Use of embryo transfer to increase the fertility of dairy herds during the summer heat stress and in repeat breeder cows

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Introduction

Although Embryo transfer (ET) is a reproductive technology widely used around the world to reproduce the animals with high genetic merit, the application of this technology in combination to traditional artificial insemination (AI) can improve the reproductive performance of high producing dairy herds. The main reason for that potential improvement is the higher fertility reported after embryo transfer in cows experiencing heat stress (Ambrose et al., 1999; Baruselli et al., 2010; Putney et al., 1989; Rodrigues et al., 2004, 2007a, 2007b; 2011) and those diagnosed as repeat-breeders (Dochi et al., 2008; Ferreira et al., 2011; Rodrigues et al., 2010; Stewart et al., 2011). The objective of this brief review is to show information generated in recent years that demonstrate how embryos can improve the fertility in dairy herds because it bypasses the problems associated with disruption of the oocyte, fertilization rates and early embryo development.

Embryo Transfer during the period of Heat Stress

Heat Stress has a tremendous deleterious effect on fertility in dairy herds around the world, especially in those areas in which summers are hot and humid. Embryo transfer is an effective tool to increase fertility during heat stress because it bypasses the damage to the oocyte and early embryo caused by hyperthermia. The oocyte can be damaged by heat stress for at least 105 days after exposure to high temperatures (Torres Jr et al., 2008) and remains sensitive to heat stress on the day of ovulation (Putney et al., 1989). The early embryo can be also damaged by heat stress but soon acquires biochemical mechanisms that protect it from elevated temperatures (Hansen, 2013). Thus, heat stress on the first day after estrus reduced embryonic development but heat stress had no effect when the embryos are between 3 to 7 days (Ealy et al., 1993). A 7-day morula and blastocyst stage embryos that

are typically transferred into recipients, are largely resistant to damage by maternal hyperthermia. Furthermore, transferring embryos in a recipient 7 days after estrus diminish the adverse effects of heat stress on ovulation, since only recipients with a corpus luteum detected by rectal palpation or ultrasonography will receive and embryo by non-surgical transfer.

A retrospective study was performed using lactating Holstein cows that were submitted to ET or AI after detection of estrus (Rodrigues et al., 2007a). Conception rates were higher across the year, but the differences were more pronounced in the warmer months of the year (November through April in the southern hemisphere) than in the cooler months of the year (Figure 1).

Embryonic loss between 30 and 60 days of pregnancy was also compared retrospectively in lactating Holstein cows subjected to AI or ET during summer and winter (reviewed by Baruselli et al., 2011). As it is shown in Figure 2, there were differences for breeding technique (AI versus ET; P=0.001), season (hot versus cool; P=0.001) and an interaction of breeding technique and season (P=0.003) on conception rates. Although, pregnancy loss was higher for ET than for AI (P=0.001) and season (P=0.001), cows receiving embryos had higher pregnancy rates after 60 days than those AI (Figure 2). Therefore, a useful management tool to maintain high pregnancy rates throughout the year would be to produce embryos during the cooler months and use them for ET during the periods of heat stress.

Embryo transfer in repeat breeder cows

Repeat breeder cows are usually defined as cows that do not become pregnant over a period of time that do not have any apparent abnormality that can be diagnosed by a veterinary examination. The reasons for poor fertility in these cows are still controversial. Although some authors reported poor fertilization rates (Graden et al., 1968) others have found similar fertilization rates after AI (Sartori et al, 2002). Others reported higher early embryonic losses (Albihn et al., 1989, 1991; Gustafsson and Larsson, 1985). Irrespective of the reason of their poor fertility, the presence of repeat breeder cows adversely affects the reproductive performance of dairy herds (Ferreira et al., 2010; Yusuf et al., 2010). In a recent study, the transfer of embryos to repeat breeder recipients resulted in increased repeat breeder pregnancy rates compared to AI, without differences in embryo/fetal losses between 30 and 60 days (Ferreira et al., 2010).

In another retrospective study (Rodrigues et al., 2007b; Figure 1), conception rates in repeat breeder Holstein cows were greater after ET (41.7%; 1609/3858) than after AI (17.9%; 1019/5693), supporting the notion that the fertility problem in some repeat-breeders may be associated with oocyte

quality and/or failure of early embryo development (Figure 1). Other reports have also shown significant improvements in pregnancy rates using in vivo (Dochi et al., 2008; Son et al., 2007) or in vitro produced embryos (Block et al., 2010) in repeat breeder cows. The best strategy to have an impact on the Fertility of the herd is to transfer the embryos at a fixed-time (without estrus detection. In yet a more recent study that compared the use of prostaglandin F2α (PGF) or fixed-time embryo transfer (FTET) it was shown that the use of a FTET protocol increased the proportion of recipients transferred and improved pregnancy rates in repeat breeder dairy cows (Rodrigues et al., 2010).

In summary, although the embryo transfer technology has been used primarily for nearly 40 years to disseminate the desirable traits, the technology can now be used to resolve reproductive problems such as the reduced fertility found during heat stress and in repeat breeder cows.

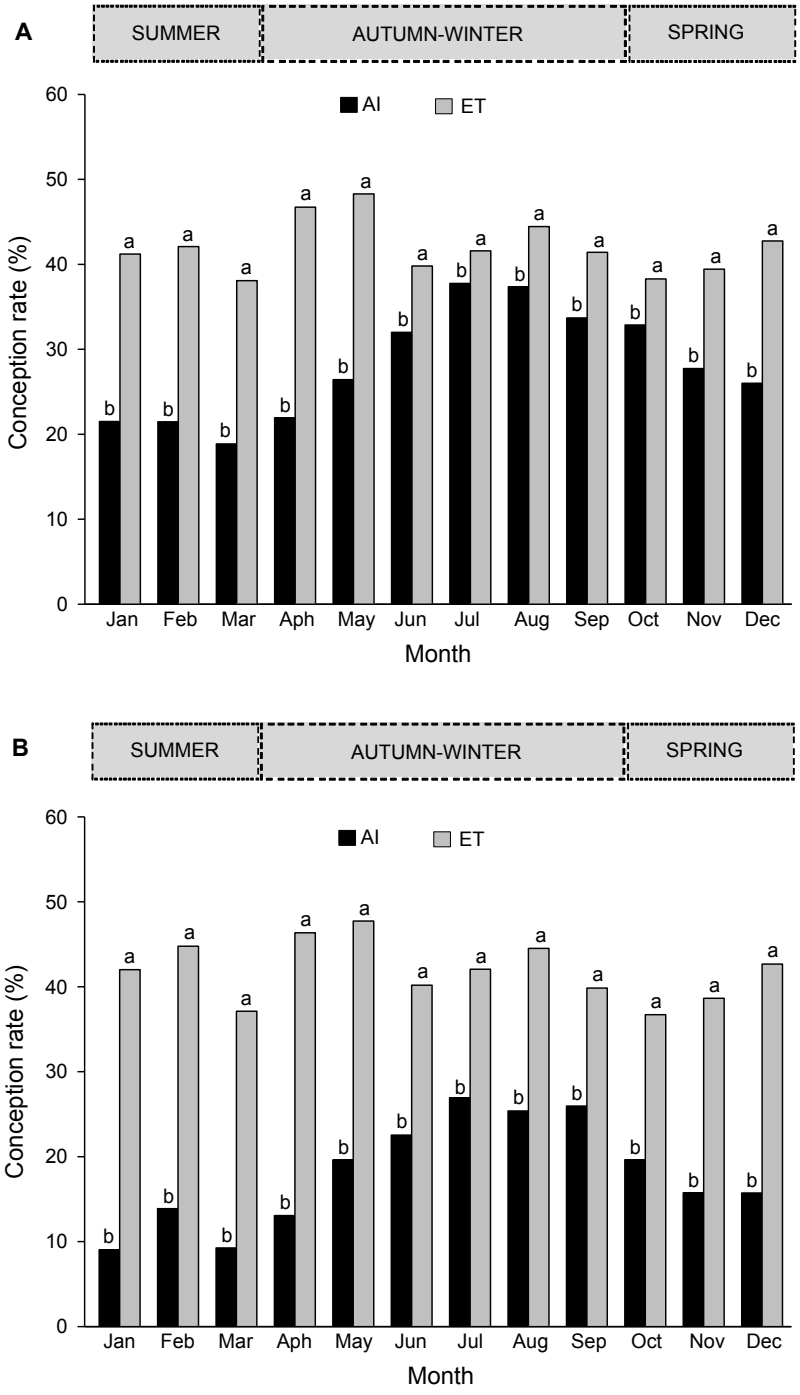

Figure 1. Conception rates of high-producing Holstein cows submitted to AI (black bars) or embryo transfer (ET; gray bars): (A) non-repeat breeders (AI = 18,568 and ET = 4,871) and (B) repeat breeders (≥4 services; AI = 5,693 and ET = 3,858; adapted from Rodrigues et al. (2007).

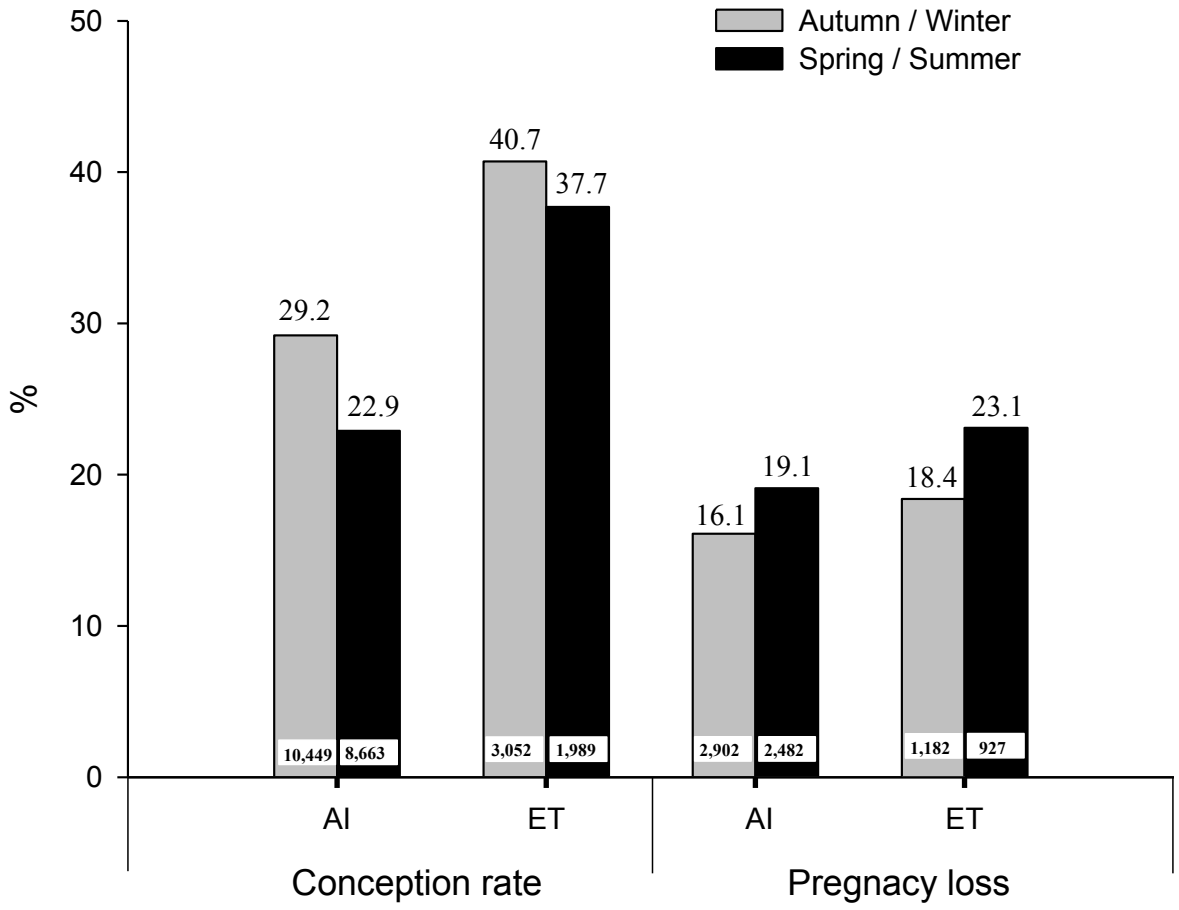

Figure 2. Conception rate and pregnancy loss (between 30 and 60 d) of high-producing Holstein cows subjected to AI (n=19,112) or embryo transfer (ET; n = 5,364) during hot (gray bars) and cool (black bars) seasons. There were differences for breeding technique (AI versus ET; P=0.001), season (hot versus cool; P=0.001) and an interaction of breeding technique and season (P=0.003) on the conception rates. Pregnancy loss was influenced by breeding technique (P=0.001) and season (P=0.001), but there was no interaction (P=0.55); adapted from Baruselli et al., 2011.

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