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Economic opportunities for using sexed semen and semen of beef bulls in dairy herds

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ABSTRACT

Dairy farmers can increase the number of dairy heifer calves born in their herd by using sexed semen. They can reduce the number of both dairy bull and heifer calves by using beef semen. Long before sexed semen became commercially available, it was believed that it would provide opportunities for increasing genetic level in both herds and populations. In this study, we studied the potential for increasing the genetic level of a herd by using beef semen in combination with sexed semen. We tested the hypothesis that the potential of increasing the genetic level and the overall net return would depend on herd management. To test this hypothesis, we simulated 7 scenarios using beef semen and sexed semen in 5 herds at different management levels. We combined the results of 2 stochastic simulation models, SimHerd and ADAM. SimHerd simulated the effects of the scenarios and management levels on economic outcomes (i.e., operational return) and on technical outcomes such as the parity distribution of the dams of heifer calves, but it disregarded genetic progress. The ADAM model quantified genetic level by using the dams' parity distributions and the frequency of sexed and beef semen to estimate genetic return per year. We calculated the annual net return per slot as the sum of the operational return and the genetic return, divided by the total number of slots. Net return increased up to €18 per slot when using sexed semen in 75% genetically superior heifers and beef semen in 70% genetically inferior, multiparous cows. The assumed reliability of selection was 0.84. These findings were for a herd with overall high management for reproductive performance, longevity, and calf survival. The same breeding strategy reduced net return by €55 per slot when management levels were average. The main reason for the large reduction in net return was the heifer shortage that arose in this scenario. Our hypothesis that the potential for beef semen to increase genetic level would be herd-specific was supported. None of the scenarios were profitable under Danish circumstances when the value of the increased genetic level was not included. A comparable improvement in genetic level could be realized by selectively selling dairy heifer calves rather than using beef semen.
Key words: sexed semen, beef semen, dairy herd, economics, genetics

INTRODUCTION

Using beef semen in dairy herds allows farmers to produce crossbred calves whose carcasses are more valuable than those of purebred calves (Wolfová et al., 2007). Furthermore, the genetic level of the herd may increase when beef semen is used in genetically inferior cows, because the offspring of these cows do not enter the milking herd. As far as we are aware, no studies have investigated the effect of using beef semen on herds' operational return (**OR**) and change in genetic level. When using beef semen in genetically inferior cows, the distribution of dams giving birth to dairy heifer calves would be expected to change in 2 ways. First, a smaller proportion of cows would deliver heifer calves, and these cows would be genetically superior. Second, the proportion of heifer calves born from heifers (nulliparous cows) would increase, and the proportion born form primi- and multiparous cows would decrease. The former change in distribution increases selection intensity, and the latter decreases generation interval. These different effects make it difficult to forecast change in genetic level as a result of using beef semen.

The genetic level of the herd increases when sexed semen is used on genetically superior animals (Ghavi Hossein-Zadeh et al., 2010; Ettema et al., 2011). This

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Table 1. Investigated scenarios for use of sexed semen on heifers and beef semen on multiparous cows

Scenario[1]	Heifers bred with sexed semen (%)	Multiparous cows bred with beef semen (%)
S0-B0	0	0
S0-B33	0	33
S25-B33	25	33
S25-B60	25	60
S50-B60	50	60
S75-B70	75	70
S75-B70Y	75	70 (Y-sorted semen)

[1]S = proportion of heifers inseminated with sexed semen; B = proportion of cows inseminated with beef semen; Y = sexed beef semen (Y-chromosome enriched).

is particularly true when sexed semen is used on the youngest generations and the breeding strategy is combined with genomic testing (Hjortø et al., 2015). However, sexed semen can create a surplus of heifers in well-managed herds. Under the environmental restrictions of most European countries, in which milk production is limited by animal units (Denmark) or by phosphate (the Netherlands), it is undesirable to produce a high number of surplus heifers. A recommendation in these countries, where heifer calves are typically raised on the farm because there is no market for them, is to counterbalance the use of sexed dairy semen in heifers with the use of beef semen in cows to limit the size of the young stock herd.

Many simulation studies have demonstrated that management level affects the profitability of improving reproductive performance (Østergaard et al., 2005a), using sexed semen (Olynk and Wolf, 2007), changing the voluntary waiting period (Sørensen and Østergaard, 2003), making replacement decisions (De Vries, 2004), or using genomic testing (Hjortø et al., 2015). Significant between-herd differences can also be expected when estimating the economic impact of using beef semen, because it reduces the availability of replacement heifers. The need for replacement heifers differs between herds. Furthermore, the reduction in heifer calves born as a result of breeding a proportion of cows with beef semen depends on the absolute number of cows bred with beef semen and the age distribution of the herd. We expected that the profitability of using beef semen would depend on a herd's management performance in terms of reproductive performance, calf survival, and culling risk.

We hypothesized that the increase in genetic level from using beef semen in genetically inferior cows in combination with sexed semen in genetically superior heifers would be largest in herds with high management levels for reproductive performance, calf survival, and longevity. To investigate this, we simulated 7 scenarios for insemination with sexed semen on heifers and beef semen on multiparous cows and studied them at 5 herd management levels.

MATERIALS AND METHODS

General Design of the Study

We used simulation models SimHerd (Østergaard et al., 2005b) and ADAM (Pedersen et al., 2009) in this study. We used SimHerd to estimate the effect of the scenarios on technical herd effects and OR, without incorporating the effect on genetic level. We used the ADAM model to quantify genetic level in the scenarios. Hjortø et al. (2015) also used these 2 simulation models when studying the economics of genomic testing.

Scenarios

We examined and compared the effects of 7 scenarios for sexed semen and beef semen at 5 management levels. An overview of the 7 scenarios is presented in Table 1. We used beef semen on second-parity and older cows. Heifers and cows that were not bred with sexed or beef semen were bred with conventional semen from dairy bulls. An average Danish dairy farm with regard to prices, costs, production system, and management level formed the basis for the simulations (Ancker, 2011).

General Framework of the Simulation Models

SimHerd IV is a mechanistic, dynamic, and stochastic dairy herd model that simulates the production and state changes of dairy cows and young stock in a herd (Østergaard et al., 2005b). The state of an animal is defined by age, parity, lactation stage, a permanent component of milk-yield potential, actual milk yield, BW, culling status, reproductive status (estrus and pregnancy), SCC, and disease status. The prediction of the current state is made week by week for each cow and heifer in the herd. The state of each animal is updated, and the production and input consumption of the herd is calculated. In the current study, where we used the output of the SimHerd model as input for the ADAM model, it was essential that genetics not be taken into account by SimHerd, because all genetic progress was modeled in ADAM.

ADAM is a general program for stochastic simulation of selective breeding schemes in livestock (Pedersen et al., 2009). It simulates a population of animals with true breeding values, phenotypes, and EBV. In this study, we used ADAM to calculate the genetic level of the females for use of sexed semen on heifers and beef semen on multiparous cows (Table 1).