Proceedings, Applied Reproductive Strategies in Beef Cattle
August 30-31, 2022; San Antonio, TX

REPRODUCTIVE SECURITY IN BEEF HERDS: CURRENT THINKING ON DISEASE PREVENTION, HERD RISKS, AND DIAGNOSIS

A. Lee Jones[1] and Dan Goehl[2]

[1]Associate Professor, Beef Production, UGA College of Veterinary Medicine, Tifton, GA
[2]Owner and Veterinarian, Canton Veterinary Clinic, Professional Beef Services, Canton, MO

Introduction

Reproductive efficiency is crucial for breeders and cow-calf herd production and profitability. Without pregnancies, calves aren't born, weaned or sold. Pregnancy has 4 times greater economic impact than any other production trait and reproductive efficiency is more important than growth or carcass traits for the cow-calf producer.

For a cow or heifer to get pregnant, the following events have to occur successfully: she needs to cycle and ovulate, conceive, recognize the presence of the embryo and the embryo needs to attach and develop the placenta and maintain pregnancy to birth. While those events are critical for pregnancy, reproduction doesn't actually end until the calf is weaned. Any loss of the embryo, fetus or nursing calf is a failure of reproduction. Reproduction, then, is an all or nothing event and can fail at several points along the way. There are numerous challenges for successful reproduction in our cow herds. Fertility is the single most significant factor for cow herd productivity. The other side of the coin is infertility, it is 6 times more costly than calf respiratory disease or other non-fatal disease (Bellows, et al, 2002). Infertility can be defined as a cow failing to breed, breeding but not delivering a live calf or breeding late. The fact is that if the calf isn't born alive and healthy then weaned, we don't have anything to sell.

While the challenges to getting cows pregnant change slightly each year, they fall into 2 categories: non-infectious and infectious. Non-infectious causes consist of the environment and management including nutrition, bull fertility, cow body condition, etc. Infectious causes of reproductive failure include viruses, bacteria, fungi, protozoa or parasites that infect the reproductive tract of cattle.

Management

Though infectious diseases resulting in failure to become pregnant or in pregnancy loss often get the most attention, herd management has more impact on overall reproductive efficiency and fertility than any other aspect of production. Good nutrition is fundamental for a good reproduction program as well as resistance to exposure to pathogens that can cause infertility or pregnancy loss. Adequate nutrition includes optimal pasture stocking density, timely nutritional supplementation including vitamins and minerals and good quality water. Cattle on a balanced diet in good body condition generally don't have problems with pregnancy loss. Testing forages for nitrates and avoiding feeding forages high in nitrates is also a good management practice. Proper storage of forages is also important. Spoiled hay or improperly ensiled forages can contain organisms that can cause abortion.

Monitoring and managing body condition of cows is a good practice to maintain reproductive performance. A cow's body condition at calving determines her opportunity to get pregnant in the next breeding season. Cows that calve in poor body condition (BCS 4 or less) likely will not be cycling when the bulls are turned out and will have fewer opportunities to rebreed than a cow that calves in good BCS. Cows that calve in BCS of 5 or 6 are usually cycling by 60 days after calving and have a better chance of maintaining a 12 month calving interval. Likewise, if a cow calves late in the calving season she will have fewer days to rebreed in a controlled breeding season. Managing cows to calve early and maintain adequate body condition during the dry period helps cows maintain annual calf production.

Selecting heifers for fertility and longevity are essential for lifetime productivity. Heifers that calve early their first year and maintain early calving can produce heavier calves each year than heifers that calve 2 cycles later. Traditional methods of heifer selection rely on physical traits such as weight, age and pregnancy status to determine whom to keep. While genetic tools can improve our ability to identify the most productive heifers earlier than traditional tools, physical traits still matter when selecting replacement heifers.

Managing our bulls is another important part of reproductive efficiency of the herd. Using fertile bulls will get more cows bred earlier than sub fertile bulls. Several studies show the benefits of a thorough annual breeding soundness exam consisting of a physical examination, thorough reproductive tract examination and semen evaluation including checking motility and morphology of the sperm. Sub-fertile bulls can take 2 or more services to get cows bred while fertile bulls get more cows bred in the first service. Every cycle a cow remains open is 30-40 lbs lost at weaning, so testing bulls and only using fertile bulls helps keep more cows bred and bred early.

Other practices like a controlled breeding season, pregnancy checking and timely culling also contribute to an efficient, productive herd. Providing timely calving assistance reduces impacts of dystocia on future fertility.

Biosecurity Plan

Minimizing exposure from introduced problems is critical. Introducing replacement cattle including bulls at the wrong time can also introduce organisms that cause abortion. Avoiding additions until after cows have calved is the best approach and making sure all new additions are free from infectious disease is critical.

Introducing new additions without any biosecurity measures is a significant threat to herd health and fertility, especially bringing in adult cows and bulls. Virgin heifers and bulls are the lowest risk. However, it is important to have a plan to receive any herd additions. New cattle should be isolated from the herd for 30 days to watch for signs of disease and acclimate to their new surroundings. If possible, it would be best to have a health examination done prior to purchase on all herd replacements or breeding stock if purchased from a known source like a breeder or through private treaty sale. The new additions should be vaccinated, dewormed and poured for lice at this time if not done previously (caution should be used when using modified live vaccines in pregnant cattle with unknown vaccination history) to get them on the same vaccination program as the rest of the herd. If not already tagged, new arrivals can be tagged with their new herd ID and new

records generated to keep track of when they arrived and what treatments they received at that time. Cattle that have clinical symptoms should not be mixed into the general herd. Wait until cattle appear healthy with no obvious problems before mixing in with other cattle.

Buying open, mature cows or used bulls can be very risky. Some of the infectious causes of abortion or fertilization failure in cows may not be apparent but may be present. Some infectious causes of abortion are *Leptosporosis*, *Camplylobacter*, BVD, *Neospora*, *Trichomoniasis* and *anaplasmosis*. Open cows purchased with the intent for breeding should be tested prior to breeding or introducing to the cow herd. It is best to keep these cattle away from the breeding herd until after they are confirmed pregnant. It is a common practice to test all potential embryo transfer recipients for several known causes of infectious reproductive diseases prior to embryo transfer. Using non-virgin bulls from other herds is a risky practice. Non-virgin bulls should have a breeding soundness exam and be tested for *Tritrichomonas foetus* prior to exposing to cows.

Protection through vaccination

Proper vaccination can help build resistance to infection and abortion caused by some common infectious organisms (Chase, 2021). The commonly available vaccines don't protect against all possible infectious causes but do stimulate immune protection against many of the common causes of abortion such as Bovine Herpes virus (IBR), Bovine Viral Diarrhea virus (BVD), campylobacter (vibrio) and Leptospirosis. Proper timing and handling of vaccine is important for vaccine to work as intended. Caution - some modified live virus vaccines can cause abortion if not given according to the label.

Vaccination does not equal protection. When administered properly, under the appropriate conditions, vaccines stimulate effective immunologic resistance to infections in livestock (Richeson, et al, 2019). However, many factors affect the immune response including, age, stage of production, handling and administration of the vaccine, nutritional status, stress, presence of disease, type of vaccine as well as others. Not all vaccines induce the same immune response. Vaccines like killed virus or modified live virus vaccines work differently and require different approaches. For instance, for optimum effectiveness, all killed virus vaccines require an initial or primary dose followed by a booster dose approximately 4 weeks later. Whereas, a modified live virus vaccine may stimulate and effective response in a single dose but it is still recommended to revaccinate all animals 2-3 weeks later to induce a response in animals that may not have responded to the first dose.

There is no one size fits all vaccination strategy (Chase, 2021). Producers are encouraged to work with their herd veterinarian to devise a vaccination plan as part of their overall herd health and reproductive program.

Pregnancy Loss in Cattle

Technically, pregnancy loss in cattle is divided into 3 categories: early embryonic loss (less than 45 days), abortion of the fetus (from 45 days until full term) and stillborn (may be born alive but fails to rise and nurse). While loss at any stage is failure of the cow or heifer to produce a live calf, determining when the loss occurred is important when trying to diagnose the cause because

there are some risk factors that are more specific to each stage of pregnancy while others can cause loss or abortion at any stage.

Pregnancy maintenance requires a healthy dam, properly functioning placental membranes and healthy fetus. If the health or function of any of these are compromised, then the pregnancy may be terminated. The list of things that can cause pregnancy loss is very long. Most producers think of infectious causes (disease caused by an organism like a bacteria or virus) when they think of abortion but other things like toxins, environment, genetic defects, physical trauma, stress or iatrogenic (caused by man) causes can also cause pregnancy loss or contribute to pregnancy loss. Not all infectious organisms are contagious. Some organisms like Leptospirosis and *Listeria* spp can be found in the environment and often affect only one or very few animals. Viruses like BVD or IBR however, can be very contagious and require immediate intervention if they are found in the herd. Abortion from BVD and IBR vaccination are also possible if the vaccine labels are not followed (Chase, et al, 2017).

Non-infectious causes

Non-infectious causes of pregnancy loss include everything else like feed high in nitrates or other toxins, poor nutrition, genetics and environmental causes. Investigating non-infectious causes can be extremely difficult and unrewarding as the variables and factors are many and random (without a pattern).

Genetic Causes

Though it is known to occur the actual incidence of bovine abortion to genetic causes is unknown. Most genetically caused abortions often don't have physically recognizable lesions and it is suspected that most abortions occur in early gestation or result in early embryonic death (EED). Genetic causes could originate from lethal genes inherited from a parent, germline mutations (Reinartz, et al, 2017) or heat induced impacts on gene expression or transcription (Wolfenson and Roth, 2019).

Numerous heritable congenital defects in calves have been described (Whitlock and Coffman, 2015; Wapenaar and Smith, 2019). Conditions such as arthrogryposis multiplex (AM) and neuropathic hydrocephalus (NH) in Angus cattle, osteopetrosis in Red Angus, Hereford and Simmental, pulmonary hypoplasia with anasarca (PHA) and tibial hemimelia (TH) in Maine Anjou and Shorthorn cattle, dwarfism in Dexter cattle, and lastly complex vertebral malformation and bovine leukocyte adhesion deficiency (BLAD) in Holsteins. Some defects may result in calves aborted shortly before full term or born alive but severe malformations leave calves weak and unable to stand or nurse. A brief summary of genetic defects in cattle can be found at https://www.asi.k-state.edu/research-and-extension/beef/agent-resources/docs/gendefects.pdf (2017).

Selective breeding in livestock through the use of artificial insemination not only results in genetic improvement of desirable traits but has also contributed to the increase in deleterious alleles carried by sires of high production traits in Holsteins (Fritz, et al, 2013) and Angus cattle

(Hoff et al, 2017). The extent of the impact on the fertility of livestock is unknown. However, these could contribute to pregnancy loss or infertility observed in specific matings.

Toxins

Exposure to toxins can lead to abortions but frequently other clinical signs accompany or precede abortions. Some toxins may have direct effects on the developing embryo or fetus while others cause abortion indirectly through clinical disease in the dam. Common toxins encountered by cattle grazing or consuming stored feeds include ergot alkaloids from Tall fescue infected with *Neotyphodium coenophialum* or *Claviceps purpurea* that infect cereal grains. Ergot alkaloids cause blood vessel constriction and can reduce blood supply to the uterus and fetus and may also cause uterine contractions and placental separation; aflatoxins produced by *Aspergillus* spp in damaged grains stored in warm conditions; zearalenone (ZEA) and dioxynivalenol (DON) are produced by molds of the *Fusarium* spp. ZEA has estrogenic activity and DON affects rapidly dividing cells in the fetus; phytoestrogens from lush legumes and other forages have been implicated to impair uterine function and pregnancy maintenance through its estrogen like activity (Baughman, 2015; Barry Blakley, Western College of Veterinary Medicine).

Exposure to toxins can be difficult to diagnose. Often analysis of feed samples for mycotoxin levels can be useful. Not all laboratories offer mycotoxin analysis and testing can be expensive.

Environment, Nutrition and Man-made causes

Cattle housed in extensive environments are exposed to numerous stressors and possible factors that could cause abortion. Cows carrying twins often abort late term and may be more sensitive to heat stress. Severe abdominal trauma, severe stress or rough handling of heavy bred cows, transportation, starvation, water deprivation, fetal hyperthermia leading to hypoxia or acidosis, and exposure to toxins such that from petroleum industry may lead to abortion. Sometimes pregnant cows inadvertently receive injections of prostaglandins or corticosteroids which can lead to abortion depending on stage of gestation. (Baumgartner, 2015) It is important to maintain a safe environment. While we can't protect cows 24/7/365, we can guard against common environmental and human oriented risk factors including: provide shade or allow access to trees during times of severe heat stress; design cattle friendly handling facilities and implement low stress handling to avoid rough handling of pregnant cows; and fence off areas of stagnant water, properly store all feeds and control access to toxic plants.

Infectious Causes of Pregnancy Loss

Infectious causes include any bacterial, viral, protozoal or fungal cause of infection and are subdivided into contagious and non-contagious. Contagious causes of infertility like *Bovine Viral Diarrhea virus (BVDv)* or *Infectious Bovine Rhinotracheitis* also known as *Bovine Herpesvirus (IBR or BHV-1)* are spread from animal to animal by direct contact or contact with body secretions or fluids. Non-contagious agents don't transmit through direct contact but require some other means of spreading like contaminated needles, reusing CIDRs, breeding or are picked up from the

environment. While the difference may seem unimportant the effects are significant and management practices needed to prevent or treat an outbreak are quite different.

Table 1. Infectious causes of infertility and abortion in cattle

Bacterial	**Fungal**	**Protozoan**	**Viral**
Campylobacter fetus	*Aspergillus fumigatus*	*Neospora caninum*	*Bovine herpes virus*
Histophilus somnus	*Mucor spp*	*Tritrichomonas fetus*	*Bovine viral diarrhea virus*
Ureaplasma	*Morteriella wolfii*	*Toxoplasma gondii*	*Bluetongue virus*
Brucella abortus		*Anaplasma marginale*	*Epizootic bovine abortion*
Leptospira spp			
Listeria spp			
Chlamydophilia spp			
Salmonella			
Coxiella burnetti			
E coli			

The most common means of transmission for *Campylobacter fetus* (vibrio) infection and *Tritrichomonas fetus* is breeding by an infected bull. *Histophilus* and *Ureaplasma* are common flora of the reproductive tract but under certain conditions can cause infection and abortion. Reusing CIDRs is a risk factor for transferring *ureaplasma* or other pathogens between cows or heifers. Brucellosis, caused by *Brucella abortus,* is mostly eradicated in the US except in areas where there is a significant source of infected wildlife such as elk and bison. *Salmonella, E coli* and any bacterial species circulating in the blood system can cause a placentitis and abortion. Fungal infections from contaminated hay and the environment are common causes of abortion as well as other problems. Cows consume *Listeria* from spoiled hay or haylage and *Leptospirosis* can be acquired from the environment or through breeding. Protozoa like *Neospora* and *Toxoplasma* infect cows if they consume feed contaminated by canine or feline feces. BVD and BHV are highly contagious and passed by direct contact or transmitted by contaminated needles. The most common cause of IBR abortion in cattle is due to vaccination of pregnant naïve cattle with a vaccine containing a modified live IBR virus . Bluetongue virus can also be transmitted by needles or by the bite of a midge. Anaplasmosis can be transmitted by ticks or also by contaminated needles. Some have speculated that anaplasmosis may be the leading infectious cause of abortion in cattle in the Southeast US.

Diagnosis of Pregnancy Loss

Sometimes farmers have open cows at calving time and assume they aborted. However, unless cows were confirmed pregnant, we cannot be sure if the cow experienced abortion or just wasn't pregnant. Obvious signs of abortion include presence of aborted fetus, placental membranes hanging from the vulva or blood-tinged discharge or abnormally enlarged uterus. Many times, producers don't see the aborted fetus or other evidence a cow aborted.

Knowing whether the fetus died in utero or was born alive is helpful. Antepartum (in utero death) is characterized by various stages of autolysis which often noted on histopathology. Grossly, the fetus may have blood tinged fluid accumulation in the thorax and abdomen, soft autolytic kidneys and some degree of brain liquefaction (Holler 2012). Deaths occurring during parturition or immediately following birth display air in the lunges, hemorrhage and possibly edema. Calves that die shortly after birth often have clots in the umbilical vessels and air in the lungs, evidence that they attempted to breathe (Holler 2012).

Diagnostic Samples

Diagnostic samples can help determine the cause of the abortion but many times the cause isn't discovered. In some studies, a definitive diagnosis wasn't found in as many as two thirds or more of the abortion cases submitted to a diagnostic lab (Dohlman, 2016). However, collecting and preserving the right samples can improve the chances of finding a diagnosis. Thorough sample collection involves collecting samples from the aborted fetus and membranes, affected cow and other members of the herd both affected and normal for comparison. Many times the only sample submitted is the fetus. Sometimes, an intact fetus is sufficient but unless the toxin or organism that caused the abortion infected the fetus and is still present it may look normal. Some organisms only infect or affect the placenta so collecting samples from the placenta improves the chances of finding the cause. If possible, it is better to deliver the fetus and placenta to the lab intact and fresh but if that isn't possible then it is important to collect the right samples. Resources are available to advise veterinarians on the best set of samples to collect and appropriate method of submission (See Appendix A) but a call to the lab prior to collecting the samples can also help answer any questions.

Many times farmers want to know if a blood test can help tell what caused the abortion(s). While blood tests can be helpful, interpreting the results can be tricky. Antibodies in the blood only indicate that the animal was vaccinated or exposed to an organism. Measuring levels of antibodies (acute sample) at the time of the abortion and comparing the levels to other normal animals as well comparing them to a second sample collected 30 days later (referred to as the convalescent sample) is most helpful to tell if the exposure occurred about the same time as the abortion. It is important to include the vaccination history as vaccines cause antibody titers and it isn't possible to differentiate vaccination and exposure antibody levels.

Occasionally, abortions may also include calves with congenital defects or weak calves. Congenital defects may be caused by a virus, toxin or a genetic abnormality. Investigating defects is equally complicated (Dittmer and Thompson 2015). However, it can also add more information as some viruses can cause abortion or defects depending on timing of exposure during gestation (Agerholm, 2015). Differentiating between infectious, toxic or genetic causes may be difficult as the initial exposure may have occurred weeks to months in the past and owners may not wish to pursue expensive diagnostic or genetic testing. Genetic testing of adults may miss a condition called germline mutation or gonadal mosaicism where the mutation is actually in the germ cells of one or more gonads of the affected sire or dam. In some cases, genetic causes may be avoidable in the future simply by selecting different bulls to avoid breeding to narrow genetic lines.

What to do with test results

If testing reveals a problem in the herd it is best to work through a plan to eliminate or reduce the threat. Examples are: BVD – test, cull and clear; IBR (BHV-1) – aggressive vaccination program with alternate killed and MLV; Vibrio – only present in natural service – test and treat or cull bulls; *A marginale* – test and control with chlortetracycline in mineral (VFD required); anaplasma is likely in the environment; *Trichomoniasis* – test and cull infected bulls; Lepto – vaccinate and reduce potential reservoirs; treat infected cows with oxytet; *Listeria*, fungus or mycotoxins – manage feed; *Ureaplasma* – health and hygiene; Neospora – test and cull (usually a one-time occurrence).

Summary

Farmers and ranchers often seek advice about testing to determine the cause of a recent abortion. Some pregnancy loss (up to 3 or 5%) is considered normal. Though any loss isn't particularly acceptable it happens, and one abortion isn't cause for alarm. It is however cause for increased attention. One case might be just an odd occurrence or the beginning of an outbreak requiring intervention. A conversation with a diagnostic lab professional can help determine which tests are warranted. Collect all your herd management records and a history as these can be helpful in determining the best course of action.

Pregnancy loss is frustrating. We have waited a whole season for the cow or heifer to calve only to find that she doesn't calve or loses the calf near calving time. Cows that experience abortion should be separated from the herd to reduce the chances of spreading something that could be contagious. A little preparation and prevention can go a long way to avoiding pregnancy loss in cows. And that of course is important; after all, without a live calf, all the work of breeding her was for naught.

References

Agerholm JS, Hewicker-Trautwein M, Peperkamp K and Windsor PA. Virus induced congenital malformations in cattle. Acta Veter Scandi (2015) 57:54

Baughman B. Bovine Abortifacient and Teratogenic Toxins, in Hopper RM (ed) *Bovine Reproduction*, 1st edn, Ames IA, Wiley and Sons, pp 589-608

Baumgartner W. Fetal disease and abortion diagnosis and causes. In Hopper R. editor. Bovine Reproduction. 1st ed. Ames IA. Wiley &Sons, Inc, 2015

Bellows D.S., Ott S.L., Bellows R.A., Review: Cost of Reproductive Diseases and Conditions in Cattle PAS (2002) 18: 26-32

Chase CL. Practical Immunology and beef and dairy vx protocols: Starting from ground zero – what, when and how. AABP Recent Graduate Conference Proceedings (2021) 54:1-18

Chase CL, Fulton RW, O'Toole D, Gillette B, Daly RF, Perry G and Clement T. Bovine herpesvirus 1 modified live virus vaccines for cattle reproduction: Balancing protection with undesired effect. Vet Micro 206 (2017) 69-77

Dittmer KE and Thompson KG. Approach to investigating congenital skeletal abnormalities in livestock. Vet Path 52 (2015) 851-861

Dohlman T. Herd health considerations for maximizing reproductive outcomes. 2016 App Repro Strat Beef Cattle 217-222

Fritz S, A Capitan, A Djari, S C. Rodriguez, A Barbat, A Baur, Ce Grohs, B Weiss, M Boussaha, D Esquerré, C Klopp, D Rocha, D Boichard. 2013 Detection of Haplotypes Associated with Prenatal Death in Dairy Cattle and Identification of Deleterious Mutations in GART, SHBG and SLC37A2 Plos One. doi:10.1371/journal.pone.0065550

Hoff J, J E. Decker, R D. Schnabel and J F. Taylor. 2017. Candidate lethal haplotypes and causal mutations in Angus cattle BMC Genomics 18:799

Holler LD. Ruminant Abortion Diagnostics (2012) VCNA Food Animal Prac 28:407-418

Murray RD. Practical approach to infectious bovine abortion diagnosis, world Buiatrics Congress.

Reinartz S, H Mohwinkel, C Sürie, M Hellige, K Feige, D Eikelberg, A Beineke, J Metzger and Ottmar Distl. Germline mutation within COL2A1 associated with lethal chondrodysplasia in a polled Holstein family (2017) BMC Genomics 18:762-771

Richeson J T, Heather D H, Broadway P R, Carroll J A. Vaccination Management of Beef Cattle. Vet Clin North Am Food Anim Pract. 2019 Nov; 35(3): 575–592

Rush J. Diagnosis of bovine abortion. Proceedings 2018, Georgia Food Animal Conference

Wapenaar W and R Smith. https://www.vetstream.com/treat/bovis/freeform/investigating-abortion-outbreaks (accessed July 18, 2019)

Whitlock BK and EA Coffman. Heritable Congenital Defects in Cattle. in Hopper RM (ed) *Bovine Reproduction*, 1st edn, Ames IA, Wiley and Sons, pp 609-619

Wolfenson D and Z Roth. Impact of heat stress on cow reproduction and fertility. Animal Frontiers, Volume 9, January 2019, Pages 32–38

Appendix A (taken from Holler 2012, VCNA 28:407-418)

Table 2. Samples to submit for ruminant abortion diagnosis

Whole fetus and placenta if proximity to laboratory is convenient; fresh (chilled) not frozen tissue samples, if entire fetus and placenta cannot be submitted:

Fresh[a]		Formalin-fixed[b]		
Lung (anterior lobes)	B, V	Lung	HP	
Kidney	B, V	Kidney	HP	
Liver	V	Liver	HP	
Spleen	V	Spleen	HP	
Heart	V	Heart	HP	
Thyroid gland (ovine)	V	Thyroid (ovine)		HP
Placenta	B, V, M	Placenta		HP
		Skeletal muscle		HP
		Thymus		HP
		Brain	HP	
		Ear notch	IHC	

Abbreviations: B- bacteriology; HP- histopathology; IHC- Immunohistochemistry; M- mycology; V- virology.
[a]Adequate fresh sample should be placed in leak-proof bags and chilled or frozen if delivery is delayed.
[b]Fix in adequate (10x) volume 10% buffered neutral formalin, submit in leak-proof sealed container.

Fetal Fluids: Fetal stomach and bowel contents: collected with sterile syringe and submitted in snap cap tube. Fetal thoracic fluid/heart blood: collect with sterile syringe and submitted in snap cap tube. Ocular fluid for nitrate/nitrite analysis: collect with sterile syringe and submitted in snap cap tube

Maternal blood for serology. Maternal blood can be collected and serum harvested and saved frozen for future use.

Other: feed and water samples