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Extension FactSheet

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Utilization of Embryo Transfer in Beef Cattle

John F. Grimes
Extension Agent
Agriculture and Natural Resources, Highland County

Background

Today's beef cow-calf producer has access to more tools than ever to make genetic progress within his herd. Technological advances in heat synchronization, data collection through the use of electronic I.D., and ultrasound measurements to determine carcass merit are a few of the tools being used more frequently to improve the genetic makeup of our breeding herds. Embryo transfer (ET) is being considered by more breeders as a means to make genetic improvement.

ET is not a new technology. It's earliest roots trace back to work done with rabbits in 1890. Sheep and goats were successfully propagated in the 1930s and it was not until the early 1950s that live beef calves were generated from ET. It was not until the early 1970s that the first commercial ETs were accomplished in the United States. These early transfers were completed using surgical techniques. The adoption of non-surgical transfer techniques signaled an increase in the use of ET.

Purpose of Embryo Transfer

The use of ET in the beef industry has been implemented by purebred breeders with some minimal use by club calf breeders. The breeders who have utilized ET have been pursuing these basic goals: to improve genetic selection by increasing the number of progeny from females that are either proven or perceived to be superior under any number of criteria; or to multiply the number of cattle in a program in order to expand the herd or to meet market demands.

There have been additional reasons given to rationalize the use of ET. Supply and demand will always result in semen with increased value. ET will allow a breeder to generate more offspring from rare and valuable semen.

It has also been stated that ET will increase the accuracy of selection traits. Caution should be used before putting too much faith in this argument. Even with the use of ET, cows will have fewer progeny than bulls which results in breeding values with lower accuracies. Keep in mind that the performance of ET calves is partially reflected by the milking ability of the recipient female. Therefore, performance data on ET calves is not directly credited to the performance evaluation of the donor female. However, the natural progeny from ET calves will eventually contribute to the original donor's Expected Progeny Differences (EPDs) at a later date.

Whatever the stated reason, ET has had a significant impact on the beef industry. Registrations of Angus cattle over the past 15 years give indication of the increased use of ET. In 1987, 3.6% (5,105) of all calves registered were a result of embryo transfer. In 2002, 25,093 calves resulting from ET were registered. This was 8.9% of all calves registered.

Procedures

ET is a highly structured process that requires aggressive management in order to obtain successful results. Considerable amounts of time and significant capital outlay can be involved in an ET program. The following is a discussion that outlines the steps involved in ET.

Donor Selection

The first and probably most important step in the process is the selection of the donor cow. A female that is known to be free of reproductive abnormalities or genetic defects can be used in ET. However, this does not necessarily mean she is a deserving donor candidate.

Regardless of your selection criteria, the value of the calves from a donor must be high enough to justify the added expense. Selection criteria can be based on actual performance, EPD's, phenotype, relationship to other outstanding individuals, or some combination of these factors. Consideration must be given to the marketability of the calves.

The purchase of a potential donor female can be an expensive proposition. The breed, selection criteria, and marketing opportunities will eventually determine the value of a donor female.

Prices may range from a few thousand dollars to tens of thousands of dollars to an extreme of several hundred thousands of dollars. The individual breeder will have to determine the purchase price that is economically feasible for their operation.

Superovulation

Once the donor cow is selected, she is treated with the gonadotropin called follicle stimulating hormone (FSH). This hormone is administered twice daily for four days in the range of 8 to 14 days following estrus while a functional corpus luteum (CL) is on the ovary. As a result of the treatment, multiple follicles should develop on the ovaries of the donor. Multiple numbers of eggs will be released at estrus. This process is called superovulation.

In order to bring the cow in estrus, a prostaglandin such as Lutalyse is injected on the fourth day of FSH treatment schedule. The prostaglandin will cause CL regression and estrus to occur approximately 48 hours later.

The amount of FSH given to a donor will vary based on the transfer record of the donor (egg numbers and quality). The response of the donor to FSH is highly variable from cow to cow and can be a source of great frustration for the breeder. Most females will respond to the superovulation treatment with an average of 5 to 7 transferable embryos. Results can range from zero to several dozen eggs per flush. In isolated cases, some cows simply will not respond to FSH treatments. Some cows that are superovulated at regular intervals will see a slight decrease in embryo numbers over time.

Cows do not respond to levels of FSH given in similar fashion. Most FSH dosage rates will fall in the 10-15 cc range over the four-day treatment period. Even within these relatively tight dosage rates, cows will respond very differently. Some cows may produce low numbers of high quality embryos while others may yield high numbers of low quality embryos at the exact same dosage. History of production will help determine the proper dosage of FSH for an individual donor.

Insemination

Proper insemination of the donor female is a critical step in the ET process. Superovulation creates many eggs which will be released over the course of several hours. The timely placement of high quality semen is necessary to create the maximum number of fertilized eggs.

Because of the variability in the number of eggs and the timing of their release, females will be inseminated 1-3 times during and after estrus. A typical scenario would be to inseminate the superovulated cow at 12 and 24 hours after the onset of standing heat. The cost of the semen used will likely determine the number of inseminations.

As with normal artificial insemination, semen should be placed in the body of the uterus or at the entrance into each uterine horn.

Embryo Recovery

Embryo recovery or flushing is generally accomplished through non-surgical techniques at approximately seven days after breeding. The recovery process is relatively simple and can be completed in 30 minutes or less.

Initially, the donor is given an epidural block at the tailhead to prevent straining. A flexible rubber tube catheter is passed through the cervix and into the body of the uterus. The cuff is inflated with saline solution to hold the catheter in place and to prevent backflow of fluids. Saline solution is flushed into the uterine horns through holes at the tip of the catheter that precede the cuff. The solution-filled uterine horn is gently massaged and the fluid containing the embryos is drawn back out through the catheter. This solution is collected through a filter and into a cylinder or dish. Embryos are then located from examination under a microscope.

Embryo Evaluation and Processing

Upon collection, embryos are evaluated under a microscope for stage of development and quality of the embryo. Embryos are collected on day 6-8 after breeding and are usually in the morula through blastocyst stage. It should be noted that the visual evaluation of embryos is a subjective evaluation and is not an exact science. The following standardized coding systems are recognized by the International ET Society, Savoy, Illinois.

Stages of Embryo Development

Stage	Description
1	Unfertilized
2	2- to 12-cell
3	Early Morula
4	Morula
5	Early Blastocyst
6	Blastocyst
7	Expanded Blastocyst
8	Hatched Blastocyst
9	Expanded Hatched Blastocyst

Embryo Quality Grades

Grade 1: Excellent or Good. Symmetrical and spherical embryo mass with individual blastomeres (cells) that are uniform in size, color, and density. This embryo is consistent with its expected stage of development. Irregularities should be relatively minor, and at least 85% of the cellular material should be intact, viable embryonic mass. This judgement should be based on the percentage of embryonic cells represented by the extruded material in the perivitelline space. The zona pellucida should be smooth and have no concave or flat surfaces that might cause the embryo to adhere to a petri dish or a straw.

Grade 2: Fair. Moderate irregularities in overall shape of the embryonic mass or in size, color and density of individual

cells. At least 50% of the cellular material should be an intact, viable embryonic mass.

Grade 3: Poor. Major irregularities in shape of the embryonic mass or in size, color and density of individual cells. At least 25% of the cellular material should be an intact, viable embryonic mass.

Grade 4: Dead or degenerating. Degenerating embryos, oocytes or 1-cell embryos: non-viable.

Embryos of suitable quality can be transferred directly to recipient cows or frozen for future use. There are two types of procedures to freeze and thaw embryos for transfer: 1) Conventional or 2) Direct Transfer. For many years, the conventional method of freezing and thawing embryos had been the commonly used choice. In this system, embryos are frozen with a cryoprotectant called glycerol. This substance must be removed through multiple washings in the thawing process before transferred because it is lethal to the embryo. This can become a time-consuming process when attempting several transfers in a single day.

In recent years, many practitioners have switched to the direct transfer system. Embryos are frozen in ethylene glycol in this system which allows the embryo to be thawed and placed directly into the recipient. Embryos frozen for direct transfer are usually frozen in yellow translucent straws. The direct transfer system also eliminates the need for expensive thawing equipment.

Transfer of Eggs

For any ET program to be successful, pregnancy rates must be maximized. Typically, 55-70% of the fresh embryos and 50-65% of the frozen embryos implanted will result in pregnancies. Many factors will influence the pregnancy rates achieved at any given operation.

Recipient herd management is crucial for success with ET. Not every cow is a good candidate to become a recipient. Good recipient prospects are cows that are reproductively sound with a proven track record of calving ease, milking ability, and mothering ability. Heifers can be used as recipients but generally are a greater risk for calving difficulties. Sound herd health practices must be in place. Recipient females should be in good body condition on a gaining plane of nutrition and cycling regularly.

In order to maximize pregnancy rates, the conditions of the recipient cow reproductive tract should closely match those in the donor. When transferring fresh embryos, the estrous cycles of the donor and recipients should be closely matched, preferably within 24 hours of each other. Prostaglandin should be administered 12 hours earlier to recipients than when prostaglandins are given to donor females. When using frozen embryos, the recipients should be synchronized to exhibit estrus at approximately 7 days prior to embryo implant date in order to match the age and stage of the frozen embryos.

To transfer an embryo to a recipient cow, the embryo must first be "loaded" into a 0.25 ml insemination straw. As with the donor female, the recipient is given an epidural block at the tailhead to prevent straining. The loaded transfer gun is carefully passed through the vulva and the cervix then guided into the uterine horn on the same side of the ovary with the active corpus luteum (CL). The embryo is placed in the forward tip of that uterine horn. Pregnancy cannot occur unless the embryo is placed in the uterine horn with the active CL.

Costs

The costs associated with ET can be significant and are highly variable. There are a wide range of services offered by ET technicians or organizations. A breeder can choose to have the ET process done entirely on the farm where the donor and recipients are located. Another option is to send the donor to a boarding facility and custom-hire the entire process. Recipients can be hauled in for implanting embryos or pregnant recipients can be purchased.

The cost of collecting and freezing embryos will vary depending on the number of donors being collected and the fee schedule of the ET practitioner. The figures presented in Table 1 represent the cost per frozen embryo produced in a low cost and high cost scenario. Two levels of egg production are represented.

The most significant expense associated with ET will be the cost of owning and maintaining recipient cows. The recipient cow issue can be handled several different ways. Breeders who choose to own their own recipient cows can purchase them or use existing cows that are less desirable in

Table 1. Estimated costs of producing frozen embryos for future transfer*

Item	7/eggs/flush	12 eggs/flush
Collection fee (includes drugs & flushing)	$200-$300	$200-$300
Semen (2 units @ $30/unit)	$60	$60
Freezing fee ($30-$50 per embryo)	$210-$350	$360-$600
Total	$470-$710	$620-$960
Cost per embryo	$67.14-$101.43	$51.67-$80
Cost per pregnancy (60% pregnancy rate)	$111.19-$169.05	$86.12-$133.33

*These costs do not include donor expense, labor, or overhead.

terms of phenotype or EPD values. The desire to have high milking recipient cows has led to the popularity of dairy-beef cross females. The annual cow cost which can range from $400-$650 contributes to the cost of raising an ET calf.

A concept that is growing in popularity is the use of cooperator herds. A cooperator herd is a location used to place the embryos from a breeder's donor(s), the calves are born and reared, then purchased back at weaning time. A premium over current market prices is paid to the cooperator for his extra labor and management. This arrangement allows the breeder to lower his overhead costs by reducing the number of cows owned and being maintained. Depending on the agreement between the breeder and cooperator, ET calves from cooperator herds can cost $650 - $900. Potential negatives associated with this practice include poor performance of embryo calves due to lack of desired management and increased exposure to new disease not found in the breeder's herd.

Labor costs will be significant for an operation considering ET. Extra time must be devoted to the administration of drugs, heat detection, and artificial insemination. Keep in mind that for the average ET procedure, a donor cow will go through the chute 12 times and a recipient 2 times prior to flush day.

Facility costs will be similar to any operation using artificial insemination. Quality of the facilities will be dictated by the number of donors and recipients as well as the time of year that ET work is being completed.

Additional costs may include drugs or products for synchronization, extra registration fees, A.I. certificates, or blood typing or DNA testing fees for donors or calves.

Summary

There is probably no single technology that will allow you to explore the vast genetic possibilities of a beef female more than ET. Each female born has thousands of potential eggs. Natural reproduction methods allow for a small fraction of a females genetic potential to be expressed.

As with the adoption of any new technology, there are positive and negative ramifications. Some of these are listed below:

Advantages

- Increased number of calves out of genetically superior cows.
- Increased marketing opportunities through the sale of offspring, pregnancies, and embryos.
- Generate more offspring from rare and valuable semen.
- Larger numbers of offspring can help prove the genetic merits of a female at an earlier age in life.

Disadvantages

- Increased expenses and higher breakeven costs for calves.
- Requires a higher level of management.
- Increased potential for spread of certain diseases.
- Not all potential donors respond positively to treatment.

Sound advice for anyone considering the use of ET is to be realistic with your goals and objectives. The decision to use this technology ultimately depends on the potential marketability and profitability of future offspring.

Table 2. Estimated cost of producing ET calves

Costs	Home-Raised	Cooperator Herd
Embryo Cost/Pregnancy (60% pregnancy rate)	$86.12 - $169.05	$86.12 - $169.05
Recipient Maintenance	$400 - $650	
Calf Development Cost		$650 - $900
Transfer Cost/Pregnancy ($25-$50/egg transferred at 60% pregnancy rate)	$41.67 - $83.33	$41.67 - $83.33
Total	$527.79 - $902.38	$777.79 - $1152.38

Note: The cost of home-raised calves does not reflect the cost of a purchased recipient female added to the herd.

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