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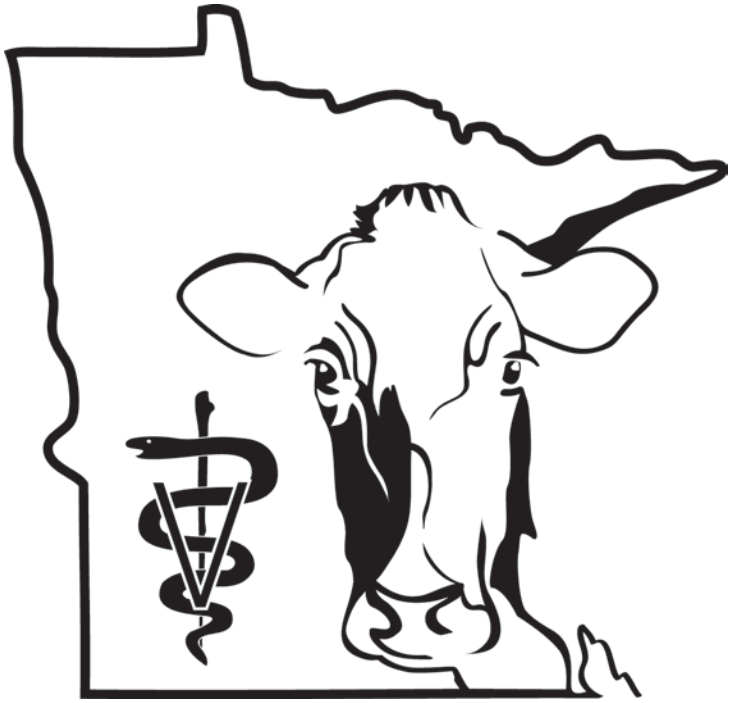

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Gender Enhanced Semen

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Introduction

Few dairy farmers complain about having too many female calves. There have been recent advances in technology that allow a dairy to use semen that will produce about 85% female calves. This technology could change both the dairy and the dairy industry.

Traditionally, breeding on dairies occurred for two reasons: to get the cow to start her next lactation, and to get female dairy calves for replacements. These needs were approximately matched – the number of pregnancies required to create fresh cows was approximately equal to the number of pregnancies needed to create future replacements. Gender enhanced semen will provide the opportunity to provide excess replacements.

This paper will discuss some of the implications of this technology. We will examine our experiences with the currently available technology, and also our estimates of the impact to the dairy and the industry if newer technology can resolve the current problems.

Farm Size Dynamics

There are roughly 9 million adult dairy cows in the U.S. and the total is relatively stable. Given that stable national herd size, the national replacement rate is fundamentally determined by the number of heifers entering the herd each year. As heifers enter the herd, older cows leave. The number of heifers entering the milk herd is determined by the pregnancy production three years earlier; the ratio of female offspring; and the heifer death loss from birth to first freshening.

Countries with better reproduction will have higher replacement rates than countries with poor reproduction. Countries that breed a high percentage of their cows to non-dairy bulls will have lower replacement rates. Countries that take better care of their female calves and replacement heifers will have higher replacement rates.

In agriculture, as in other commodity businesses, prices are fundamentally driven by supply and demand. Milk and heifer prices are especially sensitive to changes in a small change in either supply or demand. Recent experiences with BST and BSE have made this apparent.

Although reproduction determines the supply of heifers, additional economic factors influence the decisions that a dairy farm should use to replace cows. Higher milk prices will increase the replacement rate (given available replacement heifers), as will lower heifer prices and higher salvage values. The economically efficient replacement rate is probably near 35 to 40% based on current prices of milk, feed, heifers, and beef. This is approximately the current rate of springing heifer production in North America.

However, if widespread adoption of gender enhanced semen occurs, there will be excess heifers. In the short term, this will allow some dairies the luxury of increased culling to replace sub-performing cows. However, in the long term, heifer prices will decrease, as the need for excess heifers disappears.

In summary, the need for replacement dairy heifers should stay relatively constant. Thus, the ability to produce excess dairy heifers from gender enhanced semen needs to be counter-balanced by

breeding other dams to produce non-"dairy heifer" offspring. This can either be beef calves, or bull calves, or both. Alternatively, the industry can adjust to the fact that some heifers will be destined for slaughter, not lactation.

Potential Benefits of Gender Enhanced Semen

- Improved source of replacements
- Luxury to cull more rigorously
- Genetic advancement
- Fewer dystocias?
- Genetic selection for non-production traits
- Ability to cull poor heifers during the growth period
- Embryo transfer
- Twins
- Tax Management

Improved source of replacements

A dairy can be more selective about the source of replacements. Although it is difficult to quantitate, for some dairies the number of replacement heifers purchased will decrease. This might have some effect on biosecurity for some farms, as fewer outside cattle will enter the dairy. In addition, the likelihood of known parentage will increase.

Perhaps there will be increased emphasis on the quality of purchased heifers, in terms of health and vaccination status, age, growth, genetic merit, sire and dam data, etc.

Luxury to cull more rigorously

Increased supply of heifers will eventually cause heifer prices to drop to near the cost of rearing. Nearly all dairies have some cows that are poor enough to warrant replacement that might otherwise have remained in the herd. There will be a short term increase in total culling as additional heifers reach calving age, depending on the adoption rate. Long term, the value of replacing cows is still economically driven and based on various factors including the price of milk, market value of beef, and cost of replacements and feed. The overall cull rate across the nation is not expected to rise a great deal over the long term, but will probably increase short term. There will still be a need to focus on all of the factors that improve the health and longevity of the best cows, preserving their value and reducing the need to replace them prematurely.

If the value of a cow is related to the price of a springing heifer, it is likely that the value of cows will also decrease. This could affect the total equity of many operations, and might decrease their borrowing ability.

Genetic advancement

Gender enhanced semen provides an opportunity to advance the genetic merit of cows in the herd by selecting the best cows to be the dams of herd replacements. Currently, the genetic advancement in the dairy industry is primarily derived from the male side through the use of high merit AI bulls. Gender enhanced semen presents an option to make genetic improvements by both the male and female side. While there are several options to capture the most value from these extra pregnancies, accurately estimating the genetic value is paramount.

Ranking the Cows

Dairies vary in the data they have available to rank their cows. In an ideal state, a herd would have accurate parentage and accurate milk production and milk component records. If so, most DHI

organizations can calculate predictive indexes, such as PTA Milk, PTA Fat and PTA Protein. Commercial herds that do not test individual cows for components would be limited to PTA Milk.

There are also herds that are not on DHI, so they do not have access to DHI indexes. Because genetic value is derived equally from both the sire and dam, an index can be estimated from the USDA sire information to get 50% of the value as long as sire information is recorded. If the maternal grandsire is known, then another 25% (half of the dam) is known, so the accuracy rises to 75%. Herds not on DHI should start tracking maternal grand sire if they are not already doing so.

Finally, there are herds that have very poor sire information. Typically this occurs in expansion herds, or herds that have large freshening pens, and may not accurately connect the newborn calf with the correct dam. According to one of the bull studs that has done extensive blood testing, inaccurate parentage may be far more significant than previously thought.

These herds without accurate parentage must instead rely on the current milk production of the dam. Because milk production is a function of both genetics and environment, these estimates are less accurate. For instance, age, season, BST, health status, and management all can influence the milk yield of a cow independent of her genetics.

Finally, because replacement heifers have no milk production data yet, ranking those animals is not possible if accurate parentage information is lacking. No matter what the cause, errors in cow ranking decrease the value of gender enhanced semen to increase the genetic value of the herd.

If gender enhanced semen is used on the entire herd, genetic indexes have little value, nor will the herd accrue additional value from genetic improvement from the maternal side.

Dairy Breeding Options by Genetic Merit

As a general rule, assuming the heifer market needs are met and bull calves maintain strong demand, the greatest genetic (and thus economic) gain will accrue from using gender enhanced semen on the top cows, conventional semen on the middle cows, and non-dairy-heifer semen on the bottom cows. The actual proportion of cows to be bred to each strategy depends on the economics and genetic merit of the herd.

Almost all the cows need to get pregnant to continue milking, but the calf product will differ based on the semen selection strategy. The top cows will produce high-genetic dairy replacement heifers, but probably not enough to supply the entire replacement needs. The remaining dairy replacements will come from the middle cows, using conventional semen. Most of the bottom cows still need to get pregnant in order to continue lactating, but their calves are not needed as dairy replacements, so they might be bred to beef semen, and even perhaps male beef semen if the market will reward the investment. The calves from the bottom end may be crossbred bull calves and heifer calves or if bred to dairy bulls may enter the same markets that now accept dairy bull calves and freemartins.

Depending on the genetic makeup of the dairy, the dairy heifer replacements will be used on the dairy, or sold to other dairies. Herds with better genetics and or better marketing will be more likely to sell replacements, and herds with worse genetics should benefit from purchasing replacements. Every dairy will have some top-end cows that should be bred to gender enhanced semen.

What is the best mix of breedings?

Given the "products" of each type of breeding, the "profit" of those breedings can be estimated. However, the calculation of potential profit is rather complicated. The profit depends on the herd's genetic merit and the proportion of the population that is bred with female gender enhanced semen.

The profit of a gender enhanced breeding is not a fixed number. The calves from the best cows have greater value than the calves from the lesser cows. However, if only the very top cows are bred to female AGS, only a very few very valuable heifers are produced. On the opposite extreme, if most of the herd is bred with gender enhanced semen, the genetic average advantage per heifer is not much above the herd average.

The expected value of the heifers will depend on whether they are retained as replacements, or sold. If they are retained, their value is determined by their genetic merit. That is, the dairy will accrue the value of the heifer, based on her performance relative to her future herd-mates.

However, if she is sold, the market will determine the price. Markets do not always return full value to the seller. At least initially, the market may not be sophisticated enough to properly value heifers based on genetic merit. But, clearly, some herds will have already established a reputation for quality genetics that they may be able to use to better capture the true value. Meanwhile, the profit from a conventional AI breeding is not different than the current situation.

The value of the calves from the bottom end is unknown. But it is likely that cross-bred bull calves will be valued greater than dairy calves, and that males will be more valuable than females. The level of premium the beef market places on these differences is unknown and will likely depend on the number of these crossbred calves available.

The issue, then, is to determine the best mix of breedings – some combination of gender enhanced semen to the high end cows, conventional semen to the middle cows, and maybe other alternatives to the low end cows. An extensive model has been developed to help with this decision. The basis for comparison is a herd where all cows are bred with conventional AI, and the goal is to consider all possible mixes of breedings and find the one that is most profitable to the dairy.

As a general rule, herds with better genetics would tend to use more gender enhanced semen. More of the heifers produced would be of high merit and worth having or selling. Herds with good information about the genetics of their cows (and particularly their growing heifers) will have a competitive advantage in the use of this technology. Herds that want to assure full replacements will use more gender enhanced semen.

Expansion Dairy

Although one might think expanding herds will benefit from biosecurity advantages of raising their own heifers, gender enhanced semen is not a complete solution. Most dairy farms tend to need to grow in discrete chucks – the size of the next barn. These new barns need to be filled far more rapidly than is possible with the incremental calves derived from gender enhanced semen. In short, expansion herds still need to buy cows. Gender enhanced semen might require fewer purchases, but then they are investing the raising costs ahead of time.

Heifer raising capacity

If a dairy uses gender enhanced semen to produce additional heifers that they will raise for their own herd (either to be able to increase culling luxury, or decrease expansion purchases), they need to realize that they will accrue the expenses of raising the additional calves. Unless these are shipped off-site to a custom calf raiser, they need to be sure they have the resources to raise additional animals – hutches, pens, labor, feed, cash, waste handling, etc.

Results with currently available technology

Female Percentage

The percent females obtained by gender enhanced semen will have a statistical variation around 85%. Basic probability shows that for a given series of breedings, some dairies will get 85%, some more and some less. If only a few doses are used, some herds may get substantially lower than 85%, and they might suspect the technology is not working. The dairies that get over 85% will be less likely to complain. Dairies that use more doses are more likely to attain the expected 85% females.

Conception Rate
The conception rates from the currently available technology are substantially lower than regular semen. Because of that fact, most of the use of the current technology is in nulliparous heifers, as the baseline conception is significantly greater than adult cows.

In a recent review of about 5,000 breedings in 6 dairy farms, the conception rate drop ranged from 25 to 30% drop from conventional semen in heifers. In one dairy, the conception rate drop was from 68% to 39%, a drop of 43%.

A 25% drop in conception rate is very expensive in adult cows, but it is also expensive in replacement heifers. After 5 months, most dairies give up trying to get heifers pregnant. But with 60% heat detection, and 60% conception, nearly 93% of the heifers will get pregnant. However, with the same heat detection, but a 45% conception rate, the dairy will only get 85% of the heifers pregnant. Losing 8 of 100 springers due to a failure to conceive is valued at nearly $10,000, which is about $100 per eligible heifer entering the breeding population in this example.

Dystocia

While it might be assumed that cows will suffer fewer dystocias if a greater percentage of births produce female calves, this effect will not likely be a large one. If for example, the difference in dystocia rate between male and female births was 5% of calvings and if 20% of cows were breed with gender enhanced semen, then the overall herd dystocia rate change would be less that 1% (0.05 * 0.20). If gender enhanced semen is from bulls with poorer calving ease scores than for conventional AI breedings, the dystocia rate could actually be higher.

General Predictions and Thoughts
There is unlikely to be significant adoption of gender enhanced semen until two important problems are resolved. The current loss due in conception makes adoption for milking cows difficult in all but the very highest genetic merit cows under special circumstances and even makes its broad use questionable in heifers. The fact that the sorting technology is currently done away from the site where the bulls are housed severely limits the quality of bulls available, because it prevents the operation from producing a mix of gender enhanced semen and conventional semen. New technology will shortly become available that promises to resolve both of these issues. If so, the economics and adoption will change rapidly.

Embryo Transfer
The use of gender enhanced semen should be widely adopted by the embryo transfer industry. Because of the current overhead cost of embryo transfer, the costs and thus the economic gain from embryo transfer will decrease per female calf because there will be more females. Embryo transfer might make sense for commercial dairies for their top cows if they can identify them accurately. If embryo transfer becomes more widely used, the number of people providing the technical service will increase, and the price should decrease.

Record systems and animal identification

As discussed above, those herds that accurately identify parentage have a significant advantage in capturing the value from genetic improvement. Registered herds tend to have accurate parentage data, and may have marketing advantages. They are likely to be significant adopters of this technology.

Replacement heifer prices

The price of a replacement heifer is currently at an historical high. This is due to demand from new, large, expanding dairies, and in part, to a loss of supply from Canada. However, of the ~ 3.3 million replacement heifers calved annually, the current "deficit" in supply is probably only on the order of 3% or 100,000 heifers. A small upturn in replacement heifer production with gender enhanced semen should satisfy the deficit.

Once supplied, assuming moderate adoption by the industry and ample availability of gender enhanced semen, the price of heifers should drop rapidly to near the cost of production and investment predicted to be about $1,300 - $1,500.

Newborn dairy heifers

The price of a newborn dairy heifer is also at an historical high. However, there are very few of these heifers sold. The newborn heifer market is likely very price elastic and is based on both availability and predicted demand in the near future. Even a slight increase in supply should have a dramatic effect of lowering prices. Thus, any economic model that is based on accruing profit from the sale of newborn dairy heifers is suspect. Unless a dairy specifically plans to market these calves, using the current prices as justification for using gender enhanced semen is not justified and is a very risky proposition.

Conclusion

The currently available technology for gender enhanced semen has two significant faults: a very expensive impact on conception, and a lack of top-quality bulls. New technology promises to rectify both of these issues. Once that becomes available, the adoption of sexed semen should dramatically increase.

The long-term advantage of gender enhanced semen will be more rapid genetic improvement, not cheaper heifers, although certainly heifer prices will eventually drop as the supply increases.

Finally, dairies that can better identify the top genetic cows will be better able to capture the benefit.