Recent research indicates that residual feed intake (RFI) may not be related to efficiency of energy use, but few results have been published for other feed efficiency traits. The current objective was to determine the relationships of different measures of feed efficiency with indicators of energy expenditure at constant feed intake. Five performance trials were conducted to measure feed intake, growth and heart rate (HR) or heat production in growing cattle. Feed efficiency traits included those where a lesser value is more efficient [feed conversion ratio (FCR), RFI, RFI adjusted for fat composition (RFIm), RFI from model predicted feed intake (RFIm)) and those where a greater value is more efficient [partial efficiency of growth, residual gain efficiency (RGE), and residual intake and gain (RIG), which is combination of RFI and RGE]. Heart rate alone or heat production (heart rate $\times$ oxygen pulse) was measured following the performance trial. Trials 1, 3, 4 and 5 included 39 Angus bulls and heifers, 119 Brangus heifers, 115 Brangus heifers, and 45 Angus heifers fed high-roughage diets with heart rate measured on 39 animals at fasting, 16 heifers at 1.1 $\times$ expected maintenance requirement (MEM), 16 heifers restricted-fed at 120 g DM/kg $^{0.75}$, and 16 heifers at 1$\times$ expected MEM, respectively. Trial 2 included 56 Angus bulls and heifers fed a high-concentrate diet with heart rate measured on 12 bulls and 12 heifers at 1.1$\times$ expected MEM. Phenotypic correlations of feed efficiency traits with DMI and ADG were similar to published studies. Phenotypic correlations of feed efficiency traits with fasting HR in Trial 1, maintenance HR in Trial 2 and 3, and restricted-intake HR in Trial 4 were not significant. In Trial 5, FCR ($P = 0.62$), RFI ($P = 0.56$), RGE ($P = 0.60$), RFIm ($P = 0.60$), RFIc ($P = 0.60$), RFIm ($P = 0.60$), and RIG ($P = 0.65$) had strong phenotypic correlations with maintenance heat production such that more efficient heifers had greater maintenance heat production. These data indicate that proposed traits to select for improved feed efficiency have no or an inverse relationship with energy expenditure when growing cattle are fed at constant feed intake.

Key Words: cattle, energy expenditure, feed efficiency
a DDGS-based supplement does not affect growth performance, feed efficiency, and reproductive performance of subsequent female progeny.

**Key Words:** beef heifer development, fetal programming, maternal nutrition

### 739 Stocking rate and feeder design affects hay waste


Ninety-six mid-gestation spring-calving cows were stratified by BW (562.9 ± 72.6), BCS (4.9 ± 0.7), and age (45.4 ± 2.0) into 2 replicate groups of 8, 16, and 24 cows to evaluate stocking rate and feeder design effects on hay waste. Cows were fed with cradle-chains (cone), sheeting on upper (50 cm) and lower (60 cm) portion, and 16 feeding stations (45.2 cm wide) separated by vertical bars (230 cm diameter, 170 cm height). Open feeders (ring) had no sheeting and 17 feeding stations (44.4 cm wide) separated by angled bars (240 cm diameter, 120 cm height). Feeder type and stocking rate were arranged in a 2 × 3 factorial, and randomly assigned to a 6 × 6 Latin square. Tall fescue round hay bales (87.3% DM, 6.3% CP, 66% NDF, 152 cm width × 170 cm diameter) were offered on circular end and replaced every third d (8), every other d (16), or daily (24) to ensure ad libitum hay access. A single bale was offered to 8 and 16 each period, while 24 were offered 3 bales. Bale number was non-significant, so bale measures were averaged within period. Waste was collected daily, and residual forage (ORTs) was collected before new bale offering. Estimated DMI was hypothesized to not differ, while waste was expected to decrease with increasing stocking rate in ring, but not differ in cone. Estimated DMI did not differ (P > 0.10) as percent of BW (2.0 ± 0.1%) or kg hd⁻¹ d⁻¹ (11.8 ± 0.3 kg hd⁻¹ d⁻¹). A stocking rate by feeder interaction was observed due to changes in magnitude of difference when waste was expressed as kg hd⁻¹ d⁻¹ (P < 0.05), percent of disappearance (%disp) (P < 0.07), and percent of intake (%intake) (P < 0.09). Waste was greater in ring (P < 0.05) than cone for 8 (2.9 vs. 2.0 kg hd⁻¹ d⁻¹, 18.8 vs. 14.0%disp, 23.4 vs. 16.4%intake) and 24 (3.3 vs. 1.7 kg hd⁻¹ d⁻¹, 22.4 vs. 12.5%disp, 29.2 vs. 14.7%intake), for 16 waste was increased (P < 0.09) (2.7 vs. 2.1 kg hd⁻¹ d⁻¹, 18.8 vs. 15.4%disp, 23.6 vs. 18.3%intake). Increasing stocking rate to greater than 1 cow per individual feeding space did not reduce estimated DMI. Stocking hay feeders greater than 1 cow per individual feeding space or having no defined feeding space within feeder increased hay waste.

**Key Words:** hay waste, stocking rate, feeder design

### 740 Effects of feeding stockpiled tall fescue versus tall fescue hay to late gestation beef cows on circulating blood urea nitrogen and glucose concentrations

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We hypothesized that cows grazing stockpiled tall fescue (STF) during late gestation would have increased nutrient intake compared with cows fed summer-baled hay, which would result in increased prenatal nutrient supply and ultimately improved fetal development and subsequent postnatal performance. Forty-eight multiparous, spring-calving crossbred beef cows (683 ± 16 [SE] kg BW) were allocated by BW, BCS, age, and expected calving date to either strip-graze endophyte-infected STF (59.7% NDF, 12.3% CP; DM basis; n = 4 pastures) or consume ad libitum endophyte-infected tall fescue hay (HAY; 64.9% NDF, 6.2% CP; DM basis) in uncovered drylots (n = 4) beginning on d 188 ± 2 of gestation. Cows remained on their respective forage systems until calving, but STF cows were moved to drylots at 7.0 ± 1.0 d pre-calving and fed ryelage (58.6% NDF, 12.3% CP; DM basis). Within 1 wk postpartum, cow-calf pairs were moved to a single pasture for common pre-weaning management. At 52 ± 0.6 h and 83 ± 1 d postnatally, calf jugular blood samples were obtained for determination of serum blood urea nitrogen (BUN) and plasma glucose. Data were analyzed using a mixed model containing effects of treatment, sampling day, and their interaction, where sampling day was used as a repeated measure. Pasture or drylot was considered the experimental unit. During late gestation, there was a forage system × day interaction (P < 0.001) for serum BUN concentrations. Baseline serum BUN concentrations did not differ (P = 0.95) between forage systems. On d 35 and 77 of the study, cows grazing STF had greater (P < 0.001) serum BUN concentrations than cows fed hay only. There was no treatment × day interaction (P = 0.57) for plasma glucose, but cows grazing STF tended to have greater (P = 0.11) glucose concentrations than cows consuming hay. Additionally, as gestation progressed, plasma glucose increased (P = 0.02). We conclude that cows grazing stockpiled tall fescue had increased circulating BUN and glucose concentrations due to increased nutrient intake during late gestation, which may affect fetal development and subsequent calf performance.

**Key Words:** forage system, metabolite, pregnancy

### 741 Preweaning calf circulating blood urea nitrogen and glucose concentrations in a tall fescue forage system model of developmental programming

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We hypothesized that cows grazing stockpiled tall fescue (STF) during late gestation have greater nutrient intake than cows fed summer-baled hay, which would result in increased prenatal nutrient supply and ultimately improved fetal development and subsequent postnatal performance. Forty-eight multiparous, spring-calving crossbred beef cows (683 ± 16 [SE] kg BW) were allocated by BW, BCS, age, and expected calving date to either strip-graze endophyte-infected STF (59.7% NDF, 12.3% CP; DM basis; n = 4 pastures) or consume ad libitum endophyte-infected tall fescue hay (HAY; 64.9% NDF, 6.2% CP; DM basis) in uncovered drylots (n = 4) beginning on d 188 ± 2 of gestation. Cows remained on their respective forage systems until calving, but STF cows were moved to drylots at 7.0 ± 1.0 d pre-calving and fed ryelage (58.6% NDF, 12.3% CP; DM basis). Within 1 wk postpartum, cow-calf pairs were moved to a single pasture for common pre-weaning management. At 52 ± 0.6 h and 83 ± 1 d postnatally, calf jugular blood samples were obtained for determination of serum blood urea nitrogen (BUN) and plasma glucose. Data were analyzed using a mixed model containing effects of forage system, sampling day, and their interaction, where sampling day was used as a repeated measure. Pasture or drylot was included as the experimental unit; calf date of birth and sex were included in the model when P < 0.25. We have previously reported that calves born to cows consuming STF tended to weigh more at birth and d 80. There was a tendency (P = 0.07) for a forage system × day interaction for serum BUN concentrations. At 52 h postnatally, calves born to cows consuming STF tended to weigh more at birth and d 80. There was a tendency (P = 0.07) for a forage system × day interaction for serum BUN concentrations. Baseline serum BUN concentrations did not differ (P = 0.95) between forage systems. On d 35 and 77 of the study, cows grazing STF had greater (P < 0.001) serum BUN concentrations than cows fed hay only. There was no treatment × day interaction (P = 0.57) for plasma glucose, but cows grazing STF tended to have greater (P = 0.11) glucose concentrations than cows consuming hay. Additionally, as gestation progressed, plasma glucose increased (P = 0.02). We conclude that cows grazing stockpiled tall fescue had increased circulating BUN and glucose concentrations due to increased nutrient intake during late gestation, which may affect fetal development and subsequent calf performance.
STF had increased circulating BUN, which may indicate increased perinatal nutrient supply.

**Key Words:** calf metabolite, developmental programming, pregnancy

742 **Effect of supplementing heifers on pasture with bambermycin or monensin on growth and development.** Paul Beck1, John Tucker2, William Galyen2, Shane Gadberry3, Don Hubbell2, Tom Hess3, Doug Galloway1, Michael Sims3, Beth Kegley3, and Matt Cravey1, 1University of Arkansas SWREC, Hope, AR, 2University of Arkansas LFRS, Batesville, AR, 3University of Arkansas Department of Animal Science, Fayetteville, AR, 4University of Arkansas Cooperative Extension Service, Little Rock, AR, 5Huvepharma Inc., Amarillo, TX.

Spring calving (Block 1; n = 70 heifers; BW 208 ± 21.7 kg; age 231 ± 17.0 d) and fall calving (Block 2; n = 72 heifers; BW 225 ± 31.7 kg; age 276 ± 12.8 d) heifers were used to test the effects of feeding 20 mg of bambermycin (Gainpro; Huvepharma; Sofia, Bulgaria) or 150 mg of monensin (Rumensin; Elanco Animal Health, Greenfield, IN) in 0.91 kg/d corn grain feed based supplements compared with non-medicated (Control) supplements on growth performance and development of grazing heifers. Heifers were allocated by breed, BW, and age to pasture groups (n = 5/group for Block 1 and n = 6/group for Block 2). Pasture groups were then randomly assigned to treatment (Control n = 4 pastures in Blocks 1 and 2; bambermycin and monensin n = 5 pastures in Block 1 and n = 4 pastures in Block 2). Block 1 began on 29 October 2013 and lasted 189-d, and Block 2 began on 24 June 2014 and lasted for 161-d. Heifers were weighed full on 2 consecutive days at beginning and end of each block. Reproductive tract scores (1 to 5 score) were assessed before breeding using ultrasound in Block 1 and rectal palpation in Block 2. In Block 1, heifers grazed non-toxic endophyte infected tall fescue pastures, while in Block 2 heifers grazed bermudagrass pastures until 14 October and then grazed non-toxic endophyte infected tall fescue pastures. Heifers were AI bred over 10-d, and natural service bulls were placed with heifers 14-d following final AI date. Data were analyzed as a randomized complete block design using the mixed procedure of SAS (SAS Inst. Inc., Cary, NC) least squares means were separated using contrasts: Control vs. Medicated and bambermycin vs. monensin. Ending BW and ADG of Control (323 ± 4.8 kg and 0.60 ± 0.0167 kg/d) heifers was less (P ≤ 0.04) than medicated, yet monensin (346 ± 4.6 kg and 0.73 ± 0.0163 kg/d) and bambermycin (344 ± 4.6 kg and 0.74 ± 0.0163 kg/d) did not differ (P ≥ 0.69). Reproductive tract scores (3.5 ± 0.60), AI pregnancy rates (30 ± 12.3%) and total pregnancy rates (82 ± 11.5%, respectively) did not differ (P ≥ 0.36) among treatments. This experiment indicates that both bambermycin and monensin effectively increase performance of growing heifers, but did not affect reproduction.

**Key Words:** bambermycin, heifer development, monensin

744 **The influence of tick loads of Senepol cows on calf tick loads and production traits in the tropics.** Robert W. Godfrey*, Adam J. Weis, and Henry C. Nelthropp, Agricultural Experiment Station, University of the Virgin Islands, St Croix, VI.

This study was conducted to evaluate the relationship of tick load between multiparous Senepol cows (n = 127 observations) and their calves (n = 144 observations) born in fall 2010 and 2011 and spring 2011, 2012, 2013 and 2014. Cow tick load was evaluated using a visual score (clean, light, moderate or heavy) before monthly acaricide treatment at weaning. Calf BW and tick load were measured at weaning and yearling. Average daily gain (ADG) was calculated for birth to weaning and weaning to yearling. Data were analyzed using correlation and GLM procedures with calving season and cow tick load as the main effects and sire as a covariate due to unequal representation of sires across years. Calves born in the spring had greater 205-d adjusted weaning weights (P < 0.002) than calves born in the fall (319.4 ± 10.7 vs. 236.9 ± 23.2 kg, respectively) but there was no effect of cow tick loads (P > 0.10). There was no effect of calving season or cow tick load on 365-d adjusted weight of calves (P > 0.10). Spring-born calves had a higher ADG from birth to weaning (P < 0.0001) than fall-born calves (1.23 ± 0.04 vs. 0.93 ± 0.09 kg/d, respectively) but there was no effect of cow tick load (P > 0.10). Calves of cows with light tick loads had lower ADG from weaning to yearling (P < 0.0001) than calves of cows with clean, moderate or high tick loads (0.29 ± 0.02 vs. 0.49 ± 0.03 vs. 0.45 ± 0.03 vs. 0.44 ± 0.03 kg/d, respectively). Spring-born calves had greater tick loads at weaning (P < 0.001) than fall-born calves (2.3 ± 0.1 vs. 1.5 ± 0.2, respectively) but there was no difference (P > 0.10) as yearlings. Calves of cows with high tick loads at weaning had lower yearling tick loads (P < 0.02) than calves from cows with clean, light or
moderate tick load (1.4 ± 0.3 vs. 2.1 ± 0.3 vs. 2.5 ± 0.2 vs. 2.1 ± 0.3, respectively). Cow tick load at weaning had low correlations with calf tick load at weaning (r = 0.24, P < 0.008) and at yearling (r = −0.23, P < 0.04). Calf tick load at weaning was not correlated with tick load at yearling (r = −0.01, P > 0.10). Cow tick load does not affect calf tick load or pre-weaning growth. Because of the low correlation of tick load between cows and calves, and within calves, it may be difficult to select for this trait.

Key Words: cow, calves, tick load

745 Comparison of the growth of F₁ Senepol × Brahman and Brahman steers in an Indonesian feedlot. Tim J. Schatz*, Northern Territory Department of Primary Industry and Fisheries, Darwin, Northern Territory, Australia.

Most cattle in northern Australia have a high Bos indicus (usually Brahman) content as they perform better in the harsh conditions than Bos taurus cattle. However, Brahmans from northern Australia often suffer price discrimination when they are sent to Australian domestic markets as they are regarded as having less tender meat than Bos taurus. Cross-breeding with Senepol bulls has been found to be a way of producing offspring from northern Australian herds that have higher growth rates and more tender meat than Brahmans. However there is some resistance to adoption of crossbreeding as there are concerns that crossbreds are discriminated against in the Indonesian live export market (which is a major destination for young northern Australian cattle) due to the perception that they do not perform as well as high grade Brahmans in the tropical environment. Therefore a study was conducted to compare the growth of Brahman (BRAH) and F₁ Senepol × Brahman (F₁ SEN) steers in an Indonesian feedlot. F₁ SEN (n = 54) and BRAH (n = 32) steers were exported from Darwin (Northern Territory, Australia) to Indonesia through the normal live export process and fed for 121 d in a commercial feedlot near Lampung (Sumatra, Indonesia). The average weights of the genotypes at feedlot induction were 312.3 kg (F₁ SEN) and 308.5 kg (BRAH). All the steers were fed in the same pen and received the normal feedlot management and rations. Their growth was studied and the average daily gain over the feeding period was 0.17 kg/d higher (P < 0.001) in the F₁ SEN compared with BRAH (1.71 vs. 1.54 kg/d). As a result the F₁ SEN put on 21.6 kg more weight (P = 0.002) over the feeding period. There was no significant difference between the genotypes in average fat depth at the P8 site at the end of the feeding period (F₁ SEN = 10.5 mm, BRAH = 10.6 mm) despite the F₁ SEN being 25.4 kg heavier on average. This study found that the F₁ SEN steers performed better than BRAH in an Indonesian feedlot, and so the results should allow live export cattle buyers to purchase these types of animals (Brahman × tropically adapted Bos taurus) with confidence that Indonesian feedlotters will be happy with their performance.

Key Words: Senepol, Brahman, feedlot

746 Alternative weaning and finishing strategies affect finishing residual feed intake of beef steers. Jason K. Smith†*, Deidre D. Harmon†, Mark D. Hanigan†, Samer W. El-Kadi†, Sally E. Johnson†, Scott P. Greiner†, and Mark A. McCann†, 1Department of Animal and Poultry Sciences, Virginia Tech, Blacksburg, VA, 2Department of Dairy Science, Virginia Tech, Blacksburg, VA.

Recent evidence suggests that alternative early nutritional management strategies may metabolically imprint beef steers for reductions in finishing residual feed intake (RFI). To further evaluate this effect, as well as that of an alternative finishing nutritional management strategy, a 2 × 2 factorial experiment was conducted that included Angus (ANG) and Simmental (SIM) sired steers randomly assigned to one of 2 weaning treatments (early weaned [EW; weaned at 111 ± 23 d of age; n = 14] or conventionally weaned [CW; weaned at 233 ± 21 d of age; n = 14]) and one of 2 finishing treatments (high corn [HC; 68.7% of DM from steam-flaked corn; n = 14] or low corn [LC; 50% of DM from steam-flaked corn isoenergetically replaced with dried corn gluten feed; n = 14]). EW steers were fed a concentrate-based ration ad libitum for 122 d following weaning. All steers were then commingled and backgrounded on pasture for 190 d, finished in a feedlot for 154 ± 64 d, and harvested in groups upon reaching a common 12th-rib fat thickness of 1 cm. Feed intake was measured daily following a 42 d finishing ration adaptation period using a Calan-Broadbent system. Observed ADFI expressed in Mcal of NEg was regressed against average BW0.75 ADG and duration of the measurement period (R² = 0.73; P < 0.0001) via the Fit Model procedure of JMP Pro, and RFI was calculated as the difference between observed and predicted ADFI. Analysis of variance was conducted to determine the fixed main and interaction effects of sire breed, weaning treatment and finishing treatment on ADFI, ADG and RFI. Although no effects were observed for ADFI (P ≥ 0.45) or ADG (P ≥ 0.36), RFI of ANG HC steers was lower than ANG LC (−0.91 vs. 0.49 Mcal NEg; SEM = 0.22; P < 0.001), SIM LC (−0.91 vs. 0.20 Mcal NEg; SEM = 0.22; P < 0.01) and SIM HC (−0.91 vs. 0.10 Mcal NEg; SEM = 0.22; P < 0.05), and was lower for EW than CW steers (−0.27 vs. 0.21 Mcal NEg; SEM = 0.15; P < 0.05). These results provide additional evidence of metabolic imprinting of EW steers for reductions in RFI, and independent effects of sire breed, weaning treatment and finishing treatment on ADFI, ADG and RFI. Increased volatility in climate, grain prices and grid-based carcass premiums have led beef producers to search for alternative weaning and finishing management options. An experiment was conducted to evaluate the effects of an alternative weaning strategy and finishing diet on carcass marbling score (MS), quality grade (QG) and Certified Angus Beef LLC (CAB) retail brand acceptance. Angus (ANG) and Simmental (SIM) sired steers were randomly assigned to one of 2 weaning treatments (early weaned [EW; weaned at 111 ± 23 d of age; n = 14] or conventionally weaned [CW; weaned at 233 ± 21 d of age; n = 14]) and 1 of 2 finishing treatments (high corn [HC; 68.7% of DM from steam-flaked corn; n = 14] or low corn [LC; 50% of DM from steam-flaked corn isoenergetically replaced with dried corn gluten feed; n = 14]) in a 2 × 2 factorial design. Following weaning, EW steers were fed a concentrate-based ration ad libitum for 122 d before commingling and pasture backgrounding with CW steers for 190 d. Steers were then finished for 154 ± 64 d and harvested in groups upon reaching a common ultrasound-estimated 12th-rib fat thickness of 1 cm. Chilled carcasses were evaluated to determine MS, QG and CAB acceptance, and ANOVA was conducted to determine the fixed main and interaction effects of sire breed, weaning treatment and finishing treatment using the Fit Model procedure of JMP Pro. All interaction effects were removed from the final ANOVA model due to lack of significance (P ≥ 0.54). MS was greater for carcasses of EW than CW steers (741 ± 14 vs. 680 ± 15; P < 0.01), and HC than LC steers (775 ± 17 vs. 646 ± 15; P < 0.0001).
however no main effects were evident for QG or CAB acceptance ($\chi^2 \leq 2.32; P \geq 0.13$). Although weaning and finishing treatments affected MS, the effects were not detectable in QG and CAB acceptance within this experiment, and further research is warranted to increase sample size and statistical power. Nonetheless, the management practices utilized in this experiment affected MS independently, indicating that both early and late nutritional management strategies affect marbling development.

**Key Words:** early weaning, carcass, marbling