



# Western Dairy News

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## Economic opportunities for sexed semen on commercial dairies

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Dairy producers and others have been discussing the use of sexed semen for many years. Sexing bovine semen is possible because X-sperm have 3.8% more DNA than Y-sperm. This difference can be identified with a flow cytometer by staining the sperm with a fluorescent dye that binds to the DNA. The technique is reasonably accurate (10% error rate) but still very expensive and slow, which has limited widespread commercial application in the dairy industry.

Here, we explore the opportunities for commercial use of sexed semen on large-scale dairies based on current information. We note that there are technical and practical limitations of using sexed semen on large dairies.

To shed light on what might be expected from this technology in the future we examine the use of sexed semen on dairies in Denmark, where we can look at a familiar example without making implications about the situation in the U.S. – which will be studied in the future.

### Materials and methods

To study the possibilities for sexed semen, we model a typical dairy with realistic circumstances using spreadsheet-based models, linked to a whole-farm budget running in Microsoft Excel. As a standard control, all heifers and lactating cows are bred with unsexed dairy semen. All

heifer calves that are born are raised and bred. When there is a surplus, springing heifers are sold three months prior to calving. In case of a shortage, springing heifers are bought. All bull calves are sold at two weeks of age.

value higher than Holstein calves. Since sexed semen is expensive, it is used only on the better conceiving nulliparous heifers. This is also genetically the most valuable category of animals, because the youngest generation is theoretically the best. Both

**Table 1: Assumptions related to calving, stillbirths and dystocia.**

normal sex ratio (% heifers of born calves)	49.0%
twin births <sup>a</sup>	1.85%
probability dystocia, bull calf <sup>b</sup>	24.0%
probability dystocia, heifer calf <sup>b</sup> (60% of bull calf rate)	14.4%
probability stillbirth, bull calf	20.0% <sup>c</sup>
probability stillbirth, heifer calf (60% of bull calf rate)	12.0% <sup>c</sup>
dam mortality related to calving, bull calf	2.0% <sup>c</sup>
dam mortality related to calving, heifer calf (60% of bull calf rate)	1.2%

<sup>a</sup>: Johanson et al. (2001)

<sup>b</sup>: Dematawewa and Berger (1997)

<sup>c</sup>: Ettema and Santos (2004)

**Table 2: Prices of semen and livestock <sup>a</sup>**

normal semen (per dose)	€11
sexed semen	€31
beef semen	€13
14-day-old Holstein bull calf	€188
14-day-old crossbred beef calf	€255
springing heifer	€1,075
heifer raising costs	€981

<sup>a</sup>: One € currently is about \$1.31.

The main features of the model using sexed semen (which is compared to the control without sexed semen) are that all nulliparous heifers in the herd are bred with sexed semen along with a minimum number of older cows (just enough to maintain herd size) with regular, unsexed dairy semen. The remaining portion of the lactating cows is bred with beef semen, resulting in crossbred beef calves with a surplus

**Table 3: Relevant numbers (€/cow/year) of whole-farm budgets of control and sexed semen scenarios.**

scenario	control	sex sem	sex sem-control
<b>revenues</b>			
milk sales	2,731.3	2,731.3	0
beef calves	0	126.3	126.3
cull income	291.1	288.6	-2.5
2-week-old bull calves	94.6	23.2	-71.4
springing heifers	107.2	0	-107.2
loss due to dystocia	-9.1	-7.9	1.2
gross revenue	3,215.1	3,161.5	-53.7
<b>expenses</b>			
semen costs	31.7	48.4	16.8
replacement costs	463.3	372.5	-90.7
total operating expenses	2,036.8	1,963.5	-73.3
gross margin	1,178.3	1,197.9	19.6
fixed ownership expenses	243.9	243.9	0
total expenses	2,280.7	2,207.4	-73.3
<b>net return to assets</b>	<b>€934.4</b>	<b>€954.0</b>	<b>€19.6</b>

the control and sexed semen scenarios were simulated for a modern housed herd with a constant size (1,000 year-cows).

### Relevant parameters

Due to damage during the sexing process, plus using fewer sperm per dose, sexed semen results in lower conception than normal semen. In (optimal) trial circumstances, pregnancy rates of 42 to 54% were realized with sexed semen, versus 60% with unsexed semen. Conception rate  
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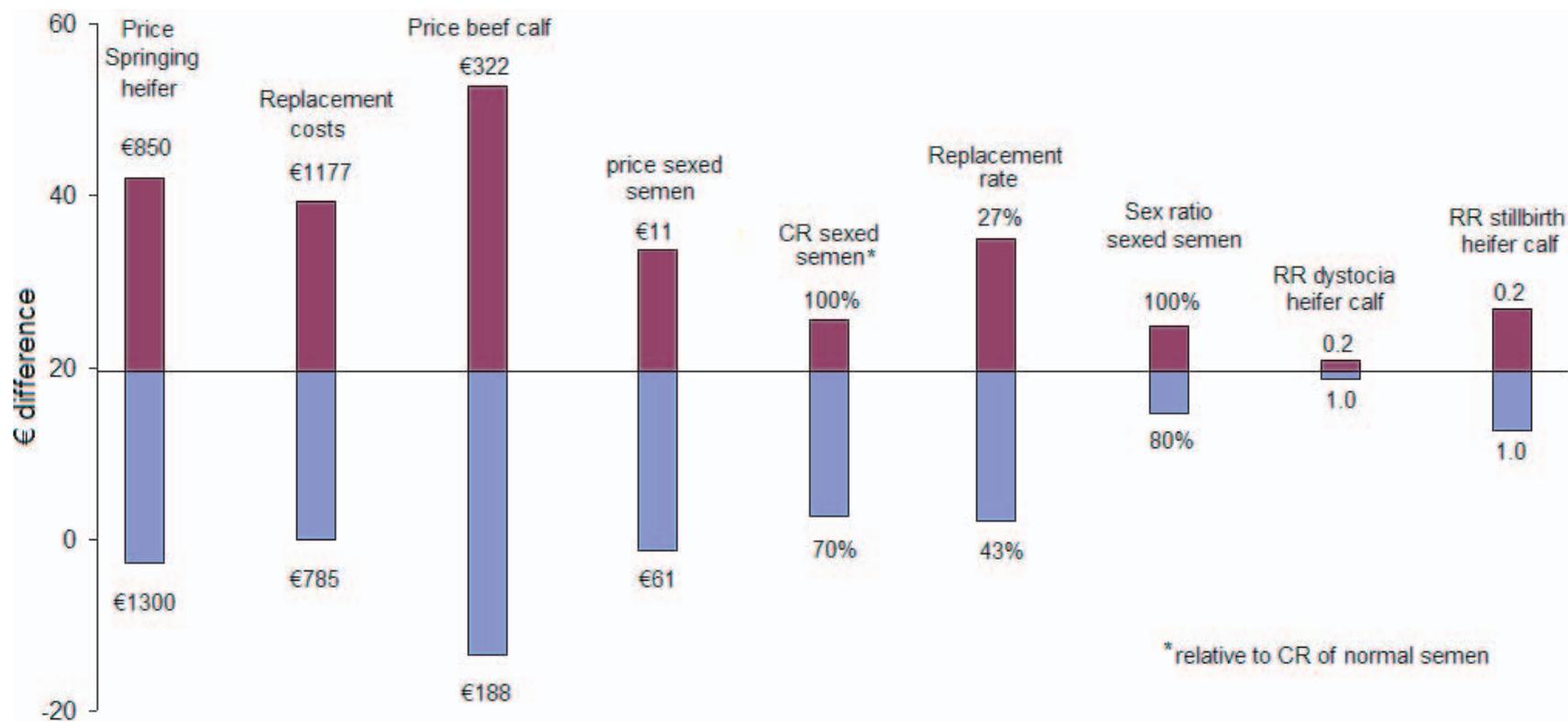


Figure 1: Difference between control and sexed semen when using lowest and highest estimate for each param-

eter. Base line represents the difference (€19.6) when using each parameter's best estimates (as presented in

Tables 1 and 2).

(CR) for nulliparous heifers and lactating cows is therefore set at 60% and 35%, respectively. Lower conception ability of sexed semen is set at 90% of the CR of normal semen (54% instead of 60%). The accuracy of sexing is set at 90% females. Assumptions related to calving, stillbirth and dystocia for nulliparous heifers are presented in Table 1. The most important prices are summarized in Table 2.

## Results and discussion

Net returns to a traditional system and a sexed semen system are compared in Table 3. With the assumptions used, the sexed semen option made €20 more per cow per year. This higher net return to assets (NRA) is realized in the equilibrium situation 5 years after implementing the change.

During the first year after implementation a €15 lower NRA is realized. It takes another 3-4 years before the herd has reached a steady state with respect to raising and selling replacements. In these years, the difference in NRA is positive for sexed semen.

These results are dependent on assumptions not yet fully backed by research. Therefore, we conducted a sensitivity analysis to determine which factors hold the key to successfully implementing a sexed semen system. Figure 1 shows how sensitive our analysis was to prices and other important factors. The baseline represents the NRA difference of €20.

The values on top and bottom of the bars represent the NRA difference when inputs are lowered or raised, while all others remain unchanged. For example, sexed semen was assumed to cost €31, but the advantage would increase from €20 to over €30 if the cost of sexed semen fell to €11. The sexed semen scenario would lose all advantage if the semen cost €61.

The model's outcome is most sensitive to the price paid for a 2-week-old beef calf.



When €322 is paid and all other prices and settings stay the same, sexed semen results

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in a €53 advantage. However, at €188 the sexed semen results in a €14 lower NRA. The price of springing replacement heifers also had big impacts on the sexed semen net advantage. However, some variables like stillbirth and dystocia have a very small impact on the difference in NRA between scenarios.

Note that with the assumptions used for the sexed semen option, some calves (males and females) are sired by beef bulls. Therefore, there will be fewer dairy replacements to sell than if all were sired by dairy bulls. This is because the plan was to produce only enough dairy heifer calves to meet replacement needs. Should there be a sustained market for selling excess replacement heifers at a profit, it may not be appropriate to use any beef semen.

Note also that some values in Table 2 differ from typical U.S. conditions.

## Conclusions

Even without including faster genetic progress in the calculations, a profitable application of sexed semen seems possible in Danish dairy herds. However, large-scale implementation would most likely affect market prices of livestock to which the outcome is most sensitive.

The spreadsheet model we designed is a tool to calculate the profitability of sexed semen for different livestock prices, levels of herd reproductive performance and different prices of sexed semen and levels of conception. The fact that the differences in NRA represent the equilibrium situation should be taken into account before making a decision; the NRA actually is lowered in the first year.

The availability of sexed semen from all A.I. bulls is not realistic at this point. However, this study and model show what could be achieved, and which assumptions are most sensitive in modeling use of sexed semen in dairy production.