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pular Article

Embryo Transfer in Cattle: Revolutionizing Breeding with Advantages and Challenges

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Introduction

Assisted reproductive technologies (ART) have made tremendous advances, in the last years. Artificial insemination (AI) is a method for achieving slow genetic progress in populations of animals. Many large and small ruminants are bred by AI, and more than a half million embryos are transferred every year around the world.

Improvements in reproductive biotechnologies of controlling the estrous cycle and ovulation have resulted in more effective programs for AI, superovulation of donors, and the management of Embryo transfer (ET).

Embryo transfer is a process by which an embryo is collected from a donor animal or produced *in vitro* and then transferred into a recipient animal which acts as a surrogate mother where the embryo completes its development. It is a principal technique that is very much necessary for achieving success in various assisted reproductive technologies (ART's). Through embryo transfer, a genetically superior female produces more offspring during her lifetime compared to natural service. Embryo transfer is used in several species of domestic animals, namely cows, buffaloes, goats, sheep, and horses. It is a revolutionary breeding strategy that has led to the faster genetic improvement of cattle. Embryo transfer is now commonly used to produce artificial insemination sires from the top-producing cows and proven bulls for the dairy industry.

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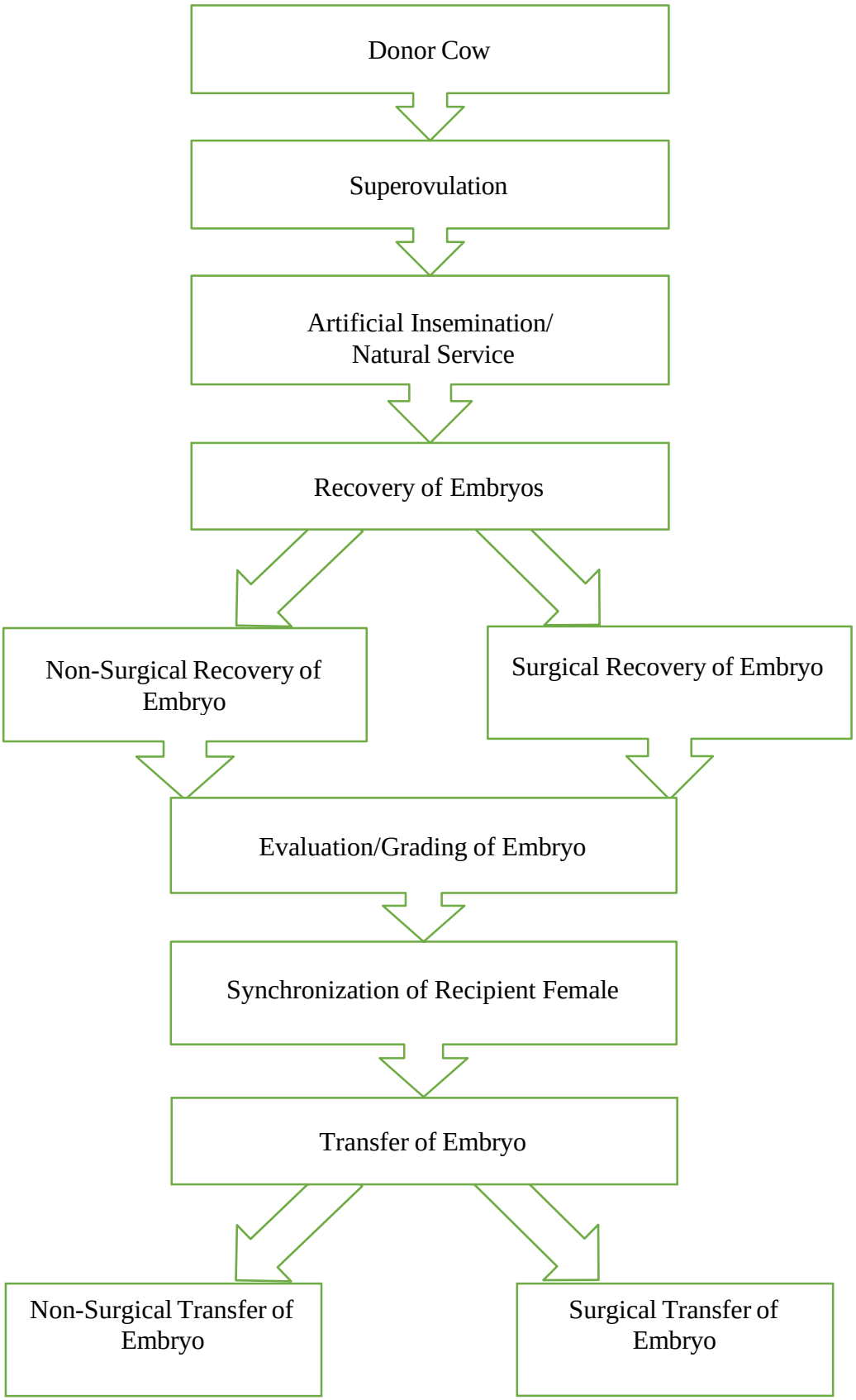
Steps in embryo transfer technology MOET (Multiple Ovulation Embryo Transfer)



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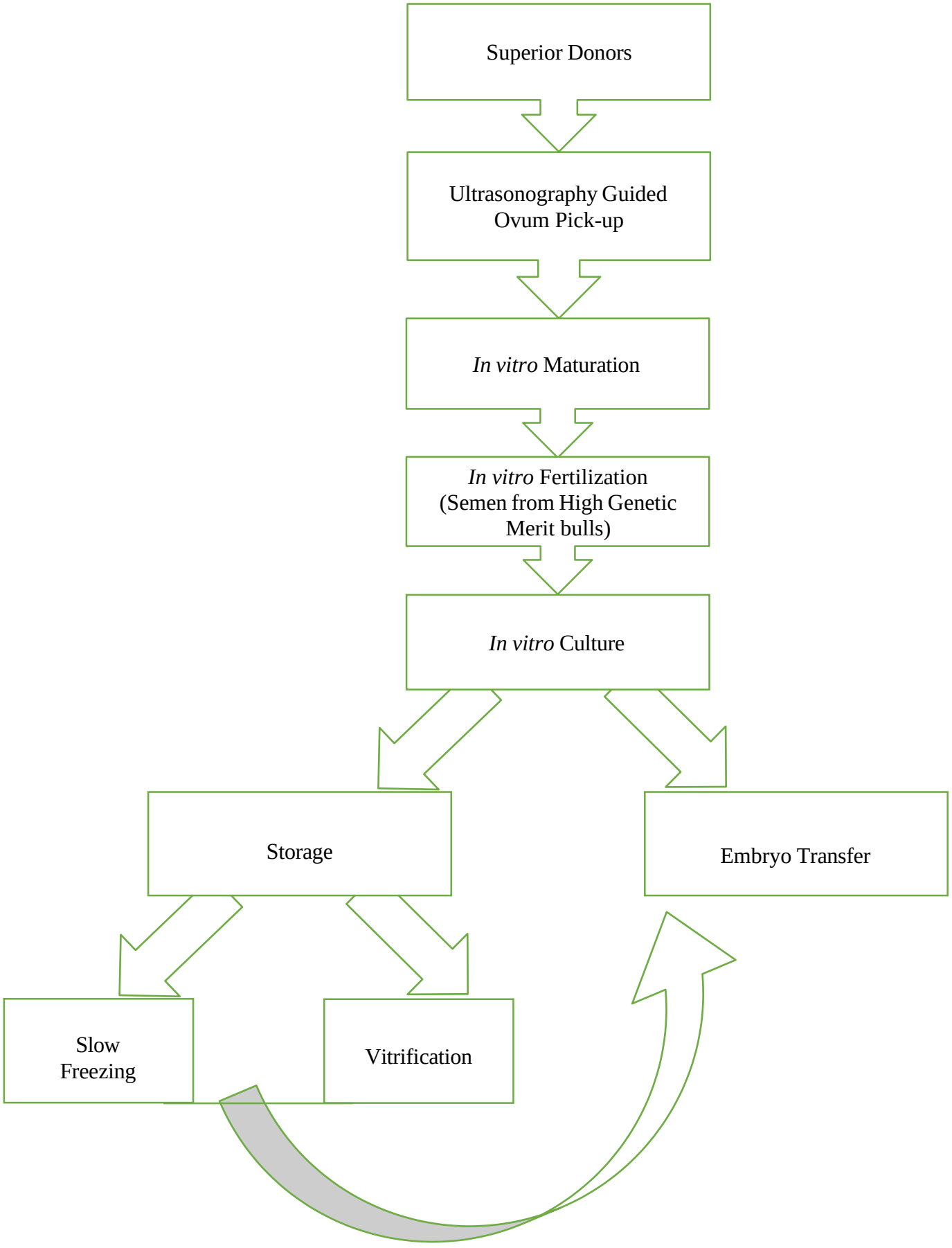
OPU- IVEP-ET (Ovum Pick up- *In vitro* Embryo Production- Embryo Transfer)



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Grading of Embryo (based on morphological characteristics of embryos)

Grade of embryos	Characteristics
Code 1: Excellent or Good	• Symmetrical and spherical embryo mass with individual blastomeres (cells) that are uniform in size, color, and density. • This embryo is consistent with its expected stage of development. Irregularities should be relatively minor, and at least 85% of the cellular material should be an intact, viable embryonic mass. • This judgment should be based on the percentage of embryonic cells represented by the extruded material in the peri-vitelline space. The zona pellucida should be smooth and have no concave or flat surfaces that might cause the embryo to adhere to a petri dish or a straw.
Code 2: Fair	• Moderate irregularities in the overall shape of the embryonic mass or in size, color, and density of individual cells. • At least 50% of the cellular material should be an intact, viable embryonic mass. • These embryos are called "transferable" but not "freezable".
Code 3: Poor	• Major irregularities in the shape of the embryonic mass or in size, color, and density of individual cells. • At least 25% of the cellular material should be an intact, viable embryonic mass. • These embryos do not survive the freezing/thawing procedure and pregnancy rates are lower than fair-quality embryos.
Code 4: Dead or Degenerating	• Degenerating embryos, oocytes, or 1–cell embryos • Nonviable and should be discarded.

Advantages of Embryo Transfer

1. Normally, one can get one calf from superior female dairy animals in a year. But by using the MOET (Multiple Ovulation Embryo Transfer) technology, one can get 10-20 calves in a year from cattle. Whereas by using OPU-IVEP technology, one can get 20-40 calves in a year from cattle.
2. Advancements in breeding techniques have led to a clear upward trend in enhancing a herd's genetic foundation. For instance, while natural breeding may require up to 20 years to see significant improvements, artificial insemination (AI) cuts this timeframe nearly in

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half. Additionally, the adoption of embryo transfer (ET) further shortens the duration to around four to five years.

3. In embryo transfer (ET), the native dam transfers passive immunity to the offspring, increasing their chances of survival, even though the embryo is entirely genetically distinct from the surrogate mother.
4. Embryos can be preserved indefinitely through freezing, allowing highly superior genetic material to remain accessible for future utilization. This method is also regarded as more cost-effective than the process of exporting or importing live animals.
5. Several superior bulls can be used in the same cycle to produce calves from different sire dam combinations.
6. Cows with healthy reproductive systems but non-functional udders and teats, which are typically culled, could be used to produce embryos.
7. High-producing females having reproductive problems such as blocked fallopian tubes, and kinked cervix could be used to produce embryos (Used as Donor animals)
8. Utilizing pre-pubertal elite heifers selected via genomic selection for calf production can effectively minimize the generation interval, consequently boosting the genetic gain per year.

Disadvantages of Embryo Transfer

1. The technology requires trained technical personnel and a high level of management. It needs technical knowledge, especially about flushing the embryos and observation of oestrus in the recipient.
2. Embryo transfer procedures can be expensive due to the need for specialized equipment, facilities, and expertise, making it financially burdensome for some breeders.
3. The relatively small gene pool sourced from the donor cows may have a negative impact in the future, especially on the rare breeds.
4. The success rate of embryo transfer is reportedly lower than the use of artificial insemination. This may be attributed to the numerous processes that have to be undertaken before the embryo is successfully implanted.
5. The manipulation of reproductive cycles and handling procedures involved in embryo transfer can induce stress on both donor and recipient animals, which may affect their overall health and well-being.
6. Embryo transfer requires significant time and effort, including the handling of donors and recipients, synchronization of estrous cycles, and careful management of embryos, which can be labor-intensive.

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Factors Affecting the Success of Embryo Transfer in Cattle

1. Travel delays may necessitate working with older embryos than planned, emphasizing the vital role of donor and recipient management in embryo transfer success.
2. The chance of passing on genetic diseases through embryo transfer is equal to natural breeding or artificial insemination.
3. The skill and experience of the technicians performing the embryo transfer procedure play a significant role in its success.
4. The genetic compatibility between donors and recipients can affect embryo transfer success, emphasizing the importance of selecting suitable breeding pairs.
5. The quality of the transferred embryos significantly impacts the success rate of embryo transfer. High-quality embryos have better chances of implantation and development.
6. Proper synchronization of the estrous cycles between donors and recipients is essential for optimal embryo transfer outcomes.

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