Sexed Semen: Is It Finally a Reality?

by Mel DeJarnette, reproduction specialist

Most of us have heard the rumor that sexed semen is "just around the corner" for as long as we have been aware of A.I. Through the years, countless numbers of techniques have been investigated with little to no indication of repeatable success.

However, in the 1980s a breakthrough in semen sexing technology was made by USDA researchers in the Lawerence Livermore Laboratory in California. The patents for this technology were licensed to a company named XY Inc. of Fort Collins, Col., which has performed a considerable amount of research during the 1990s to optimize efficiency of these sorting procedures.

Commercialization of sexed semen in the United States has been initiated with a 2003 license granted to Sexing Technologies (ST) in Navasota, Texas. Select Sires and ST are partnering to bring highly proven, Gender SELECTed™ Sires to U.S. dairy producers.

Flow-Sorting Technology

The only repeatable technique to sex sort sperm uses a device called a flow-cytometer to detect a 3 to 4 percent difference in DNA content between male and female sperm. The first step in this procedure is to dilute sperm to a very low concentration and stain them with a fluorescent dye. The sample is then sent through the flow-cytometer at 60 mph under 40 to 60 psi of pressure. As sperm pass through the internal laser beam, the fluorescent dye is excited. Because of the larger X chromosome, female sperm emit slightly more light than male sperm, which possess the smaller Y chromosome. Detectors measure the amount of fluorescence and assign positive or negative charges to each droplet containing a single sperm. Charged deflector plates then split the single stream into three streams: positively charged particles containing one sex go one way, negatively charged particles containing the other sex are deflected in the opposite direction, while uncharged droplets containing multiple sperm or sperm with unidentified sex pass straight through. Confirmed with tens of thousands of offspring born in world-wide research trials, the procedure separates sperm of the two sexes with approximately 90 percent purity.

Technology Limitations

There are several major limitations that have stifled implementation of sex-sorted semen. Without question, reduced conception rate has been a primary hurdle. As you can image from the description above, sex sorting of sperm is a highly invasive procedure that negatively impacts sperm viability and longevity compared to normally cryopreserved semen.

In addition, the procedure is extremely slow and inefficient. To properly sort, sperm must be precisely oriented as they pass through the laser and fluorescence detectors in the flow cytometer. Due to the flat shape of bovine sperm heads, only about 30 percent are correctly oriented and half of these are female. Thus, only 15 percent of the sperm going into the machine are recovered as a marketable, sexed product. Although the 3,000 to 5,000 sperm of each sex sorted per second sounds like a lot, this translates into approximately 1.3 hours of sorting to process enough semen for a standard 20 million sperm/straw dosage. Thus, due to the slow sorting speed, commercialization is only possible with very low sperm numbers per straw (about 2 million). If these limitations were not enough, the high cost of flow cytometry equipment (approximately $250,000 per machine) and intensive amounts of highly skilled labor required to sort sperm dictates that sexed semen will not be inexpensive. Because of the low sperm numbers per dose and compromised sperm viability, sex-sorted semen is only recommended for use in well-managed, highly fertile virgin heifers. While many research herds have realized very acceptable conception rates, averages indicate well-managed herds that achieve 60 to 65 percent conception rates in virgin heifers with normal semen can expect 45 to 55 percent conception rates with sexed semen. Sex-sorted semen is ***not*** recommended for lactating cows. Sex-sorted semen should also not be used when flushing for embryo transfer.

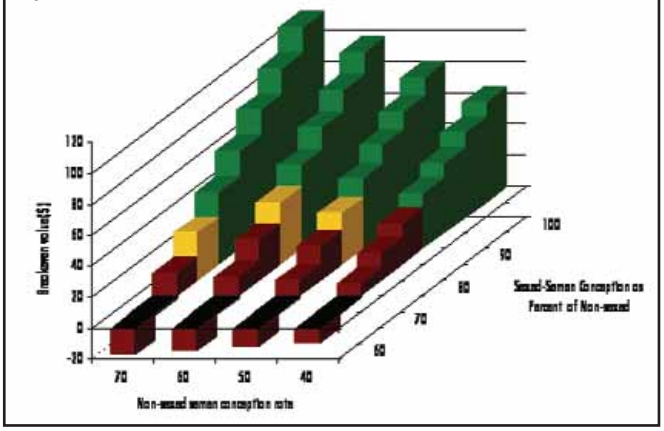
Is sexed-semen ready for the market and is the market ready for sexed semen?

Select Sires would like to state openly and honestly from the onset with no sugar-coating of the subject: We don't know the answers to these questions.

After describing the facts and background of sexed-semen technology, many producers suggest they would still like to give it a try. Select Sires is introducing Gender SELECTed Sires to the U.S. market in a cautious effort to try and answer these questions while providing a valued product and service to our member owners. Although the high rate of sperm loss precludes use of our "most elite" sires for production of sexed semen, we are making available semen from several genetically outstanding, proven Holstein and Jersey sires for research herds willing to help us answer these questions.

The return on investment for the dairy producer depends on a complex interaction between the initial conception rate with non-sexed semen, the percent reduction in conception (if any) due to use of sexed semen, the price differential between sexed and conventional semen, and the value differential between bull and heifer calves. Most of these factors will change considerably from herd to herd, which differentially affects the breakeven value of sexed semen to each respective producer. Figure 1 illustrates how the conception rate of both non-sexed and sexed semen interacts to influence the breakeven value of sexed semen to the producer. By breakeven value I mean: How much extra (not counting genetic value of semen) can the producer afford to pay for sexed semen and still show a

Figure 1. Breakeven value from use of sex-sorted semen.



return on investment. Even when sexed semen conception rates are 100 percent of non-sexed (i.e., no reduction), it's clear from the back row that herds with higher conception rates have a higher breakeven value and thus a greater opportunity to harvest a return on investment. However, irrespective of the initial conception rate, reduction in conception with sex sorted sperm can be tolerated and still be profitable. Gender SELECTed Sires are being offered at a price of $45, which includes the genetic value of approximately $15 per sire. Thus, only $30 "extra" is being paid for the sex sorting procedure. The green bars in the figure above correspond to conception scenarios where a profitable return on investment is highly likely. The red bars illustrate non-profitable scenarios and yellow bars are basically borderline or breakeven. Previous research has demonstrated that many herds can easily harvest a return on investment from the use of sexed semen at these prices, however, we are equally confident that some herds will not.

It is for these reasons that Select is cautiously introducing Gender SELECTed Sires to the U.S. market in the form of a controlled research trial. To optimize opportunity for success and considering the fact that lower conception rate herds have marginal economic capacity to tolerate conception rate reductions, we must insist that research herds have a track record of achieving conception rates of 60 percent or better in virgin heifers with non-sexed semen. Research herds must also agree to abide by the following "Keys to Success" to ensure optimum probability for conception.

Keys to Success

Use of sexed-semen will require a breeding gun designed to accommodate the smaller diameter ¼-cc straws. Straws are to be thawed and handled identical to their ½-cc counterparts. However, the smaller diameter and compromised semen quality will make them much more sensitive to cold shock and errors in semen handling. To maximize potential for success:

- Thaw straws in 95°F water bath for 45 seconds.
- Semen thawing and handling environments should be warm and draft free.
- Warm all semen handling equipment including guns, sheaths, and paper towels prior to contacting straws.
- Only highly experienced technicians should use this product.
- Use only in well-managed, virgin heifers that have achieved greater than 60 percent of their mature weight by 14 months and are in moderate or better body condition.
- Inseminate heifers eight to 12 hours after observed estrus (AM/PM Rule).
- Use of estrus synchronization and breeding to observed estrus is encouraged, but use of timed-A.I. in the absence of observed estrus is discouraged.

Can Anyone Purchase Gender SELECTed Semen?

Once the initial research semen has been allocated, there will be limited opportunities for other herds to purchase semen from Gender SELECTed Sires. However, Select Sires only condones use of this product in virgin heifers and only if 60 percent or better conception rates can be achieved with non-sexed semen. Again, Gender SELECTed Sires should ***not*** be used in lactating cows or in animals super-ovulated for embryo transfer (cows or heifers).

Semen Identity and Packaging

Sex-sorted (female) semen will be packaged in pink ¼-cc straws. As shown above, each straw will be labeled with the sire's complete identification as would be on a normal straw. Additionally, the phrase "Sexed Female" will be printed at the beginning of the identification line and the number "203" will be inserted just prior to the freeze code to represent the semen processing laboratory. Straws will be packaged with 10 straws in a single goblet placed on the bottom of each cane, rather than the typical two goblets with five straws each. Each cane of sexed semen will be identified by a pink cane top with black lettering identifying the sire's NAAB code number, short name, and the phrase "Sexed-F."

Female Probabilities

Research has consistently demonstrated that this technology produces sexed-sorted sperm with about 90 percent purity. However, that still leaves 10 percent male sperm available to compete for fertilization. Odds and ratios tell that in about 26 percent of the herds, 80 percent or less of the offspring will be female. Seven percent of the time, 70 percent or less of the offspring will be female. These are simple mathematical probabilities of which the herd owner should be aware before purchasing Gender SELECTed sires.

Summary

There is no question sex-sorted sperm for gender selection is a reality. Whether or not the technology is sufficiently developed to offer a return on investment to enough producers that it will be a commercially sustainable product is yet to be determined. In an effort to answer these questions while offering our customers the opportunity to use the latest in animal breeding technologies, Select Sires is cautiously introducing Gender SELECTed Sires to the US market. Pending results of this research phase in mid-to-late 2005, the program will either be maintained, expanded or discontinued completely. We'll keep you posted as we proceed. ◆

Select Sires makes no guarantees, expressed or implied, as to the actual conception rates and (or) gender bias that may be achieved in any given herd.

Figure 2. Sexed semen cane top and sexed semen straw.