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Sexed Semen: A Scientific Approach to Gender-Controlled Calf Production

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Artificial insemination (AI) has revolutionized livestock breeding by offering a safe, scientific, and economical way to produce improved animals. In this technique, semen containing healthy, living sperm is collected from a superior male and carefully introduced into the female reproductive tract at the right time using special instruments and strict hygienic measures. Artificial insemination results in normal and healthy offspring and has been widely adopted across the world. Over the years, continuous research transformed artificial insemination into a powerful tool for genetic improvement, enabling farmers to use superior bull germplasm irrespective of distance, while also reducing the spread of reproductive and other infectious diseases.

With the success of artificial insemination, modern science has taken livestock breeding a step further through the introduction of sexed or sorted semen. This advanced technology allows farmers to choose the desired sex of the calf even before conception. This innovation is particularly valuable in planned breeding programmes, where the preference for male or female calves varies according to production goals. In dairy farming, heifer calves are highly desirable for herd replacement and expansion, whereas in beef production, male calves are often preferred due to their superior growth and market value. The use of sexed semen enables seedstock and commercial producers to selectively produce high-quality breeding females or uniform feeder steers, thereby improving genetic progress, economic efficiency, and overall sustainability of livestock enterprises.

What is sexed semen?

Sexed semen refers to semen that has been processed to contain predominantly X-chromosome or Y chromosome bearing sperm, enabling the production of offspring of a desired sex either female or male with about 80-90% accuracy. Unlike conventional semen, which gives an equal chance of male or female calves, sexed semen allows farmers to plan breeding more efficiently according to their production goals. The technology for sperm sex sorting was developed by scientists of the United States Department of Agriculture (USDA) and is popularly known as the Beltsville Sperm Sexing Technology. It is based on separating sperm using flow cytometry by exploiting the small difference in DNA content between X and Y chromosome–bearing sperm.

In India, sexed semen has emerged as an important tool for dairy development, where the demand for female calves (heifers) is much higher than male calves. To address this need, the Government of India has promoted sexed semen under schemes such as the Rashtriya Gokul Mission, aiming to increase the availability of replacement heifers, improve genetic quality, and reduce the number of unwanted male calves. Several governments, cooperative, and private semen stations—along with international companies—are now producing and supplying sex-sorted semen across different states, including Gujarat, where it is being used to strengthen dairy herds and enhance farmer income. Thus, sexed semen is becoming a practical and farmer-friendly technology for sustainable dairy farming in India.

How is Sexed Semen Produced?

Sexed semen is produced by separating X and Y chromosome bearing sperm based on their DNA content. In cattle, X bearing sperm contain about 3.8% more DNA than Y bearing sperm. This difference is used for sperm sorting. The most effective method is flow cytometry, in which sperm are stained with a DNA-binding dye and passed through a laser-based system that identifies and separates X and Y sperm. This technique can achieve over 90% accuracy and is widely used commercially worldwide. Several other approaches for sperm sexing such as albumin or Percoll gradient methods, swim-down techniques, free-flow electrophoresis, identification of H-Y antigen, and genetic methods have also been explored. However, these techniques still require further refinement and validation before they can be widely used on a commercial scale.

Advantages of Using Sexed Semen

- Higher production of female calves, helping meet the growing demand for replacement heifers in dairy herds.

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- Efficient use of farm resources, as expenditure on unwanted male calves is minimized.
- Opportunity to generate additional income through the sale of surplus heifers to other farmers or farms.
- Accelerated genetic improvement by improving the efficiency of Progeny testing programmes, Embryo transfer (ET) and in vitro fertilization (IVF) programmes.
- Improved herd biosecurity, as herd expansion can be achieved without purchasing animals from outside sources, reducing disease risk.
- Higher proportion of viable sperm, since dead or damaged sperm are removed during the sorting process, allowing effective fertilization even at lower sperm concentrations.
- Reduced risk of dystocia (difficult calving) due to fewer male calves, making sexed semen especially beneficial for maiden heifers

Limitations of Using Sexed Semen

A. Technological Limitations

- High capital cost of sex-sorting equipment.
- Low sorting speed and efficiency, limiting large-scale production.
- Requirement of highly skilled personnel to operate and maintain sorting systems.
- Potential sperm damage during sorting due to shear stress, electrostatic forces, droplet formation, and sudden deceleration.
- Loss of nearly 50% of sperm during the sorting process.
- Reduced cryo-survivability of sorted sperm compared to conventional semen.

B. Implementation Limitations (Indian Scenario)

- High cost per dose of sexed semen due to technology and intellectual property costs (approximately ₹1500–4500 per dose, compared to ₹15–20 for conventional semen).
- Lower conception rate, generally 10–15% less than conventional semen.
- Greater field-level challenges in India due to low AI coverage (20–25%) and low overall AI conception rate (25–35%)
- Lack of standardized insemination protocols, particularly critical because sexed semen contains only 2–4 million sperm per dose, compared to about 20 million sperm per dose in conventional semen.

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