MANAGEMENT

Repro Tracks

▶ by Cliff Lamb, University of Florida

Innovations in reproduction

The theme for this issue is research and innovation, so I thought it would be a good idea to focus on some of the interesting research projects that may one day have application to beef cattle producers. There are many technologies that have been developed during the past 50 to 100 years that are now common in our production systems. However, those technologies were not developed overnight. To develop and refine technologies takes countless hours, days or years in coming up with an idea, developing the idea, and conducting the research until a final product is released for application by cattle producers.

Advancements

At times, researchers may be perceived to be focusing on research that does not have immediate applicability; nevertheless, this work may lead to a technology that alters production practices. One example of this may be the development of fixed-time artificial insemination (TAI). Development of estrus-synchronization systems for cattle was initiated in the 1960s and 1970s when prostaglandin F2α (Lutalyse) and melengestrol acetate (MGA) were first being manufactured. From that point until now, thousands of experiments have been conducted to refine reliable, efficient and practical protocols to synchronize estrus. This eventually led to the TAI protocols we use today.

What are some of the issues facing researchers today?

Researchers need to continue to be innovative and always have the future in mind when conducting experiments to ensure that future technologies will have broad application in the industry.

However, most researchers working in agriculture are under more pressure now than at any point previously. Funding for animal research has not increased at the same rate as for other agricultural commodities. For example, national sales receipts from livestock account for 48% of all agricultural commodities, yet USDA funding for animal sciences is currently less than 30%.

Fewer and fewer people of the U.S. population have an appreciation for science or for agriculture. Therefore, developments that are backed by science may never have the chance to have positive impacts on animal agriculture. This can be noted in the continued discussion associated with genetically modified foods (GMOs), antibiotics or the use of steroid implants. Regardless of the science, the rhetoric generated through various forms of media appears to trump science and affect the potential development and application of valuable innovations to animal agriculture.

What is somatic cell nuclear cloning and how could this be used?

Somatic cell (a cell that makes up most of the cells in a body and can be differentiated into various tissues) nuclear cloning has been used to produce offspring in at least 20 species and is a commercial reality in cattle. This process involves fusion of a somatic cell nucleus (usually encased in the entire cell) with an enucleated nucleus, activation of the newly formed embryo to initiate cell proliferation, and culture of the embryo until transfer into recipients.

The major use of somatic cell nuclear cloning is in the genetic duplication of superior animals. This use is only practical when the individual to be cloned has a high degree of financial or emotional value

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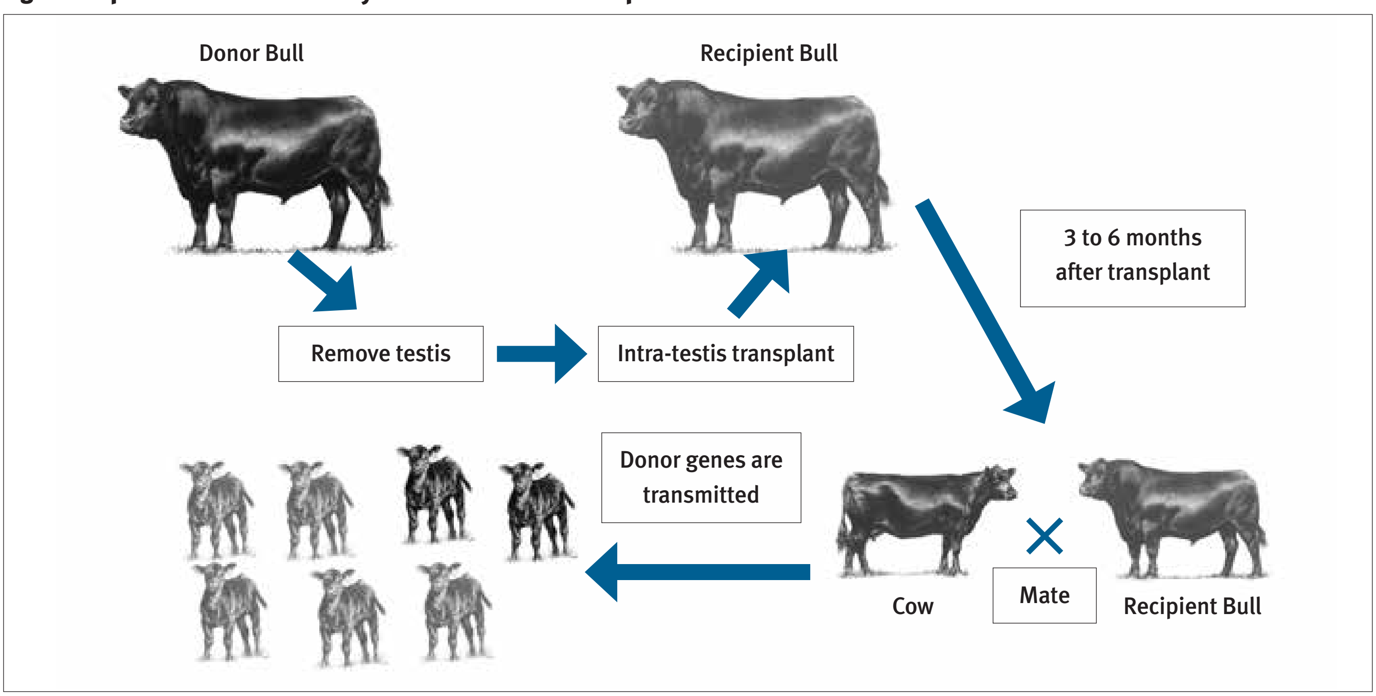
Fig. 1: A representation of what may occur for stem cell transplant of testis



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because inefficiencies in the cloning process make it financially unaffordable.

Nuclear cloning could improve rates of genetic selection by increasing selection intensity (only a few sires and dams need to be produced) and, because the accuracy of selection can be improved, by recording performance of specific genotypes under a variety of environments. However, unless the efficiency of the technology is increased, the increase in genetic merit achieved by incorporation of cloning in selection programs will not be enough to offset the costs.

Recently, scientists at West Texas A&M University demonstrated one way in which this technology could be used. These scientists cloned a bull from the carcass of a steer that graded Prime Yield Grade (YG) 1, and three heifers were cloned from another Prime Yield Grade (YG) 1 heifer carcass. Semen from the bull was then used to generate embryos from the heifers to produce live calves, which are the first calves to ever be produced from two cloned carcasses. While the true success of the project will need to be determined on a large scale, this is one case demonstrating that this technology may have some future applications.

Table 1: Transmission of sex from males carrying Tcr transgene

Trt	No. of sires	Males	Females	Total	% male
Tcr	7	217	114	331	65.5
No Tcr	5	231	240	471	49

Source: Adapted Herrman et al., 1999.

How may stem cell technology have an impact on animal agriculture?

Stem cells are self-renewing cells that can differentiate into specialized phenotypes. Technologies based on the production and manipulation of stem cells have implications that may prove useful for developing novel methods for manipulation of male and female gametes. These cells exist throughout the body and participate in maintaining the integrity of regenerating tissues.

An intriguing potential use of stem cells could be the use of somatic stem cells of a genetically superior bull transplanted into the testis of numerous less desirable bulls, or bulls that are adapted to tolerate certain climatic conditions could receive a transplant. These stem cells could become established in the seminiferous tubules and give rise to spermatozoa. Presence of sperm from transplanted testicular cells in semen has been demonstrated in cattle, and live offspring have been produced from sperm derived from a testicular cell transplant in goats. Fig. 1 (page 124) demonstrates how this technology may be applied to beef cattle.

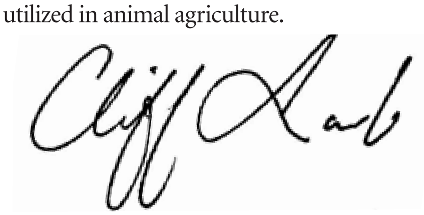
Another stem cell technology that may prove to be useful in the future is to modify males so that all spermatozoa carry the X chromosome. This could be achieved with somatic stem cells derived when genetic female cells are transplanted into the testis.

What is the potential for transgenic cattle?

Assisted reproductive tools may provide the opportunity to incorporate transgenic technologies into our beef cattle systems in the future. Although not imminent, transgenic technologies may be utilized in cattle by 2050. For example, there may be the opportunity to have terminal-cross genes expressed on the Y-chromosome. The females may have maternal traits including small size, but give birth to males that are born small but exhibit rapid growth or improved efficiency to the complement of performance-related genes.

Perhaps another transgenic example may be to distort sex ratio transgenically so that 70%-90% of calves from a particular sire will be one sex or the other without sexing semen. This concept has already been demonstrated in mice (see Table 1). Therefore, as transgenic technology continues to evolve, the potential may exist to incorporate this technology into commercial beef cattle production systems.

Obviously the reproductive technologies discussed in this article do not have immediate application. As researchers continue to refine these procedures, it is not unreasonable to believe that 50 years from now these may be common techniques utilized in animal agriculture.



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