Repro Tracks

▶ by **Cliff Lamb,** *University of Florida*

Advanced reproductive technologies

My last column focused on some more traditional or earlier reproductive management developments that have a large impact on improving beef production. My goal in this column is to discuss the current status of more recent reproductive technologies that are used in the industry today. These assisted reproductive technologies are being used by many beef cattle producers in the United States, and researchers are refining these procedures in such a way that they are becoming more user-friendly and enhancing efficiency of reproduction.

The primary reasons that producers choose not to use these technologies in their operations is usually associated with time, labor, poor facilities or the simple fear of doing something new. Nonetheless, these technologies do provide opportunities for many beef producers.

What does artificial insemination (AI) offer a beef producer?

AI is not a new technology. The developmental research that preceded our modern techniques dates back to Russia in the late 1800s and early 1900s. The accidental discovery that glycerol has properties to protect and maintain semen viability through freezing set the stage for the development of the AI industry as we know it today.

For beef producers a major opportunity exists to increase the genetic potential of their herd through the use of AI. With AI, the most genetically superior sires are available to a large number of producers rather than being confined to the cows that are on a single pasture.

In addition, the accuracy of expected progeny differences (EPDs) of young sires with no progeny (typical of most natural service sires) is less than that of sires with a large number of offspring (typical of "proven" AI sires). One of the primary advantages of using AI is that semen from sires with EPDs and accuracies far superior to most natural-service sires is available.

High accuracy of EPDs in proven AI sires allow producers more confidence that the advertised performance and phenotypic characteristics of offspring will be realized, compared with offspring from low-accuracy, natural-service sires. The risk of unexpected performance is greater when using low-accuracy natural-service sires. In addition, improving the accuracy of sire breeding value predictions may increase the overall rate of genetic change on beef operations, and improved rate of genetic change can lead to subsequent improvements in overall profitability.

How useful is synchronization of estrus or ovulation to beef producers?

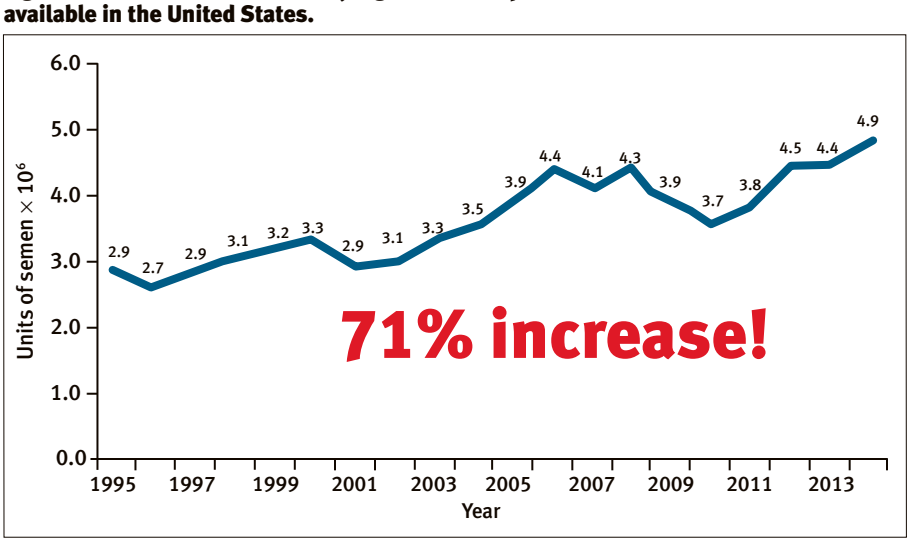
Synchronizing the estrous cycle with the use of exogenous (administered by injection or insert/implant to the cow) hormones has been developed and incorporated into beef production systems primarily to facilitate the use of AI for more than 40 years. A primary factor limiting the use of AI is the labor required to perform AI and to detect estrus in females and ensure they are inseminated at the appropriate time. It is now possible to expect to achieve pregnancy from AI in more than 50% of the herd during the first week of the breeding season.

The success of estrus synchronization in increasing the proportion of pregnancies derived from AI will increase the rate of genetic improvement through mating with genetically superior AI sires. However, other benefits have become evident, including the potential to alter the calving season and increase uniformity of calves. Estrus-synchronization protocols, particularly those that include a progestin, may induce cyclicity in non-cyclic females. These mentioned advantages to utilize estrus synchronization have enhanced its use in beef operations and is usually used in conjunction with AI.

Currently, only 7.6% of beef operations in the United Sates utilize AI as a reproductive-management tool, whereas 72.5% of all pregnancies in dairy females are the result of AI. When queried as to their reluctance to utilize AI, more than 53% of operations cited labor concerns or complicated estrus-synchronization protocols as primary reasons for not implementing this reproductive technology.

Research projects addressing these key areas of producer concern have been developed, and improvements in the actual protocols and their subsequent ability to effectively synchronize estrus and ovulation have been made. Regardless, in spite of a decreased herd size in the United States, we continue to see an increase in the quantity

Fig. 1: Amount of semen from major genetics companies and custom-collected semen available in the United States.



Source: National Association of Animal Breeders, 2014.

of semen available to be inseminated in beef cows, with a 71% increase since 1995 (see Fig. 1).

Does sex-sorted semen have a place in beef production systems?

The technology that has been developed to sort spermatozoa by the presence of either a Y or an X chromosome has the potential to alter the efficiency of beef production. Depending on the production goals of an operation, the availability of either more bull or heifer calves creates the opportunity for more profitability. Males are preferred over females when feeding animals for the production of beef. Steers are more efficient at converting feed to muscle, which equates to more efficient production of beef. Many producers focus on the generation of replacement females, and, in these operations, a benefit may be realized for more heifer calves.

Processes to generate sex-sorted spermatozoa are fairly inefficient and costly, which has limited its use. Damage incurred during the sorting process and/or fewer spermatozoa per dose result in decreased fertility with sex-sorted spermatozoa. A producer can expect pregnancy rates of approximately 70% to 80% of that normally achieved with the use of conventional semen. However, the technology is advancing significantly and research now indicates that pregnancy rates are approaching those of conventional semen, but more field studies are needed to determine whether those results remain true.

In commercial beef cattle operations, sexed semen provides the opportunity to use a small number of elite cows to generate replacements while mating the remainder of the cows to terminal sires.

However, the most common use of sexed semen in the beef industry is to increase the number of the desired sex of animals in purebred operations. Generating more bull calves from a superior herd sire to produce bulls for the commercial sector is an important consideration.

Similarly, deriving more daughters from a purebred maternal line would also be advantageous to certain purebred breeders. Therefore, although sexed semen may not be utilized extensively throughout the beef industry, it will continue to provide beef producers an opportunity to alter management practices that will enhance beef production efficiency.

How does embryo transfer (ET) play a role in beef production systems?

Incorporating ET into beef production systems is a fast way to change the genetic base of a herd using existing females. Females of poor or even average genetic potential have the opportunity via ET to serve as a surrogate to carry a calf of exceptional genetic merit.

In vivo embryo production through superovulation of donor females and *in vitro* production following ovum pickup (OPU) allow a single female to generate a substantially greater number of offspring than she would be capable of producing in conventional systems. When ET technology is coupled with the use of genetically superior sires and possibly the use of sex-sorted semen, genetic improvement can increase exponentially within a herd.

The use of estrus-synchronization protocols to achieve donor-recipient synchrony decreased the number of available recipients necessary. The advancements of cryopreservation also decreased the number of recipients necessary, as well as relaxed the timing requirements of ET, making it more feasible and efficient for many producers, and increasing the use of the technology.

In spite of these advantages, many procedures used in ET are expensive and inefficient, which limits the practical application for beef producers. Perhaps the most promising aspect of these technologies is the ability to transport embryos, rather than live animals, to areas where improved genetics would rapidly increase production of beef.

Even though the use of *in vivo*-derived embryos continues to increase, a major limitation has been the lack of successful superovulation in donor females. Although research continues in the development of superovulation protocols, as well as techniques to predict which donor females may respond well to superovulation, this remains an inhibitor of using *in vivo*-derived embryos.

As number of embryos per flush increases, the overall cost per embryo produced will likely decrease. Since cost of the technology is one of the reasons that producers have been hesitant to incorporate ET, finding methods to improve superovulatory response and coincident number of transferrable embryos per flush would likely increase its use.

To avoid the potential disadvantage of poor response to superovulation, the use of *in vitro*-produced embryos is increasing. Proper facilities and expertise are required, but when females can be subjected to frequent sessions of transvaginal ultrasonically guided OPU, oocytes can then be subjected to *in vitro* fertilization and culture resulting in more transferrable embryos.

These embryos are more likely to be transferred fresh because their viability decreases with cryopreservation to a greater extent than *in vivo*-derived embryos. Until this hurdle can be mediated, the ability to transport and store these embryos will be limited and will thus limit its use on a global scale to improve overall efficiency of production.

It is possible to culture *in vitro*-produced embryos in the oviduct of sheep, and these embryos survive cryopreservation as well as their *in vivo* counterparts, giving promise to increased potential in this area. Nonetheless, as improvements in this technology continue, it is conceivable to believe that *in vitro*-produced embryos will be transferred at a lower cost than *in vivo*-produced embryos, ultimately resulting in a decline in the quantity of *in vivo*-produced embryos and an increase in *in vitro*-produced embryos.

Beef producers should keep an eye on the advances in *in vitro* technologies, because companies in the United States are currently offering this technology, and I believe this is the reproductive technology that will see the largest growth in the next decade.

While these technologies may not be procedures that you have used in the past, they offer tremendous opportunities for increased reproductive efficiency and overall production. They are generally not only tools for enhancing genetics, but may assist in altering breeding season length, inducing non-cycling cows to initiate estrous cycles and increase calf value.

EMAIL: gclamb@ufl.edu

Editor's Note: *Cliff Lamb is a beef cattle specialist for the University of Florida and coordinator of the Florida Bull Test.*