The Cost Effectiveness of Dairy Cow Embryo Transfers

Mackenzie E. Crawford

Department of English: Virginia Tech

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Professor Emily Hemmer

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Introduction

Since coming to Virginia Tech, I have found a peak interest in the reproductive strategies of dairy operations. I had the privilege to intern with large animal veterinarians last year and personally see multiple different breeding management plans. With my major being Dairy Science I have learned a lot about the reproductive track and the biology behind these breeding techniques. Learning how the cow operates and different management choices, it made me start to wonder how these advancements are economically being sustained and are they affordable to everyone? Coming from a smaller town, embryo transfers (ET) are not a big factor and only show animal companies are utilizing the new advancements. Due to that, I wanted to explore how economically efficient are embryo transfers compared to artificial insemination (AI) to the dairy cattle industry in the United States.

Research

Dr. Kayla Alward is a professional who currently is in a research lab where she conducts Ovum Pick-up (OPU) and in vitro fertilization (IVF) with cattle embryos. Dr. Alward did her undergrad and master's in Dairy and Animal Science at the University of Georgia and now works at Virginia Tech in Dr. Alan Ealy's Reproduction Lab. I asked Dr. Alward to talk with me about certain topics within ET and explain some of the ET protocols.

When looking at the financial aspects of ET, I contacted Ashby Genetics, a local genetics lab in Harrisonburg, Virginia. They are a very well-known lab that travels around the nation and ships globally. They provided me with their pricing sheet for all the services they do. Any numbers regarding the cost of ET and AI will be coming from their standards.

For information about current research and data for ET, I looked in various online sources and relied heavily on past research experiments or papers. Most of my sources were found through the Virginia Tech Library.

Background on Embryo Transfers

Embryo transfers are the process of retrieving an embryo from a donor cow and then transferring that same embryo to the recipient animal. ET has become a groundbreaking breeding strategy for cattle operators everywhere. In the year 2022, the United States Department of Agriculture (USDA), reported "39.5 million head of female cattle" were available for breeding (U.S. Department of Agriculture, 2022). The United States cattle in the same year, produced 840,815 transferable embryos through OPU (Viana, 2023). The reasoning behind the potential switch is farms are striving to have the best genetically inclined breed while humanly handling them. The goal in selecting genetics is to create a linage of cattle that will be high producers in their field. For dairy, this is high milk production from cows. Currently other gene pools are being bred into herds. For example, cattle having a sex-linked gene to calve only heifers, females, or having a calf that is polled, which means it is born with no horns. Other operators that may be utilizing ET are the ones producing show animals. They will be selecting genes for a physically good-looking animal, not based on milk production.

Right now, the main breeding structure is artificial insemination with a bull to "clean up" the rest of the herd if they do not conceive from the selected semen. These breeding strategies are a key player in the genetic advancements the dairy industry is striving to have. The average farm will use AI to selectively breed for these genes, but embryo transfer is a strategy that allows for a selected cow to carry the pregnancy.

Process of Embryo Transfers

Dr. Alward (2024), deeply explained that the whole timeline to successfully transfer an embryo can take up to 28 days per donor cow. There are two sides to this process, the donor cow, and the recipient animal. The donor is the cow producing the selected embryo which will then be extracted and implemented into the recipient cow. The recipient cow is going to be an animal that may be younger in the herd or doesn't have the best genetics, but it still produces milk well and is not at risk of losing the offspring. Once the animals themselves have been established they will be on ovulation sync, this will be achieved through added hormones such as FSH (follicle stimulating hormone) and GnRH (Gonadotropin-releasing hormone). For the embryo to survive from the donor to the recipient, the environment must be as similar as possible. This includes the stage of menstruation the animal is in, thus the importance of syncing the animals together. Syncing the animals into the same stage can take anywhere from seven days to 14 days. Dr. Alward (2024), continued to explain, once both cows have been identified the donor cow will undergo superovulation which will include the added hormones in hopes that she will produce many oocytes which in turn could become embryos. Superovulation takes about five days, after she has started ovulating the donor will be inseminated. A few days after insemination, retrieval of the embryo will take place, this should be scheduled to happen around seven or eight days after. There are different ways of retrieving the embryo, the most common ways must be performed by a specialist. Directly after retrieval, the embryos will be graded and classified. Class I and II are the highest and will be used for breeding, Class III is rarely considered viable. The grading is performed by an embryologist who will look at the embryos in media under a microscope. Producers then have the choice to freeze the embryos to use later or they may do fresh transfers. Fresh transfers must be conducted directly after the embryos have been graded and sorted. As soon as the embryo is inserted into the recipient animal, she is considered

pregnant. The process from starting with syncing the animals to then having the choice to freeze or transfer fresh is about 28 days total per embryo (Alward).

Background on Artificial Insemination

Artificial Insemination is the process of manually inserting selected semen into the cervix of a heifer or cow in hopes she will conceive and produce a calf. AI only requires the selected semen, a skilled individual and will only take roughly five minutes per animal. This is completed by the individual taking the semen from the storage tank, palpating the animal to locate the cervix, and then dispensing the semen in the cervix using a specialized rod. This strategy is the most common breeding program in U.S. cattle and requires less specialized labor. AI is only truly effective when the semen is presented into the environment when the cow is in estrus. Timing is the biggest factor to stay attentive too as the window for peak opportunity is low. AI is typically done daily to smaller groups of animals that are in heat, estrus, at the same time. AI is very time efficient and very accessible to operators as herd managers are typically the ones conducting this breeding strategy.

Industry Goals

For dairy farms, two big factors are thought about when deciding when to breed an animal. Is she is high producer or does she have a history of pregnancy problems? Besides the animal's overall health, operators want cows that are going to produce a high milk quantity. Cows can be or become more of a risk to carry pregnancies and to have a safe calving experience. If an operator has a cow with a high milk yield or quality genetics but is at risk of losing the calf, ET comes into play to provide a way out. ET will allow the producer to take an embryo from the higher quality cow and transfer the embryo that contains the first cow's genetics, into a different animal that will be a safer environment for the offspring. This allows

operators to have a high producing offspring while eliminating the stress from the pregnancies on the older or less quality cow. ET is also going to allow you to take the cow that may be a risk to calving but milks well in the herd. All dairy farms are looking for in an animal is milk production and quality offspring, to keep a cow lactating, she must calf. While AI does allow you to pick the genetics from the sire, dad, the genetics from the dam, mom, are still a factor. ”In this context, it has been estimated that an ET program with 1024 transfers per year in 512 females can boost the rate of genetic gain by approximately 30% above what can be attained with conventional AI using sires selected through the official progeny-testing program [25].” (Baruselli, et al., 2020, p.1). ET is going to eliminate the genetics of the dam but keep their cow producing milk, which makes them money and a more genetically inclined herd.

While this is a great technique for operators, the questions of if they can economically participate is brought about. A lot of different factors must be calculated, such as how much each embryo costs, the labor expenses, the success rate, etc. ET is not guaranteed to be successful and can possibly leave some health risk behind for the donor cow. This leads to the question of is ET economically efficient or is AI still going to be the main structure?

Results and Discussion

Just based off the interview with Dr. Alward there is a big lean towards ET compared to AI looking at just the production side. ET is going to allow the operator to make a high production herd while relieving reproduction stress off unfit cows. This strategy is also going to allow the farm to keep the cow producing but not pass her genetics on. This idea is explained by Dr. Alward, “Some cows may be lower quality cows, you don’t want to keep her genetics on the farm, but she milks good, so she is still making you money. You want to keep her lactating. That

is a cow you may put a high genetic quality embryo in to keep good genetics in the herd" (Alward).

Another factor that is bringing in more profit for operators is the new strategy of beef on dairy using ET. The draw to this is producers can breed their dairy cows with beef embryos so the cow will produce milk, but they can take the calf straight to the sale and get more money for it being a beef calf (Alward). Beef on dairy is going to help operations that are already overflowing with calves but need to keep up with milk production. The reason AI will not meet this advancement is because AI is going to mix the beef genes with the dairy genes and the calf won't sell as high as an ET calf that is fully beef genes.

Although the strategy of ET shows genetic and possible production advantages the drawback is the price tag. When comparing the price of a single transfer to the price of a single AI there is a significant difference. According to Ashby Genetics' rate to transfer one embryo from a donor to the recipient animal is going to cost $670 per transfer. AI, however, is roughly $287 per animal (M. Switzer, personal communication, March 27, 2024). Both total costs exclude any travel cost for the required professionals and are subject to change at any given time. Operators are going to argue that genetics are worth it while others are looking strictly at how sustainable these rates are going to be for their production. When contemplating this decision, a few things need to be considered. How accessible are the professionals needed, what is the goal of my operation, and what is the success rate of the breeding strategy? According to the Bureau of Labor Statistics, there are about 78,000 licensed veterinarians in the United States (U.S. Bureau of Labor Statistics, 2024), for most ET to be performed, a licensed veterinarian or someone under their supervision must do the procedure (American Veterinary Medical Association, n.d.). This is the sole reason why many producers are going to stick with AI because

AI doesn't require a veterinarian, just a certified individual for reproductive management in AI. According to Dr. Alward of Virginia Tech, "AI is still the dominant breeding strategy due to its price, it's a good bit cheaper than ET" (Alward).

The goal for ET is solely up to the producer and what their goal is for the cow. The biggest downfall that will continue to have AI being more in demand than ET is because of the long process and how much it costs. While there are companies or individuals just about everywhere in the U.S., they still must be certified either as a veterinarian or have some other type of schooling (Alward). The whole procedure of ET can take up to 28 days. Withing those days all the steps are very time dependent and require specific conditions to make the full transfer successful, thus making this an expensive technique. If the timing of the transfer is not done at the ideal time, it can lead to a decrease in conception rates (Roper, et al, 2018).

While there are some economic concerns, the health risk for the recipient and offspring is a very low risk. However, there is a higher risk present for a mis dosage of FSH (follicle stimulating hormone) in the donor cow. Many studies have been done to bring caution to how much FSH is being given to the donor cow. Dr. Alward explained that body condition is the big factor for how much FSH is being given. "While you want her [the donor cow] to produce more follicles, if you give too much, then it can lead the fertility issues later." (Alward). Nonetheless, FSH has been tested by many researchers and is a positive stimulant to superovulation if given in the correct dosage (Sanderson, Martinez, 2020).

Conclusion

There are many considerations when trying to decide if ET or AI is the better option, and there is no set-in stone answer. Each farm has a different goal, and each herd is different. If you are an operator looking to increase herd quality or need to breed but don't need the calves, then

ET may be the right choice if you can afford it. For someone who already has good genetics and is wanting to maintain or simply grow herd size, AI is going to be the more reasonable answer. ET is a very drawn-out process that has many moving parts that if not done correctly could cost a lot of money. It will however allow the operator to have more control over what is being bred into the herd or how much that calf can be sold for. AI is a quicker, less expensive, and extensive strategy that is going to put more importance on the cow. However, the farm will be able to have more cows being bred the same way and could put their money into a different aspect of the operation. Embryo transfers are going to allow the producer more freedom in the genetics field but are guaranteed to cost more. For a commercial dairy herd, AI is going to maintain to be the dominant choice. It's cost effective, there is less risk of FSH misuse, and for the average operation, they are still going to meet their production goals.

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