REPLACEMENT FEMALE STRATEGIES
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Introduction

Most beef operations are reliant on the generation of replacement heifers. Replacement heifers are intended to replace old or non-productive cows, incorporate new and hopefully improved genetics into the herd, and be productive females as young cows and then subsequently deliver several more generations of calves. Thus, there are both short-term and long-term objectives when selecting and developing replacement beef heifers. As such, implementing proper selection criteria, growth and developmental strategies, health and nutritional management, and breeding programs for replacement beef heifers are essential to meet both short-term and long-term objectives of the operation. From a short-term standpoint, retaining and developing a replacement heifer represents a considerable investment. Failing to properly develop a young female may limit her ability to reach puberty, conceive, and calf. In addition, improper development can impede her ability to stay in the herd for more than a few years and impact her progenies performance. From a long-term perspective, the future genetic make-up of the cowherd is contingent on the decisions made when selecting and developing the replacement heifers. Thus, the genetic composition and production traits of the beef herd for the next seven to ten years is derived from heifer selection done today. This article focuses on targeted breeding systems to yield potential replacements, selection of replacements, and management practices and nutritional delivery for developing replacement beef heifers.

Breed and Sire Selection

To be the most effective, heifer selection decisions should be made prior to the birth of the eventual replacement heifers. This involves selecting the breed of the replacement heifer as well as the sire. Although most beef producers have established the breed(s) of cattle that they prefer and believe are the best suited for their environment, management, and marketing plans; careful considerations should be made on the ultimate genetic make-up of the eventual replacement heifers. Moreover, the intent of this article is not to argue over which cattle breeds are superior. Rather, recognize that progressive cattlemen should use foresight to select breeds and/or selected matings that have the potential to deliver genetically superior replacement heifers. Included in this foresight is the argument that most commercial cow/calf producers would benefit from using crossbred rather than purebred beef cows. As will be indicated in data presented below, the long-term impacts of implementing a crossbreeding program are substantial. For producers not currently utilizing crossbred cows, initiating a crossbreeding program into the herd through strategic cow matings to deliver crossbred replacement heifers is recommended.

Crossbreeding offers two distinct advantages, 1) heterosis (hybrid vigor), which is the superiority in performance of the crossbred animal compared to the average of the purebred parents, and 2) using complementary breeds and combining strengths of the various breeds that make up the cross. As it relates to replacement heifers, crossbreeding may offer specific advantages to the heifer and her ability to reach puberty and her lifetime productivity in the cowherd. An approach to reduce the age of puberty of replacement heifers is crossbreeding with another breed that has a similar or younger age at puberty. Therefore, utilizing hybrid vigor results in a replacement heifer that is anticipated to reach puberty at a younger age and lesser body weight than the average of her parents. Perhaps a greater advantage of crossbreeding is realized in the mature cowherd. Studies conducted at Purdue University (Stewart and Martin, 1981) in Angus, Shorthorn, and Angus x Shorthorn crossbreds demonstrated that, due to hybrid vigor, during their lifetime the crossbred Angus x Shorthorn cows had 0.9 more calves, yielded 506 more pounds of weaning weight, and averaged approximately 64 more pounds of calf at weaning each year than the purebred cows. Similar lifetime productivity advantages of crossbred cows over purebred cows have been demonstrated by researchers at the USDA Experiment Station in Clay Center, NE (Table 1; Cundiff and Gregory, 1999). Thus, by utilizing an appropriate crossbreeding system, beef producers can
reduce the age at puberty of their replacement heifers and subsequently expect greater lifetime performance of these crossbred females when they enter the cowherd.

The greatest advancement in genetic improvements in a beef herd begins with sire selection for generating replacement females. The replacement heifers in a beef operation should represent the best and most advanced genetics in the cowherd. Without this approach, little genetic improvement is made. With such an impact that sire selection can have on a beef operation, it is important that producers are utilizing the best available tools for selecting sires to generate replacement heifers. The tool most readily available to assist with genetic evaluation is Expected Progeny Differences (EPDs), which are designed to assist the producer in predicting the performance of the future offspring.

When using EPDs to assist with sire selection it is advisable to follow these recommendations: 1) Traits of economic importance should be prioritized and based on management practices and marketing plans of the specific herd; 2) The traits selected and level of the traits should be matched to the nutritional resources available and the environment. For example, selecting a sire with high milk EPD may not be a prudent choice if the nutritional resources are not available for that heifer to achieve this level of milk production; 3) Strive towards optimization rather than maximization. In other words, don’t select a sire base only on him excelling in one trait (i.e. birth weight) but rather select a better-rounded sire that has above average numbers for multiple traits of importance. A few EPDs to pay close attention to when selecting a sire to generate replacement heifers include maternal traits such as Milk, Birth Weight, Calving Ease, and Calving Ease Maternal as well as Docility and Scrotal Circumference.

**Birth to Weaning Management**

Once breeding is accomplished the next managerial step in replacement heifer development is the period from birth to weaning. Although this period is often overlooked when developing beef heifers, poor management during this period of development can have dire consequences. The first step in management at this stage has nothing to do with the heifer calf itself, but rather her mother. Try to ensure that cows delivering the potential replacement female heifer calves are in adequate body condition score (BCS; 1 = emaciated, 9 = obese) at the time of calving. Cows should be between a 5 and 6 BCS at calving. Failing to have cows at least a 5 BCS will result in reduced colostrum production and reduced colostrum quality. Without adequate colostrum to provide the required antibodies and immunity to disease, the newborn heifer is already off to a poor start. In addition, cows in adequate BCS also produce more milk than thin cows, thus increase growth rate of their calves.

At birth, calves should be identified through ear tagging and dam, birth date and birth weight recorded for future reference. Not knowing dam, sire, birth date, and birth weight limits the ability to make managerial decisions. Also having this information allows for more appropriate heifer selection criteria to be used and more efficient identification of unproductive older cows for culling. At calving replacement heifers should not be administered a growth promoting implant. Furthermore, although some growth promoting implants are approved for use in older replacement heifers, due to the potential risk of lessened fertility, it is a general recommendation to not implant potential replacement heifers at any age. In addition, producers should work with their local veterinarians to develop a herd vaccination program specific to their location and diseases prevalent.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Observed Improvement</th>
<th>% Heterosis</th>
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</thead>
<tbody>
<tr>
<td>Calving rate, %</td>
<td>3.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Survival to weaning, %</td>
<td>0.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Birth weight, lb.</td>
<td>1.6</td>
<td>1.8</td>
</tr>
<tr>
<td>Weaning weight, lb.</td>
<td>18.0</td>
<td>3.9</td>
</tr>
<tr>
<td>Longevity, yr.</td>
<td>1.36</td>
<td>16.2</td>
</tr>
<tr>
<td><strong>Cow Lifetime Production:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of calves</td>
<td>.97</td>
<td>17.0</td>
</tr>
<tr>
<td>Cumulative weaning wt., lb.</td>
<td>600</td>
<td>25.3</td>
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Adapted from Cundiff and Gregory, 1999 & S. P. Greiner, Virginia Tech Cooperative Extension Publication 400-803
Pre-weaning growth rate is important to sexual maturation and attainment of puberty in beef heifers. It has been demonstrated that pre-weaning average daily gain (ADG) has a more consistent impact on age at puberty in beef heifers than post-weaning ADG (Wiltbank et al., 1966) and that heifers with greater pre-weaning body weights tend to reach puberty at an earlier age (Arije and Wiltbank, 1971). Additionally, Buskirk et al. (1995) reported the probability of beef heifers reaching puberty is positively influenced by weaning weight in addition to post-weaning gains. Other research has also demonstrated that strategies that indirectly increased early growth performance (prior to 7 mo of age) reduced age at puberty in heifers (Mejia et al., 1999; Lacau-Mengido et al., 2000; Madgwick et al., 2005). Without question pre-weaning growth impacts subsequent sexual development, however the constraint is how to effectively manage this at the farm. The best managerial strategy is to ensure the cows nursing the potential replacement heifers are adequately fed, thus allowing them to produce adequate milk for calf growth. Another potential strategy is creep feeding. Creep feeding has an inherent risk however, in that providing excess nutrition during early life may impair mammary gland development through promotion of fat deposition and negatively impact milk production as a mature cow (Hixon et al., 1982). This is most evident in early maturing British breeds. For later maturing and larger-framed Continental breeds, creep feeding may not as drastically impact maternal performance (Friedrich et al., 1975). Thus breed composition and aggressiveness of creep feeding program must be considered before implementing such a program.

Heifer Selection at Weaning

At weaning several criteria exist for selecting those heifers that should be specifically developed and kept as replacement females. In general it is advisable to keep 10 to 25% more heifers than ultimately needed. This allows subsequent culling of heifers that fail to perform during later stages of development, accounts for potential death loss, and unfortunately not all heifers developed will conceive and become pregnant. Avoid freemartins, or a heifer calf that was a twin to a bull calf. Greater than 90% of the time, the female in a male-female twin scenario will be infertile. Also, cull heifers that are not structurally sound, do not appear to have strong maternal characteristics, had extreme birth weights, those that were born to unproductive cows, and those that have a history of health issues.

The key is to select heifers that have the greatest probability to reach puberty on time, conceive, produce calves that perform, and are able to remain in the cowherd for numerous years. In general, select heifer calves that have the greatest actual weaning weights and are the oldest at weaning. Using actual weaning weight rather than 205-adjusted weaning weight provides a more accurate reflection of weight gain needed prior to breeding. Selecting the heifers that are oldest at weaning means she will be older at breeding, which is critical as age at puberty is determined by age and weight. Also, being born early in the calving season potential provides some indication of her potential fertility as her dam conceived early in the breeding season. Although selecting the heaviest and oldest at weaning may be a ‘general recommendation’, individual animal characteristics as well as desired future herd composition must also be considered. At times, the heaviest heifers at weaning may be overly fat and/or exhibit “bullish” characteristics, both traits that are not desirable in replacement heifers. In addition, if a producer wants to reduce mature cow size, selecting the heaviest and/or largest framed heifers at weaning may not be the prudent choice. In such instances, producer may consider selecting heifers that fall within a previously established 205-day weaning weight ratio, thereby not selecting the heaviest but heifers that still had greater weaning weights than the herd average.

Weaning to Breeding Management

Once heifers are selected at weaning, the most intensive management portion of heifer development begins. A goal of heifer development is to nutritionally manage heifers in a manner that allows them to reach puberty by 12 to 13 months of age, thereby allowing them to conceive by 15 months of age and calve at 24 months of age. It has been demonstrated that heifers that have more estrous cycles prior to the start of the breeding season
have a greater opportunity to conceive early in the breeding season (Byerley et al., 1987). Developing heifers so that they conceive early in the breeding season and subsequently calve early in the calving season is critical for heifer longevity in the herd as well as the performance of her progeny in subsequent generations. A recent report by Kill et al. (2012) demonstrates the importance of early conception in beef heifers. This study evaluated the longevity data of over 2,100 heifers on South Dakota ranches and longevity and weaning weight data on 16,549 individual heifers (data gathered for 20 years) at the U.S. Meat Animal Research Center (USMARC). In both scenarios, heifers were classified as calving in either the first 21 days (day 1 to 21) of the calving season, second 21 days (day 22 to 42) of the calving season, or greater than 42 days after the start of the calving season. The results clearly demonstrated from both South Dakota and USMARC (Figure 1; Kill et al., 2012) that heifers that calve later at their first calving fail to remain in the herd as long as heifers that calve earlier at their first calving.

Similarly, when weaning weights of calves were evaluated at USMARC, weaning weights of calves from cows calving later at their first calving were less (P < 0.05) compared to heifers calving earlier at their first calving and this significant difference in weight was observed for their first 5 calves (Figure 2; Kill et al., 2012). The reason for these observations can be explained. If a heifer conceives late and subsequently calves late, she has less time from calving until the start of the subsequent breeding season, she is more likely to be anestrus, or not having estrous cycles, at the start of breeding, will likely then conceive late again in the second breeding season, and the cycle continues to repeat until eventually she fails to conceive in a confined breeding period and is culled from the herd. Likewise, her calf will continually be the youngest calves at weaning and hence the lightest given that age at weaning has the greatest influence on weaning weight.

To ensure the heifers conceive early in the breeding season, heifers must reach puberty prior to the beginning of the breeding season. Attainment of puberty is a function of both age and weight with the underlying influence of genetics (breed variations). Although breeds of cattle vary in their approximate age at puberty, most Bos taurus breeds used in the mid-west are capable of reaching puberty by 15 months of age given that proper nutrition is provided. This is another advantage of crossbred females, as their age at puberty is less than the average of the purebreds that make up the cross. Age plays a critical role in puberty attainment, hence the desire to select heifers that are older than the herd average at weaning. Nutrition and growth performance is the aspect of puberty most influenced by post-weaning management. The question is: how much must a heifer weigh at breeding to ensure she has attained puberty? The general rule for heifer development is that at breeding, heifers should weigh approximately 65% of their estimated mature cow weight. As such, if a producer has moderate-framed cows with an average cow weight of 1250 lbs., at breeding heifers should weigh 813 lbs. If the cows are larger-framed and mature cow weight averages 1400 lbs, heifers should weigh 910 lbs. at breeding. The growth curve by which the heifers reach their target weight at breeding does not impact their ability to
attain puberty as long as the target weight is achieved (Figure 3; Clanton et al., 1983; Lynch et al., 1997; Freely et al., 2001). Slow growth followed by a period of rapid growth and compensatory gain is an effective method of heifer development and has been demonstrated to be the most cost-effective method. However, such an approach does have a risk. If an unexpected event occurs during the rapid growth period (examples include a late spring snow storm or disease outbreak) that limits feed intake or growth rate, the target weight may not be achieved, thus negatively impacting heifer performance. Likewise, rapidly growing the heifers and then slowing growth rate and “holding them back” is also acceptable. However, with this strategy producers run the risk of over-finishing the heifers and having them overly fat at breeding. Excessive fat deposition is unwanted and has the potential to negatively impact reproductive performance. A linear growth rate may be the easiest to accomplish. By knowing weaning weights, date of initiation of the anticipated breeding season, and target weights required, the average daily gain required by the heifers to reach their target can be derived. For example, if average weaning weight was 550 lb. on October 10, the breeding season is anticipated to begin on May 15 (218 days), and the target weight to reach 65% of estimated mature body weight was 813 lb. (equation: (813-550)/218); heifer would have to gain 1.2 lbs. per day. With this information and diet can be designed to achieve this weight gain.

Regardless of the strategy chosen for growth rate in heifers from weaning to breeding an additional problem exists: not all heifers will have the same weaning weights. The question then become, what weaning weight do I use to figure the required gains to reach the target weight? If you use the average weight at weaning to calculate the required average daily gain, half of the heifers will be over the target weight and overly condition, while the other half will fail to meet the target. To avoid this dilemma, it is advisable, when possible, to split heifers into multiple groups. By splitting heifers in to a heavy and light group (or more groups if capable), producers can specifically design diets and deliver feed for each group independently, and reaching the target weight for each heifer will be easier to achieve.

Breeding and Post-Breeding Management

It is advisable to begin the breeding season for replacement heifers two or three weeks prior to the start of the breeding season of the mature cows. This allows more time after calving for the first-calf heifers to reinitiate having estrous cycles thus increasing their likelihood of getting pregnant in the subsequent breeding season. At calving, heifers should be approximately 85% of their estimated mature body weight and in a body condition score of 5.5 to 6. Be cautious not to have them overly fat as this can increase the incidence of calving difficulties.

A complete other article could be written on reproductive management of heifers at breeding that discusses the advantages of estrous synchronization and artificial insemination (AI). In brief, both reproductive management technologies offer numerous advantages. Estrous synchronization allows producers to get more heifers bred in the earlier part of the breeding season, which as discussed above has numerous benefits. In addition, many of the estrous synchronization protocols available include a progestin, a hormone that will stimulate pre-pubertal heifers to attain puberty. Thus, further assisting more heifers to get pregnant sooner in the breeding season. Using AI allows producers to select genetically superior bulls that are proven to have low birth weights and calving ease, traits important in bulls used to breed heifers. In addition, there are several AI sires that provide
exceptional calving ease genetics but still retain tremendous growth potential in their progeny.

At the start of the breeding season, producer must be cognizant of sudden nutritional changes that the heifers may be experiencing. In many instances, heifers are developed in a dry-lot environment. Once breeding season arrives, often heifers are immediately sent to pasture either following AI or just let out with herd bulls. This creates two potential problems. First, the nutritional difference in the dry-lot diet and the forage available may be considerably. Second, heifers that have been in the dry-lot are not accustom to eating grass. Both scenarios often cause a period of weight loss and or change in nutritional metabolites that can negatively impact reproductive performance (Perry et al., 2009; S. Lake, University of Wyoming & R. Lemenager, Purdue University, Unpublished). Therefore, if developing heifers in a dry-lot scenario, try to avoid over-feeding concentrates and rather use a forage-based diet. If a high-concentrate diet is used during heifer development, once heifers are moved to pasture continue moderate supplementation until heifers adapt to the pasture diet.

**Take Home Message**

Heifer selection and development is critical for the future productivity of beef operations. Moreover, it is an expensive aspect of beef production and thus should be critically managed. Heifer development should not begin at weaning of the heifers or even at birth of the potential replacement but rather the breeding season before when sires are selected. For commercial cattlemen there are definite advantages to developing breeding systems to deliver crossbred females. Once the heifer calf is born, the actual management of that specific female begins. Every aspect of her development, including pre-weaning management, post-weaning growth and development, breeding, and post-breeding management can impact her ability to conceive, maintain a pregnancy, deliver a live calf, and her longevity in the herd. The importance of heifers reaching puberty prior to the start of the breeding season thus increasing their probability of conceiving early in the breeding season cannot be overly stressed. Failing to meet the target weights and failing to properly manage the heifer so she can conceive in the first 21 days of the breeding season drastically impedes her longevity in the herd and the performance of her subsequent progeny for generations to come. Proper heifer development is therefore setting the stage for the future productivity of the cowherd.

**References**

Driftless Region Beef Conference 2013

*Beef Cow Symposium*. Paper 263.
