Proceedings, Applied Reproductive Strategies in Beef Cattle
November 12 and 13, 2005, Texas A&M University, College Station

DEVELOPEMENT AND MANAGEMENT OF HEIFERS FOR CONTROLLED BREEDING PROGRAMS

David W. Forrest
Department of Animal Science, Texas A&M University, College Station, TX

Introduction

Cow-calf producers require a consistent source of replacement females in order to maintain the size of the breeding herd at the desired level. Replacement females may be produced internally or acquired from external sources. This discussion will focus upon the critical control points that range from the selection criteria used in mating decisions to produce potential replacement heifers to the factors that influence successful rebreeding of the first-calf heifer. Heifers must attain puberty and conceive before 15 months of age to meet the goal of calving at 2 years of age. In order to successfully enter the cow herd, replacement females must be developed, conceive early in the breeding season, produce a live calf and conceive as a first-calf heifer. Heifer age and body weight (BW) significantly influence the onset of puberty. General guidelines have been proposed for target BW at specific stages of development relative to expected mature BW.

Genetic Factors

Mating decisions for production of potential replacement heifers should consider breed type, expected progeny difference for selected performance traits and age of dam. In a study of nine different sire breeds, breed group of sire significantly affected age and weight of heifers at puberty (Thallman et al., 1999). However, pregnancy rate of heifers was not affected by breed group of sire. Wolfe et al. (1990) reported that selection for growth traits did not have a detrimental effect on age at puberty in Hereford heifers.

Although reproductive traits are generally considered to have low heritability, recent studies indicate that selection for certain traits may allow identification of females with higher genetic potential for fertility. Doyle et al. (2000) conducted a study to determine whether heifer pregnancy (HP) and subsequent rebreeding (SR) were heritable in an experimental population of Angus cattle. The genetic relationships among HP, SR and stayability (probability of a female having at least 5 calves with the first calf born when the heifer is 2 years old) were determined in the same population. The authors concluded that HP (average heritability = .21) and stayability (average heritability = .15) were heritable and should respond favorably to selection. SR did not appear heritable in the same Angus cattle population. However, Buddenberg et al. (1989) and Snelling et al. (1996) concluded that SR was heritable in the Hereford and Angus populations in their studies. Doyle et al. (2000) suggested that the nonlinear relationships among HP and stayability indicate that selection for improved female fertility would be most effective by having predictions on both traits.

Martinez et al. (2005) reported moderate estimates of heritability in Hereford cattle for stayability to calving and to weaning. The authors concluded that it is possible to select for sires whose daughters have an increased probability to remain longer in the herd. Utilization of an EPD for stayability can enhance reproductive lifespan of females through sire selection. Future development of an EPD for heifer pregnancy probability could allow selection of sires with daughters that have increased genetic potential to conceive at first breeding.

Preweaning Management

Preweaning growth is significantly influenced by calf age, level of maternal milk production and genetic potential for growth. Evans et al. (1999) reported a 10 percentage point advantage in the probability of pregnancy for each 20-day increment earlier that the heifer is born during the calving season. Heifers born to dams from 2 to 4 years of age had a 6 to 14% lower probability to become and remain pregnant to 120 days than heifers born to mature dams (5 to 9 years of age; Doyle et al., 2000). Creep feeding of suckling calves is one option for enhancing postnatal growth but does increase cost of heifer development. Although use of a growth-promoting implant after weaning can reduce fertility of replacement females, the use of an appropriate implant in suckling calves may be beneficial in certain management systems. A single implant at 2 months of age increased early weight gain and decreased subsequent calving difficulty scores without affecting reproduction or calf production of 2-year-old cows (Hancock et al., 1994).

An effective vaccination program is essential for calves to realize their genetic potential for gain and to minimize the potential for adverse effects on reproductive performance. Programs to control internal and external parasites should be designed for the particular production environment. For example, liver flukes (Fasciola hepatica) can decrease performance and impair reproduction in some regions including the Southern United States. Experimental infection of 4-month-old heifers with F. hepatica delayed the onset of puberty by 39 days compared with non-infected controls (Lopez-Diaz et al., 1998). Paczowski et al. (2004) infected Angus-sired heifers with F. hepatica at 4 months of age in south-central Texas. Age and weight at puberty did not differ significantly between infected and control heifers under the conditions of this study.

Weaning Management

Innovative weaning strategies provide potential to minimize stress and reductions in weight gain that are frequently associated with conventional methods of weaning. Providing fenceline contact for cows and calves at weaning increases calf average daily gain compared with the traditional method of weaning by separation (Price et al., 2003). A two-stage method of weaning cattle further reduced distress of calves (Haley et al., 2005). Calves were prevented from nursing their dams by placement of a plastic antisucking device (noseflap) for 3 to 14 days (Stage 1) before calf separation (Stage 2). The authors recommended an optimum duration of Stage 1 is 4 to 5 days.

Postweaning Management

Postweaning growth rate, age at puberty, and pregnancy rate affect both the cost of developing replacement heifers and subsequent productivity of those replacements. Funston and Duetscher (2004) compared the effects of developing British X Continental heifers to either 53 or 58% of mature BW at breeding on reproduction and calf production. Costs of developing heifers to 53% of mature BW were lower than costs of developing heifers to 58% of mature BW while not adversely affecting reproduction through the fourth pregnancy or calf production through the third gestation.

The effects of three heifer development strategies based upon timed nutrient limitation (High, Medium or Low-High) on primiparous heifer performance were reported by Freetly et al. (2001). The authors concluded that pattern of growth may not affect the ability of a heifer to conceive or calf growth potential if heifers achieve a minimal BW before mating.

Ionophores can improve average gain by .1 to .2 lb/day, inhibit coccidiosis and enhance the onset of puberty in growing heifers by approximately 2 weeks. Supplements containing ionophores have been shown to decrease the age and weight at puberty of beef heifers (Moseley et al., 1977). Anthelmintics can reduce the gastrointestinal parasite load and increase weight gain. Purvis and Whittier (1996) reported that age and weight at puberty were reduced by administration of an ionophore or an anthelmintic. However, the effects of the ionophore and the anthelmintic on age and weight at puberty were not additive under the conditions of their study. Modified live vaccines to booster protection against respiratory diseases can be administered at least 30 days before the start of the breeding season.

Initial studies failed to demonstrate a beneficial effect of exposure to bulls on age at puberty in heifers. Subsequent reports indicate that heifer growth rate may interact with the biostimulatory influence of bulls on age at puberty in beef heifers. Roberson et al. (1991) assigned heifers (approximately 8.5 months of age) to either bull exposure (175 days) or isolated from bulls (NE). Heifers were fed to gain at either a moderate (1.3 lb/day) or high (1.8 lb/day) growth rate. Heifers exposed to bulls attained puberty at younger ages than NE heifers, and the effect on puberty was greater for high than for moderate growth rate heifers.

Breeding

The period from weaning to puberty is critical in the management of replacement heifers. However, body weight and condition score at the beginning of the breeding season appear to be more important than rate of gain. Grings et al. (1999) reported that age at puberty was delayed by 28 days in heifers produced by 2-year-old cows compared to heifers produced by 5-year-old cows. Although ADG from weaning to breeding was similar between heifers born to either 2- or 5-year-old dams, the heifers from 2-year-old dams were 73 lb lighter at weaning.

The 5-point reproductive tract scoring (RTS) system was developed by Anderson et al. (1991) to estimate pubertal status of heifers. Lafever and Odde (1986) reported higher estrous and conception rates to artificial insemination after synchronization for heifers determined to be pubertal (RTS of 4 or 5) than for prepubertal heifers (RTS of 1, 2 or 3). Rosenkrans and Hardin (2003) conducted a study which validated the repeatability and accuracy of the RTS system to evaluate pubertal status of heifers prior to the onset of the breeding season. Rathmann (2005) quantified the relationship between RTS of heifers and 2-year reproductive performance in 90-day natural mating breeding systems under range conditions. Heifers with a RTS of 1 were lighter at weaning and younger at the start of breeding than heifers of RTS from 2 to 5. Pregnancy rate as a yearling and as a first calf heifer was only 62.5% for heifers with RTS of 1 or 2 compared with 91.2% for heifers with RTS of 3, 4 or 5 ($P<0.01$).

First-calf Heifer Management

Heifers should achieve a body condition score of 6 at first calving in order to optimize rebreeding efficiency and enhance the probability of conception early in the breeding season. Restriction of the suckling stimulus can accelerate the initiation of ovarian cyclicity after parturition. Methods of suckling restriction include early weaning, once- or twice-daily suckling and short-term calf removal (typically 48 to 72 hours). These management techniques are more labor intensive and require appropriate feeding and health strategies to ensure adequate growth rate of the calf.

The presence of bulls hastens the onset of ovarian cyclicity (Custer et al., 1990) and improves reproductive performance (Fernadez et al., 1993) in first-calf, suckled beef cows. This management practice typically requires that the bulls are modified to prevent the presence of spermatozoa in the ejaculate and (or) to prevent their ability to achieve copulation. A recent study by Berardinelli and Joshi (2005) reported an alternative approach to achieve the desired response without joining bulls with the cows. Beginning on day 35 after calving, primiparous cows were restricted to suckling twice-daily and assigned to one of four treatments. Cows were exposed to a bull (BE), exposed to excretory products of a bull (EPB), not exposed to a bull (NE) or exposed to excretory products of cows (EPC). Cows in the EPB and EPC groups were placed in enclosures from 1830 to 0800 daily, and the enclosure was either occupied by bulls (EPB) or left empty (EPC) from 0800 to 1830 daily. Mean interval to resumption of luteal function reduced for BE and EPB groups. In addition, the exposure to exretory products of cows hastened resumption of luteal function compared to NE cows by 60 daysof treatment.

Conclusions

Successful development and management of replacement heifers requires formulation of a plan that spans the continuum from the mating decisions involved with production of the heifer calf through timely rebreeding of the young cow. Technologies that encompass genetics, nutrition, health, reproduction and animal behavior need to be effectively integrated in order to accomplish the objective of producing replacement females that will calve early as a two-year-old and continue calve early in subsequent years.

References

Anderson, K. J., D. G. Leferer, J. S. Brinks, and K. G. Odde. 1991. The use of reproductive tract scoring in beef heifers. Agri Practice 12: 19-26.

Berardinelli, J. G. and P. S. Joshi. 2005. Initiation of postpartum luteal function in primiparous restricted suckled beef cows exposed to a bull or excretory products of bulls or cows. J. Anim Sci. 83: 2495-2500.

Buddenberg, B. J., C. J. Brown, Z. B. Johnson, J. E. Dunn and H. P. Patterson. 1989. Heritability estimates of pregnancy rate in beef cows under natural mating. J. Anim Sci. 67: 2589-2594.

Custer, E. E., J. G. Berardinelli, R. E. Short, M. Wehrman, and R. Adair. 1990. Postpartum interval to estrus and patterns of LH and progesterone in first-calf suckled beef cows exposed to mature bulls. J. Anim. Sci. 68: 1370-1377.

Doyle, S. P., B. Z. Golden, R. D. Green, and J. S. Brinks. 2000. Additive genetic parameter estimates for heifer pregnancy and subsequent reproduction in Angus females. J. Amin. Sci. 78: 2091-2098.

Fernandez, D. L., J. G. Berardinelli, R. E. Short and R. Adair. 1993. Temporal requirement for the presence of mature bulls to alter the postpartum period to resumption of ovarian cycling activity and reproductive performance in first-calf suckled beef cows. Theriogenology 39:411-419.

Freetly, A. C., C. L. Ferrell, and T. G. Jenkins. 2001. Production performance of beef cows raised on three different nutritionally controlled heifer development programs. J. Anim. Sci. 79:819-826.

Funston, R. N. and G. H. Deutscher. 2004. Comparison of target breeding weight and breeding date for replacement beef heifers and effects on subsequent reproduction and calf performance. J. Anim. Sci. 82:3094-3099.

Grings, E. E., R. B. Staigmiller, R. E. Short, R. A. Bellows and M. D. MacNeil. 1999. Effects of stair-step nutrition and trace mineral supplementation on attainment of puberty in beef heifers of three sire breeds. J. Anim. Sci. 77:810-815.

Haley, D. B., D. W. Bailey and J. M. Stookey. 2005. The effects of weaning beef calves in two stages on their behavior and growth rate. J. Anim. Sci. 83:2205-2214.

Hancock, R. F., G. H. Deutscher, M. K. Nielsen, and D. J. Colburn. 1994. Effects of Synovex C implants on growth rate, pelvic area, reproduction and calving performance of replacement heifers. J. Anim. Sci. 72:292-299.

Lefever, D. G. and K. G. Odde, 1986. Predicting reproductive performance in beef heifers by reproductive tract evaluation before breeding. CSU Beef Program Report, Fort Collins, CO. p. 13-5.

Lopez-Diaz, M. C., M. C. Carro, C. Cadorniga, P. Diez-Banos, and M. Mezo. 1998. Puberty and serum concentrations of ovarian steroids during prepuberal period in

Friesian heifers artificially infected with Fasciola hepatica. Theriogenology 50: 587-593.
Martinez, G. E., R. M. Koch, L. V. Cundiff, K. E. Gregory, S. D. Kochman and L. D. van Vleck. 2005. Genetic parameters for stayability, stayability at calving and stayability at weaning to specified ages for Hereford cows. J. Anim. Sci. 83: 2033-2042.
Moseley, W. M., M. M. McCartor and R. D. randel. 1977. Effects of monensin on growth and reproductive performance of beef heifers. J. Anim. Sci. 45:961.
Paczkowski, M., T. M. Craig, D. D. Magee, J. A. Thompson, and D. W. Forrest. 2004. Effects of experimental Fascioliasis on puberty in beef heifers. Beef Cattle Research in Texas, Texas A&M University, College Station, pp 177-182.
Price, E. O., J. E. Harris, J. E. Borgwardt, M. L. Sween and J. M. Connor. 2003. Fenceline contact of beef calves with their dams at weaning reduces the negative effects of separation on behavior and growth rate. J. Anim. Sci. 81: 116-121.
Purvis, H. T. II, and J. C. Whittier. 1996. Effects of ionophore and anthelmintic administration on age and weight at puberty in spring-born beef heifers. J. Anim. Sci. 74:736-744.
Rathmann, R. 2005. Effects of conventional or low bull to female ratio and utilization of reproductive tract scores in extensively managed, natural mating breeding groups. M. S. Thesis, Texas A&M University, College Station.
Roberson, M. S., M. W. Wolfe, T. T. Stumpf, L. A. Werth, A. S. Cupp, N. Kojima, P. L. Wolfe, R. J. Kittock, and J. E. Kinder. 1991. Influence of growth rate and exposure to bulls on age at puberty in beef heifers. J. Anim. Sci. 69:2092-98.
Rosenkrans, K. S. and D. K. Hardin. 2003. Repeatability and accuracy of reproductive tract scoring to determine pubertal status in beef heifers. Theriogenology 59:1087-1092.
Snelling, W. M., M. D. McNeil and B. L. Golden. 1996. Genetic evaluation of heifer pregnancy. In: Proc. Beef Improvement Federation 28th Research Symposium and Annual Meeting, Birmingham, AL. pp 194-199.
Thallman, R. M., L. V. Cundiff, K. E. Gregory and R. M. Koch. 1999. Germplasm evaluation in beef cattle – cycle IV: Postweaning growth and puberty of heifers. J. Anim, Sci. 77:2651-2659.
Whittier, J. L., G. P. Lardy and C. R. Johnson, 2005. Precalving nutrition and management programs for two-year old beef cows. Prof. Anim. Sci. 21:145-150.
Wolfe, N. W., T. T. Stumpf, P. L. Wolfe, M. L. Day, R. M. Koch and J. E. Kinder. 1990. Effect of selection for growth traits on age and weight at puberty in bovine females. J. Anim. Sci. 68:1595-1602.