REPRO TRACKS

by Cliff Lamb, Texas A&M University

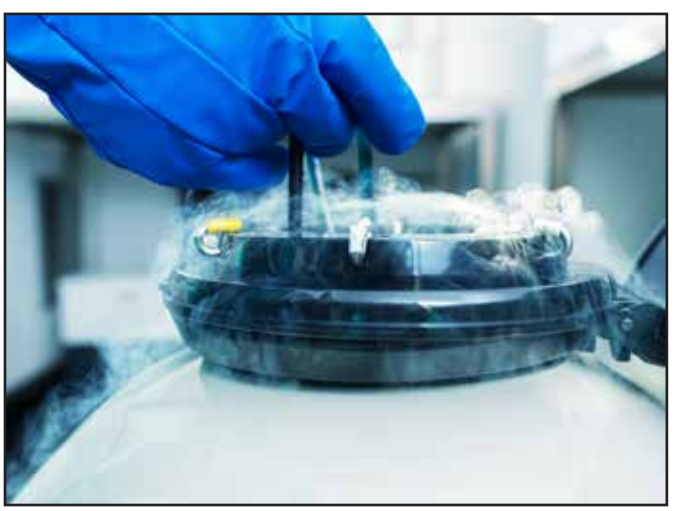
Multiple-ovulation Embryo Transfer and *In Vitro* Fertilization for Beef Herds

Today's cattle industry offers a number of reproductive technologies to help better your next calf crop.

The utilization of embryo transfer (ET) is an opportunity for genetic improvement in a cattle operation. Through ET a single, genetically superior female is able to generate a greater number of offspring than through a conventional system, and, when coupled with spermatozoa from a genetically outstanding sire, embryos of exceptional genetic quality can be produced. In addition, recipient females of poor or average genetic merit have the opportunity to serve as surrogates and receive an embryo with high genetic value. Therefore, these recipients would give birth to calves with greater genetics than they would otherwise. Through ET, genetic progress can be hastened, which is particularly useful in cattle due to their relatively long generation interval when compared to other livestock species. Another great advantage of this technology is the ability to transport embryos, instead of the live animals themselves, to areas where the production of beef needs to be advanced.

Embryo transfer

Since 1951 when the first calf was produced by ET, biotechnologies have evolved to allow for ET to take place in a commercial setting.



Initially, a technician would use a surgical procedure to transfer an embryo into the lumen of the uterine horn while the horn was exteriorized by a surgeon through the flank. However, over time, improvements were made to allow for successful transcervical transfer of bovine embryos.

MOET protocols

In current multiple-ovulation embryo transfer (MOET) protocols, donor females are superovulated through treatment with follicle-stimulating hormone (FSH) in order to stimulate the release of multiple oocytes at the time of ovulation. These superovulated females are artificially inseminated, and, if successful, a number of embryos will be recovered at the time of uterine flushing.

Following collection, embryo viability is determined, and viable embryos are either transferred fresh to recipient females or frozen for future use.

On average, 6.9 viable embryos are recovered per flush in beef females. This number fluctuates depending on cow breed, age and within breed variation. The transfer of fresh embryos typically yields 10%- 15% greater pregnancy rates than the use of frozen and thawed embryos.

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In vitro fertilization

An alternative to embryos derived from MOET is the production of embryos in a laboratory via *in vitro* maturation (IVM), *in vitro* fertilization (IVF) and *in vitro* embryo culture (IVC), which are collectively referred to as IVF. The first successful generation of live offspring produced by IVF was in rabbits in 1959.

From then on IVF technology improved drastically, such as with the development of embryo cryopreservation. This was first successful in 1972 with mouse embryos and one year later with bovine embryos.

During the IVF process, oocyte maturation — during which ooctyes complete their first meiotic division — needs to take place. Similarly, spermatozoa used for IVF need to undergo capacitation before they are able to penetrate the *zona pellucida* of the oocyte.

Oocytes that mature spontaneously *in vitro* or *in vivo* are highly capable of sperm penetration. However oocytes matured *in vitro* have shown reduced developmental capacities in comparison to those matured *in vivo*. In addition, the viability of IVF-derived embryos decreases with cryopreservation to a greater extent than *in vivo*-derived embryos; therefore, these embryos should be considered for fresh transfer when possible.

Ovum pick-up

The predominant oocyte collection technique is known as aspiration or ovum pick-up (OPU). Through OPU, unfertilized oocytes can be harvested directly from the ovaries of a donor cow or heifer using an ultrasound probe and an aspiration needle. This technique may be performed two to three times during a cow's estrous cycle for as long as six months, which is more frequent than what MOET can be performed. A greater number of transferrable embryos per donor can be generated through IVF than through MOET.

As improvements to IVF techniques are made, costs to generate embryos will likely be reduced, leading to an increase in the adoption of IVF embryo production.

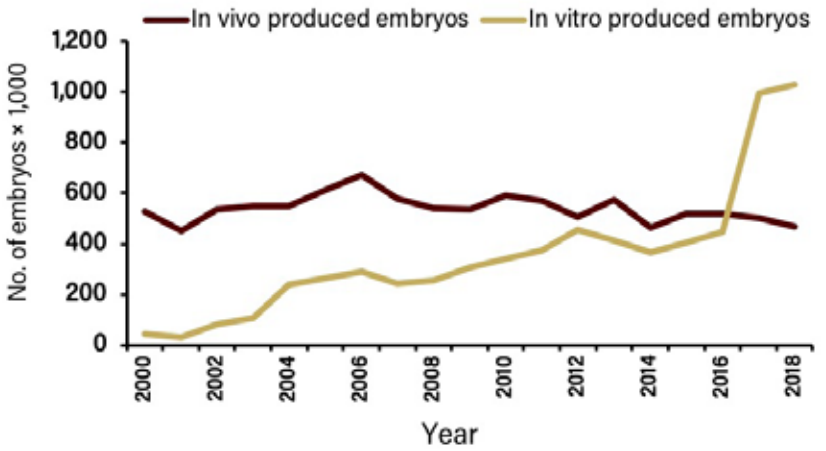
During the past 18 years, the number of *in vitro*-produced embryos has increased by more than 600% (Fig. 1), and according to the International Embryo Transfer Association (IETS; 2017), 66% of the embryo transfers performed in 2018 were with embryos generated through IVF.

In vitro fertilization may generate pregnancies from a donor female that is already pregnant and requires fewer units of semen.

Furthermore, the potential disadvantage of a poor response to a superovulation protocol can be avoided by utilizing IVF.

An excellent virtual overview of the IVF process was recently presented at the Texas A&M University Beef Cattle Short Course (*https://beefcattleshortcourse.com/*). For those interested in understanding the process, consider viewing the virtual presentation.

Fig. 1: ***The number of embryos transferred that were produced per year by* in vivo *and* in vitro *techniques***



(IETS Data Retrieval Committee Reports; *https://www.iets.org/* accessed July 20, 2020).

In summary

The use of embryo transfer provides significant opportunities for enhancing genetic improvement in seedstock operations. MOET and IVF provide tools to enhance genetics, but it is always a good idea to ensure that you know and understand the positive outcomes and the drawbacks before embarking on the use of these technologies. Having realistic expectations before implementing these procedures will ensure that you are satisfied with the results. AJ

Editor's note: Cliff Lamb is the animal science department head and a professor at Texas A&M University in College Station, Texas.