WSASAS Symposium: Ruminant Stress: Implications on Health and Performance of Ruminants

810 Effects of environment on fetal programming in ruminant livestock. S. W. Limesand,* D. T. Yates, A. R. Macko, and X. Chen, *University of Arizona, Tucson.*

Environmental heat stress reduces placental transfer of oxygen and nutrients to the fetus and can influence the set-points of metabolic pathways. Developmental adaptive responses to heat stress-induced placental insufficiency promote thrifty fetal metabolism and are necessary for in utero survival. However, thrifty metabolic programming can be detrimental after birth when sufficient nutrition and oxygen are available. The endocrine pancreas plays an important role in metabolic homeostasis even before birth by secreting insulin from β-cells in response to stimulation by nutrients, thus coordinating fetal growth with nutrient supply. Our goal is to understand the mechanisms by which developmental adaptations in β-cells occur in heat-stressed fetuses and determine how they manifest into less desirable production traits. We induce placental insufficiency and intrauterine growth restriction (IUGR) in fetal sheep by exposing the pregnant ewe to chronic heat stress during mid-gestation. This treatment results in fetal hypoxemia and hypoglycemia that progressively worsens throughout the third trimester. Glucose-stimulated insulin secretion (GSIS) in IUGR fetuses is also reduced by more than 80% compared with controls due to a 78% reduction in β-cell mass and less insulin per β-cell. However, β-cells isolated from IUGR fetuses secrete more insulin relative to total insulin content in vitro, indicating that stimulus-secretion coupling is greater than in control β-cells. In contrast, fetal sheep that are hypoglycemic only (produced by chronic maternal insulin infusion) exhibited a 45% reduction in GSIS in vivo as well as diminished insulin secretion from isolated islets. Together, these data demonstrate that hypoxemia is a major cause of developmental adaptations observed in β-cells after fetal heat stress. We are currently exploring elevated catecholamines as a mediating factor of hypoxemic effects. Plasma norepinephrine concentrations are negatively correlated with blood oxygen content and have been shown to inhibit insulin secretion. We have recently found that fetal islets chronically exposed to elevated norepinephrine in vivo exhibit enhanced insulin secretion after norepinephrine is removed, indicating that adaptive changes persist.

Key Words: intrauterine growth restriction, heat stress, pancreas

811 An evaluation of cold stress on ruminant nutritional requirements. B. Olson,* *Montana State University, Bozeman.*

In northern climates, cold may challenge a cow's ability to meet its energy/nutritional requirements during winter. For this reason, cattle are commonly fed 2 to 3 tons of hay per head, at high cost, to offset this perceived stressor, presumably because cold, often combined with wind, is thought to challenge a cow's thermal balance. At times, feeding hay meets a cow's direct physiological needs. Besides being fed hay during winter, cold temperatures can increase activity level, shivering, or metabolic rate, which require energy, or increase use of energy reserves, which reduces insulation. However, these are not long-term responses to cold stress. Alternatively, cattle in good body condition entering winter adjust behaviorally to maximize energy gain, primarily from the sun, and to minimize energy loss, primarily from wind. They also may reduce activity level under extreme conditions, and lower metabolic rate to conserve energy. Cattle that do not adjust, and subsequently produce a weak calf or do not rebreed are likely to be culled. Several studies indicate that the 1996 NRC model over-estimates maintenance requirements for beef cattle grazing winter range, presumably because the model does not account for the benefits of solar energy to help meet a cow's thermal balance, and their behavioral adjustments to winter conditions.

Key Words: cold, thermal, winter

812 An evaluation of temperament on performance and health of ruminants. R. F. Cooke,* *Oregon State University, EOARC, Burns.*

Temperament is defined as the fear-related behavioral responses of cattle when exposed to human handling. Our group evaluates cattle temperament using: 1) chute score; 1–5 scale that increases according to violent behavior during chute restraining, 2) exit velocity; speed of cattle exiting the chute, 3) exit score; dividing cattle according to exit velocity into quintiles and using a 1–5 scale (slowest to fastest quintiles), and 4) temperament score; average of chute and exit scores. To facilitate interpretation and dissemination of results, our group also assigns a final temperament type to cattle; adequate temperament (ADQ; temperament score ≤3) or aggressive temperament (AGR; temperament score >3). To understand the implications of temperament on beef production, our group recently evaluated the impacts of this trait on cattle productive, reproductive, and health parameters. As expected, AGR cattle had greater plasma cortisol vs. ADQ cattle during handling, independent of breed type (*Bos indicus* × *B. taurus*, $P < 0.01$; *B. taurus*, $P < 0.01$) or age (cows, $P < 0.01$; heifers, $P < 0.01$). In regards to reproduction, AGR females had reduced annual pregnancy rates vs. ADQ cohorts, independent of breed type (*B. indicus* × *B. taurus*, $P = 0.03$; *B. indicus*, $P = 0.05$). Moreover, *B. taurus* AGR cows had decreased pregnancy rate ($P = 0.03$), calving rate ($P = 0.04$), weaning rate ($P = 0.09$), and kg of calf weaned/cow exposed ($P = 0.08$) vs. ADQ cohorts. In regards to feeder cattle, AGR calves had reduced weaning BW ($P = 0.04$), heightened acute-phase protein response upon feedlot entry ($P \leq 0.05$), and reduced carcass weight ($P = 0.07$) vs. ADQ cohorts. Our group also reported that exposing *B. indicus* × *B. taurus* or *B. taurus* heifers to frequent human handling improved temperament ($P \leq 0.02$), reduced plasma cortisol ($P < 0.01$), and hastened puberty ($P \leq 0.02$). Similar benefits, however, were not observed in mature cows or feeder cattle. In conclusion, temperament affects productive, reproductive, and health parameters of beef cattle independent of breed type. Hence, strategies to improve herd temperament are imperative for optimal production efficiency of beef operations worldwide.

Key Words: cattle, production, temperament

813 Impact of weaning, transportation. and vaccination stress on beef cattle performance. J. D. Arthington,* *University of Florida, Range Cattle Research and Education Center, Ona.*

Stress is the result of an external or internal pressure which causes an organism to deviate from homeostasis. Professionals engaged in food animal production systems are certainly aware of the range of stressors affecting their animals; however, the repercussions of these events on nutrition and performance considerations are recently becoming better understood. This presentation will discuss research findings directed toward the acute phase protein (APP) reaction and performance of beef calves. Our research, and the work of others, has identified several

instances where BW gain was negatively correlated to blood concentrations of APP. Although other studies have linked APP concentrations to instances of feedlot morbidity and/or disease, our research has focused on response variables collected from overtly healthy cattle being exposed to normal production stressors such as weaning, vaccination, transportation, and castration. Each of these practices will create an inflammatory reaction in cattle, the magnitude of which depends on a variety of factors which are currently not well understood. These can be both deliberate and non-deliberate in nature. Some common deliberate production practices are castration or the inclusion of an adjuvant within a vaccine. Production practices which may induce non-deliberate inflammatory responses include transportation, weaning, and commingling. Typically, deliberate production stressors are associated with some degree of tissue injury, whereas non-deliberate production stressors are linked to a disruption in social order, depression, or anxiety. Despite the source of stress, these inflammatory reactions tend to respond similarly in beef cattle and lead to the initiation of the APP reaction. The APP reaction begins with the production of pro-inflammatory proteins called cytokines (namely interleukin −1, interleukin-6, and tumor necrosis factor α). These cytokines are the initial instigators of the acute phase reaction, which orchestrates the subsequent production of APP and ultimately metabolism alterations affecting feed intake, nutrient utilization, and growth. These cytokines are highly pleiotropic and affect food animal performance both (1) directly, by decreasing circulating concentrations of insulin-like growth factor-1 via a reduction in hepatic cell sensitivity to growth hormone, and (2) indirectly, by stimulating the production of plasma proteins, thus diverting energy and nutrients away from BW gain and toward the production of inflammatory proteins and support of the immune system. In terms of total protein mass, the combination of immunoglobulin and the APP sum the majority of plasma protein mass observed following an acute phase inflammatory reaction. Our research group has specifically targeted 3 APP, including haptoglobin, ceruloplasmin, and fibrinogen. These proteins were selected due to their abundance in the blood of cattle responding to inflammatory signals, their acceptable stability during storage (i.e., freezing, thawing, and re-freezing), and their relatively simple and cost-effective measurement in routine assay systems. The collective results of these studies implicate an important relationship between beef calf performance and the APP response to normal production stressors. An overreaching goal of these efforts is to seek modifications to beef production practices that help ameliorate the inflammatory response and thus improve beef cattle performance and well-being.

Key Words: stress, acute phase proteins, cattle

814 Impact of environmental stress on feedlot cattle. T. L. Mader,* *University of Nebraska, Concord.*

In the Midwest and Plains states, the heat waves of 1995, 1999, 2006, 2009, and 2010 were particularly severe with documented cattle losses approaching 5,000 head each year. However, during the summer of 2011, nearly 15,000 head of cattle perished across 5 states as a result of heat stress. The winters of 1992 to 93, 1996 to 97, 1997 to 98, 2006 to 07, and 2008 to 09 also caused hardship for cattle producers with some feedlots reporting losses in excess of 1,000 head. Up to 50% of the newborn calves were lost in many areas with over 75,000 head of cattle lost in the Northern Plains states during the 1996 to 97 and 2008 to 2009 winters. Late fall and early winter snowstorms in 1992, 1997, and 2006 resulted in the loss of over 25,000 head of feedlot cattle each year in the Central and Southern Plains of the United States. Economic losses from reduced performance of cattle experiencing severe environmental stress likely exceed losses associated from cattle death by 5- to 10-fold. Use of alternative supplementation programs may need to be considered for cattle challenged by adverse environmental conditions. Use of additional water for consumption and cooling, shade, and/or alternative management strategies need to be considered to help cattle cope with heat stress. During the winter, catastrophic losses typically occur during severe snowstorms, however early winter moisture combined with poor drying conditions may result in greater losses in performance and income due to muddy lot conditions and muddy cattle. Strategies need to be employed to minimize effects of mud, which is probably the single largest contributor to poor cattle performance in winter and spring. The above-mentioned weather events suggest that there are ample opportunities for cattle producers to minimize impact of environmental stress. Data will be presented regarding use of environmental models to determine benefits of sprinklers, shade and/or other mitigation techniques, which can reduce animal discomfort and address consumer concerns regarding welfare of animals housed outside. A greater understanding of cattle responses to weather challenges will be conveyed to caretakers to help animals cope with adverse climatic conditions.

Key Words: environmental stress, models, livestock management