The Economic Value of Using Sexed Semen for Heifers

Victor E. Cabrera

University of Wisconsin-Madison, Department of Dairy Science, Madison, WI

Take Home Messages

- Use of sexed semen is warranted when the conception rate of heifers with conventional semen is 57% or higher and the conception rate with sexed semen is at least 60% of that of the conventional semen (34.2%)
- The net present value of 1 or 2 sexed services outperforms the net present value of 3, 4, or 5 sexed services. Therefore, if sexed semen is to be used, then 1 or 2 services at most with sexed semen are recommended
- The most important factors on deciding the use of sexed semen are in order (relation with net present value): 1) the conception rate of sexed semen (+), 2) the conception rate of conventional semen (+) and 3) the cost of sexed semen (-).
- Economic factors such as discount rate, value of female and male calves, the daily raising costs of heifers, the slaughter value and the replacement costs exert only marginal influences into the net present value of using sexed semen.
- Due to a large variability on farm conditions, farm-specific analyses on the feasibility of sexed semen use are justified. An interactive online decision support tool has been created for such purpose: http://www.uwex.edu/ces/dairymgt/tools/NPVSexedSemen.swf

Introduction

Reproductive efficiency is paramount on dairy farm profitability. Important economic benefits are realized when a cow becomes pregnant such as the value of an off-spring and the milk

production in relation to the pregnancy. Sexed semen is relatively a new technology that has proven to produce a higher proportion of female calves than conventional semen. Because female calves are much more valuable than male calves, the use of sexed semen is highly attractive. However, research has also proven that the insemination with sexed semen decreases the conception rate (CR) compared with using conventional semen. Additionally, the technology of sexed semen is substantially more expensive than conventional semen. The economic decision of using sexed semen instead of conventional semen should then be based on a careful analysis of the balance between additional investment and potential revenue. Because the higher cost and reduced CR, sexed semen seems more appropriated for virgin heifers (De Vries, 2009) which have naturally higher CR than adult cows.

Calculating the Economic Value of Using Sexed Semen

Partial budgeting is a suitable method to analyze the economic benefits of using sexed semen on heifers. Partial budgeting of testing a new technology tracks the additional revenues, the additional costs, the revenues foregone and the reduced costs. Reproductive programs that include a series of services must include the aggregation of the above factors for each one of the services and because these services occur at different times, a fair comparison has to be performed using a discount rate to bring all balances to present values to calculate and compare net present values (NPV). The economic value of a sexed semen reproduction protocol would lack of utility if it is not compared with conventional semen reproduction programs. Therefore, the economic value of using sexed semen should be the difference between a sexed semen protocol and the conventional semen: if positive, the sexed semen has an advantage over the conventional semen. Assuming that producers will attempt 5 reproductive services on heifers (Kuhn et al., 2006), the analysis could include the economic values when sexed semen is used in 1, 2, 3, 4, or 5 consecutive services. Those services not using sexed semen would use conventional semen.

The NPV is calculated as the aggregation of the discounted monetary values of successive services starting on 14-month old heifers plus the discounted value of the probability of the heifers being culled and replaced if not pregnant after 5 consecutive services. Conditional

reproduction probabilities are then needed to determine the CR and the probability of pregnant and non-pregnant heifers after each one of the services.

More specifically, the economic value (*EV*) of different reproduction programs for virgin heifers are assessed as the difference between the *NPV* of five consecutive services starting at 14-month of age of sexed semen (*X*) programs and a conventional unsexed semen (*NX*), Equation 1.

$$EV = NPV(X) - NPV(NX) \quad [1]$$

The *NPV* is the aggregation of the discounted monetary values of successive services (*s*) plus the discounted value of the probability of a heifer being culled and replaced if not pregnant after 5 services, Equation 2.

$$NPV = \sum_{s=1}^{5} (\delta_s)(NPV_s) + (\delta_5)(HC - HR)(1 - PP_5) \quad [2]$$

where δ is a discount rate, HC is the received heifer cull value (slaughter value), HR is the calculated value of a 20-month pregnant heifer and PP_5 is the proportion of pregnant cows after the fifth service. The *NPV* after each service is:

$$NPV_s = CR_s^{'} * CV - (1 - PP_s) * MC - IAC \quad [3]$$

where *CR′* is the conception rate achieved in a service, *CV* is the calf value calculated as the probability of heifer calf multiplied by the heifer calf value plus the probability of bull calf multiplied by the bull calf value, *MC* is the non pregnant heifer maintenance cost and *IAC* is the cost of semen.

Conditional probabilities are used to determine the *CR′* and *PP* in each one of the services as indicated in Equation 4.

$$PP_1 = CR_1^{'} = CR_1$$
$$PP_s = PP_{s-1} + (1 - PP_{s-1}) * CR_s \text{ for s=2 to 5} \quad [4]$$

$CR_s^{'} = PP_s - PP_{s-1}$ for s=2 to 5

Reproductive and Biological Parameters

A baseline CR for conventional semen for US Holsteins can be assumed to vary between 40 and 70% (Kuhn et al., 2006). Some studies have found that depending on management conditions, the CR of sexed semen could vary between 50 and 75% of the conventional semen (Seidel 2003; Seidel and Schenk, 2002). It is also reported that the CR decreases with each additional service. The CR may drop an absolute 2.5% for each successive service after the first service (Kuhn et al., 2006) whether conventional or sexed semen is being used.

A baseline calf female rate can be assumed to be 46.7% with conventional semen (Silva del Rio et al., 2007) and 87.2% with sexed semen with (Cerchiaro et al., 2007).

Economic Parameters

A baseline cost of conventional and sexed semen dose (*IAC*) can be set at $15 and $45, respectively (Olynk and Wolf, 2007), which indicates a premium of about $30 when using sexed semen compared with conventional semen. This premium paid per sexed semen is likely to decrease with technological advances and efficiencies on producing sexed sorted semen.

The following economic parameters are not critical in the calculation of the economic value of using sexed semen because these are applied equally to conventional and sexed programs. Because of the timing and the CR probabilities, these affect differently to conventional and sexed semen programs, however these changes are only marginal and would not have enough influence to determine a change in a decision.

The value of a female calf can be considered to be $562 whereas the value of a male calf can be considered to be $48 (Wisconsin USDA Market report, 2008). The average cost of maintenance of non-pregnant heifers between 15 and 20 months of age can be considered to be $2.4/d (Zwald

et al., 2007). The average weight of a 20-month non-pregnant heifer is assumed to be 505 kg (NRC, 2001). The slaughtering value (cull) of a 20-month non-pregnant heifer can be assumed to be $1.79/kg and the replacement value of an equal weight pregnant heifer to be $1,200 (Wisconsin USDA Market report, 2008). Finally, an annual interest rate similar to the minimum charged by credit card companies of 12% can be assumed to calculate the NPV of the studied programs.

The Economic Value of Using Sexed Semen for Heifers

When the CR of conventional and sexed semen are expected to be high (70 and 52.5%, respectively) it would pay to use 1, 2, 3, or 4 sexed semen services. Using sexed semen would bring between $25 and $64 of additional income per heifer. The maximum NPV of $ 64 is observed when 2 sexed services are used. When the CR of conventional and sexed semen are high the use of 5 sexed services has a NPV of -$5 indicating that conventional semen would have higher value than using 5 sexed services.

When the CR of sexed semen is expected to be low (50% of conventional), it would not pay to use sexed semen because the calculated NPV would always be negative. This negativity will increase with more services varying between -$19 and -$162 when conventional semen CR is expected to be high and between -$46 and -$316 when conventional semen CR is expected to be low. The break-even point where the additional investment of using sexed semen equals the value of the additional revenue of sexed semen use would occur for high conventional semen CR when sexed semen CR is 51, 55, 61, 68, and 76% for 1 to 5 services, respectively. This break-even point for low conventional semen CR would occur when sexed semen CR is 74, 78, 83, 88, and 93% for 1 to 5 services, respectively.

Another important factor in the calculation is the price of the semen. Under the scenario that sexed semen dose would decrease its price from $45 to $30, the possibilities of using sexed semen would greatly increase. Under this scenario, 1 and 2 sexed semen would have positive NPV in all cases, except when both conventional and sexed semen CR are low. When both CR are low (40 and 20%, respectively) the NPV of sexed semen will always be negative regardless

of the price of the sexed semen. Because very low CR (conventional + sexed) the additional revenue of additional female calves is also very low, which would not justify the use of sexed semen.

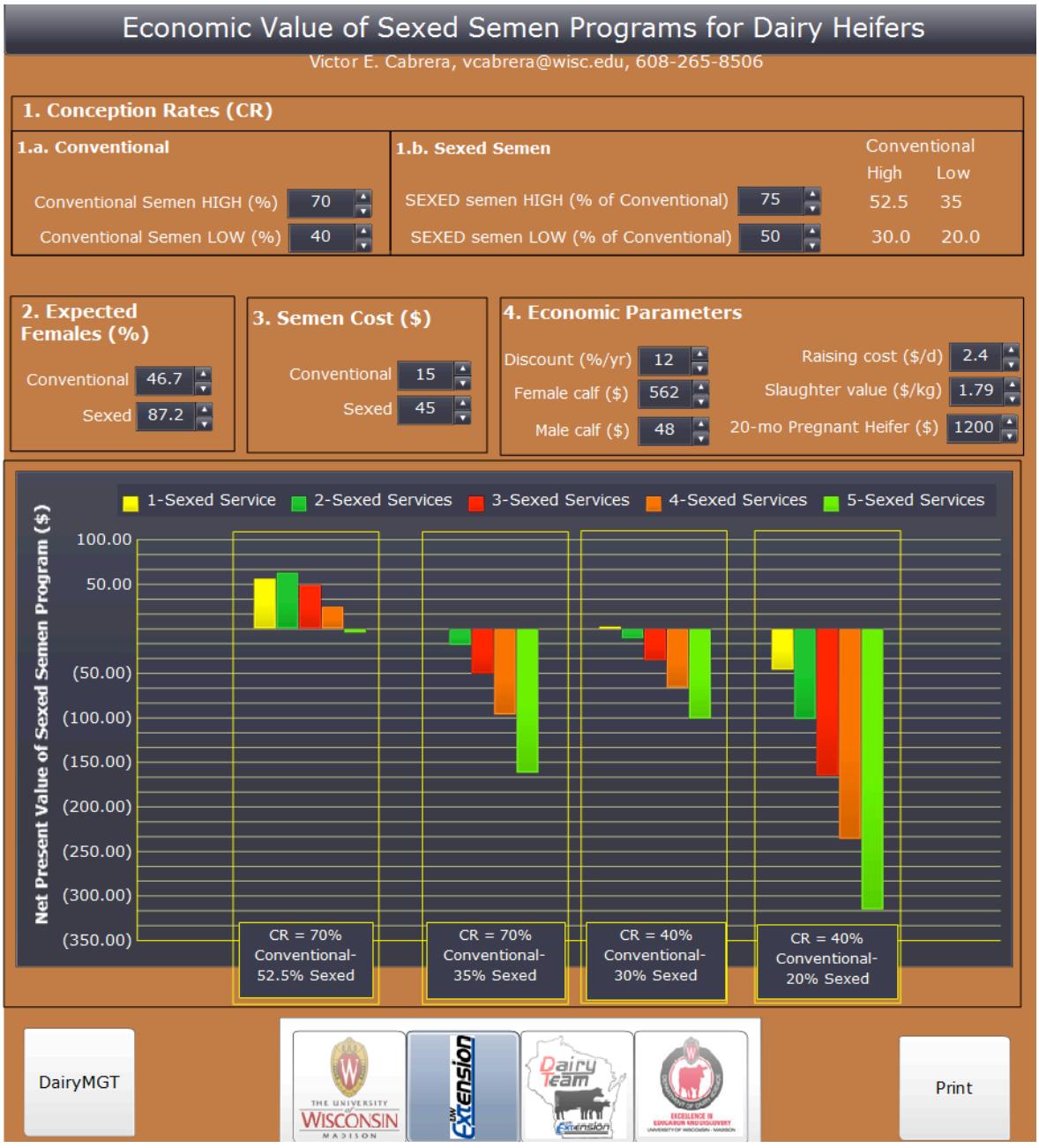

Figure 1. Screenshot of decision support system to calculate the net present value of using sexed semen programs on virgin heifers. This decision support system is available at http://www.uwex.edu/ces/dairymgt/: Management Tools.

Custom-tailor Analyses

The opportunity of using sexed semen would greatly depend on particular farm conditions for which specific analysis at the farm level are warranted. Results of using default values as it was done in previous section give a good indication of possibilities and some take-home messages, however these cannot be used to infer and extract particular recommendations. The analysis should be performed on an individual basis and because of that an interactive online tool has been created (Figure 1). The decision support tool called "Economic Value of Sexed Semen Programs for Dairy Heifers" together with supplemental documentation is freely available from the University of Wisconsin Dairy Management website: http://www.uwex.edu/ces/dairymgt/ under the section "Management Tools" and title "Economic Value of Sexed Semen Programs."

References

Cerchiaro, I., M. Cassandro, R. Dal Zotto, P. Camier, and L Gallo. 2007. A field study on fertility and purity of sex-sorted cattle sperm. J. Dairy Sci. 90:2538-2542.

De Vries, A. The economics of sexed semen in dairy heifers and cows. The Institute of Food and Agricultural Sciences (IFAS) Extension, University of Florida, AN 214. Gainesville.

Kuhn, M. T., J. L. Hutchinson, and G.R. Wiggans. 2006. Characterization of holstein heifer fertility in the United States. J. Dairy Sci. 89:4907-4920.

Olynk, N.J., and C. A. Wolf. 2007. Expected net present value of pure and mixed sexed semen artificial insemination strategies in dairy heifers. J. Dairy Sci. 90:2596-2576.

Seidel, G. E., Jr. 2003. Economics of selecting for sex: The most important genetic trait. Theriogenology 59:585–598.

Seidel, G. E., Jr., and J. L. Schenk. 2002. Field trials with sexed, frozen bovine semen. Pages 64–69 in Proc. 19th Technol. Conf. Artif. Insemination Reprod. Natl. Assoc. Anim. Breeders, Columbia, MO.

Silva del Rio, N., S. Stewart, P. Rapnicki, Y. M. Chang, and P. M. Fricke. 2007. An observational analysis of twin births, calf sex ratio, and calf mortality in Holstein dairy cattle. J. Dairy Sci. 90:1255:1264.

Wisconsin USDA Market Report. 2008. Wisconsin cattle summary for the week ending Friday Oct 24, 2008. Available at: http://www.ams.usda.gov/mnreports/md_ls150.txt.

Zwald, A., T. L. Kohlman, S. L. Gunderson, P. C. Hoffman, and T. Kriegl. 2007. Economic costs and labor efficiencies associated with raising dairy herd replacements on Wisconsin dairy farms and custom heifer raising operations. UW Extension. Available at: http://www.uwex.edu/ces/cty/sheboygan/ag/dairy/documents/CostofRaisingHeifers-2007ICPAReport.pdf.