Management of Bovine Reproduction

Kuilei Kramer
Animal Science 450
Fall 2013

Abstract

Having a well-coordinated reproductive program reflects the healthy performance of cattle herds. In most large operations, regular physical examinations are conducted to determine the overall health and proper function of breeding stock, as well as, treating diseases and culling animals with abnormalities and infertility. Cows and heifers are typically assessed via vaginal examination, rectal palpation and ultrasonography of the genital tract. Nutrition can also be applied in that well-portioned consumption of feeds yield greater conception rates and maintain ideal body condition scores. Bulls are more closely evaluated via Breeding Soundness Evaluations (BSE) for physical health, libido, scrotal palpation and measurement, rectal palpation, and semen quality testing.

Artificial insemination (AI) programs rely on the expression of estrus or “heat.” Monitoring for estrous behavior in females requires skilled labor in simply observing them a few times per day prior to the breeding season. The availability of estrus detecting technologies allows more flexibility in knowing how much breeding stock is standing to be bred. If there are females that are still not cycling, then estrus synchronization can be utilized. Prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) injections are commonly given to induce estrus cycling after some number of days and are administered in several different methods.

Diseases that are present within the herd tend to negatively affect reproductive performance, leading to delayed estrus cycling, infertility, and long term subfertility after treatment. Metritis and endometritis are common bacterial infections within the uterine body in postpartum females. Bovine viral diarrhea virus (BVDV) occurs in both male and female cattle causing acute or persistent infections that can be transmitted through infected semen, fomites, and placental membranes.

Introduction

Possessing a fundamental basis of managing bovine reproductive activity is required in both veterinarians and cattle operations. Largely-sized operations overseeing standard or elite status herds utilize reproductive control programs to increase profitability, efficiency and uniformity of the final product. Regular examinations of the breeding stock prior, during or following insemination are able to indicate presence or lack of reproductive soundness, physical deformities, and diseases.

Timing of artificial insemination (AI), or natural service breeding methods is crucial to regulate calving to subsequent estrus cycling intervals. Therefore, knowing when females are in standing heat and using estrus synchronization methods can lead to more uniform conception and calving times between cows.

Many of commonly occurring diseases, such as Leptospirosis, can result in reduced reproductive performance of infected cattle. Abortions, weak or dying calves, conception difficulties, delayed estrus and ovulation, and infertility are all possibilities if not treated as soon as possible. In the end money and time invested into the operation will be wasted, but can be prevented if adequate reproductive programs are upheld.

Female Reproductive Examination

Post-pubertal female cattle should be physically examined to determine the state of general health and presence of disease that could inhibit reproductive performance. Commonly, the examination is conducted after 21 days postpartum or when heifers are ready to be bred (Sheldon et al., 2006). Females that have not conceived after the first insemination should be re-examined 24 days after the end of the voluntary waiting period (Sheldon et al., 2006). The following are typically evaluated: body condition, vaginal examination, transrectal palpation, and ultrasonography of the reproductive tract.

Body condition scoring should be intermediate, not too thin and no too fat. Insufficient adipose tissue for energy mobilization may lead to difficulties in conception and carrying out the gestation to full term, and the possibility of calving problems and very weak offspring. Excess in fats have similar results as being very underweight along with another. Subsequent to parturition depressed appetite may occur, therefore body score will decrease significantly (Sheldon et al., 2006), especially in dairy cows during peak lactation.

Examination of the genital tract via palpation or ultrasound is able to diagnose any infections and pathogens if present. Contents within the vagina, such as mucus, can be inspected for odor, viscosity, and color. Presence of pus would usually indicate the effects of endometritis (LeBlanc et al., 2002). For this particular scenario there is an estimated 44% success rate when using prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) or intrauterine antibiotics over a two-week period (Sheldon and Noakes, 1998). Hence routine examinations by a veterinarian are highly recommended.

Breeding Soundness Evaluation in Bulls

If the option of AI is not available, then natural service from breeding bulls can be utilized. Prior to mating, it is advised to evaluate the selected bulls for any reproductive abnormalities via breeding soundness evaluation (BSE). The assessment includes observation of physical health, libido, testicular size, scrotal circumference, and semen quality (LeaMaster and DuPonte, 2007).
In the physical examination, the bull should walk on a hard, solid surface in order to see any lameness or hoof problems that could negatively affect mounting ability (LeaMaster and DuPonte, 2007). Other things to be aware of include eyesight, presence of disease, and parasites.

Possibly one of the more important and difficult parts of BSE is evaluating libido or sex drive. One way to conduct this is to expose the bull, but restrain it enough to prevent mating to cows, and see any presence or lack of sexual interest. Some studies have reported that libido in a yard test is highly correlated with serving capacity (number of females able to be mounted per bull) in pasture to where almost 10% of bulls could be culled due to inadequate sex drive (LeaMaster and DuPonte, 2007).

Similar to the physical exam, the reproductive organs, such as the penis and scrotum, should be inspected. Any deformations of the glans penis can lead to inability to copulate. Common abnormalities when palpating the scrotum include small or soft testicles, differences in size of testes, scrotal hernia, dermatitis, cryptorchids, and palpable epididymal conditions (LeaMaster and DuPonte, 2007). Circumference measurement of the scrotum indicates fertility and amount of sperm that can be produced. A larger circumference indicates a larger quantity of semen and therefore, a higher chance in healthy, motile spermatozoa. Bulls with above average scrotal size, especially in beef cattle, have shown to sire heifers that reach puberty at an earlier age than average (LeaMaster and DuPonte, 2007). To evaluate the inner reproductive organs, a veterinarian can perform a rectal palpation (similar to a prostate exam given to humans), to feel the prostate, the pelvic urethra, vesicular glands, ampullae, vas deferens, and internal inguinal rings (LeaMaster and DuPonte, 2007). Common abnormalities of these include seminal vesiculitis.

Lastly, semen inspection is conducted for quality and motility of spermatozoa. Assessment of volume, concentration, and percentage alive are no longer valid as scoring criteria due to low correlation with fertility and poor consistency with multiple collections (LeaMaster and DuPonte, 2007).

Typically, it is advised to perform a BSE before the start of the breeding season. Any bull that has been observed with a defect or inability to mate can be immediately culled from the herd. However obtaining one or more replacement bulls may take time that could possibly cut into the breeding season. This also depends on when evaluations were conducted and availability of desirable sires. Another time, but relatively uncommon for BSE’s, is during the actual season. Semen collection during this period can show if the bull has an adequate spermatogenesis rate while mating the herd (LeaMaster and DuPonte, 2007). Any decrease in semen quality would indicate overuse and the bull would need to rest and/or be replaced. Examinations, however, can be held at any time when necessary.

### Nutrition

The quality and diversity of nutrients consumed by cows and heifers reflect their time of coming into puberty, estrus, ovulation and conception rates. Energy in the diet is one of the most important nutrients for cattle during the early postpartum period. Lactation requires a large amount of energy resources, especially in dairy breeds. Grains and concentrates are needed to maintain body condition. High-yield milk-producing cows tend to be in a negative energy balance state longer than less productive cows (Beever et al., 2001). This period can last up to 20 weeks in some postpartum cows (Beever et al., 2001).

Various hormones can be assessed from peripheral blood samples collected from cows in the negative balance state. Non-essential fatty acids (NEFA), β-hydroxy butyrate (BHB), glucose, insulin and insulin-like growth factor-1 (IGF-1) are measured to determine metabolic and fertility status (Kruip et al., 1998; O’Callaghan et al., 2001). Concentrations of NEFA and BHB indicate the amount of tissue being mobilized for energy production and are indirectly associated with fertility (Sheldon et al., 2006). Glucose, insulin, and IGF-1, on the other hand, influence reproductive function by acting on the ovaries, brain, and tubular genital tract (Wathes et al., 1998; Beam and Butler, 1999).

Urea is also measured as a metabolic parameter. When protein is broken down in the rumen, urea is produced. Thus, a high consumption of protein causes increased urea concentrations. Butler et al. (1996) observed cattle with 20% decreased pregnancy rates when blood urea concentrations were more than 7 mmol/L at the time of insemination. Elevated urea can also lead to excess ammonia, which may negatively affect oocyte and early embryo development (McEvoy et al., 1997).

### Estrus Detection

Near initiation of the breeding season, cows and heifers must be receptive to mounting by experiencing estrus. Estrus or “heat,” starts once at puberty and proceeds in a continuous cycle every 21 days on average with the actual estrous period lasting for a few days or so. However heifers experiencing their first cycle may stay in estrus for only one day or less, and not being receptive to mounting or having their first ovulation.

Potentially estrous females should be visually observed 2 to 3 times daily to see which can be bred (DuPonte, 2007). The most common behaviors expressed are mounting, standing to be mounted, and increased vocalization and activity. Physical indicators consist of having a swollen vulva that is slightly reddened and secreting mucus discharge. The mucus should be colorless, opaque, and should have a thick viscosity (DuPonte, 2007).

Estrus can be detected by simply observing specific cues in the herd. If this method cannot be done, there are several standing heat detector programs that...
can be implemented. Steers (castrated bulls) can be equipped with a marker halter device strapped to the chin. When the bull successfully mounts, the chin-ball marker will activate and paint marks will appear on the left side of the female’s back (DuPonte, 2007).

Adhesive heat pads are plastic detectors that are glued on the high spot in between the hipbones along the vertebrae. The cow must be ridden for at least 3 seconds in order to trigger the mechanism, causing a visual change or audible signal to be emitted (DuPonte, 2007). This particular method is not recommended when animals are out on pasture with low-lying trees or structures. An example of an adhesive heat pad is HeatWatch. This device uses the pressure pad as stated before, but also consists of radio telemetry that emits a signal to a computer when activated (Sheldon et al., 2006). KaMaR and Bovine Beacon are similar types of pads that turn color from white to red when triggered from persistent pressure (Sheldon et al., 2006).

**Estrus Synchronization**

Estrus synchronization is a reproductive program that utilizes techniques involving drugs, which suppress estrus for a certain period of time and then re-express estrus-inducing hormones. In other words, all synchronized females will come into heat, conceive, and give birth at relatively equal intervals. Natural methods that do not normally use injections exist; however, we will only talk about common drug-related methods that AI-based cattle operations typically use. The more common drugs involve prostaglandin F$_{2\alpha}$ (PGF$_{2\alpha}$). PGF$_{2\alpha}$ is a lipid compound that plays various roles in the body, such as increasing blood pressure. More importantly, it takes part in luteolysis of corpora lutea in the ovaries. After the antral follicle releases the oocyte during ovulation, the follicle becomes a corpus luteum (yellow body), which secretes the pregnancy maintenance hormone, progesterone. Injection of PGF$_{2\alpha}$ causes luteolysis and regresses the corpus luteum so that estrogen can continue to be released for the estrus cycle after some number of days.

Administration of prostaglandin drugs are intramuscular and should be given deep in the neck area (DuPonte and Lee, 2007) in order to avoid residue accumulation in high-value carcass cuts. The correct amount of PGF$_{2\alpha}$ should be given based on criteria stated in the instructions given with a long needle, such as 18-gauge (DuPonte and Lee, 2007).

The one-shot PGF$_{2\alpha}$ method, by its name, consists of just one injection. At the start of breeding from days 1 to 5, only females that are in estrus are to be mated or inseminated as normally done. If animals are still not displaying signs of receptivity subsequent to day 6, PGF$_{2\alpha}$ can be administered. By day 11 a high percentage of the PGF$_{2\alpha}$ cows should be cycling and can be bred (DuPonte and Lee, 2007). This procedure is based on the assumption that the herd is in adequate health. If less than 25% were able to be bred by day 6, then PGF$_{2\alpha}$ should not be given, as this could be a problem with animals coming into estrus (DuPonte and Lee, 2007). Subpar quality nutrition or presence of reproductive diseases is most likely the cause of cycling difficulties.

Modified two-shot PGF$_{2\alpha}$ involves two events of injections: the first on day 1 and the second on day 13. During the 13-day waiting period, the herd should be turned out to good quality pastures to maintain health and normal cyclicity (DuPonte and Lee, 2007). Originally the unmodified version required the second injection to be on day 11 rather than 13. However Deutscher (1990) stated that delaying the second shot results in a higher percentage of females coming into estrus. The regression of highly matured corpora lutea can cause increased receptive behaviors.

The controlled internal drug releasing (CIDR) device method incorporates a progestin implant with a plastic vaginal applicator that is inserted inside females on day 1. Then on day 6, all cows and heifers are administered with PGF$_{2\alpha}$. On day 7 the implants are removed from the vagina and animals are monitored for signs of estrus. Females will usually exhibit standing heat within 24 to 72 hours after injection (DuPonte and Lee, 2007). Anestrous and pre-pubertal females that take part in this method will cycle and come into puberty respectively from the progestin implant. Thus it is normal to see an approximate 10% increase of cattle experiencing sexual behaviors (DuPonte and Lee, 2007). But remember that young heifers first coming into their cycles may not be able to ovulate or carry out gestation without difficulties.

Comparing and contrasting between the three different techniques the one-shot method has the lowest drug expense, but in turn, requires almost three times as much skilled labor than the others (DuPonte and Lee, 2007). One-shot can also be flexible if less than 25% of the herd is not observed to have cycled before PGF$_{2\alpha}$ injection.

An advantage of the modified two-shot method is that the skilled labor is far less than that is required in one-shot. However, this takes the longest amount of time spent to complete (17 days) due to the waiting period between the first and second injections. In addition cows and heifers that are still not found to be cycling, especially after the second PGF$_{2\alpha}$ shot, will greatly increase costs (DuPonte and Lee, 2007).

Lastly, the CIDR method is the most expensive of the three methods, but involves the shortest amount of completion time and least amount of skill. The progestin implant is also able to induce estrus in non-cycling females, as well as bringing young heifers into puberty (DuPonte and Lee, 2007).
Clinical Diseases

In contrast to the vaginal environment, the uterine environment is maintained sterile and highly protected from pathogens. However immediately after parturition, invasive microorganisms are able to enter the reproductive tract in higher numbers, resulting in increased risk of infection. As stated earlier, it is important to evaluate breeding cows so that any diseases present can be treated.

Postpartum cows suffering from bacterial inflammatory reactions may have metritis. All layers of the uterus: endometrium, submucosa, muscularis and serosa, are severely inflamed (BonDurant, 1999). Up to the first 10 days cows experience high fevers (39.5°C or more). Odoruous pus-filled discharge may be secreted from the vulva due to delayed uterine involution (Sheldon et al., 2006). Treatment is usually done by administering parenteral antibiotics, such as oxytetracycline or cephalosporins. Although oxytetracycline is widely used, it is not the optimal path for treatment as bacterial resistance and high minimum inhibitory concentrations exist (Sheldon et al., 2004).

Endometritis is similar to metritis, but specifically affects the endometrial layer of the uterus. Inflammation and vaginal pus are noted from persistent pathogenic bacteria for more than 3 weeks postpartum. Incidence of this infection is approximately 10 to 20% of dairy cattle (LeBlanc et al., 2002). If not immediately treated, endometritis can result in infertility throughout the period of infection and even subfertility after eradication of the pathogens (Sheldon et al., 2006).

Reproductive soundness can also be influenced by the presence of a virus. Occurring in both male and female cattle, the bovine viral diarrhea virus (BVDV) is one of the most serious reproductive pathogens worldwide (Fray et al., 2000). The virus exists in two types: non-cytopathogenic (NCP) and cytopathogenic (CP). The more common type is NCP as it is able to cross the placenta in BVDV-positive mothers, which can cause constant infection to the offspring. The CP type is unable to cause lifelong infections in calves (Brownlie et al., 1989), but can be derived from mutations of NCP viruses (Donis, 1995). The virus, regardless of type, is transmitted via contact with acutely infected cattle, fomites, bovine sera, rectal examination, infected semen, and contaminated vaccines (Nettleton and Entrican, 1995). In summation, BVDV is able to detrimentally affect the fertility and reproductive performance of host animals, especially those that are persistently infected (PI).

Viral bulls particularly in AI semen distribution companies must be dealt with care. PI bulls are still capable of producing semen of acceptable quality (Bielanski and Loewen, 1994), but are often associated with less than ideal fertility in most cases (Fray et al., 2000), such as abnormal morphologies and decreased motility in spermatozoa (Rerell et al., 1988). Offspring of these sires are not always guaranteed to be clinically infected, but have a high risk of becoming PI hosts (Fray et al., 2000).

Cows and heifers infected shed the virus throughout their entire reproductive tract: layers of the uterus, placental membranes, oviducts (Booth et al., 1995), and the ovaries. Within the ovaries, Fray et al. (1998) reported that viral samples have been found in the interstitial, luteal, granulosal and thecal cells, and also in the follicular fluid. Infection during the time prior to ovulation reduces follicular growth rates (Fray et al., 1999). Females that have been treated with hormones that induce superovulation (more than one oocyte released) are not necessarily affected in regards to follicle growth (Kafi et al., 1997). However, quality of embryos and number of ovulations subsequent to superovulation are greatly decreased (Kafi et al., 1997).

It is still not fully understood how BVDV influences ovarian function, but there are three possible modes of action that could explain this. The first being that the pituitary gland within the brain is infected with the virus; thus rendering it unable to provide sufficient gonadotrophic support for normal ovulation (Anderson et al., 1987). The next idea suggests that since estradiol levels in plasma have been seen to reduce during infection; estrus cycling and ovulation cannot occur or function properly (Fray et al., 1999). The third is in regards to acute infections and states the possibility of reduced leukocytes in the ovaries, which help maintain normal follicle activity, due to the insufficient number of blood leukocytes (Adashi, 1990).

Conclusion

Planning and holding cattle examinations prior to the breeding season opens a large window of preparation. There will be times when the breeding stock will need to be replaced or treated for ailments in order to carry out functioning reproductive cycles. Efficient estrus detection can be time-consuming and may sometimes require a bit more effort than what is typically expected. When dealing with estrus synchronization, economic projections must be taken into account, as these can be futile and unnecessarily expensive if poor nutrition, disease, and the like are prevalent. However, cattle herds can become highly valuable in relation to efficiency and profitability as long as proper management within the operation is continually regulated.
Works Cited


