

DONOR AGE AS A LIMITING FACTOR IN THE CONSERVATION OF ENDANGERED CATTLE BREEDS THROUGH ASSISTED REPRODUCTIVE TECHNOLOGIES

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Background

Genetic erosion threatens livestock biodiversity, with local cattle breeds being among the most affected. Local breeds are essential for adaptation and resilience under harsh climates and challenging farming conditions, such as water or resource shortages.

The FAO has defined an **Endangerment Threshold** to assess whether a local breed is at risk of extinction.

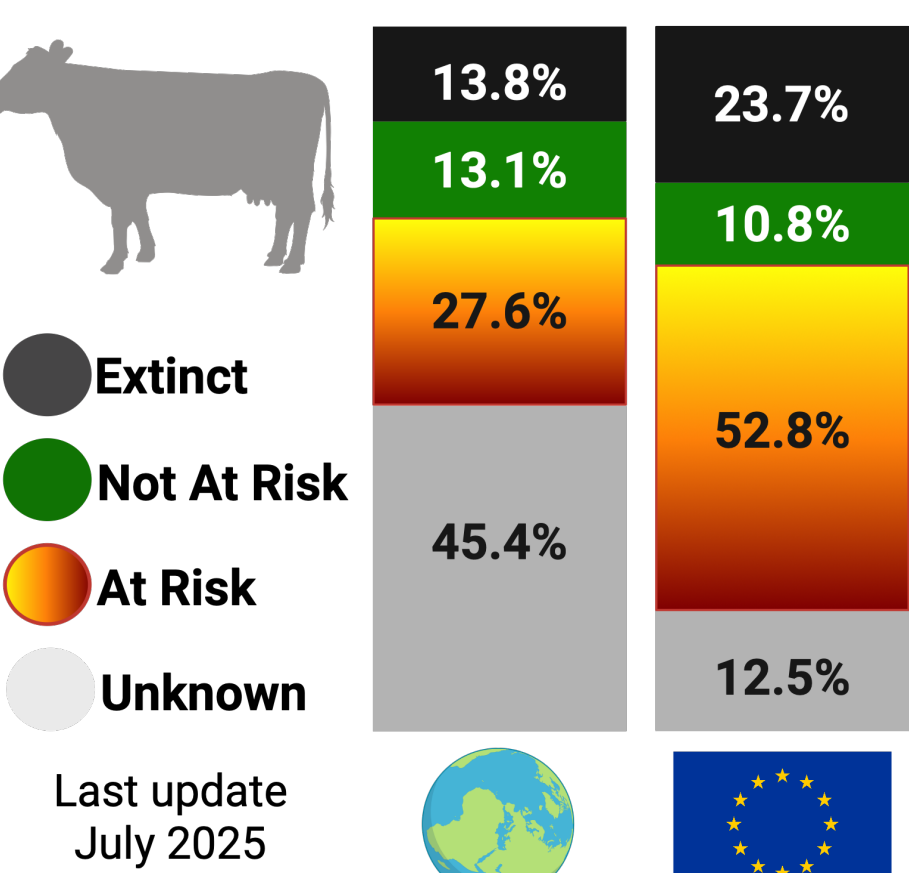
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Local Cattle Breeds Risk Status



Extinct
Not At Risk
At Risk
Unknown

Last update July 2025



Negative trends compared to the previous year!

Varzese-Ottone-Tortonese (VOT) Breed

Origin: Lombardy, Italy

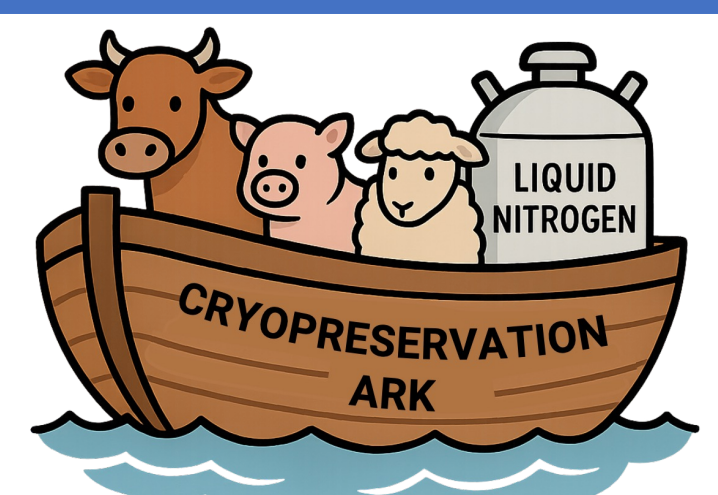
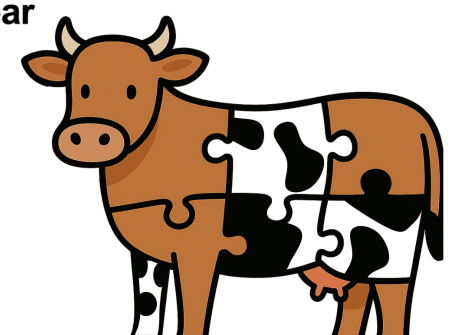
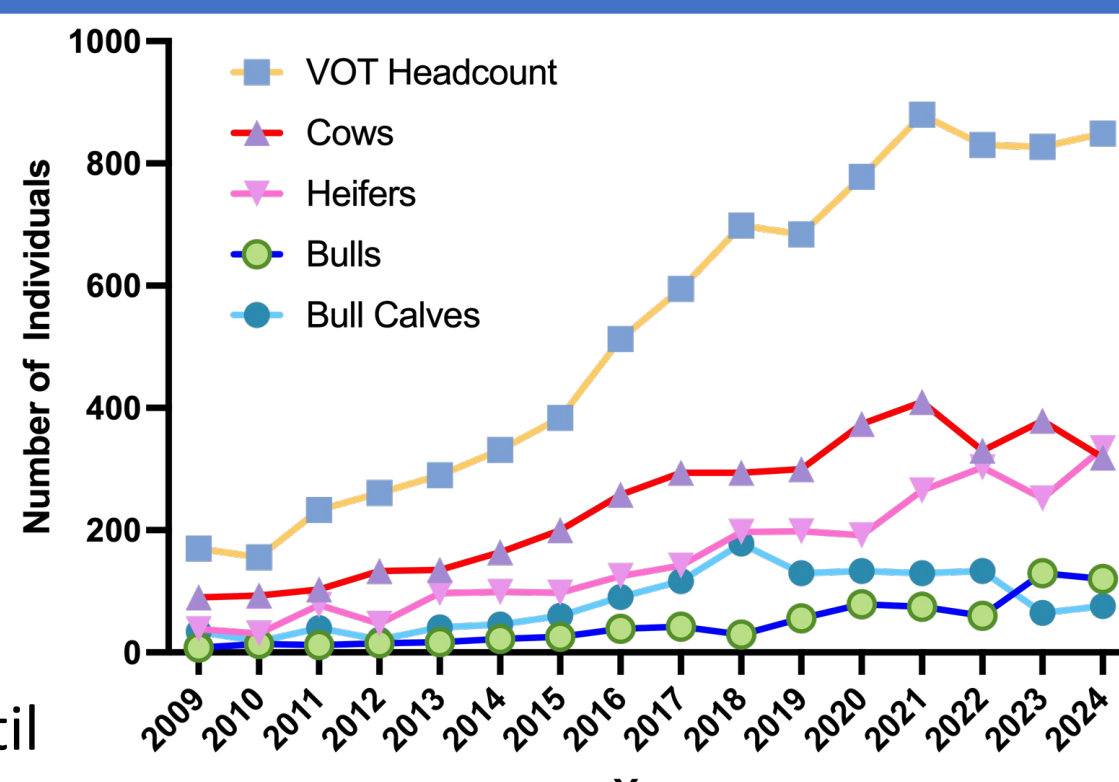
Characteristics: Rusticity, resilience, and dual-purpose value, providing high-quality milk and meat

Risk status:

Unknown
Not at risk
Vulnerable
Endangered - maintained
Endangered
Critical - maintained
Critical
Extinct



The VOT breed was widespread until the 1960s, but the introduction of high-yielding breeds led to a **dramatic decline**, reaching a historic low of **just 39 animals in 2001**. Thanks to conservation policies, the VOT population has slowly increased, but **still far from reaching FAO's threshold**.

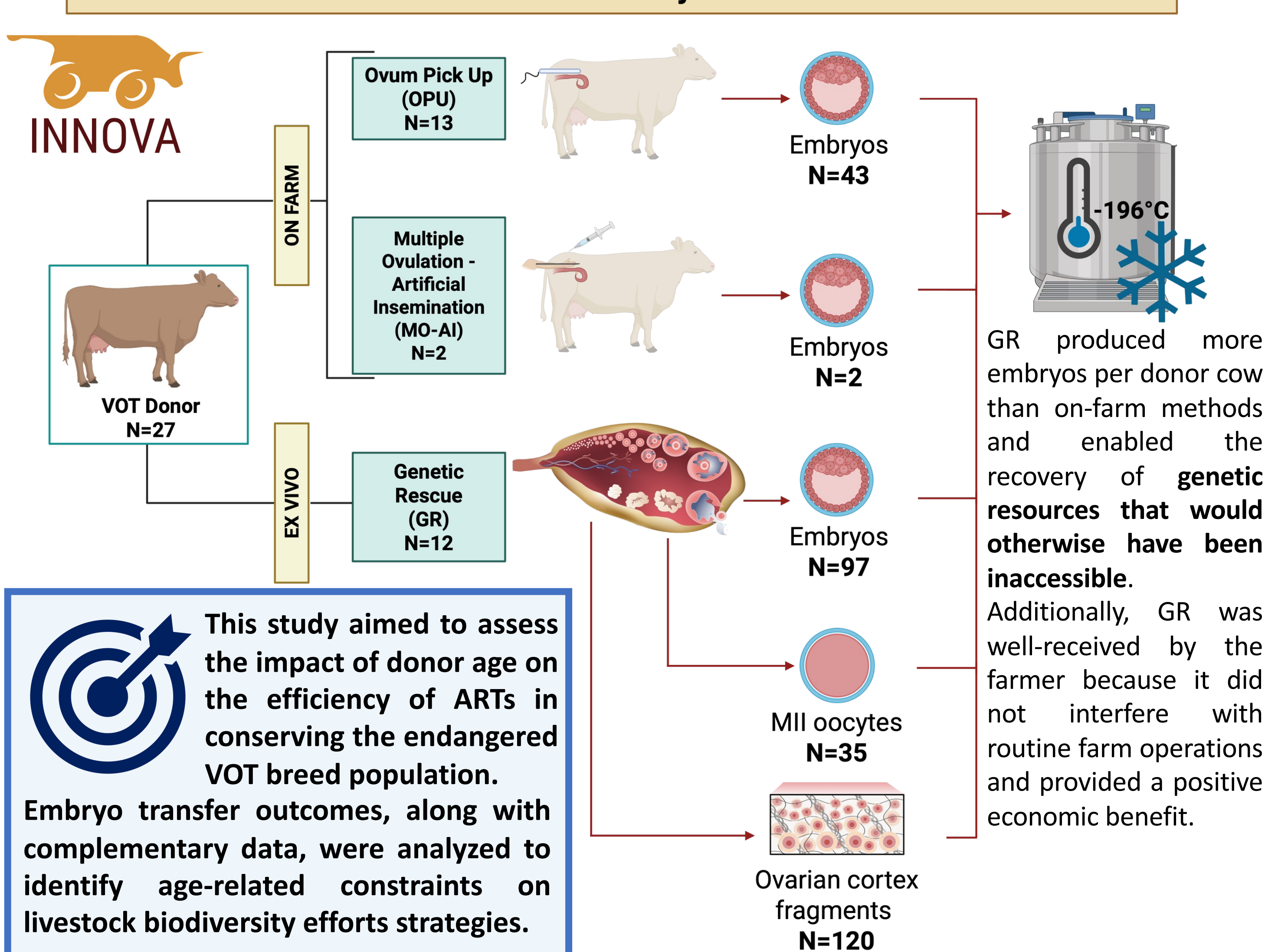


Assisted reproductive technologies (ARTs) and cryobanking of viable gametes, embryos, and ovarian tissue provide significant potential for preserving genetic diversity.

Experimental Design and Aim

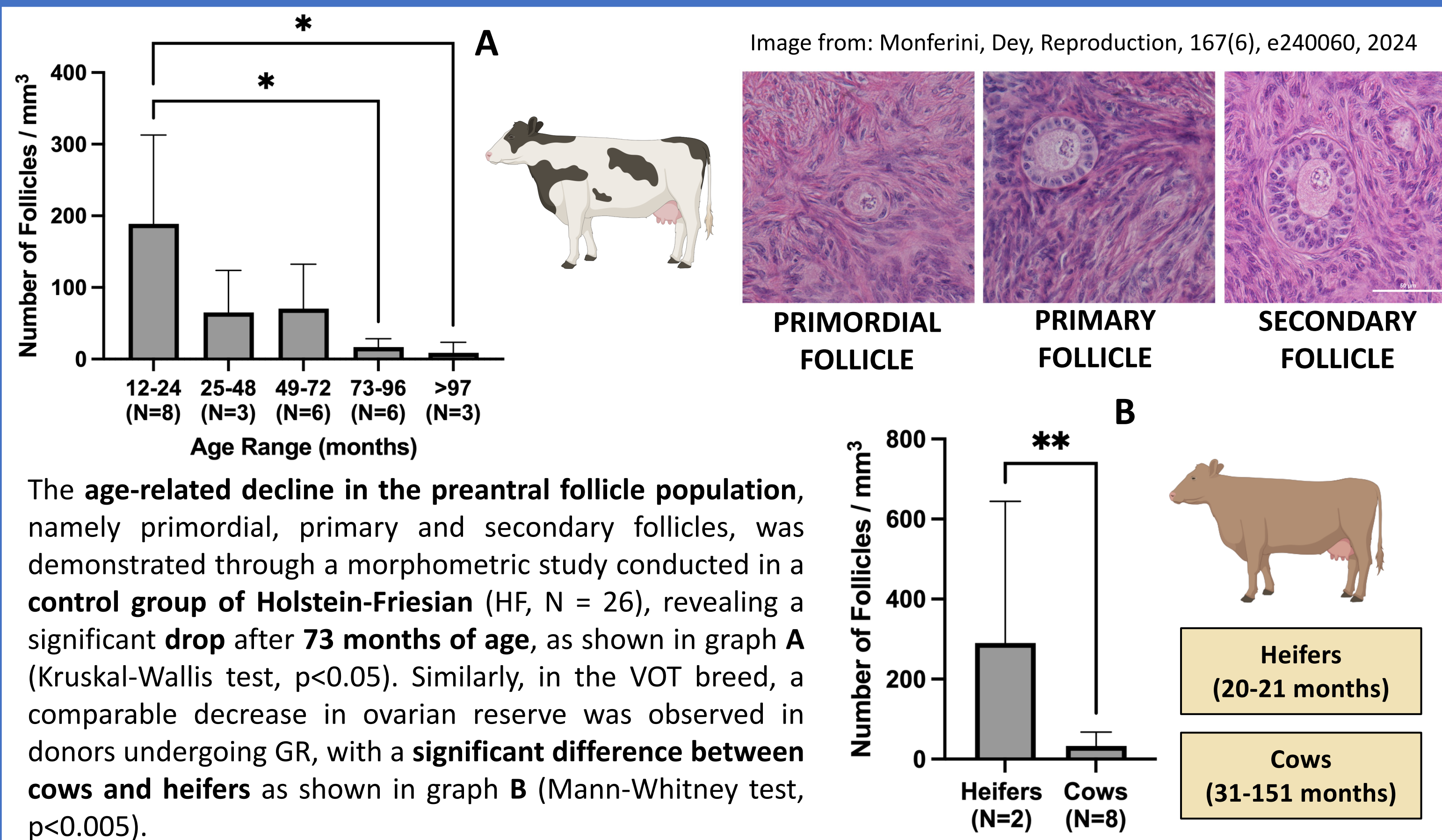
The **INNOVA Project** is an integrated **ex-situ conservation program** focused on the retrieval of germplasm from female VOT donors through ARTs and cryobanking, with voluntary participation from VOT farmers.

INNOVA Project

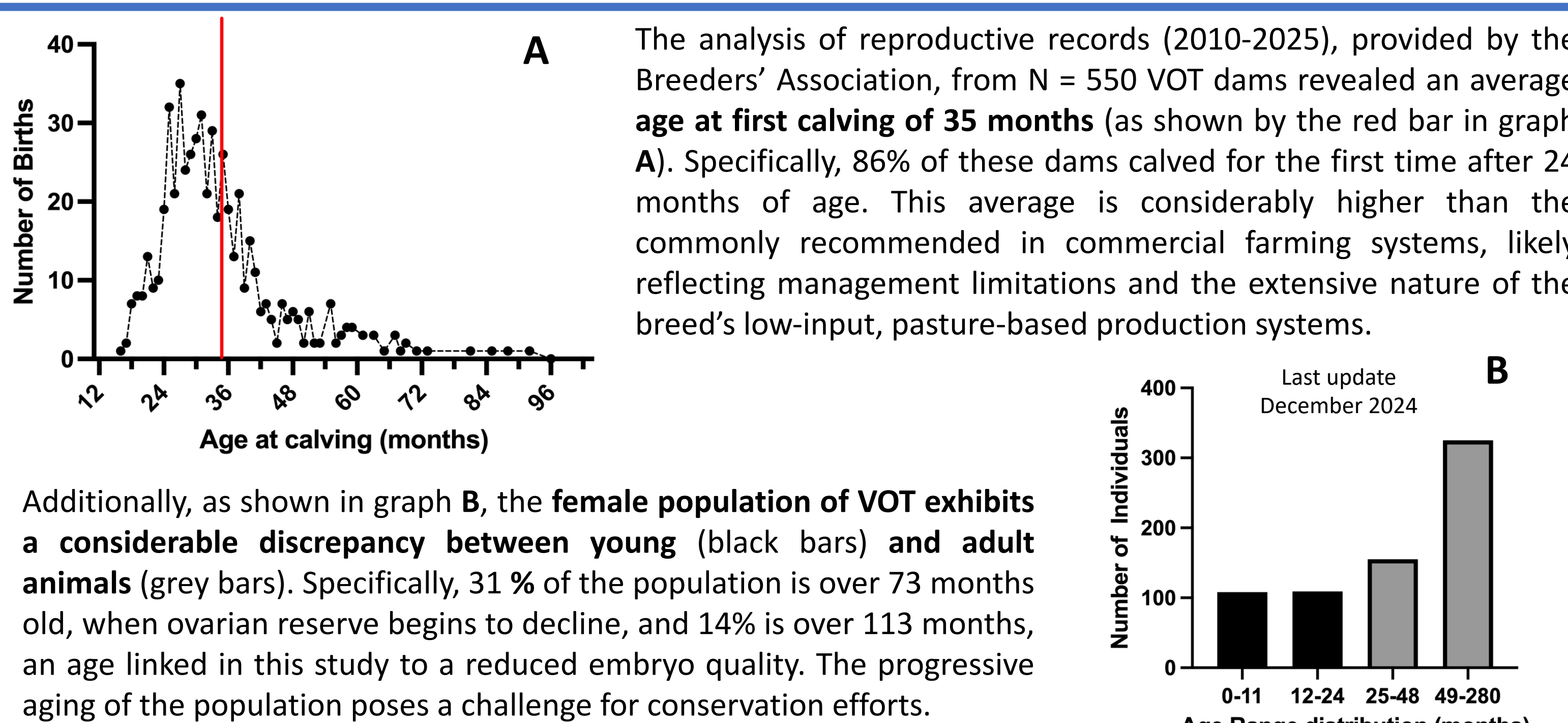


This study aimed to assess the impact of donor age on the efficiency of ARTs in conserving the endangered VOT breed population. Embryo transfer outcomes, along with complementary data, were analyzed to identify age-related constraints on livestock biodiversity efforts strategies.

Results 2 - Morphometric Analyses



Results 3 - Population Analyses

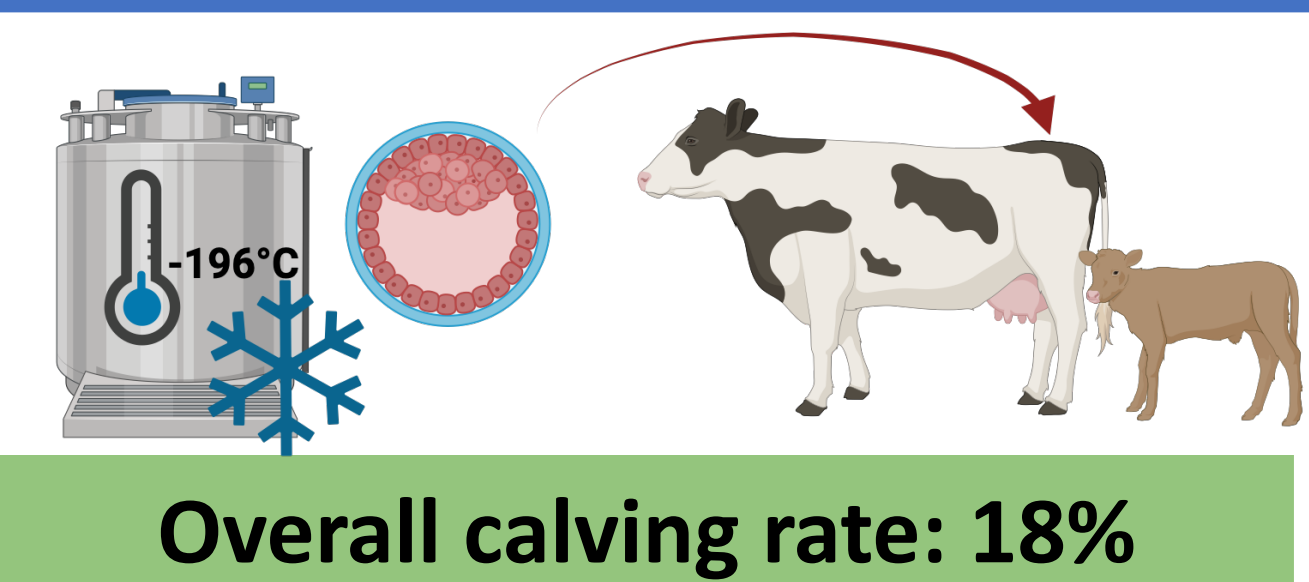


Conclusions

- Integrated, **multi-tool conservation programs** that combine different ARTs and cryobanking strategies represent **the future of biodiversity preservation**, not only for wild species but also for endangered livestock breeds. Specifically, on-farm techniques should always be **complemented by ex vivo retrieval methods** to maximize the use of genetic resources, as these approaches have proven to be effective.
- ET is a valuable tool to enhance calving opportunities in endangered breeds. However, **donor age represents a major limiting factor**, significantly affecting calving rate, a trend already observed in a large-scale earlier study that identified 15 years as a critical age for donor cows (Hasler, Theriogenology, 27(1), 139, 1987). **Follicle density decreases with age** in both HF and VOT breeds, with a notable decline observed after six years of age (73 months). Since the **VOT female population** is considerably aging, **early interventions are necessary to improve reproductive efficiency**. This involves improving on-farm management to maximize the reproductive potential in heifers.
- Our results indicate that **advanced maternal age in donor cows negatively impacts** embryo quality and implantation efficiency. Further studies are ongoing to explore how these findings can be directly applied to enhance protocols for genetic rescue and fertility preservation interventions. This knowledge will be vital in refining assisted reproductive strategies aimed at maintaining the reproductive potential of endangered breeds, especially when working with limited and aging genetic resources.

Results 1 - Embryo Transfer

As proof of principle that cryopreserved VOT embryos can support **cross-breed implantation**, N = 22 IETS grade 1 embryos were randomly transferred into synchronized surrogate dams, **successfully resulting in the birth of N = 4 live calves**.



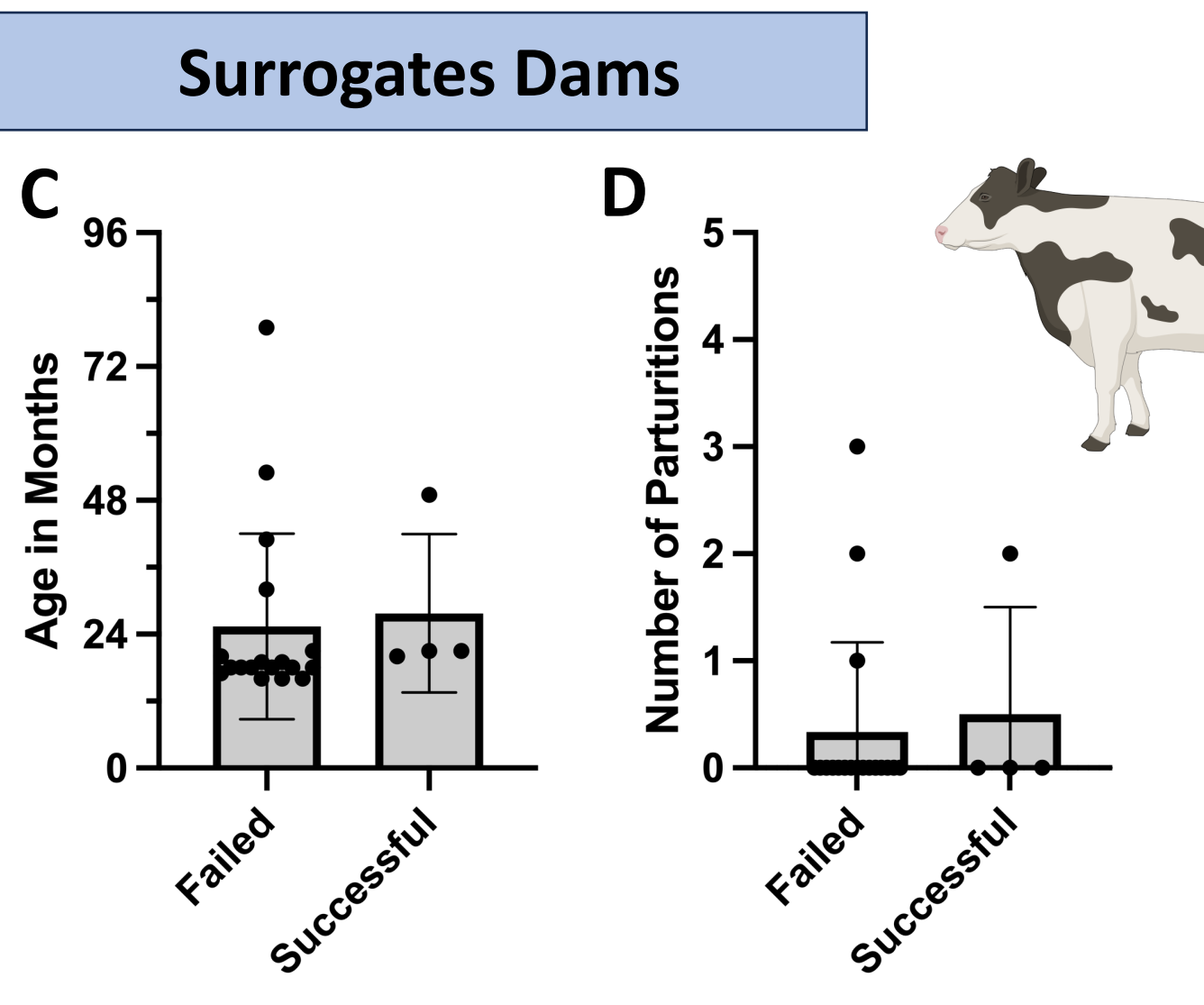
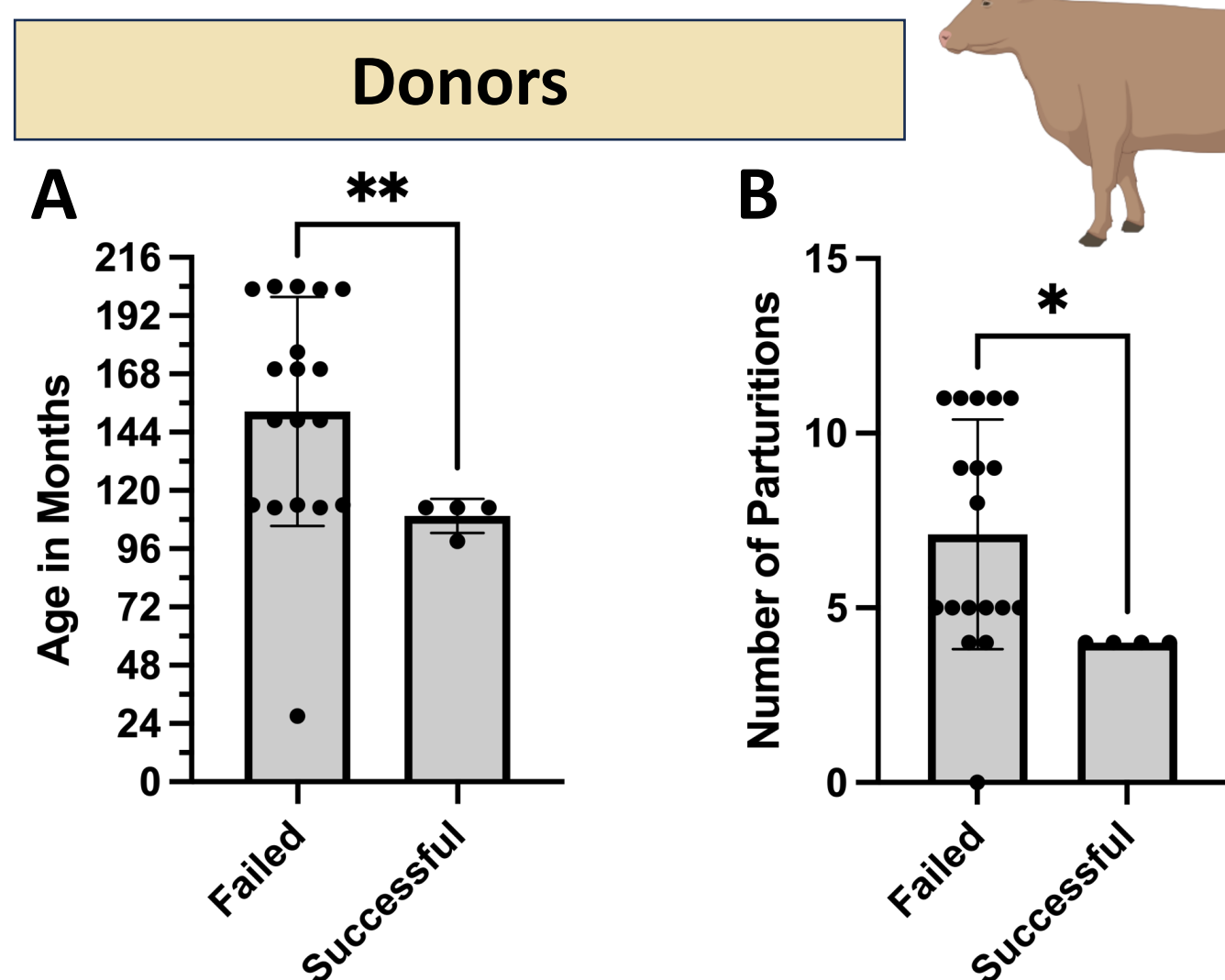
Overall calving rate: 18%

Successful pregnancies occurred only from embryo transfer (ET) derived **from donors aged ≤113 months**. All **pregnancies from older donors failed**, as shown in graph A (Mann-Whitney test, $p < 0.005$). In addition, as shown in graph B, parity also differed significantly between the two groups: the mean parity for successful pregnancies was 4.0, compared to 7.11 ± 3.29 for failed pregnancies (Mann-Whitney test, $p < 0.05$).

In contrast, **no significant differences were observed in either age or parity of the surrogate dams** between those that successfully carried pregnancies to term and those that did not, as shown in graphs C and D.



Gestation length, birth weight, and APGAR score were recorded for each calf. The image above shows one of the newborn VOT calves with the surrogate dam and Dr. Duchi, who assisted during delivery.



Curious to see the calves?
Scan the QR code!



Acknowledgments: We thank INALCA Spa staff for assistance with ovary collection and AVANTEA Srl. Work supported by Italian Ministry of University and Research (MUR), PRIN2020, No. 20209L8BN4 (InfinitEGG), by Regione Lombardia FEASR Programma di Sviluppo Rurale 2014-2020, No. 202102146691 (R-INNOVA) and by MUR, PRIN2022, No. 20227EB74M (CoMatrix). Images created with Biorender.com or generated with AI (ChatGPT/DALL-E, OpenAI, 2025).