SEXING SEMEN: THE OPPORTUNITY HAS ARRIVED

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TAKE HOME MESSAGES

- Sexed semen from dairy bulls is now commercially available.
- Sexed semen will produce about 90% heifer calves.
- Fertility with sexed semen is about 75% of normal fertility so it is only recommended for use on virgin heifers that have shown good standing estrus.

INTRODUCTION

Being able to select the sex of offspring is something that animal producers have desired for many years. The desire is often greatest when farms have a high incidence of bull calves, just by random chance. After years of research and testing, a way of sex preselection that has been tested thoroughly is now commercially available. In the last year, a technique to separate sperm to produce primarily male or female offspring has been introduced.

There are several advantages to being able to control the sex of offspring. More heifer calves allows dairy farmers to grow more of their own replacements. This is a particular advantage when biosecurity of the replacements is an issue because the replacements will have a known biosecurity status. In addition, if the calves are sold soon after birth, heifer calves are more valuable. Another advantage is that heifer calves are usually smaller than bull calves, a real advantage when the newborn calf is being delivered by a first-calf heifer.

Many stories have been told about how to produce calves of the wanted sex. For example, I remember hearing anecdotes that breeding cows facing north produces heifer calves or facing south produces bull calves or that breeding cows early or late in their cycle influences sex ratio. But in large studies none of these have been proven to provide calves of the desired sex consistently. In fact, considerable research has demonstrated that sperm that generate females and sperm that generate males are nearly identical, except for a chromosomal difference. So separating sperm based on sperm behavior or their surface proteins does not hold much promise. On the other hand, considerable research and thousands of offspring demonstrate that this new technique provides sperm that will produce offspring of the desired sex.

SORTING PROCEDURE

In the last year or so, a process that can separate sperm into those that have X and those that have Y chromosomes has become commercially available. Remember that the sperm determines the sex of the offspring. Sperm that contain an X chromosome produce females and sperm that contain a Y chromosome produce males. This new process separates sperm based on a difference in total DNA content of the sperm. The X chromosome is larger than the Y chromosome so sperm with an X chromosome have more DNA. In cattle, sperm with an X
chromosome have about 3.8% more DNA. In other animals the difference is larger. For example, in chinchillas, the difference between X- and Y-bearing sperm is about 8%, allowing easier separation of X- and Y-bearing sperm. This procedure can also be used to separate X- and Y-bearing sperm from boars, stallions and other males based on their difference in total DNA.

A machine, called a flow cytometer, can measure the amount of DNA in sperm. This is used to separate the sperm into those with X and those with Y chromosomes. To label the DNA, sperm are stained with a fluorescent stain that penetrates into sperm and binds DNA in proportion to the total amount of sperm DNA. The sperm with more DNA (with an X chromosome) have more fluorescence than sperm with a Y chromosome. The flow cytometer sends these sperm under high pressure (about 50 psi) in a stream of droplets through a chamber, one-by-one, at a high speed (about 55 mph). The amount of fluorescence, corresponding to the amount of DNA in each sperm, is measured. A laser is used to make the sperm fluoresce and a detector senses the fluorescence. Once the fluorescence is measured, a charge is placed on the droplet, depending on the fluorescence and then charged plates deflect the droplet containing a sperm into pools. One group will be sperm that have less DNA (produce males), one group will be sperm that have more DNA (produce females) and a third group will be sperm that could not be sorted and will be discarded. About 70% of the sperm aren’t sorted properly because they are not oriented properly as they pass through the flow cytometer or are at the margins of the X or Y groups and are less than 90% pure. Remember that bull sperm are shaped like a spade and they must be oriented properly to be sorted. Even though not all the sperm entering the flow cytometer are sorted, those that are sorted into the 2 groups are sorted accurately. About 90% of the sperm in the X-bearing group do, in fact, have an X-chromosome. That semen will produce 90% heifer calves.

A very practical consideration when sexing semen is that the bulls must be located near the flow cytometer. Once the semen is collected, it must be sorted before being frozen in straws. Sorting sperm that has been frozen once and then freezing it again after sorting is too damaging to sperm. This procedure is slow and only about 8-10 doses of semen can be sorted each hour. Plus the machines are expensive (more than $300,000 each) so it is a costly process. Because of the costs, there is a higher price put on the semen. Nonsexed semen that would sell for $15-20 per straw sells for $40-60 after being sexed.

**USING SEXED SEMEN**

To make the use of sexed semen economically feasible, fewer sperm are put into each straw. Rather than the 15-20 million sperm put into a typical straw of unsexed semen, which would require about an hour of sorting time, about 2 million sperm are packaged into straws of sexed semen. To accommodate fewer sperm, the straws are thinner so a different AI gun is necessary for insemination. Research indicates that fertility with a dose of sexed semen will be about 75% of what it would be with normal unsexed semen, which is partly due to a reduction in the number of sperm in the straw. But part of the fertility reduction is also because there is some damage to sperm as they are being sorted. The sperm are put under high pressure (40-50 psi) and placed under high speeds (55 mph) and then suddenly stopped as the droplets containing them are added to the sorted pools of semen. Placing sperm under these physical forces has detrimental affects on sperm.
Therefore, most scientists recommend that sexed semen be used only on virgin heifers showing very good visible signs of estrus. Sexed semen can be used on heifers whose estrus has been synchronized if the heifers were observed in standing estrus. I recommend that producers time insemination using the AM/PM rule. Breeding only once a day may reduce conception rates and fertility. I also recommend that only herds with very good reproductive management use sexed semen. There are reports that fertility can fall to 50-60% of normal AI controls if reproductive management is average or marginal. Furthermore, only very experienced inseminators should use sexed semen and he or she should follow all recommended AI procedures precisely. Even under optimal conditions, conception rates in virgin heifers are usually about 45% using sexed semen.

Users of sexed semen will not always get 9 heifers from every 10 calves born. Users of unsexed semen do not always get 5 heifers out of every 10 heifers born because of random chance. But the larger the number of calves born, the closer the percentage of heifers will be to 50%. If dairy farmers use a small number of straws of sexed semen, they may not run exactly at 90% heifers; they may be higher or lower than that. Using sexed semen, about 93% of the time, farmers would find 8-10 heifer calves in a group of 10 calves born. But 7% of the time, they would find less than 8 heifers in a group of ten. The greater the number of calves born from sexed semen, the greater than chance of getting closer to exactly 90% heifer calves.

**OPPORTUNITIES SEXED SEMEN OFFERS**

Because it will allow dairy farmers to produce heifer calves when desired, the ability to use sexed semen offers substantial opportunities for dairy producers to increase production efficiency. One can produce heifers from genetically superior animals in a herd. Animals with lower genetic merit can be bred to beef bulls to produce calves that are more valuable as beef animals than those with only dairy genetics. One may want to use unsexed semen or semen with Y-bearing sperm on the most outstanding cows to produce bull calves to be used for breeding purposes. Dairy farmers could also improve the health and welfare of first-calf heifers by allowing them to have heifer calves that will be smaller and easier to deliver than bull calves.

**RESEARCH AND DEVELOPMENT**

In the last 10 years, about 30,000 offspring have been produced using sexed semen. It has been commercially available in the United Kingdom since 2000. To date, no defects have been found in the offspring. Calves resulting from the use of sexed semen were not different in gestation length, birth weight, calving ease, calf vigor, abortion rate, death rate and incidence of abnormalities. Of course, heifer calves had shorter gestation periods, were smaller, and were delivered more easily compared to bull calves. When the heifer calves grew to adulthood, they have delivered normal calves after being inseminated with either unsexed or sexed semen.

It is important to mention that the research to accomplish this was originally done by USDA in the mid to late 1980s. USDA holds the patent and then a license and sublicense were granted. Although the initial work was done about 20 years ago, considerable research was required to refine and speed the technique to make it commercially practical. But now we have a method that will allow dairy farmers to produce a larger number of replacements for sale or for incorporation in their herds in a biosecure manner from selected heifers in the herd.