

Calf Sex Ratios

IN CATTLE

Climate, Genetics or Management?

In the pursuit of optimising livestock productivity, a topic of interest is the skewing of sex ratios in calves. The secondary sex ratio, defined as the proportion of male to female offspring at birth, plays a critical role in livestock production and breeding strategies. A balanced sex ratio is expected under evolutionary equilibrium, but both scientific studies and field observations suggest that several biological and environmental factors can tip this balance. Recent investigations have uncovered intriguing links between climatic variables, cow condition, genetics, and management practices that may influence the probability of producing more male or female offspring in cattle.

Climatic Influences on Sex Ratio: Heat, Evaporation, and Beyond

One of the most comprehensive studies on dairy cattle, spanning 34 years and over 8,000 calving records in New Zealand, provides compelling evidence that ambient climate conditions near the time of conception can subtly influence the likelihood of producing male calves. Specifically, a 1°C rise in maximum ambient temperature during the week before conception increased the probability of a male calf by 1%, while each additional millimeter of daily evaporation boosted the male probability by nearly 3 percentage points (Roche et al., 2006).

Interestingly, while sunlight hours, rainfall, and radiation showed trends, they did not reach statistical significance, suggesting that thermal stress or environmental cues linked to temperature and water loss may signal optimal conditions for raising resource-demanding male offspring. This pattern supports the Trivers–Willard hypothesis, which suggests that mothers in better condition or under

favorable environmental circumstances are more likely to produce the sex with higher reproductive potential—typically males in polygynous species like cattle (Roche et al., 2006).

The Role of Cow Factors: Previous Offspring, Body Condition, and Seasonality

The same study revealed that the sex of a cow's previous calf strongly predicted the sex of her next—the odds of having a male were 3.74 times higher if the previous calf was also male (Roche et al., 2006). Additionally, cows in better body condition at calving were more likely to have female calves at their next parturition, possibly due to greater condition loss post-calving and a subsequent reduction in energy reserves at conception.

Seasonality also played a role, with week of the year showing a small but significant influence. As the breeding season progressed, the probability of male calf birth increased. This may correlate with seasonal changes in climate and forage availability that influence dam physiology and mating dynamics (Roche et al., 2006; Delesa et al., 2014).

Genetic and Sire Effects: Skewed Ratios from Within the Herd

In beef cattle, a different angle was explored through analysis of over 5,700 progeny across five registered breeds. Here, sire effects, though accounting for just 0.27% of the variance, revealed individual bulls that consistently produced either more male or more female calves. This suggests that while sex ratio variation is not strongly heritable, individual bulls may exhibit biologically skewed sperm ratios or subtle reproductive traits influencing fertilization outcomes (Baublits et al., 2003).

What does our South African data show us?

Two composite beef breeds with large populations were considered to evaluate this phenomenon using our South African data. Only progeny that were sired by natural mating were included to avoid issues related to the use of sexed semen. For accuracy, only bulls with at least 300-500 progeny were evaluated. Table 1 shows the ratio of male to female progeny seen over these populations.

Table 1 Average male to female ratio of calves of different populations

Population	Sires with more than 300 progeny (M:F)	Sires with more than 500 progeny (M:F)
Breed 1	49.30 : 50.70	50.91 : 49.09
Breed 2	49.18 : 50.82	49.32 : 50.68

As seen in Table 1 the overall secondary sex ratio is around 50/50 as indicated in literature. But during the evaluation of sires with more than 500 progeny in breed 2 some sires identified did not conform to a 50/50 ratio as seen in the study mentioned above. Some individual bulls can have a skewed distribution (as mentioned by Baublits et al., 2003). Two examples of such individuals stand out in Breed 2. Both these bulls produced many progeny. Bull 1 has 1 125 progeny with a ratio of 21.51 % bull calves to 78.49 % heifer calves, while Bull 2 fathered 895 progeny with a ratio of 78.44 % bull calves to 21.56 % heifer calves. Although unexpected by expected norms, we therefore see that there are individual bulls that can be skewed to produce either more female (Bull 1) or more male progeny (Bull 2).

The use of sexed semen

Sexed semen is a reproductive technology that allows for the separation of sperm carrying either the X or Y chromosome, which determines the sex of the offspring. The process involves sorting sperm cells based on their DNA content, as sperm carrying the X chromosome have slightly more DNA than those with the Y chromosome. This difference allows for the use of a specialized flow cytometer to sort and isolate the sperm based on their sex chromosome. Sexed semen is then used in artificial insemination to selectively produce male or female offspring, depending on the desired outcome. In cattle production, sexed semen can significantly impact herd management and profitability. For example, farmers may use sexed semen to increase the number of heifer calves

for herd expansion or to focus on producing more male calves for beef production, especially for cross breeding programs such as “beef on dairy” that has become commonplace among many dairy farmers. While sexed semen can improve the efficiency of breeding programs, its use may be costlier due to the advanced technology involved, and the semen generally has lower fertility rates than conventional semen. Nonetheless, its ability to tailor the sex of offspring to meet specific production goals offers substantial potential in optimizing cattle breeding operations.

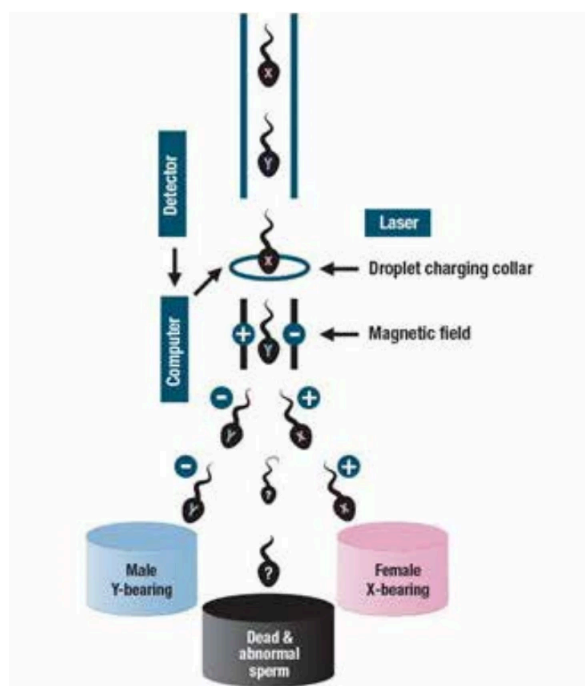


Figure 1 The process of sexing semen

Conclusion: A Complex Web of Influences

While the secondary sex ratio in cattle generally hovers near 50:50, a combination of climatic, physiological, genetic, and management factors can sway this balance. Understanding these effects not only satisfies scientific curiosity but has tangible economic implications. Whether through selective sire use, optimized timing of breeding (mating season), or herd condition management, targeting calf sex ratio may be a viable strategy to align production goals with biological possibilities.

References

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Figure 1 sourced from TAG-Sexing Technologies ULC

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