

on an accrual basis. Highlights include: 5 year trends showing the Dairy Profitability Cycles, farms split into profit quartiles to see what the top 25% do to make so much money, also are broken down into different size groups that show the impact of various herd sizes and costs are shown on a per cow and per cwt. basis. In this 30 minute presentation, we will cover the key factors that contribute to successful farms. Herd size, productivity, efficiency, cost control and internal herd growth (IHG). The average dairy farm return on assets (ROA) over the past 5 years has ranged from 1.9% to 7.5%. This is not very high for the risk involved. It is not financially wise to just be average. Dairy farmers today must step up their management intensity if they want to make progress. My one liner is "To have a quality of life, you have to run your farm as a business". The Northeast summary covers 9 of the 12 states that Hoards defines as the Northeast region. There are about 18,000 commercial dairy farms with New York, Pennsylvania and Vermont having the major dairy concentration. Almost all of the farms grow their own forages with a trend of smaller ones utilizing intensive grazing. The farms in our summary average 230 cows. The Region averages 80 cows per farm.

Key Words: Profitability, Dairy, Business

267 Profitability of pasture-based versus confinement dairy farming. G. Benson* and S. Washburn, *North Carolina State University, Raleigh.*

Purpose: To review and integrate existing information on the relative profitability and longer term viability of pasture-based dairy farming.

Evidence from several studies shows that profit margins for pasture-based farms are higher than for confinement farms. Most data are from north central and northeastern states. A recent study using 2000-2003 data showed an advantage in annual net farm income from operations for pasture-based farms of \$243 per cow in Wisconsin and \$210 per cow in New York. Compared to the confinement farms, the advantage to pasture-based farms is 64% and 92% higher, respectively. Data for other regions is limited but is supportive of the competitiveness of pasture-based dairy farms. Reliance on pasture and pasture management practices can vary widely and are seldom well defined in these studies. Data show wide variation in profitability among farms of a similar type, whether confinement or pasture based. Dairy farm numbers are declining, particularly small farms, and reported average sizes of pasture-based farms are small, although herds of > 300 cows exist. In the short run, the observed financial advantage enhances survival relative to similarly sized confinement farms. However, the income potential for any small dairy farm is limited and the trend in profit per cow is down, which is an obstacle for the long-run viability of some pasture-based farms. The distance milking cows can walk to pastures, acreage and farm layout affect herd expansion opportunities on a specific site. Some pasture-based dairies have options to add income by supplying a growing market for specialty products produced by methods valued by consumers. These include homestead cheese, farm bottled milk, pasture-raised, and certified organic. The transition to organic likely is simpler for pasture-based dairies because the pasture requirements are already in place and reported herd health problems are fewer. Well managed pasture-based dairies create fewer environmental impacts and are more likely to be socially acceptable, thereby reducing external threats to farm viability.

Key Words: Pasture-based dairy, Profitability

Food Safety: Ruminant and Nonruminant Foodborne Pathogens

268 Development of a cost-effective method to enumerate *Escherichia coli* O157 in cattle feces. J. T. Fox*, D. G. Renter, M. W. Sanderson, and T. G. Nagaraja, *Kansas State University, Manhattan.*

Our objective was to evaluate the application of the most-probable number (MPN) enumeration technique to quantify *E. coli* O157 in cattle feces. Cattle (n = 10) were inoculated orally with a mixture of three strains of *E. coli* O157 (1.4×10^{10} per animal) that were made resistant to nalidixic acid. Feces were collected twice a week for three weeks (60 samples) beginning 3 d post inoculation. A known amount of feces (2.0 ± 0.5 g) was diluted in 18 mL of gram-negative broth (1:10 dilution) containing cefixime, cefsulodin and vancomycin (GNccv). Serial 10-fold dilutions (200 μ L in 1.8 mL GNccv) of 1:10 dilution were then made, in triplicate, in a 96 well (2.5 mL capacity) dilution block to yield dilutions of 10^2 to 10^6 . Diluted samples were direct plated onto sorbitol-MacConkey agar containing cefixime and potassium tellurite (SMACct) plus nalidixic acid to establish a gold standard for the concentration of *E. coli* O157 in the sample. Following 6 h enrichment at 37°C, a loopfull of each dilution was streaked onto SMACct. Also, 1 mL of 10^1 , 10^2 , 10^4 and 10^6 dilutions were subjected to immunomagnetic separation (IMS) and plated on SMACct. On the next day if needed 1 mL of 10^3 or 10^5 was subjected to IMS and plated on SMACct. Diluted samples in each well that yielded sorbitol negative colonies (direct streak or plating after IMS) which were positive for indole production and latex agglutination were considered as positive for *E. coli* O157. Concentration of *E. coli* O157 in the original sample

was determined by MPN procedure. Mean concentration of *E. coli* O157 in samples, as determined by the gold standard method was 16,635 cfu/g. Both direct streak MPN ($r = 0.81$) and IMS MPN ($r = 0.52$) values correlated ($P < 0.01$) with the gold standard. Because IMS is expensive and labor intensive, the direct streak procedure of the diluted and enriched sample offers a simple and cost-effective method to enumerate *E. coli* O157 shed in the feces of cattle.

Key Words: *E. coli* O157, Enumeration, Cattle feces

269 Effect of vaccinating against type III secreted proteins of *E. coli* O157:H7 on its pre- and post-harvest occurrence on cattle hides. R. E. Peterson*, D. R. Smith, R. A. Moxley, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

A trial was conducted to test the effect of vaccination against type III secreted proteins of *E. coli* O157:H7 (EC) on the probability to detect EC on hides of vaccinated and nonvaccinated cattle and on hides pre- and post-harvest. Steers (n=336) were stratified by weight and assigned randomly to one of two vaccination treatments. Vaccination treatments included vaccinated or non-vaccinated pens of steers (n=42 pens; 21 vaccinated and 21 not vaccinated). Two doses of vaccine (2 mL dose) were given to vaccinated steers. Placebo was given to nonvaccinated steers. Eighty-four days post treatment a hide sample was collected from each steer at the feedlot the day they were sent to harvest (pre-harvest) and from each steer at the packing plant (post-harvest). Steers were loaded onto clean trucks at the feedlot, held in lairage,

and harvested within the same treatment group. EC was isolated and identified using standard methods involving selective enrichment, immunomagnetic separation, and PCR confirmation. The outcome variables were recovery of EC from hides of vaccinated and nonvaccinated cattle and pre- and post-harvest. Outcomes were tested by modeling the probability of detecting EC from hides using the logit link function in a multivariable generalized estimation equation. EC was recovered from 56 of 621 hide-culture observations (9%). Vaccination reduced the probability for hides of feedlot cattle to test positive for EC (OR = 0.53, $P = 0.04$). There was no pre-harvest, post-harvest interaction ($P = 0.80$), indicating vaccination was equally protective at the feedlot and at the processing facility. Overall, vaccination reduced the probability of hide-contamination by 44%. Further, the probability of detecting EC on hides post-harvest was 4.7 times greater than that of detecting EC on hides pre-harvest at the feedlot of origin (OR = 5.5, $P < 0.0001$).

Key Words: Cattle, *Escherichia coli*, Vaccination

270 Influence of exogenous triiodothyronine (T_3) on fecal shedding of *E. coli* O157 in cattle. T. S. Edrington^{*1}, T. R. Callaway¹, D. M. Hallford², R. C. Anderson¹, and D. J. Nisbet¹, ¹USDA-ARS-FFSRU, College Station, TX, ²New Mexico State University, Las Cruces.

Fecal prevalence of *E. coli* O157 in ruminants is highest in the summer months and decreases to low or undetectable levels in the winter. We hypothesize that the seasonal variation of this pathogen is a result of physiological responses within the host animal to changing day-length. The thyroid is one gland known to respond to changing day-length. Two experiments were conducted to determine if a hyperthyroid status would initiate fecal shedding of *E. coli* O157 in cattle during the winter when shedding is virtually non-existent (Winter experiment) or influence cattle actively shedding *E. coli* O157 (Summer experiment). Yearling cattle were group-penned under dry-lot conditions, adjusted to a high concentrate ration, and randomly assigned to treatment: Control (1 mL corn oil injected s.c. daily) or T_3 (1.5 mg T_3 suspended in corn oil injected s.c. daily). Cattle were individually processed daily for collection of fecal and blood samples. Treatment with exogenous T_3 produced a significant change in serum thyroid hormone concentrations indicative of a hyperthyroid status in both experiments. No differences ($P > 0.10$) were observed in fecal shedding of *E. coli* O157 in the winter experiment. In the summer experiment, fecal shedding of *E. coli* O157 was decreased ($P = 0.05$) by administration of T_3 during the treatment period (d 1 to 10), tended to be lower ($P = 0.08$) during the following 7-d period of no treatment and was lower ($P = 0.01$) when examined across the entire experimental period. Results of this research indicate that the thyroid or its hormones may be involved in the seasonal shedding patterns of *E. coli* O157 in cattle.

Key Words: *E. coli* O157, Thyroid, Cattle

271 Isoamyl acetate application as a method to reduce pathogens and methane production in cattle prior to harvest. T. R. Callaway^{*}, A. M. B. Prazak, T. S. Edrington, R. C. Anderson, and D. J. Nisbet, USDA/ARS, Food and Feed Safety Research Unit, College Station, TX.

Cattle can carry foodborne pathogenic bacteria, especially *E. coli* O157:H7, in their gastrointestinal tracts. These pathogens are spread to consumers through contaminated meat products, water, fruits or

vegetables. The microbial population of the ruminant is inefficient and also produces methane which can waste up to 12% of the GE of the diet of the animal. Methods to improve food safety do not currently carry an economic advantage to implementation; but if a method to reduce pathogens simultaneously reduces the inefficiencies of fermentation then the economics of food safety can be improved. Isoamyl acetate (IA; banana oil) is a naturally occurring aliphatic carboxylic ester widely used as a flavoring agent in foods that has been reported to have bacteriostatic activity. In the present study we added IA at various concentrations (from 0 to 50 mM) to pure cultures of *E. coli* O157:H7 (initial concentration of 10^6 cfu/mL) and found that approximately 30 mM IA demonstrated significant ($P < 0.05$) antibacterial activity. Mixed rumen contents from grass-fed Holstein cows were used for the in vitro mixed culture studies. Rumen fluid (containing 1 g/L glucose and xylose) was inoculated with 10^4 cfu/mL *E. coli* O157:H7 and added to separate anaerobic tubes (n=16). IA was added to achieve final concentrations from 0 to 50 mM in each tube. Tubes were incubated at 39°C for 24 h. Samples were serially diluted (10-fold increments) and plated to determine populations of inoculated *E. coli* O157:H7. *E. coli* O157:H7 populations were reduced ($P < 0.05$) in tubes containing >30 mM IA. Parallel tubes (n=16) were incubated to determine the effects of IA on the ruminal fermentation. Total gas volume, CH₄, and total VFA concentrations were reduced ($P < 0.05$) in tubes containing >30 mM IA. Results suggest that IA could be used as a surface or hide disinfectant with more efficacy than as a feed additive because the impact on the overall fermentation efficiency appears to be probably detrimental.

Key Words: Intervention, Pathogen, *E. coli*

272 Microbial characteristics of ground beef produced from beef trimmings treated with potassium lactate, sodium metasilicate, peroxyacetic acid or acidified sodium chlorite. S. A. Quilo^{*}, F. W. Pohlman, A. H. Brown, P. G. Crandall, P. N. Dias-Morse, R. T. Baublits, and C. Bokina, University of Arkansas, Fayetteville.

Beef trimmings (90/10) were inoculated with a mixture (7 log cfu/mL each) of *Escherichia coli* (EC) and *Salmonella typhimurium* (ST) and left untreated or treated under vacuum in a tumbler with 3% potassium lactate (KL), 4% sodium metasilicate (NMS), 0.1% acidified sodium chlorite (ASC) or 0.2% peroxyacetic acid (PAA) prior to grinding. Trimmings were ground, weighed, packaged and sampled at 0, 1, 2, 3 and 7 days of simulated retail display for EC, ST, coliforms (CO), and aerobic plate counts (APC). All treatments reduced ($P < 0.05$) EC approximately 1 log or more on day 0 of display and maintained the same reduction pattern through day 7 of display. All treatments reduced ($P < 0.05$) CO counts 0.86 log or more throughout display. The ASC was the most effective by day 7 of display with a CO reduction of 2.26 logs, which demonstrates a residual reduction that was effective across days. Regardless of day, the APC counts were lower ($P < 0.05$) for all antimicrobial treatments, with a reduction of approximately 1 log for the KL, NMS and PAA treatments and a 2.5 log reduction for ASC on day 7. All the treatments demonstrated ST reductions ($P < 0.05$) during day 0, 3, and 7 of display including a 2.92 log reduction at day 7 of display for the PAA treatment. These results suggest that the use of these antimicrobial agents on beef trimmings reduced bacterial counts of ground beef under retail display, and ASC and PAA demonstrated the highest microbial reduction on day 7 of display.

Key Words: Ground beef, Antimicrobials, Bacteria

273 Effects of feeding wet corn distiller's grains with solubles and monensin and tylosin on the prevalence and antibiotic susceptibilities of fecal commensal and foodborne bacteria in feedlot cattle. M. Jacob*, J. T. Fox, S. Narayanan, J. S. Drouillard, and T. G. Nagaraja, *Kansas State University, Manhattan.*

Our objective was to evaluate prevalence and antibiotic susceptibilities of fecal commensal and foodborne bacterial pathogens in feedlot cattle fed steam-flaked corn or a combination of steam-flaked corn and wet corn distiller's grains with solubles (WDGS), with or without monensin and tylosin. Cattle (n = 370) were allotted to 54 pens with 6 to 7 animals in each pen and 9 pens per treatment. Treatments were arranged in a 2 × 3 factorial arrangement with factor 1 being 0 or 25% WCDGS and factor 2 being the inclusion of no antibiotics, monensin only (300 mg/d), or monensin (300 mg/d) and tylosin (90 mg/d). Fecal samples were collected on d 122 and 136 and pooled within pen for isolations of commensal bacteria (generic *Escherichia coli* and *Enterococcus* species) and foodborne pathogens (*E. coli* O157 and *Salmonella* serotypes). Antimicrobial susceptibilities of isolates were determined for twenty antimicrobial compounds by broth microdilution method. Prevalence of *Salmonella* ($P = 0.62$) or *E. coli* O157 ($P = 0.15$) were not different among diets. *Enterococcus* species were more likely to be resistant to macrolides (erythromycin and tylosin) if fed diets with monensin or monensin and tylosin than diets with no antibiotics ($P < 0.01$). Generic *E. coli* from cattle fed monensin and tylosin were less likely to express resistance to oxytetracycline than those isolated from cattle fed diets with no antibiotics ($P < 0.01$). *Enterococcus* species were less likely to be resistant to flavomycin in pens fed WDGS than in pens without WDGS ($P < 0.01$). Feeding distiller's grains, monensin, or tylosin to feedlot cattle had no measurable effect on prevalence of major food-borne pathogens, but these factors may indeed impact susceptibility of bacteria to common antimicrobials.

Key Words: Distiller's grains, Feed additives, Foodborne bacteria

274 Prevalence of *Salmonella typhimurium* in swine at slaughter. M. H. Rostagno*¹, H. S. Hurd², and J. D. McKean², ¹USDA, ARS, Livestock Behavior Research Unit, West Lafayette, IN, ²Iowa State University, Ames.

Salmonella is recognized as an important foodborne pathogen with multiple potential sources, including pork. Although *Salmonella* constitutes a very heterogeneous group of bacteria, including more than 2,400 serotypes, only a limited number of serotypes are responsible for most outbreaks. Despite the importance of *Salmonella typhimurium* as the most common cause of foodborne infection, limited serotype-specific information is available to date, particularly in swine. Therefore, the objective of this cross-sectional study was to analyze data available from multiple studies conducted by our research team estimating the prevalence of *Salmonella typhimurium* in swine at slaughter. A total of 1,110 pigs from 3 large capacity abattoirs located in the Midwestern U.S. were individually sampled at slaughter. Individually paired samples (cecal contents and mesenteric lymph nodes) were collected in multiple occasions in all 3 abattoirs, transported to the laboratory, and processed for the isolation and identification of *Salmonella*. The *Salmonella* prevalence, based on any of the samples collected (i.e., pigs positive in at least one of the samples), was: 57.1% in abattoir A, 48.3% in abattoir B, 70.2% in abattoir C, and 62.6% overall. Various serotypes were isolated in all abattoirs. The prevalence rates of *Salmonella typhimurium* were 18.8% in abattoir A, 5.8% in abattoir B, 38.7% in abattoir C, and 27.3%

overall. This study confirms that *Salmonella* prevalence in swine at slaughter is frequently high requiring attention due to the associated risk of contamination of the abattoir environment, and consequently, of pork products. This study also shows that the prevalence of *Salmonella typhimurium* varies considerably between abattoirs.

Key Words: *Salmonella*, Swine, Food safety

275 Resting pigs on transport trailers: A potential intervention to reduce *Salmonella* prevalence at slaughter. M. H. Rostagno*¹, H. S. Hurd², and J. D. McKean², ¹USDA, ARS, Livestock Behavior Research Unit, West Lafayette, IN, ²Iowa State University, Ames.

Prior to slaughter, pigs are usually held for at least two hours to recover from the stress of transport, improve meat quality, and maintain a constant supply for the slaughter line. However, recent research has shown that much pre-harvest *Salmonella* infection occurs immediately before slaughter during this rest period in the contaminated abattoir holding pens. Intervention strategies to reduce the occurrence of *Salmonella* infections during the pre-slaughter holding are necessary, in order to reduce the number of pigs carrying the bacteria into the slaughter line, increasing the risk for pork and pork products contamination. The objective of this study was to evaluate a potential intervention strategy to reduce the prevalence of *Salmonella*-positive pigs at slaughter, which consisted in resting (or holding) pigs prior to slaughter on their transport vehicle, instead of in the abattoir holding pen. A total of 120 animals were included in the experiment, divided in 4 replicates (n=30 pigs per replicate). Upon arrival at the abattoir, 15 randomly chosen pigs were unloaded, and moved to a holding pen, whereas the remaining 15 pigs stayed in the transport trailer. After approximately 1.5 h of resting, both groups were slaughtered, and samples collected. Samples collected included; distal ileum portion (10 cm), cecal content (10 g), and ileocecal lymph node. Results showed higher *Salmonella* recovery rates ($P < 0.05$) from pigs held in the abattoir pens (40.7% vs 13.3%). This study demonstrates that, except for unloading logistics, the possibility of resting pigs on the transport vehicle has the potential to decrease *Salmonella* levels entering the abattoir. Moreover, this study shows the importance of avoiding the exposure of pigs to the contaminated lairage environment.

Key Words: *Salmonella*, Swine, Food safety

276 Project supported by the European Union to find alternatives to antibiotic growth promoters. G. Schatzmayr*¹, R. Beltran², and K. C. Mountzouris³, ¹BIOMIN GmbH, Herzogenburg, Austria, ²BIOMIN USA Inc., San Antonio, TX, ³Agricultural University of Athens, Athens, Greece.

Due to the ban of antibiotic growth promoters (AGP's) the European Commission is supporting multinational research projects on finding alternatives to AGP's. One of the projects aimed at the development of a defined multi-species competitive exclusion product for poultry. By applying various growth media about 500 bacterial strains were isolated from different parts of the gastrointestinal tract of chicken. These strains were further subjected to different tests like an inhibition assay to determine their potential to counteract pathogenic bacteria like *Salmonella*, *E. coli*, *Clostridium perfringens* and *Campylobacter*. Further selection criteria were adhesion capability to mucosal cell lines, pH-reduction, formation of different organic acids and immunological activity. Based on these results a product consisting of 5 isolates belonging to the genera *Enterococcus*, *Pediococcus*, *Lactobacillus* and *Bifidobacterium* was designed. This product (Biomim®PoultryStar

[BPS]) was tested in a feeding trial with three hundred 1 d old broilers. These were allocated to 3 experimental treatments for 6 wk. Experimental treatments were: C (corn-soybean basal diet), PFW (basal diet containing BPS) and A (basal diet containing 2.5 mg avilamycin/kg). Overall BW in treatment A (2314 g) was higher ($P \leq 0.05$) than in treatment C (2216 g), but did not differ from treatment PFW (2276 g). The cecal microflora (log cfu/g wet cecal content) of probiotic treatment PFW had higher ($P \leq 0.05$) concentrations of bacteria belonging to *Bifidobacterium spp.*, *Lactobacillus spp.* and Gram positive cocci respectively, compared to treatments C and

A. Treatments PFW had numerically higher VFA concentrations in intestinal contents and also higher ($P \leq 0.05$) specific activities of α -galactosidase and β -galactosidase. The results showed that when the probiotic product was administered a growth promoting effect similar to the antibiotic avilamycin could be obtained. In addition Biomin®PoultryStar modulated the composition and the activities of the cecal microflora, resulting in a significant probiotic effect.

Key Words: Pathogens, Natural growth promotion, Probiotics

Forages and Pastures: Silages

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

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

Key Words: Particle size, Comminution, Ruminant

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

Forage particle length and proportion of forage determine the mean particle length (MPL) and physical effectiveness of diets. Adequate physically effective fiber (PEF) is required to minimize displaced abomasum, milk fat depression and other negative production and health responses. Impact of low PEF may be reduced by reducing the fermentability of dietary carbohydrate, but some requirement for PEF remains. Excessive forage length negatively impacts stability of silage, diet mixing, and feed intake. Most cows sort somewhat against the longest particles in the diet so the diet consumed has a shorter MPL and less neutral detergent fiber (NDF) than the diet offered. Not only are long fibers sorted more than intermediate fibers, but long fibers are sorted more when diets contain more long fiber. Both these factors contribute to wider chemical and physical differences between the diet offered and consumed for diets rich in long particles, although increasing the proportion of long fibers in the diet offered will increase the MPL of the diet consumed. Dryer diets are more susceptible to sorting, but adding liquids to diets complicates measuring MPL.

Increased NDF content in alfalfa did not increase sorting; however increased NDF in long particles will amplify the effect of sorting to reduce dietary NDF. Cow variation is large relative to the effect of diet on mean measures of sorting, and this complicates estimating risk associated with diet, especially for sporadic negative health events. Cows housed in groups can sort more on average than individually fed cows, but extreme sorting by a few cows may be difficult to measure in loose housing. MPL is obviously strongly correlated with the percentage of larger particles and it is not clear that either is a better predictor of PEF. It takes more added mass of moderate length fibers to increase MPL compared to if longer particles are added, however the former will provide a consumed diet closer in physical and chemical makeup to the diet offered.

Key Words: Sorting, Particle length, Physically effective fiber

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

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