BEEF

Chapter 2

Selection and Management of Heifers and Young Cows

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Introduction

Proper development of beef heifers is an important component of the profitability of a cow-calf operation. It can take the net revenue from 6 calves to cover the costs associated with development of one replacement heifer (Perry et al., 2012). Maximum lifetime productivity is obtained when heifers calve by 24 months of age (Núñez-Dominguez et al., 1991). Many factors go in to planning replacement heifer selection and development, including selecting the right genetics for the cow herd; considerations of individual heifer selection, such as structure and temperament; profitability of raising your own replacements versus buying new animals; and nutritional strategies leading up to and following the first breeding.

Genetics

Beef cattle producers are presented with 3 opportunities to utilize genetic information to assist in making selection decisions that will impact their herd for years to come. The first is the selection of sires to produce the replacement heifers; the second is the selection of the replacement heifers from their contemporaries; and the third is the selection of sires to be mated to the replacement heifers.

Sire Selection

When a commercial cow-calf operation decides to generate their own replacement females, over 85% of the genetic progress of the cow herd is contributed by the last three sires in the pedigree. As such, selecting sires that are the most appropriate for a given production system is essential to the profitability of the operation. Economically relevant traits such as frame size, growth, and milking ability should be carefully prioritized based on the environment and available feed resources. For example, large-framed, heavy-milking females may not be the most appropriate, or profitable, in a semi-arid environment where grazing resources are limited (e.g., western South Dakota and eastern Colorado). On the other hand, where ample feed resources exist, the added weight of the calves produced by larger-framed, heavy-milking females may more than offset the cost of the feed, thereby making the system more profitable.

Key Points

- All genetic improvement programs should be part of the replacement heifer selection process, selection of sires to produce the replacement females, and selection of the bulls to be bred to heifers (e.g., calving ease).
- The decision to buy or raise replacement heifers has ramifications on resource utilization, cost of production, and ultimately the success of the business.
- Heifer development programs need to be planned around the goal of obtaining pregnancy no later than 15 months of age. This should be done in a manner that makes the best use of available feed and labor resources. This can be accomplished through steady gain programs or development strategies that take advantage of low cost feeds early in development, followed by feeding heifers so they are on a positive plain of nutrition in the last 60-90 days of the feeding regimen and throughout the breeding season (e.g., stair-step).

Key Points, *continued*

- Heifers need to stay on a good plane of nutrition up to their second calving. Heifers and first parity cows are still growing and their nutrient requirements are higher than mature cows. Feeding heifers and young cows separately from the older cowherd allows for improved management.
- Recent research indicates that nutrition of the dam during pregnancy can affect the reproductive performance of her female offspring.

There are certain traits that should be considered when selecting sires, regardless of the production system. Survey data from the USDA Animal and Plant Health Inspection Service indicates that 25.7% of the calf death loss before three weeks of age and 17.3% of breeding cattle death losses can be attributed to calving related problems (USDA-APHIS, 2010). Consequently, selection of sires that will minimize dystocia (i.e., calving problems) is imperative. This is true not only of sires used to produce replacement females, but also of the sires used to breed first-calf heifers. The potential to cause dystocia cannot be accurately or reliably evaluated visually. Producers should utilize expected progeny differences (EPDs) to select sires. The various causes of dystocia can be broadly categorized into two groups: 1) factors that affect the size or shape of the calf and 2) factors that affect the ability of the dam to give birth (Anderson, 2012).

Since EPDs are based upon real-world observations of large number of animals, they are always the best estimate of the individual's value as a parent given the information currently available. Depending on the breed, there are EPDs available for calving ease direct and calving ease maternal that can be utilized to evaluate a sire's genetic potential for unassisted births. Calving ease direct refers to a percentage of unassisted births when sires are mated to first calf heifers. Calving ease maternal refers to a percentage of unassisted birth among daughters as first calf heifers. Calving ease direct should be considered for all sires and calving ease maternal is important when the intent is to retain replacement heifers. When the breed of interest does not calculate or publish calving ease EPDs, the next best alternative is to select bulls with low birth weight EPDs. However, if both calving ease and birth weight EPDs are available, calving ease should be used in lieu of birth weight. With that said, when using natural service, it is often difficult to procure sires with high accuracies for calving traits. Under these circumstances, selecting bulls with favorable EPDs for calving ease direct and sired by high accuracy calving ease sires is the next best alternative.

Accuracy of the EPDs should be used as a risk management tool. Accuracy is a numerical indication that ranges from 0 to 1 which conveys the level of confidence for the EPD as reported by the breed association. The higher the accuracy, or closer to 1, the more reliable the reported EPD of that animal. Genomic data may also be available to assist in the evaluation of calving ease, and in some cases, genomic data has been incorporated into genomic-enhanced EPDs published by breed associations. Genomic data relies on the previously known relationships between changes in DNA and production traits.

Another trait that is beneficial regardless of the production system is scrotal circumference. It would seem that scrotal circumference would only affect bull fertility; however, evidence suggests it may also be correlated with age at puberty in heifers. Although the correlation appears to be small, data suggests that heifers sired by bulls with larger scrotal circumference may reach puberty at an earlier age (Martínez-Velázquez et al., 2003). Consequently, they could be bred sooner and have a greater likelihood of becoming pregnant during their second breeding season.

Docility, historically considered a convenience trait, has been determined to have economic value to the beef production system. Calves that were more docile in the feedlot grew faster, were healthier, and had higher quality grades at slaughter (Busby et al., 2005). Docility is known to have relatively high heritability and thus could have a significant impact on the bottom line for several years. Use of highly docile sires increases the likelihood that the females they produce will be docile as brood cows and that the steers and non-replacement heifers will be docile in the feedlot. Several breed associations have developed EPDs for docility to help facilitate the selection process.

A final consideration when selecting sires for the production of replacement females is the benefits of crossbreeding. In general, reducing the replacement rate of a cow herd can result in increased profitability because of the added pounds of calf available for sale from older cows. It has also been shown time and time again that reproductive performance (i.e., % calf crop weaned) is the most important factor influencing production efficiency. Unfortunately, most reproductive traits are lowly heritable and consequently are difficult to select for. However, traits that are lowly heritable generally respond quite well to heterosis. Crossbreeding also reduces the accumulation of deleterious DNA mutations within the herd and a good example of this is crossbreeding to eliminate curly calf syndrome (i.e., arthrogryposis multiplex). As such, crossbreeding is one of the best ways to improve the reproductive performance and longevity of the cow herd.

Selecting Replacement Heifers

Regardless of whether the replacement heifers are raised or purchased, selecting the right females for a given production system is key to long-term productivity. When selecting replacement heifers, numerous traits should be considered.

As mentioned previously, reproductive efficiency is paramount to profitability in a beef production system. Crossbreeding to produce the replacements is an effective method to improve reproductive efficiency. Pre-breeding reproductive tract scores are one way to estimate which females reproductively fit before the start of the breeding season. With that said, genomic data may be available to assist with the selection of heifers based on reproduction. The American Angus Association recently began publishing a genomic-enhanced EPD for heifer pregnancy. As technology develops and more populations of cattle are sampled, it is likely that more data such as this will become available. There are also some factors that producers can evaluate as early as calving. For example, it has been shown that heifers born early in the calving season tend to calve earlier themselves (Funston et al., 2012a). Heifers born early in the calving season are also heavier at weaning, are more likely to be pubertal at an earlier date. They also wean heavier calves through the first six calving seasons and are more likely to be in the herd after the fifth calving season (Cushman et al., 2013).Calving time is also a great time to evaluate the vigor of the heifer as a calf, the maternal instinct of her dam, and the milking ability and udder quality of her dam.

Weaning time is the next critical time to evaluate potential replacement heifers. Adjusted 205-day weaning weights can be utilized to compare the growth performance of a group of contemporaries. However, caution should be exercised when selecting for greater weaning weight. Weaning weight is influenced by maternal milk production and is highly correlated with mature cow size. Over time, selecting for greater weaning weights may result in an increase in average milk production and frame size of the cow herd. It is absolutely essential to monitor these traits and to insure that the milking ability and physical size of the cowherd fit the environment and feed resources available in the given production system. Utilizing terminal sires (i.e., bulls from which no replacement heifers will be retained) from Continental breeds in the cow herd is one way of achieving heavier weaning weights without increasing maternal milking ability.

Carcass traits can also be evaluated at weaning or shortly thereafter. Nearly every breed association publishes carcass EPDs and carcass EPDs are available on crossbred cattle. Genomic data can also be utilized to assist with the evaluation of carcass merit. Finally, as the heifers become yearlings, their actual carcass merit can be determined via ultrasound. Once again, it is important for producers to determine the importance of selecting for carcass traits in their production and marketing system.

In addition to the selection traits for which data exists, it is essential to assess the physical attributes of the heifers. Replacement females should have fleshing ability (ability to maintain body condition), body capacity, and be structurally sound. Furthermore, since the heifers will be contributing half of the genetics to their offspring that are fed for slaughter, muscling is important. However, caution should be exercised when selecting for muscling. Females that are heavy-muscled and lean tend to not breed as well as those that are of average to above average in muscling and in good body condition. Finally, given the number of genetic abnormalities in various beef breeds, it is important for producers to be cognizant of the status of their females as homozygotes or heterozygotes for each relevant defect. In many cases, the status can be determined by pedigree. In other instances, it will be essential to collect a DNA sample and submit it for testing to determine the status of a given animal.

Buying vs Raising Replacements

The age-old question on whether to buy or raise replacement heifers has caused the demise of untold numbers of trees and pencil lead. Unfortunately, there is no easy answer. This decision has tremendous ramifications on resource utilization, cost of production, and ultimately the success of the business. According to Schulz and Gunn (2014), several factors should be considered when determining the optimal strategy. They include:

- Interest rates on savings and other uses of capital
- Interest rates on borrowed capital
- Cash flow needs
- Labor availability and costs
- Relative price difference between cull cows and heifer calves
- Reproductive rates
- Forced culling rates
- Environmental restrictions on growth to weaning
- Genetic improvement potential and/or maintaining a desired genetic base
- Ensuring the heifer population will thrive in a given environment
- Price and availability of bred replacement heifers
- Tax implications

Although evaluation of each of these factors can be complex, it may very well affect profitability of the operation on an annual basis. As such, Schulz and Gunn (2014) suggest that producers should remain flexible and capable of modifying their herd replacement strategy on an annual basis.

There are advantages and disadvantages to both methods of procuring replacement females. Producers have greater genetic control over retained replacements and they have a complete understanding of the background and health status of the heifers. Purchasing replacement heifers may increase resource flexibility and allow producers to incorporate females into their herds that are genetically superior to what they could raise. Purchasing replacements would also allow for more rapid herd expansion should it be desired. For many producers the question ultimately comes down to cost. Which method is cheaper will vary from situation to situation and potentially from year to year. Utilization of partial budget analysis can help producers identify and compare their cost of production for raised replacement females and the costs associated with purchasing replacement females.

Nutritional development programs

Heifer development programs need to be planned around the goal of obtaining pregnancy no later than 15 months of age while minimizing feed costs. Heifer replacement costs affect the overall profitability of beef cattle operations and minimizing feed input costs to a heifer development program can improve financial viability. Other than opportunity cost, the greatest cost in developing heifers is for feed during the growing phase from weaning to breeding (Dhuyvetter and Lardy, 1999). Drylot feed costs can represent over 40% of total costs over the year period.

To start, post-weaning nutritional management programs need to consider nutritional status of heifer calves at weaning. Preweaning rate of gain has been shown to strongly influence age at puberty (Wiltbank et al., 1966; Arije and Wiltbank, 1971; Gasser et al., 2006). The main goal of a heifer development program is to have heifers reach puberty before breeding. Several studies have shown that a heifer that has at least three estrus cycles before breeding will be more likely to breed in the first 21 days of the breeding season (Byerley et al., 1987; Vraspir et al., 2013). Data in Table 1 shows that heifers that were pubertal at the beginning of the breeding season were heavier and had increased overall pregnancy rates compared with heifers that had not reached puberty by this time.

Table 1: Effect of pubertal status before breeding on reproductive performance of beef heifers. *Adapted from Vraspri et al., 2013*

	Pubertal	Non-pubertal
Body weight at AI, lbs	785[a]	766[b]
AI pregnancy rate, %	61.9	55.5
Overall pregnancy rate, %	94.2[a]	87.7[b]
Days to from start of breeding to calving	284[a]	288[b]
% calving within the first 21 days	77.8[a]	66.2[b]

[a,b] Means with different superscripts differ ($P < 0.01$)

Because age at puberty is related to weight, feeding heifers to reach an adequate weight for puberty is critical. Expected weight at puberty differs by breed, depending upon mature cow size and relative breed leanness. Heifers of breeds with heavier mature weight tend to reach puberty at older ages and heavier weights.

Historically, guidelines for developing beef heifers have suggested that the target weight should be 65% of mature body weight by first breeding (Patterson et al., 1992). This target weight was intended to allow heifers to reach puberty in advance of first breeding for improved conception rates and to be in good nutritional condition while undergoing a first pregnancy. Recent research suggests that development of beef heifers to about 55-60% of mature body weight at breeding may provide economic benefit in comparison to the previously recommended 65% of mature weight (Funston et al., 2012b). A recent study reported a $38 cost savings per pregnant heifer wintered on corn residue compared with heifers developed to a heavier weight in the drylot (Summers et al., 2014).

Nutritional management approaches to raise heifers to approximately 55% of mature weight and save on feed costs have included the use of roughages or grazed forages, while another approach has been to limit dry matter intake of relatively more nutrient dense diets, such as those based on corn silage. Heifers wintered on cornstalks or winter range had similar pregnancy rates to heifers fed in drylots (Funston and Larson, 2011), but some other studies in which heifers have been bred at 55% of mature body weight have reported lower pregnancy rates (Roberts et al., 2009) or fewer heifers bred in the first 21 days of the breeding season (Eborn et al., 2013) compared to those raised to 65% during the same time period. Because lifetime cow productivity is positively related to heifers conceiving within the first 21 days of the breeding season, this potential impact of lowered pre-breeding weight on day of conception is a very important management consideration.

When calculating expected breeding weight for heifers, plan breeding so that heifers calve several weeks before the mature cow herd. This will allow for the opportunity to focus on heifers, which may have more calving difficulty, without having to check on the rest of the herd. Having heifers calve earlier than the cow herd will also allow these younger cows extra time to gain back body condition before the next breeding season.

Developing a nutritional management strategy to get heifers to target weight by breeding will depend on desired weight and feedstuffs available. Designing a replacement heifer development strategy may include the following steps:

1. Evaluate the expected mature size of your heifers as cows. Use weights of cows five years and older to calculate this. Table 2 shows the relationship between frame size and mature body weight for beef cows along with the hip height at seven and 14 months (BIF, 2010). These values can be used to help determine expected weight needed at the beginning of the breeding season. For example, a heifer with a hip height of 47.4 inches at weaning (seven months) is expected

to be 1400 lbs at maturity and should weigh 840 lbs at first breeding if you are targeting 60% of mature body weight. A table with hip heights for a greater range of ages is available from the Beef Improvement Federation website at http://www.beefimprovement.org/content/uploads/2013/07/Master-Edition-of-BIF-Guidelines-Updated-12-17-2010.pdf

Table 2: Frame score and hip height of female beef cattle at 7-months, 14-months and maturity and body weight of female cattle of different frame scores at maturity and 60 of mature body weight.

Age	Frame Score					
	3	4	5	6	7	8
Hip Height, inches						
7-mo of age	39.2	41.2	43.3	45.3	47.4	49.6
14-mo of age	44.1	46.1	48.0	50.0	52.0	54.0
Maturity	48.2	50.0	52.0	53.9	55.8	57.8
Body Weight, lbs						
Maturity[1]	1000	1100	1200	1300	1400	1500
60% of mature BW	600	660	720	780	840	900

[1] At body condition score 5.

2. Determine your target weight. Are you going to use 55 or 65% of mature body weight as your goal?

3. In calculating the dates of breeding, plan to have the heifers calve several weeks before the mature cow herd.

4. Using weights at weaning, calculate the rate of gain needed to get heifers to target weight by breeding. Subtract weaning weight from target weight and divide by the number of days between weaning and breeding.

5. Formulate diets based on current weight, desired average daily gain and available feedstuffs. See Chapter 15 for more information on least cost ration formulation.

Heifers can be managed in a manner that makes the best use of available feed and labor resources. Development strategies that take advantage of low cost feeds early in development, followed by feeding heifers to make faster rates of gain in the last 60 to 90 days before breeding have been successful (Clanton et al., 1983; Freetly et al., 2001; Lynch et al., 1997).

One option is to feed diets that provide a steady rate of gain from weaning to breeding. Alternatively, 'stair-step' or 'slowfast' programs can be used that switch heifers between periods of slow and fast gain where they may gain at slower rates during the winter, when feed resources may be more limited, followed by a period of more rapid gains closer to breeding. These programs might include pasture or range grazing during fall and winter with some supplementation provided when needed. This slow gain period can be followed by feeding for higher rates of gains in the drylot for 60 to 90 days before breeding or through improved nutrition associated with spring forage green-up. However, heifers should not be allowed to experience a dramatic change in nutrient intake (i.e., change from drylot to pasture) after AI or when being turned out with bulls. Allow at least seven days for heifers to acclimate to their new environment so they can learn where food and water are. This will avoid a severe depression in nutrient intake during a critical reproductive window (fertilization and early pregnancy).

The season of calving needs to be considered if heifers are expected to make rapid gains on forage before breeding.

Forage quality in the last 90 days before breeding for heifers in late spring calving herds may not be of high enough quality to produced desired gains for a 'slow-fast' gain type of program (Grings et al., 2007).

One way to save winter fed costs for a development program may be to raise heifers on rangeland or forages with supplementation. Table 3 shows an example of the performance of heifers raised on range from weaning to breeding in northwestern South Dakota compared with heifers fed in a drylot. Heifers were either weaned in August and raised on rangeland with supplementation of dried distiller's grains with solubles (Range) or stayed on the cow until early November and then placed in a drylot with access to grass hay and supplement (Drylot). Both groups of heifers were commingled in May when they were turned out to grazing on native rangeland. Heifers underwent an estrus synchronization protocol followed by breeding by natural service. The study showed that developing August-weaned heifers on range + supplement resulted in similar reproductive performance with lowered feed costs compared to heifers raised in a drylot. Other studies have also shown good results with range-raised heifer programs (Mulliniks et al., 2013).

Table 3: Weight and reproductive performance of August-weaned heifers developed on range + supplement compared to November-weaned heifers developed in a drylot.

	Range	Drylot
Initial BW, lbs[1]	460 ± 9.3[a]	605 ± 9.5[b]
May 18 BW lbs	859 ± 12.9	830 ± 13.1
Overall ADG, lbs/d	1.6 ± 0.03[a]	1.34 ± 0.03[b]
% Puberal before the breeding season	94	100
Pregnancy Rate, %	91	88
Feed cost, $/Heifer/day	$0.52	$0.74

[1] Weight at the beginning of treatments after a period on a weaning diet: Range = September 25, Drylot = December 2
[a,b] WIthin a row, means with unlike superscripts differ, $P < 0.05$.

Decreasing prebreeding body weight to 55% of mature weight in beef replacement heifers has sometimes shown favorable economics when evaluating the cost of developing a pregnant heifer (Roberts et al., 2009). That is, when accounting for decreased feed costs along with sale value of an open heifer, the cost per pregnant heifer was decreased when compared to feeding for more rapid rates of gain with higher pregnancy rates. However, Patterson et al. (2005) suggested that variations from year to year in heifer development cost increases with lower pregnancy rates because of variation in the sale value of open heifers. Also, if the replacement heifer development system has negative impacts on getting a cow bred with her second calf, it can have negative economic impacts on the system, as the value of the cull two-year-old may be less than the value of the open heifer (Clark et al., 2005). This can be mitigated by ensuring heifers have access to adequate feedstuffs throughout the first pregnancy that allows them to reach 85% of mature body weight by calving.

Nutrition and management around the time of breeding is critical for reproductive success of beef heifers. Chapter 30 discusses estrus synchronization programs that are useful in getting heifers bred early in the breeding season. Post-AI management is discussed in Chapter 27 and provides information on why this is such as critical period.

Managing the bred heifer until first calving

Getting the heifer bred is not the end of special management for the beef heifer. It is important to keep the heifer on a good plane of nutrition up to her first calving, at which time she should be about 85% of mature weight. Yearling heifers are still growing and nutrient requirements continue to be greater than mature cows, even into their second pregnancy. Heifers and young cows with their first calf can be separated from the older cowherd through winter to allow more intensive management of these females. The NRC (2000) provides nutrient requirement tables for bred heifers from breeding to first calving (Table 4). Heifers are assumed to be bred at 60% of mature body weight in these tables.

Proper nutrition of the bred heifer is always important, but emphasis needs to be placed on this if heifers are raised to only 55-60% of mature weight at breeding. In an experiment which evaluated retention of heifers in the herd to four years of age, a group of heifers was developed using 80% of the feed inputs provided to a group of their herd-mates that were allowed full access to feed. Those fed at the 80% level had lower pregnancy rates compared to the full-fed group. These heifers were then continued on either full or restricted feed input levels (primarily different amounts of winter supplement while grazing rangelands) during their lifetime. Fewer heifers from the group that received less feed before first breeding and also received lowered winter feed inputs were retained in the herd to four years of age when compared with heifers receiving higher feed inputs in their lifetime (Endecott et al., 2013). The impact of heifer development on long-term retention of cows in the herd needs to be carefully considered. Continued good nutrition will be needed for lighter weight heifers to be retained in the herd for many years. As shown in Table 5, the target weight of 85% of mature weight at first calving is a key goal. Insuring that young cows are in good body condition at second breeding is key to this success.

Table 4: Nutrient requirements of pregnant beef heifers. *NRC, 2000*

	Months since conception								
	1	2	3	4	5	6	7	8	9
1,200 pound mature weight									
Shrunk BW, lbs	747	773	800	827	853	880	907	933	960
Target ADG, lbs/d	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
DMI, lbs/d	19.3	19.8	20.3	20.9	21.5	22.2	23.0	23.7	24.4
CP, %	7.21	7.19	7.18	7.22	7.31	7.52	7.89	8.53	9.62
TDN, %	50.5	50.5	50.7	50.9	51.4	52.3	53.8	56.2	59.9
ME, mcal/lb	0.46	0.46	0.46	0.47	0.48	0.49	0.51	0.55	0.61
Ca, %	0.23	0.23	0.022	0.22	0.22	0.21	0.31	0.31	0.30
P, %	0.18	0.18	0.18	0.17	0.17	0.17	0.23	0.22	0.22
1,400 pound mature weight									
Shrunk BW, lbs	871	902	933	964	996	1027	1058	1089	1120
Target ADG, lbs/d	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
DMI, lbs/d	21.7	22.3	22.9	23.5	24.2	24.9	25.8	26.6	27.4
CP, %	7.25	7.22	7.21	7.23	7.31	7.48	7.81	8.38	9.33
TDN, %	50.7	50.8	50.9	51.2	51.6	52.4	53.7	55.8	59.0
ME, mcal/lb	0.47	0.47	0.47	0.47	0.48	0.49	0.51	0.55	0.60
Ca, %	0.24	0.24	0.23	0.23	0.22	0.22	0.31	0.30	0.30
P, %	0.18	0.18	0.18	0.18	0.18	0.18	0.23	0.22	0.22

Separating younger cows from the older cow herd will make it easier to meet their higher nutritional requirements. Younger cows may also be less competitive at getting supplements than older cows and feeding them separately gives them a better chance to get what they need. These younger cows can also be fed to have them in better flesh at calving. Cows with their first calf will make less milk than older cows, but nutrient requirements are greater because they are still growing. Therefore, these young cows may lose more body condition while raising their first calf. It is important to pay close attention to these cows and provide them an opportunity to gain condition before their second breeding. While mature cows can be targeted to be at a body condition score of 5 at calving, younger cows can be targeted for a body condition score of 6 (See Chapter 4). Table 5 provides some guidelines for continued growth of females to their second calving. Fetal programming effects on reproduction

A relatively new area of research, sometimes called 'fetal programming', has involved evaluating the impact of cow nutrition during pregnancy on lifetime performance of her offspring. Much of this research has focused on growth and meat quality, but a small amount of research data exists on the impact of maternal nutrition on lifetime performance of female calves. In Nebraska, more heifers born to dams that received a protein supplement during winter grazing in their third trimester of pregnancy calved in the first 21 days of their first calving season (Martin et al., 2007). In a Montana study, more heifers born to late-winter calving cows that had grazed irrigated pasture in the fall were retained to 4 years of age compared to heifers born from cows grazing native rangeland in the same period (Grings and Roberts, 2013). These studies suggest that there may be some long-term advantage to improved nutrition during pregnancy on performance of female offspring, but more research is needed to fully evaluate this.

Table 5: General guidelines for target body weights of beef females to second calving. *Whittier et al., 2005*

Timeframe	Percentage of estimated mature BW
Pre-breeding	60 to 65
First breeding	65 to 70
First pregancy diagnosis	70 to 75
First calving	80 to 85
Second calving	90 to 95

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