

REVIEW

REVIEW: System application of sexed semen in beef cattle

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ABSTRACT

Significant amounts of sex-selected or sexed semen only became commercially available to the beef industry in 2008. The use of sexed semen in the beef industry may be limited by information on results in various applications as well as reduced reproductive efficiency. Use of sexed semen in AI applications in beef cattle results in a 10 to 20% decrease in AI pregnancy rates. This decrease is consistent with observations in dairy cattle inseminated with sexed semen. However, 89 to 94% of females pregnant to sexed semen produce calves of the desired sex. Pregnancy rates to sexed semen are not different among beef heifers and postpartum beef cows. The percentage of transferable embryos from embryo-transfer or in vitro-fertilization procedures is reduced when sexed semen is used in place of conventional semen. Despite the reduction in overall pregnancies or embryos from the use of sexed semen, the economic and genetic advantage of producing more offspring of a desired sex may offset the reduction in total calves produced. Feasible applications for sexed semen in beef cattle include generation of crossbred maternal-line females, reducing generation interval by heifers producing only heifers, and shifting of sex ratios to enhance marketing. In addition, the ap-

plication of sexed semen in in vitro-fertilization systems appears to be extremely promising.

Key words: sexed semen, beef cattle, system

INTRODUCTION

Sexed semen became commercially available to the dairy industry in 2003 with widespread use by 2006 (De Vries, 2012). In comparison, use of sexed semen in the beef industry was limited by low availability of sexed semen, need for application, and variable economic returns. The number of beef sires with commercially available sexed semen increased from 0 in 2007 to over 70 in 2011 (Hall, 2011). Increased research in the efficacy of AI with sexed semen in production beef situations provides new insight into the potential applications and economic returns to the use of sexed-semen technology in the beef industry.

Technological adoption usually lags behind development of new technology at a rate dictated by emergence of new applications as well as positive economic advantage. For example, color television was developed in the early 1950s but did not reach 50% market penetration until the mid-1970s because of the lack of color broadcasts and no significant information advantage from having a color

set (The Wall Street Journal, 1998). In contrast, the switch to smart phones has been rapid, partially because of the large number of applications available.

Adoption of technology in the beef industry is slow, particularly in the cow-calf sector. Use of AI in the beef industry (6.4% of all females) still lags behind the dairy industry (72.5% of females) because of labor, cost, and difficulty of use (USDA-APHIS, 2009 a,b). Use of fixed-time AI (FTAI) should improve application of AI in beef cattle (Patterson et al., 2003). In addition, economic and market signals support the use of AI to enhance production and product quality. The increased availability of sexed semen from beef sires, along with an interest in its use in seedstock and commercial sectors, is the primary impetus for this review and discussion of potential applications of sexed semen in beef cattle.

REVIEW AND DISCUSSION

Results of AI with Sexed Semen in Beef Cattle

Controlled studies comparing sexed semen from beef sires in beef-cattle breeding programs are considerably more limited than experiments in dairy cattle. However, with the greater availability of sexed semen

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from beef sires, the amount of research data are increasing. Sufficient data are available to give some insight to the successes and limitations of sexed semen in the commercial and seedstock sectors of the beef industry.

Results in Heifers. Early work that combined results from dairy and beef heifers indicated that conception rates to sexed semen were 70 to 90% of conception rates to conventional semen (Seidel et al., 1999). Deutscher et al. (2002) reported a 3 to 13% reduction in AI pregnancy rates when using sexed semen compared with conventional semen in yearling beef heifers. Similarly, a wide variation in the reduction of pregnancy rates was reported when using sexed semen compared with conventional semen in beef heifers (4 to 38% reduction; Rhinehart et al., 2011). More recently, insemination of heifers synchronized by the melengestrol acetate-prostaglandin protocol (Johnson et al., 2013) with sexed semen resulted in a 17% decrease in pregnancy rates to AI compared with heifers inseminated with conventional semen (Meyer et al., 2012). In this study, heifers detected in estrus were bred 12 to 18 h after estrus, whereas heifers not detected in estrus were mass mated at 72 h after administration of prostaglandin $F_{2\alpha}$. A concomitant dose of gonadotropin-releasing hormone was given at insemination. Overall, these results are consistent with studies in dairy heifers that indicate a 10 to 20% decrease in conception rates with sexed semen compared with conventional semen (DeJarnette et al., 2009).

Results in Postpartum Cows. Fixed-time AI combined with conventional semen resulted in pregnancy rates exceeding 60% in multiple studies (Patterson et al., 2011). Although use of sexed semen with FTAI has been discouraged, the use of FTAI with sexed semen in postpartum cows holds some promise. From 2008 to 2010, our laboratory investigated the use of X-sorted sexed semen in postpartum beef cows to produce replacement females (Hall et al., 2010). During this time period, cows were

bred using fixed-time AI after the 5-d CO-Synch + CIDR protocol (Johnson et al., 2013) regardless of semen type, except in 2008 when 37 cows were inseminated with sexed semen after detected estrus. Over the 3-yr period, AI pregnancy rates for cows bred with sexed semen (52%; $n = 235$) were decreased by 6% compared with cows inseminated with conventional semen (58%; $n = 507$). These results were obtained with a limited number of bulls (4 sexed-semen bulls and 8 conventional-semen bulls). In addition, there was considerable year-to-year variation with a pregnancy rate depression of up to 20% for sexed semen compared with conventional semen (Hall et al., 2010). Other laboratories reported reductions in AI pregnancy rates of 9 to 33% for cows bred by FTAI with sexed semen compared with those inseminated with conventional semen (Sá Filho et al., 2010; Rhinehart et al., 2011).

The results of AI with sexed semen in beef heifers and cows indicate that application of sexed semen to the beef industry is feasible. However, adoption of any application of sexed semen must be entered into with the knowledge of the downside risks of reduced AI pregnancy rates. Current experiments aimed at improving our understanding of the role of follicular size, timing of insemination, and differences in bull fertility after sex sorting (Sá Filho et al., 2010; Meyer et al., 2012) should enhance results with the application of sexed semen in the near future.

Calves produced from sexed semen are normal with growth rates comparable to their herdmates that are products of conventional semen. Across 3 calving seasons, there was no difference in weaning weights of AI calves from sexed or conventional semen (Hall et al., 2010; Hall and Glaze, 2012). Similarly, Tubman et al. (2004) found no difference in abortion rates, birth weight, calving ease, calf vigor, calf health, weaning weights, or mortality before weaning in more than 1,100 calves from sexed semen compared with 793 calves from conventional semen.

Applications of Sexed Semen in the Beef Industry

Development of Maternal Lines. The effect and value of heterosis derived from use of crossbred females in the commercial cowherd is well documented (Olson et al., 1978; Dearborn et al., 1987; Gregory et al., 1987; MacNeil et al., 1988). Maternal lines mated to terminal sire lines are used effectively in several other meat species to enhance product output and quality. Similar breeding strategies are effective in beef production as well. However, adoption is limited by the ability of the cow-calf operation to generate crossbred females while breeding replacement heifers. This is especially true in herds of less than 100 cows.

Despite the documented advantages, adoption of systematic crossbreeding and terminal sires in the cow-calf sector has been limited by need for separate herds, multiple breeds of bulls, and variation in calf crop. Even a simple 2-breed rotational cross is difficult in small herds or results in excessive variation in calf uniformity. Sexed semen provides the technology to generate crossbred replacements from a small group of elite cows while the remainder of the cowherd is mated to terminal sires.

From 2008 to 2013, our laboratory has included using sexed semen (X-sorted) on 20% of the cows to generate Angus × Hereford replacement heifers. In this paradigm, cows are identified as candidates as “heifer dams” before the breeding season based on performance records, visual appraisal, and, in the near future, custom EPD. These elite cows are bred once by FTAI to X-sorted semen followed by natural mating to a maternal-type bull. Cows pregnant to sexed semen (X-sorted) consistently produced calves that were 90 to 92% female. Overall, calves from this group of females were 62 to 78% female (Hall et al., 2010; J. B. Hall, unpublished data). The cows not chosen as heifer dams were mated to terminal-type Angus and Simmental sires.

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