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Evaluation of sexed semen use in the Irish Dairy Industry



Key external stakeholders:

Dairy farmers, dairy industry, AI companies, veterinary practitioners, DAFM, universities

Practical implications for stakeholders:

- Sexed semen presents farmers with new options regarding the reproductive management of their herd
- The fertility performance of sexed semen relative to conventional semen has improved markedly in recent years
- Careful selection of the highest fertility breeding females results in the greatest likelihood of successful pregnancy establishment following an insemination with sexed semen.
- In an expansion scenario, it is possible to expand more rapidly and more profitably by incorporating sexed semen into the breeding programme.

Main results:

- The conception rates that can be achieved with sexed semen relative to conventional semen are approximately 87%. This means that conception rates with conventional semen of 70%, 60% and 50% will drop to 61%, 52% and 44% with sexed semen, respectively.
- The factors that affect fertility outcomes with sexed semen are similar to conventional semen. The best fertility outcomes are achieved in heifers. Cows that are in first or second lactation, calved >9 weeks and have BCS > 3.0 are the best cows to target.
- Using sexed semen on heifers only or on both heifers and cows can accelerate herd expansion. If only sexed semen is used in a herd that is expanding over a long term horizon (>10 years), both cash flow and profit can become negative during the period of rapid expansion. Hence, a careful business plan is necessary to ensure that the farm business stays liquid and profitable during the expansion phase

Opportunity / Benefit:

The results of this research have:

- Demonstrated the potential benefit of utilising sexed semen as part of the total number of semen straws used to breed dairy cows.
- Identified the best strategies to maximise the likelihood of pregnancy establishment (and hence return on investment) when using sexed semen

Collaborating Institutions:

ICBF, Sexing Technologies, NCBC, Dovea Genetics

Teagasc project team:

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1. Project background:

Following the initial development of the flow-cytometric method of sex-sorting semen, numerous technical advances have enhanced the throughput and sorting efficiency of the process. Sexed semen is now widely available in dairy industries around the world. The process distinguishes X- and Y-chromosome bearing sperm by measuring differences in fluorescence following staining the sperm with a non-toxic, DNA-binding dye (Hoechst 33342). Despite reliably producing ~90% gender bias, the fertility of the sexed semen product is compromised. At the start of this project, available literature estimates indicated that the conception rate of sexed semen relative to conventional (unsorted) semen was between 70 to 80%.

The principle of seasonal, pasture-based systems is to maximise utilisation of grazed grass by matching the peak intake demands of the dairy herd to the flush of spring pasture growth. The importance of reproductive performance is emphasised in seasonal production systems compared with year-round production systems, and is a key factor in determining profitability on pasture-based dairy farms. As a result, the uptake and usage of sexed semen to date has been limited in seasonal pasture-based systems. Indeed, the majority of the current data available on the use of sexed semen, in both controlled research trials and on-farm records is from year-round production systems.

Deleted:

The potential benefits to a dairy farmer and the wider industry of a sexed semen product that delivers a 90% gender bias with minimal reductions in fertility are considerable. The direct effect of increased numbers of dairy heifer calves born in a herd using sexed semen immediately presents the farmer with a number of options. The objectives of this project were to model the physical and economic effects of different scenarios of sexed semen usage in expanding herds, and also to conduct a field trial to benchmark the fertility performance of sexed semen relative to conventional semen in seasonal pasture-based systems of dairy production in Ireland.

2. Questions addressed by the project:

- Does utilising sexed semen as part of the herd reproductive management result in faster expansion and greater profitability compared with using conventional semen only?
- What is the current fertility of sexed semen compared to conventional semen from Irish bulls processed using the best available technology?
- How should sexed semen be used to maximise the likelihood of successful pregnancy establishment?

3. The experimental studies:

This project was composed to two separate strands of research: modelling the effects of sexed semen usage over a 15 year time horizon in expanding herds (study 1) and a field trial to evaluate the current fertility performance of sexed semen in Irish dairy herds (study 2).

Study 1:

A model was developed to examine the effects of sexed semen use on replacement heifer numbers and rate of herd expansion in a seasonal dairy production system. Three separate herd scenarios were established according to the type of semen used on virgin heifers: conventional frozen-thawed (Conv), sexed fresh (SFre), or sexed frozen-thawed (SFro). In the model, sexed semen was used for the first and second inseminations in heifers only. Pregnancy rates achieved with sexed fresh and sexed frozen-thawed semen were assumed to be 94% and 75% of those achieved with conventional frozen-thawed semen, respectively. Initial herd size was 100 cows, which was maintained for the first 2 years of the 15 year simulation, after which all available replacement heifers were retained to facilitate herd expansion. Two different scenarios of land availability (S1 and S2) were examined for each of the 3 herds using different semen types: land

available allowed expansion to a maximum herd size of 150 cows (S1) or 300 cows (S2). Once maximum herd size was reached, sexed semen use was discontinued and all excess heifer calves were sold at 1 month of age. All capital expenditure associated with expansion was financed with a 15-year loan. Each of the different options was evaluated in terms of annual farm profit, annual cash flow, and total discounted net profit. The analysis was completed at a milk price of €0.27/L, and sensitivity around milk price was carried out at €0.22/L and €0.32/L.

A follow-up modelling exercise added the use of sexed semen in lactating cows. Five separate herd scenarios were established according to the type of semen used: conventional frozen-thawed (Conv), sexed fresh semen used in lactating cows for the first 3 weeks of the breeding season (SFre1), sexed frozen-thawed semen used in lactating cows for the first 3 weeks of the breeding season (SFro1), sexed fresh semen used in lactating cows for the first 6 weeks of the breeding season (SFre2), or sexed frozen-thawed semen used in lactating cows for the first 6 weeks of the breeding season (SFro2). In the SFro1, SFre1, SFro2, and SFre2 herds, sexed semen was used for the first and second artificial insemination in virgin heifers.

Study 2

A large-scale field trial involving over 15 000 inseminations on 392 dairy farms was conducted in Ireland in 2013. The objective of the trial was to fully investigate the fertility of both fresh and frozen-thawed sexed semen relative to conventional semen in both virgin heifers and lactating dairy cows in spring calving, pasture-based dairy herds. Nine Holstein–Friesian bulls were used in the study, and each ejaculate was split to allow comparison of three sexed semen treatments (fresh sexed semen, 1×10^6 sperm/straw; fresh sexed semen, 2×10^6 sperm/straw; and frozen sexed semen, 2×10^6 sperm per straw) with fresh conventional semen (3×10^6 sperm per straw). All of the sexed semen treatment straws were processed to achieve 90% purity.

4. Main results:

Study 1 (heifers only)

- The use of SFre generated more replacement heifers and thus faster herd expansion compared with SFro and Conv semen. Maximum herd size was reached in yr 5, 6, and 7 under S1, and in year 10, 12, and 14 under S2 for SFre, SFro, and Conv herds, respectively.
- Total discounted net profit under S1 for the SFre herd was €19,929 greater than that of the SFro herd and €41,852 greater than that of the Conv herd. Under S2, discounted net profit for the SFre herd was €138,587 greater than that of the SFro herd and €239,987 greater than that of the Conv herd.
- All 3 herds suffered negative cash flows for extended periods under both S1 and S2 at the lower milk price of €0.22/L, although cash flows were most negative in the SFre herd.

Study 1 (cows and heifers)

- Maximum herd size under S1 was reached in year 5, 5, 4, 5, and 7 for the SFre1, SFro1, SFre2, SFro2, and Conv herds, respectively. Under S2, maximum herd size was reached in year 8, 10, 7, 9, and 14 for the SFre1, SFro1, SFre2, SFro2, and Conv herds, respectively.
- Total discounted net profit under S1 for the SFre2 herd was €4,130, €38,869, €47,231, and €52,089 greater compared with the SFre1, SFro1, Conv, and SFro2 herds, respectively. Under S2, discounted net profit for the SFre2 herd was €44,204, €255,524, €280,373, and €325,815 greater compared with the SFre1, SFro1, SFro2, and Conv herds, respectively.

Study 2

- Overall, the conception rate achieved with conventional semen was 61.7% in heifers and 47.8 in cows. When sexed frozen semen was used, these figures were reduced to 52.5% and 40.4%, respectively. These figures indicate that the conception rates achieved with sexed frozen semen were approximately ~85% of those achieved with conventional semen in both virgin heifers and lactating cows. Hence, the performance of sexed frozen semen relative to conventional semen was markedly improved compared with previous published reports.
- The CR achieved with the two fresh sexed semen treatments (1×10^6 sperm/straw and 2×10^6 sperm/straw) were similar (~82 to 84% of conventional). There was a continual problem with sperm agglutination in the two sexed fresh treatments, and this likely explains the failure of the sexed fresh treatments to outperform the sexed frozen treatment in this study.

- Lactating dairy cows inseminated with sexed semen had greater CR when BCS was ≥ 3.0 compared with cows with BCS ≤ 2.75 (41.6% v. 28.5%, respectively). Similarly, lactating dairy cows inseminated with sexed semen that were ≥ 63 days in milk (DIM) had greater likelihood of conception compared with cows that were ≤ 62 DIM (43.3% v. 27.3%, respectively). Cows that were both ≥ 63 DIM and had BCS ≥ 3.0 had a likelihood of conception of 51.1%.

Clearly, sexed semen should be targeted at the higher fertility animals in a herd (i.e. early calving cows in good BCS).

5. Opportunity/Benefit:

- The use of high fertility sexed semen in dairy heifers facilitates faster and more profitable expansion compared with the use of conventional frozen-thawed semen. Financial pressures caused by low milk price were greatest when the rate of expansion was highest
- The negative effects of low fertility sexed semen on herd fertility reduced farm profitability and will prevent its widespread use in lactating cows. A high fertility sexed semen product is required for sexed semen to become viable in the Irish dairy industry
- There are a number of other potential advantages of using sexed semen that require further study. These include improved biosecurity by maintaining a closed herd, greater potential for beef output from the dairy herd, more compact replacement heifer calving and rearing periods, and greater attractiveness of Jersey cross-breeding.
- The current fertility performance achieved with sexed semen is markedly improved relative to earlier published reports. As the fertility of sexed semen gets closer to that of conventional semen in the coming years, the attractiveness (and usage) of sexed semen will likely markedly increase

6. Dissemination:

Main publications:

- Butler, S. T., I. A. Hutchinson, A. R. Cromie, and L. Shalloo. 2014. Applications and cost benefits of sexed semen in pasture-based dairy production systems. *Animal* 8(Suppl S1):165-172.
- Hutchinson, I. A., L. Shalloo, and S. T. Butler. 2013a. Expanding the dairy herd in pasture-based systems: The role for sexed semen use on virgin heifers. *Journal of Dairy Science* 96(2):1312-1322.
- Hutchinson, I. A., L. Shalloo, and S. T. Butler. 2013b. Expanding the dairy herd in pasture-based systems: The role of sexed semen use in virgin heifers and lactating cows. *Journal of Dairy Science* 96:6742–6752.

Popular publications:

- Hutchinson, I. A. and S. T. Butler (2012). Sexed semen in Irish dairy herds? *TResearch* 7(1):22-23
- Hutchinson, I. A. and S. T. Butler (2013) Sexed semen – has it a role in Ireland? *Moorepark '13: Irish Dairy, Harvesting the potential*. Open Day booklet page 81 to 82.

Other:

- No bull – farmers aim to control the gender of calves: *Sunday Times* page 7, 01/04/2014.
- Science Squad, *RTÉ 1*, 27/09/2013

7. Compiled by: Dr. Stephen Butler