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TITLE: Conception Rates of Sexed Semen in Lactating Cows

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Conception Rates of Sexed Semen in Lactating Cows

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INTRODUCTION

The use of sexed semen has provides dairymen the ability to produce more replacement heifers on their farms. Due to stress and high production cows are often not lasting long on farms. Due to this stress it may become very important that dairymen produce a large number of heifers for use as replacements in their own herds. Sexed semen is one way dairymen may be able to produce more replacements for their herds. Also, when heifer prices are high it is better for the dairymen to raise them at home for a lower cost to the dairy. Sexed semen is a potential way to increase the numbers of replacements, but problems may arise due to conception rates in both virgin heifers and lactating cows using sexed semen. Conception rates may be much lower than with the use of conventional semen in both heifers and cows.

The conception rates may be lower because sexed semen straw contains fewer sperm cells than the conventional straw. Also, the process of separating the female sperm and male sperm using a flow cytometer may cause minimal damage. Another reason conception rates may be lower is the technique of the technician. If the technician does not follow standard procedures it may cause problems with the semen integrity. Not being thawed correctly, or not being placed into the cows' uterus correctly, or breeding at the wrong time of the cows' cycle causes reduced conception rates. Also reproduction infections may cause a decrease in conception rates. A potential solution to the low conception rates using sexed semen could be to put more sperm cells in each straw to have as much as conventional straws, keeping a close watch when cows are in heat and being more precise with the proper time to inseminate, making sure that the technique of the technician is following the guidelines, and keeping cows healthy and with as low stress as possible.

The focus of this paper is to look at the conception rates of sexed semen in lactating cows versus the conception rates of conventional semen in lactating cows. It will look at the advances in Artificial Insemination and the economic value of heifers. It will also look at the process of sexing sperm and conception rates in virgin heifers.

LITERATURE REVIEW

Importance of Dairy Heifers

With the growing numbers of cull cows, as high as 19 to 29 percent of the herd, heifers have become more and more important to the herd for replacements (6). Because of high milk production, more concrete in facilities, and diseases cull rates has been climbing. With the average dairy cow only being on the dairy until the age of four, for this reason more heifers to be needed on the farm. Because cull rates are so high some producers do not raise enough replacements in house and have to go outside the dairy to buy replacements. In some cases heifer to bull calf ratios are not always 50% heifers and 50% bulls, putting a strain on replacement heifers (5). Also with high calf death rates the numbers fall below what a dairy needs for replacements. Heifers are the next generation of cows on a dairy. The use of high genetic value artificial insemination semen generally produces heifers that are superior to the mother. This conception is used to create a better herd from generation to generation. Also, it may be possible to raise heifers at a minimum cost saving the dairyman money in not needing to buy replacements later on. Having more replacements gives the dairymen an advantage in being able to cull more cows. Having home grown heifers also allows the dairy to not bring in other animals that may be carrying diseases

which may effect the rest of the herd. Also knowing what a person has is another reason for wanting enough heifer replacements, the dairyman knows where they come from, what genetic merit they have and what to expect. Building a herd from with in is often the safest and most economical way to build a superior and healthier herd from the rest of the dairies.

Economic Value of Heifers

With the prices of replacement heifers at an average of \$2000 or more having home grown heifers may be important to save the dairyman money (3). The earlier heifers can calve out the more money the dairyman can save. The appropriate age of calving is between 22 and 24 months of age. This comes into account because raising replacements can cost up to 15t o 20 percent of milk production costs (9). Mortality rates can have a negative effect on replacement numbers on a dairy. Other than feeding the animals addition costs include: buildings, equipment, property, machinery, depreciation, interest on investment, repairs, taxes and insurance, labor, bedding, utilities, veterinary care, breeding costs, and supplies. Table 1 on the following page illustrates typical costs to raising a heifer.

TABLE 1. Typical heifer raising costs (10) 10

	Birth-Weaning	Weaning-6 month	6 Months-1st Bred	Bred- Prefresh	Totals
Operating Costs	74.25	186.78	261.29	416.53	938.85
Capital Ownership	1.81	7.18	27.79	40.79	77.57
Costs					
Animal Ownership	11.65	16.8	25.36	58.33	112.14
Costs					
TOTALS	87.71	210.78	314.44	515.65	1128.56
Per Day	2.25	1.53	1.17	2.02	1.6
ADG, Ib	1.5	1.8	1.8	2	1.87
Per Ib/gain	1.5	0.85	0.65	1.01	0.86

Being able to raise heifers within rather than buying replacements could save dairyman up to \$850 a heifer depending on price of heifers at a specific time. Having enough heifers on the farm gives the producer a big advantage; not having to purchase replacement heifers. By using sexed semen and maintaining reasonable conception rates it can ensure that the producer will have enough replacements for the farm. If extra replacements are produced they can be sold to give the dairy some extra income instead of having the expense of buying replacements.

Bull Calves

In the dairy industry the desired result of a pregnant animal is to have a heifer calf. When a bull calf is produced there may be no need for this calf on the farm. As of Fall 2009 in the industry these bull calves may be sold for \$10 if not less. However, the semen cost is the same and the bull calf has to be fed until it leaves the farm. On some dairies, bull calves are not feed colostrum and are not very well taken care of. With the use of sexed semen there would be much few bull calves to deal with.

Process of Sexing Semen

Sexed semen was invented in the 1970's, but it wasn't until 1990 when the first calf was born from using this technology. A flow cytometer is used to separate the X chromosome semen, and the Y chromosome. First, sperm cells are collected from a bull. Using a teaser cow to get the bull to mount and with the use of an artificial vaginal the bull ejaculates into the artificial vagina and the semen sample is collect into a small collection tube at the end of the artificial vagina.

After the semen sample has been collected the semen is diluted and dyed with a fluorescent dye. Then the sample is sent though a flow cytometer the process is shown on figure 1. The sample is sent through the flow cytometer at 60 mph at around 40 to 60 pounds per square inch. The particles are then forced one by one in front of the laser to be read. When passing through the laser the fluorescent die becomes more prominent. The sperm cells with X chromosome are seen better because the X chromosome has more genetic material than the Y chromosome and the florescent will been seen more making it easier to distinguish which is which. The laser detectors will put either a negative or positive charge on each sperm cell and separate them. The positive charged semen, which is the Y chromosome, male, will separate one way. The negative charged semen, which is the X chromosome, female, will separate another way (3).



Figure 1. Flow Cytometer process (9)

Finally semen with no charge or unknown chromosomes is separated as well. This process is about 85% to 90% accurate. The samples are then mixed with an extender to ensure that the sample will last longer and help in preventing damage in the freezing and thawing process (6). Each sample is filled with 2 million cells of sexed sperm. Conventional semen raws contain approximately 20 million cells.(10) They are labeled and then frozen in liquid nitrogen at – 320 degrees F.



Figure 2. Example of semen straws

Artificial Insemination

When using artificial insemination the technician must first prepare the semen. The first step is to go to the liquid nitrogen tank and pull up the canister holding the desired semen that is going to be used for the certain cow. Once the straw is removed from the liquid nitrogen tank it is practiced to give it a little flick to ensure there is no excess liquid nitrogen on the straw. Then the straw is place into a water bath at approximately 38 degrees C for about thirty seconds (4). When loading an A.I. gun the technician must make sure to have the right semen intended for use first, then dry the straw well and insert the end with the plug first. Then cut the other end and put a sheath over

the gun. Using the o-ring to hold the sheath in place. Keep the gun close to your body to help keep it warm. Using an A.I glove and lube place the arm into the rectum of the cow. Clean the vulva with a paper towel and insert the gun into the vagina. Once in the gun should be weaved through the cervix and the semen should be implanted in the body of the uterus. When the cow is in estrus is the time for artificial insemination. This can last from 10 to 25 hours seen in table 2.

TABLE 2. Proper timing of insemination.(6)

	Should be	Too late for
Cows showing estrus		
	Inseminated	good results
In morning	Same day	Next day
In afternoon	Morning of next day	After 3 p.m.
	or early after noon	next day

A cow in estrus will allow another cow to mount her. If she does not stay away from being mounted or attack the other cow trying to mount her is a sign of estrus. The number of mounts and the amount of time between mounts for a cow during standing estrus varies a great deal due to the number of cows in estrus at that time, footing for the cows, environmental temperature, and other factors. Research has shown that an average cow will stand to be mounted approximately 4 times/hour during standing estrus, with each mount lasting about 7 seconds (5). Another sign is a thin, clear, watery mucus discharge from the vulva. This mucus is secreted by the cervix and vagina and is clear. This mucus can also appear on the cows tail and pin bones from the tail movement. Also cows in stanchions can have a puddle of mucus behind them. When in estrus feed intake may possibly be reduced. Also, a drop in milk production may be a sign of estrus in some cows while other cows are unaffected.

Sexed Semen in Virgin Heifers and Conception Rates

Because of the lower conception rates and higher costs of sexed semen dairymen may be using sexed semen on their virgin heifers. Data published from Select Sires, Inc. reveals that greater than 70 percent of herds using conventional semen achieved a conception rate of greater than 70 percent of



TABLE 3. Sexed Semen Conception Rates in Heifers (8)

first-service heifers. While using sexed semen conception rates are expected to be between 49 and 63 percent (1). Lower number of sperm cells may achieve greater success in heifers rather than in cows because the virgin reproductive tract lacks the intense nutritional demands such as no lactation or postpartum stress (1). Using good technique and proper insemination timing may result in better conception rates. Sexed Semen Conception Rates In Cows

High conception rates of dairy cows are very important to the success of a dairy. The cow is open and not pregnant the more money is spent on feeding the cow. Also the longer the cow is open the lower and lower milk production goes until the cow calves, figure 3 is a good example of the effect on return due to pregnancy. The desired calving interval is 12 months. Better conception rates will also give the producer more calves on the dairy. The faster cows get pregnant the more return the producer will receive on his investment in trying to get her pregnant. Cows that are not pregnant are also more likely to be culled from the herd. The losses of not having animals pregnant include milk loss, extra feed cost, and money spent on artificial insemination technician and semen, and any medication given to the animal.



Figure 3. Histogram of increasing pregnancy rates and total return

Sexed semen was conventionally used on virgin heifers to get a better conception rates. Conventional semen would generate about 46% conception rate and sexed semen would give about 21% conception rate in cows (1). Conception rates are lower in sexed semen because of the separation process and there is less semen in each sexed straw. Having good thawing technique and proper heat detection is even more critical than with conventional artificial insemination semen. There are many other factors to low conception rates other that the semen and techniques of the inseminator. High milk production, heat stress, infections of the reproductive tract and mammary, or other diseases can affect fertility. Any of these problems can result in lower conception rates and infertility.



Figure 4. Histogram showing the difference in sexed and convention semen

conception rates

Diet also can affect the reproduction. If the cow is not feed a well balanced diet and is deficient in nutrients that she needs can cause a problem. Also the time and procedure of the artificial inseminator effects pregnancy rate as well. These are many reasons why conception rates are higher on virgin heifers because they usual don't have the stress. High milk production, and usually don't have reproductive infection because they have never calved before.

MATERIALS AND METHODS

The literature review looked at the conception rates of cows using sexed semen. Data was analyzed to give the conception rates of sexed semen versus convention semen. All research came from professional journals, dairy publications, and scholar sources. The materials present in this paper will assist in determining whether or not conception rates are efficient enough to use sexed semen on cows on the dairy.

RESULTS AND DISCUSSION

Artificial Insemination. Over many years the way dairymen breed there animals have changed dramatically over the years. It started with the original method of putting a few cows together with a bull and letting them breed them selves as nature intended them to. Then the idea of artificial insemination came along, which was a new concept that took semen from the bull and allowed the dairyman to breed the cow himself. This was a huge advancement to the dairy industry. This allowed the dairymen to be able to use many different types of bulls in their herd instead of maybe just one or two. From this genetic evaluation of bulls came around which allowed the dairyman to buy certain bulls that were more compatible to the types of cows they desired. Artificial insemination has become a staple in the dairy industry. Dairymen are able to have the best genetics brought into the dairy to breed there animals without having the expense and dangerous situation in having bulls on a farm. The next advancement was sexed semen.

Sexed Semen. This concept of sexed semen has been around since about 1999. It only really started to become available though artificial insemination companies in about 2004. The popularity of this product has become more and more popular within the industry because of how useful it is for dairymen

in the industry. Many dairymen dreamed of every calf on the dairy being born is a heifer and now that dream could come true. As will all new advances sexed semen does tend to have a few problems compared to conventional semen. The biggest problem is lower conception rates compared to conventional semen. Because of the low conception rates dairymen tend to not use this as much commercially because of the hard time most have getting cows pregnant. Most feel the risk of lower conception rate is more damaging that having a few bull calves in the mix. Also because sexed semen is more expensive than conventional semen most dairymen tend to take the cheaper route. Artificial insemination companies are trying to fix the problems with conception rates and as the product becomes more popular the costs will decrease as well.

Conception Rates. Conception rates are much lower with sexed semen because of the lower amount of sperm in sexed semen straws versus a conventional straw and because of the sexing process. The process of sending the semen through the flow cytometer causes damage to the sperm. The laser beam and high-speed separation may not cause a lot of damage, but it does cause some. Lactating cows with conventional semen tend to have decent conception rate, but with sexed semen they go down a lot more just because of the lower sperm count in the straws and the flow cytometer process.

CONCLUSION

With herd sizes growing and cull cow percentages rises the dairy industry is finding itself in a bind with a shortage of heifers. With calf mortality rates and disease on the farm having enough heifers to support the cull cow rates is hard enough to keep up with and then if a dairymen is trying to increase herd sized it becomes very difficult to keep up with enough heifers. Not having enough heifers causes dairymen to have to go pay high prices to buy new replacements. This may cause new disease out break and leaves the dairyman not knowing the history of the animals and how their health or genetic value is. Shortage of heifers causes many problems for the dairymen.

A solution to the problem of heifer shortage can be the introduction on sexed semen to a herd. Using sexed semen could dramatically increase the numbers of heifers on a farm compared to the numbers of conventional semen. Using sexed semen can save the dairyman money in not having to buy high cost replacement heifers and can take away the risk of bringing new disease into the from outside animals. Using sexed semen will fixed the problem of not having enough replacement and many even give the dairyman more than he needs allowing him to keep the most productive animals in his herd and selling other animals for extra income. This also gives the dairyman more control over what types of animal he want in his herd and which ones he would like to get rid of while keeping his herd numbers up. Not having to buy replacements and keeping the farms herd closed is a great advantage for any dairy owner.

Although sexed semen sounds like the best solution and is going to fix everything there are some problems with it. The biggest problem is that sexed semen conception rates are much lower that the conception rates of conventional semen. With the higher cost of sexed semen and having to use more of it to breed the same amount of cows most dairyman tend to not use it. Also because it costs more many dairymen cannot afford to use them in there breeding program. Some dairymen do not want to take the risk in spending more money on semen with a lower conception rate just to get a heifer calf. Most dairyman are more concerned with getting the cow milking at peak again then getting a for sure heifer calf.

The author's recommendations would be to keep using conventional semen on lactating cows because it costs less and the conception rates are higher. It is more important to get cows pregnant and keep conception rates high than to get a heifer calf out of each calving. Another recommendation that author make is to use sexed semen on virgin heifers. Even though sexed semen has a lower conception rate of about 45% with sexed semen versus 60% with convention semen it is still worth the use in virgin heifers. When artificial insemination companies figure out how to increase conception rates then the author recommends the use of sexed semen on lactating cows but as of now only on virgin heifers if an average conception rate can be meet.

REFERENCES

- 1. Dalton, J. Comparing gender-selected A.I. semen pregnancy results in heifers and cows. Western Dairy News. September 2007
- 2.

De Vries, A., R. Nebel. National Heifer Supply and the Effects of Sexed Semen. Western Dairy Management Conference. Pg. 131-140

- 3. De Vries, A. The Economics of Sexed Semen in Dairy Heifers and Cows. Department of Animal Sciences. University of Florida, Gainesville.
- 4. Faber, S. 2008. Thinking of Switching to Sexed Semen. Hoard's Dairymen. Fort Atkinson, Wisconsin.
- 5. Ferreira, L. 2008. Dairy Science 330 Artificial Insemination Handbook. Cal Poly, San Luis Obispo.
- 6. Hadley, G. 2006. Dairy Cattle Culling Patterns, Explanations, and Implications. ADSA. Journal of Dairy Science.
- 7. H. Gray, M. Varner. Signs of Estrus and Improving Detection of Estrus in Cattle. University of Rhode Island and University of Maryland.
- 8. Linderoth S. 2008. Sexed Semen Primer. Dairy Herd Management. Vance Publishing Corporation.
- 9. Nolla, H. Basic Principles in Flow Cytometry. University of California, Berkeley
- 10. Schriefer, T. 2009. Heifer Economics. The Pennsylvania State University. Department of Dairy and Animal Science.
- 11. Webb, D. 2003. Artificial Insemination in Dairy Cattle. Animal Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.