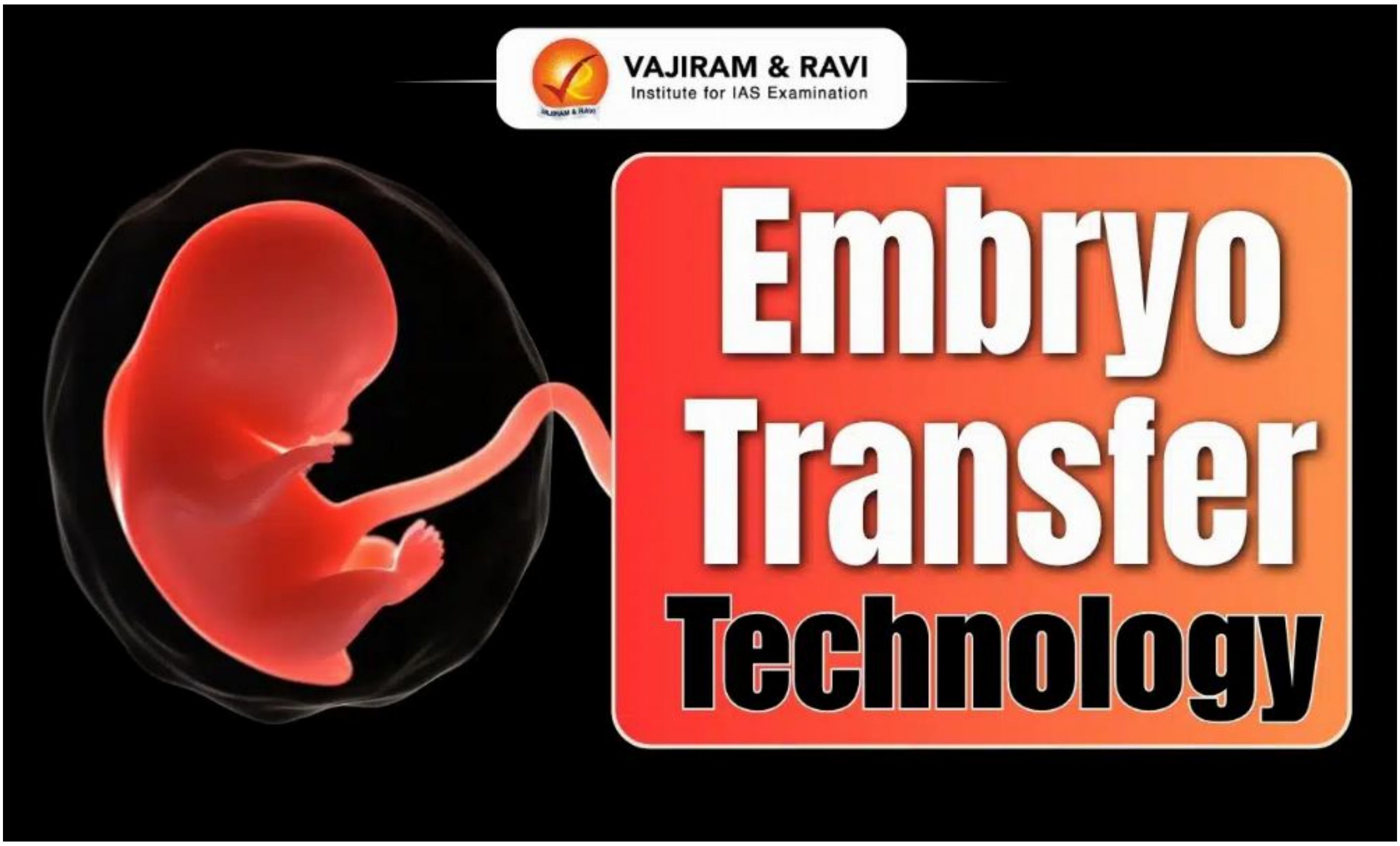
Embryo Transfer Technology (ETT), Meaning, Working, Benefits

July 21, 2026 • vajiramandravi.com



Embryo Transfer Technology (ETT) is an assisted reproductive technology in which an embryo is transferred into the reproductive tract of a recipient female to establish pregnancy. It is used in livestock breeding for genetic improvement, breed conservation and rapid multiplication of superior animals, and is also applied in human assisted reproduction, particularly IVF.

About Embryo Transfer Technology

Embryo Transfer Technology (ETT) is a **reproductive technology** in which an embryo produced from a genetically superior female and a selected male is transferred into the reproductive tract of another female, known as the recipient.

The recipient carries the pregnancy and gives birth to the offspring. However, the genetic characteristics of the offspring come from the donor female and the male whose sperm fertilised the egg, and not from the recipient.

Thus, the recipient provides the environment for pregnancy, while the embryo carries the genetic potential of the selected parents.

Embryo Transfer Technology History and Major Milestones

The development of embryo transfer technology began with experiments in rabbits and gradually expanded to livestock breeding.

- **1890**: Walter Heape successfully performed embryo transfer in rabbits, marking an important early milestone in mammalian embryo transfer.
- **1951**: The first calf produced through embryo transfer was reported.
- **1983**: Embryo transfer was reported in the Asian buffalo.
- **1987**: The first embryo-transfer calf in the **ICAR** system was born.
- **2012**: The world's first mithun calf produced through embryo transfer was born at the ICAR-National Research Centre on Mithun.
- **2023**: ICAR-National Research Centre on Equines produced India's first Marwari horse foal through embryo transfer technology. The foal, born on 19 May 2023, was named 'Raj-Prathama'. A blastocyst-stage embryo from a donor mare was transferred to a synchronised recipient mare.
- **2026**: ICAR-IVRI produced five healthy Sahiwal calves within five days beginning 28 February 2026 through OPU-IVF-ET. The achievement demonstrated the recovery of oocytes under non-stimulated conditions and reported blastocyst production rates exceeding 47% in cattle.
- These milestones reflect the transition of embryo technology from conventional embryo transfer to advanced reproductive technologies such as OPU, IVF and in-vitro embryo production.

Embryo Transfer Technology Working

Embryo Transfer Technology involve following steps: Selection of superior parents → Production of embryos → Collection and evaluation of viable embryos → Transfer to a synchronised recipient → Pregnancy and birth of offspring

1. **Selection of superior parents**: A genetically superior female is selected as the donor, and a suitable male is selected to provide the sperm.
2. **Production of embryos**: The egg from the donor female is fertilised with the sperm of the selected male to produce embryos. This may be done inside the animal or in a laboratory.
3. **Collection and examination of embryos**: The embryos are collected and examined to identify healthy embryos suitable for transfer.
4. **Preparation of the recipient female**: A healthy female is selected and its reproductive cycle is synchronised with the development of the embryo.
5. **Transfer of the embryo**: The selected embryo is placed in the uterus of the recipient female.
6. **Pregnancy and birth**: The recipient female carries the pregnancy and gives birth to the offspring.

Major Approaches to Embryo Production

Embryos used for embryo transfer can be produced through two major approaches:

1. **Multiple Ovulation and Embryo Transfer (MOET)**: In MOET, a genetically superior female is given hormonal treatment to stimulate the release of multiple eggs instead of the usual number during one reproductive cycle. After fertilisation, multiple embryos develop inside the donor and are later collected and transferred to suitable recipient females.
2. **OPU-IVF-ET:** This is a more advanced approach in which embryos are produced outside the animal under laboratory conditions.

- **Ovum Pick-Up (OPU)**: Eggs are collected from the ovaries of a live donor using ultrasound guidance.
- **In-Vitro Maturation (IVM)**: The collected eggs are matured in the laboratory.
- **In-Vitro Fertilisation (IVF)**: The eggs are fertilised with semen from a selected male.
- **In-Vitro Culture (IVC)**: The fertilised eggs are cultured until they develop into embryos.
- **Embryo Transfer (ET)**: The embryos are transferred to synchronised recipient females.

Factors Affecting Successful Embryo Transfer

The success of Embryo Transfer Technology (ETT) depends on the quality of the donor and recipient, proper synchronisation and the quality of the embryo.

- **Donor quality**: The donor should possess superior genetic and productive traits, good reproductive health and overall fitness. Performance records, pedigree and genomic information may be used for selection.
- **Recipient quality**: The recipient should be healthy, reproductively sound and capable of maintaining pregnancy. It should have a functional corpus luteum at the appropriate stage.
- **Reproductive synchronisation**: The reproductive cycle of the recipient must correspond with the developmental stage of the embryo so that the uterus is ready for implantation and pregnancy.
- **Embryo quality**: Embryos are examined for their developmental stage, cellular structure, uniformity and overall quality before transfer.
- **Correct site of transfer**: The embryo is generally transferred to the uterine horn corresponding to the ovary containing the functional corpus luteum, which produces progesterone needed for pregnancy maintenance.

Cryopreservation of Embryos

Embryos can be preserved for long periods through cryopreservation, allowing valuable genetic material to be stored for future breeding and conservation programmes. It also facilitates the movement of germplasm without transporting live animals. However, specialised techniques are required for the freezing, storage and thawing of embryos, and embryo viability must be maintained throughout the process.

Applications of cryopreservation:

- Long-term storage of valuable genetic material;
- Conservation of rare and endangered breeds;
- Creation of genetic reserves;
- Future breeding programmes;
- Easier movement of germplasm.

Applications of Embryo Transfer Technology

Embryo Transfer Technology is primarily used to multiply desirable genetic traits, conserve valuable animal genetic resources and support advanced reproductive research. Its major applications are:

- **Rapid genetic improvement**: It enables the genetic traits of superior animals to be multiplied much faster than through natural reproduction.
- **Production of superior offspring**: Several offspring can be produced from a genetically superior female, helping improve the quality of livestock populations.
- **Breed conservation**: It helps conserve and multiply rare, endangered and valuable breeds, including indigenous livestock breeds.
- **Preservation of genetic material**: Embryos can be cryopreserved and stored for future breeding and conservation programmes.
- **Safe transfer of genetic resources**: Valuable genetic material can be transported as embryos instead of live animals, reducing the need for animal movement and associated disease risks.
- **Assisted reproduction**: It can help produce offspring from genetically valuable animals that are unable to reproduce naturally but can still provide viable eggs or embryos.
- **Sex selection in breeding**: When combined with sex-sorted semen, it can increase the likelihood of producing offspring of the desired sex.
- **Conservation of endangered species**: Embryo transfer and related assisted reproductive technologies can support the conservation of threatened animal species.
- **Research and advanced biotechnology**: It provides a foundation for in-vitro embryo production, cryopreservation, genomic selection, cloning and other reproductive technologies.

Significance of Embryo Transfer Technology for India

For India, Embryo Transfer Technology (ETT) is significant because it can help address the gap between the country’s large livestock population and the relatively low productivity of many animals.

- **Improving livestock productivity**: Helps increase the availability of genetically superior cattle and buffaloes with desirable traits.
- **Strengthening the dairy sector**: Faster genetic improvement can enhance the efficiency of India’s dairy economy, the world’s largest in milk production.
- **Improving indigenous breeds**: Supports the scientific improvement of Indian breeds while retaining their local adaptability.
- **Supporting region-specific breeding**: Enables the development of breeding programmes suited to India’s diverse agro-climatic conditions.
- **Improving rural livelihoods**: Better-quality breeding animals can contribute to higher productivity and income for livestock-dependent households.
- **Building indigenous biotechnology capacity**: Promotes domestic expertise in IVF, in-vitro embryo production, cryopreservation and genomic selection.
- **Supporting the Rashtriya Gokul Mission**: Complements government efforts for the conservation and genetic improvement of indigenous bovine breeds.

Government Initiatives

The **Rashtriya Gokul Mission** is the principal government programme for the development, conservation and genetic improvement of indigenous bovine breeds. It promotes modern breeding technologies such as IVF, in-vitro embryo production, genomics and sex-sorted semen. The revised RGM has a total outlay of ₹3,400 crore for the 15th Finance Commission cycle (2021-22 to 2025-26). The scheme also provides a 3% interest subvention on eligible loans for the induction of high-genetic-merit IVF-born heifers. (Animal Husbandry & Dairying)

Initiative	Key Role
Rashtriya Gokul Mission (RGM)	Genetic improvement and conservation of indigenous bovine breeds; promotes IVF, in-vitro embryo production, genomics and sex-sorted semen.
National Milk Recording Programme	Identification of elite animals based on production performance for targeted genetic improvement.
National Bovine Genomic Centre for Indigenous Breeds (NBGC-IB)	Supports genomic selection for identifying high-genetic-merit indigenous bovines.
IVF and In-Vitro Embryo Production Programmes	Enable rapid multiplication of high-genetic-merit cattle and buffaloes.
Sex-Sorted Semen Technology	Increases the probability of producing calves of the desired sex, particularly female calves for dairy breeding.
Minimum Standard Protocol for Embryo Production and Transfer	Provides a framework for standardisation and quality control in embryo production and transfer.

Embryo Transfer Technology Challenges

Despite its benefits, the wider use of Embryo Transfer Technology faces several technical, biological and economic challenges:

- **High Cost**: ETT requires specialised laboratories, equipment and trained professionals. It is therefore more expensive than conventional Artificial Insemination.
- **Shortage of Skilled Personnel**: Embryo production, evaluation, cryopreservation and transfer require specialised veterinary and laboratory expertise.
- **Recipient Management**: The availability of healthy and properly synchronised recipient females is essential for successful embryo transfer.
- **Species-Specific Limitations**: The efficiency of embryo production varies between species and breeds. Buffalo reproductive biotechnology, in particular, requires further research and protocol optimisation.

- **Cryopreservation Challenges**: The freezing and thawing of in-vitro-produced embryos require specialised protocols and further optimisation for wider field-level use.
- **Uneven Infrastructure**: Advanced reproductive technologies remain concentrated in selected institutions and regions.
- **Risk of Genetic Narrowing**: Excessive dependence on a limited number of elite animals may reduce genetic diversity and increase vulnerability to diseases and changing environmental conditions.
- **Biosecurity Concerns**: Strict health screening and biosecurity protocols are necessary during the production, storage and movement of embryos and other reproductive materials.

Way Forward

The future of Embryo Transfer Technology lies in making it more efficient, affordable and accessible while ensuring that genetic improvement does not compromise genetic diversity.

- **Reduce costs**: Improve technologies and expand facilities to make ETT more affordable.
- **Expand infrastructure**: Increase access to embryo production, IVF and cryopreservation facilities.
- **Build skilled manpower**: Train more veterinarians, embryologists and laboratory technicians.
- **Improve technical efficiency**: Develop species-specific protocols to improve embryo production and pregnancy success.
- **Integrate genomics**: Combine genomic selection with ETT for more accurate identification of genetically superior animals.
- **Protect genetic diversity**: Balance rapid genetic improvement with the conservation of indigenous and locally adapted breeds.
- **Strengthen biosecurity**: Ensure proper health screening, quality control and safe handling of embryos.
- **Widen access**: Extend the benefits of ETT beyond elite breeding programmes through suitable institutional and financial support.

Source: https://vajiramandravi.com/current-affairs/embryo-transfer-technology/