 was greater for BMR and SS compared with PM and PMCG at d 0 ($P < 0.05$; 1,657, 1,958, 1,205, and 1,297 kg h^{-1}, respectively) and at d 14 ($P < 0.05$; 4,007, 4,670, 3,485, and 2,962 kg h^{-1}, respectively). In 2015, DM yield was greater at d 0 for BMR, SS, and PM compared with PMCG ($P < 0.05$; 2,548, 2,755, 3,016, and 2,039 kg h^{-1}, respectively) and at d 42 for BMR compared with SS, with PM and PMCG as intermediates ($P < 0.05$; 2,880, 1,577, 2,294, and 2,219 kg h^{-1}, respectively). Average daily gain was significantly ($P < 0.05$) higher for steers grazing BMR (0.90 kg/d) compared with steers grazing SS and PMCG (0.68 and 0.62 kg/d, respectively) but did not differ from steers grazing PM ($P > 0.05$; 0.79 kg/d). These findings suggest that BMR, SS, PM, and PMCG may all be used in beef cattle production systems but BMR may outperform SS, PM, and PMCG on the parameters of forage yield and animal performance.

Key Words: warm-season annual forages, beef, performance

0625 Microbiota attachment and structural components of *Lolium perenne* L. and *Festuca arundinacea* Schreb. during in vitro fermentation.

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The objective of this research was to evaluate the effect of lignin aggregation in *Lolium perenne* and *Festuca arundinacea* on microbiota attachment and cell wall components during in vitro degradation. Stages of senescence (0, 30, and 60%) were measured in summer and winter. Leaf tissue structure and cell wall components were studied using histochemistry technique. An in vitro fermentation test was performed during 72 h, and microbiota attachment to grass residues was studied using scanning electron microscopy. The experimental design was split plot, and PROC MIXED of SAS was used to evaluate the stage effect, whereas means were compared with a Tukey test. The central vein (CV) of 0% senescence showed higher lignified tissue in summer than in winter, whereas for 30 and 60% senescence, lignified tissue was higher in *Lolium* compared with *Festuca* ($P < 0.05$). The extension of the vascular

bundle sheath (EVBS) of the CV contributed the most to leaf lignification ($P < 0.05$). Senescence affected IVDMD, and total VFA production of *Lolium* and *Festuca* at 30% senescence was lower in winter, but in summer, is was higher compared with 60% senescence leaves ($P < 0.05$). Microbiota cell wall attachment was higher in 0% senescent leaves in both grasses, but in 30 and 60% senescent leaves, microbiota was reduced and attached to lignified walls of fibers and vessels of xylem ($P < 0.05$). It is concluded that leaves cell aging of *Lolium* appears as lignification of the EVBS with higher values in summer, whereas no differences were found in *Festuca*. The oldest leaves of *Festuca* showed higher NDF and ADF, which affected in vitro response and fermentative variables of the ruminal inoculum and microbiota attachment. As far as we know, this is the first contribution about tissue identification during leaf lignification of *Lolium* and *Festuca* in winter and summer.

Key Words: leaf structure, lignified tissue, microbiota attachment

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0626 Correlation of fermentation characteristics with intake and digestibility of alfalfa silage in gestating ewes. V. Niyigena*[1], K. P. Coffey[2], W. K. Coblentz[3], A. N. Young[1], D. Philipp[2], H. L. Bartimus[4], and R. T. Rhein[1], *[1]Department of Animal Science, University of Arkansas Division of Agriculture, Fayetteville, [2]University of Arkansas, Division of Agriculture, Fayetteville, [3]U.S. Dairy Forage Research Center, Marshfield, WI, [4]Department of Agriculture and Environmental Sciences, Lincoln University, Jefferson City, MO*.

Baled silage production provides benefits to farmers because it reduces leaf losses and requires a shorter wilting time, thereby limiting risks of exposure to rain compared with making hay. Our objective was to investigate the correlation of alfalfa silage fermentation parameters with intake and digestibility in gestating ewes. Alfalfa from 3 field blocks was baled in large round bales at a mean moisture concentration of 59.1 ± 4.30% and then wrapped with plastic on the day of baling or 1, 2, or 3 d after baling; this resulted in considerable variability in silage fermentation measurements. Following approximately 5 mo of storage, the alfalfa was chopped and then offered for individual ad libitum consumption by 16 gestating ewes (63.5 ± 1.71 kg average BW) where total feces were collected for 7 d following a 10-d dietary adaptation in each of 3 different periods. Diets were rerandomized to different ewes for each period such that ewes were not offered the same treatment in any period. Data were analyzed using PROC CORR of SAS to determine the correlation between alfalfa fermentation parameters with intake and digestibility measurements. Dry matter and OM intakes were positively correlated ($P < 0.05$) with silage moisture and lactic acid and propionate concentrations and negatively correlated ($P < 0.05$) with ADF concentrations. Dry matter and OM digestibilities were positively correlated ($P < 0.05$) with proportion of lactic acid to total acids (mol/100 mol) but negatively correlated ($P < 0.05$) with ADF concentration, and OM digestibility was also positively correlated ($P < 0.05$) with silage pH. Digestibility of ADF was positively correlated ($P < 0.05$) with silage pH but negatively correlated with water content, lactic acid, total acids, and propionate. Digestible DM and OM intakes (g/kg BW) were positively correlated ($P < 0.05$) with water content of silage, total silage acids, lactic acid, propionate, and butyrate. Therefore, managing alfalfa silage to ensure more desirable fermentation should also result in greater intake of digestible OM, which should improve overall energy status of ruminants. The study was supported in part by USDA-ARS specific cooperative agreement 58-3655-4-052.

Key Words: alfalfa, digestibility, fermentation

0627 A Bayesian approach to unmixed diet composition. N. Vargas Jurado*, K. M. Eskridge, and R. M. Lewis, *University of Nebraska-Lincoln, Lincoln*.

Accurately measuring diet composition is key to delineating feed efficiency, but under grazing conditions, doing so is challenging. Plant-wax markers can be used to estimate the composition of diet mixtures. However, traditional methodologies such as nonnegative least squares (NNLS) ignore variability in and relationships (covariances) between such markers. More recently, Bayesian hierarchical models for linear unmixing (BHLU) have been successfully used for estimating mixing proportions in hyperspectral image analysis

Table 0627.

Table 1. Efficiency of BHLU under four specifications and NNLS

Plant mixture	BDU	BDG	BCU	BCG	NNLS
NMSE					
2	14.4	52.2	11.0	34.0	23.2
3	25.3	66.1	25.1	45.7	39.2
8	321.1	417.1	210.4	463.3	431.8
CP					
2	0.97	0.74	0.91	0.76	0.72
3	0.98	0.89	0.98	0.85	0.73
8	0.18	0.16	0.12	0.17	0.17

and could be applied to estimate diet composition. The objective of the present study was to determine the efficiency of BHLU under five scenarios: 1) BHLU with no covariance and uniform priors, 2) BHLU with no covariance and Gaussian priors, 3) BHLU with covariances and uniform priors, 4) BHLU with covariances and Gaussian priors, and, for completeness, 5) NNLS. A simulation study was performed using *n*-alkane and long-chain alcohol concentrations measured on eight forage species in western rangelands: *Bouteloua gracilis*, *Bromus tectorum*, *Amorpha canescens*, *Schizachyrium scoparium*, *Hesperostipa comata*, *Bouteloua curtipendula*, *Melilotus officinalis*, and *Pascopyrum smithii*. Three mixtures were formed: 1) the two plants *M. officinalis* and *B. tectorum*; 2) the three plants *M. officinalis*, *B. tectorum*, and *B. gracilis*; and 3) all eight plants. For the two- and three-plant mixtures, proportions were drawn from a Dirichlet distribution. The eight-plant mixture reflected the composition of a field in spring. Covariances between markers were specified based on observed correlations. In each case, 900 samples were drawn. Efficiency was assessed through normalized mean squared error (NMSE) and coverage probability (CP). Accounting for covariances between markers increased efficiency of estimation, as shown by lower NMSE and increased CP (Table 1). Gaussian priors increased errors and reduced coverage. Although not entirely comparable with Bayesian methods, NNLS performed reasonably well in terms of NMSE but achieved lower CP. In the eight-plant scenario, all methods performed poorly, suggesting that delineating individual plants grazed in complex swards will be difficult.

Key Words: diet composition, plant-wax markers, Bayesian inference

0628 Dry matter yields and nutritional composition of corn and sorghum for silage in Florida.

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The objective of this retrospective study was to determine the effect of forage type and planting season on DM yield and nutritional composition of corn and sorghum for silage. Data were obtained from hybrid test trials performed by University of Florida. Evaluated forages included corn, forage sorghum (FS), and sorghum Sudan (SS) planted during spring and summer of each year from 2008 to 2014. Plantings occurred on March 17 (±13 d) and July 17 (±3 d) for corn and April 16 (±9 d) and July 18 (±2 d) for sorghum species during spring and summer seasons, respectively. Nutritional composition of harvested and nonensiled samples was determined using NIRS (Dairyland Labs, WI). Data were analyzed using Proc MIXED of SAS. The statistical model included the effects of year (random; df = 6), the treatments (fixed; df = 5), and the residual error (df = 30). Orthogonal contrasts were used to test the effect of planting season (contrast 1), corn vs. sorghum (contrast 2), interaction of season and corn vs. sorghum (contrast 3), FS vs. SS (contrast 4), and the interaction of season (FS vs. SS; contrast 5). Dry matter yield was greater ($P <$??) for corn than for sorghum. Summer planting resulted in 30 to 35% lower ($P <$??) DM yields than spring planting in all forages. Dry matter yields did not differ ($P >$??) between sorghum species. Corn had lower ($P <$??) concentrations of NDF, greater ($P <$??) concentrations of starch, and greater ($P <$??) NDF digestibility than sorghum species. Sorghum Sudan had greater ($P <$??) concentrations of NDF than FS. In conclusion, spring season forages yielded more DM of better nutritional quality than summer season forages. Also corn yields more DM of better nutritional quality than sorghum forages.

Key Words: corn, sorghum, silage.

0629 Influence of plant population, maturity and ensiling time on fermentation profile, nitrogen fractions, and starch digestibility in earlage.

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The objective of this study was to evaluate the effect of plant population, maturity at harvest, and ensiling time on

Table 0628.

Table 1. Effect of planting season on yield and composition of different corn (CN), forage sorghum (FS) and sorghum Sudan (SS) for silage.

	Spring			Summer				*P* value[1]				
	CN	FS	SS	CN	FS	SS	SEM	1	2	3	4	5
DM Yield, ton/acre	8.9	7.8	8.3	6.1	5.4	5.4	0.46	0.01	0.02	0.75	0.57	0.48
DM, %	30.8	29.7	30.0	31.8	29.0	28.6	0.68	0.36	0.01	0.02	0.92	0.47
CP, %	8.4	7.1	6.8	8.2	7.0	7.8	0.47	0.47	0.01	0.35	0.59	0.21
NDF, %	41.8	55.9	58.9	43.9	56.3	58.8	1.15	0.12	0.01	0.26	0.01	0.46
NDFD, % NDF	60.0	52.9	47.9	52.2	48.5	45.4	2.20	0.01	0.01	0.18	0.05	0.63
Starch, %	34.3	17.3	16.5	31.3	14.1	10.8	2.39	0.01	0.01	0.52	0.26	0.51

[1] For testing orthogonal contrasts.

fermentation profile, N fractions, and ruminal in vitro starch digestibility (ivSD; 7 h incubations on dried and 4-mm ground samples) in earlage (contains husks, kernels, and cob). Samples from 4 hybrids (used as experimental unit), each planted at 4 different plant populations (64,000 [64K], 79,000 [79K], 94,000 [94K] or 109,000 [109K] plants/ha) and harvested at 2 maturities (one-half kernel milk line [1/2ML] or black layer [BL]), were collected at harvest, inoculated (Buchneri 500; Lallemand Animal Nutrition, Milkwaukee, WI), and ensiled in vacuum-sealed bags for 30, 60, 120, and 240 d. Ensiled and fresh samples were analyzed at Dairyland Laboratories Inc. (Arcadia, WI). Data were analyzed using Proc Mixed of SAS with the fixed effects of ensiling time, plant population, maturity, and their interactions. Regressions to determine linear relationships were performed using Proc Reg in SAS. Except for greater (P = 0.01) DM content for 64K than for 94K and 109K or slightly greater ivSD for 94K than for other treatments (P = 0.04; 65.5 vs. 63.3% of starch, on average), no effects of plant population were observed (P > 0.10). Although contents of DM, CP, starch, and sugars were greater (P > 0.01), lactate, acetate, 1,2-propanediol, ethanol, and total acid concentrations were lower and, thus, pH was greater in BL earlage. Furthermore, soluble CP and ammonia N concentrations and ivSD were reduced by 5.5, 1.0, and 8.3 percentage units, respectively, in BL than in 1/2ML. Measurements of pH were greater (P = 0.001) for 30 d than the other ensiling times in relationship to a shift in fermentation from lactate (P = 0.001) toward acetate and 1,2-propanediol (P = 0.001) as fermentation progressed. Gradual increases were observed (P < 0.001) from 30 to 240 d for soluble CP (40.6, 47.6, 49.7 and 69.5% of CP) and ammonia N (4.3, 5.4, 5.9, and 9.6% of N). Likewise, the ivSD measurements increased with ensiling time (P < 0.001; 57.9, 59.9, 67.8, and 69.9% of starch). Both ammonia N (R^2 = 0.42, P = 0.001) and soluble CP (R^2 = 0.45, P = 0.001) were positively related to ivSD. Fermentation profile, N fractions, and ivSD of earlage were influenced to a greater extent by ensiling time and maturity than by plant populations. Ammonia N and soluble CP were both good indicators of ivSD in earlage.

Key Words: earlage, ensiling time, starch digestibility

0630 Replacing alfalfa silage with birdsfoot trefoil silage varying in tannin content in lactating cow diets. U. C. Hymes Fecht*, *USDA ARS Dairy Forage Research Center, Madison, WI.*

Silages made from birdsfoot trefoil (BFT) containing 3 levels of condensed tannins (CT) were compared with alfalfa silage (AS) as the principal forage in the diets of lactating dairy cows. Thirty-five multiparous and 15 primiparous Holstein cows were fed a covariate diet for 2 wk and then blocked by parity and DIM and randomly assigned to 1 of 5 diets in a trial of randomized complete block design. Experimental diets were fed as total mixed ration for 12 wk and contained 48% (DM basis) AS or 16% AS plus 32% BFT with low CT (BFTL), normal CT (BFTN), or high CT (BFTH) or a mixture with equal DM from all 3 BFT silages. The BFTL, BFTN, and BFTH contained 5.1, 8.4, and 14.8 g CT/kg DM, respectively. The balance of dietary DM was fed as corn silage, high-moisture shelled corn, soybean meal, soy hulls, Energy Booster, and macro- and trace minerals plus vitamins A, D, and E. Diets were formulated to 16.5% CP and 30% NDF. Statistical analyses were performed using the mixed procedures of SAS. Intake and yield of milk, ECM, true protein, lactose, and SNF were greater (P < ??) on BFTL and BFTN than on AS and BFTH, whereas the BFT mix was intermediate. Apparent N efficiency also was numerically higher (P > ??) on BFTL and BFTN than on the other 3 diets; MUN was lower (P < ??) on all BFT diets than on AS. These results suggest that CT concentrations of approximately 5 to 8 g/kg DM in BFT improve utilization of forage nutrients for milk production.

Key Words: birdsfoot trefoil, condensed tannins, milk production

Table 0630.

Table 1. Production results

	Legume silage source						
Item	AS	BFTL	BFTN	BFTH	BFT mix	SEM	P > F
DMI, kg/d	24.0^{bc}	25.6^{a}	25.4^{a}	23.2^{c}	24.9^{ab}	0.41	< 0.01
Milk, kg/d	36.6^{b}	40.1^{a}	39.5^{a}	36.3^{b}	38.6^{ab}	0.95	0.02
ECM, kg/d	34.7^{bc}	38.3^{a}	37.3^{ab}	33.8^{c}	35.8^{abc}	1.13	0.04
Fat, kg/d	1.39	1.55	1.53	1.36	1.42	0.061	0.11
True protein, kg/d	1.09^{bc}	1.21^{a}	1.15^{ab}	1.06^{c}	1.10^{bc}	0.030	0.01
Lactose, kg/d	1.74^{bc}	1.92^{a}	1.84^{ab}	1.71^{c}	1.84^{ab}	0.048	0.02
SNF, kg/d	3.16^{bc}	3.48^{a}	3.32^{ab}	3.09^{c}	3.26^{abc}	0.084	0.02
MUN, mg/dL	10.3^{a}	9.1^{bc}	9.5^{ab}	9.1^{bc}	8.6^{c}	0.29	< 0.01
Milk-N/N intake, %	26.4	28.0	28.1	26.7	26.3	0.80	0.29

^{a,b,c} Means within a row with different superscript differ (P < 0.05).

0631 Bacterial and fungal community structure of conventional and brown midrib corn hybrids ensiled with or without a combo inoculant at high dry matter concentrations. J. J. Romero*[1,2], Y. H. Joo[3], Y. Zhao[4], J. Park[3], M. A. Balseca-Paredes[1], E. Gutierrez-Rodriguez[5], and M. S. Castillo[1], *[1]Department of Crop Science, North Carolina State University, Raleigh, [2]Animal and Veterinary Sciences, University of Maine, Orono, [3]Division of Applied Life Science (BK21Plus, Inst. of Agri. & Life Sci.), Gyeongsang National University, Jinju, the Republic of Korea,[4]Department of Animal Nutrition and Feed Science, China Agricultural University, Beijing, P. R. China, [5]Department of Food, Bioprocessing, and Nutrition Sciences, North Carolina State University, Raleigh*.

The objective was to evaluate the effects of a combo inoculant on the microbial community structure of 4 corn hybrids ensiled at high DM. Treatment design was the factorial combination of 4 corn types (HYB) ensiled with (INO) and without (CON) inoculant. Corn hybrids were TMF2R737 and F2F817 (A and B; 44.0 and 38.1% DM, respectively; from Mycogen) and P2089YHR and P1449XR (C and D; 42.0 and 41.3% DM, respectively; from Pioneer). F2F817 and D were brown midrib mutants. The inoculant added contained *Lactobacillus buchneri* and *Pediococcus pentosaceus* (4×10^5 and 1×10^5cfu/g of fresh corn). Experimental design was a complete randomized design with treatments replicated 6 times (silos). Corn was chopped, treated or not with inoculant, packed into 7.6-L bucket silos, and stored for 100 d. At d 0, neither HYB nor INO affected the relative abundances of Enterobacteriaceae (61.4 ± 4.54%) and Brucellaceae (3.8 ± 1.24%) bacterial families. F2F817 had more abundance ($P \leq 0.05$) of Rhizobiaceae (5.2 vs. 2.41 ± 0.48%) and Pseudomonadaceae (3.3 vs. 1.8 ± 0.17%) families, compared with A and C. For fungi, 45% (±4.17) consisted of unidentified fungal sequences followed by unidentified sequences of the Tremellales order, which were more abundant in C vs. the others (21.4 vs. 9.5; $P \leq 0.05$). At d 100, a HYB × inoculation effect was observed for the Lactobacillaceae and Leuconostocaceae bacterial families ($P < 0.02$). For the former, INO increased its abundance in all HYB (99.1 vs. 58.9 ± 5.3%) but to a larger extent for B (98.3 vs. 34.3%), and for the latter, INO reduced its abundance in all HYB (0.1 vs. 11.3 ± 3.58%), except C (0.06 vs. 6.67), and to a larger extent in B (0.7 vs. 28.7). INO decreased ($P < 0.01$) the Enterobacteriaceae (0.6 vs. 23.5 ± 1.16%), Streptococcaceae (0.1 vs. 4.6 ± 0.54%), Aeromonadaceae (0.01 vs. 0.55 ± 0.03%), and Brucellaceae (0.01 vs. 0.39 ± 0.05%) families. For fungi, INO had less abundance ($P < 0.01$) of Pichiaceae (6.5 vs. 47.3 ± 5.19%) but more of the Debaryomycetaceae (63.1 vs. 17.3 ± 4.1%) and Mucoraceae (2.7 vs. 0.8 ± 0.53%) families when compared with CON. The results indicate that epiphytic microbial composition differ depending on HYB and that after ensiling, INO favors the dominance of the Lactobacillaceae and Debaryomycetaceae families compared with a more diverse microbial community in the CON.

Key Words: corn silage, bacterial and fungal diversity, combo inoculant

0632 Bacterial and fungal community structure of oats ensiled with or without a combo inoculant. J. J. Romero*[1,2], Y. Zhao[3], M. A. Balseca-Paredes[1], Y. H. Joo[4], J. Park[4], E. Gutierrez-Rodriguez[5], and M. S. Castillo[1], *[1]Department of Crop Science, North Carolina State University, Raleigh, [2]Animal and Veterinary Sciences, University of Maine, Orono, [3]Department of Animal Nutrition and Feed Science, China Agricultural University, Beijing, P. R. China, [4]Division of Applied Life Science (BK21Plus, Insti. of Agri. & Life Sci.), Gyeongsang National University, Jinju, the Republic of Korea, [5]Department of Food, Bioprocessing, and Nutrition Sciences, North Carolina State University, Raleigh*.

The objective was to evaluate the effects of a combo inoculant on the microbial community structure of oats ensiled at high DM concentrations (44.0%). From each of 6 sections in a field, whole oats at heading stage were mowed, wilted for 21 h, chopped, treated (INO) or not (CON) with inoculant, packed into 19-L plastic bucket silos, and ensiled for 217 d. The inoculant added contained *Lactobacillus buchneri* and *Pediococcus pentosaceus* (4×10^5 and 1×10^5 cfu/g of fresh oats). The V4 region of the 16S rRNA gene and the ITS-1 region were amplified and sequenced using an Illumina MiSeq platform for describing the bacterial and fungal communities, respectively. Experimental design was a complete randomized design replicated 6 times (silos). At d 0, there were no differences due to INO for the relative abundance of the Leuconostocaceae (82.9 ± 4.27%), Enterobacteriaceae (15.2 ± 3.52%), Streptococcaceae (0.5 ± 0.10%), and Pseudomonadaceae (0.2 ± 0.13%) bacterial families. For fungi, most of the total relative abundance consisted of unidentified sequences (56.9 ± 6.46%). INO had a higher abundance of the Davidiellaceae family (34.3 vs. 19.6 ± 4.47%) and a lower abundance of unidentified sequences of the Pleosporales order (1.5 vs. 3.2 ± 0.40%) vs. CON ($P \leq 0.05$). No differences between INO and CON were observed for the Pleosporaceae (5.1 ± 2.08%), Nectriaceae (1.9 ± 0.51%), and Debaryomycetaceae (0.6 ± 0.35%) families. At d 217, INO had a lower relative abundance of Leuconostocaceae (42.3 vs. 95.8 ± 4.64%) and a higher relative abundance of Lactobacillaceae (57.4 vs. 3.9 ± 4.65%) bacterial family vs. CON ($P < 0.01$). No effects of INO were observed on the Enterobacteriaceae family (0.05 vs. 0.03 ± 0.02%). For fungi, there were no differences between INO and CON for the relative abundance of Pichiaceae, Trichocomaceae, and Debaryomycetaceae (0.33 ± 0.22%) families and unidentified sequences of the Saccharomycetales order (13.9

± 11.4%), Ascomycota phylum (5.9 ± 4.0%), and Fungi kingdom (1.46 ± 0.96%). However, there was a large numerical decrease of Pichiaceae (41.2 vs. 82.5 ± 20.68%) and increase of Trichocomaceae (14.0 vs. 1.9 ± 6.71%) families in INO vs. CON ($P < 0.23$). In conclusion, INO had only a relative minor influence on the epiphytic fungi but not on the epiphytic bacterial composition. After ensiling, INO favored the dominance of Lactobacillaceae compared with Leuconostocaceae bacterial family in CON. No effects of INO were observed on the fungal community at d 217, but a large numerical decrease was observed in Pichiaceae and increase in Trichocomaceae fungal families vs. CON.

Key Words: oats haylage, bacterial and fungal diversity, combo inoculant

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0633 Microbial count, fermentation, and aerobic stability of regular and brown midrib corn hybrids ensiled with or without a combo inoculant at high moisture concentrations. J. J. Romero*[1,2], J. Park[3], M. A. Balseca-Paredes[1], Y. Zhao[4], Y. H. Joo[3], A. Heitman[1], E. Gutierrez-Rodriguez[5], and M. S. Castillo[1], *[1]Department of Crop Science, North Carolina State University, Raleigh, [2]Animal and Veterinary Sciences, University of Maine, Orono, [3]Division of Applied Life Science (BK21Plus, Insti. of Agri. & Life Sci.), Gyeongsang National University, Jinju, the Republic of Korea,[4]Department of Animal Nutrition and Feed Science, China Agricultural University, Beijing, P. R. China, [5]Department of Food, Bioprocessing, and Nutrition Sciences, North Carolina State University, Raleigh*.

The objective was to evaluate the effects of a combo inoculant on microbial count, fermentation, and aerobic stability of 4 hybrids of corn ensiled at high moisture concentrations. Treatment design was the factorial combination of 4 corn types ensiled with (INO) and without (CON) inoculant. Corn types (HYB) were TMF2R737 and F2F817 (A and B, respectively; from Mycogen) and P2089YHR and P1449XR (C and D, respectively; from Pioneer). F2F817 and D were brown midrib hybrids. The inoculant added contained *Lactobacillus buchneri* and *Pediococcus pentosaceus* (4×10^5 and 1×10^5 cfu/g of fresh corn). Experimental design was a complete randomized design with 6 replicates (silos). Corn was chopped, treated or not with inoculant, packed into 7.6-L bucket silos, and stored for 100 d. At d 0, there were differences due solely to hybrids ($P \leq 0.05$). The percent DM was 30.5, 26.3, 31.1, and 31.5 for A, B, C, and D, respectively; lactic acid bacteria (LAB) count (log cfu/g of fresh corn) was similar for C and D (8.4) and both were greater than A and B (7.7 ± 0.23); yeast count was greatest in C (6.8 vs. 6.0 ± 0.14) and mold count was lowest in D vs. the others (4.6 vs. 5.2 ± 0.15; $P \leq 0.05$). At opening, INO increased ($P \leq 0.05$) LAB (9.3 vs. 7.1 ± 0.29), acetic acid (3.44 vs. 1.32 ± 0.35% of DM), and 1,2-propanediol for all HYB (0.7 vs. 0.0) except D (0.3 ± 0.11% of DM; INO × HYB, $P < 0.01$); decreased yeast (3.1 vs. 4.6 ± 0.45) and molds (1.5 vs. 3.0 ± 0.61); and extended the aerobic stability (582 vs. 111 ± 128 h) vs. CON. However, INO decreased ($P \leq 0.05$) DM recovery (95.6 vs. 97.4 ± 1.05%) and lactic acid for all HYB (4.2 vs. 7.6) except A (4.9 ± 0.59% of DM; INO × HYB, $P < 0.01$) and WSC (1.2 vs. 2.3 ± 0.17% of DM) vs. CON. Also, INO increased pH for all HYB (4.1 vs. 3.9) except D (3.9 ± 0.03; INO × HYB, $P < 0.01$) and decreased ethanol only for D (0.8 vs. 1.3) but not for the others (0.6 ± 0.08% of DM; INO × HYB, $P < 0.01$). The results indicate that the inoculant used consistently improved aerobic stability across HYB by increasing acetic acid and reducing fungal counts but reduced DM recovery of the corn ensiled at high moisture.

Key Words: corn silage, microbial counts, combo inoculant

0634 Forage quality of two different pasture systems incorporating warm and cool season forages for grazing organic dairy cattle. K. E. Ruh*[1,2], B. J. Heins[1], and J. Paulson[3], *[1]University of Minnesota West Central Research and Outreach Center, Morris, [2]University of Minnesota, Saint Paul, [3]University of Minnesota Extension, Rochester*.

Two pasture systems (perennial and annual grass species) with enhanced in-field and landscape-level species diversity were analyzed for forage quality characteristics across the grazing season at the West Central Outreach and Research Center organic dairy in Morris, MN, for 3 yr. System 1 was a diverse mixture of cool season grasses and legumes (perennial ryegrass, white clover, red clover, chicory, orchardgrass, meadow bromegrass, alfalfa, and meadow fescue). System 2 was a combination of perennial polycultures and annual warm-season grasses (BMR sorghum-sudangrass and teff grass). Grazing of lactating cows was initiated when forages were 20 to 30 cm tall, and strip size was adjusted to leave 7 to 13 cm of refusals. Random samples of pasture forage were sampled every other day when a group of cows moved to a new paddock. Pasture clippings were randomly collected in a 0.76-m^2 square of pasture. Forage samples were sent to Rock River Laboratory, Inc., Watertown, WI, and were analyzed with NIR spectrophotometry for DM, CP, and total tract NDF digestibility (TTNDFD). Data were analyzed using the MIXED procedure of SAS. Independent variables for analyses were the fixed effects of system (perennial [1] or perennial–annual [2]), month (June to October), forage (perennial grass pasture, oats/turnips mix, BMR sorghum-sudangrass, or teff grass), year (2013, 2014, and 2015), and their interactions, and date of harvest was a random variable. The DM was 23.3 and 22.4% for systems 1 and 2, respectively ($P = 0.44$). The CP was 23.0 and 18.0% for systems 1 and 2, respectively ($P < 0.001$). The CP for system 1 was 20.9% in 2013, 23.2% in 2014, and 24.7% in 2015 ($P < 0.05$). The CP for system 2 was

14.6% in 2013, 18.9% in 2014, and 20.5% in 2015, and 2013 was lower ($P < 0.05$) than 2014 and 2015. The TTNDFD was 54.6% and 54.9% for system 1 and system 2, respectively ($P = 0.84$). The TTNDFD was 63.8% in 2013, 48.0% in 2014, and 51.9% in 2015 for perennial grass pastures ($P < 0.01$) and 59.3% in 2013, 46.3% in 2014, and 59.0% in 2015 for warm season annual grasses. In summary, CP was greater in perennial cool-season pasture systems; however, TTNDFD and DM did not differ between pasture systems. Yearly effects and weather may affect forage quality in both pasture production systems.

Key Words: grazing, teff, sorghum-sudangrass

0635 Meta-analysis of the effect of homolactic and facultative heterolactic bacteria inoculation on silage quality II: Aerobic stability and yeast, mold and clostridia counts.

A. S. Oliveira*[1], Z. G. Weinberg[2], A. A. P. Cervantes[3], K. G. Arriola[3], I. M. Ogunade[3], Y. Jiang[3], D. Kim[3], M. C. M. Gonçalves[4], D. Vyas[3], and A. T. Adesogan[3], *[1]Universidade Federal de Mato Grosso – Sinop, Sinop, Brazil, [2]Department of Food Quality and Safety, Agricultural Research Organization, The Volcani Center, Rishon Le Zion, Israel, [3]Dep. of Animal Sciences, IFAS, University of Florida, Gainesville, [4]Instituto Federal Goiano, Rio Verde, Brazil*.

Data from 120 peer-reviewed papers were summarized to evaluate the effects of homolactic and facultative heterolactic bacteria (HAB; *Lactobacillus plantarum*, *Pediococcus pentosaceus*, *Enterococcus faecium*, *Lactobacillus rhamnosus*, or their combinations) inoculation on aerobic stability and microbial profile of silages. The effects were statistically analyzed by comparing raw mean differences between inoculant and control treatment means that had been weighted by inverse variance using random models. Heterogeneity sources evaluated by meta-regression included crop species, application rate (AR; $<10^4$, 10^5 to 10^6 or $>10^7$ cfu/g, representing 3.7, 93.6 and 2.7% of studies, respectively), HAB species, and silo type (laboratory or farm-scale; 92.2 and 7.8% of studies, respectively) as covariates. Corn/sorghum, temperate and tropical grasses, sugarcane, alfalfa, other legumes, and other crops silages accounted for 22.8, 32.3, 7.8, 10.2, 4.8, 12.9, and 9.2% of the silages, respectively. High heterogeneity (I^2 statistic > 50%) was detected for all response variables. No interactions ($P > 0.05$) between the covariates were detected. Inoculation did not affect aerobic stability (2.4 h; $P = 0.33$, $n = 44$) but reduced counts (log cfu/g as fed) of Clostridia (−2.31 log cfu/g; $P < 0.01$, $n = 7$) mainly in grass silage studies ($n = 6$). Inoculation did not affect mold counts in corn/sorghum silages (0.05; $P = 0.73$, $n = 15$), but it reduced mold counts in temperate (−0.50; $P < 0.01$, $n = 10$) and tropical grasses (−1.68; $P = 0.04$, $n = 2$). Inoculation increased yeast counts (0.30; $P < 0.01$, $n = 82$). Inoculation with HAB did not affect aerobic stability, but it increased the growth of yeasts in all crops and reduced clostridia and mold populations in tropical and temperate grass silages.

Key Words: clostridia, *Lactobacillus plantarum*, mold, yeast

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0636 Meta-analysis of the effect silage inoculation with homolactic or facultative heterolactic bacteria on the performance of dairy cows.

A. S. Oliveira*[1], Z. G. Weinberg[2], A. A. P. Cervantes[3], K. G. Arriola[3], I. M. Ogunade[3], Y. Jiang[3], D. Kim[3], M. C. M. Gonçalves[4], D. Vyas[3], and A. T. Adesogan[3], *[1]Universidade Federal de Mato Grosso – Sinop, Sinop, Brazil, [2]Department of Food Quality and Safety, Agricultural Research Organization, The Volcani Center, Rishon Le Zion, Israel, [3]Dep. of Animal Sciences, IFAS, University of Florida, Gainesville, [4]Instituto Federal Goiano, Rio Verde, Brazil*.

Data from 13 peer-reviewed papers were summarized to examine the effect of silage inoculation with homolactic or facultative heterolactic bacteria (HAB) on the performance of dairy cows. The effects were compared by raw mean differences (RMD) between inoculant and control treatment means and weighted by inverse variance using random-effect models. Heterogeneity sources evaluated by meta-regression and included as covariates crop species (grass, alfalfa, corn, or mixtures of silages representing 68.8, 12.5, 6.3, and 12.5% of experiments, respectively), HAB species (*Lactobacillus plantarum* or HAB combinations were each used in 50% of the studies), diet type (total mixed ration [TMR] vs. non-TMR were used in 25 and 75% of the studies, respectively), and level of milk yield of control cows (<22 or >22 kg/d were produced in 56.3 and 43.7%, respectively, of the studies). All studies had HAB application rates of 10^5 to 10^6 cfu/g fed. High heterogeneity was detected for DMI (I^2 statistic = 71.5%), milk yield ($I^2 = 81.6\%$), and milk protein concentration ($I^2 = 88.7\%$), whereas moderate heterogeneity was detected for milk fat concentration ($I^2 = 49.1\%$). No interaction ($P > 0.10$) was detected between the covariates. Inoculation with HAB increased DMI (RMD = 0.66 [0.22, 1.10] kg/d; $P < 0.01$, $n = 11$), did not affect milk yield in cows producing <22 kg of milk/d (RMD = −0.89 [−1.93, 0.13] kg/d [$P = 0.09$]; milk yield for control cows = 19.60 ± 1.88 kg/d; $n = 9$), but increased milk yield in cows producing >22 kg/d (RMD = 1.07 [0.26, 1.88] kg/d [$P < 0.01$]; milk yield of control cows = 29.92 ± 8.64 kg/d; $n = 6$). Inoculation with HAB tended to increase milk fat concentration (RMD = 0.06 [−0.004, 0.11] % milk; $P = 0.07$, $n = 15$) and increased milk protein concentration (RMD = 0.10 [0.05, 0.15] % milk; $P < 0.01$, $n = 13$, $n = 2$ outliers). However, there was a trend for inoculation with a mixture of HAB species to give a higher milk protein response (RMD = 0.15 [0.02, 0.25] % milk; $P = 0.02$, $n = 6$)

than inoculation with *L. plantarum* alone (RMD = 0.04 [0.01, 0.07] % milk; $P < 0.01$, $n = 7$). Inoculation with HAB with improved the performance of dairy cows producing more than 22 kg of milk/d but did not affect that of those producing lower quantities of milk.

Key Words: forage conservation

0637 Screening of microorganism and effects of different bacterial additives on fermentation quality of rye silage harvested at dough stage.

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This study was investigated to select a new inoculant and estimate its effects on rye silage harvested at dough stage. Twenty-four rye silages were collected from the commercial beef cattle farms. A total of 180 dominant microorganisms from these rye silages were selected and identified as *Lactobacillus* spp. Those were confirmed the antimicrobial activities against such as mycotoxigenic fungi through antagonism screening. The isolates also were analyzed for acidification ability through monitoring a change of bromophenol blue color and pH of MRS broth. Finally, the isolates were evaluated for fibrinolysis ability through the enzyme plate assay test using four enzymes (cellulase, xylanase, esterase, and chitinase). Eight isolates among 180 isolates indicated antimicrobial activities against *Fusarium moniliforme*. Two isolates indicated strong acidification ability (R4-26 and R7-24). In enzyme plate assay test, one isolate was effective for all enzymes (R48-27). Selected isolates R48-27 (LP1) and R4-26 (LP2) were evaluated on rye silage to improve fermentation quality. Rye forage was grown at the research farm of Gyeongsang National University, Jinju, the Republic of Korea, and harvested at dough stage (46% DM). The forages were divided into five treatments: CON (distilled water at 2 mL/kg of fresh forage), LP1 (*Lactobacillus plantarum* R48-27 at 4.0×10^4 cfu/g of fresh forage), LP2 (*L. plantarum* R4-26 at 4.0×10^4 cfu/g of fresh forage), MIX (mixture of LP1 and LP2 at 1:1 ratio), and LB (*Lactobacillus buchneri* at 4.0×10^4cfu/g of fresh forage). The forage was chopped and ensiled into 10-L mini-silos with 4 replications for 100 d. The NDF concentration was higher ($P < 0.05$) in CON and MIX silages compared with the other silages, whereas ADF concentration was lower ($P < 0.05$) in LP2 silage than the other silages. The LB silage produced the lowest pH that was equated with higher lactate production ($P < 0.05$), whereas the LP2 silage produced the highest acetate and propionate ($P < 0.05$). The LB silage resulted in the highest lactate-to-acetate ratio ($P < 0.05$). Mold was not detected only in the LP2 silage. In conclusion, the new inoculant (LP2) could be suggested to improve the silage safety, which has a strong effect against mycotoxin fungi.

Key Words: rye silage, inoculant, fermentation quality

0638 Effects of cow and bag type on the undigested neutral detergent fiber after two hundred forty hours in situ incubation.

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The effect of cow and in situ bag type on undigested NDF (uNDF) content of corn silage, wheat straw, and alfalfa silage after 240 h in situ incubation were evaluated in three rumen-cannulated Holstein cows. Two corn silages, a wheat straw, and an alfalfa silage sample were dried and ground to pass through a 2.5-mm screen. After thorough mixing, 1 , 2, and 5 g of each forage were placed into F57 Ankom bags (4 by 5 cm), Ankom 5- by 10-cm nylon bags (part number R0510), or Ankom 10- by 20-cm nylon bags (part number R1020), respectively. There were three duplicates for each treatment within each cow. Sample mass to surface area by bag was 25, 20, and 12.5 mg cm^{-2}, respectively. The residual NDF was analyzed after 240 h incubation. Data was analyzed by SPSS 19.0. Within each forage, the effect of cow and bag type on uNDF within forages was determined by ANOVA. Means were compared by Duncan's multiple range test. The contents of the uNDF significantly differed due to bag type ($P < 0.001$). The content of uNDF in F57 bags was significantly higher than in R0510 and R1020 nylon bags ($P < 0.05$) and there was no significant difference in uNDF between R0510 and R1020 nylon bags ($P > 0.05$). The uNDF differed within cow for wheat straw ($P < 0.001$). Bag type and effective surface area should be taken into consideration when measuring uNDF by in situ methods; the estimate of uNDF in relatively indigestible materials, such as wheat straw, may also be affected by cow.

Key Words: undigested neutral detergent fiber, in situ, bag type

0639 WS Immunodetection of the Cry toxin in leaves of transgenic maize hybrids. G. Balieiro Neto*[1], A. W. P. Freitas[2], R. Botelho Ferraz Branco[2], K. Maria Roncato Duarte[2], F. Porto Pela[3], and M. D. Baruffi[3], *[1]Sao Paulo State Agency Agribusiness Technology, Ribeirao Preto, Brazil, [2]São Paulo State Agency Agribusiness Technology, Ribeirao Preto, Brazil, [3]University of São Paulo, Ribeirao Preto, Brazil*.

This assay aimed to evaluate the Cry toxins concentration in the last completely expanded leaf at 7, 14, 28, 35, 70, 84, and 96 d after planting of five corn hybrids. The evaluated hybrids were Syngenta Impact TL TG, Monsanto DKB 390 VT PRO II, Monsanto AG 8088 PRO II, Biomatrix 2B655 Herculex from Dow, and Syngenta 7205 Viptera. To analyze the toxin concentrations, antibodies were produced and a PTA-ELISA was developed. The positive controls used to produce the calibration curves were Sigma-Aldrich BF412b (Cry1Ab), Sigma-Aldrich BF418b (Cry1F), and Sigma-Aldrich BF423b (Vip3Aa20). The experimental design was randomized blocks in a factorial arrangement 5 (hybrid) × 7 (samples) with five repetitions. There were a significant interaction between hybrid and sampling period. The mean concentrations of the Cry toxins in the hybrids Herculex, AG 8088 PRO II, DKB 390 VT PRO II, Viptera, and Impacto were 7.58, 13.05, 16.81, 22.67, and 34.05 µg/g of fresh tissue, respectively. The mean concentration of Cry toxins were 16.77, 15.16, 18.46, 22.87, 22.85, 20.62, and 15.98 µg/g of fresh tissue at 7, 14, 28, 35, 70, 84, and 96 d after planting. Higher concentration of Cry toxin occurred between 35 and 70 d after planting and the hybrids with the higher concentrations were Viptera and Impacto with concentrations of 34.6 and 39.6 µg/g of fresh tissue, respectively. This information can integrate selection criteria of hybrids for cultivation in different regions according to the level of infestation of pests and resistance thereof to different Cry toxin concentrations.

Key Words: corn, Cry toxin, OGM, PTA ELISA

0640 The effect of defoliation severity during late autumn–winter on herbage production, regrowth, and nitrogen uptake. G. Cun*, G. R. Edwards, and R. H. Bryant, *Lincoln University, Lincoln, New Zealand*.

Nitrate leaching is an important environmental concern in livestock production in temperate pastures with leaching losses often high in late autumn/winter. Management strategies are sought to reduce nitrate leaching by enhancing pasture growth and uptake of nitrogen (N) over the winter period. The objective of this experiment was to determine the effect of five postgrazing heights on herbage production, quality, and N uptake of a diverse pasture mixture containing *Lolium perenne* (perennial ryegrass), *Trifolium repens* (white clover), *Cichorium intybus* (chicory), *Plantago lanceolata* (plantain), and *Medicago sativa* (lucerne) during the late autumn winter season. Pasture areas were defoliated to five different residual heights (20, 30, 40, 50, and 60 mm) by a push lawn mower in a randomized block design with four replicates. All swards were allowed to regrow for 112 d and herbage accumulated over the regrowth period was measured. Swards defoliated to 20, 30, and 40 mm had greater herbage regrowth (1,884, 1,508, and 1,322 kg DM/ha, respectively) compared with those defoliated to 60 mm (1,289 kg DM/ha) over 112 d. Repeated measures analysis on N concentration of herbage showed a significant interaction ($P = 0.012$) of defoliation treatment with time. For the 20-mm defoliation, N concentration increased from 18.8 to 29.7 g N/kg whereas the 60-mm defoliation decreased from 26.1 to 24.9 g N/kg during the regrowth period. During this 112-d regrowth period, pastures defoliated to 20 mm accumulated 56.01 kg N/ha compared with 32.07 kg N/ha in plots defoliated to 60 mm. The results indicate severely grazing to postgrazing heights <40 mm may improve growth and N uptake in the late autumn/winter period.

Key Words: grazing management, nitrogen uptake, defoliation severity

Table 0641.

Table 1. Biomass yield and quality of tall wheatgrass (TW) in fall interseeded with hairy vetch in the previous year.

	Treatments*			
Variable	TWCon	TWHV	p-value	SEM
DM yield, kg/ha	502.92	526.67	0.7016	52.44
DM, %	53.46[a]	45.12[b]	0.0039	1.30
NDF, %	68.21[a]	65.21[b]	0.0058	0.63
ADF, %	38.49[a]	36.54[b]	0.0227	0.45
ADL, %	3.51[a]	3.85[b]	0.0317	0.10
IVDMD, %	43.35	47.52	0.1976	2.03

* Control, no interseeding (TWCon) and TW + HV interseeding (TWHV)
[a,b] P <0.05

0641 Tall wheatgrass biomass yield and quality after interseeding with hairy vetch. M. Menghini[1,2], H. M. Arelovich*[1,2,3], M. F. Martínez[1], R. D. Bravo[1], and M. D. Chamadoira[1], *[1]Dto. Agronomia, Universidad Nacional del Sur, Bahia Blanca, Argentina, [2]CIC, Bahia Blanca, Argentina, [3]CERZOS, Bahia Blanca, Argentina*.

Tall wheatgrass (TW; *Thinopyrum ponticum*) is a reliable perennial temperate grass frequently used as a pasture in southwest semiarid Argentina. However, grass quality and biomass yield is affected by soil fertility. Mixes with annual legumes well adapted to the area such as hairy vetch (HV; *Vicia villosa*) may affect grass biomass yield and nutritive value. The aim of this study was to evaluate the effect of interseeding HV within an existing TW pasture on the biomass yield and nutritional value measured in fall, once the life cycle of the legume is finished. The experimental site was located at 62°00′56″ W, 38°10′16″ S. Pastures arranged in plots of 9 m^2 were used as experimental units. The treatments were control, no interseeding (TWCon), and TW + HV interseeding at a density rate of 20 $kg \cdot ha^{-1}$ (TWHV) in a complete block design ($n = 3$). Interseeding dates for HV were March 20 and 22 of 2013 and 2014, respectively, with a similar biomass yield composition of 80 and 83% for HV in the spring of both years. The plots were manually clipped at 8 cm height on March 21, 2014 (Y1), and May 12, 2015 (Y2). Subsamples of 0.4 m^2 were obtained from each plot to determine forage DM content and biomass yield, CP, NDF, ADF, ADL, and in vitro DM digestibility (IVDMD). Data were analyzed as a mixed model and means were compared by Tukey ($\alpha = 0.05$). An interaction treatment by year was only apparent for CP ($P < 0.05$). Then, CP concentration was analyzed for each treatment; TWCon was 8.2 and 3.8% vs. a higher level for TWHV 13.5 and 6.8% for Y1 and Y2, respectively ($P < 0.05$). The year mean for the rest of the variables are shown in the table. Except for ADL, which was higher for TWHV, the DM, NDF, and ADF contents resulted lower for TWHV than for TWCon ($P < 0.05$), whereas for DM yield and IVDMD, the differences attributed to the interseeding were not significant. Interseeding HV into TW existing pastures improve the nutritional value of the TW regrowth.

Key Words: *Vicia villosa*, *Thinopyrum ponticum*, intercropping

0642 Effect of canopy height on the nutritive value of elephant grass silage. E. B. Alves, I. L. De Oliveira, J. R. Gervasio, M. S. Bastos, S. M. Da Silva, J. O. Gusmao, L. M. Lima, and T. F. Bernardes*, *Federal University of Lavras, Lavras, Brazil*.

The ideal canopy height (CH) to harvest elephant grass for making silage has not been determined. Therefore, the objective of this study was to evaluate the yield of elephant grass (*Pennisetum purpureum* cv. Cameroon) and the silages produced from plants harvested at five CH: 100, 140, 180, 220, and 260 cm (described as CH100, CH140, CH180, CH220 and CH260, respectively). The experiment consisted of 25 plots with four rows each. The plants used to assess forage yield and to produce the silages were cut at ground level from the two central rows of each plot every time the canopy reached the target height. To make silages, the plants were chopped with a theoretical cut length of 20 mm and packed to a wet density of 688 kg/m^3 in 15-L laboratory silos. To measure effluent production, 10 kg of sand were placed on the bottom of the silos. The silos were sealed with plastic lids, weighed, and maintained at room temperature for 60 d. At silo opening, silage was removed and subsamples were taken to determine fermentation end products, microbial counts (bacteria, yeasts, and molds), and nutritive value. The experimental design was randomized blocks with five repetitions. The data were analyzed by the mixed-model method using the MIXED procedure (SAS Institute, 2004). The means were compared by a Tukey test at 5%. Canopy height was considered a fixed effect and block was considered a random effect. CH100 and CH140 had the lowest yield (on average, 12.8 ton DM/ha) and CH260 had the highest (22.4 ton DM/ha). CH180 and CH220 showed an intermediate production (on average, 17.3 ton DM/ha). The DM concentration of the plants before ensiling ranged from 11.6 to 21.5% ($P < 0.001$). Canopy height did not affect fermentative and microbial characteristics of the silages. Effluent losses were greater ($P < 0.0001$) in silages with plants harvested at CH100 (58.4 kg/ton of fresh forage), whereas the silages from CH260 had the lowest effluent production (24.1 kg/ton of fresh forage). The in vitro digestibility of the silages produced with plants harvested at CH100, CH140, and CH180 was greater (on average, 69.9%; $P = 0.0007$) than that of the other treatments (57.1%). As no differences among treatments were observed in terms of fermentation quality, it is possible to conclude that the right CH to produce elephant grass silage range from 180 to 220 cm due to the greater balance between forage yield and silage digestibility.

Key Words: cut-and-carry system, forage harvesting, tropical forage

0643 Compost inclusion level in soil on chemical composition and in vitro dry matter digestibility of native and improved cactus forage varieties. J. A. Santos-Haliscak*[1], J. Kawas[1], H. Fimbres-Durazo[1], G. Moreno-Degollado[1], R. E. Vázquez-Alvarado[1], E. Olivares-Sáenz[1], and H. Andrade-Montemayor[2], *[1]Universidad Autonoma de Nuevo Leon, San Nicolas de los Garza, Mexico, [2]Universidad Autónoma de Querétaro, Querétaro, Mexico*.

The objective of this study was to determine DM and protein production per hectare, chemical composition, and in vitro digestibility of two cactus varieties planted in soil with three compost levels. A randomized complete block design with a

factorial arrangement of treatments, with the two cactus varieties, one with spines (WS) and one without spines (WOS), four seasons (summer, fall, and winter of 2013 and spring 2014) and three levels of compost (0, 61, and 122 tons/ha) was conducted. Compost was purchased from a local feedlot. The WS variety was Forrajero Mina and the WOS was COPENA F1. These were planted in double rows, with a spacing of 0.5 m between plants and 0.6 m between rows in 1.2-m-wide beds. The design included 5 beds (repetitions), for a total of 300 plants per variety and 600 for the entire experiment. The WS variety had higher concentrations of NDF (30.5 vs. 22.3%; $P = 0.001$), hemicellulose (17.5 vs. 7.9%; $P = 0.001$), ash in NDF (4.09 vs. 3.14%; $P = 0.005$), iron (59.8 vs. 49.8 ppm; $P = 0.020$), and manganese (41.1 vs. 34.3 ppm; $P = 0.005$), whereas the WOS variety had higher concentrations of lignin (1.4 vs. 0.7%; $P = 0.001$), ash in ADF (0.92 vs. 0.45%; $P = 0.03$), calcium (3.1 vs. 2.9%; $P = 0.001$), and zinc (44.6 vs. 39.0 ppm; $P = 0.03$). In vitro DM digestibility was higher (79 vs. 67%; $P = 0.001$) for the WOS variety. The inclusion of compost increased DM (2.8 to 4.4 tons/ha; $P = 0.018$) and CP (196 to 556 kg/ha; $P = 0.001$) production, lignin (0.83 to 1.22%; $P = 0.008$), phosphorus (0.10 to 0.23%; $P = 0.001$), and zinc (36.7 to 44.1 ppm; $P = 0.025$) while decreasing the concentration of ash in ADF (0.93 to 0.51%; $P = 0.031$). The two cactus varieties had high ash and moisture content, which may reduce the energy density of this feed for livestock. Nitrogen associated with the ADF fraction (0.65%) may reduce nitrogen availability for bacteria in the rumen.

Key Words: cactus, chemical composition, in vitro digestibility, compost.

0644 Neutral detergent fiber digestibility of diets supplemented with soy hulls, corn stover, or alkali–ethanol–treated stover in lactating dairy cows. D. M. Donnelly*[1], L. C. de Resende[2], and D. K. Combs[3], *[1]Department of Dairy Science, University of Wisconsin-Madison, Madison, [2]University of Wisconsin-Madison, Madison, [3]Department of Dairy Science, University of Wisconsin, Madison*.

The objective of this study was to evaluate the digestibility of diets supplemented with three sources of NDF: soy hulls, untreated corn stover, or corn stover treated with NaOH and ethanol. Total tract apparent DM and NDF digestibility were measured with eight lactating Holstein cows in a replicated 4 × 4 Latin square design with four 21-d periods. The diets consisted of a low-fiber control diet (25% of diet DM as NDF) and treatment diets containing the control diet supplemented with 2.1 kg of soy hulls, untreated corn stover, or NaOH/ethanol–treated stover. Treatment diets contained approximately 30% of diet DM as NDF. Feed intake, orts, and milk yield were recorded daily. During the third week of each period, 12 fecal samples were collected to cover a 24-h period and composited. Milk collected from the last four milkings of each period was analyzed for milk composition. Data was evaluated using PROC MIXED (SAS version 9.3) with cow within block and period as random effects and treatment set as a fixed effect. Milk yield, milk fat percentage, and DMI did not differ among treatments ($P > 0.05$). Intake of NDF and iNDF intake as a percentage of BW were similar across treatments. Cows fed the control diet and the diet with supplemented soy hulls had higher DM digestibility (57.7 and 60.0% DMD, respectively) compared with cows fed diets supplemented with untreated stover (52.4%; $P < 0.0001$). The DM digestibility of the diet with supplemented treated stover was similar to both the untreated stover and soy hull rations. In vivo NDF digestibility was lowest when cows were fed the untreated stover ration. Digestibility of NDF was improved when soy hulls or treated

Table 0644.

	Control	Soy Hulls	Treated Stover	Untreated Stover	SEM	P - Value
MY, kg	28.0	30.7	27.9	29.9	3.3	0.36
Fat, %	4.4	4.1	4.2	4.4	0.3	0.39
DMI, kg	29.1	30.3	29.6	28.7	1.2	0.28
NDF Intake, kg	10.1	10.5	10.3	10.0	0.4	0.28
DMD, %	57.7[a]	60.0 [a]	54.8 [ab]	52.4 [b]	1.6	< 0.0001
In Vivo NDFD, %	35.6[a]	41.63[b]	38.2 [ab]	31.9 [c]	1.5	< 0.0001
NDF Intake, %BW	1.39	1.44	1.40	1.36	0.08	0.24
iNDF Intake, % BW	0.140	0.149	0.145	0.142	0.008	0.24

stover were added to the diets ($P < 0.0001$). The NaOH/ethanol treatment process appears to improve the DM and NDF digestibility of corn stover to values similar to those of soy hulls. Supplemental fiber did not affect milk yield, DMI, or fiber intake.

Key Words: in vivo, neutral detergent fiber, NaOH

0645 Yield and nutritive value of photoperiod-sensitive sorghum and sorghum-sudangrass in central Wisconsin. E. Remick*[1], H. Su[2], W. K. Coblentz[3], and M. Akins[2], *[1]University of Wisconsin-Madison, Madison, [2]University of Wisconsin, Madison, [3]U.S. Dairy Forage Research Center, Marshfield, WI.*

A study was conducted to evaluate the yield and nutrient composition of photoperiod-sensitive (PS) and non-PS forage sorghum, sorghum-sudangrass, and sudangrass compared with corn planted on 2 dates and harvested using single- or multiple-cut harvest strategies at 2 research stations (Marshfield and Hancock), each located in central Wisconsin. At each site, treatments were arranged in a randomized complete block design with 4 replicates. The experiment was analyzed as a split-split-plot design with planting date (early or mid June) designated as the main plot, harvest strategy (single cut or multiple cut) as the subplot, and 8 forage cultivars (corn silage, PS forage sorghum, PS sorghum-sudangrass, forage sorghum, BMR forage sorghum, sorghum-sudangrass, BMR sorghum sudangrass, or PS-BMR sudangrass) designated as the sub-subplot treatment factor. Multiple-cut plots were harvested in late August and early October with single-cut plots harvested only in early October. Data were independently analyzed for each location. Overall, forage yields were numerically greater for Hancock plots compared with Marshfield plots (Table 1). At Hancock, DM yields were greater for the early compared with late planting date (16,225 vs. 12,080 kg DM/ha; $P = 0.014$), but there were no effects of planting date at Marshfield (overall mean = 8,228 kg DM/ha; $P = 0.90$). The lack of response at Marshfield was likely due to delayed germination of early planted plots following heavy rains. At both sites, the single-cut harvest (17,517 kg DM/ha at Hancock and 11,729 kg DM/ha at Marshfield) was greater ($P < 0.01$) than the multiple-cut harvest system (10,789 kg DM/ha at Hancock and 4,726 kg DM/ha at Marshfield). There were yield differences for variety as well as variety by harvest type interactions ($P < 0.01$) at both locations (Table 1). At both sites, the multiple-cut harvest strategy reduced yields of all hybrids. The sorghum-sudangrass and PS sorghum-sudangrass varieties had the greatest numerical yields among the sorghum types tested under both harvest strategies. Reduced yields of varieties harvested using multiple-cut strategies may reflect reduced tillering and regrowth capabilities of certain varieties. Using a single harvest, several sorghum forage types has similar or better forage yields compared with corn silage.

Key Words: forage sorghum, sorghum-sudangrass photoperiod sensitive

0646 Cutting interval and water application influence *Sericea lespedeza* yields and condensed tannin content. L. C. Nuti*[1], J. P. Muir[2], E. A. Duffus[1], Y. Jung[1], A. A. James[1], N. M. Cherry[3], and G. R. Newton[1], *[1]Prairie View A&M University, Prairie View, TX, [2]Tarleton State University, Stephenville, TX, [3]Texas A&M AgriLife Research, Stephenville, TX.*

Sericea lespedeza (SL; *Lespedeza cuneata*) contains tannins that may provide beneficial effects in gastrointestinal nematode suppression in small ruminants. The objective of the present work was to investigate the effect of cutting frequency and water application on forage yield, total tannin content, and active protein bound to tannins. *Sericea lespedeza* was grown in 30 raised boxes (1.5 m^2 by 0.3 m) containing a commercial potting soil mixture. Established (yr 3) SL was randomly assigned to a cutting interval of 30, 45, or 60 d over a 120-d trial period. Within each cutting frequency, boxes were randomly assigned to a watering treatment of ambient rainfall or 2.5 or 5.0 cm of applied water per week (AWW). At the designated harvest intervals, SL was cut to a height of 12.5 cm and weighed (wet weight). The effect of cutting frequency and water treatments were analyzed using SAS 9.3 general linear model procedure for repeated measure design. No interaction was detected between cutting frequencies and water application rates. Cutting interval ($P < 0.08$) and water treatments ($P < 0.03$) influenced overall wet weight yield of SL over the 120-d growing period. A 45-d cutting interval produced more SL forage ($P < 0.07$; 8.43 ± 0.39 kg) when compared with a 30-d cutting interval (7.15 ± 0.39 kg) but was similar to yields obtained on Day 60 (7.56 ± 0.39 kg). Plants supplemented with 5 cm AWW produced more SL forage (8.61 ± 0.4) than plants grown under ambient conditions (7.12 ± 0.4 kg; $P < 0.03$) or supplemented with 2.5 cm AWW (7.42 ± 0.34 kg; $P < 0.9$). *Sericea lespedeza* was then sun dried and condensed tannin (CT) and protein-bound (PB) CT were determined using 50 μg DM and the protein precipitable phenolics method of Hagerman and Butler (1978). Total CT was not influenced by water application rates ($P > 0.1$). A cutting interval of 45 d increased the amount of plant CT (153.18 ± 12.95 μg; $P > 0.01$) when compared with the 30- (100.75 ± 11.51 μg) or 60-d (107.73 ± 15.86 μg) cutting intervals. Concentrations of PB CT were not influenced by cutting interval or water application rates. Growth of SL under ambient conditions in Texas is good but can be improved with irrigation. A 45-d cutting interval maximizes plant yield and total tannin concentrations.

Key Words: *Sericea lespedeza*, growth, tannins

0647 A comparison of in vitro rumen digestibility and fermentation indices of tannin-rich chestnut meal. J. H. Park*[1], J. W. Jang[1], J. H. Kim[1], H. J. Lee[2], Y. H. Joo[2], S. S. Lee[2], I. H. Choi[3], and S. C. Kim[1,2], *[1]Department of Animal Science, Gyeongsang National University, Jinju, the Republic of Korea, [2]Division of Applied Life Science (BK21Plus, Insti. of Agri. & Life Sci.), Gyeongsang National University, Jinju, the Republic of Korea, [3]Department of Companion Animal & Animal Resources Science, Joongbu University, Geumsan, the Republic of Korea*.

This study was conducted to estimate in vitro rumen digestibility and fermentation indices of tannin rich chestnut meal probiotic using a novel wireless automated gas production system. The chestnut separated to whole chestnut (WCP), endodermis (EDP), or kernel (KNP) and then ground by cutting mill. The ground chestnuts were mixed with combo inoculant (*Lactobacillus acidophilus*, 1.0×10^6 cfu/g; *Saccharomyces cerevisiae*, 1.0×10^6 cfu/g; and *Bacillus subtilis*, 4.5×10^6 cfu/g), individually placed into 10-L mini-silos, and incubated at 39°C for 4 d to produce each chestnut probiotic. Each chestnut probiotic (0.5 g) was placed into the incubation bottles with rumen fluid mixture (40 mL), which was mixed with Van Soest medium in a 2:1 ratio. Rumen fluid was collected from cannulated Hanwoo heifers. Four replicates in each treatment with three blanks were incubated at 39°C for 48 h, and gas pressure was measured at 30 min intervals. The bottle contents were centrifuged at the end of incubation. The supernatant was used for pH, ammonia N, and VFA and the residue was used for in vitro digestibility of DM (IVDMD) and NDF (IVNDFD). The KNP (76.5 and 60.1%) had greater ($P < 0.05$) IVDMD and IVNDFD, respectively, than WCP (49.5 and 19.2%, respectively) or EDP (46.1 and 20.1%, respectively). The KNP had greatest ($P < 0.05$) concentrations of total VFA (116 m*M*/L), propionate (26.6%), and butyrate (23.4%), whereas EDP had greatest ($P < 0.05$) pH (6.60) and concentrations of ammonia N (35.9 mg N/100 mL) and valerate (52.5%). Acetate concentration and acetate-to-propionate ratio in WCP (52.6% and 2.12, respectively) and EDP (52.5% and 2.14, respectively) were higher ($P < 0.05$) than those in KNP (46.4% and 1.75, respectively). The rapidly fermentable fraction (0.72 vs. 0.28 mL/g) in KNP was greater ($P < 0.05$) than in WCP. The KNP (4.93 mL/g, 5.65 mL/g, and 0.29%/h) had greatest ($P < 0.05$) total fermentable fractions and fractional fermentable rate. The lag phases (4.69 and 4.81 vs. 3.72 h) in EDP and KNP were greater ($P < 0.05$) than in WCP. In conclusion, it is suggested that KNP could be used to improve the rumen fermentation characteristics for ruminants.

Key Words: chestnut, digestibility, fermentation characteristics

0648 Inoculant effects on bermudagrass silage nutritive value and fermentation characteristics. E. C. Freitas[1], J. M. D. Sanchez*[2], F. A. Kuhawara[3], U. Cecato[4], J. M. B. Vendramini[5], and A. Aguiar[1], *[1]DeLaval Manufacturing, Bannockburn, IL, [2]UF/IFAS Range Cattle Research and Education Center, Ona, FL, [3]Sao Paulo State University, Botucatu, Brazil, [4]UFL, Ona, FL, [5]UF/IFAS, Range Cattle Research and Education Center, Ona, FL*.

The objective of this study was to investigate the nutritive value and fermentation parameters of 'Jiggs' bermudagrass (*Cynodon dactylon* L.) silage treated with FeedTech microbial inoculants M20XC and M25AS (2×10^6 cfu/g of treated forage [as fed]) and F600 and F20 (2×10^6 cfu/g of treated forage [as fed]) or control (C). The experiment was conducted in Florida in 2014. Plots (experimental units, 3 by 2 m) were staged on August 15 at an 8-cm stubble height and fertilized with 80 kg N/ha. Forage was harvested with a 4-wk regrowth interval, immediately packed into a mini-silo at a density of approximately 382 kg fresh forage/m^3, and ensiled for 106 d. Treatments were distributed in a randomized complete block design with 5 replicates. The data were analyzed using PROC MIXED with treatment as a fixed effect and block as a random effect. There was an increase on DM recovery ($P = 0.04$; 99.7 vs. 84.4%) and IVTD ($P = 0.06$; 57.8 vs. 53.8%) on silage treated with M20XC compared with the control. No differences were detected among treatments on DM, CP, ADF, NDF, and NDFD ($P > 0.10$). Silage pH, acetic acid, propionic acid, butyric acid, and ammonia concentrations were similar among treatments ($P > 0.10$). However, there was a trend ($P = 0.14$) that M20XC had the greatest concentration of acetic acid between treatments. There was no effect ($P > 0.27$) of inoculants on mold and yeast count (mean = 1.7 and 1.3 log cfu/g, respectively) and mycotoxins (aflotoxin, vomitoxin, zearalenone, and T2) among treatments. FeedTech M20XC may be an efficient inoculant to increase DM recovery and IVTD of bermudagrass silage in the Southeastern United States.

Key Words: grass, silage, inoculants

0649 The effect of a microbial inoculant at two application rates on the aerobic stability of high-moisture corn. E. Benjamim da Silva*, R. M. Savage, S. A. Polukis, M. L. Smith, A. E. Laubach, K. M. Pacer, and L. Kung Jr., *University of Delaware, Newark*.

The purpose of this study was to evaluate the effect of a microbial inoculant at two application rates on the fermentation and aerobic stability of high-moisture corn (HMC). High-moisture corn (74% DM) was 1) untreated (control), 2) treated with *Lactobacillus buchneri* (NCIMB 30139) at an application rate of 400,000 cfu/g of fresh material (LB400), or 3) treated with *L. buchneri* (NCIMB 30139) at a rate of

600,000 cfu/g of fresh material (LB600). The inoculant was supplied by Volac Intl., Ltd., United Kingdom. Five replicated lab silos (7.5 L) for each treatment were packed (density of 658 kg DM/m^3) and ensiled for 30 and 92 d between 21 and 23°C. Data were analyzed as a 3 × 2 factorial arrangement of treatments with the main effects of treatment, day, and their interaction. High-moisture corn was analyzed for fermentation end products, number of yeasts, and aerobic stability. At 92 d, the pH of LB400 and LB600 (4.48 and 4.47) was higher ($P < 0.01$) than that of control (4.33). All treatments had similar concentrations of lactic acid at 30 d, but by 92 d, lactic acid concentrations decreased ($P < 0.01$) in LB400 and LB600 (0.36 and 0.41%) compared with untreated HMC (0.58%). At 30 d, treatment with LB400 and LB600 (0.36 and 0.30%) had higher ($P < 0.01$) concentrations of acetic acid compared with control (0.05%). At 92 d, untreated HMC (0.15%) had lower ($P < 0.01$) concentrations of acetic acid than LB400 and LB600 (0.79 and 0.86%). Treatment with LB400 and LB600 (0.32 to 0.55%) increased ($P < 0.01$) 1,2-propanediol concentrations compared with untreated HMC (0.00 to 0.09%) at both 30 and 92 d. At both ensiling times, HMC treated with LB400 and LB600 (<2.00 to 2.97 log cfu/g) had fewer ($P < 0.01$) yeasts than control HMC (4.04 to 5.93 log cfu/g). At 30 and 92 d, treatment with LB400 and LB600 (>217 h) greatly increased ($P < 0.01$) aerobic stability compared with untreated HMC (16 to 56 h). This experiment showed that inoculation with *L. buchneri* (NCIMB 30139) can improve the fermentation characteristics and the aerobic stability of HMC.

Key Words: aerobic stability, high-moisture corn, *Lactobacillus buchneri*

0650 Meta-analysis of the effect of homolactic and facultative heterolactic bacteria inoculation on silage quality: III Dry matter recovery, chemical composition and in vitro digestibility.

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Data from 120 peer-reviewed papers were summarized to evaluate the effects of inoculation with homolactic and facultative heterolactic acid bacteria (HAB) on DM recovery (DMR), chemical composition, and 48-h in vitro DM digestibility (IV-DMD) of silages. The effects were statistically analyzed by comparing raw mean differences between inoculant and control treatment means that had been weighted by inverse variance using random models. Heterogeneity sources evaluated by meta-regression included crop species, application rate (<10^4, 10^5 to 10^6, or >10^7 cfu/g, which represented 3.7, 93.6, and 2.7% of the studies, respectively), HAB species, and silo type (laboratory or farm-scale, which represented 92.2 and 7.8% of the studies, respectively) as covariates. Corn/sorghum, temperate and tropical grasses, sugarcane, alfalfa, other legumes, and other crops silages represented 22.8, 32.3, 7.8, 10.2, 4.8, 12.9, and 9.2% of the silages, respectively. No interactions ($P > 0.05$) between the covariates were detected. High heterogeneity (I^2 statistic > 50%) was observed for all response variables, except ADIN ($I^2 = 41.6\%$) and water-soluble carbohydrates (WSC; $I^2 = 0$). Inoculation did not affect DMR of corn/sorghum silages ($P = 0.10$, $n = 18$) but increased DMR ($P < 0.05$) of temperate grasses (2.89%; $n = 10$) and tropical grasses (2.89%; $n = 8$) and reduced DMR of sugarcane (−2.87%; $P < 0.01$). Inoculation did not affect the DM concentration of corn/sorghum silages ($P = 0.80$, $n = 45$) and sugarcane ($P = 0.11$, $n = 14$) but increased DM ($P < 0.05$) of temperate grasses (0.60%; $n = 54$), tropical grasses (0.45%; $n = 17$), alfalfa (0.31%; $n = 11$), other legumes (0.77%; $n = 30$), and other crops silages (0.86%; $n = 20$). Inoculation did not affect CP concentration ($P = 0.56$, $n = 106$), tended to reduce ADIN concentration (−0.13% nitrogen; $P = 0.09$, $n = 9$), and reduced WSC concentration (−0.32% DM; $P < 0.01$, $n = 150$) and lignin concentration (−0.28% DM; $P = 0.01$, $n = 20$), but it did not affect IV-DMD ($P = 0.24$, $n = 33$). Inoculation with HAB did not improve DMR of corn/sorghum silages, but it improved those of tropical and temperate grass silages and reduced that of sugarcane silages. Inoculation with HAB did not improve chemical composition or IV-DMD of silages.

Key Words: forage conservation, *Lactobacillus plantarum*

0651 Percentages of alfalfa and grass in fresh and ensiled binary mixtures using near infrared reflectance spectroscopy: Developing a robust calibration.

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Evaluating alfalfa and grass content of alfalfa–grass mixtures is useful for quantifying forage and diet quality. No studies have attempted to evaluate percent alfalfa content of silages and no commercial forage laboratory currently offers this service. Our objective was to develop a robust near-infrared reflectance spectroscopy (NIRS) method to estimate percent composition of binary alfalfa–grass mixtures in the Northeastern United States. Alfalfa–grass samples were collected across New York state over 4 growing seasons and hand separated, and a subset was separately ensiled. Dry samples were coarsely ground, mixed in known proportions, and reground for analysis by NIRS at Dairy One Forage Laboratory, Ithaca,

NY. Samples were mixed to range from 0 to 100% alfalfa for NIRS calibration, with a total of 741 individual samples from 2011, 2012, and 2014 used for calibration. Prediction equations were developed using three NIRS instruments. Dairy One calibrated a Foss 6500 NIRS instrument as well as two newer generation Foss XDS instruments, analyzing most samples with all three instruments. A total of 1,480 spectra were collected for calibration, with samples packed twice and scanned in duplicate. Calibration statistics were similar for the three instruments. Close agreement between R2 (0.99) and 1-VR (0.99) for all three equations indicates consistent results among the cross-validation groups and suggests that the calibration models are robust. There was no benefit in separate sample calibrations for fresh and fermented samples. Spectra from the three instruments were combined to develop and support a single calibration for use in a commercial setting across multiple platforms. Calibrations for grass and alfalfa percent worked well with all instruments and equally well with fresh versus ensiled forage. The three prediction equations had relative prediction deviation values of 4.35, 4.97, and 4.62, indicating calibrations were satisfactory. A diverse set of 98 samples from 2015 were used for validation of the equations. Mixture content was predicted with good precision and accuracy showing biases of 2.49 and SE of prediction of 5.06, with R2 of 0.972, using the equation developed across multiple instruments. These data indicate that with selection of a robust set of calibration samples over many environments, NIRS can be used to determine the botanical composition of alfalfa–grass samples, regardless of whether they are fresh or ensiled, and that replicate scans from multiple instruments can be combined to develop a single calibration that will perform with equal efficiency across different instruments.

Key Words: forage evaluation, botanical composition

0652 Comparison of dry matter measurements between three hand-held near-infrared units with oven drying at sixty degrees Celsius for forty-eight hours.

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This study compared DM predictions of three hand-held near infrared spectrophotometer (NIRS) units (Moisture Tracker, Digi-Star Inc., Fort Atkinson, WI) to conventional oven drying at 60°C using two alfalfa and two corn silages. Corn and alfalfa silages (1,500 g) obtained from the University of Wisconsin Dairy Cattle Center (DCC) and the Arlington Research Station (ARS) were analyzed for DM daily for 20 d. Three NIRS calibrations were also tested within each unit: NIRf, NIRa, and NIRb. The DM predicted from the factory-preset calibrations was NIRf. NIRa was an adjusted DM prediction, where the average difference between oven-dried forage and NIRf determined on duplicate forage samples for 3 d before the experiment was used as a bias adjustment for all subsequent DM determinations. NIRb was a bias-adjusted DM prediction based on the average difference between oven-dried forage and NIRf over the 20-d experiment. NIRb was determined on each forage sample after the experiment had been completed. Each forage was scanned 20 times by each NIRS unit. The average predicted DM from the 20 scans was recorded as the forage DM. The process was repeated three times with each NIRS unit. Two 100-g subsamples of each forage were then oven-dried for 48 h at 60°C daily. Data was analyzed using PROC MIXED (SAS, version 9.3), with method, day, feed, method × day, and method × feed as fixed effects and equipment as the random effect. Oven DM of ARS and DCC alfalfa silages was 37.34 and 48.52%, respectively. Oven DM of ARS and DCC corn silages was 34.69 and 37.41% DM, respectively. NIRf DM predictions were significantly different from their respective oven values for ARS corn silage and ARS haylage ($P < 0.0001$), and NIRf DM tended to differ from oven DM for DCC Corn Silage; $P = 0.06$). NIRf and oven DM for DCC haylage were similar ($P = 0.99$). All NIRb DM values were similar to oven-dried DM for all four forages ($P > 0.05$). The hand-held NIRS units accurately predicted DM content of the alfalfa and corn silages when the factory preset calibrations were corrected for bias.

Key Words: dairy cattle, dry matter, near-infrared

0653 Grazing intensities and season affect N_2O emissions in a tropical pastureland.

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The study assessed a tropical pasture in Brazil to determine how grazing height and season influences N_2O production and consumption. Nitrous oxide fluxes were measured over 2 yr in a Marandu palisade grass pasture with 3 grazing heights (15, 25, and 35 cm), 6 replicates, and 4 seasons (spring, summer, autumn and winter) using static closed chamber and chromatography quantification. The N_2O flux (μg N_2O-N m^{-2} h^{-1}) was integrated by linear interpolation to cumulative emissions. The patters of N_2O fluxes were displayed by using means and SEM. The data were submitted to ANOVA by using R statistical software. When significant, a polynomial orthogonal contrast was done. Nitrous oxide emissions were maximum following rainfall events and application of urea fertilizer (Fig. 1). Nitrous oxide emissions were greatest in the summers whereas lower fluxes associated with frequent instances of N_2O uptake in other seasons. The topmost rate of N_2O emissions was measured in the second week of December 2013 when mean fluxes were 469, 394, and 279 μg N_2O-N

m^{-2} h^{-1} for 15, 25, and 35 cm of pasture heights, respectively.

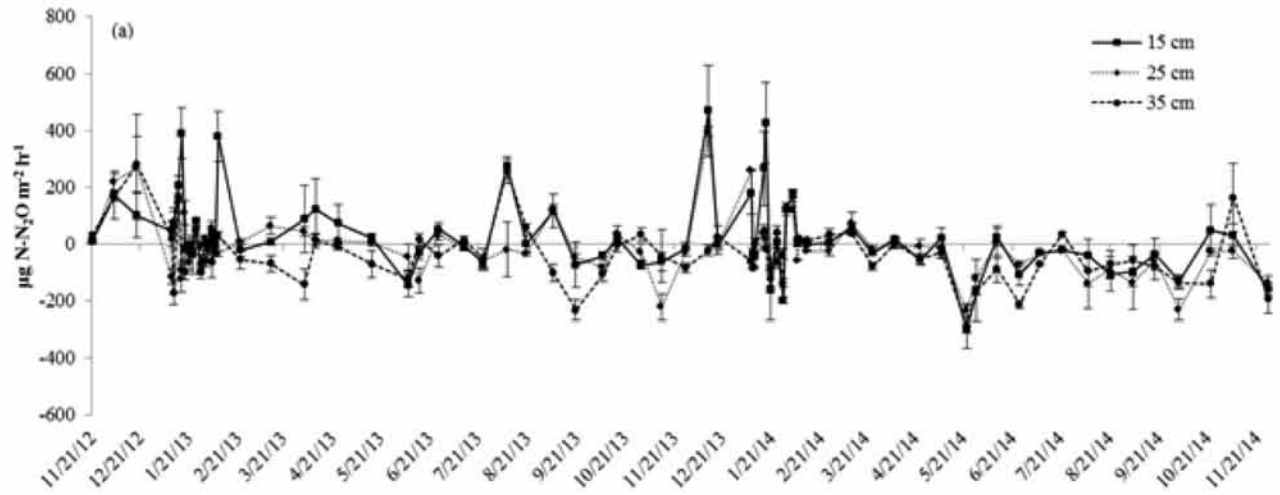

Fig 0653.

Figure 1. N_2O flux (μg N_2O-N m^{-2} h^{-1}) for three grassland intensities (15, 25, and 35 cm) during two years of evaluation (November 21, 2012 to November 26, 2014).

Negative fluxes were detected in approximately 60% of all N_2O sampling especially in the spring and autumn of the yr 2 when lower values of water-filled pore space were also recorded. The highest rate of N_2O consumption was measured on May 23, 2014, when mean fluxes were −299, −235, and −287 μg N_2O-N m^{-2} h^{-1} for pastures heights of 15, 25, and 35 cm, respectively. Grazing intensity was significantly correlated with N_2O flux during the summer. There was a linear reduction in annual cumulative N_2O emissions ($P < 0.05$) with decreasing grazing intensities for both years. The total N_2O emissions were 300.1, 41.6, and −48.3 mg N_2O-N m^{-2} in yr 1 and −153.2, −263.7, and −298.7 mg N_2O-N m^{-2} in yr 2 for 15, 25, and 35 cm of pasture heights, respectively. The greater grazing intensity had the highest levels of N_2O emissions in all seasons except for in the spring of yr 1. The grassland intensity on cumulative N_2O emissions was negatively linear in the annual analysis ($P < 0.05$) driven by the negative associations observed in the summer ($P < 0.05$) and even more so in the autumn ($P < 0.001$). There was a negative linear effect of pasture height on the amount of N_2O emitted/consumed. High stocking rates in the grazing systems influenced the increment of N_2O production, although lower grazing intensities contributes to N_2O mitigation in tropical pastures.

Key Words: continuous stocking, greenhouse gas, pasture height

0654 Impact of foliar spray on yield and chemical composition of alfalfa hay. S. Acharya* and D. P. Casper, *Dairy Science Department, South Dakota State University, Brookings*.

The study objective was to determine the response to foliar nutrient application (proprietary product) on DM yield and chemical composition of second-cutting alfalfa hay. Two fields with a total area of 38.4 ha were selected, where half of the second-cutting alfalfa hay field was sprayed as the Test and half of the field was unsprayed as the Control. The spraying rate was 23.4 L/ha. Crop was planted following established standard procedure of alfalfa, and the interval between first and second cutting was 28 d. Each field was divided into four replications, two represented by Control Plot and two by Test Plot. After harvesting alfalfa and drying in the field, hay was square baled (at moisture level of 14.2%) and weighed and samples were taken using a standard hay probe bale sampler later on. A total of eight hay samples (4 samples from each field) were sent to a commercial laboratory for analysis of nutrient composition. Dry matter yield was increased ($P < 0.01$) for Test (1.48 and 1.34 mt/ha for Test and Control, respectively) compared with Control. Similarly, digestible DM was also found improved ($P < 0.01$) for Test Plot (0.93 and 0.80 mt/ha) compared with Control. Crude protein percentage was increased ($P < 0.05$) for Test Plot (21.1 and 19.1%) compared with Control. There was a trend ($P < 0.10$) of increase in in vitro DM digestibility (62.6 and 59.8 5) and a numerical increase in NDF digestibility (52.1 and 50.8%) for Test compared with Control. This could be explained by a significantly ($P < 0.05$) lower lignin content of Test (8.07 and 8.71%) compared with Control. The nonfiber carbohydrates content was higher ($P < 0.05$) for Test (22.2 and 21.3%) compared with Control. This could further

be explained by a significant ($P < 0.01$) higher NE for lactation content for Test alfalfa (1.28 and 1.19 Mcal/kg) compared with Control. The use of foliar nutrient sprays increase DM yield and nutrient digestibility of alfalfa, thus being able to support more milk yield and feed efficiency.

Key Words: foliar spray, alfalfa, chemical composition

0655 Evaluation of in vitro gas production and energy available in low-lignin alfalfa varieties. K. P. Ortega*, G. Getachew, D. H. Putnam, and E. J. DePeters, *University of California, Davis, Davis*.

Lignin is composed of cross-linked phenolic compounds that impact forage quality. As forage plants mature, lignin concentration increases and DM and fiber digestibility decrease. Low-lignin alfalfa varieties offer potential for improved forage quality and animal production as well as increased yield by allowing for harvests at later maturity while maintaining high digestibility. Lignin synthesis in alfalfa was reduced by genetic manipulation through suppressing enzymes in the lignin biosynthetic pathway. In the current study, two genetically modified alfalfa lines (LL) and their respective controls (CL) were used to study the effect of reduced lignin content on in vitro gas production and predicted ME concentration. Sixty-four samples, that is, four alfalfa lines (two LL and two CL), four field replicates, two cuttings (cut 1 and 3), and two cutting schedules (28 and 35 d), were used. An in vitro technique was used to determine differences in in vitro gas production and predicted ME concentration between two CL and two LL varieties of alfalfa. Alfalfa samples were compared at cuttings 1 and 3 as well as cutting schedules that occurred at 28 and 35 d. Ground alfalfa samples were incubated in buffered rumen fluid using an in vitro gas technique at various time points over 72 h to determine the influence of lignin on rate and extent of in vitro gas production. Four in vitro incubations were conducted, and rate and extent of gas production were calculated using an exponential model. The ME was estimated using the 24 h gas production and CP content of each sample as described by Menke and Steingass (1988). Total ME ($P < 0.0001$) and rate of gas production ($P < 0.0001$) were higher in the LL varieties than the CL varieties, whereas no significant difference was found in extent of gas production. Low-lignin alfalfa varieties offer potential to increase the ME concentration in alfalfa, which needs to be further evaluated by animal feeding studies.

Key Words: alfalfa, low lignin, in vitro gas production, metabolizable energy

0656 WS Influence of supplement type and monensin addition on utilization of low-quality, cool-season forage by beef cattle. D. W. Bohnert*[1], M. C. Rodrigues[1], M. C. Vieira[1], K. C. Swanson[2], S. J. Falck[3], and R. F. Cooke[1], *[1]Oregon State University – EOARC Burns, Burns, [2]North Dakota State University, Fargo, [3]USDA-ARS, EOARC Burns, Burns, OR*.

Two studies were conducted to evaluate the influence of supplement composition and monensin addition on intake and digestibility of a low-quality (4.5% CP), cool-season forage as well as cow performance. Treatments included a nonsupplemented control (CON), approximately 30% CP supplements consisting of corn and urea (CU), CU + monensin (200 mg/d; CU+M), dried distillers' grains (DDGS), or DDGS + monensin (200 mg/d; DDGS+M). In Experiment 1, 5 steers were used in an incomplete 5 × 4 Latin square with four 28-d periods to compare the effects of monensin and supplement type on forage intake, digestibility, and ruminal fermentation characteristics. Forage intake tended to be greater with supplementation ($P = 0.06$), was greater with DDGS compared with CU ($P = 0.03$), and was decreased with monensin addition ($P = 0.04$). Ruminal pH was increased with monensin; however, it was increased more with monensin addition to the DDGS supplement compared with the CU supplement ($P < 0.01$). In Experiment 2, 80 late gestation cows were stratified by age, BCS, and BW and randomly allotted to treatments (20 pens; 4 cows/pen and 4 pens/treatment). Precalving and postcalving BCS change were more positive with supplementation ($P < 0.01$), whereas monensin addition to the supplements benefited precalving ($P = 0.02$) and postcalving ($P = 0.02$) BCS change a greater amount with the CU supplement compared with the DDGS supplement. Monensin addition, irrespective of supplement type, reduced forage intake while maintaining performance of beef cattle consuming low-quality forage.

Key Words: cattle, cool-season, forage, ionophore, monensin, supplementation

0657 WS Methods to increase productivity of spring calving production systems in the Nebraska Sandhills. D. Broadhead*[1], A. Stalker[1], J. A. Musgrave[2], and R. N. Funston[3], *[1]University of Nebraska-Lincoln, North Platte, [2]University of Nebraska, Lincoln, [3]University of Nebraska, North Platte*.

A 2-yr study evaluated effects of late-gestation supplementation, postpartum progestin administration, and creep feeding on productivity of March calving cows. In yr 1, 120 crossbred cows (BW 479 ± 57 kg) were assigned to 1 of 4 levels of late-gestation supplementation, 1 of 2 levels of postpartum progestin, and 1 of 2 levels of creep feed in a 4 × 2 × 2 factorial arrangement of treatments in a completely random design. The

four supplement levels fed were 1) 0 kg/d Dec. 1 to Mar. 1, 2) 0.41 kg/d DM Dec. 1 to Mar. 1, 3) 0.41 kg/d DM Jan. 15 to Mar. 1, or 4) 0.82 kg/d DM Jan. 15 to Mar. 1 while cows grazed dormant upland range. Levels of exogenous progesterone postpartum were 1) controlled internal drug release device for 7 d or 2) no progesterone administration. Creep feed levels were 1) unrestricted access by the calf to creep feed, which contained an intake limiter, or 2) no access to creep feed. The higher levels of late-gestation supplementation increased cow BW ($P < 0.05$) and increased cow BCS ($P < 0.05$) but did not affect ($P > 0.12$) reproductive measures or calf performance. Exogenous progesterone administration postpartum did not affect ($P > 0.13$) cow or calf performance. Allowing calves access to creep feed increased ($P < 0.01$) calf BW at weaning by 21 kg.

Key Words: creep feed, progesterone, supplement

0658 Performance of stocker cattle grazing 'Tifton 85' bermudagrass supplemented with dried distillers' grains on per-animal and per-area bases: A two-year summary.

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The supply of dried distillers' grains (DDG) generated from the ethanol industry provides great opportunities for feed additives and supplementation of stocker cattle. The objective of this study was to evaluate performance of stocker calves grazing 'Tifton 85' bermudagrass [*Cynodon dactylon* (L.) Pers.] when supplemented daily with varying levels of DDG. Steers ($n = 96$ [4 testers pasture^{-1} yr^{-1}], 363 ± 3.7 kg initial BW, and approximately 15 mo of age) were stratified by BW and randomly allocated to each of 16 pastures (0.7 ± 0.01 ha) across 2 yr (2014 and 2015). Pastures were randomly allocated to each of 4 levels of DDG supplementation for about 110 d at 0, 0.25, 0.5, or 1% BW hd^{-1} d^{-1}. Steers were group fed daily at 0800 h and weighed every 21 d. Grazer animals were added to pastures based on visual and forage mass assessments to maintain a similar forage allowance among pastures. Data were analyzed using SAS PROC MIXED or PROC GLIMMIX. Least squares means were calculated for treatments and separated using *F*-protected *t* tests with the Tukey–Kramer adjustment. Average daily gain was greatest ($P < 0.05$) from steers offered 1% BW DDG (1.25 kg/d) and least from non-DDG steers (0.77 kg/d), with 0.25 and 0.5% BW being intermediate (1.05 and 1.12 kg/d, respectively). Additional gain from DDG supplementation was greater ($P < 0.05$) from 1% BW DDG (0.68 kg/d) than from 0.25 and 0.5% BW steers (0.47 and 0.54 kg/d, respectively). There was a trend ($P = 0.13$) toward increased supplemental feed to additional gain ratios of 4.2, 5.4, and 7.2 for 0.25, 0.5, and 1% BW DDG, respectively, indicating that higher levels of DDG supplementation resulted in substitution of forage in the diet. There was no measurable difference ($P = 0.33$) in stocking rate (318 kg = 1 steer) among treatments (overall mean = 12.4 hd/ha), whereas gain per area was greatest ($P < 0.05$) at 1,883 kg/ha from pastures offered DDG at 1% BW followed by intermediate values of 1,268 kg/ha at 0.25% and 1,399 kg/ha at 0.5% BW. Pastures receiving no supplementation had steers gaining 906 kg/ha. Supplementation of stocker calves with DDG while grazing Tifton 85 bermudagrass is a viable management strategy to optimize gain per animal or per area.

Key Words: Tifton 85 bermudagrass, dried distillers' grains, stocker, supplement

0659 Monensin effects on early-weaned beef calves grazing annual ryegrass pastures.

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The objective of this study was to evaluate the effects of monensin on performance of early weaned beef calves grazing annual ryegrass (*Lolium multiflorium*). The experiment was conducted at the University of Florida/Institute of Food and Agricultural Sciences Range Cattle Research and Education Center, Ona, FL, from January 12 to April 14, 2015. Treatments were calves receiving monensin (20 mg/kg of estimated total DMI) or control (no monensin) distributed in a randomized complete block design with four replicates. Calves were weaned with 81 ± 6 kg BW at 84 ± 20 d of age. Calves were supplemented with 1% BW concentrate (18% CP and 78% TDN) daily. Four calves were allocated to each pastures (0.3 ha, experimental unit) in a continuous and fixed stocking rate. Herbage mass and nutritive value were evaluated every 14 d, and calf BW was recorded every 28 d. Blood samples were collected at the termination of the study. Data were analyzed using the Proc Mixed of SAS with treatment as fixed effect and block as random effect. There was no difference ($P \geq 0.05$) in herbage mass (mean = 1,450 kg/ha), CP (mean = 22.2%), and in vitro digestible OM (mean = 78.7%) between treatments. Calves receiving monensin had greater ADG (0.71 vs. 0.57 kg/d; $P = 0.003$) and tended to have greater IGF-1 (89.5 vs. 67.9 ng/mL; $P = 0.09$) but there was no difference ($P \geq 0.05$) in BUN (mean = 26.7 mg/dL), glucose (mean = 86.3 mg/dL), and insulin (mean = 2.31 uIU/mL). The incidence of coccidiosis was lesser (0.49 vs. 1.35 log count) for calves receiving monensin. Adding monensin to the concentrate supplement

is a feasible management practice to improve performance of early weaned calves grazing annual ryegrass pastures.

Key Words: supplementation, beef cattle, monensin

0660 Reduced enteric methane emissions on legume versus grass irrigated pastures. J. W. MacAdam*[1], K. A. Beauchemin[2], A. I. Bolletta[3], and L. R. Pitcher[4], *[1]Department of Plants, Soils, and Climate, Utah State University, Logan, [2]Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada, [3]National Institute of Agricultural Technology, Bordenave, Argentina, [4]Utah State University, Logan*.

Life cycle assessment that compared the cow–calf and feedlot phases of beef production in western Canada demonstrated that the greatest source of greenhouse gas emissions, in carbon dioxide equivalents (CO_2 eq.), was enteric methane (CH_4). Furthermore, the cow–calf phase was responsible for approximately 80% of CO_2 eq. Perennial legume forages contain less fiber than grasses and are, therefore, more digestible, and condensed tannins (CT) have been reported to reduce ruminant enteric methane emissions. Our objective was to measure enteric CH_4 emissions of beef cows and heifers grazing irrigated pastures. We compared a grass with two nonbloating legumes, one that had CT and one that did not. Our treatments were meadow bromegrass (*Bromus riparius* Rehmann), CT-containing birdsfoot trefoil (*Lotus corniculatus* L.), and non-CT cicer milkvetch (*Astragalus cicer* L.). The study was a randomized complete block design with 5 replications. The experimental unit was a 0.365-ha rotationally stocked pasture containing one forage treatment and one cow in late gestation (616 ± 8 kg; 2014) or two heifers (each 439 ± 7 kg; 2015). Following a 5- (2014) or 2-wk (2015) adjustment period, enteric methane was sampled on 4 d/wk for 5 wk on 1 (2014) or 2 (2015) reps/wk using the sulfur hexafluoride method (Johnson et al., 2007). Forage disappearance from pastures was estimated from pre- minus postgrazing herbage DM, measured using a rising plate meter calibrated for each species. This value is presented as percent of BW. The herbage of the cultivar of birdsfoot trefoil used in this study, *Langille*, contained 20 to 30 mg CT/g DM whereas the CT concentration of the other two pasture species was negligible. We conclude that methane emissions were reduced by approximately half for cows grazing legumes compared with grass and by approximately one-third for heifers grazing legumes compared with grass. However, there did not appear to be an effect of CT on enteric CH_4 emissions.

Key Words: birdsfoot trefoil, cicer milkvetch, meadow bromegrass

0661 Milk production, rumination, and body condition score of organic dairy cattle grazing two pasture systems incorporating warm and cool season forages. K. E. Ruh*[1,2], B. J. Heins[2], and J. Paulson[3], *[1]University of Minnesota, Saint Paul, [2]University of Minnesota West Central Research and Outreach Center, Morris, MN, [3]University of Minnesota Extension, Rochester*.

Organic dairy cows ($n = 90$) of Holstein and crossbred genetics were used to evaluate the effect of two pasture production systems (perennial versus perennial/annual systems) over two grazing seasons (May to October of 2014 and 2015) on milk production, milk components (fat, protein, MUN, and SCS), rumination (min/d), BCS, and BW. Cows were assigned to one of two pasture systems: 1) system 1, a diverse mixture of cool season grasses and legumes (perennial ryegrass, white clover, red clover, chicory, orchardgrass, meadow bromegrass, alfalfa, and meadow fescue), or 2) system 2, the same combination of perennial polycultures and annual warm season grasses (brown midrib sorghum-sudangrass [BMRSS] and teff grass). Cows rotationally grazed pasture and moved to a new paddock every 2 d and were supplemented corn (2.27 kg/d) and provided free-choice mineral on pasture. Weekly milk production, monthly milk components, and biweekly BW and BCS were recorded for each of the six replicate groups. Activity and rumination time (daily) were monitored electronically using HR-LD Tags (SCR Engineers Ltd., Netanya, Israel) for the grazing season. The PROC MIXED of SAS was used for statistical analysis, and independent variables were fixed effects of system (1 or 2), forage (perennial grass, BMRSS, or teff) nested within system, year (2014 or 2015),

Table 0660.

Table 1. Enteric methane emissions and forage allowance on irrigated pastures

	Birdsfoot trefoil	Cicer milkvetch	Meadow bromegrass
Enteric methane (g/head/d)			
Cows, 2014	167b	159b	355a
Heifers, 2015	152b	145b	215a
Forage disappearance (kg DM/d/kg BW)			
Cows, 2014	1.63a	2.04a	2.17a
Heifers, 2015	1.99b	2.68a	1.62b

Numbers within a row followed by different letters are statistically different at $P < 0.05$.

system nested within year, and week nested within system, with replicate nested within system as a random effect with repeated measures. System 1 and system 2 cows had similar ($P > 0.05$) milk production (14.7 and 14.8 kg/d, respectively), fat percentage (3.92 vs. 3.80%, respectively), protein percentage (3.21 vs. 3.17%, respectively), MUN (12.5 and 11.5 mg/dL, respectively), and SCS (4.05 and 4.07, respectively). There was a significant yearly effect ($P < 0.05$) for milk production, MUN, and SCS for both systems. Milk production was higher ($P < 0.05$) in 2015 compared with 2014 (15.6 vs. 13.9 kg/d, respectively). There was no effect ($P > 0.05$) of forage type on milk production, fat, protein, MUN, or SCS. Cows in system 1 had greater ($P < 0.05$) daily rumination (530 min/d) compared with cows in system 2 (470 min/d). The BW (485 and 497 kg) and BCS (3.10 and 3.06) were similar ($P > 0.05$) for system 1 and 2, respectively. In summary, warm season annual forages may be incorporated into grazing systems for organic dairy cattle while maintaining milk production and quality.

Key Words: grazing, BMR sorghum-sudangrass, teff

0662 Evaluation of production, rumination, milk fatty acid profile, and profitability for organic dairy cattle fed sprouted barley fodder. B. J. Heins*[1], J. Paulson[2], and H. Chester-Jones[3], *[1]University of Minnesota West Central Research and Outreach Center, Morris, [2]University of Minnesota Extension, Rochester, [3]University of Minnesota Southern Research and Outreach Center, Waseca*.

Certified-organic cows (n = 36) were used to evaluate the effect of feeding sprouted barley fodder to dairy cows on production, SCS, BW, BCS, daily rumination, milk fatty acid profile, and profitability. Cows were assigned to one of two replicated treatment groups (4 groups; n = 9 cows each group): 1) no fodder supplementation or 2) fodder supplementation at 9.1 kg/cow per day. Supplement was fed with a total mixed ration of organic corn silage, alfalfa haylage, and an organic grain mix (corn and minerals). The fodder replaced 2.7 kg of DM of organic corn. The no-fodder cows were fed 3.6 kg of organic grain in the supplement. The study was conducted at the University of Minnesota's West Central Research and Outreach Center, Morris, MN. For 70 d during the summer of 2015, 28 fodder trays (0.6 by 1.8 m) from a FarmTek Fodder Pro system were filled with 4.1 kg of presoaked barley grain, which was soaked for 24 h, to produce sprouted barley fodder. Each tray was automatically watered three times a day for 4 min each time. Weekly milk production, monthly milk components, and biweekly BW and BCS were recorded for each of the four replicate groups. Activity and rumination time (daily) were monitored electronically using HR-LD Tags (SCR Engineers Ltd., Netanya, Israel). Data were analyzed using the MIXED procedure of SAS on a pen basis. Independent variables for analyses were the fixed effects week of study and fodder supplementation group and replicate was a random effect. Milk production and SCS were not different ($P > 0.05$) for the fodder (12.3 kg/d and 3.63, respectively) and no-fodder (13.3 kg/d and 3.55, respectively) supplementation groups. Furthermore, BW (503 kg vs. 505 kg) and BCS (3.17 vs. 3.17) for fodder and no-fodder cows were not different. The fodder cows tended ($P < 0.10$) to have less rumination (519 vs. 550 min/d) compared with the no-fodder cows. The fodder cows tended ($P < 0.10$) to have a lower omega 6:omega 3 ratio (1.16 vs. 1.40) than the no-fodder cows. Net income per cow per day was similar for fodder ($2.96 vs. $3.18 cow/d) and no-fodder cows, respectively. In summary, the results show that sprouted barley fodder may have no benefit in an organic production system.

Key Words: sprouted fodder, production, organic

0663 Effect of tillage and planting date of wheat pasture on forage production and calf performance. P. A. Beck*[1], W. Galyen[2], T. Hess[3], and D. S. Hubbell III[3], *[1]University of Arkansas SWREC, Hope, [2]University of Arkansas, Fayetteville, [3]University of Arkansas Livestock and Forestry Research Station, Batesville*.

The objectives of this experiment were to determine how fall wheat forage production and animal performance are affected by establishment method (conventional tillage [CT] vs. no-till [NT]) and timing in dedicated wheat fields (1.6 ha). No-till pastures were planted on August 15 (n = 8), September 1 (n = 8), or September 15 (n = 8) and CT pastures were planted on September 1 (n = 3) or September 15 (n = 3). Preconditioned steers (n = 236; 245 ± 21.1 kg BW) were placed on wheat pasture when forage mass reached a minimum of 1,100 kg DM/ha. Steers were destocked from pastures on 23 February 2015 and 11 February 2016. Forage mass was estimated monthly using a calibrated rising plate meter, with 20 plate readings per pasture. Data were analyzed as a randomized complete block design using the mixed procedure of SAS (SAS Inst. Inc., Cary, NC). Forage mass in November for NT did not differ (P = 0.91) between the August 15 (1,525 ± 386 kg/ha) and September 1 (1,548 ± 386 kg/ha) planting dates but was greater than (P = 0.05) the September 15 planting date (1,153 ± 386 kg/ha). November forage mass for CT planted on September 1 (1,982 ± 426 kg/ha) tended (P = 0.10) to be greater than that for CT planted on September 15 (1,444 ± 426 kg/ha) and NT planted on August 15 or September 1. No-till planting on September 15 (1,153 ± 386 kg/ha) produced less ($P \leq 0.05$) forage in November than other planting methods. The average starting date of grazing was November 26 for CT planted on September 1 or September 15 and NT planted on August 15 or September 1 whereas the average starting date of grazing was delayed ($P < 0.01$) until December 8 for the NT September 15 planting. Initial forage allowance (3.79 ± 0.93 kg forage DM/kg steer BW) did not differ ($P \geq 0.84$) among tillage methods and planting dates and, therefore, ADG (1.24 ± 0.10 kg/d) did

not differ ($P = 0.63$) among planting methods. Steer grazing days per hectare and BW gain per hectare were reduced ($P \leq 0.02$) by NT planting on September 15. Planting wheat pasture in mid August using NT did not result in improved forage production or animal gains compared with CT or NT on September 1. If planting is delayed until mid September, use of CT provides advantages over NT.

Key Words: Wheat pasture, tillage, planting date, steers

0664 Impact of high-energy forages on grass-finished steer performance and carcass merit.

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The research objective was to compare high-energy forage options during the finishing period for Upper Midwestern forage-finished beef production systems. Twelve 0.80-ha pastures were randomly assigned to 1 of 3 forage treatments including mixed pasture (MIX), simple cereal grain/brassica mixture (SIMP), and complex cereal grain/brassica mixture (COMP). Red Angus–influenced steers (439.99 kg ± 4.21 BW; $n = 24$) were stratified by BW and randomly assigned to 1 of 12 paddocks and were grazed for a 76-d finishing period. Steers had ad libitum access to water, free choice mineral, and supplemental hay and were allowed access to strips in each grazing treatment, which were back fenced to allow for forage regrowth. Overnight fasted BW was measured on d 0, 36, 66, and 76. At the end of the finishing period, steers were slaughtered under federal inspection and carcass data were collected 48 h postmortem. Data were analyzed using Proc Mixed (SAS version 9.4) where paddock was the experimental unit. Steers had different d 0 to 76 BW gains ($P < 0.01$), where gains were greatest for MIX (90.15 kg ± 3.32) followed by COMP (73.71 kg ± 3.32) and then SIMP (64.64 ± 3.32). Although overall BW gains were greatest for steers in MIX, there was a tendency ($P = 0.11$) for d 67 to 76 gains to be highest in COMP and least for MIX (19.28 kg ± 2.07 and 12.47 kg ± 2.07, respectively).There was a treatment × period interaction for d 76 BW ($P < 0.01$), where steers on COMP and SIMP had less BW (514 kg ± 4.7 and 505 kg ± 4.7, respectively) than those on MIX (530 kg ± 4.7), yet each had greater ($P < 0.01$) dressing percents (56.95% ± 0.44 and 59.96% ± 0.44 versus 54.67% ± 0.44, respectively).There were no differences ($P > 0.05$) among steer carcasses from all treatments for HCW, backfat, LM area, KPH, YG, and marbling score. These data indicate that steers grazing all treatments had reasonable gains and carcass merit and that these systems can be a viable component of forage-finishing systems in the Upper Midwest.

Key Words: brassicas, beef, grass finished

0665 Effect of stocking rate on performance, diet selection, and apparent total-tract digestibility among heifers grazing cover crops.

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Grazing cover crops can increase lands available for cattle production and reduce costs associated with winter feeding. Unfortunately, data are limited on stocking rates that allow optimal utilization of cover crops by cattle. We evaluated effects of stocking rate among heifers (573 ± 9.5 kg BW) grazing cover crops. Cover crop pasture (12.1 ha) consisted of a mixture of annual ryegrass (*Lolium multiflorum*; 66.5%), radish (*Raphanus sativus*; 20%), and purple top turnip (*Brassica rapa*; 13.5%). Pasture was divided into 12 paddocks. Heifers were blocked by weight before initiation of the experiment and randomly assigned to 1 of 4 BW blocks. Stocking rate treatments were designed to obtain 45, 55, or 65% forage utilization and were achieved by randomly assigning 3, 4, or 5 heifers within each BW block to paddocks. All paddocks in 3 BW blocks contained a ruminally cannulated heifer to facilitate measures of diet selection, and heifers were allowed to graze for 48 d. Heifers were weighed on consecutive days at the beginning and end of the experiment and on d 9 to 22. Heifers were provided TiO_2 from d 14 to 23, and composite fecal samples (d 18 to 24) allowed estimates of fecal output. Estimates of DMI and diet digestibility were obtained from determination of fecal and diet acid detergent insoluble ash. Initial, intermediate, and final diet samples were collected on d 2, 24, and 46 by ruminal evacuation. Fecal and diet samples were analyzed for DM, OM, NDF, and ADF. Reductions in stocking rate tended to increase intermediate (linear effect, $P = 0.06$) and overall (linear effect, $P = 0.10$) ADG. However, estimates of DMI tended (quadratic effect, $P = 0.07$) to be less as stocking rate was reduced. Reduced stocking rate tended (quadratic effect, $P = 0.06$) to increase diet DM; however, stocking rate had no impact ($P \geq 0.15$) among diet OM, NDF, and ADF. Estimates of DM and OM digestibility decreased (quadratic effect, $P < 0.01$) with reduced stocking rate. Similarly, reduced stocking rate tended (linear effect, $P = 0.06$) to reduce NDF digestibility, but stocking rate had no effect ($P \geq 0.23$) among estimates of ADF digestibility. These data indicate that reduced stocking rate among heifers grazing cover crops tends to increase performance. It is unclear why estimates of DMI and diet digestibility decreased with reduced stocking rate.

Key Words: cattle, cover crops, stocking rate

0666 The physiological consequences of ingesting a toxic plant (*Diplotaxis tenuifolia*) and medicinal supplements influence subsequent foraging decisions by sheep. F. H. Catanese[1], J. J. Villalba*[2], and R. A. Distel[1], [1]*Universidad Nacional del Sur, Bahia Blanca, Argentina,* [2]*Utah State University, Logan*.

There is a large group of highly nutritious plants that are commonly avoided by grazing livestock due to the presence of toxic plant secondary compounds. Our hypothesis was that aversion toward toxic plants is learned and that their negative postingestive effects could be attenuated by specific nutrients. Therefore, we determined the impact of supplements on physiological parameters and feeding behavior in Merino sheep consuming *Diplotaxis tenuifolia* ("Wild rocket"), a plant with high concentration of glucosinolates (37.2 ± 3.6 μmol/g). Thirty-six sheep were randomly assigned to four feeding treatments in a split-plot design with lambs (n = 9) nested within treatment: Wild rocket (DT), Wild rocket and a protein (160 g/d) supplement (DT+P), Wild rocket and a protein supplement containing iodine (10 mg/d) and copper (40 mg/d) (DT+P+M), or alfalfa pellets (CTRL) in amounts that paired the ingestion of Wild rocket in DT. Toward the end of a 35-d exposure period, sheep in DT showed the lowest intake of Wild rocket (P = 0.04) as well as reduced concentrations of plasma thyroid hormones (T3 and T4; P < 0.001 and P = 0.05, respectively) and the enzyme alanine aminotransferase (P = 0.02) and a trend toward reduced hemoglobin concentration (P = 0.07) relative to sheep in DT+P and DT+P+M, which, in turn, showed concentrations of hormones and hepatic enzymes similar to those recorded in CTRL. Total serum protein and albumin levels were greater (P = 0.03 and P = 0.04, respectively) in supplemented than in unsupplemented sheep fed Wild rocket, which could have elicited a protective effect on glucosinolate ingestion. Foraging behavior was evaluated in an experimental arena where animals could select among randomly distributed buckets containing a fixed amount of Wild rocket or variable amounts of barley grain. Regardless of barley grain availability, sheep in DT showed lower intake and lower time spent eating Wild rocket than sheep in DT+P or in DT+P+M (19.0 vs. 48.5 and 43.2 ± 6.0 g [P = 0.007] and 26.8 vs. 54.4 and 48.9 ± 4.78 s [P = 0.005], respectively). Sheep in CTRL showed intake levels of Wild rocket and behavioral responses similar to those observed in supplemented sheep. In conclusion, nutritional supplements have the potential to attenuate the negative postingestive effects of glucosinolates in Wild rocket and enhance the utilization of the plant at pasture. A negative feeding experience with Wild rocket is needed for animals to display the typical pattern of aversion commonly observed in grazing conditions.

Key Words: feeding behavior, food aversions, glucosinolates

0667 Lining bunker wall with oxygen barrier film reduces nutrient losses of corn silages. L. M. Lima, J. P. Dos Santos, I. L. De Oliveira, J. O. Gusmao, M. S. Bastos, S. M. Da Silva, E. B. Alves, J. R. Gervasio, and T. F. Bernardes*, *Federal University of Lavras, Lavras, Brazil*.

Spoiled silage at the shoulders of bunker silo is common. The objective of this study was to evaluate the effect of two systems for covering corn silage in bunker silos. The first system comprised a sheet of 45-μm-thick oxygen barrier film (OB; polyethylene + ethylene-vinyl alcohol) placed along the length of the sidewall before filling, with approximately 2 m of excess draped over the wall. After filling, the excess film was pulled over the wall, and a sheet of polyethylene was placed on top. The second system involved using a standard sheet (ST) of 180-μm-thick polyethylene film. Eight commercial bunker silos were divided into two parts lengthwise so that half of the silo was covered with OB and other with ST system. During the filling, three bags with chopped corn were buried in the central part of the bunkers (CORE) in three 10-m-apart sections. After filling, 18 bags (9 per covering system) were buried in the upper layer of the three sections. These bags were placed at three distances from the bunker walls (0 to 50, 51 to 100, and 101 to 150 cm). During unloading, the bags were removed from the silos to determine the DM losses, fermentation end products, and nutritive value. The Milk2006 spreadsheet was used to estimate milk per ton of DM. The experiment was set up as randomized blocks with eight replicates (silos). Two orthogonal contrasts were tested to compare silages under the two covering systems with that in the CORE (OB versus CORE and ST versus CORE). Three orthogonal contrasts compared the distances from the bunker walls (OB50 versus ST50, OB100 versus ST100, and OB150 versus ST 150). Variables were analyzed with the PROC MIXED procedure of the SAS at 5%. The OB method produced well-fermented silages, which were similar to the CORE, whereas the PE system showed less lactic acid and greater pH and mold counts compared with the CORE. The PE method had 116.2 kg of milk/ton less than the CORE (P = 0.0016), as the OB system and the CORE were similar (1,258.3 and 1,294.0 kg/ton, respectively). Regarding the distances from the walls, the effects were more pronounced in the corner zones (0 to 50 cm). OB50 silages had better fermentation profile and lower spoiled microorganisms and DM losses than ST50. Corn silage at the shoulders has quality similar to the CORE when the OB system is used.

Key Words: aerobic deterioration, bunker silo, silage covering

0668 Effects of method and storage time on the nutritive value of sugarcane for dairy cattle.
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Fresh chopped sugarcane is an important forage source for dairy cattle in tropical environments; however, daily harvest has been a major constraint for producers. Therefore, the objective of this study was to evaluate two storage methods (stem and whole plant) in different times on the nutritive value, microbial counts, and DM losses to extend the intervals between harvests. Two experiments were performed for 2 yr (Experiment 1 and 2). In both experiments, 288 plants of sugarcane were manually collected during the crop harvesting window. Leaves were removed from 144 plants and other part remained intact (whole plants). Sugarcane stems and plants were split into 18 bunches (8 stems or plants per bunch) and placed on the ground in a barn at ambient temperature for 0, 2, 4, 6, 8, and 10 d. For each day of evaluation, three bunches of each treatment were weighed to determine DM losses. Afterward, bunches were chopped to assess nutritive value and microbial counts (bacteria, yeasts, and molds). In experiment 2, additionally to these parameters was assessed the leaf carbon balance (CO_2 uptake during photosynthesis minus CO_2 loss during respiration) in sugarcane plants. Treatments were arranged in a completed randomized design with repeated measurements over time. The data were analyzed by the mixed-model method using the MIXED procedure (SAS Institute, 2004). The means were compared using a Tukey test at the 5% probability. In both experiments, DM and NDF concentrations and in vitro DM digestibility were lower in stems compared with whole plants. Storage time had an inconsistent effect on chemical composition and microbial counts. Only DM losses were affected by the interaction between method and storage time. Whole plants reached losses more than 90 kg MS/ton at 6 and 8 d in the experiment 1 and 2, respectively. On the other hand, stems showed the maximum DM losses at 10 d (55.1 and 35.0 kg MS/ton for experiment 1 and 2, respectively). The carbon balance of leaves in whole plants was negative due to respiration losses from 2 d storage, which might explain the rise in DM losses. Overall, sugarcane stems is the most effective method to store forage under a cut-and-carry system because stems have greater nutritive value and take up less space in the barn with a long duration of aerobic stability (10 d).

Key Words: cut-and-carry system, forage harvesting, tropical forage

0669 Bunk heating of rations containing corn silage with various inoculants, a stabilizer, or wet grain byproducts: A field survey.
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Inoculation of corn silage with *Lactobacillus buchneri* (LB) retards yeast growth and delays heating of corn silage exposed to air. The objective of this survey was to quantify the effects of LB inoculation of corn silage on temperature stability of total mixed ration (TMR) containing corn silage with or without added wet feeds (12 with whey, 9 with wet distillers' grains, and 5 with wet corn gluten). Effects of adding a feed stabilizer ($n = 6$) to the TMR also were monitored. Samples of 57 TMR as delivered to the bunk at 55 dairies in the Upper Midwest were obtained during June of 2015. These TMR samples were exposed to air at room temperature and TMR temperatures were recorded after 6, 12, 24, 36, 48, 60, and 72 h of air exposure by an individual not familiar with the silage treatments or TMR additions. Although 9 different silage inoculants were used, only one of the inoculants contained LB. When compared with the TMR containing corn silage with other inoculants, TMR containing corn silage treated with LB had TMR temperatures that were 2, 5, and 7°C lower ($P < 0.05$) at 6, 12, and 24 h. Temperature responses differed among the various wet feeds that were added. Including wet distillers' grains in the TMR resulted in a 6°C greater ($P < 0.05$) temperature by 24 h but differences thereafter were not significant ($P > 0.10$). Including wet gluten or whey in the TMR resulted in temperatures that were 7°C and 5°C greater ($P < 0.05$), respectively, at 12 h than TMR not containing these wet feeds. Total mixed rations containing wet grains plus corn silage treated with LB had temperatures that were 3, 7, and 8°C lower ($P < 0.02$) at 6, 12, and 24 h than those TMR containing wet grain plus corn silage not treated with LB. Addition of the feed stabilizer failed to significantly alter the TMR temperature at any time. In conclusion, LB inoculation of corn silage that was included in the TMR reduced heating of the TMR as delivered to lactating cows for 24 h whether or not wet feeds were included in the TMR.

Key Words: corn silage, inoculants, temperature stability

0670 The effect of *Lactobacillus brevis* and fibrolytic enzymes on fermentation of switchgrass silages.

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The objective of this study was to determine the effect of *Lactobacillus*, enzymes, and *Lactobacillus* + enzymes mixture on fermentation characteristics, nutritive value, and microbial diversity of switchgrass silage. Switchgrass (*Panicum virgatum* L.) was harvested at vegetable stage and treated with distilled water (control), *Lactobacillus brevis*, fibrolytic enzymes, and *L. brevis* + fibrolytic enzymes (denoted C, LB, E, and LB+E, respectively) before ensiling. Treated switchgrass was ensiled in sealed 1.0-L plastic jars. Inoculation accelerated the decline of silage pH. Compared with other treatments, LB+E had the greatest decline ($P < 0.05$) in pH during the first 3 d of ensiling. After 30 d, for C, LB, E, and LB+E, pH declined to 5.3, 4.6, 4.8, and 3.7, respectively. There was no butyric acid detected in LB and LB+E. Lactic acid concentration of LB and LB+E increased by 5.53 times and 21.75 times than that of C, respectively. Acetic acid concentration of LB and LB+E decreased by 36.34 and 9.40%, respectively. NH_3–N concentration of LB, LB+E, and E decreased by 67.7, 74.55, and 69.88%, respectively. Treatments with enzymes (E and LB+E) effectively ($P < 0.05$) decreased NDF and ADF concentration. Neutral detergent fiber concentration of E and LB+E decreased by 8.09 and 8.43%, respectively. Acid detergent fiber concentration of E and LB+E decreased by 3.03 and 10.88%, respectively. Crude protein content of C, LB, E, and LB+E was 77.6, 96.2, 88.0, and 97.0 g/kg DM, respectively, suggesting that inoculation increased CP content of switchgrass silage ($P < 0.05$). The 16S rRNA gene-based pyrosequencing was used to analyze the community of the 30-d silage, and results indicated that the diversity of microorganisms differed among treatments ($P < 0.05$). *Enterobacter* was the dominant genus in C, and the relative abundance of *Enterobacter* was 53.60%. *Enterobacter* was the dominant species in E, although the relative abundance of *Enterobacter* decreased to 40.67% and that of *Lactobacillus* increased to 26.13% in E. In LB and LB+E, *Lactobacillus* was the advantageous species (91.19 and 96.89%, respectively), and *Enterobacter* was effectively inhibited. In conclusion, the addition of bacterial and enzymatic additives can improve the switchgrass silage fermentation quality at different extent. Adding the mixture of *L. brevis* and fibrolytic enzymes worked more efficient than adding either *L. brevis* or fibrolytic enzymes, respectively.

Key Words: switchgrass silage, fermentation characteristics, nutritive value

0671 Effects of wrapping time delays on fermentation characteristics of baled alfalfa silages.

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Baled silage is an attractive forage conservation approach for small and mid-sized dairy or beef producers, partly because it limits the risks associated with baling dry hay during wet or unstable weather conditions. Our objectives were to test the effects of delayed wrapping on silage fermentation and the storage characteristics of baled alfalfa silages. A secondary objective was to evaluate a prototype bale wrap containing an O_2–limiting barrier, against an identical polyethylene wrap without the O_2 barrier. Sixty-four 1.19- by 1.25-m round bales of alfalfa were made from 4 field blocks at a mean moisture concentration of 59.1 ± 4.3% and a mean initial wet bale weight of 473 ± 26.4 kg. Large-round bales were wrapped in plastic film within 4 h of baling (d 0) or after delays of 1, 2, or 3 d and then stored for 97 d. All bales were wrapped with 7 polyethylene layers. At wrapping, internal bale temperatures were greater for all bales with wrapping delays compared with bales wrapped on d 0 (54.9 vs. 34.9°C; $P < 0.01$) and linearly increased ($P < 0.01$) to a maximum of 63.9°C after a 3-d delay. No internal bale temperature for any treatment combination exceeded 30°C by 23 d after baling. Concentrations of water=soluble carbohydrates linearly declined with bale temperature at wrapping ($y = -0.039x + 6.5\%$; $r^2 = 0.634$); conversely, the buffering capacity of pre-ensiled forages linearly increased with bale temperature ($y = 2.98x + 316$ mEq/kg DM; $r^2 = 0.759$). Total silage fermentation acids were greatest when bales were wrapped on d 0 compared with bales wrapped with 1-, 2-, or 3-d time delays (4.64 vs. 2.26%; $P < 0.01$) and declined with both linear ($P < 0.01$) and quadratic ($P < 0.01$) effects of time delay. Similar responses were observed for lactic acid but without the quadratic effect of time ($P = 0.18$). Butyric acid also was detected and was greatest within bales wrapped on d 0 compared with those wrapped after 1, 2, or 3 d (0.99 vs. 0.38%; $P < 0.01$), and a similar response (0.68 vs. 0.52%; $P < 0.01$) was observed for NH_3–N (% of DM). Bale wrap had no effect on any silage fermentation response ($P \geq 0.07$), likely because of the conservative (7-layer) wrapping protocol. Silage fermentation characteristics deteriorated with time delays before wrapping, but responses were exacerbated when delays exceeded 1 d.

Key Words: alfalfa, baled silage, fermentation

0672 Effects of wrapping time delays on the nutritive value of baled alfalfa silages. W. K. Coblentz*[1], K. P. Coffey[2], and E. A. Chow[3], [1]*U.S. Dairy Forage Research Center, Marshfield, WI,* [2]*University of Arkansas, Division of Agriculture, Fayetteville,* [3]*Kuraray America, Inc., Pasadena, TX.*

Baled silages are an attractive forage conservation option, especially for small and mid-sized beef and dairy producers. Our objectives were to test the effects of delayed wrapping on the nutritive value of baled alfalfa silages on a pre- and post-storage basis. A secondary objective was to evaluate a prototype bale wrap containing an O_2–limiting barrier against an identical polyethylene wrap without the O_2 barrier. Sixty-four 1.19- by 1.25-m large-round bales were wrapped in plastic film within 4 h of baling (d 0) or after delays of 1, 2, or 3 d. All bales were wrapped with 7 polyethylene layers. The internal bale temperature for all bales declined to <30°C by 23 d after baling, regardless of wrapping time delay. Internal bale temperatures ranged from 34.9 to 63.9°C, 38.1 to 66.7°C, and 29.7 to 39.6°C when determined at the time of wrapping, as the maximum temperature during storage, and as mean for the initial 23 d of storage, respectively. In each case, these responses were explained by linear ($P < 0.01$) effects of time delay; a quadratic ($P = 0.01$) effect of time also was observed for the 23-d mean temperature. After completing a 97-d storage period, NDF concentrations could be linearly related to internal bale temperature at wrapping ($y = 0.14x + 40.5\%$; $r^2 = 0.67$). Concentrations of neutral-detergent insoluble CP ($y = -0.0009x^2 + 0.16x - 1.3\%$ of DM; $R^2 = 0.84$) and acid-detergent insoluble CP ($y = -0.0003x^2 - 0.014x + 2.1\%$ of DM; $R^2 = 0.70$) both quadratically increased with internal bale temperature at wrapping. Energy density calculated as TDN with the summative approach declined in a quadratic relationship with internal bale temperature at wrapping ($y = -0.0039x^2 + 0.31x + 51.2\%$ of DM; $R^2 = 0.61$), which represented a loss of approximately 3 TDN units when wrapping was delayed by 3 d. Generally, responses were less clear when samples of unfermented forage were obtained immediately before bales were wrapped in polyethylene. The type of bale wrap had no effect ($P \geq 0.32$) on any aspect of forage nutritive value, likely because of the conservative (7-layer) wrapping protocol. The nutritive value of fermented round-bale silages deteriorated with time delays before wrapping, but responses were exacerbated with delays longer than 1 d.

Key Words: alfalfa, baled silage, nutritive value

0673 Effects of corn planting density and maturity on yield and nutritional quality of corn silage. G. Ferreira* and C. L. Teets, *Virginia Polytechnic Institute and State University, Blacksburg.*

The objective of this study was to determine the effects of planting density and maturity on yield and nutritional quality of corn for silage in a double-crop rotation system. The study was performed at an 800-cow dairy farm located in southern Virginia. Corn was planted in experimental plots within 2 cornfields, one of which was irrigated with a central-pivot irrigation system. Planting densities were 55, 70, 85, and 100 seeds/ha (× 1,000) in 4 replicates per cornfield (2 fields × 4 densities × 4 replicates = 32 plots total). Plots were twelve 50-m-long rows separated by 76 cm. The irrigated cornfield was watered with approximately 100 mm of water before silking. At one-fourth and three-fourths milk-line stages of maturity (early and late, respectively), 10 plants from each plot were cut (15 cm above ground), weighed, chopped, mixed, and analyzed using wet chemistry. Additionally, 200 to 400 g of chopped material were placed into mini-silos and analyzed after 60 d. Data was analyzed as a completely randomized design with repeated measures. The statistical model included the fixed effects of density (D) and irrigation (I), the interaction of D × I, the whole-plot error, the fixed effect of maturity (M), and the interactions of M × D, M × I, and M × D × I. Dry matter yield linearly increased ($P < 0.01$) when increasing planting density at both maturity stages. Concentrations of CP, NDF, and starch of the fresh material were not affected ($P > 0.13$) by planting density at any maturity stage. Maturity did not change CP ($P > 0.20$) and NDF ($P > 0.54$) concentrations but increased starch ($P < 0.01$) and decreased ($P < 0.01$) sugars concentrations in the fresh materials. The decrease in sugars concentration with maturity was greater ($P < 0.05$) for

Table 0673.

Effect of corn planting density (plants/ha x 1000; D), irrigation (I) and maturity (M) on yield and nutritional quality of corn silage.

	Early Maturity								Late Maturity									P value						
	No Irrigation				Irrigation				No Irrigation				Irrigation											
	55	70	85	100	55	70	85	100	55	70	85	100	55	70	85	100	SEM	I	D	IxD	M	MxI	MxD	MxIxD
Plant Weight, kg/plant	0.350	0.302	0.270	0.234	0.427	0.328	0.293	0.280	0.421	0.346	0.281	0.276	0.430	0.398	0.329	0.290	0.017	0.01	0.01	0.97	0.01	0.38	0.38	0.06
DM Yield, kg/ha x 1000	18.5	19.6	21.4	22.5	22.7	20.9	22.8	26.3	22.3	22.5	22.4	26.4	22.9	25.3	25.5	27.2	1.9	0.01	0.01	0.99	0.01	0.38	0.58	0.09
DM, %	32.0	31.6	31.0	32.2	30.3	29.0	28.7	30.1	37.6	37.5	37.9	36.5	33.7	33.9	33.1	31.9	1.32	0.01	0.63	0.95	0.01	0.04	0.16	0.92
CP, %	10.0	10.1	10.6	10.2	10.9	10.7	10.8	10.6	10.0	9.9	10.1	10.6	10.0	10.2	10.6	10.9	0.53	0.08	0.49	0.99	0.20	0.47	0.29	0.48
NDF, %	38.0	39.8	38.8	40.3	41.0	40.3	42.6	39.5	38.0	39.2	39.9	42.1	38.0	38.7	40.1	40.8	1.98	0.36	0.18	0.34	0.54	0.16	0.39	0.83
Starch, %	34.6	35.3	34.8	34.3	30.3	31.8	30.5	32.8	37.6	36.9	37.1	34.9	34.5	38.1	37.0	32.4	2.07	0.01	0.26	0.62	0.01	0.11	0.12	0.43
Sugars, %	17.4	14.4	16.1	14.1	11.3	13.2	16.5	12.8	10.0	8.1	8.3	8.3	8.5	8.3	10.7	8.3	1.61	0.06	0.01	0.01	0.01	0.05	0.84	0.62
Silage pH	3.65	3.71	3.71	3.74	3.65	3.65	3.61	3.66	3.80	3.82	3.82	3.85	3.78	3.79	3.78	3.80	0.30	0.01	0.11	0.34	0.01	0.11	0.94	0.62
DM Silage, %	30.5	30.9	30.3	30.9	28.5	27.1	28.8	28.9	35.4	35.9	35.9	35.5	32.7	32.4	31.9	31.5	1.14	0.01	0.98	0.75	0.01	0.16	0.63	0.66
Ash Silage, %	4.9	4.9	4.3	4.5	4.7	4.4	4.6	4.4	4.2	4.3	4.3	4.4	3.6	3.7	3.8	4.3	0.39	0.04	0.92	0.62	0.01	0.27	0.10	0.68
CP Silage, %	10.5	11.2	11.2	10.9	10.7	10.9	11.5	10.9	9.2	9.7	10.2	10.1	9.7	11.0	10.7	10.9	0.48	0.07	0.05	0.79	0.01	0.05	0.64	0.12
NDF Silage, %	44.1	46.9	44.1	45.5	44.7	45.6	45.4	41.1	39.2	39.4	43.9	44.3	39.8	37.2	39.0	40.7	2.00	0.03	0.65	0.17	0.01	0.26	0.02	0.26
Starch Silage, %	28.5	27.3	29.6	28.4	28.9	31.9	28.9	31.6	31.7	35.1	28.9	26.8	32.1	32.8	31.6	28.5	2.25	0.14	0.14	0.82	0.05	0.38	0.02	0.14
Sugars Silage, %	6.2	7.6	7.1	6.6	8.9	8.2	7.7	8.6	2.3	1.9	2.0	2.3	3.1	2.5	2.4	2.3	1.07	0.01	0.91	0.59	0.01	0.07	0.73	0.43

nonirrigated than for irrigated corn (6.8 and 3.5 percentage units, respectively). A cubic effect ($P < 0.01$) of planting density on sugars concentration was observed for fresh samples. Planting density did not affect silage pH ($P > 0.11$) but late maturity silages had greater pH ($P < 0.01$) than early maturity silages (3.81 vs. 3.67, respectively). The concentrations of NDF, starch, and sugars of silages did not change with planting density ($P > 0.14$). In conclusion, increasing planting density increased DM yields while minimally affecting the nutritional composition of corn silage at any maturity stage.

Key Words: planting density, corn silage, nutritional quality

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9674 Effect of homolactic bacteria inoculation and aerobic stress during ensiling on the nutritional and fiber digestibility characteristics of spring triticale. L. C. Solórzano*[1], L. L. Solorzano[2], A. A. Rodriguez[1], and J. A. Teisberg[4], *[1]University of Puerto Rico, Mayagüez, [2]Lankin, Fitchburg, WI, [3]Nurealm, LLC, Hutisford, WI.*

Silage is often aerobically stressed during storage due to improper management, weather, or mechanical issues, resulting in diminished silage quality. The effect of homolactic bacteria inoculation (HBI; supplying >9.1 × 10^{10} cfu/g containing *Lactobacillus plantarum*, *Enterococcus faecium*, *Lactococcus lactis*, *Pediococcus pentosaceus*, and *Pediococcus acidilactici*) and aerobic stress during ensiling on fresh whole plant spring triticale (x Triticosecale spp.) was evaluated. Triticale was fermented for 120 d at a temperature of 20 to 23°C using 3-L capacity PVC mini-silos fitted with two-way mechanics to vent gas. Sixteen mini-silos were filled with about 2 kg of the crop at about 35% DM and 5.2% soluble carbohydrates (DM basis). Four treatments were A) no HBI with gas vent closed, B) HBI with gas vent closed, C) no HBI with gas vent open during the ensiling period, and D) HBI with gas vent open during the ensiling period. Upon opening, nutritional characteristics and fiber digestibility were determined at a commercial lab (Rock River Lab, Watertown, WI). Statistical analysis was performed using a completely randomized designs. Treatment had no effect ($P > 0.05$) on the content of the following characteristics, which averaged (%) CP (16.9), ADICP (0.61), fat (3.54), aNDF (55.9), lignin (2.04), starch (0.17), sugar (1.73), NFC (11), ash (14), total tract NDF digestibility (49.2), or NDF K_d (4.25%/h). Treatment C (31.4%) had a lower ($P < 0.05$) DM content compared with treatment D (33%) but did not differ ($P > 0.05$) from treatments A (31.3%) or B (31.8%). The digestibility of NDF was lower ($P < 0.05$) for treatments C (52.8%) and D (52.5%) compared with that of treatments A (54.1) and B (57.5%). The content of uNDF240 was higher ($P < 0.05$) for treatment D (13.2%) compared with treatment B (12%) but it was similar ($P > 0.05$) to treatments A (13%) and C (12.7%). Silage that was inoculated and kept in anaerobic storage conditions resulted in lower uNDF240 and may help explain the numerically higher NDF digestibility observed. Aerobic stress (treatments C and D) during the ensiling period decreased fiber digestibility. Inoculating silage that was aerobically stressed resulted in DM content higher compared with that of silage kept under aerobic conditions but not inoculated. Therefore, it is recommended to inoculate silage to prevent DM content and fiber digestibility losses in case of aerobic exposure during the storage period.

Key Words: silage, inoculation, fiber digestibility

0675 Effect of homolactic bacteria inoculation and aerobic stress during ensiling on the fermentation characteristics, dry matter recovery, and aerobic stability of spring triticale. L. C. Solórzano*[1], L. L. Solórzano[2], A. A. Rodriguez[1], and J. A. Teisberg[3], *[1]University of Puerto Rico, Mayagüez, [2]Lankin, Fitchburg, WI, [3]Nurealm, LLC, Hutisford, WI.*

On farm silage storage is often aerobically stressed due to slow ensiling, improper chop length, and packing or poor covering. The effect of homolactic bacteria inoculation (HBI; supplying >9.1 × 10^{10} cfu/g containing *Lactobacillus plantarum*, *Enterococcus faecium*, *Lactococcus lactis*, *Pediococcus pentosaceus*, and *Pediococcus acidilactici*) and aerobic stress during ensiling on fresh whole plant spring triticale (x Triticosecale spp.) was evaluated. Triticale was fermented for 120 d at a temperature of 20 to 23°C using 3-L capacity PVC mini-silos fitted with two-way mechanics to vent gas. Sixteen mini-silos were filled with about 2 kg of the crop at about 35% DM and 5.2% soluble carbohydrates (DM basis). Four treatments were A) no HBI with gas vent closed, B) HBI with gas vent closed, C) no HBI with gas vent open during the ensiling period, and D) HBI with gas vent open during the ensiling period. Upon opening, DM recovery and fermentation characteristics were determined at a commercial lab (Rock River Lab, Watertown, WI). Aerobic stability (AS) was determined by monitoring temperature at 6 h intervals during 7 d. Statistical analysis for fermentation characteristics and DM recovery was performed using a completely randomized design (CRD). Statistical analysis for AS data was performed as a CRD with 4 treatments by 29 time point factorial arrangement of treatments. Treatment B increased ($P < 0.05$) the content of lactic acid (5.33%) and total VFA (9.19%) compared with treatments A (3.71 and 8.18%, respectively), C (3.57 and 8.59%, respectively), and D (3.78 and 8.37%, respectively). Treatment B decreased ($P < 0.05$) pH (4.87) and acetic acid (3.56%) compared with treatments A (5.07 and 4.20%, respectively), C (5.07 and 4.65%, respectively), and D (4.96 and 4.31%, respectively). Treatment C (66%) had lower ($P < 0.05$) DM recovery compared with treatments A (88.6%), B (79.6%), or D (87.1%). Silage that was inoculated and aerobically stressed (treatment D) yielded an additional 24% DM recovery compared with noninoculated silage that was aerobically stressed (treatment C). All silages, regardless of treatment, were

aerobically stable and averaged 18.7°C. Inoculating triticale silage improved the DM recovery when the silo was aerobically stressed to levels comparable to that of anaerobic silages. Inoculating silage stored in anaerobic conditions improved fermentation characteristics. Therefore, it is recommended that silages be inoculated as protection against aerobic stresses due to suboptimal management, whether controllable or not.

Key Words: silage, aerobic stress, inoculation

0676 Effects of inoculant application on chemical composition, fermentation indices, and microbial counts of corn silage.

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This study was performed to determine the effect of inoculant application on chemical composition, fermentation indices, and microbial counts of corn silage and changes of microbes after the silo was opened. Two corn hybrids (Kwangpyeonok [KP] and Pioneer1543 [PI]) were harvested at 29.7 and 29.7% of DM, respectively. The harvested corn forage was chopped to 4 to 6 cm lengths and treated with 2 inoculants at the ratio of 1.2×10^5 cfu/g of *Lactobacillus plantarum* (LP) and 1.2×10^5 cfu/g of *Lactobacillus buchneri* (LB) on a fresh-weight basis. Treatments had a 2 × 2 factorial arrangement with three replications. The chopped corn forage (10 kg) was ensiled in a 20-L mini-silo for 100 d. After the silo was opened, a sample (5 kg) was collected for analyses of chemical compositions, fermentation indices, and microbial counts. The remained silage was stored in a mini-silo under aerobic condition and subsampled on 1, 2, 4, and 8 d of opening the silo to analyze the microbial counts. Data were analyzed with a model including hybrid, inoculant, and the interaction using the GLM procedure of SAS. The KP silage had higher ($P < 0.05$) DM (28.4 vs. 26.7%), crude ash (6.85 vs. 5.96%), in vitro DMD (71.4 vs. 64.3%), and in vitroNDFD (50.2 vs. 45.2%) but lower CP (8.62 vs. 9.61%) and ADF (25.9 vs. 27.1%). The LP silage had higher ($P < 0.05$) CP (9.24 vs. 8.99%) than LB silage. The PI silage had higher ($P < 0.05$) ammonia N (0.11 vs. 0.09%) and acetate (1.00 vs. 0.88%) and lactate-to-acetate ratio (4.22 vs. 3.51) than KP silage. The LP silage had higher ($P < 0.05$) lactate (3.12 vs. 2.07%) but lower acetate (0.76 vs. 1.12%). The LP silage had higher ($P < 0.05$) lactic acid bacteria (6.15 vs. 4.50 log10 cfu/g) and yeast (6.08 vs. 5.21 log10 cfu/g), whereas mold was not detected. During aerobic exposure, PI silage had higher ($P < 0.05$) mold count than KP silage. The counts of LAB, yeast, and mold were lower ($P < 0.05$) in silages treated with LB than in silages treated with LP. Therefore, the KP hybrid with LB application could improve the silage quality not only in the front end phase but also in the feedout phase to the farmers.

Key Words: corn silage, fermentation indices, inoculant

0677 Impact of temperature after defrosting on fermentation of high-moisture corn.

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Late harvest of high-moisture corn (HMC) into late fall and winter months during 2014/2015 raised concerns among northern Wisconsin dairy farmers about fermentation of frozen HMC. Although silage maintains fermentation capacity on defrosting, low temperature may inhibit fermentation. Therefore, the objective of the present study was to evaluate the effect of temperature on fermentation profile of defrosted HMC stored frozen for a longer period. An unfermented HMC sample obtained from the University of Wisconsin – Madison Agricultural Research Station (Arlington, WI) on October 2013 was immediately frozen and stored at −20°C until March 2015. Sample was defrosted, homogenized, and divided into 33 subsamples of 250 g each. Three subsamples were randomly selected as fresh samples whereas the remaining 30 subsamples were vacuum-sealed in plastic bags and randomly assigned to 10 treatments (3 reps per treatment). Treatments were mini-silos fermenting in the dark either in a warm (at room temperature 20°C; WR) or cold (in the refrigerator set for 3°C; CD) temperature and allowed to ferment for 1, 3, 7, 14 or 28 d. All samples were analyzed for DM, fermentation profile, and ammonia N (% DM). Data were analyzed using Proc Mixed of SAS with the fixed effects of temperature, ensiling time, and their interaction. Content of DM was slightly greater for CD than for WR ($P = 0.01$; 71.5 vs. 71.1%, respectively). A temperature × ensiling time interaction was observed ($P < 0.001$) for pH, ammonia N, lactate, acetate, ethanol, and total acid concentrations. All parameters followed a similar pattern with gradual reduction in pH (6.27, 5.40, 4.97, 4.93, and 4.72, respectively) or increases in ammonia N (0.00, 0.01, 0.01, 0.02, and 0.02% of DM, respectively), lactate (0.12, 0.24, 0.39, 0.45, and 0.43% of DM, respectively), acetate (0.00, 0.11, 0.15, 0.17, and 0.19% of DM, respectively), ethanol (0.00, 0.09, 0.17, 0.20, and 0.20% of DM, respectively), and total acid (0.12, 0.35, 0.54, 0.68, and 0.72% of DM, respectively) concentrations as fermentation progressed from 1 to 28 d in WR. In contrast, except for a difference in pH for 28 d compared with 1 d (6.41 vs. 6.48, respectively) of fermentation, ensiling time did not affect other fermentation parameters in CD. These findings suggest that although HMC maintains fermentation capacity on defrosting

even after frozen for a prolonged period in storage, fermentation will not occur until warm temperature is reached. Future research is warranted to elucidate at which temperature fermentation progresses normally.

Key Words: high-moisture corn, fermentation

0678 The effect of two microbial inoculants on the aerobic stability of high-moisture corn. S. A. Polukis*, M. L. Smith, R. M. Savage, E. Benjamim da Silva, A. E. Laubach, A. M. Gray, and L. Kung Jr., *University of Delaware, Newark*.

The objective of this study was to evaluate the effect of two microbial inoculants on the fermentation characteristics and aerobic stability of high-moisture corn (HMC). High-moisture corn (71% DM) was 1) untreated (control) or 2) treated with *Lactobacillus hilgardii* (LH) (600,000 cfu/g of fresh material), 3) treated with *Lactobacillus buchneri* 40788 (600,000 cfu/g), or 4) treated with *L. hilgardii* + *L. buchneri* 40788 (LH+LB) (300,000 cfu/g). Inoculants were supplied by Lallemand Animal Nutrition, Milwaukee, WI. Five individually replicated lab silos (7.5 L) for each treatment were packed (packing density of 669 kg DM/m^3) and ensiled for 10, 30, and 92 d between 21 and 23°C. Data were analyzed using the Fit Model in JMP (SAS Inst. Inc., Cary, NC) as a 4 × 3 factorial arrangement of treatments with the main effects of treatment, day, and their interaction. The numbers of lactic acid bacteria were greater for LH (8.91 log cfu/g) than the control (8.41 log cfu/g) at 30 d, whereas all inoculated treatments had higher numbers (7.91 to 8.03 log cfu/g) than the control (7.18 log cfu/g) at 92 d ($P < 0.01$). At 10 d, all treated HMC had lower numbers of yeasts (3.53 to 4.18 log cfu/g) than the control (5.68 log cfu/g). The same occurred at 30 d (<2.00 to 2.26 vs. 5.18 log cfu/g) ($P < 0.01$). At 92 d, LH (4.30 log cfu/g) was numerically lower than the control (4.91 log cfu/g) and LH+LB and LB (both < 2.00 log cfu/g) had lower numbers of yeasts ($P < 0.01$). There were lower ($P < 0.01$) concentrations of lactic acid for treated HMC compared with the control at both 30 (0.74 to 0.80 vs. 1.04%) and 92 d (0.68 to 1.15 vs. 1.45%). All treated HMC had higher ($P < 0.01$) concentrations of acetic acid than the control at 30 (0.47 to 0.57 vs. 0.13%) and 92 d (0.98 to 1.16 vs. 0.23%). Concentrations of ethanol for treated HMC were lower ($P < 0.01$) than the control at 92 d (0.39 to 0.48 vs. 0.73%). All inoculated HMC were more ($P < 0.01$) aerobically stable than the control at 10 (42 to 56 vs. 22 h), 30 (>250 vs. 31 h), and 92 d (>250 vs. 49 h). The inoculants used in this study altered the fermentation characteristics and improved the aerobic stability of HMC.

Key Words: aerobic stability, *Lactobacillus buchneri*, *Lactobacillus hilgardii*

0679 Investigating the relationship between corn silage fiber digestibility and rainfall, growing degree days, and soil type. S. A. Flis*[1], T. P. Tylutki[2], and P. Sirois[1], [1]*Dairy One, Ithaca, NY,* [2]*AMTS LLC, Cortland, NY*.

The relationship of rainfall, growing degree days (GDD), and soil type on aNDFom and aNDFom digestibility (aNDFdom) measured at 30, 120, and 240 h was evaluated on corn silage harvested in New York in the fall of 2015. Five fresh corn silage samples were taken from four different fields at three different farms in New York during the 2015 harvest (n = 60). Samples were analyzed for DM, aNDFom, aNDFdom30, aNDFdom120, aNDFdom240, and K at a commercial laboratory. Farms are located in Saratoga County, NY; Cayuga County, NY; and Livingston County, NY. Farm records of daily rainfall, daily temperature, GDD50, planting dates, corn hybrid, harvest dates, soil type, and nutrient applications from manure and fertilizer were collected from each farm. Data was analyzed using JMP by correlation and regression. Total rainfall (planting to harvest) and cumulative GDD50 were correlated to decreased aNDFdom30 ($r = -0.44$, $P < 0.001$) and aNDFdom240 ($r = -0.27$, $P < 0.05$). As aNDFom increased, the aNDFdom120 ($r = -0.41$, $P < 0.01$) and aNDFdom240 ($r = -0.38$, $P < 0.01$) decreased. Both aNDFdom240 ($r = -0.62$, $P < 0.001$) and aNDFdom30 ($r = -0.66$, $P < 0.001$) decreased with increased rainfall in July. August rainfall had a negative effect on aNDFom120 ($r = -0.61$, $P < 0.001$). Temperature effect (cumulative GDD) on aNDFdom30 begins with the temperatures the plant is exposed to in May ($r = -0.68$, $P < 0.001$). This effect was greater in June ($r = -0.72$, $P < 0.001$). Stepwise regression analysis found that 53% of the variation in aNDFom30 was explained by May and June GDD and May rainfall. There was a strong relationship of soil type to aNDFdom30, aNDFom120, and aNDF0m240, where soils more prone to being wet had lower digestibility ($r = -0.56$ to -0.78, $P < 0.001$). This small sample size did not allow for investigation of the relationships of aNDFdom digestibility to hybrid. Rainfall, GDD, temperature, and soil type were all found to effect aNDFdom digestibility times. Higher cumulative rainfall or rainfall in specific months decreased aNDFdom digestibility. Additional data relating aNDFom digestibility to environmental and soil characteristics could result in improved water management systems and potentially altering timing for planting and harvest.

Key Words: fiber digestibility, corn silage, rainfall

0680 Forage yield and quality of four maize cultivars sown in single and double rows. M. A. Ramirez*, *Universidad Nacional Autonoma de Mexico, FMVZ, Mexico, City, Mexico*.

Corn silage is an important component in feedlot and dairy rations. The aim of the study was to determine forage yield

and quality of four maize cultivars sown in single and double rows. Cultivars were two hybrids, Gladiator and Fog, and two natives, Red and White; single rows were 80 cm apart and double rows were a pair of rows 40 cm apart with 80 cm separation between pairs of rows. Seeding rate was 80,000 plants ha^{-1}. Experimental design was a completely random with four replicates, the experimental unit was a 4.8- by 3-m plot, and treatments were in a 4 × 2 factorial arrangement. Harvest was at one-half milk line stage. Variables measured were forage yield on DM basis and CP, NDF, and ADF contents. The cultivar × sowing method interaction did not influence ($P > 0.05$) forage yield and quality measures. There was a trend ($P = 0.10$) for native cultivars to show higher forage yield than the hybrids (25.4 vs. 21.4 t/ha, respectively), whereas double-row sowing tended ($P = 0.19$) to yield 12% more forage than single-row sowing (24.7 vs. 22.2 t/ha, respectively). Cultivar determined ($P < 0.05$) CP content; native Red showed the highest content, 9.7%, whereas hybrid Fog showed the lowest, 8.8%. Cultivar and sowing method did not influence ($P > 0.05$) NDF content; the overall mean was 66.5%. There was a trend ($P = 0.09$) for the hybrids to show a lower ADF content than natives (36.1 vs. 38.7%, respectively). The conclusion was that maize cultivar and sowing method could be important factors in forage yield and quality.

Key Words: maize, forage yield, forage quality

0681 Evaluation of genetic diversity of *Lactobacillus plantarum* isolated from alfalfa silage using the BOX-polymerase chain reaction.

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The objective of this study was to evaluate the genetic diversity of isolates of *Lactobacillus plantarum* obtained from wilted and nonwilted alfalfa silage. Alfalfa was harvested at 50 d of regrowth and wilted for 6 h. Alfalfa was chopped into particles of 1.5 cm, packed in plastic bags of 25 by 35 cm, and sealed under vacuum. Lactic acid bacteria (LAB) were isolated from samples of fresh alfalfa plants without wilting, fresh forage (Day 0) wilted for 6 h, and its both nonwilted and wilted silages in different fermentation periods (1, 3, 7, 14, 28, and 56 d). The DNA of the strains of LAB was extracted by using a commercial kit (Wizard Genomic DNA Purification kit; Promega). The sequences of the 16S rRNA gene were amplified by PCR using the primers P027F and 1492R. The sequences of the isolates were compared with those available in the GenBank database and aligned using the BLASTn algorithm (basic local alignment search tool) for nucleotides. Of the 138 isolates identified, 58 were *L. plantarum*; therefore, the BOX-PCR was used to evaluate the diversity of these isolates using the primer BOX-A1. The PCR products were separated on 1.6% agarose gel at 60 V for approximately 2 h. The fingerprint of BOX-PCR was documented using the image display system (Kasvi, K33-312). Ten well-defined banding patterns of polymorphism were obtained between the evaluated isolates, with the same distributed in 10 distinct clades. In each clade, *L. plantarum* was considered to be present when clones showed a percent similarity equal to or greater than 90%. Only three *L. plantarum* strains presented no clones with a percentage of less than 90% similarity. No pattern of days of fermentation was observed and no wilting effect on the grouping of the isolates in the clades was observed. Supported by Fapemig, CNPq, and INCT-CA.

Key Words: 16S ribosomal ribonucleic acid, molecular characterization, primer box

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0682 Volatile organic compounds in sugarcane silage treated with chemical and microbial additives.

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This study aimed to evaluate the production of volatile organic compounds in sugarcane silage treated with different additives. The treatments were sugarcane silage without additive (control) and sugarcane silage with *Lactobacillus buchneri* (LB), *Lactobacillus plantarum* and *Pediococcus pentosaceus* (LPPA), *L. plantarum* and *Propionibacterium acidipropionici* (LPPA), 5 g kg^{-1} CaO (SS5CaO), 10 g kg^{-1} CaO (SS10CaO), 5 g kg^{-1} urea (SS5urea), and 10 g kg^{-1}urea (SS10urea). The contents of ethyl acetate, ethyl lactate, ethanol, and other organic acids were determined at the University of Berlin, Germany. Fifty grams of silage were weighed into glass beakers and 200 mL of distilled water and 1 mL of toluene were added to each beaker and mixed with a glass stirrer in a chemical fume hood. The beakers were immediately sealed with Parafilm and stored in a refrigerator (4°C) overnight. The next day, the solution was carefully mixed by swirling each beaker and the silage extract was obtained by filtration through a Whatman No. 54 filter paper. The extract was further filtered through a microfilter and analyzed for fermentation end products using HPLC and special GC techniques. A lower acetone concentration was verified ($P = 0.001$) for the treatment SS10urea, which did not differ for treatments LB, SS5CaO, SS10CaO, and SS5urea. In relation to methanol ($P = 0.001$), a lower concentration was also verified for the treatment SS10urea but did not differ for treatments SS, LPPP, LPPA, and SS5CaO. The propanol ($P = 0.001$) presented lower concentrations for the treatments SS5urea and SS10urea but did not differ for the treatments LPPP and LPPA. Butanol was only detected in the treatment SS10CaO ($P = 0.001$), whereas only for the treatments SS5CaO, SS10CaO, and LB was the presence of 1,2-propanediol ($P = 0.001$) observed, with the lowest concentration associated with LB. A lower concentration of ethanol was observed for

the treatment SS5CaO and SS10CaO and a greater concentration was observed for LB, but the values did not differ among LPPA, LPPP, and SS treatments. The silages treated with CaO presented lower ethyl esters and ethanol and there was a correlation between ethyl acetate + ethyl lactate and ethanol contents. The ensilage conditions strongly affect the concentrations of acids that are produced during the fermentation process, although in the present experiment, low concentrations of these acids were obtained, thereby indicating that the ensilage was satisfactorily performed. However, more research is needed to understand the role of these compounds in silages.

Key Words: ethanol, ethyl acetate, ethyl lactate

0683 Meta-analysis of the effect of homolactic and facultative heterolactic bacteria inoculation on silage quality: I – Fermentation profile.

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Homolactic and facultative heterolactic acid bacteria (HAB) inoculants enhance silage fermentation by rapid production of lactic acid, which decreases the pH and reduces DM and nutrient losses. Data from 120 peer-reviewed papers were summarized to evaluate the effects of inoculation with HAB on silage fermentation profile. The effects were analyzed by comparing raw mean differences between inoculant and control treatment means that had been weighted by inverse variance using random models. Heterogeneity sources evaluated by meta-regression included crop species, application rate ($<10^4$, 10^5 to 10^6 or $>10^7$ cfu/g, representing 3.7, 93.6 and 2.7% of studies, respectively), HAB species, and silo type (laboratory or farm-scale) as covariates. Inoculation did not affect the pH of corn/sorghum silages ($P = 0.34$, $n = 59$) but reduced the pH ($P < 0.05$) of temperate grasses (−0.17; $n = 60$), tropical grasses (−0.17; $n = 17$), sugarcane (−0.03; $n = 28$), alfalfa (−0.30; $n = 8$), other legumes (−0.25; $n = 29$), and other crops (−0.26; $n = 17$). Inoculation increased lactate (0.97% DM; $P < 0.01$, $n = 249$) and reduced butyrate (−0.05% DM; $P < 0.01$, $n = 56$) but did not affect propionate ($P = 0.61$, $n = 109$). Inoculation did not affect acetate in alfalfa silages ($P = 0.15$, $n = 9$) but reduced acetate in corn/sorghum (−0.10% DM; $P < 0.01$, $n = 57$), temperate grasses (−0.30% DM; $P < 0.01$, $n = 71$), tropical grasses (−0.16% DM; $P = 0.03$, $n = 19$), sugarcane (−0.34% DM; $P < 0.01$, $n = 26$), other legumes (−0.47% DM; $P < 0.01$, $n = 24$), and other crops (−0.11% DM; $P < 0.01$, $n = 12$). Inoculation did not affect NH_3–N (% total nitrogen) concentration in corn/sorghum ($P = 0.63$, $n = 22$) or sugarcane ($P = 0.33$, $n = 5$) but reduced it ($P < 0.01$) in temperate grasses (−2.17% N; $n = 49$), tropical grasses (−1.78% N; $n = 9$), alfalfa (−1.47% N; $n = 6$), other legumes (−1.77% N; $n = 18$), and other crops (−1.36% N; $n = 9$). Inoculation with HAB did not improve the fermentation of corn/sorghum silages or sugarcane silage but markedly improved those of grasses, legumes, and other crop silages independent of the HAB species.

Key Words: ammonia, forage conservation, organic acids

0684 The effects of air and heat stress on the aerobic stability of silage treated with a chemical additive.

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The chemical additive Safesil (active ingredients: sodium benzoate, potassium sorbate, and sodium nitrite; Salinity, Sweden) was evaluated for its effects on the fermentation and aerobic stability of corn silage. Whole plant corn samples were harvested at 40% DM, chopped, processed, and treated with 1) no additive (control), 2) Safesil (2 L/t), or 3) Safesil (3 L/t). Silos (7.5 L; forage density of 224 kg of DM/m^3) from each treatment were stored at either 22 ± 2 or 30 ± 2°C and subjected to no air stress or a 2-h weekly air stress. After 100 d of ensiling, 5 replicate silos were opened for each treatment. Data were analyzed by ANOVA as a 3 × 2 × 2 factorial arrangement of treatments with main factors of additive, storage temperature, air stress, and their interactions. Silages were analyzed for numbers of yeasts, fermentation end products, and aerobic stability. Both application rates of Safesil resulted in silages with lower numbers of yeasts ($P < 0.01$) compared with control silage (3.96 vs. <2.00 log cfu/g). Silos that were stressed with air also had higher ($P < 0.01$) yeast counts compared with silos without air stress (3.21 vs. <2.00 log cfu/g). Treatment with Safesil at both 2 and 3 L/t lowered ($P = 0.01$) the concentration of ethanol in both unstressed and air stressed silos (0.52 to 0.70%) compared with control silages (1.27 to 1.47%). When silos were stored at 22°C, treatment with Safesil at 2 and 3 L/t increased ($P < 0.01$) aerobic stability in unstressed silos (185 and 236 h, respectively) compared with unstressed control silos (72 h). When silos were stored at 30°C, only treatment with Safesil at 3 L/t improved ($P < 0.01$) aerobic stability in silos that were both not stressed (168 h) and stressed (225 h) compared with control silos that were not stressed (79 h) and stressed (44 h). Air-stressed silos treated with Safesil 3 at L/t and stored at 30°C (225 h) had greater ($P < 0.01$) aerobic stability compared with stressed silos treated with Safesil at 3 L/t and stored at 22°C (95 h). The use of Safesil has the potential to improve aerobic stability of corn silage

in warm climates even with decreased silo integrity.

Key Words: corn silage, aerobic stability, sodium benzoate

0685 Effects of chemical additives on fermentation characteristics of high-moisture alfalfa silage.

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Alfalfa is sometimes harvested with a high moisture content that increases the chances for undesirable fermentations. The objective of these experiments were to determine the effectiveness of Safesil (SF; active ingredients: 10% potassium sorbate, 20% sodium benzoate, and 5% sodium nitrite) and Safesil Challenge (SC; active ingredients: 7.5% potassium sorbate, 15% sodium benzoate, and 10% sodium nitrite) from Salinity, Sweden, on improving the fermentation of high-moisture alfalfa silage. Alfalfa was directly chopped at 23% DM and used in two experiments. In Experiment 1, we evaluated the effect of SF on the characteristics of early fermentation. Four individual 1-kg replicates of untreated alfalfa or alfalfa treated with 4 L/t of SF were ensiled in vacuumed and heat-sealed, nylon–polyethylene bags for 1, 2, 4, and 7 d. Data were analyzed as a 2 × 4 factorial arrangement of treatments, with main factors of treatment, days of ensiling, and their interaction. In Experiment 2, the long term effects of SF or SC with and without air stress during storage were determined. Replicated silos (7.5 L) were packed (density of 224 kg of DM/m^3) with the same forage described above and were untreated or treated with SF (3 and 4 L/t) or SC (2 and 3 L/t). Half of the silos were submitted to a 2-h weekly air stress. Data were analyzed by ANOVA as a 2 × 5 factorial arrangement of treatments with main factors of air stress, treatment, and their interaction. In Experiment 1, pH decreased and acids and ethanol similarly increased for untreated and treated silages as ensiling progressed. Compared with untreated silage, treated silages had fewer yeasts ($P < 0.01$) at 4 d of ensiling (4.52 vs. 2.96 log cfu/g) and less enterobacteria after 1 d (6.79 vs. 5.81 log cfu/g). Ethanol concentration was numerically lower for treated silages at all time points. In Experiment 2, for silos submitted to air stress, the DM recovery after 100 d was higher ($P = 0.04$) for SF- and SC-treated silage than for untreated silage. After 100 d, numbers of yeasts and molds were less than 2.00 log cfu/g for all treatments. These experiments showed that Safesil can quickly reduce harmful microorganisms, such as yeasts and enterobacteria, in high-moisture alfalfa and that Safesil and Safesil Challenge can improve DM recovery in silage submitted to air stress.

Key Words: alfalfa, silage, Safesil

FORAGES AND PASTURES SYMPOSIUM: GREENHOUSE GAS EMISSIONS IN PASTURE-BASED DAIRY AND BEEF CATTLE SYSTEMS

0686 Comprehensive national assessment on the sustainability of beef production.

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To develop better scientific understanding of the sustainability of beef in the United States, a national assessment is being conducted by the National Cattlemen's Beef Association, a contractor to the beef checkoff. This includes a life cycle assessment (LCA) of greenhouse gas emissions along with other environmental, social, and economic impacts. Assessments are being made for representative cattle operations in each of seven geographic regions to form the national total. Producer surveys and visits are used to characterize region-specific production systems, and the information gathered provides a basis for system simulation and a farm-gate LCA. Assessments have been completed for the central plains and midwestern regions and are in progress for the western and eastern regions of the country. Results thus far show farm-gate carbon footprints of representative production systems vary from 16 to 28 kg CO_2e/kg of carcass weight (CW) with a mean around 20 kg CO_2e/kg CW. The cow–calf operation is the source of 67 to 77% of this footprint and stocker operations contribute up to 18% of the footprint. Therefore, depending on whether cattle are backgrounded on pasture or in a feedlot, the grassland-based portion of the system can contribute 67 to 85% of the farm-gate carbon footprint of finished beef cattle. Enteric methane emission is the source of about 60% of the total greenhouse gas emissions from cow–calf and stocker operations and 35% of that from feedlot finishing operations. Nitrous oxide emissions contribute about 20% of the carbon footprint of grazing cattle. Considering post-farm gate sources (harvest, retail, restaurant, and consumer), the full carbon footprint is about 45 kg CO_2e/kg of consumed beef. Of this total, 58 to 73% can be attributed to emissions from grazing cattle and the inputs required to maintain them. A similar result is found for environmental impacts such as total reactive nitrogen loss, where 50 to 70% of the farm-gate footprint is attributed to grazing cattle. Therefore, to make substantial reductions in the environmental impacts of beef production, our analysis to this point indicates that mitigation strategies are needed to reduce greenhouse gas and nitrogen emissions from grassland systems. This provides a major challenge for beef cattle research because practical technologies or strategies for reducing these emissions are