Reproduction Techniques in the Whitetail Industry in America Progress and Innovation are Hallmarks.

R. Greg Stewart DVM, MS, PhD and Stan Bychawski DVM, Diplomate ACT
Southern Veterinary Services, Inc.
Farmington, Georgia

Progress and innovation are the foundation of the United States Whitetail Deer Industry. Progress and innovation have been its paradigm. Handling systems, nutritional advances, preventive health management, anesthetic routines, fence composition, facility layout, lighting control, transportation, health monitoring systems, identification systems…..many innovations exist but let's look at specific innovation adoption in the reproduction area of our industry.

First allow the authors some digression and a little theory on the science of "innovation diffusion." This concept outlines how and at what speed new ideas and technology penetrate a culture or an industry. When hybrid corn was introduced into Iowa cornfields, the study of its diffusion was an integral part of work which culminated in a textbook in 1962 by Everett Rogers called ***Diffusion of Innovations.***

One can find earlier references dating back to 1890 in France (Gabriel Tarde) and Germany/Austria. Many factors relate to innovation technology but there are five stages in the decision process:

1 **Knowledge**-individual exposed to but uneducated as to nature of innovation
2 **Persuasion**- individual is interested and seeks details
3 **Decision**-concept is weighed for merit and decision to accept or reject is made
4 **Implementation**-individual uses innovation, assesses usefulness, and may seek more information
5 **Confirmation**-final decision made and innovation may be used to fullest potential

There are five types of individual that adopt the innovation (typically varying in the speed of that adoption and certain other factors.)

1 **Innovators-**first, willing to take risk, close to scientific sources, have clarity of financial thought, may be younger, experience with other innovations
2 **Early Adopters**-second fastest adopters, high degree of opinion leadership(those whose opinions are highly valued by their peers), more clarity of financial thought and purpose, younger, advanced education
3 **Early Majority**- time of adoption much later, some contact with early adopters, may show some opinion leadership
4 **Late Majority**- adoption later than the average, high degree of skepticism toward innovation, adopt after the majority has tested and approved
5 **Laggards**- last to adopt, no opinion leadership or clarity of financial purpose and objective, oldest class, "a typical aversion to change" type individual.

The reproductive cycles of whitetail deer and elk have been manipulated for some years. ***The first innovation strategy beyond mass mating*** may have involved bringing "in heat" (estrus) females to the sire and having them bred to that sire and after a specific period of time the doe was either returned to the home farm or kept in place to fawn on her own. One could imagine what came next, ***the industry learned to anesthetize the sires*** and a ***process of collection of semen called electroejaculation*** was implemented to collect semen from the sire for use as fresh extended semen to breed estrus does. This semen properly extended could be kept for some hours by coordinated chilling. Vaginal application was the method used to breed several does over a 24 hour period.

What was missing in this scenario was ***not being able to bring multiple does into estrus on the same day*** so that each fresh extended collection could be maximized , i.e. used over as many does as possible. Next innovation? You guessed it: ***Estrus Synchronization.*** This technology was borrowed and adapted from the sheep and red deer industry. The use of intravaginal devices (sponges or CIDRs) that contain progesterone compounds are used to suppress estrus and are adapted to the whitetail estrus cycles. When these devices are removed, standing heats in a high percentage of does are recognized in a predictable pattern. Being able now to bring multiple females into estrus at roughly the same time became a commonly accepted procedure. That allows maximum use of semen if fresh extended or fresh extended chilled. One ejaculation may yield enough semen to breed 70 females or more based on sperm cell counts.

Next innovation: ***Semen has to be preserved!*** We can adopt what other animal industries have adopted. ***Develop extenders and cryoprotectants that are compatible with whitetail deer semen and "guesstimate" how many sperm cells constitute a dose.***
Because fresh semen or chilled fresh semen is long living, very viable and can achieve high levels of conception the industry now began to adapt to other methods other than live breeding. Preservation and storage and transportation required semen to be frozen. But the lifespan of frozen and thawed semen is much shorter than that of fresh semen. Simple vaginal deposition was not enough to get acceptable conception rates.

Yet more innovation was needed: what method of application of frozen semen would be effective? Just depositing the sperm cells into the vaginal vault into copious amounts of thick estrus mucus was not satisfactory. ***Development of cervical artificial insemination techniques*** improved the conception rate but results were still not optimum with frozen semen.

Discussions among scientists at various gatherings now centered on what supportive role ***the application of some type of follicle stimulating hormone might have on tighter synchrony of estrus*** and on insuring that we could consistently provide twins at birth. When some follicle stimulating hormone is coupled with very high quality semen, a cervical deposition at an appropriate time after removal of the CIDR (vaginal progestin device) can yield satisfactory results. The best operators with the best semen can attain 70 % plus conception rates if the does are healthy and properly prepared for cervical AI.

As semen costs began to escalate, more innovations were borrowed from other animal industries to improve conception rates and to further define costs. ***Laparoscopic artificial insemination (LAP AI) was coupled with sound anesthesia techniques*** in properly programmed does yields much higher conception rates. The use of a small laparoscope (5mm) to visually inject semen into the uterus of the synchronized doe allowed the veterinarian to actually see that the doe is in good heat and that she is reproductively sound. This procedure in the proper hands takes only two to three minutes and can give conception rates that are much higher than cervical AI (conception range 75-100%). It allows the client to maximize the use of semen. This method of artificial insemination is widely used today throughout North America. ***However, the various whitetail organizations have not adopted standards for semen quality and count that have been adopted by other purebred organizations.*** The American College of Theriogenology (ACT) holds standards for other livestock species. This has leveled the playing field for semen transactions and has forced poor semen and poor semen collection operators out of the market. One can attend any number of sales of purebred cattle and purchase semen passing quality standards set forth by the livestock association and characterized and encoded by ACT. This allows for recourse in disputes as well. One will not find any semen marked "Farm Use Only" being sold at these purebred cattle sales. It is either premium semen or it is not.

Why spend money on new innovations? The outcome fulfills our goals for genetic improvement in our whitetail deer. What are the selection pressures? What traits will we breed for in our deer? We are selecting for a trait or various traits. Examples are: mothering ability, livability in various climates, antler growth and development as well as antler shape. Pick your trait. ***With the advent of scientific breeder colony facilities we can apply classical genetics and advanced reproductive techniques and make rapid genetic progress. Proof: Look at the sire ads and recall the Boone and Crockett scores of just 5 years ago.***

Producers in Texas can purchase semen from massive antlered bucks in the upper Midwest. The result is progeny that are a composite of the northern genetics and the southern genetics. But why can't the producer simply go to the breeder in the Midwest and purchase a sire or a couple of pregnant does and bring them home to his Texas pens instead? Monitoring and certification programs for a prion disease or TSE (transmissible spongioform encephalopathy) called Chronic Wasting Disease (CWD for short) are now well established and there are local (state) and federal regulations about the interstate and intrastate movement of live cervids. There are no concerns about the transmission of TSEs with the movement of semen or embryos. A producer in one state who has been cooperating in the CWD Program for a significant number of years can be certified by these programs and at a point in the program can ship his live animals to another state which allows such importation. Some states do NOT allow any importation regardless of status. Pure certified stock can be obtained from particular breeders in certain states and shipped interstate. You cannot obtain any live animals from other breeders if you happen to live in one of the restricted states. These market conditions must be lived with and dealt with when you run a business of this type. Innovation needed?

Most livestock industries in the United States have adopted another innovation that has further propelled the economic value of these industries and has hastened genetic progress. Imagine making a desired mating and receiving for your effort one doe fawn and one buck fawn. You spend valuable time and money growing out the fawns and you believe that this mating has yielded one of the best antlered bucks you have ever raised or seen. You decide to remake the mating because of this buck. You remake the mating and for your reward you receive two doe fawns. The next year you make the same mating and you also breed the young buck's mother's sister with the same sire. You get two buck fawns out of the progeny and neither of them make you happy. How long did this process take that resulted in what appears to be failure? Almost five years!

What if you made this mating in a MOET (multiple ovulation embryo transfer) or superovulated doe? A doe that was superovulated and was flushed to give you seven embryos that resulted in five fawns three of which were buck fawns and all of these fawns could be grown out in the same year, same lots, same alfalfa hay crop, same weather conditions, and same vaccination and feed programs. Under this scenario all the bucks turned out to be average. How much time was utilized in this project? One year to eighteen months. Time savings –huge! Decision making ability improved? Vastly!

What is MOET? The principal advantage of embryo transfer is simply put: the increased reproductive capacity of valuable individuals. It can decrease the genetic interval by allowing multiple progeny from young donors in some instances. It certainly allows for the movement of germplasm (genetics in basic embryo form) from one region to another without introducing disease. It can insure the breeder's herd should a catastrophic incident occur. It can store valuable genetics for long periods of time in order to preserve certain lines or species which can be restored later for other breeding experiments. For example, if a producer had all of his valuable genetics captured in frozen embryos and sitting in two locations and a virulent Anthrax and EHD (Epizootic Hemorrhagic Disease) outbreak hits his ranch in one year after big 15 inch rains in early summer and mortality in his pens closes in on 70%. Wiped out?
Surely not if it weren't for the self insurance program where most of his valuable genetics were captured in frozen embryos sitting comfortably in liquid nitrogen.

The process of MOET involves a routine of estrus synchrony between multiple does. The superovulated does are called DONORS and the other does synchronized for the program are the does receiving embryos from the donor's womb. Receiving does are called RECIPIENTS. They are surrogate mothers. They will carry the progeny of the DONOR and the DONOR'S MATE. The recipient female contributes nothing to the genetics. She is simply a borrowed high tech incubator. The multiple ovulated eggs from the donor are released into her oviduct and are fertilized in one of three ways: fresh chilled semen AI, frozen semen AI, or through natural mating with the buck. If the eggs are fertilized and they begin to cell divide they are called embryos.

The MOET or superovulated DONOR cannot have a litter like a pig or a dog because the increased number of fawns will do her harm. So we surgically remove the entire embryo contents of her uterus through a process called flushing. In this short surgery a specialized fluid is "flushed" through her uterus to be trapped in a collection vessel for evaluation and washing. Under the microscope the embryologist removes the unfertilized eggs (ova) if present and concentrates on grading, washing, and caring for the embryos present. (Proper paperwork is generated to catalog the results of each DONOR flushed). The embryos either are implanted into RECIPIENTS (surrogate mothers), frozen, or disposed of if the embryo is degenerate or has stopped cell division.

The process of fresh embryo implantation occurs soon after the embryos are cataloged, graded, and recorded. Each RECIPIENT receives from one to three embryos of the same mating directly into her uterus. She is first evaluated by the veterinarian with his laparoscope to insure that she has ovulated on her own. If she is normal and has ovulated, she is implanted under modest anesthesia and returned to her pen to be grouped with the rest of her band of recipients. The recipient is now carrying the donor's embryos. ***The procedures are very safe in trained veterinary hands. The loss of a donor or a recipient is rare but can happen. <u>It must be stressed that this procedure is for use only in very skilled and trained hands.</u>*** The use of unskilled hands has resulted in extremely high mortality or does who are reproductively ruined or who have little conception. Pregnancy rates in recipients on fresh programs can reach 70 to 80 % in well managed herds. Recipient management is the key to good embryo "stick rates." Young does from sixteen to thirty six months of age are the best recipients.

The author has had the good fortune to be acquainted with two generations of a very special family in the purebred cattle business. The current generation of family was interviewed in preparation for this article. In that interview the decision-making owners were asked about adoption of innovations in reproductive technologies and their effects on their business and the industry. The adoption of MOET has increased sales, international and domestic, and increased genetic quality, improved decision making ability, saved time, and provided insurance against catastrophe. Those who were leaders in the industry before the adoption of the innovation, i.e. the "Innovators" and "Early Adopters" remained the leaders and there were only minor changes in reordering of the hierarchy of the industry. The rank and file changed only slightly. The author was also informed that oversupply has happened in that industry before and after the use of MOET. Moet did lead to oversupply. The use of MOET has increased the quality of the animals in the market. Demand may change in some areas. The use of MOET has created a market for the cull females. There is now a market with a floor price for recipient females. The bottom end cows are bought, sold, and traded for recipients. This technology did not ruin the cattle industry any more than it will ruin our industry.

<u>MOET should only be used on exceptional animals that have normal estrus cycles</u>.
Only the top two to three percent of does should qualify to be donors and only after they have fawned on their own and are proven mothers. Bottle-fed and dog tame please! You will be rewarded for this. Recipients tame please! MOET is a modern tool just like frozen semen, cervical breeding, laparoscopic breeding, and advances in estrus synchrony and

anesthesia. It makes for the most rapid genetic progress available. The DONOR is mated to one sire for the MOET procedures and can be mated to another sire after the surgery to have her own progeny if desired. For many, the reason to select MOET is the potential for genetic improvement in the herd. Through artificial insemination with frozen semen superior male genetics can be spread rapidly across a herd. With MOET, superior female genetics can be spread in that herd. Each of these offspring would potentially carry the superior traits of the mother.

The timeline for MOET starts many months before the actual day of “flushing surgery”. Recipients must be obtained and commingled for most of the late summer and autumn to get over social and pecking order stresses. This allows for contact exposure to new disease agents such as respiratory and gynecological pathogens and gives opportunity for active immunity to occur. Pick them all from the same farm or ranch to minimize the risks. Raising them yourself is the best strategy as the “stick rates” in homegrown recipients is always better than those acquired. It never fails.

All vaccination, worming, marking and grouping must be finished well ahead of actual start of the program. The recipients and the donors are not to be overfed during the summer. Let the fawns deplete the condition of the doe naturally down to normal summer body condition. Approximately twenty days prior to CIDR IN dates begin the uphill feeding of energy NOT protein to the does. This is called “nutritional flushing” in which the body condition of the female is increased in order to increase the number of ovulations she will have on succeeding estrus cycles. This is a good strategy for both the donors and the recipients. Start modestly and increase slightly throughout the pre-CIDR period and the CIDR-IN period up through surgery day and for the recipients that are implanted for another 21 days after implantation.

The program of MOET lasts for 20-30 days depending on type of program used. On the way to CIDR-OUT the donors are stimulated to superovulation with various injections of follicle stimulating hormones. The donors are bred after CIDR-OUT and the embryos are harvested several days later after breeding. Our clients sign booking agreements complete with a consent for surgery and including a confidentiality agreement about our procedures. The entire protocol of drugs and agents including anesthesia is provided. Good “stick rates" have been experienced for each of the last three years in fresh programs and more experience is being gained in the frozen programs.

The numbers of frozen embryos implanted now is sufficient to allow us to expect 50% or greater stick rates in well managed recipients. MOET will allow us to better understand the traits of so-called “Superdoes," it will allow for faster genetic progress and this will allow for lower costs to emerge in the bucks sold for harvest. With improved genetics and more rapid progress we should be able to provide 190-220 class bucks well before the time previously required for antler growth to occur. If harvest was set for six years for this class of buck three years ago, it will soon be under four years. Each year we hold a buck in inventory waiting unnecessarily wastes valuable resources. It increases the risk of accident or mortality due to disease.

MOET will create a market for recipient females. Specialty recipient producers will emerge. Ranchers will self insure using frozen embryos. The Innovators and Early Adopters are going to be rewarded as they have been in most of the other industries studied. North Americans are good at innovating. We seem to thrive on it. If we take genetics from another continent and work on the genetics here for 20 years and we can pass all of our competition. One of the authors has spent several decades in production-oriented genetics/medicine/reproduction. It has been meaningful work. It has always included adoption of innovation. ***The most consistent thing that we as human beings face on a daily basis is change. You can either welcome it, understand it because it is common and ordinary, or be fearful of it. It's up to us.***

If readers are interested in further understanding of the political machinations of an industry that tried to suppress MOET innovation, look no further than one of America's quarter horse associations and see what happened there. Suppression attempts were also not good for the llama and alpaca industry when they were tried there.

We will see more innovation occur in our industry.

- We will place successful pressure on sex selection.
- We will test for selected traits in potential sires and dams before they are mated.
- We will eliminate deleterious genes from our population as they emerge using very modern laboratory genetic techniques.