Raj-Prathama: India's first Marwari filly born through embryo transfer technology

Horses have been a symbol of bravery, power and vigour, as well as a means of fast movement and transport since ancient times. India is a complex amalgamation of varying terrains and climatic conditions, in which different species of the family Equidae are used in diverse roles. The country is bestowed with a rich biodiversity of equids and this is reflected in the form of seven distinct horse breeds, namely Kathiawari, Marwari, Spiti, Zanskari, Bhutia, Manipuri and recently recognized Kachchhi–Sindhi breed[1]. The equine population is declining (continuously, which reflects its fast reducing economic and social importance due to continuous mechanization of agriculture and transport, and little efforts in genetic improvement through selection).

The 19th and 20th Livestock Census (2012–19) revealed that the population of horses, donkeys and mules in India was 0.34, 0.12 and 0.08 million respectively, which decreased by 45.58%, 61.23% and 57.09% respectively. Collectively, equines have reduced by 52.71% during the period 2012–19. According to the 20th Livestock Census (conducted between 1 October 2018 and 20 September 2019), 0.06% of the livestock population is contributed by horses and ponies[2]. Despite the decreasing population of equines in India, the economic impact of these animals is appreciable. Although equines are gradually losing economic and social importance, there is a tremendous potential for their growth and development in the country. The elite equine industry has unlimited potential in terms of contribution to India's GDP. This is reflected in two ways – first through races and other equestrian events, and second, more important, through the breeding of best-quality indigenous horses for this industry, which can later be exported world over. Further, conservation of elite animals of each breed is one of the main issues that needs to be addressed on priority because of the limitations in current equine improvement programmes.

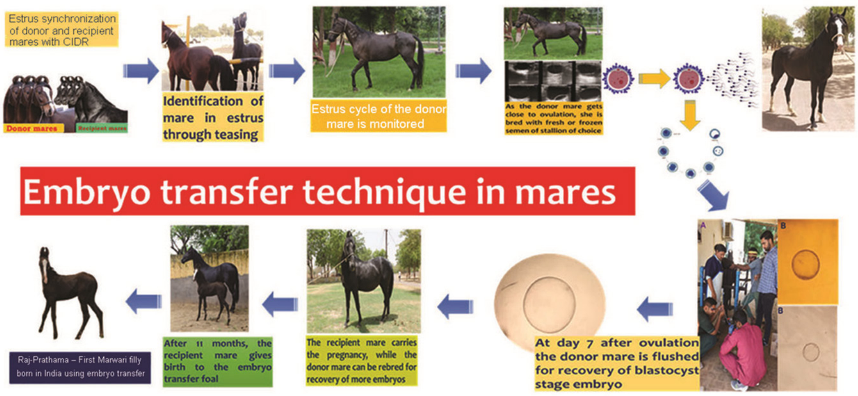

Figure 1. Step-by-step procedure for producing foals through embryo transfer in horses. Raj-Prathama is India's first Marwari filly born through embryo transfer born on 19 May 2023.

Figure 2. ***a***, Biological mother/donor mare of foal. ***b***, Raj-Prathama with surrogate mother/recipient mare. ***c***, Stallion/sire for Raj-Prathama, whose semen was used for producing the foal.

Over the past decades, the National Research Centre on Equines (NRCE) has been working on the genetic conservation and propagation of indigenous breeds of horses and donkeys. For faster multiplication of elite equine indigenous germplasm, NRCE has developed technologies for cryopreservation of semen and artificial insemination of frozen semen. Through these initiatives, NRCE is not only conserving but also propagating the indigenous equine germplasm. Live foals from Marwari, Kathiawari, Zanskari and Manipuri breeds have been produced through artificial insemination of frozen semen[3–5]. In this endeavour, scientific team at the Equine Production Campus, Regional Station, ICAR-National Research Centre on Equines, Hisar, has taken up another challenge to cryopreserve the indigenous horse breed embryos and to produce foals through embryo transfer technology. Figure 1 depicts the entire procedure to produce foals through embryo transfer in equines.

To produce foals by embryo transfer, estrus synchronization of donor and recipient mares was carried out using controlled intravaginal drug release (CIDR). Estrus of the mares was closely monitored and just before ovulation, the donor mares were inseminated with either fresh or frozen semen from proven fertile stallions and recipient mares were left without breeding. Donor mares were flushed at day 7 after ovulation for the recovery of embryos, and the recovered embryos were transferred into synchronized surrogate recipient mares for the conception. After 11 months, a filly was born through embryo transfer and named as Raj-Prathama (Figures 1 and 2). Marwari horses are known for their sturdiness, endurance potential, relative disease resistance and majestic look, and thus much sought after by horse breeders and owners. However, owing to indiscriminate breeding and lack of sound breeding policies, the characteristics of this breed are being diluted and, presently, only a few thousand true Marwari horses are known to survive[6]. To avoid further loss of potential unique genes and to preserve genetic diversity within this breed, the team of scientists at NRCE have taken up a project to cryopreserve the embryos of this breed through which elite genetics can be preserved. Until now, the team has successfully cryopreserved 15 Marwari horse embryos. This achievement will help us envisage the feasibility of equine embryo transfer in India. Embryo transfer technology in equines will bring new dimensions to our efforts to produce quality indigenous horse breeds. Also, the farmers will benefit from this advanced reproductive technology, which will lead to future stability of indigenous horse breeds that are fast declining.

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Assured access to neutron and muon sources at RAL, UK under the DST–STFC collaboration

The DST-RAL project is a collaborative agreement between the Department of Science and Technology (DST), India, and the Science and Technology Facility Council (STFC), the United Kingdom, representing a cutting-edge initiative to enhance and streamline access to neutron and muon facilities at the Rutherford Appleton Laboratory (RAL), UK. This project is dedicated to advancing research in nanoscience and technology, focusing on quantum materials, energy, advanced engineering and healthcare. The main objectives of this project are to nurture researchers, enhance instrumental resources, and foster collaborations in neutron and muon techniques.

On 16 January 2015, the Government of India and STFC partnered to benefit the latter's ISIS neutron and muon facility, and India's Nano Mission. ISIS is acknowledged as a world-class centre for research in the physical and life sciences. Figure 1 shows various neutron and muon instruments situated at target stations 1 and 2. A few other facilities in India offer similar research capabilities. Under this agreement, scientists involved in India's Nano Mission will be given dedicated access to ISIS instruments.

The Director of STFC's ISIS, Robert McGreevy, and C. N. R. Rao, Chair of India's Nano Mission, officially established the partnership through a letter of intent. The Nano Mission is dedicated to advancing material studies on a nanoscale, aiming to deepen our understanding of science on this level. The acquired knowledge will be used for the development of technologically important materials, such as steel for household appliances or polymers for drug-delivery systems, with practical applications in the real world.

The inaugural phase of this five-year undertaking has yielded substantial scientific contributions, which have been published in renowned journals. These contributions span various subjects, including energy materials, carbon dioxide capture, nanomaterials, biomaterials and quantum materials. Researchers from many research and academic institutions in India have had the opportunity to utilize these state-of-the-art facilities. Notably, close to 100 Ph.D. students actively participated in experiments conducted at RAL. This initiative has played a pivotal role in supporting the professional development of researchers and post-doctoral fellows. Through workshops and training programmes, it has also facilitated extensive scientific collaboration and knowledge exchange among researchers in India. It is worth noting that this project, overseen by the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru is slated for completion by 31 December 2023. A proposal for the next phase of this project is under consideration by DST.

Techniques available at RAL

Neutron diffraction

Neutron diffraction experiments are helpful in uncovering the atomic or magnetic arrangement within a material. This method involves elastic scattering of neutrons from the material. It is somewhat akin to X-ray diffraction, but offers complementary insights because it employs a different type of radiation. To perform a neutron diffraction experiment, a sample is positioned in the path of a beam of either thermal or cold neutrons. The neutron diffraction pattern of the sample provides details about the atomic arrangement. Neutrons interact directly with the nucleus, and the contribution to the intensity of the diffracted neutrons differs for each isotope. For instance, hydrogen and deuterium have distinct effects. Even though neutrons are electrically neutral, they possess spin which interacts with magnetic moments, including those created by the electron cloud surrounding an atom. Consequently, neutron diffraction can unveil the microscopic magnetic configuration of a material.

Target systems: Crystalline solids, gases, liquids, thin films and amorphous materials.

Instruments: Engin-X, GEM, HRPD, INES, NIMROD, PEARL, Polaris, SANDALS, SXD and WISH.

Neutron spectroscopy

Inelastic neutron scattering is a technique that measures how a neutron's energy changes as it interacts with a sample. This method serves as a versatile tool for investigating a broad spectrum of physical