Physiology and Endocrinology Symposium: Factors Controlling Puberty in Beef Heifers

533 Management implications associated with the onset of puberty and persistence of estrous cycles in beef heifers. G. C. Lamb*[1], K. M. Bischoff[1], T. E. Black[1], V. R. G. Mercadante[1], G. H. L. Marquezini[1], R. F. Cooke[2], and N. DiLorenzo[1], *[1]North Florida Research and Education Center, University of Florida, Marianna, [2]Eastern Oregon Agricultural Research Center, Oregon State University, Burns.*

For optimal economic return and lifetime productivity, replacement beef heifers need to attain puberty and conceive early during their first breeding season. Significant costs are associated with development and management of replacement beef heifers; therefore, management strategies that maximize the number of replacement heifers attaining puberty before their first breeding season are vital for the efficiency of cow-calf operations. We demonstrated that fertility in replacement beef heifers was not compromised by delaying the majority of weight gain until the last third of the developmental period before the onset of the breeding season, and BW at the onset of the breeding season and weight at puberty were not compromised compared with heifers on a constant rate of gain during the developmental period. Periods of reduced nutrient intake are analogous with losses in BW, BCS, decreases in luteal activity, and cessation of estrous cycles. Persistence of estrous cycles after establishment of puberty are affected by dietary energy restriction and repletion, but may be activated gradually in response to dietary manipulation, unrelated to many metabolite changes. Reproductive development also may be accelerated with the use of exogenous hormones such as progestins for synchronization of estrous and/or ovulation. The use of protocols containing progestins initiate estrous cycles of prepubertal heifers and results in pregnancy rates that are 15% greater than untreated controls. Acclimation of heifers to human handling after weaning may also be an alternative to hasten puberty attainment and improve pregnancy rates. In both *Bos taurus* and *B. indicus* heifers, the use of acclimation techniques reduced stress-related physiological responses and increased the percentage of replacement heifers that were pubertal at the initiation of the breeding season. Incorporation of nutritional, reproductive, and stress management during the development of replacement beef heifers increases the percentage of heifers that reach puberty at the onset of the breeding season and enhances overall reproductive performance of beef cattle operations.

Key words: puberty, beef heifer, management

534 How SNP chips will advance our knowledge of factors controlling puberty and aid in selecting replacement females. W. M. Snelling*[1], R. A. Cushman[1], G. L. Bennett[1], J. W. Keele[1], L. A. Kuehn[1], T. G. McDaneld[1], R. M. Thallman[1], and M. G. Thomas[2], *[1]USMARC, USDA-ARS U.S. Meat Animal Research Center, Clay Center, NE, [2]New Mexico State University, Las Cruces.*

The promise of genomic selection is that genetic potential can be accurately predicted from genotypes. Simple DNA tests might replace low accuracy predictions based on performance and pedigree for expensive or lowly heritable measures of puberty and fertility. The promise is greatest if the DNA variants affecting puberty and other measures of fertility are known with some certainty. Several of the 50,000 SNP in a standard assay have tentatively been associated with age at puberty, antral follicle count, pregnancy and related traits measured on different sets of heifers. At best, these SNP may be imperfectly correlated with causal variants and indicate genomic regions affecting puberty, but sample sizes are too small and SNP density too sparse to be definitive. Associations between individual SNP and similar phenotypes are inconsistent across data sets, and genomic predictions do not appear applicable to unrelated cattle. Discrepancies may be a result of different QTL segregating in the sampled populations, differences in linkage disequilibrium (LD) patterns so the same SNP are not correlated with the same QTL, and spurious correlations with phenotype. Larger samples and denser SNP will increase power to detect real associations with SNP having more consistent LD with underlying QTL. Meta-analysis combining results from different studies will effectively increase sample size. High-density genotyping with heifers pooled by early and late puberty, or extremes for quantitative indicators of puberty, can be a cost-effective means to sample large numbers. Networks of genes, implicated by associations with multiple traits correlated with puberty and fertility, could provide insight into the complex nature of these traits, especially if corroborated by functional annotation, established gene interaction pathways, and transcript expression. Integrating information about gene function and regulation with statistical associations from whole-genome SNP genotyping assays will enhance knowledge of genomic mechanisms affecting puberty, enabling development of more reliable DNA tests to guide heifer selection decisions.

Key words: genomics, puberty

535 Nutritional aspects of developing replacement heifers. R. N. Funston*, *University of Nebraska West Central Research and Extension Center, North Platte.*

Studies in numerous species provide evidence that diet during development can partially control physiological changes necessary for puberty. Numerous studies have reported inverse correlations between postweaning growth rate and age at puberty and pregnancy rates in heifers. Thus, rate of postweaning growth was determined to be an important factor affecting age of puberty, which influenced pregnancy rates. This and other research conducted during the late 1960s through the early 1980s indicated puberty occurs at a genetically predetermined size, and only when heifers reach their target weight can high pregnancy rates be obtained. Guidelines were established indicating replacement heifers should achieve 60 to 65% of their expected mature body weight by breeding. Traditional approaches for postweaning development of replacement heifers used during the last several decades have primarily focused on feeding heifers to achieve or exceed an appropriate target weight, and thereby maximize heifer pregnancy rates. Intensive heifer development systems may maximize pregnancy rates, but not necessarily optimize profit or sustainability. Since inception of target weight guidelines, subsequent research demonstrated the pattern of growth heifers experience before achieving a critical target weight could be varied. Altering rate and timing of gain can result in periods of compensatory growth thereby providing an opportunity to decrease feed costs. Recent research from our laboratory has demonstrated feeding replacement heifers to traditional target weights increased development costs without improving reproduction or subsequent calf production relative to development systems where heifers were developed to lower target weights ranging from 50 to 57% of mature BW.

Key words: beef cattle, heifer development, target weight

536 Harnessing basic knowledge of factors controlling puberty to improve synchronization of estrus and fertility in heifers. G. A. Perry*, *South Dakota State University, Department of Animal and Range Sciences, Brookings.*

The development of replacement heifers is a major economic investment for all beef and dairy operations. The costs associated with heifer development cannot be recovered if heifers do not conceive and remain productive in the herd; therefore, heifers need to conceive on schedule or risk being culled from the operations. Previous research has reported up to a 21% increase in fertility from a heifer′s pubertal estrus to the third estrus. The use of reproductive tract scores to determine pubertal status has demonstrated that peripubertal and pubertal heifers have an increased pregnancy success to synchronization protocols compared with heifers that were prepubertal. The development of radioimmunoassays has allowed for accurate measurement of changes in hormone profiles to characterize the pubertal process and determine when puberty occurs. This basic knowledge has increased our understanding of the mechanisms that control puberty and sexual development in heifers. In addition, understanding the hormonal changes that occur during the estrous cycle has allowed for the development of estrous synchronization protocols that result in increased control of follicular growth, regression of luteal tissue, and ovulation. Transrectal ultrasonography has resulted in an increased understanding of the endocrine regulation of follicular waves and development of methods to synchronize follicular waves for purposes of fixed-time AI. Current topics of research include the affect of antral follicle count on fertility and the affect of maternal nutrition (on the fetus in utero) on subsequent reproductive potential of a heifer (e.g., fetal programming). Advancements in genomic technologies will likely provide a powerful tool for selecting heifers at birth that will have a high probability of being reproductively successful if managed correctly. Therefore, the basic knowledge gain through research has improved and will continue to improve heifer development and pregnancy success.

Key words: heifer development, estrous synchronization, puberty