Experts Explore Reproductive Techology

The mechanics of natural service and AI breeding, reproductive health issues and the future of genetic selection were the focus of ARSBC's Wednesday lineup.

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Photos by
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The Robert E. Taylor Memorial Symposium is conducted by Colorado State University (CSU) every other year to provide current, research-based information for improving profitability in the beef cattle industry. The Applied Reproductive Strategies in Beef Cattle (ARSBC) program was developed by the Beef Cattle Reproduction Task Force to improve understanding and application of reproductive technologies, including AI, estrus synchronization and factors affecting male fertility.

In 2008, CSU and the Task Force collaborated to provide the Dec. 2-3 symposium in Fort Collins. In the January *Angus Beef Bulletin*, we published summaries of most of Tuesday's presentations. What follows are the summaries of Wednesday's presentations.

To listen to any of the presentations, review the accompanying PowerPoint or view other presentations from the symposium, visit the newsroom at *www.appliedreprostrategies.com*.

Genetic selection for fertility, performance

Beef cattle breeders seeking to enhance profitability through genetic improvement should focus on economically relevant traits, advised Colorado State University (CSU) geneticist Denny Crews. Crews said traits related to fertility and maternal productivity definitely are economically relevant and typically have a greater effect on profitability than traits related to growth and carcass merit.

Crews said few large-scale genetic evaluations for fertility traits have been implemented. Rather, economically relevant traits (ERTs), such as heifer pregnancy and cow stayability (productive longevity), have largely been relegated to evaluation and selection for easily measured indicator traits. These are traits that are genetically correlated with ERTs, but are not themselves economically important.

> **"Make sure genetic selection decisions are based on economically relevant traits and not directly on an indicator," — Denny Crews**

For example, Crews said, scrotal circumference in yearling bulls serves as an indicator trait, since it is known to be favorably correlated with bull fertility and age of puberty in related females. Its heritability is relatively high. The drawback is that it is also highly correlated with growth rate.

"Make sure genetic selection decisions are based on economically relevant traits and not directly on an indicator," advised CSU geneticist Denny Crews.

And an increased growth response to selection for increased scrotal circumference may not complement selection goals for increased fertility.

"We need a novel approach to uncouple scrotal circumference from the growth component," Crews said. "An alternative measure of scrotal circumference more closely describing its indication of genetic merit for fertility is needed."

Systems for better genetic evaluation of fertility-related ERTs are being pursued, with the goal of predicting expected progeny differences (EPDs) with increased accuracy. Crews said the combination of multiple-trait approaches to modeling, increasing accuracy with indicator traits and the potential of marker-assisted selection should aid selection for beef cattle fertility.

Crews urged symposium attendees to remember the distinction between ERTs and indicator traits.

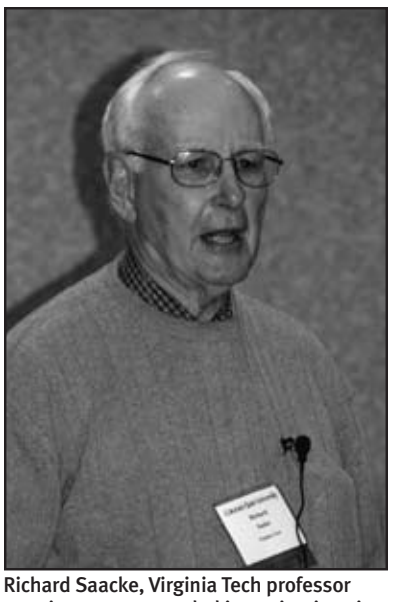
"Make sure genetic selection decisions are based on economically relevant traits and not directly on an indicator," Crews warned. "The best selection for an economically relevant trait is based on a model involving multiple indicators."

— by Troy Smith

Factors affecting fertilization in synchronization programs

Whether or not cattlemen are using synchronization protocols in beef cattle breeding programs, "the rules of biology" still have to be followed in order to achieve fertilization, Richard Saacke, Virginia Tech professor emeritus, told symposium attendees.

Saacke emphasized that the bottom line in successful insemination and fertilization comes down to sperm transport in the cow. He explained that insemination places billions of sperm in the cervix that then must travel up the reproductive tract to the oviductal sperm reservoir.



Richard Saacke, Virginia Tech professor emeritus, recommended insemination six to 10 hours prior to the onset of ovulation to optimize fertilization and embryo survivability.

During this process, timing is critical, he said. Numerous sperm get lost in the reproductive tract, and only thousands actually reach the reservoir where fertilization occurs. Quality of the semen is also important during this process because many of the sperm simply do not survive.

"So, in a sense, the female has a selection that she exerts on the sperm," Saacke said.

To enhance sperm transport in the cow to achieve fertilization, Saacke said three important factors must be considered:

1. Bull effect. Saacke emphasized that reliable semen should always be used. He

encouraged producers to consider a sire's reproductive history and make certain natural and AI sires have passed a breeding soundness exam.

2. Inseminator. A skilled inseminator can also help reduce AI mistakes commonly made. Saacke said not only does semen need to be handled carefully during the thawing process, but inseminators must also make certain they are skilled in placing the semen in the uterine body. He recommended inseminators take the time to be retrained to ensure they remain proficient at AI breeding.

3. Timing of insemination. Most importantly, timing is everything with insemination. Saacke told attendees that, especially when using a synchronization protocol, the time and tightness of ovulation must be known. He explained that accessory sperm must be able to make it up the female's reproductive tract and into the oviductal sperm reservoir with enough time to access the freshly ovulated egg, but not so late as to ignore sperm transport time in the cow and risk the possibility of missing ovulation.

Saacke shared research that showed if you breed too early, fertilization rates tend to be low, but embryo quality is high. Conversely, if you breed too late, fertilization rates may be high, but embryo quality tends to be lower due to the aging eggs.

Thus, Saacke said, "Timing of AI is a compromise. … We need to go in between and find a happy medium. That's why we recommend insemination six to 10 hours prior to the onset of ovulation."

— by Tosha Powell & Kindra Gordon

Applications of technology in bull reproduction

Research continues in an aim to learn more about improving bull semen to ultimately increase bull fertility and improve herd genetics, said Jim Graham, CSU professor in the Department of Biomedical Sciences.

CSU's Jim Graham discussed the value and limitations of breeding soundness exams and sexed semen.

Graham emphasized that cow-calf producers should take heed of breeding soundness exams (sometimes referred to as BSEs) and the information they provide to evaluate bull fertility. All three components of the exam — the physical exam, the health evaluation and the semen analysis — are important.

Graham suggested producers cull bulls that fall into the lowest 15%-20% of the exam categories.

"Remember, the most important thing is fertility and getting cows bred," he said. Thus, culling bulls based on BSE results, such as a small scrotal circumference or low motility, is a step toward improving herd fertility. "This is a very cost-effective approach," he added.

Graham acknowledged there are still advancements that need to be made in the process of semen analysis. Sperm can be infertile for a number of different reasons, but current lab assays only evaluate a few

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characteristics. As an example Graham said, "We can identify poor-quality semen samples, but we can't identify high-quality [samples]."

To that end, he reported that research is ongoing to develop new assay methods. One current project looks at chromosome defects. Another new method, which is called the Fourier Harmonic Amplitude, evaluates sperm morphology and then enters it into a computer database to get a prediction line of the quality of the sperm.

Additionally, research efforts are continuing to learn more about the freezing ability of semen. Graham noted that because the dairy industry has worked primarily with genetics produced by artificial insemination (AI) for the past 60 years, semen quality and freezing characteristics of dairy bulls is much better than that of beef bulls.

As more is learned about freezing semen from stallions, some of that information may be applicable to beef cattle, Graham said. For example, the horse industry is using diluents with different compositions because some horse semen freezes better than others and that can vary with the type of diluent used.

Different diluents may also be used more in the future for beef sires, Graham predicted. Adding cholesterol to the bull sperm membrane has been found to increase viable sperm significantly. However, this practice appears to lower fertility. Thus, some trials are looking at insemination occurring earlier to try and increase the window of time for fertilization.

Lastly, Graham mentioned the status of sexed semen in cattle. He explained that the only way to sex semen reliably is based on the different DNA composition of the X and Y chromosomes — the X chromosome is 3.8% larger than the Y. "That's not very much," Graham noted.

A flow cytometer is used to stain and sort sperm into X- or Y-bearing categories. Graham reported sorted sperm are very different than non-sorted sperm due to the pressure of going through the flow cytometer.

"Sex-sorted cells swim differently; die more quickly and have more damage," he noted.

Because of the fertility differences in bulls, semen from some bulls cannot be sorted, Graham said. "Some don't take the stain through the sorting process or because of the added damage to the cells after sorting, they won't freeze."

CSU research has shown that sexed semen is safe to use in breeding programs and that there are no differences in calves born from sexed semen compared to calves born from non-sorted semen, but Graham wants people to understand that the sorting process does limit the amount of sexed semen available.

— by Kindra Gordon

Bull management considerations for natural service

It isn't new, and it isn't rocket science, but understanding the dynamics of bull fertility and management of breeding bulls is fundamental to sustaining a successful breeding herd. CSU Extension veterinarian Roger Ellis said the fundamental goals of natural service breeding programs are threefold:

- Achieve the highest possible pregnancy rates early in the breeding season.
- Produce the highest possible number of calves from bulls of the greatest genetic merit.
- Achieve the previous goals as efficiently as possible.

Producers commonly have high expectations of bulls classified as "satisfactory" following a breeding soundness evaluation. However,

A breeding soundness exam is not a lifetime guarantee a bull will perform to a producer's expectations, said Roger Ellis, Colorado Extension veterinarian.

Ellis reminded producers that the standardized breeding soundness evaluation is a risk management tool that assesses testicular development and health, spermatozoa quality and quantity, and a bull's physical capability and soundness to accomplish mating. Applied correctly, the procedure identifies faults or weaknesses that would contribute to subfertility at that point in time. It does not predict whether a bull will be a superior or inferior breeder.

"It is not a lifetime guarantee that a bull will meet expectations," Ellis stated. "Fertility is a dynamic condition. It is in a state of change, on a day-to-day basis."

The evaluation does not predict a bull's eagerness to mate (libido). Nor does it reveal how the environment and management might influence the actual performance of bulls previously determined to be potentially satisfactory breeders. The age and experience of bulls and herd social hierarchy influence breeding performance, as does the bull-to-female ratio.

"Luck plays a role, too — whether or not a bull remains injury-free during the breeding season," Ellis added. "Mating is a hazardous occupation, and the most common cause of removal from a natural mating situation is injury."

Ellis urged producers to observe and evaluate the reproductive and physical soundness of bulls throughout the breeding season. They should be observant of changes in libido and mating activity, and apply bull rotation or replacement as necessary. When natural service is used in conjunction with an estrus synchronization program, producers should be even more vigilant.

— by Troy Smith

Survival of the fittest

With costs continuing to escalate in the cattle business, cow-calf producers need to become more astute managers and find ways to add value to calves in the future, advised Casey Gabel, CattleFax analyst. Gabel provided an overview of the current state of the industry, noting that the U.S. beef cow inventory is expected to be just under 32 million beef cows in 2009 – the smallest inventory since 1963. Along with that, Gabel said, cash operating cost per cow continues to escalate due to labor, insurance, diesel, vaccinations, feed, etc.

"Our forecast is showing it may take $436 to run a cow each year," he said.

Because of this, the breakeven price on calves continues to go up, which means producers need to find ways to make more money to stay in business, Gabel said.

To that end, Gabel emphasized that "adding value" to calves means finding ways to differentiate calves in the marketplace. He encouraged producers to develop a good marketing strategy, such as backgrounding options, value-added programs, and/or retaining ownership. For instance, quality genetics, calf health programs and weaning protocols are all

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ways to differentiate calves and can add premiums up to $60 per head.

"Find a program that fits your operation," Gabel encouraged. He listed natural and organic programs, source and age verification, preconditioning and weaning protocols, performance history, and carcass data as examples of ways to differentiate calves — and add value — in the marketplace. Even humane handling is starting to garner interest as an added value.

Pounds are going to continue to be worth more in the future, Gabel said. "Finding alternative ways to put pounds on calves postweaning will be beneficial." Using economical feed resources such as cake, grass, leftover hay, cornstalks, etc., may be worth it to producers.

"Genetics certainly plays a part in the profitability scenario for cow-calf operators," Gabel said, predicting feed efficiency will have added value in the genetics realm.

Annual cow costs may average $436 per cow, Cattle-Fax analyst Casey Gabel said.

"The gist of it all is that we are going to have to sharpen our pencils. We are going to have to become more astute managers and pay close attention to our input costs," Gabel concluded. By adapting some of these management protocols, Gabel said, those beef producers who "are fit to survive will see some good returns as we move forward."

— by Tosha Powell & Kindra Gordon

New advances in reproductive technology

Most so-called "new" reproductive technologies stem from decades-old concepts and many years of research. According to CSU reproductive physiologist George Seidel, technologies like sexed semen, cloning and transgenics seem new because of their recent application by the beef cattle industry.

Sexed semen. The subject of more than 50 years of serious research, recent years have seen development of a practical technique for sorting sperm cells so the gender of a calf can be predetermined through artificial insemination with sexed semen. The accuracy with which sperm cells can be sorted approaches 90%. Most large bull studs in the U.S. now offer sexed semen, but beef producer interest pales in comparison to the dairy industry.

"Still, it's an imperfect product," Seidel stated. "The fertility is lower than unsexed semen, and it is available from a limited number of sires. It's also more expensive, currently costing about $25 more per straw."

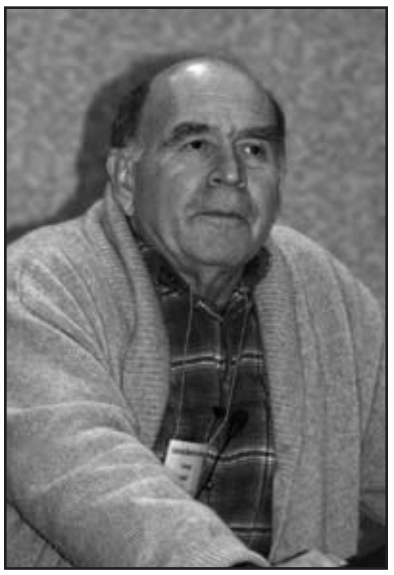
Seidel said he sees the use of sexed semen to breed heifers to produce more replacement heifer candidates as a logical application of this technology. Advantages would include less calving difficulty (no big bull calves) and a hastened introduction of the freshest genetics to the breeding herd. This would also allow most mature cows to be bred for a terminal cross, since replacements would be chosen from calves born to first-calf heifers.

Cloning. Another "new" technology, cloning isn't all that different than planting potatoes. It's a form of asexual reproduction, where a piece of the

original organism is used to produce a genetically identical organism. One way is to divide an embryo into two pieces to produce twins, but clones can be produced from body cells taken from skin, roots of hair, or somatic cells from milk or semen.

Seidel said practical value might be derived from cloning an animal that is genetically outstanding, but the success rate is low. Cloned embryos are transferred to recipient cows for gestation, but abortion rates are high, and a relatively high percentage of those that survive after birth are abnormal. And cloning is extremely expensive.

Transgenics. With the ability to sequence the bovine genome also has come the ability to add, delete, and modify its parts, Seidel said. In other words, it is possible to change an animal's DNA. Termed transgenics, Seidel said this technology may represent the ultimate tool for animal breeding. After "correcting" an animal's DNA, the change would be passed on and present in all of the animal's offspring.



CSU reproductive physiologist George Seidel discussed application of newer technologies, such as sexed semen, cloning and transgenics.

"An example would be to take an outstanding horned Hereford bull, obtain some skin cells, modify the DNA sequence from horned to polled, in a homozygous way, clone from the modified cells, and end up with an exact copy of the bull — except for being polled. And all of his offspring would be polled," Seidel explained.

The procedure has become quite reliable, but costs are too high to make it practical for the beef industry. Additionally, the concept of transgenics prompts food safety concerns among some segments of society (see page 132).

Seidel said most of the technologies discussed will be limited to niche applications in the near term. Eventually, they may become sufficiently inexpensive and efficacious to be as widely practiced as estrus synchronization and artificial insemination are today.

— by Troy Smith

Dealing with trichomoniasis

Trichomoniasis and bovine viral diarrhea (BVD) are reproductive diseases that can both have a big impact on the profitability of a cattle herd. That's why it is important that producers use management and biosecurity to mitigate these diseases, said Bob Mortimer, CSU associate professor of integrated livestock management.

"Some of these management practices are so simple," Mortimer said in his opening remarks. Because trichomoniasis, or trich, has been a focus of his career and is of big concern in Colorado, Mortimer focused his remarks on that disease.

Trich commonly causes poor pregnancy rates, with 10%-50% open cows not uncommon. It also tends to spread out the calving season, reduce weaning weights and increase herd health costs. Mortimer emphasized that to combat this costly

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disease it is necessary to understand what causes it and then design a plan to keep it out of your operation.

What is Trich? *Tritrichomonas foetus* is a single-celled protozoan that is transmitted sexually. In bulls, the organism localizes in the crypts, or microscopic folds within the skin surface of the penis and sheath, Mortimer explained. Because these crypts become deeper as the bull ages, there is an association between age and infection. Mature bulls are more apt to become infected and stay infected. And, once a bull is infected with trich, he is infected for life.

Infection of the cow can take place at breeding, but Mortimer noted that not every female will become infected when bred. If the protozoa is transmitted to the female, it will attach to the cells lining the vagina. The protozoa form colonies, which spread to the uterus and oviducts, resulting in an inflammatory response. This may cause the cow to abort her calf and rebreed, or cows may carry the infection for several months and then mount an immune response and clear themselves of infection, but they are then susceptible again to the infection.

The bottom line in managing and treating trich is for producers to be knowledgeable enough to put a biosecurity program together to protect themselves, CSU's Bob Mortimer said.

Because the bull is a chronic (lifetime) carrier, and cows can clear the organism following infection, herd diagnosis usually is made by testing bulls, Mortimer explained.

Diagnostic testing of samples from the sheath are necessary for diagnosis. It is recommended that bulls have at minimum two weeks of sexual rest before undergoing testing. And, in order to make a definitive diagnosis, it is recommended that bulls be sampled by a veterinarian once a week for three weeks in a row, Mortimer said.

Treating trich. Mortimer said the bottom line in managing and treating trich is that producers need to be knowledgeable enough to put a biosecurity program together to protect themselves.

Because there is no treatment approved for trich, bulls that test positive should be sent to slaughter. "This doesn't mean you sell him to somebody else. That is how the problem is spread," Mortimer said.

Additionally, he advised working with neighbors to ensure that all herds with fenceline contact have the same focus on managing trich. "This is a disease of neighborhoods. If you can't get your neighbors involved, you're never going to get it out of the area," he said.

If neighboring pastures are leased out for grazing, he suggested working with the local cattlemen's group to write the landowner or leasee a letter asking that screening for trich (and other transmittable herd diseases) be part of the leasing agreement. For grazing associations with cattle from multiple herds, Mortimer also emphasized that it is important that all bulls be screened.

Likewise, leased bulls are a concern because they often are in multiple herds. "If you are going to lease a bull, require at least three negative tests," Mortimer

said. "Keep in mind that takes 30 days."

He added, "This is an easy disease to handle, but it's got time constraints for the testing."

Mortimer said vaccination is available for cows, but it is not effective for bulls. Additionally, he said it does not prevent infection in cows, but it may decrease the severity of the disease.

Additional management tips from Mortimer include:

- If possible, incoming cows should be virgin heifers from a reputable source.
- Purchase only virgin bulls or bulls tested negative via three weekly tests.
- Using AI and synchronization programs can also decrease the need for bulls and the risk of exposure to Trich. Be certain the semen comes from a reputable source.

— by Kindra Gordon

Understanding high-mountain disease

Tim Holt, CSU assistant professor of veterinary medicine and biomedical science, gave symposium attendees an overview of bovine high-mountain disease, also known as "brisket disease." Throughout his presentation he emphasized the need for development of an expected progeny difference (EPD) or genetic test to better help predict heritability of the disease.

Brisket disease is the accumulation of fluid in an animal's brisket area as a result of congestive heart failure. The condition is caused by hypertension in response to low oxygen levels at higher elevations, making cattle that originated at lower elevations and moved to higher elevations highly susceptible to the disease.

Holt, who has been studying the disease for more than two decades, said high-mountain disease typically occurs at elevations above 5,000 feet, but he has seen it occur in cattle at 2,800 feet.

Holt explained, "When a bull comes from the coast and walks into high elevation, he gets hypoxia. Hypoxia happens because his oxygen is decreasing. As the symptoms progress, this eventually leads to congestive heart failure."

How fast can the disease take effect on cattle? Holt said it most often takes three to six weeks for brisket disease to take form, although it's been witnessed as quickly as 48 hours. Jugular distention in the animal's neck is one of the first signs.

As a result of its rapid onset, brisket disease is extremely costly for ranchers in mountainous regions. Presently, the primary treatment for the disease is simply moving cattle to lower elevations. The pulmonary arterial pressure (PAP) test has been used for many years by Holt and his colleagues to test cattle for the disease. It can help determine which animals are most at risk for brisket disease and detect early signs of the disease.

Because this disease is heritable, Holt

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CSU's Tim Holt, who has been studying brisket disease for more than two decades, said it typically occurs above elevations of 5,000 feet, but he has seen it occur in cattle at 2,800 feet.

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said he would like to see the beef cattle industry develop an EPD to help predict susceptibility to brisket disease. He pointed out that most artificial insemination (AI) sires are from low-elevation areas, and it would be beneficial to have a database in the form of an EPD to help better manage against the disease.

"We want more accuracy; we need better answers," he emphasized.

Holt concluded by adding that with an EPD, producers could minimize some of the economic impact brisket disease has on herds. It would also enhance breeding selection and aid in culling decisions.

— by Tosha Powell & Kindra Gordon

What does the future look like?

According to geneticist Ronnie Green, with Pfizer Animal Genetics, the impact of emerging DNA technology will startle many within the beef cattle industry. The industry stands at the front end of the most significant era of transition in genetic selection, he said.

Borrowing technology from human genome mapping research, animal geneticists have sequenced the bovine genome, publishing the first draft in 2007. Now, Green said, DNA markers for 50,000 genotypes have been identified. He predicted rapid advancement of the technology during the next 18 months.

"In a short time, we'll be talking about 500,000 and then a million markers. And we'll apply markers to predict the genetic value of animals for more and different traits, including critically important feed efficiency, postweaning gain, and disease resistance," Green said. "I firmly believe we're on the verge of an animal genetics renaissance, and it's coming quickly."

Ronnie Green of Pfizer Animal Genetics warned producers to be wary of new DNA products, making sure they know what percentage of genetic variation a test accounts for and that it is validated by a third party before they buy in.

Green told the audience to expect a new wave of DNA-testing products involving panels of markers, and new numerical predictions for genetic improvement, similar to expected progeny differences (EPDs). He called for a collaborative effort to educate the various segments of the industry regarding this new technology.

Green warned producers to seek knowledge and be wary as companies introduce new products. He advised them to make certain new DNA tests have been validated by an independent third party.

"You also need to ask what percentage of genetic variation for a trait is described by any test being considered. Up to now, that information hasn't been offered. But it is important," Green said.

— by Troy Smith