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Comparing gender-selected A.I. semen pregnancy results in heifers and cows

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There are two populations of sperm in bull semen. One consists of X-chromosome-bearing sperm; the other consists of Y-chromosome-bearing sperm. In contrast, **all** cattle ova contain an X chromosome. That is why when an X-chromosome-bearing sperm fertilizes the ovum a female (XX) develops, and when a Y-chromosome-bearing sperm fertilizes the ovum, a male (XY) develops.

Ratios of the number of male and female calves born are usually very close to 50:50 – which is why the ability to select the gender of calves in advance could have a significant impact on the genetics and economics of your dairy herd.

How are X and Y sperm separated?

The separation of X- and Y-chromosome-bearing sperm is accomplished with the use of a high-speed cell-sorter, called a flow cytometer. The X chromosome is larger and contains approximately 4 percent more DNA genetic material than the smaller Y chromosome. After sperm are treated with a fluorescent dye, the X-chromosome-bearing sperm glow brighter when exposed to a laser than Y-chromosome-bearing sperm because of their increased DNA content.

Next, as sperm flow through the sorter single-file, a positive or negative electrical charge is attached based on the sperm's florescence intensity. Sperm then pass an electrical field and the X- and Y-chromosome-bearing sperm are sorted into different collection tubes.

Although current technology allows for 90 percent separation accuracy at a rate of approximately 3,000 to 5,000 sperm per second, the process is slow. In fact, it would take about 1.5 hours to sort the 20 million sperm in just one conventional A.I. dose. Since this is not economically feasible, research has focused on maximizing fertility of low numbers (1 to 3 million) of frozen-thawed, gender-separated sperm. Currently, a commercial dose (.25 mL) of gender-separated sperm usually contains approximately 2.1 million sperm.

Research results in heifers

Numerous research trials using frozen-thawed, gender-separated sperm have reported conception rates in dairy and beef heifers that were 70 to 90 percent of frozen-thawed, non gender-separated controls. Recent published data from Select Sires, Inc. reveals that greater than 70 percent of herds using gender-separated sperm achieved a conception rate of greater than 70 percent of first-service control heifers (bred with frozen-thawed, non gender-separated sperm). Therefore, if you currently achieve a 70% conception rate in your heifers with frozen-thawed, non gender-separated semen, you can expect to achieve a conception rate between 49 and 63 percent with frozen-thawed, gender-separated sperm. Most reports describe an accuracy of 90 percent in the predetermination of the sex of calves born. Furthermore, there is no evidence that gender-selecting procedures result in abnormal offspring.

Why the difference in conception rates between frozen-thawed, gender-separated sperm and frozen-thawed, non gender-separated controls? It may be due to:

1. Sperm injury during the staining process prior to flow cytometry.
2. The current inability to determine before separation if a semen sample from a bull will be able to withstand gender separation, freezing and thawing, while still retaining acceptable fertility.

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3. Low sperm numbers deposited in the female.

It is widely known that sperm from different bulls differs in its ability to withstand freezing. Therefore, staining sperm from different bulls will most certainly differ in the ability to tolerate gender selecting and freezing.

Gender-separation research has traditionally focused on heifers because well-managed heifers tend to have conception rates resulting from A.I. with frozen-thawed, non gender-selected semen of up to 70 percent, compared to less than 40 percent in lactating cows. Furthermore, low numbers of sperm may achieve greater relative success in heifers because of the virgin reproductive tract and lack of intense nutritional demands such as no lactational or postpartum stress.

Not surprisingly, gender-selected sperm is currently recommended for use only in well managed virgin heifers that exhibit signs of natural estrus.

Research results in lactating cows

Although the current recommended use for gender-selected sperm is in virgin heifers only, recent research has focused on the use of gender-selected sperm in lactating dairy cows. In one of the first reports, researchers from Finland reported an average conception rate of 21 percent with gender-selected sperm and 46 percent with conventional, non gender-selected sperm following first-service in Holstein cows. No estrus or ovulation synchronization was used in this study. The conception rate achieved with gender-selected sperm was 45.6 percent of conventional sperm.

In another study conducted by scientists in the U.S., Holstein cows (lactation 1 to 4, and between 20 and 140 days in milk) were artificially inseminated with gender-selected sperm or conventional sperm after synchronization (prostaglandin or Ovsynch) or natural estrus.

Overall conception rates were 25 percent for cows in the gender-selected group, and 37.7 percent for cows in the conventional group. Conception rate achieved with gender-selected sperm was 66.3 percent of conventional sperm.

Cows receiving A.I. with gender-selected sperm following a natural estrus had a greater conception rate than cows that were synchronized (either with prostaglandin or Ovsynch). Furthermore, conception rates following A.I. with gender-selected sperm at 100 days in milk or more were approximately 8 percent higher than earlier in lactation, and over 6 percent lower in older cows (third and fourth lactations) than in younger cows.

Consequently, the researchers concluded that the highest conception rates following A.I. with gender-selected sperm may be achieved in first and second lactation cows exhibiting natural estrus and being greater than 100 days in milk.

Another study recently focused on the efficacy of selecting only "reproductively normal" lactating dairy cows for timed A.I. (Ovsynch) with gender-selected sperm. All cows (lactation 1 to 9) were initially enrolled in Presynch (two injections of prostaglandin 14 days apart). After the second prostaglandin injection, ultrasonography was performed and only those cows with normal ovarian and uterine status (55 percent of the total evaluated) were enrolled in Ovsynch. Timed A.I. was performed 16 to 19 hours after the second GnRH injection of Ovsynch.

The overall conception rates were 40.4 percent for cows receiving gender-selected sperm, and 55.6 percent for cows inseminated with conventional sperm. Conception rate with gender-selected sperm was 72.6 percent of conventional sperm. Although the authors concluded that conception rates of presynchronized, reproductively normal lactating cows following timed A.I. were acceptable, they cautioned that the study was very small (~115 animals) and should not be over interpreted.

Gender-selected sperm will not be the "silver bullet" to cure what ails a reproductive and/or replacement program.

Reproductive success with frozen-thawed, gender-selected sperm in lactating cows is likely to be elusive. Outside the confines of a controlled research trial, conception rates following A.I. with gender-selected sperm in lactating dairy cows are likely to be unacceptably low, perhaps due to:

1. Previous "wear and tear" on the uterus.
2. Completeness of uterine involution at the time of A.I.
3. Nutritional and lactation demands.
4. Inherent lower fertility of lactating cows.
5. Inability to accurately detect heat and or comply with all the components of a reproductive protocol. Consequently, usage of gender-selected sperm in lactating dairy cows is still not recommended.

Practical use, cost and availability of gender-selected sperm

Currently, the most obvious practical use of gender-selected sperm is to breed heifers to have heifer calves, thus decreasing the incidence of calving difficulty, as heifer calves tend to be lighter than bull calves at birth. To further reduce calving difficulty it may also be possible to use X-chromosome-bearing sperm from a bull known to produce a low percentage of calves with difficult births.

Perhaps more important for some dairy producers, however, will be the ability to heavily use X-chromosome-bearing sperm to enable closed herd expansion. Closed herd expansion will virtually eliminate biosecurity risks normally present due to the introduction of purchased animals.

Sexing Technologies (www.sexingtechnologies.com) is currently sorting X- and Y-chromosome-bearing sperm for Select Sires, Inc., ABS Global, Alta Genetics, Genex, Heifer Quest, and Lagoa (a subsidiary of Holland Genetics located in Brazil). The cost of gender-selected sperm is currently $30 to $55 per dose.

Accelerated Genetics does not currently have a gender-selected sperm product on the market. Instead, Accelerated Genetics recently developed Bovatel, a gender-bias semen product that is advertised as being able to yield 10 additional heifer calves for every 100 pregnancies.

Although four of the five major U.S. A.I. studs are currently marketing gender-selected sperm from a variety of bulls, it is unrealistic to believe that gender-selected sperm from the most elite bulls will be available anytime soon, due, in part, to:

1. Slow processing speed.
2. Disposal of greater than 50 percent of each ejaculate that is sorted (the undesired Y-chromosome-bearing sperm, and sperm the flow cytometer is unable to distinguish as X- or Y- chromosome-bearing).
3. The reality that gender-selected sperm from different bulls will most certainly differ in their ability to tolerate sexing, freezing and thawing, and to achieve acceptable conception rates when used at low sperm numbers per A.I. dose.

Final thoughts and considerations

Gender-selected sperm is available in .25 mL straws, which require the use of an A.I. breeding gun that is designed to accommodate the smaller diameter straws. Although .25 mL straws containing gender-selected sperm may be handled similarly to .5 mL straws, their smaller diameter makes them more sensitive to cold shock and to semen handling errors.

Gender-selected sperm will not be the "silver bullet" to cure what ails a reproductive and/or replacement program. As gender-selected sperm is used by dairy producers, success will be achieved by those with intense management skills.

Accurate heat detection and well-trained inseminators will be mandatory to maximize fertility with gender-selected sperm. Furthermore, herds struggling with poor management, inaccurate heat detection, and improper semen handling will continue to struggle and may witness plummeting conception rates while using gender-selected sperm.

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