Growth and Development I

M120 Effect of protein supplementation in the last trimester of gestation in Nellore cows on subsequent growth of their bull calves submitted or not submitted to creep-feeding. F. M. da Rocha[3], A. V. Pires[2], R. Sartori[2], D. D. Nepomuceno[2], M. V. Biehl*[3], I. Susin[2], E. M. Ferreira[2], M. V. C. Ferraz Junior[3], J. R. S. Goncalves[4], L. H. Cruppe[1], and M. L. Day[1], *[1]The Ohio State University, Columbus, [2]University of Sao Paulo, Piracicaba, SP, Brazil, [3]University of Sao Paulo, Pirassununga, SP, Brazil, [4]Experimental Station Hildegard Georgina Von Pritzelwitz, Londrina, PR, Brazil.*

The objective of this study was to evaluate the effect of supplemental protein to Nellore cows in the last trimester of gestation on subsequent growth of their calves, submitted or not to creep-feeding. Cows (n = 227) were assigned to a randomized complete block design. Blocks were balanced for BW (432 ± 50 kg) and BCS (2.85 ± 0.4; 1 to 5 scale). Treatments were arranged in a 2 × 2 factorial. Cows and bull calves were kept on pasture containing 8% crude protein (CP). The treatments were 1 and 2 - cows (n = 119) supplemented with soybean meal (0.5 kg/cow/d) and bull calves in either a creep (1, n = 114) or non-creep feeding program (2, n = 113) and; 3 and 4 - cows not supplemented (n = 108) and bull calves in either a creep (3) or non-creep (4) feeding program. Chemical composition of the creep diet was 22% CP, and 72% TDN. Data were analyzed using GLM procedure of SAS and differences among means were tested using Student's *t*-test ($P < 0.05$). At weaning time, there were no effects of cows prepartum supplementation on ADG and BW of bull calves (0.789 ± 0.16 vs. 0.777 ± 0.17 kg/d and 189.7 ± 34.0 vs. 191 ± 38.1 kg) for supplemented or not supplemented cows, respectively. Bull calves supplemented with creep feeding had greater ($P < 0.01$) ADG (0.842 ± 0.14 vs. 0.725 ± 0.16 kg/d for creep vs. non-creep feeding program, respectively) and BW at weaning (196.0 ± 30.1 vs. 184.6 ± 40.3 kg for creep vs. non-creep feeding program, respectively). In conclusion, supplementation with 0.5 kg of soybean meal in Nellore cows during the last trimester of gestation did not alter subsequent growth of their bull calves. However, the creep feeding increased ADG and BW at weaning in Nellore bull calves.

Key Words: beef cattle, fetal programming, creep diet

M121 Protein supplementation of Nellore cows in the last trimester of gestation and consequent performance of their heifer calves in creep feeding. D. D. Nepomuceno[2], A. V. Pires[2], R. Sartori[2], F. M. da Rocha[3], M. V. Biehl*[2], I. Susin[2], E. M. Ferreira[3], M. V. C. Ferraz Junior[3], J. R. S. Goncalves[4], F. M. Abreu[1], L. H. Cruppe[1], and M. L. Day[1], *[1]The Ohio State University, Columbus, [2]University of Sao Paulo, Piracicaba, SP, Brazil, [3]University of Sao Paulo, Pirassununga, SP, Brazil, [4]Experimental Station Hildegard Georgina Von Pritzelwitz, Londrina, PR, Brazil.*

The objective of this study was to evaluate the effect of supplemental protein to Nellore cows in the last trimester of gestation on subsequent growth of their heifer calves in creep feeding. Cows and their calves were managed on pasture containing 8% crude protein (CP). The cows were assigned to a complete randomized block design. Blocks were balanced for BW (431 ± 49 kg), age (8.9 ± 2.2 years), and BCS (2.8 ± 0.4; 1 to 5 scale). Treatments were arranged in a 2 × 2 factorial. The treatments were designated: 1 and 2 - cows (n = 106) supplemented with soybean meal (0.5 kg/cow/d) and heifer calves in either a creep (1, n = 106) or non-creep (2, n = 103) feeding program or; 3 and 4 - cows not supplemented (n = 103) and heifer calves in either a creep (3) or non-creep (4) feeding program. Chemical composition of the creep diet was 22% CP, and 72% TDN. Data were analyzed using GLM procedures of SAS and differences among treatments means were tested using Student's *t*-test ($P < 0.05$). At weaning time, there were no effects of cow supplementation on ADG and BW of heifer calves (0.677 ± 0.13 vs. 0.664 ± 0.126 kg/d and 168.2 ± 26.0 vs. 170.5 ± 32.8 kg) for supplemented or non-supplemented cows, respectively). Heifer calves supplemented with creep feeding showed greater ($P = 0.01$) ADG (0.708 ± 0.112 vs. 0.632 ± 0.13 kg/d) and BW at weaning (172.7 ± 26.7 vs. 165.8 ± 31.9 kg) than those not supplemented. In conclusion, supplementing 0.5 kg of soybean meal for Nellore cows in the last trimester of gestation did not alter subsequent growth of their heifer calves but ADG and BW at weaning were increased with creep feeding.

Key Words: beef cattle, growth, production systems

M122 Identification of key amino acids associated with fetal skeletal muscle growth in sheep. F. A. Sales*[1,4], B. P. Treloar[1], D. Pacheco[1], H. T. Blair[2], P. R. Kenyon[2], G. Nicholas[3], M. Senna-Salerno[3], and S. A. McCoard[1], *[1]Agresearch Grasslands, Palmerston North, New Zealand, [2]Sheep Research Centre, Massey University, Palmerston North, New Zealand, [3]Agresearch Ruakura, Hamilton, New Zealand, [4]Instituto de Investigaciones Agropecuarias, Punta Arenas, Chile.*

The role played by free amino acids (FAA) in the regulation of muscle growth during gestation in ruminants is poorly understood. The objective of this study was to compare maternal and fetal plasma and muscle FAA profiles between single and twins fetuses, and to examine the potential association between these profiles and muscle weight from well-fed late-gestation ewes. Single- (n = 9) and twin-bearing (n = 10) ewes, fed ad libitum on pasture were used. At d 140 of gestation ewes were euthanized, maternal and fetal plasma and fetal semitendinosus muscle (ST) collected and stored at −80°C. Reverse phase HPLC was used for FAA determination in plasma and ST muscle. Analysis of variance was used for comparisons of muscle weight and FAA concentration between single and twins and Pearson correlation analysis to estimate the relationship between ST weight and intracellular FAA. Twin fetuses had lighter ST muscles compared with singles (8.6 ± 0.3 g vs. 11.1 ± 0.9 g, $P = 0.02$). Total maternal plasma FAA was similar between single- and twin-bearing ewes ($P > 0.05$). Total fetal plasma FAA was similar between single and twin fetuses ($P > 0.05$). Twin fetuses had lower plasma concentrations ($P < 0.05$) of aspartate, glutamate, citrulline, and ornithine, and higher ($P < 0.05$) concentrations of glutamine and methionine compared with single fetuses. In muscle, lower concentrations of aspartate and threonine, and higher concentrations of citrulline and methionine were found in twins compared with singles ($P < 0.05$). Significant correlations between ST weight and intracellular arginine concentrations were found in both singles ($r = 0.62$, $P = 0.007$) and twins ($r = 0.67$, $P = 0.03$). These results indicate that restricted growth of twins compared with singles may be associated with altered placental AA transport and/or fetal AA metabolism. Observed differences between singles and twins in plasma AA and muscle FAA profiles indicate possible differences in AA transport and/or utilization in muscle. Arginine was the only FAA correlated with muscle mass in both single and twins, indicating that arginine may play an important role in the regulation of muscle growth in the ovine fetus.

Key Words: skeletal muscle, amino acids, sheep

M123 Is placental functionality different between singletons and twins in sheep? D. S. van der Linden* and S. A. McCoard, *Animal Nutrition Team, AgResearch Grasslands Limited, Palmerston North, New Zealand.*

A greater understanding of the factors that regulate placental nutrient transport will help elucidate mechanisms underlying perturbations in fetal growth. This study investigated the relationship between fetal weight and placentome type and size in placentae of singleton and twin fetuses in late pregnancy. In addition, free amino acid (AA) profiles were measured in fetal, umbilical artery and vein plasma using ion exchange chromatography and used as an indicator of placental nutrient transport. Singleton (n = 9) and twin (n = 10) placentae, from ewes offered ad libitum grazing throughout pregnancy were studied at d 140 of pregnancy. Blood samples from each fetus, umbilical vein and artery were collected before being removed from the placenta. Individual placentae per fetus were dissected and placentomes were classed per type and size and placentome number and individual weight were recorded. Data was analyzed using the PROC MIXED procedure in SAS with the fixed effects of birth rank, plasma pool type, their interactions and the random effect of ewe.Twin fetuses were 16% lighter (P = 0.01) than singletons, and had a smaller placenta with 28% decreased placentome weight (P = 0.03) and 35% fewer placentomes (P = 0.001). However, compared with singletons, twins tended (P = 0.19) to have a 17% more efficient placenta than singletons. In addition, twins showed a different distribution of placentome type and size compared with placentae of singletons, such that twins showed a greater proportion of type B and light placentomes compared with singletons. Fetal plasma of twin fetuses had 44% lower arginine (P = 0.03), 34% lower histidine (P = 0.02) and 20% lower leucine (P = 0.04) concentrations than singletons. In twins, fetal plasma had 55% lower asparagine (P = 0.005) and 47% (P = 0.03) higher glutamine (Glu) (P = 0.03) concentrations than umbilical artery plasma. No differences in AA concentrations between fetal, umbilical vein and artery plasma were observed in singletons. Glutamine is a major oxidation-energy source for the placenta and the fetal liver is the net producer of Glu. This may indicate that the functionality of the feto-placental unit is different between singletons and twins. In conclusion, individual placentae of twins may differ in functionality and nutrient transport from singletons and more research is warranted to better understand placental nutrient transport and function.

Key Words: placenta, sheep, amino acid

M124 Placental efficiency at birth has no effects on postnatal muscle development. T. A. Wilmoth*[1], C. S. Perkins[2], Z. E. Kerley[2], Z. D. Callahan[2], M. E. Wilson[1], and B. R. Wiegand[2], [1]*West Virginia University, Morgantown,* [2]*University of Missouri, Columbia.*

By d100 of gestation the populations of primary and secondary muscle fibers have formed. This number changes little after birth and throughout postnatal growth, however the size of these fibers can change, influencing pork quality. Placental function is an important factor in fetal and muscle development. Placental efficiency (fetal weight divided by placental weight) is often a measure of placental function and may impact muscle development during gestation and assumedly at slaughter. The objective of this work was to determine the relationship of placental efficiency to muscle development of the market weight hog. Placental efficiency was determined for each piglet at birth. At 2 mo of age, barrows (n = 19) were individually housed and fed to a final weight of 121 kg. Following a 24 h chill, a 2.5 cm^2 sample of longissimus dorsi (LD) at the 10th rib and semitendonosus (ST) from the middle of the muscle were collected and frozen. Two sections were taken of each muscle type and 2 images of each section were captured. The number and diameter of primary and secondary fiber types were determined by ATPase assay using acid preincubation. From each image 15 primary fibers and 20 secondary fibers were measured for diameter. The GLM procedures of SAS were used to determine Pearson correlation coefficients between variables. The diameter of primary and secondary muscle fibers in LD were positively related (P < 0.0001, r = 0.80). The diameter of primary muscle fibers was negatively correlated to the number of secondary muscle fibers in the LD (P < 0.05, r = −0.42). As primary fiber diameter increased in the LD, primary and secondary fiber number also increased in the ST (P < 0.05, r = 0.62, r = 0.56, r = 0.49, respectively). The number of secondary muscle fibers in LD were negatively correlated to the diameter of secondary muscle fibers in LD (P < 0.05, r = −0.40). In ST, the secondary to primary fiber ratio was found to be positively correlated to the diameter of primary fibers (r = 0.39, P < 0.05). Placental efficiency, determined at birth, appears to have to no effects on future muscle development of the animal.

Key Words: fiber number, postnatal growth, placental efficiency

M125 Effects of metabolizable protein supply during late gestation on ovine offspring growth and development. C. A. Schwartz*[1], K. R. Maddock-Carlin[1], C. O. Lemley[1], L. E. Camacho[1], W. L. Keller[1], J. S. Caton[1], R. D. Yunusova[1], C. S. Schauer[2], and K. A. Vonnahme[1], [1]*Department of Animal Sciences, North Dakota State University, Fargo,* [2]*Hettinger Research Extension Center, North Dakota State University, Hettinger.*

The objective of this study was to evaluate the effects of maternal metabolizable protein (MP) supply on fetal growth in sheep. Multiparous singleton pregnant ewes (n = 18) were randomized to receive 1 of 3 diets that were isocaloric and formulated to supply 60% (MP60), 100% (MP100), or 140% (MP140) of MP requirements during late (d 100 to 130) gestation. Metabolizable protein requirements were calculated as: MP (g/d) = (CP, g/d x (64 + (0.16 x undegraded intake protein of diet)))/100. Pregnant ewes and fetuses were euthanized and necropsied on d 130 ± 1 of gestation. Data were analyzed using PROC GLM of SAS. There was no effect ($P \geq 0.12$) of maternal MP supplementation during late gestation on fetal BW, empty BW, curved crown rump length, heart girth circumference, or adrenal, brain, heart, kidney, lung, pancreas, large intestine, spleen, and stomach weights when expressed as g or as g/g BW. Fetuses from MP140 ewes (8.8 ± 0.4) had increased ($P \leq$ 0.05) small intestinal mass (g/g BW) at d 130 compared with fetuses from MP60 (7.3 ± 0.5) and MP100 (7.0 ± 0.5) and ewes. Fetuses from MP60 (21.4 ± 1.59) ewes had increased ($P \leq 0.05$) perirenal fat mass (g and g/g BW) compared with fetuses from MP100 (15.5 ± 1.5) and MP140 (17.2 ± 1.5) ewes. Although all pregnant ewes were provided adequate energy, restricting levels of maternal MP supply during the defined period of gestation increased fetal perirenal fat whereas high levels of MP supply increased fetal small intestinal mass, all while not altering fetal BW.

Key Words: fetal growth, metabolizable protein, ovine

M126 Vascularization in ovine utero-placental tissues during early pregnancy: Effects of assisted reproductive technology (ART). P. P. Borowicz,* L. P. Reynolds, D. A. Redmer, and A. T. Grazul-Bilska, *Department of Animal Sciences, and Center for Nutrition and Pregnancy, North Dakota State University, Fargo.*

Compromised pregnancies can be caused by genetic, epigenetic, environmental and/or other factors. Assisted reproductive technology (ART) has profound effects on placental and fetal development, leading eventually to compromised pregnancy. Development of an adequate blood supply to the placenta, which is regulated by numerous angiogenic factors, is critical to support normal fetal development. We hypothesized that vascular development, reflected by the number, density and size of capillaries, is altered in utero-placental tissues in compromised pregnancies due to ART. Pregnancies were achieved through natural breeding (NAT, control, n = 3), transfer of embryos generated through natural breeding (NAT-ET, n = 7), in vitro fertilization (IVF, n = 4), or in vitro activation (IVA; parthenogenetic clones, n = 4). On d 22 of pregnancy, cross sections of gravid uteri, containing utero-placenta, were collected and fixed for histochemical (hematoxylin and periodic acid Schiff staining) detection of capillaries followed by image analysis to determine the capillary area density (CAD), capillary surface density (CSD, exchange area), and capillary number density (CND) per unit of maternal placental (caruncular) tissue area, as well as area per capillary (APC; i.e., average capillary size).Data were analyzed using the general linear models (GLM) procedure of SAS with the main effect of pregnancy type. Area per capillary (APC) was less ($P < 0.05$) in IVA and IVF vs. NAT or NAT-ET groups (NAT, 203 ± 32; ET, 177 ± 21; IVF, 110 ± 27; IVA, 117 ± 27; μm^2). Capillary number density (CND), CAD and CSD were similar for all pregnancy types. Thus, in sheep, ART affects specifically capillary size, which may reflect altered vascular growth and function of utero-placental tissues. These data provide a foundation for determining the basis for altered vascularization in placental tissues in compromised pregnancies and may help to identify strategies for rescuing placental development in such pregnancies. Supported by Hatch Project ND01712; USDA 2007–01215 to LPR and ATGB, NIH HL64141 to LPR and DAR, and NSF-MRI-ARRA-0959512 to ATGB.

Key Words: sheep placenta, vascularity, early pregnancy

M127 Influence of *Bos indicus* genetics on pregnancy-associated glycoproteins (PAG) and their association with fetal development. P. M. Mercadante*[1], K. M. Bischoff[2], V. R. G. Mercadante[2], G. C. Lamb[2], and A. D. Ealy[1], *[1]University of Florida, Gainesville, [2]University of Florida, North Florida Research and Education Center, Marianna.*

Cross-breeding *Bos indicus* and *Bos taurus* genotypes improves various production traits for cattle maintained in sub-tropical or tropical climates. Pregnancy-associated glycoprotein (PAG) concentrations are influenced by various factors during gestation and recent evidence indicates that *Bos taurus* subspecies impacts concentrations of PAG and fetal size during early gestation. We determined the correlation between maternal genotype, PAG concentrations, and fetal development during early gestation in cattle with distinct subspecies genotypes. A fixed-time AI estrous synchronization protocol with semen of multiple sires within each breed was used on multiparous Angus (n = 17), Brangus (n = 25) and Braford (n = 9) cows. Transrectal ultrasonography was used to measure fetal size at 35 (crown-rump) and 62 d (nose-crown) of gestation. Blood was harvested to determine plasma concentrations of PAG and progesterone (P4). Orthogonal contrasts were used to compare outcomes for cattle containing *Bos indicus* genetics (Brangus and Braford) from those containing solely *Bos taurus* genetics (Angus). Concentrations of PAG tended to be greater ($P = 0.09$) in Angus (5.0 ± 0.5 ng/mL) than Brangus (4.3 ± 0.5 ng/mL) and Braford (3.4 ± 0.5 ng/mL) at d 35 of gestation. At d 62 of gestation, concentrations of PAG tended ($P = 0.09$) to be lower in Angus (2.0 ± 0.4 ng/mL) than Brangus (2.5 ± 0.4 ng/mL) and Braford (3.3 ± 0.4 ng/mL). Concentrations of P4 were not influenced by cow genotype. Concentrations of PAG were positively correlated ($P = 0.01$) with concentrations of P4 at d 35 but not at d 62 of gestation. Cow breed did not affect fetal size at d 35 of gestation(15.5 ± 0.4, 15.4 ± 0.4 and 14.6 ± 0.4 mm for Angus, Brangus, and Braford, respectively), but at d 62 of gestation Angus cows (29.6 ± 0.3 mm) contained larger fetuses ($P \leq 0.01$) than Brangus (28.0 ± 0.3 mm) and Braford (28.4 ± 0.3 mm) cows. No correlation between PAG and fetal size were observed at 35 or 62 d of gestation. In conclusion, cow genotype influenced fetal size on d 62 and tended to influence concentrations of PAG on d 35 and 62. Plasma PAG concentration had a correlation with cow breed and plasma P4 concentrations, indicating that maternal genotype may influence placental activity and early fetal development.

Key Words: PAG, fetal size, cow genotype

M128 Fetal size and pregnancy-associated glycoprotein concentrations are influenced by *Bos indicus* genetics during early gestation. C. M. Waits,* P. M. Mercadante, S. E. Johnson, A. D. Ealy, and J. V. Yelich, *University of Florida, Gainesville.*

Several gestational events influence newborn calf size and survivability. Subspecies genotype (*Bos taurus* vs. *Bos taurus* × *Bos indicus*) influences fetal development and uteroplacental activity during late gestation and recent evidence suggests it also may affect events of pregnancy in early gestation. The objective of this study was to examine fetal size and plasma pregnancy-associated glycoprotein (PAG) concentrations between Angus and Brangus cows in early gestation. Primiparous and multiparous Angus (n = 43) and Brangus (n = 33) cows were bred by AI to multiple sires within their respective breeds. Transrectal ultrasonography was completed by the same technician on d 33–34, 40–41, 47–48 and 54–55 post-insemination and crown rump length or nose to crown length (d 54–55 only) was recorded. Blood was collected on each occasion, plasma was harvested, and concentrations of PAGs were determined by enzyme immunoassay. Data were analyzed by ANOVA. Fetuses in Angus cows tended to be smaller at d 33–34 than fetuses in Brangus cows (1.29 vs. 1.37 cm; pooled SE: 0.03, $P = 0.06$). Fetus size was not different between genotypes on d 40–41 and 47–48 but nose to crown size was greater for fetuses in Angus than Brangus cows (2.08 vs. 1.95 cm, pooled SE: 0.03, $P = 0.001$). Breed-dependent changes in the rate of fetal growth were also detected. Specifically, the rate of change in fetus size between d 33–34 and 54–55 was greater for fetuses from Angus than Brangus cows (4.14 vs. 3.67 cm, pooled SE: 0.09, $P = 0.003$). Plasma PAG concentrations were less in Angus than Brangus cows at each time point and after averaging PAG concentrations across time points (4.9 vs. 8.2 ng/ml; pooled SE: 0.9, $P = 0.005$). In conclusion, the *Bos taurus* × *Bos indicus* (Brangus) genotype influences fetal size, rate of fetal development, and placental PAG production in the first 8 weeks of gestation in cattle. Such effects may help explain postnatal growth potential for these animals.

Key Words: fetal size, pregnancy-associated glycoprotein, early gestation

M129 Effects of nutrient restriction in beef cows during early gestation on maternal and fetal small intestinal and hepatic mass and in vitro oxygen (O_2) consumption. L. D. Prezotto,* L. E. Camacho, C. O. Lemley, J. S. Caton, K. A. Vonnahme, M. Kapphahn, M. Van Emon, R. S. Goulart, R. D. Yunosova, T. J. Swanson, and K. C. Swanson, *Animal Science Department, North Dakota State University, Fargo.*

The objectives were to examine the effects of maternal nutrient restriction during early gestation on maternal and fetal small intestinal and hepatic mass and in vitro O_2 consumption. Pregnant multiparous beef cows at d 30 of gestation were randomly assigned to one of 2 treatment groups: 100% NRC (CON; n = 6) or 60% NRC (RES; n = 6) requirements. At d 85 of gestation, animals were slaughtered and fetuses were immediately removed, weighed, and liver and intestine were collected. Maternal liver and jejunal tissues were also collected, and weighed. After collection, fetal and maternal tissues were transported to the laboratory for O_2 consumption analysis. Tissue weight relative to BW (g/kg) in the cow (liver = 7.58 ± 0.7; jej = 2.4 ± 1.5) and fetus (liver = 37.2 ± 3.4; jej = 18.6 ± 1.9), and tissue weight (g) for maternal liver and jejunum (4148.3 ± 462.7; 1270.5 ± 791.5), and fetal small intestine (2.4 ± 0.4), were not influenced ($P > 0.2$) by nutrient restriction. However, fetal liver weight (CON = 4.29 ± 0.27g; RES = 5.1 ± 0.7g; $P = 0.04$) was greater for the RES group. Oxygen consumption per unit of tissue (maternal liver = 1.62 ± 0.52µl/g/hr; maternal jej = 0.87 ± 0.36µl/g/hr; fetal liver = 2.95 ± 0.85µl/g/hr; fetal jej = 0.9 ± 0.3µl/g/hr), total O_2 consumption per tissue (maternal liver = 6729.4 ± 2325.4µl/tissue/hr; maternal jej = 1098.9 ± 780.5µl/tissue/hr; fetal liver = 14.1 ± 5.4µl/tissue/hr; fetal jej = 2.2 ± 0.8µl/tissue/hr), and O_2 consumption relative to BW (maternal liver = 12.28 ± 4.05µl/BW/hr; maternal jej = 2 ± 1.4µl/BW/hr; fetal liver = 110.1 ± 30.1µl/BW/hr; fetal jej = 17.1 ± 5.7µl/BW/hr) were not influenced ($P > 0.2$) by nutrient restriction in maternal and fetal liver and intestine. These data indicate that nutrient restriction in pregnant cows during early gestation increased fetal liver mass at d 85 but did not alter maternal and fetal O_2 consumption in liver and small intestine.

Key Words: oxygen consumption, gastrointestinal tract, gestational nutrition

M130 The effects of intrauterine growth retardation (IUGR) due to poor maternal nutrition on muscle development in lambs.
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Recent research has demonstrated that poor maternal nutrition can cause a decrease in carcass quality as the resulting offspring exhibit a reduction in muscle tissue. We hypothesized that lambs experiencing intrauterine growth retardation (IUGR) due to poor maternal nutrition will have decreased muscle development and reduced expression of key genes involved in myogenesis. Ewes pregnant with twins (n = 24) were fed 100% (CON), 60% (RES) or 120% (OVER) of NRC requirements beginning at d 85 of gestation. The offspring were euthanized within 24 h of birth (d 1; n = 3/treatment) or at 3 mo of age (n = 3 to 5/treatment). Animals maintained until 3 mo of age were removed from the ewe and fed a control diet of milk replacer and 18% creep feed. Quadricep muscle was collected immediately following euthanasia for gene expression analysis using real time-reverse transcriptase (RT)-PCR. Data were analyzed using ANOVA with significance considered as $P \leq 0.05$. As reported, BW were reduced in RES lambs by 16% at d 1 and 3 mo ($P \leq 0.05$) compared with CON. There was a tendency for a 2.9 ± 0.1-fold increase in *IGF-I* mRNA expression in RES animals at d 1 ($P \leq 0.18$) but not at 3 mo ($P \geq 0.90$). A difference in *IGF-I* mRNA expression was not observed in OVER lambs at d 1 or 3 mo ($P \geq 0.76$). We did not observe an effect of poor maternal nutrition on the expression of markers of muscle development, *myogenin, myogenic regulatory factor-5* (*myf-5*) and *paired box protein-7* (*PAX7*), at either time point ($P \geq 0.32$). In addition, we did not observe an effect of treatment on genes affected by glucose availability, *glucose transporter type 4* (*GLUT4*) and *tuberous sclerosis protein 2* (*TSC2*; $P \geq 0.36$), within the muscle. In summary, although we did not observe an effect of IUGR on markers of myogenesis, *IGF-I* gene expression tended to be increased in RES lambs at d 1 but not at 3 mo. Based on the reduced size of the RES lambs and the critical role of IGF-I in muscle growth, these data suggest there may be altered sensitivity to IGF-I in the muscle of lambs suffering from IUGR at birth.

Key Words: intrauterine growth retardation, insulin-like growth factor-I, muscle

M131 Maternal diet interactions with fetal sex in beef cattle.
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Prenatal nutrition affects postnatal life in many mammals, including cattle. Our aim is to determine which physiological processes are affected, to what degree, and how we can optimize prenatal nutrition to ensure/enhance performance in economically important traits. Multiparious beef cattle (n = 46) were fed a haylage-based TMR containing 20% wheat straw at either 85% (n = 23; LOW) or 140% (n = 23; HIGH) of maintenance energy requirements (NEm). The treatment began mid-way through gestation (~150 ds), and continued for 105 ds. Diet treatment (TRT) had a significant effect upon cow ADG ($P < 0.0001$), and TRT and cow age had significant effects upon cow average end weight (AEWt) (both $P < 0.0001$). Only cow age was significant for average start weight (ASWt) ($P = 0.0001$). Least squares means AEWt for HIGH and LOW cows was 853 and 765 kg resp., therefore dietary treatment performed as expected. Birth weights of calves born from these cows were evaluated using a mixed model which included TRT and sex of calf (plus interaction), and cow age as fixed factors, with pen as random effect. Only TRT*calf sex was significant ($P = 0.038$). Cow weight measurements (ASWt, CowADG, AEWt) were tested separately as covariates in the model for calf birth weight. Both ASWt and AEWt significantly interacted with TRT, and appeared to explain some of the same variation in birth weight as fetal sex. In retrospect we included calf sex in models for ASWt, CowADG, and AEWt. We found that CowADG was significantly affected by both TRT and calf sex ($P < 0.0001$, $P = 0.013$ resp.). Cows carrying bulls as opposed to heifers gained more weight during the trial. By weaning there was no difference in cow weights for any parameters tested except cow age ($P = 0.0019$). Adjusted (205-d) weaning weights of calves, as well as average daily gain from birth to weaning, were not affected by any parameters tested. These results illustrate that maternal diet during the second trimester in beef cattle has sex-specific effects upon birth weight of calves, and that fetal sex interacts with rate of gain in pregnant cows. Translating the maternal-fetal dialog can lead to innovative management practices for the pregnant beef cow.

Key Words: fetal-programming, epigenetics, bovine

M132 Lamb growth in response to the duration of maternal undernutrition during gestation in twin sheep pregnancies.
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The experimental objective was to determine the impact of duration of maternal undernutrition during gestation in twin pregnancies on lamb growth and development. Multiparous western whiteface ewes were randomly assigned to one of 3 treatments and acclimation to individual pens (7d) began at 21 d of gestational age (dGA). Ewes were fed 100%

(Control; n = 8), or 50% of their nutrient requirements from 28 to 78 dGA and readjusted to 100% beginning at 79 dGA (50–100; n = 10), or 50% from 28 to term (50–50; n = 9). Lambs were birthed naturally and harvested at 18 wk of age. Data were analyzed by preplanned orthogonal contrasts: Control vs. 50–100 and 50–50 and 50–100 vs. 50–50. Lambs born to 50–100 ewes were heavier ($P = 0.02$; 5.41 ± 0.28 kg) than 50–50 (4.34 ± 0.29 kg) lambs. Crown-rump length (CRL) tended ($P = 0.09$) to be greater in 50–100 (17.90 ± 0.54 cm) than 50–50 (16.38 ± 0.68 cm) lambs. Body weight of 50–100 lambs was greater ($P < 0.05$) than 50–50 lambs at 2 (8.52 ± 0.51 kg vs. 4.34 ± 0.29 kg) and 3 wk (9.79 ± 0.53 kg vs. 7.94 ± 0.53 kg) and the same trend ($P = 0.07$) was observed at 4 wk (11.63 ± 0.70 kg vs. 9.51 ± 0.81 kg). At 4, 16 and 17 wk body weight tended ($P < 0.10$) to be greater in Control than 50–100 and 50–50 lambs. At 18 wk rear leg length was greater ($P = 0.03$) in 50–100 (63.92 ± 1.30 cm) and 50–50 (61.54 ± 1.26 cm). At 18 wks CRL of 50–100 (114.46 ± 2.82 cm) lambs tended ($P = 0.09$) to be greater than 50–50 (107.30 ± 3.72 cm) lambs. At 18 wk, brain weight was greater ($P = 0.03$) in 50–100 (107.98 ± 2.61 cm) than 50–50 (99.74 ± 2.47 cm) lambs. Elevated body weight and CRL of 50–100 lambs at birth may indicate a shift in fetal metabolism to compensate for nutrient restriction during early gestation. This project was supported by National Research Initiative Competitive Grant no. 2009–35206–05273 from the USDA National Institute of Food and Agriculture.

Key Words: maternal undernutrition, lamb growth, sheep