Forages and Pastures: Silages and forages in dairy production systems

M110 Cool season grass-legume mixtures in north-central Florida. Erick R. S. Santos*[1], José C. B. Dubeux Jr.[1], Lynn E. Sollenberger[2], Marta M. Kohmann[2], Stephanie Pope[2], Hiran M. S. Silva[1], and Ana C. C. Melo[1], *[1]University of Florida–North Florida Research and Education Center (NFREC), Marianna, FL, [2]University of Florida – Agronomy Department, Gainesville, FL.*

Grass-legume mixtures may increase dry matter (DM) yield and forage N concentration due to biological N_2 fixation. A study was conducted to evaluate yield and botanical composition in different cool season grass-legume mixtures in Gainesville, FL from 4 February to 14 May 2014 (4 harvests). Treatments were allocated in a split-plot arrangement in a completely randomized block design with 4 replicates. Main plots were formed by annual ryegrass (*Lolium multiflorum* Lam.) or a rye (*Secale cereal* L.)-annual ryegrass mixture. The subplot was the combination of cool-season legumes or presence/absence of N fertilizer in grass monocultures, as follows: (1) hairy vetch (*Vicia villosa* ssp.), (2) crimson clover (*Trifolium incarnatum* L.), (3) red clover (*Trifolium pratense* L.), (4) ball clover (*Trifolium nigrescens* Viv.), (5) hairy vetch-red clover-ball clover, (6) crimson clover-red clover-ball clover, (7) N-fertilized grass (50 kg N·ha^{-1}·cut^{-1}), and (8) unfertilized grass. Total DM yield was greater for N-fertilized grass in the 2nd and 3rd harvests (660 and 1360 kg DM·ha^{-1}). Mixtures containing subplot-Treatments 3 and 6 increased total DM yield in the 4th harvest (1250 and 1280 kg DM·ha^{-1}, respectively) and did not differ from N-fertilized grass in this harvest. Legume DM yields were minimal in Harvests 1 and 2. In the 3rd and 4th harvests, the crimson clover-red clover-ball clover mixture had the greatest legume DM yield (330 and 730 kg DM·ha^{-1}), followed by crimson clover (320 kg DM·ha^{-1}) in the 3rd harvest, and by red clover (660 kg DM·ha^{-1}) in the 4th harvest, whereas hairy vetch presented the lowest productivity in both harvests (33 and 31 kg DM·ha^{-1}). Dry matter yield of annual ryegrass and rye-annual ryegrass did not differ among harvests. Grass DM yield was greater for N-fertilized grass in the 2nd and subsequent harvests (660, 1360, and 1220 kg DM·ha^{-1}). Red clover and the crimson clover-red clover-ball clover mixture were not different in DM yield than N-fertilized grass in the last harvest, while the other mixtures did not differ from the unfertilized grass.

Key Words: annual ryegrass, rye, crimson clover

M111 Length of ensiling effects on fermentation characteristics, DM recovery and aerobic stability of corn Shredlage. Luis C. Solórzano*[1], Luis L. Solórzano[2], and Abner A. Rodríguez[1], *[1]Universidad de Puerto Rico, Mayagüez, PR, [2]Lankin, Fitchburg, WI.*

The effect of length of ensiling (LOE) on fresh whole-plant corn Shredlage was evaluated after it was fermented for 0, 45, 90, or 180 d at a temperature of 20 to 23°C using 3-L capacity PVC mini-silos fitted with mechanics to vent gas. Mini-silos were filled with about 1.9 kg of the crop at about 33% DM, >3.1% soluble carbohydrates (fresh matter). Four mini-silos were opened at each LOE to determine fermentation characteristics and DM recovery. Statistical analysis was performed according to a completely randomized design with a 4 LOE. Aerobic stability (AS) was determined by placing the ensiled material from each mini-silo in Styrofoam containers placed inside a Styrofoam chamber. Temperature was measured at 6-h intervals for 7 d. Statistical analysis used a split-plot design with a 3 LOE by 29-timepoint factorial arrangement using silo as the repetitive measurement. Significance ($P < 0.05$) is denoted by $^{a, b, c}$. Ensiling increased the % of lactic acid, from fresh (0.12^a), to 45 d (5.26^b), 90 d (6.32^b), and 180 d (5.31^b). A similar trend occurred for acetic (0.07^a) and propionic acid (<0.01^a) from 0d to 45d (0.51^b, 0.16^b), 90 d (0.72^b, 0.19^b) and 180 d (0.62^b, 0.16^b). Low TVFA at 0 d (0.19^a), increased at 45 d (5.93^b), 90 d (7.23^b) and 180 d (6.09^b). Butyric acid was < 0.01 and not different among LOE. Recovery of DM did not differ among LOE and averaged 91.33%. Starting pH at 0d was highest (5.75^a) compared with 45d (3.71^c) and 90 d (3.64^c), and both of these were lower than pH at 180 d (3.87^b). Ammonia-N (% of CP) has an increasing trend from 0 d (0.65^c) to 45 d (2.54^b) and 90 d (2.37^b), which were lower than at 180 d (4.5^a). Loss of AS occurred on 45 d by 36 h post-aerobic exposure (PAE), 90 d by 48 h PAE, and 180 d by 42 h. PAE. Ensiling resulted in increases of lactic, acetic, propionic acids and TVFA, resulting in a lower pH. There were no differences in these parameters after 45 d of ensiling. Ammonia-N increased due to ensiling and was not different between 45 and 90 d, and increased after 180 d. The shorter LOE resulted in lower AS. Shredlage continues to cure for at least 180 d of fermentation.

Key Words: corn silage, fermentation, aerobic stability

M112 Fermentation of frozen whole-plant corn silage after defrosting. Luiz F. Ferraretto*[1], Gilson S. Dias Junior[1,2], John P. Goeser[1,3], and Randy D. Shaver[1], *[1]University of Wisconsin, Madison, WI, [2]Universidade Federal de Lavras, Lavras, MG, Brazil, [3]Rock River Laboratory Inc., Watertown, WI.*

Late harvest of whole-plant corn silage (WPCS) into late fall and winter months during 2014/2015 raised concerns among central and northern Wisconsin dairy farmers and their nutritionists about fermentation of frozen WPCS. The objective of the present study was to evaluate fermentation profile of defrosted WPCS after several months stored frozen. An unfermented WPCS sample that had been obtained from the University of Wisconsin–Madison Agricultural Research Station (Arlington, WI) on September 23, 2014, was immediately frozen and stored at −20°C until January 26, 2015. Sample was defrosted, homogenized, and divided into 24 sub-samples of 250 g each. Sub-samples were vacuum-sealed in plastic bags and randomly assigned to 8 treatments so that each treatment had 3 replications. Treatments were 0, 0.5, 1, 2, 3, 7, 14, and 28 d fermentations. Bags were stored in the dark at room temperature (approximately 20°C) until reaching the targeted ensiling time. All samples were analyzed for DM, pH, organic acids and ammonia-N (%DM). Data were analyzed using Proc Mixed of SAS with the Fixed effect of ensiling time and the random effect of bag. Content of DM did not differ ($P = 0.31$; 36.1% on average). Measurements of pH were affected by ensiling time ($P = 0.001$) with a decline observed after only 1 d (5.23) of fermentation and a gradual decrease until 28 d (3.84). This is related to the gradual increase ($P = 0.001$) in lactate and acetate concentrations from 1 (0.88% and 0.39%, respectively) to 14 d of fermentation (5.48% and 1.22%, respectively). Total acid concentrations follow the same pattern ($P = 0.001$). Propionate concentration did not differ ($P = 0.77$) whereas butyrate was not detected. Concentration of succinate increased ($P = 0.001$) after 1 d of fermentation, peaked on 3 d and decreased on 14 d. Ethanol concentration was greater ($P = 0.001$) for 2, 3, 7, 14 and 28 d (0.32% on average) compared with 0, 0.5 and 1 d (0.03% on average). Ammonia-N increased ($P = 0.001$) 3-fold from 0 to 28 d of fermentation (0.02% vs. 0.06%, respectively). These findings

suggest that WPCS maintains fermentation capacity upon defrosting even after frozen for a prolonged period in storage.

Key Words: corn silage, fermentation

M113 Length of ensiling effects on starch characteristics of corn Shredlage. Luis C. Solórzano*[1], Luis L. Solórzano[2], Beatriz A. Quintana[1], and Abner A. Rodríguez[1], [1]*Universidad de Puerto Rico, Mayagüez, PR,* [2]*Lankin, Fitchburg, WI.*

The effect of length of ensiling (LOE) on fresh whole-plant corn Shredlage was evaluated after it was fermented for 0, 45 or 180 d at a temperature of 20–23°C using 3 L capacity PVC mini-silos fitted with mechanics to vent gas. Mini-silos were filled with about 1.9 kg of the crop at about 33% DM, > 3.1% soluble carbohydrates (fresh matter). Four mini-silos were opened at each LOE to determine starch characteristics and in vitro starch digestibility (IVSd) during 2 in vitro fermentation endpoints (FEP, 3 or 7 h.). Statistical analysis for nutritional characteristics was performed using a completely randomized design (CRD) for 3 LOE. Data for IVSd was analyzed using a CRD with a 3 LOE by 2 FEP factorial arrangement. Different superscripts denote statistical significance ($P < 0.05$). The structure of the starch granule was documented using a scanning electron microscope (SEM) at each LOE. Ammonia-N (% of CP) and IVSd increased as LOE increased, while sugar decreased (Table 1). There were no changes for starch content across LOE. Increasing the FEP from 3 to 7 h. increased IVSd from 72.4[a] to 84.1[b]%. The 2,000× micrograph at ensiling (0 d) shows starch granules with a smooth surface and a spherical shape surrounded by protein bodies. After 45 d of ensiling, the starch granules lost their sphericity and some of the protein bodies start to break down into small pieces (supported by increases in ammonia-N). After 180 d of ensiling, starch agglutination may be observed as well as some pitting of the starch granule due to hydrolytic enzyme activity. In summary, structural changes in the starch-protein matrix and in the starch granule during ensiling result in increased starch digestibility.

Table 1 (Abstr. 113). Effects of length of ensiling (0, 45, or 180 d) on nutrient characteristics and starch digestibility of corn Shredlage

	Length of ensiling, d					
	0		45		180	
Item	Mean	SD	Mean	SD	Mean	SD
N	4		8		8	
Ammonia-N, % of CP	0.65[c]	0.1	2.54[b]	0.04	4.5[a]	0.39
Starch, % of DM	34.2	2.39	30.4	1.58	32.2	1.84
Sugar, % of DM	8.7[a]	0.21	1.9[b]	0.26	2.8[c]	0.22
In vitro starch digestibility, % of starch	65.4[a]	11.2	76.5[ab]	10.8	84.1[b]	8.1

Key Words: length of ensiling, corn silage, starch digestibility

M114 Relationship between corn silage processing score and kernel fraction geometric mean particle size in whole-plant corn silage. Gilson S. Dias Junior[1,2], Luiz F. Ferraretto*[1], Gustavo G. S. Salvati[1], Lucas C. de Resende[1,2], Pat C. Hoffman[1], and Randy D. Shaver[1], [1]*University of Wisconsin, Madison, WI,* [2]*Universidade Federal de Lavras, Lavras, MG, Brazil.*

Greater kernel processing increases starch digestibility in whole-plant corn silage (WPCS). Corn silage processing score (CSPS), the percentage of starch passing through a 4.75 mm sieve, is widely used to assess degree of kernel breakage in WPCS. However, the geometric mean particle size (GMPS) of the kernel fraction that passes the 4.75 mm sieve has not been well described. Therefore, the objective of this study was to evaluate the relationship between CSPS and GMPS of the kernel fraction. Samples of WPCS (n = 80) from 3 field trials representing varied theoretical lenght of cut settings and processor types and settings were evaluated. Each sample was divided in 2 and then dried at 60°C for 48 h. The CSPS was determined in duplicate on one of the split samples, while on the other split sample the kernel and stover fractions were separated using a hydrodynamic separation procedure. After separation, the kernel fraction was re-dried at 60°C for 48 h in a forced-air oven and dry sieved to determine GMPS (µm) and surface area using 9 sieves with nominal square apertures of 9.5, 6.7, 4.75, 3.35, 2.36, 1.70, 1.18, 0.589 mm and pan. Regressions to determine linear and quadratic relationships were performed using Proc Reg of SAS (SAS Institute, 2004). Linear relationships between CSPS and kernel fraction GMPS ($R^2 = 0.11$; $P = 0.01$), surface area ($R^2 = 0.06$; $P = 0.03$) and proportion passing through the 4.75 mm screen ($R^2 = 0.34$; $P = 0.001$) were poor. Strong quadratic relationships between proportion of kernel fraction passing through the 4.75 mm screen and kernel fraction GMPS ($R^2 = 0.70$; $P = 0.001$) and surface area ($R^2 = 0.56$; $P = 0.001$) were observed. Corn silage processing score was poorly correlated with kernel fraction GMPS and surface area. These findings suggest that hydrodynamic separation and dry sieving of kernel fraction may provide better assessment of kernel breakage in WPCS.

Key Words: mean particle size, corn silage, processing score

M115 The effects of different silo plastics on the fermentation, aerobic stability, and dry matter recovery of corn silage. Michelle Windle*, *Vita Plus, Madsion, WI.*

The objective of this experiment was to evaluate the efficacy of 4 different silo plastics to mitigate silage surface spoilage. Bag silos (60 cm × 30 cm) were created by heat-sealing single layers of 4 different types of silo plastics: black and white plastic (BW, KSI Supply Inc., Sheboygan Falls, WI), Silostop oxygen barrier plastic (SS, Bruno Rimini Ltd., London, United Kingdom), KSI oxygen barrier plastic (KSI), and Hitec oxygen barrier plastic (HT, Shanghai Hitec Plastics Co. Ltd., Shanghai, China). There were 5 silos per each types of plastic, yielding 20 experimental silos. Approximately 2.75 kg of chopped whole plant corn (40.9% DM) were placed in each silo, manually compressed and sealed. One sample per plastic type was analyzed for oxygen transfer rate (OTR). Silages were stored for 112 d at 15–21°C and data were analyzed using the Fit Model procedure of JMP. Means were compared using the Tukey's test. Relationships were evaluated between OTR and fermentation parameters. The OTR for BW, KSI, SS and HT were 4039, 154, 23.2 and 8769 cc/m^2/d, respectively. Dry matter, CP, soluble CP, NH_3-N, and water-soluble carbohydrates of corn silage were not affected by plastic type ($P > 0.05$). Silages ensiled with HT had a lower DM recovery, higher pH, less lactic and acetic acids, and less ethanol, as compared with silages stored in BW, SS or KSI ($P < 0.05$). Aerobic stability was lowest for silages ensiled within HT (8 h), intermediate for BW (37 h) and greatest for KSI (76 h) and SS (67 h) ($P < 0.05$). Colony forming units of yeasts for KSI, SS, BW and HT were 3.94, 4.56, 6.19, and 8.05, respectively. Relationships between OTR and fermentation parameters indicated that as OTR increased, corn silage was less stable, had a higher pH, more yeasts, ethanol, and a lower lactic-to-acetic ratio ($P < 0.05$).

Results indicate that ensiling corn silage with differing "oxygen barrier" plastics results in large differences in silage quality.

Key Words: spoilage, silo plastic, yeast

M116 Length of ensiling effects on nutritional characteristics and in vitro NDF digestibility of corn Shredlage. Luis C. Solórzano*[1], Luis L. Solórzano[2], and Abner A. Rodríguez[1], [1]*Universidad de Puerto Rico, Mayagüez, PR,* [2]*Lankin, Fitchburg, WI.*

We evaluated the effect of length of ensiling (LOE) on fresh whole plant corn shredlage (CS) that was fermented for 0, 45, 90, or 180 d at a temperature of 20 to 23°C using 3-L capacity PVC mini-silos fitted with mechanics to vent gas. Mini-silos were filled with approximately 1.9 kg of the crop at about 33% DM, >3.1% soluble carbohydrates (fresh matter). Four mini-silos were opened at each LOE to determine nutritional characteristics and in vitro NDF digestibility (NDFd) during 3 in vitro fermentation endpoints (FEP, 0, 30 or 120 h.) at a commercial laboratory. Statistical analysis for nutritional characteristics was performed using a completely randomized design (CRD) for 4 LOE. Data for NDFd was analyzed using a CRD with a 4 LOE by 3 FEP factorial arrangement. Significance ($P < 0.05$) is denoted by [a, b, c]. There were no LOE differences ($P > 0.5$) on the % content of ADF, NDF, lignin and ash, which averaged, 24.19, 36.71, 1.76, and 3.96, respectively. There were significant differences in the % content of DM, CP, ADF bound protein (ADFBP), fat and cell wall protein (CWP). Increasing LOE led to a decrease in the DM content from 0 d (36.68[a]), to 90 d (32.25[b]), and 180 d (32.51[b]), but did not differ from 45 d (34.04[ab]). The content of CP increased for LOE 90 d (8.78[a]) and 180 d (8.16[a]) compared with LOE at 0 d (7.19[b]) or 45 d (7.32[b]). The amount of ADFBP was 0.52[b] at 0 d, similar to ADFBP at 90 d (0.62[b,c]). The ADFBP content at 90 d did not differ from 45 d (0.74[a]) and 180 d (0.67[a,c]). Fat content increased at 90 d (3.40[a]) and 180 d (3.45[a]) compared with 0 d (1.95[b]) or 45 d (2.36[b]). At 0 d (0.18[b]) CWP did not differ from 45 d (0.47[b]), or 180 d (0.28[b]), but all 3 did differ from 90 d (1.20[a]). Increasing the LOE led to an increase in IVNDFd from 0 d (40.39[a]) and 45 d (34.91[a]) to 90 d (50.46[b]) or 180 d (60.83[c]). Ensiling leads to various nutritional changes over time, which can affect ration balancing and on-farm ration preparation. This calls for continuous silage nutritional monitoring over time to proper balance rations and feed cows.

Key Words: corn silage, fiber digestibility, nutritional characteristics

M117 Ensiling practices of corn on California dairies. Jennifer M. Heguy*[1] and Noelia Silva-del-Rio[2], [1]*University of California, Ag & Natural Resources, Modesto, CA,* [2]*University of California, VMTRC, Tulare, CA.*

The aim of this study was to obtain information on current corn ensiling practices in California's San Joaquin Valley. In summer 2014, 20 dairies were visited to create a snapshot of ensiling practices. Producers answered a short survey, and observations at the silage structure were made. Herd size ranged from 350 to 5250 cows (median = 1800). Five consecutive truckloads of corn silage delivered to dairies were sampled and composited for wet chemistry nutrient analysis (Table 1). Descriptive statistics were conducted with PROC MEANS of SAS and correlations were evaluated with PROC CORR of SAS. Structures were primarily wedge piles (n = 16). Delivery rate varied; the 5 truckloads of corn were delivered in as little as 8 min and in as many as 64 min. Most dairies utilized one packing tractor (n = 12), with delivery rate of the 5 loads ranging from 8 to 40 min. Fewer dairies used 2 packing tractors (n = 7), with delivery rate ranging from 10 to 64 min, and one dairy utilized 3 packing tractors with a delivery rate of 22 min. Fourteen custom harvesting companies were utilized on the 18 dairies that did not harvest their own corn, with 4 of the companies harvesting on more than one dairy. Corn silage processing score (CSPS) was analyzed; 9 samples were optimally processed (CSPS > 70%) and 11 samples were adequately processed (CSPS between 50% and 70%). No samples were inadequately processed. No correlation was found between DM and starch content (r = 0.290, $P = 0.214$) or DM and CSPS (r = −0.001, $P = 0.995$). Harvesting parameters varied, but kernel processing was a practice utilized on each dairy; CSPS showed that all samples were either adequately or optimally processed.

Table 1 (Abstr. M117). Nutrient composition (% of DM unless otherwise noted) of chopped corn (n = 20) taken at harvest in California's San Joaquin Valley

	DM, %	CP	ADF	NDF	Starch	NFC	Ash	CSPS (%)
Average	35.9	7.7	24.4	41.0	30.2	43.6	5.4	70.7
Median	35.9	7.8	24.9	42.3	29.0	43.2	5.4	69.4
Minimum	31.2	6.2	20.2	35.2	23.3	36.6	4.2	50.7
Maximum	40.3	8.8	28.3	46.7	36.7	50.7	6.8	82.2
SD	2.5	0.6	2.1	2.8	3.6	3.1	0.7	9.8

Key Words: California, corn silage, corn silage processing score

M118 Investigation into the accuracy of a commercially available activity meter for measuring grazing duration. Emer Kennedy*, James Moloney, Donagh P. Berry, Michelle Liddane, and Frank Buckley, *Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland.*

Grass intake is influenced by grazing duration. Current methods of measuring grazing behavior are best suited to research environments. Activity meters, used primarily for oestrus detection, are now incorporating behavioral measures. The hypothesis was that an activity meter would provide similar information on grazing duration to that generated by a behavior recorder. One hundred 24-h records were obtained from grazing Holstein-Friesian cows between August 26 and September 30, 2014. Grazing time was recorded using IGER behavior recorders (IGER), which were processed using the 'Graze' analysis software. All cows were fitted with MooMonitor+ activity meters (MOO; Dairymaster, Causeway, Co. Kerry). Total grazing time data from the MOO was obtained from the Dairymaster database. Total 24-h grazing duration determined by the IGER was linearly regressed on the MOO grazing duration to determine the association between each method; no intercept was fitted in the model. A fixed effects linear model was used to quantify the association between parity, measurement day and IGER recorder number on the IGER recorded grazing duration. Two-way interactions between the MOO grazing duration and the main fixed effects were considered in the model to determine if the association between the MOO and IGER grazing duration differed by any of the main effects. Mean 24-h grazing duration was 543 (±6.39 SEM) min for IGER and 540 (±5.9 SEM) min for MOO. A correlation of r = 0.72 existed between the IGER and MOO grazing durations. The regression coefficient of IGER grazing duration on MOO grazing duration was 1.003 (±0.008 standard error) which was not different from the expectation of unity should the measured differences in grazing duration between the 2 devices be equivalent. Neither parity nor calendar day was associated with the difference in grazing duration estimated by the 2 devices. The regression coefficient of the IGER on the MOO grazing duration varied from 0.87 to 1.1. The results from this study, albeit from a limited data

set, indicate good concordance between 24-h grazing duration estimated from the IGER and MOO recorders.

Key Words: grazing behavior, dairy cow, activity meter

M119 Forage quality of two different pasture systems incorporating warm and cool season forages for grazing organic dairy cattle. Kathryn E. Ruh*[1,2], Bradley J. Heins[1,2], and Jim C. Paulson[3], [1]*West Central Research and Outreach Center, Morris, MN,* [2]*University of Minnesota, St. Paul, MN,* [3]*University of Minnesota Extension, Rochester, MN.*

Two pasture systems (cool and warm season 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, Minnesota, for 2 years. System 1 was a diverse-mixture of cool season grasses and legumes (perennial ryegrass, white clover, red clover, chicory, orchardgrass, meadow bromegrass, alfalfa, 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 20–30 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 [cool (1) or cool-warm (2)], month (May to October), forage (grass pasture, turnips, BMR sorghum-sudangrass or teff), year (2013 or 2014) and their interactions, and date of harvest was a random variable. The DM averaged 20.7% and 21.2% for systems 1 and 2, respectively ($P = 0.75$). The CP was 21.2% and 18.3% for systems 1 and 2, respectively ($P < 0.05$). The CP for system 1 averaged 19.9% in 2013 and 22.5% in 2014 ($P < 0.01$). The CP for system 2 averaged 16.1% in 2013 and 20.4% in 2014 ($P < 0.01$). The TTNDFD averaged 69.9% and 53.1% for system 1 and system 2, respectively ($P < 0.01$). The TTNDFD was 78.1% in 2013 and 61.7% in 2014 for cool-season grasses, and 59.8% in 2013 and 46.4% in 2014 for warm season grasses ($P < 0.0001$). In summary, CP and TTNDFD were greater in cool-season pasture systems; however, DM did not differ between pasture systems. Yearly effects and weather may affect forage quality in both pasture production systems.

Key Words: teff, organic, grazing

M120 Effect of starchy or fibrous carbohydrate supplementation of an herbage diet on ruminal fermentation and methane output in continuous culture. Kathy J. Soder*[1], Aimee N. Hafla[1], Andre F. Brito[2], Melissa D. Rubano[1], and Curtis J. Dell[1], [1]*USDA-ARS, Pasture Systems and Watershed Management Research Unit, University Park, PA,* [2]*University of New Hampshire, Durham, NH.*

A dual-flow continuous culture fermentor system was used to assess the effect of supplementing 2 levels (5 or 10% of diet DM) of starchy (barley: BAR) or fibrous (beet pulp: BP) carbohydrate (CHO) to an orchardgrass diet on nutrient digestibility, VFA production, bacterial protein synthesis, and methane output. Treatments were randomly assigned to fermentors in a 4 × 4 Latin square design with a 2 × 2 factorial arrangement using 7 d for diet adaptation and 3 d for sample collection. Treatments included: 1) 57 g DM herbage + 3 g DM BAR; 2) 54 g DM herbage + 6 g DM BAR; 3) 57 g DM herbage + 3 g DM BP; 4) 54 g DM herbage + 6 g DM BP. Feeding and pH sampling occurred at 0730, 1030, 1400 and 1900 h. Gas samples for methane analysis were collected at 0725, 0900, 1000, 1355, 1530, and 1630 h. Effluent samples were analyzed for OM, CP, NDF, nutrient digestibilities, estimation of bacterial protein synthesis, ammonia-N and VFA. Data were analyzed using the MIXED procedure of SAS with period and treatment as fixed effects and fermentor as random. Orthogonal contrasts were tested for CHO type and level. No significant interactions were detected. Apparent and true OM digestibilities were not affected ($P > 0.10$) by CHO source (72.4 and 81.9%, respectively). True CP digestibility was greater ($P < 0.05$) for BP (75.3%) than BAR (52.5%) diets. Apparent NDF digestibility was lower ($P < 0.05$) for BP (79.5%) than BAR (85.1%) diets. Barley diets produced lower ($P < 0.05$) molar proportions of acetate (43.5 vs. 49.4 mol/100 mol, respectively), lower concentrations of total VFA (67.2 vs. 72.2 mmol/L, respectively) and tended ($P = 0.08$) to have greater mean pH (6.75 vs. 6.72) compared with BP diets. Methane production was not affected ($P > 0.10$) by CHO source. The 10% supplement produced greater ($P < 0.05$) concentrations of methane (35 vs. 27 mmol/d) and tended ($P = 0.07$) to increase apparent DM digestibility. Diet had no effect on bacterial efficiency or ammonia-N. Supplementation of an herbage-based diet with BP improved CP digestibility compared with barley but did not affect OM digestibility, methane production, or microbial efficiency.

Key Words: barley, beet pulp, ruminal fermentation

M121 Heifer growth performance from fall-oat pastures. Wayne K. Coblentz*[1], Geoff E. Brink[2], Nancy M. Esser[3], Jason S. Cavadini[3], and Patrick C. Hoffman[4], [1]*US Dairy Forage Research Center, Marshfield, WI,* [2]*US Dairy Forage Research Center, Madison, WI,* [3]*University of Wisconsin, Marshfield, WI,* [4]*University of Wisconsin, Madison, WI.*

Fall-grown oat has shown promise as an emergency fall forage option, or to extend the grazing season in Wisconsin. Our objectives for this project were: (1) to assess the pasture productivity and forage characteristics of 2 fall-grown oat cultivars (Ogle and ForagePlus; OG and FP, respectively) using grazing initiation dates timed to late-September (EARLY) or mid-October (LATE); and (2) to evaluate growth performance by heifers grazing these oat forages compared with performance of heifers reared under controlled conditions with traditional confinement management (CONTROL). A total of 160 gravid Holstein heifers (80 heifers/yr) were stratified by weight, and assigned to 10 research groups (8 heifers/group). Initial BW was 509 ± 40.5 kg in 2013 and 517 ± 30.2 kg in 2014. Heifer-groups were maintained as units, and assigned to specific pastures arranged as a 2 × 2 factorial of oat cultivars and grazing initiation dates. Grazing heifer groups were allowed to strip-graze oat pastures for 6 h daily before returning to the barn, where they were offered a forage-based basal TMR. During both years, oat forage mass increased until early-November before declining in response to freezing weather conditions, exhibiting linear ($P < 0.01$) and quadratic ($P < 0.01$) effects of calendar date, regardless of oat cultivar. For 2013 and 2014, the respective maximum forage mass was 5329 and 4501 kg/ha for FP, and 5046 and 5111 kg/ha for OG. ForagePlus oat did not reach the boot stage of growth during either year; in contrast, OG matured more rapidly, and reached a late-heading stage during 2013, but only the early-boot stage in 2014. For 2013, ADG for CONTROL did not differ from grazing heifer groups (overall mean = 0.63 kg/d; $P = 0.619$); however, ADG from FP was greater than OG (0.68 vs. 0.57 kg/d; $P = 0.02$), and greater from EARLY than LATE (0.82 vs. 0.43 kg/d; $P < 0.01$). During 2014, ADG from CONTROL exceeded grazing heifer groups

(0.81 vs. 0.57 kg/d; $P = 0.01$), and ADG from EARLY again exceeded LATE (0.70 vs. 0.44 kg/d; $P < 0.01$). These results suggest that delaying grazing until mid-October to allow more oat forage to accumulate will consistently suppress heifer growth performance.

Key Words: heifer, grazing, oat

M122 Fertilization of fall-grown oat with dairy slurry or urea.
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Oat has shown promise as a fall-forage option for dairy producers in Wisconsin. Our objectives were to assess the effects of summer applications of urea fertilizer or dairy slurry on the DM yield, N uptake, and apparent N recovery from fall-grown oat forages. 'ForagePlus' oat was established in early-August of 2013 and 2014, and fertilized with 0, 20, 40, 60, 80, or 100 kg N/ha as urea (46–0-0), or dairy slurry applied at rates of 43,250 (LM) or 86,500 L/ha (HM). All plots were harvested in early-November of each year. Yields of DM increased in response to fertilization with urea, exhibiting linear ($P < 0.01$) and quadratic ($P = 0.03$) effects of fertilization rate. The 2-yr mean DM yield at the 100 kg N/ha fertilization rate was 3968 kg DM/ha, which was nearly twice that of the unfertilized (0 kg N/ha) check plots (2105 kg DM/ha). Yields of DM from LM and HM plots differed from unfertilized check plots (3164 vs. 2105 kg DM/ha; $P < 0.01$), but did not differ from each other (3029 vs. 3298 kg DM/ha; $P = 0.15$). Collectively, total N uptake from plots fertilized with urea differed from unfertilized check plots (89 vs. 44 kg N/ha; $P < 0.01$), and also increased linearly ($P < 0.01$) with N fertilization rate from 44 kg N/ha for the unfertilized checks to 110 kg N/ha at the greatest urea fertilization rate. Uptake of N for plots receiving dairy slurry also differed from unfertilized check plots (77 vs. 44 kg N/ha; $P < 0.01$), but the HM and LM application rates only tended to differ (82 vs. 71 kg N/ha; $P = 0.06$). The apparent N recoveries from plots receiving urea differed from those receiving dairy slurry (83.0 vs. 23.1%; $P < 0.01$); however, apparent N recoveries for plots fertilized with urea only tended ($P = 0.10$) to decrease with N fertilization rate (range = 101.2 to 67.8%), and apparent N recoveries for LM and HM plots did not differ (27.2 vs. 19.0%; $P = 0.65$). When expressed as a percentage of the NH_4-N applied within dairy slurry, apparent N recoveries for LM and HM accounted for approximately half of the NH_4-N applied, but there was no statistical difference between slurry rates (66.7 vs. 46.9%; $P = 0.22$). Overall, fall-grown oat exhibited excellent ability to recover readily available fertilizer and manure N during a short fall growing season.

Key Words: apparent N recovery, fall-grown oat, N uptake

M123 Effect of different ruminal incubation orders on in situ degradability of maize silage and alfalfa haylage in lactating dairy cows.
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A study using 4 ruminally cannulated Holstein cows was conducted to evaluate the degradability of maize silage and alfalfa haylage by different ruminal incubation orders. Maize silage and alfalfa haylage samples were dried and ground to pass through a 2.5-mm screen. All nylon bags containing feed samples for each cow were either placed in rumen simultaneously (OI) or removed from rumen simultaneously (OII). Samples were incubated in the rumen for 2, 6, 12, 24, 36, 48, and 72 h. For maize silage, OI had higher neutral detergent fiber (NDF) and acid detergent fiber (ADF) degradability at 6 h and 12 h ($P < 0.05$) compared with OII. Contrarily, slowly degraded fraction (b) of OI was significantly lower than that of OII ($P < 0.05$). For alfalfa haylage, different ruminal incubation orders had significant effect ($P < 0.05$) on the NDF degradability at 6 h and 12 h, constant rate of slowly NDF degraded fraction (K_d), and rapidly ADF degraded fraction (a) (Table 1). Overall, the effects of different ruminal incubation orders concentrated during first 12 h of incubation period, but did not affect ruminally degradable part.

Table 1 (Abstr. 123). Degradability and degradation variations of NDF and ADF of maize silage and alfalfa haylage incubated in situ in different ruminal incubation orders[1]

	Maize silage				Alfalfa haylage			
Item	OI	OII	t	*P*-value	OI	OII	t	*P*-value
NDF								
2 h	7.14	5.59	0.98	0.39	3.70	5.59	−0.53	0.19
6 h	1.41[a]	6.23[b]	4.01	0.01	11.62[b]	7.75[b]	0.20	<0.01
12 h	17.92[a]	8.38[b]	4.03	0.01	21.31[a]	15.76[b]	0.10	0.05
a	1.84	−1.33	2.25	0.07	−0.52	0.96	−1.19	0.28
b	59.91[b]	81.87[a]	−4.16	0.01	38.20	51.02	−1.34	0.27
K_d	3.14	1.86	2.76	0.07	6.70[a]	3.70[b]	2.58	0.04
RDNDF	31.10	29.33	1.20	0.31	25.40	25.39	0.01	0.99
ADF								
2 h	4.02	4.18	−0.12	0.91	0.61	2.63	−1.36	0.25
6 h	7.15[a]	3.65[b]	2.49	0.05	7.73	4.74	0.65	0.15
12 h	14.14[a]	7.34[b]	2.77	0.03	17.60	13.03	1.71	0.14
a	−1.49	−3.30	1.05	0.34	−5.04[a]	−1.94[b]	−3.65	0.02
b	65.25[b]	81.54[a]	−3.15	0.03	42.35	44.43	−1.23	0.27
K_d	2.84	2.00	2.00	0.14	6.21	4.17	1.82	0.13
RDADF	28.85	28.45	0.28	0.79	22.84	23.09	−0.16	0.88

[a,b]Means with different superscript letters with the same row represent a significant difference between treatments ($P < 0.05$).
[1]OI = placed simultaneously, OII = removed simultaneously, t = t-test, a = soluble fraction, b = slowly degradable fraction, Kd = rate of slowly degradability fraction, RDNDF/RDADF = ruminally degradable NDF/ADF.

Key Words: in situ incubation order, degradability, lactating cow

M124 Productive performance and morphological composition of two genotypes of *Brachiaria* grazed by dairy calves in Mexico's Central Highlands.
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The objective of this study was to evaluate the production and morphological characteristics of Insurgente (*Brachiaria brizantha*), and Mulato II (hybrid *Brachiaria*) forages, when grazed by dairy calves during the rainy season in Mexico's Central Highlands. The variables net herbage accumulation (NHA), leaf proportion and appearance of stems was evaluated in 3 periods consisting of 21 d each, between July and September 2014. The pasture used was composed of 16 plots (15 m × 4 m), with 4 plots per species and were fertilized with vermicompost (10 t·ha^{-1}). The pasture was grazed continually by 4 dairy calves, aged

12 ± 4 mo, weight of 250 ± 35 kg. Sixteen exclusion cages (1m × 1m) and a metal quadrant measuring 0.16 m^2 (0.40 m × 0.40 m) were used. Leaf proportion was measured for each period, with a 100 g sample taken randomly from each plot. In the appearance of stems was identified the number of plants for each plot by m2, and selected a single plant randomly. At the beginning of each period the initial population of stems was measured for each plant, and marked with a plastic yellow ring. Then, new stems were counted every 15 d and marked with a ring of another color. The design was based on plots divided at random, with larger plots (species) and smaller plots (time periods). A variance analysis was conducted, using MINITAB, and measurements were compared using the Tukey's test ($P < 0.05$). Significant differences ($P < 0.015$) in the NHA were noted in the Insurgente and Mulato II species and in the interaction ($P < 0.001$). Higher NHA was found in Mulato II forage (10,584 kg DM·ha^{-1}). In both species the highest NHA was found in P2 and P3 2,662 and 3,858 kg DM·ha^{-1}, respectively ($P < 0.05$). Also, 11% more leaf appearance was found in Mulato II. The greatest appearance of stems was found in Mulato II forage (240 stems/m^2; $P < 0.001$). Insurgente and Mulato II demonstrated different growth behaviors under continuous grazing during the rainy season. Mulato II showed better performance, had higher net herbage accumulation, leaf proportion and appearance of stems.

Key Words: *Brachiaria*, pasture

M125 Effect of processing methods on in situ degradability of maize silage and alfalfa haylage in lactating dairy cows. Yang Zou*, Shuangzhao Dong, Yun Du, Yajing Wang, Shengli Li, and Zhijun Cao, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China.*

A study using 4 ruminally cannulated Holstein cows was conducted to evaluate the degradability of maize silage and alfalfa haylage prepared by different processing methods. Maize silage (20-mm length) and alfalfa haylage (40-mm length) were either wet (MSW; AHW) or air-dried (MSD; AHD). Air-dried silage and haylage were also ground to pass through a 2.5-mm screen (MSG; AHG). Samples were incubated in the rumen for 2, 6, 12, 24, 36, 48, and 72 h. Cows were fed ad libitum with free access to water. Treatment MSW had a lower acid detergent fiber (ADF) degradability at 2 h ($P < 0.05$) compared with air-dried samples (MSD and MSG). Processing methods had significant effects ($P < 0.05$) on NDF degradability at 72 h, ADF degradability at 36, 48, and 72 h, and ruminal degradable ADF. All of the highest values were observed in AHG treatment (Table 1). Based on this study, processing methods of drying and grinding should be taken into consideration when evaluating nutritive values of forages.

Contd.

Table 1 (Abstr. M125). Degradabilities of NDF and ADF in differently processed maize silage and alfalfa haylage incubated in situ[1]

	Maize silage				Alfalfa haylage			
Item	MSW	MSD	MSG	*P*-value	AHW	AHD	AHG	*P*-value
NDF								
2 h	13.72	16.68	14.48	0.31	24.62	27.76	27.81	0.30
36 h	40.96	41.91	39.91	0.94	50.79	46.23	51.89	0.27
48 h	43.40	42.69	40.80	0.80	51.08	52.75	55.96	0.18
72 h	48.58	55.20	47.31	0.28	53.68^{b}	56.54^{ab}	59.42^{a}	0.03
RDNDF	31.16	34.18	29.81	0.39	41.96	42.82	44.57	0.31
ADF								
2 h	12.16^{b}	14.58^{ab}	16.17^{a}	0.09	20.61	21.50	23.91	0.54
36 h	41.54	41.39	51.57	0.22	41.71^{ab}	39.26^{b}	46.68^{a}	0.04
48 h	44.54	45.21	43.30	0.97	46.19^{b}	47.66^{b}	53.10^{a}	0.03
72 h	50.06	54.43	50.95	0.68	49.20^{b}	51.75^{b}	57.05^{a}	<0.01
RDADF	31.41	33.14	33.04	0.85	35.75^{b}	36.62^{b}	40.04^{a}	0.04

^{a,b}Means with different superscript letters with the same row represent a significant difference between treatments ($P < 0.05$).

[1]MSW = wet maize silage, MSD = air-dried maize silage, MSG = air-dried ground maize silage, AHW = wet alfalfa haylage, AHD = air-dried alfalfa haylage, AHG = air-dried ground alfalfa haylage, RDNDF = ruminally degradable NDF, RDADF = ruminally degradable ADF.

Key Words: processing method, degradability, lactating cow

M126 Effectiveness of plastic underlays with or without oxygen barrier properties in maintaining corn silage quality. Peter H. Robinson*[1], Nadia Swanepoel[1], and Jim Ralles[2], [1]*Department of Animal Science, University of California, Davis, CA,* [2]*ARI, Belmont, CA.*

Use of only a single layer of plastic to cover silage piles can lead to substantial surface spoilage of silage (i.e., increased pH and temperature, discoloration, molding). The extent of spoilage losses can be curtailed if a thin plastic underlay film is utilized under the outer white/black plastic cover. Our objective was to determine if a clear plastic polyethylene film (Poly) has an impact on the nutritional quality of the outer 50 cm layer of corn silage vs. an oxygen barrier (OB) film when used as an underlay. Two wedge type corn silage piles with east/west, and 2 with north/south, orientation were constructed in fall 2014. Each pile was alternately covered with a clear, pliable polyethylene film of 1.6 mil HiTec Underlay (ARI, Belmont, CA) or an OB plastic film of 1.8 mil from Industria Plastica, Mongralese, Italy (trade name 'Silostop') with a 1.8 m overlap between sections and then covered with a conventional plastic cover. After 90 d, all piles were sampled to a 50 cm depth with a silage probe, divided into 2 samples of 25 cm (i.e., 0–25, 25–50 cm depth) each at 4 sample points in each of the 4 sections. Temperatures and pH were determined at core extraction. Each core sample was preserved individually (n = 32) for mold and yeast counts and part was pooled by section location (upper vs. lower; n = 16) and analyzed for volatile fatty acids, lactic acid and ethanol. There were no differences between the silages under the Poly and OB films in temperature (24.7 vs. 24.2 for N/S and 23.1 vs. 22.4°C for E/W piles), pH (3.79 vs. 3.84 for N/S and 3.77 vs. 3.84 for E/W piles) or mold and yeast counts, which were all below 0.5 million cfu/g. Volatile fatty acids were similar between treatments, with lactic, acetic and propionic acid averaging 2.93 and 3.57, 1.73 and 1.93, 0.38 and 0.24% DM for N/S and E/W piles respectively, with none being statistically different. Butyric acid occurred at a very low level, 0.05% DM, and ethanol was 0.53% DM, with no differences. Overall, it was judged that there were no differences in the silage quality of the outer 50 cm layer of corn silage after ~90 d of ensiling when covered

with a clear polyethylene film vs. an oxygen barrier film under the outer black/white plastic cover.

Key Words: volatile fatty acids, silage quality

M127 Defining and measuring losses (shrink) from well-managed corn silage silos, and identifying stages in silo life where losses occur. Peter H. Robinson*[1], Nadia Swanepoel[1], Jennifer Heguy[2], and Deanne Meyer[1], [1]*Department of Animal Science, University of California, Davis, CA* [2]*UCCE Stanislaus, San Joaquin & Merced Counties, University of California, Davis, CA.*

Silage shrink (weight lost between ensiling and feedout) represent loss of nutrients to dairy producers, and the potential to degrade air quality if that loss is as volatile carbon compounds, or degrade water quality due to weepage to surface water and seepage to subsurface aquifers. No research has documented silage shrink in large commercial silage structures (silos) common in the SW US. 'Shrink' can be expressed as loss of wet weight (WW), oven dry weight (oDM) and oDM corrected for volatiles lost in the oven (vcoDM). Shrink losses, and the phase of the process where losses occurred, were measured using 7 corn silage silos (2 rollover, 1 bunker, 4 wedge) from the 2013 crop year on 4 dairy farms in 2 San Joaquin Valley areas, all covered within 48 h with an oxygen barrier inner film and black/white outer plastic weighted with tire chains. Total WW, oDM and vcoDM losses (not including wastage) calculated from weights of fresh chop delivered to the silo and silage placed in a feed mixer (n = 7) were 9.0 ± 1.69, 6.8 ± 1.82 and 2.8 ± 2.08%, suggesting that much of the WW shrink was water and much of the oDM shrink was volatiles driven off during oven drying. The largest part of shrink occurred in the silage mass (measured using in/out weights of 9–15 buried bags in each of 4 silos) before face exposure (WW, oDW and vcoDW losses from the mass were 3.9 ± 2.40, 7.2 ± 1.12 and 3.5 ± 1.27% respectively), with losses from the exposed face (measured as loss in core weight between freshly exposed faces and ~21 h exposed faces from 4 cores of 50 cm depth on 2 occasions in each silo), as well as between face removal and the mixer (measured between compositional changes between freshly exposed faces and silage placed in the mixer on 2 occasions in 4 silos), being negligible. Silo bulk density, face management, rate of face use and face orientation had no obvious effects on shrink. Real shrink losses (i.e., vcoDM) of well managed corn silages piles are much lower than has been generally assumed, the exposed face is a very small portion of those losses, and many of the proposed mitigations may not be effective in reducing shrink, possibly because it is quantitatively so small in large well managed silos.

Key Words: volatile compound, air quality

M128 Effects of sealing time post-filling and sealing material on fermentation, nutritional quality, and organic matter loss of whole-plant corn ensiled in a drive-over pile. Katie Nutcher[1], Estela Uriarte[2], Keith K. Bolsen*[2], Ron Kuber[3], and Connie Kuber[3], [1]*California Polytechnic State University, San Luis Obispo, CA,* [2]*Kansas State University, Manhattan, KS,* [3]*Connor Agriscience, Clovis, CA.*

Sealing time, immediate and 24-h delay, and sealing material, standard plastic (std.) and oxygen barrier (OB) film, was compared using whole-plant corn. The crop was harvested on August 21 and 22, 2013 in the 2-thirds milk line stage, contained 32% DM, and was inoculated at the forage harvester. The forage was ensiled in a drive-over pile, which was 18 m wide x 60 m long × 1.8 m apex height with an east to west orientation. One-half of the forage was harvested the first day, packed with a payloader, and not sealed. On the second day, the remainder of the corn was harvested and packed with a payloader. One-half of each day's forage surface was sealed with a sheet of std. plastic, and the other half sealed with a sheet of OB film, which was protected from UV light with a sheet of std. plastic. The sealing materials were removed from the south half of the pile after 90 d. Samples were collected at 0 to 15, 15 to 30, and 30 to 45 cm depths from the surface at 3 north to south locations, which were equal distance from the east and west boundaries of each of the 4 sealing treatments. The results are presented for the mean of the 3 sampling depths. The immediate sealed silages had a lower ($P < 0.05$) pH value than the delay sealed silages. The silage that was delay sealed with std. plastic had higher ($P < 0.05$) ash and NDF contents and lower ($P < 0.05$) NDF digestibility than the silage that was delay sealed with OB film and the silages that were sealed immediately with std. plastic or OB film. The OB film was more effective than std. plastic in preventing the entry of oxygen into the surface of the corn silage during the 90-d storage period. Delay sealing increased OM loss in the original top 0 to 45 cm of corn silage by 27.2% compared with immediate sealing (15.64 vs. 12.30%). However, delay sealing with OB film decreased OM loss in the original top 0 to 45 cm of corn silage by 20.6% compared with immediate sealing with std. plastic (12.33 vs. 15.54%).

Key Words: silage, sealing, delay