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REPRODUCTION ON THE RANCH

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INTRODUCTION

It is generally acknowledged that reproductive parameters are the most important components of a profitable beef operation. Research in beef cattle reproduction has led to a number of management strategies, each of which could improve efficiency of production and profitability. However, to make good decisions regarding applicability of these strategies to a specific operation requires a thorough cost:benefit:feasability analysis. Whether a strategy is appropriate for a given enterprise will be determined by the goals of the owner/manager and the human, animal, land and fiscal resources available. The following are a few of the most important considerations when making decisions regarding management of the reproductive process on a ranch.

REPRODUCTION IS THE MOST IMPORTANT TRAIT

Traits associated with reproduction have about five times more economic value to commercial beef cattle production than do those associated with calf growth or production of the milk by the cow (Trenkle and Willham, 1977). Increasing reproductive efficiency reduces the cost of production by spreading the expense of the cowherd over more product units (i.e. calves). For example, a 5% increase in calf crop for a herd of 300 cows results in 15 more calves. Total expenses remain relatively constant whether there is an 85% or 90% calf crop, and net profit is affected accordingly. Alternatively, a 5% increase in calf crop means that the same level of calf production could be maintained with 15 fewer cows; expense of the cowherd is reduced, causing profit margin to be increased. Reproductive traits such as the number of cows that become pregnant during the breeding season, percentage calf crop weaned and interval from calving until the cow becomes pregnant should be managed to insure enterprise profitability. A small investment in improving reproductive performance will likely have a higher rate of return than investment in any other aspect of the beef production process.

The economic value of reproductive traits lies both in the number of calves produced and in the overall stability of the cow herd. Cows that fail to become pregnant each year are not profitable because of a lack of production and/or the cost of purchasing replacements or raising replacements. Income from culled cows offset only about 60% of the expense of their replacements, resulting in decreased profitability (Werth et al., 1991). Increasing the reproductive success of cows prolongs their life in the herd and reduces the number of replacements needed, resulting in increased profit.

Genetics account for less than 10% of the variation in reproduction. Thus, minimal gains in reproductive efficiency can be made by selection. An exception is that cows can be selected for increased twining rate (Gregory et al., 1990), which results in increased pounds of calf produced, but those gains may be offset by the increased management challenges. In contrast, reproductive efficiency responds rapidly to changes in environment and/or management. However, managing for maximum reproduction does not necessarily insure maximum net profit. For example, there usually is a positive net return on investment for the additional cost of feed per cow to increase calf crop from 80% to 90%, but this may not be true when increasing calf crop from 90% to 95%. Individual beef cow operations must balance the expense associated with a given management practice with the economic benefit.

HEIFER DEVELOPMENT AND MANAGEMENT

Careful management of replacement heifers is critical for successful reproduction as they have a longer interval from calving to estrus than mature cows. Therefore, if first-calf heifers calve 2-3 weeks before the older cows, they have extra time to return to estrus during that critical first year. Heifers should conceive by approximately 14 months of age if they are to calve as two-year olds. Breeding heifers on their pubertal estrus with artificial insemination should be avoided, as it is about 20% less fertile (Byerley et al., 1987). The goal for management is to have heifers actively cycling 1-3 months before the breeding season. To make sure that heifers reach puberty early, they need to be in an environment that allows growth rates appropriate for reaching puberty by 13-14 months of age. Heifers fed to have faster rates of growth after weaning are younger at puberty, and also have increased pregnancy rates as two year olds (Patterson et al., 1999). The goal of production is to push the first calf heifers to reach puberty as soon as possible in order for them to breed and begin to provide a return on investment. However, each operation must make the economic decisions of pushing those females hard enough with extra nutrition to breed early versus allowing them to mature at their own rate on minimal supplementation at least cost and not breeding them until they are older. We can expect heifers to begin cycling when they reach 60 to 75% of their mature body weight (Patterson et al., 1992). First-calf heifers have the most difficulty becoming pregnant. Because they are not fully mature, some nutrients are partitioned for growth, which decreases nutrients available to support reproduction. Thus, feeding additional supplement to first-calf heifers can increase the percent in estrus and conception rates (Spitzer et al., 1995; Vizcarra et al., 1998).

The added nutritional cost of developing heifers to breed early is a factor for management to consider when making production decisions. Another factor to consider is the potential for decreased milk production in heifers that are pushed too hard. Heifers should not gain more than 2 lb/d in order to minimize fat deposition. Higher rates of gain will result in large amounts of fat storage in mammary tissue. Fat stores in the mammary tissue inhibit milk production in that tissue over the life of the cow. A stair-step increase in feeding can be used to regulate early growth and maximize growth later before breeding. Adding an ionophore, such as monensin, to the ration can also increase growth and hasten the onset of puberty (Patterson et al., 1992). Ionophores repartition energy from the feed to minimize fat deposition and increase feed efficiency. When the heifers are bred, the plane of nutrition can be scaled back to minimize costs but continue growth through the time of calving.

It is important to shorten the calving season of two-year olds in order to reduce labor costs during calving and to increase the percentage exhibiting estrous cycles at the start of the breeding season. Estrus synchronization is often used to insure a "tight" calving season for first-calf heifers whether they are bred using and AI or natural service. Synchronization of estrus in beef heifers has been reviewed extensively (Patterson et al., 2003), and most protocols use $PGF_{2\alpha}$ in combination with gonadotropin releasing hormone (GnRH) and(or) progestins such as melengestrol acetate (MGA) or an intravaginal progesterone releasing device (CIDR). Using estrus synchronization protocols that include a progestin can induce puberty in some heifers (Patterson et al., 1992; 1999). In one study, puberty was induced in 55% of heifers treated with a CIDR (Rasby et al., 1998). Progestins also increase synchrony of estrus (Lucy et al., 2001), which shortens the subsequent calving season. When using these synchronization protocols, management must perform artificial insemination or insure adequate bull numbers in order to service the majority of the females being in estrus simultaneously.

Breeding yearling heifers by AI provides an opportunity to decrease dystocia by using bulls with highly accurate EPD's for low birth weight. However, even when using the right bulls and having large framed heifers, dystocia is always a possibility. First-calf heifers usually have less milk production than mature cows so it is important to select bulls that in addition to low birth weights, have higher than average growth traits to compensate for the limited milk production. Semen is available from bulls of several breeds that have a low EPD for birth weight and good EPD's for weaning and yearling weight.

In order for first calf heifers to return to estrus in time to stay on schedule with the rest of the cow herd, they should be at 80 – 85% of mature body weight and in a body condition score of at least 6.5 at the time of calving. This breeding will be the most difficult time to get that female rebred during her lifetime. The number of first-calf heifers in estrus during the breeding season can be increased by removal of calves for 48 hours (Bell et al., 1998). This removal creates a feedback response from lactation in the heifer which will stimulate cyclicity. Similarly, when calves are permanently weaned from first-calf heifers after 6-8 weeks, they gain BCS and have a greater chance to become pregnant during the breeding season. In one study, weaning calves from first-calf heifers at 6-8 weeks increased the number of cows exhibiting estrus during the first 20 days of the breeding season by as much as 25% (Bell et al., 1998). In another study, weaning calves at 6 to 8 weeks from first-calf heifers that were in thin condition resulted in a 56% increase in the number of heifers with ovarian activity by 85 days after calving (Lusby et al., 1981). Interval from calving to conception was decreased, and pregnancy rates during the breeding season were increased by 37% (Lusby et al., 1981). However, the effect of early weaning of calves on subsequent udder development and lactations needs to be evaluated before recommending widespread adoption of this procedure.

The key to getting first calf heifers bred back in time to stay on schedule with the rest of the herd is nutrition. The heifer's body condition must be closely monitored during the months prior to calving. If heifers are too thin at calving, it will be an uphill battle to get them bred. Conversely, if the heifers are in a body condition score of 6.5, then the opportunity for that heifer to remain productive in the herd is greater. Under extreme environmental conditions, heifers may require supplementation to maintain body condition during lactation.

FACTORS AFFECTING REPRODUCTION IN MATURE COWS

Genetic Effects of Heterosis

The effects of heterosis from crossbreeding have been well documented for production traits. Heterosis will increase birth weights, growth weights, and finished weights in beef animals. Heterosis also has an effect on reproduction through the maternal side of the production operation.

Many types of breeding rotations have been tested for beef cattle production in an effort to maintain a high level of heterosis. Heterosis for reproductive traits is 10 to 30% (Table 1) for the cow. However, heritability of that higher level of performance is very low. If heterosis is high for a trait, then heritability is usually low and vice versa.

Table 1. Summary of Total Heterosis by Type of Trait

Trait	Heritability	Total heterosis
Carcass measurements Skeletal measurements Mature weight	High	Low (0 to 5%)
Growth rate Early weights Milk production	Med	Med (5 to 10%)
Maternal ability Reproduction Health Cow longevity Overall productivity	Low	High (10 to 30%)

Kress, Don D. and M. D. MacNeil. 1999

When making management decisions in a crossbreeding program, it is important to know the level of heterosis that can be expected (Table 2). Some traits will be influenced by heterosis by both the calf and the cow. Therefore, total expected heterosis from a crossbreeding system for that trait will be the sum of the two contributions.

There are two traits in beef cattle that are profoundly affected by heterosis. By using crossbred cows, cow longevity can be increased 38% which increases cow lifetime productivity increase of 25% (Table 2). The ability for the cow to produce 2 – 3 more calves in her lifetime will have a positive effect on profitability especially when spread across the entire herd.

Few studies have attempted to evaluate the economic impact of heterosis. Kress and MacNeil (1999) attempted to summarize the effects of heterosis and determine economic impact.

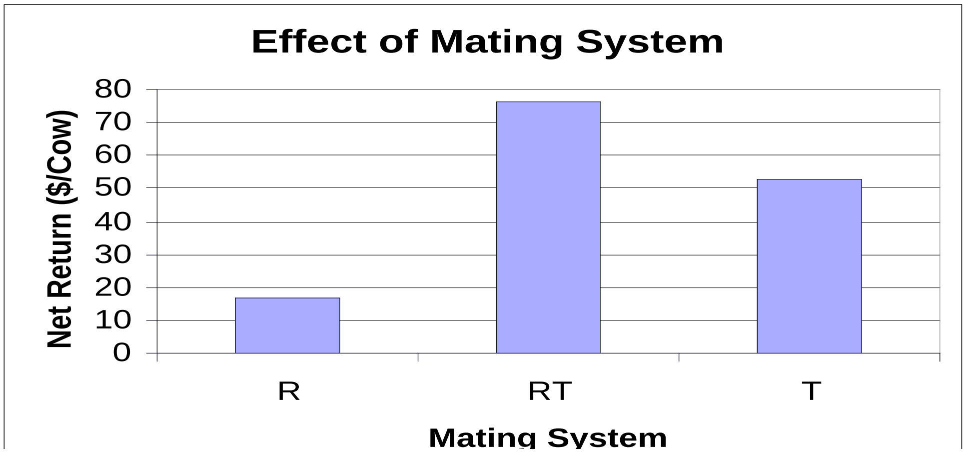
Table 2. Average Levels of Heterosis for Traits of Beef Cattle

Trait	**Total heterosis, %**
Cow milk production	9
Calf wn. wt./cow exposed[a]	18
Cow forage intake	2
Cow efficiency	2
Cow-calf TDN consumed	3
Calf wn. wt./cow wt.	8
Cow longevity	38
Cow lifetime productivity	25

Adapted from Kress, Don D. and M. D. MacNeil. 1999

Figure 1 shows the results from research that compared different types of crossbreeding systems for maximum net return per cow. The results are based upon slaughter of the progeny, and all
costs associated with the cow, including opportunity costs. Relative to a straight-bred system, the rotational system increased net return by $19/cow, the rotational terminal sire system improved net return by $76/cow, and the static terminal sire system improved net return by $56/cow (Figure 2).

Characteristics of a cow herd can be changed rapidly through crossbreeding, but producers must be aware that biggest is not always best, especially in the West. Carefully monitoring the “fit” of the cow to the environment is required. In low feed situations, heterosis tends to be larger and the risk associated with making the incorrect choice of cow biological type is greater. A successful crossbreeding program requires careful planning and breed selection.



Adapted from Kress, Don D. and M. D. MacNeil. 1999

Figure 1. Effect of mating system (R=3-breed rotation, RT=2-breed rotational terminal sire, and T=static terminal sire) on net return per cow.

Breeding Season

Limiting the length of the breeding season is primarily to establish defined calving seasons. By adjusting the time of breeding, producers can match the period of maximum nutritional
requirement of the cow with the time of maximum nutrient production by the environment. With a fixed breeding season, calves are of similar size, weight, and age at weaning, and can be managed and marketed more efficiently. The breeding season can be altered to take advantage of seasonal markets and provide a larger number of more uniformly sized calves. Furthermore, using a fixed breeding season assures a larger number of uniform heifers that should have similar age and weight at puberty as potential replacement heifers. Using a limited breeding season also provides defined checkpoints for productivity during growth and reproductive cycles (Larsen et al., 1994). Management procedures such as weaning, vaccination, and pregnancy diagnosis can be performed at specific times for the entire herd. This can help identify fertility problems, improve culling decisions, and help determine the number of replacement heifers needed.

Long breeding seasons perpetuate poor reproductive performance and decrease cow herd productivity (Wiltbank, 1970). Extending the breeding season allows cows that continually have long postpartum intervals and become pregnant later in the breeding season to remain in the herd. This in turn increases the number of calves born late in the calving season, which will be younger and lighter at weaning. Cows that become pregnant late in the breeding season will usually continue to breed and calve late and are at greater risk of not becoming pregnant and being culled.

In a 5-year study in Nebraska, crossbred cows were managed to have a breeding season of 30, 45, or 70 days (Deutscher et al., 1991). In addition, breeding seasons were initiated early (May 20) to have cows calve beginning March 1 or late (June 20) to have cows calve beginning April 1. Average pregnancy rate of the early and late groups during the 30-day breeding season was 83.9%, which was less than the average pregnancy rate of the 45- and 70-day breeding seasons. Pregnancy rates for the 45-day breeding season (86.8% and 91.6% for early and late groups, respectively) were not lower than those for the 70-day breeding season (94.6 % and 93.4% for early and late groups, respectively). Available resources, management practices, culling and replacement rates, cattle prices and marketing options are some of the factors that must be considered when establishing the calving season Many producers have opted to leave bulls in longer and requiring veterinarians to determine gestation length through palpation or ultrasonography. Cows that are late breeders can then be marketed as bred cows rather than cull cows.

Calve to Match Forage Availability

Maximum biological efficiency is achieved by manipulating the breeding, and thus calving seasons, so that peak nutrient demand of the cow is matched with peak forage production. Deviating very far from this principle increases feed costs and may have negative consequences for reproduction. The first 45-60 days of lactation is the time of production with the maximum nutritional requirements. Matching this nutritional demand with the time when the environment will be providing the most nutritional opportunities (spring) will result in less condition loss in the cow, faster gain in the calves, and increase the likelihood of getting the cow bred back in a fixed breeding season.

Seed stock producers may want to calve a month or two earlier than optimum forage availability to have bulls ready for sale before the breeding season of their customers. Commercial producers that retain ownership through the finishing phase may be able to take advantage of higher fed cattle prices in March and April if they calve cows a month or two earlier than the appearance of green grass. However, any premiums will have to be greater than the additional nutritional costs required to sustain milk production of the cows and to get them to breed back. In the West, the timing of grazing permits on Federal lands and the problems associated with predators often motivate producers to calve earlier, despite the increase of feed costs.

Postpartum Interval

Nutrition and suckling are the major negative factors regulating the postpartum anestrous interval (Short et al., 1990). Proper nutritional management has a profound positive effect on postpartum interval.

The body condition score (BCS) system is one of the best tools for assessing the nutritional status of a cow (Figure 2). The BCS system uses visual and tactile appraisal of the amount of fat at the vertebral process, ribs, and pin bones, and is a good estimate of the amount of carcass fat or body energy reserves of cows and heifers. The BCS system for beef cattle is based on a nine-point scale, with 1 being emaciated and 9 being obese. Interval to first estrus decreases as BCS at calving increases (Richards et al., 1986).

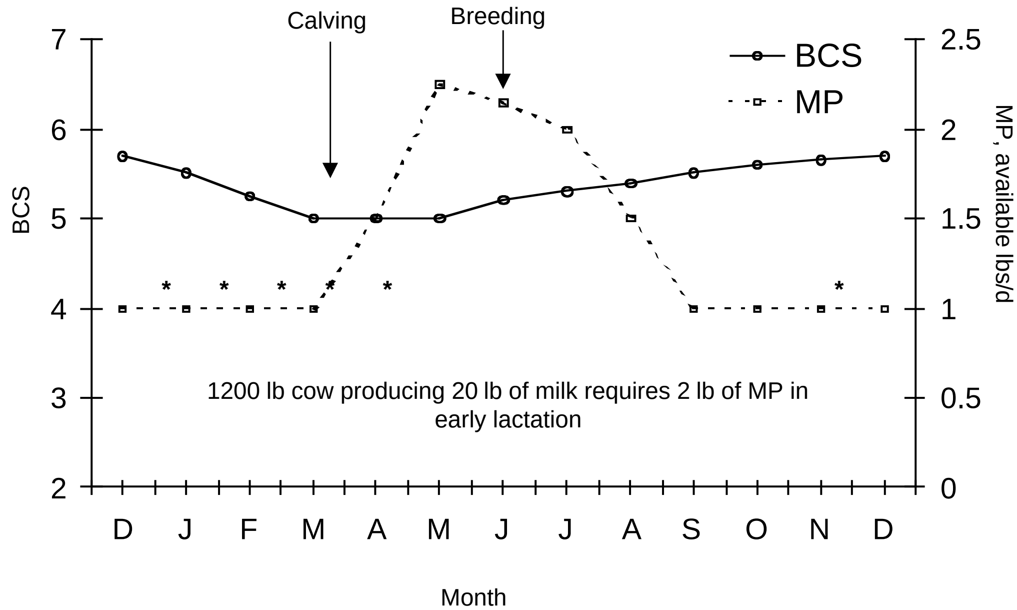


Figure 2. Changes in amount of metabolizable protein (MP) supplied by native range and body condition score (BCS) throughout the year. Asterisks indicate when supplement is fed. Source, R. P. Wettemann.

Average interval to first estrus is approximately 60 days for cows calving with a BCS 5, and usually is around 50 days for cows with a BCS 6. First calf heifers should calve with a BCS 6 and typically do not return to estrus for approximately 80 days after calving (DeRouen et al., 1994).

Body condition score at calving is a good predictor of subsequent pregnancy rate in beef cows. When cows calve with a BCS 5 or greater, more cows exhibit estrus during the breeding season, pregnancy rates are increased, cows become pregnant earlier in the breeding season, and require fewer services per conception, resulting in older, heavier calves at weaning (Wiltbank et al., 1962; Selk et al., 1988). Pregnancy rates for cows calving with a BCS 5 or greater range from 85-90%, but decreases to approximately 65% for cows with a BCS 4 with a breeding season of 60 days or less (Selk et al., 1988). Pregnancy rates for cows with a BCS 7 or more are not increased significantly compared with those of cows with BCS 5 or 6.

Feeding additional supplement to cows that are thin (BCS 4) at calving can improve pregnancy rates 15-20% (Richards et al., 1986), although they typically will still be less than for cows with a BCS 5 (Vizcarra et al., 1998). A cow's body weight must change approximately 75 pounds to lose or gain one BCS, making it difficult and very expensive to increase the BCS in lactating cows between the time of calving and breeding. Therefore, it is easiest to increase BCS of thin cows during the 60 days before calving. Cows with a BCS 5 or greater have only minimal increases in pregnancy rates when fed additional supplement after calving, so cows with a BCS <5 should be fed separately.

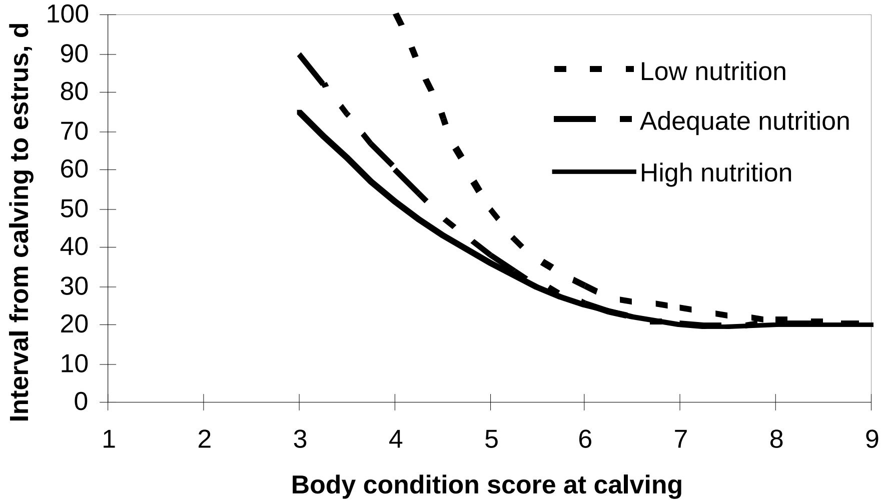


Figure 3. Effects of body condition score at calving and level of postpartum nutrition on the postpartum anestrus interval (adapted from Short et al., 1990).

It is thought that “priming” the reproductive system with progesterone is critical for initiating normal reproductive cycles. Treating with progestins can induce estrous cycles (Patterson et al., 1989; Fike et al., 1997). Using a CIDR, in conjunction with PGF2 (Lucy et al., 2001) or GnRH plus PGF2 (Lamb et al., 2001), increased the percentage of non-cycling cows exhibiting estrus cycles, and that became pregnant during the breeding season. However, pregnancy rates will not be as high as that for cows that were having estrous cycles before synchronization (Lucy et al., 2001).

Artificial Insemination and Estrus Synchronization

Artificial Insemination (AI) is a powerful technology for genetic improvement, yet, only 5 to 10% of calves born to beef cattle in the United States are sired via AI (USDA, 1997). However, recent advances in estrus synchronization and fixed time insemination can reduce the time and labor required for AI.

The benefits of an AI program for reproduction are due primarily to estrus synchronization. There are three main benefits in terms of reproduction; 1) the percentage of cows conceiving early in the breeding season is increased resulting in older, heavier calves at the next weaning; 2) increased synchrony of conception shortens the subsequent calving season and allows cows more time to return to estrus the next year; 3) pregnancy rates of cows that calve late are increased. These same benefits can be achieved using estrus synchronization with natural service. Using protocols with progestins and GnRH allow producers to eliminate estrus detection and use fixed time AI with good success (Patterson et al., 2003) and will improve synchrony of estrus and increase pregnancy rates compared with protocols that use only PGF2α (Patterson et al., 2003). Cows must have a cycling ovary for PGF2α to be used for synchronization of estrus. It will not induce estrous cycles. Estrus synchronization can reduce the time and labor required for AI by 47% (Loseke et al., 1990), and can decrease the total time required to check pregnant cows the next year by shortening the calving season.

Most financial analyses indicate that including labor, cost per AI pregnancy is similar to that of natural service pregnancy. Loseke et al. (1990) evaluated seven different systems of AI with various herd sizes, and compared their cost to the cost of natural service. Cost for AI systems per pregnancy ranged from $0.30 to $11 over natural service. Hogan (1998) determined that cost per AI pregnancy was less expensive than natural service when purchase price of bulls that would service cows for 5 years was greater than $2500.

The decision for using AI is operation based. Each enterprise must determine if the added management of using AI will be overcome by increased returns at the market.

BREEDING SOUNDNESS EXAMS FOR HERD SIRES

In contrast to the large effort to insure maximum fertility of cows, surprisingly little attention is paid to fertility of the bulls. Lameness, poor semen, or other factors can reduce a bull's ability to breed cows. By performing a breeding soundness exam (BSE) before each breeding season, fertility of herd sires can be accurately determined. Bulls are evaluated on a physical examination, scrotal circumference, sperm motility, and sperm morphology, to classify their potential reproductive performance into one of three classifications: satisfactory, classification deferred, or unsatisfactory.

Both scrotal circumference and semen quality positively influence fertility. In one study, cows were mated to bulls with at least 80% normal sperm morphology or to bulls that had not been tested (Wiltbank and Parish, 1986). Pregnancy rates were 93% and 87%, respectively. On average, pregnancy rates can be increased 6-10% by using bulls that pass a BSE compared to bulls of questionable or unknown classification. Based on increased pregnancy rates, every $1 invested in BSE yields a potential return of $17 (Chenoweth, 2000). A BSE is one of the best investments to increase the reproductive rates of a commercial beef cattle operation.

Cows mated to bulls that pass a BSE are more likely to become pregnant at first service, resulting in older heavier calves at weaning. Because bulls that pass a BSE have greater fertility, the bull to cow ratio can often be decreased. Commercial cattle producers typically use a bull-to-cow ratio of 1:25 (Chenoweth, 2000). Bull-to-female ratios of 1:40 and 1:60 during the breeding season have been used without a decrease in calving rate (Rupp et al., 1977; Neville et al., 1979). Decreasing the bull-to-cow ratio from 1:25 to 1:50 means that half as many herd sires are needed to service the same number of cows, resulting in decreased expense of purchasing and maintaining bulls. However, the ratio may need to be increased if the herd is maintained in rugged terrain, or if more than 25-30 estrus-synchronized cows are to be bred simultaneously (Healy et al., 1993).

Breeding soundness exams have other economic benefits. Bulls that have larger scrotal circumference, a component of BSE, sire calves that reach puberty at a younger age. Reduced age at puberty has been associated with increased fertility during a cow's lifetime resulting in more calves produced and decreased annual replacement costs (Brinks, 1994). Thus using bulls that have passed a BSE has both immediate and long-term advantages in herd fertility and profitability.

Finally, during a BSE, steps can be taken to diagnose and confirm clinical ailments that can potentially cause the loss of an entire calf crop. Samples to detect *Trichomonas fetus*, a parasite that causes infertility, can be taken during a BSE. Such a test is required by law in several states when non-virgin bulls are sold for breeding purposes. Penile and preputial diseases as well as seminal vesiculitis, which results in pus in the semen, can also be diagnosed during a BSE.

Breeding soundness exams are a vital management tool for maintaining reproductive soundness in bulls.

THE FUTURE

New reproductive procedures and technologies are being continually being developed and/or improved. For example, procedures for cloning animals are becoming more common. However, there is no apparent routine application in a commercial beef operation for this very expensive technology. Methods to synchronize ovulation, rather than estrus, to allow timed insemination of beef cows are being improved, but routine application of this technology for cows with calves also is unlikely in most operations.

The technology that has the most potential to improve reproductive performance in beef cattle is the use of "sexed" semen for production of replacement heifers. It is now possible to sort sperm on the basis of whether they contain the X (females) or Y (males) sex chromosome. Of the thousands of calves born as a result of AI with sexed semen, approximately 90% are the predicted sex. One of the most perplexing problems for a beef producer is how to match his cow with his environment and still maintain growth rates and carcass qualities desired by the feedlot and the consumer in the calves. The result usually is a compromise as cow size increases and fertility rates decrease as feedlot performance increases or vice versa. When sexed semen becomes routinely available, it will be possible to breed replacement heifers with X-bearing semen to produce more replacement heifers. This allows the development and maintenance of a cow herd with excellent foraging, reproductive and maternal characteristics which can then be bred to a terminal cross sire to improve feedlot and carcass characteristics. This approach has a number of advantages: 1) If you have a carefully thought out breeding program and are making genetic improvement, your best genetics should be in your replacement heifers. Breeding them to produce the next set of replacement heifers should speed up genetic progress. 2) Heifer calves weigh approximately 6 pounds less than bull calves at birth, thus you do not have to make as many genetic sacrifices to breed to low birth weight bulls. 3) This approach allows the rancher to better match his cow herd to the environment and should, therefore, reduce operating costs.

There may also be a negative impact if "sexed" semen becomes routinely available at an appropriate price. It is possible that up to half of the 11 million dairy cows in the country would be bred to have a beef/dairy crossbred bull calf which may impact the beef market.

SUMMARY RECOMMENDATIONS

1. Before using any procedure to modify reproductive performance, be certain that use of the procedure will advance your goals and fit with available resources.
2. A well designed crossbreeding program results in increased conception rates, calf survival, weaning weight, reproductive performance and longevity, which result in increased lifetime productivity and profits.
3. In general, beef heifers should be bred before the cow herd to maximize their chances of rebreeding as first-calf heifers and remaining in the herd.
4. The calving/breeding season should be limited and, in most cases, matched to the available forage.
5. In special cases, treatments for synchronization of estrus can induce puberty an/or post-partum estrous cycles and enhance reproductive performance.
6. Breeding Soundness Exams for bulls is a key strategy to increase reproductive performance and reduce costs in nearly all cow herds.

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