**Investing in the Future: Heifer Development for Longevity**

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Selection and development of replacement heifers has, rightfully so, garnered considerable attention in research, educational programming, and popular press for many years. While the basic concepts have not changed for decades, new technologies, changes in market dynamics, and leveraging improved genetics has enabled producers to become more efficient with the dollars and time they invest in replacements.

## Options for Procuring Replacement Heifers

There are three basic options for obtaining bred replacement heifers. The most common, but not necessarily the best, method is to retain heifers from each calf crop to develop and breed on-farm. Selling all the heifers in a calf crop and purchasing bred replacements or open heifers to breed is another option. The third option, and seemingly least used in beef cattle production, is to retain heifers from the calf crop and have them custom developed by someone else. Nuances develop in these three basic methods depending on geographical and individual farm/ranch influences. Several factors that impact this decision include economics, available resources, experience, genetic improvement, and convenience. The financial concerns of developing replacement heifers are related to diverting cash flow and resources. Consider purchasing replacements if higher returns can be generated by an alternative use for the proceeds from feeder calf sales.

Farm or ranch resources will also direct this decision. If forage or feed supplies are already maximized or overextended by the mature cow herd, then purchasing replacement heifers would be an obvious choice. Proper development of heifers takes a certain amount of knowledge and experience that differs from management of a mature cow herd. Opportunity costs are often overlooked when making management decisions. The convenience of having someone else raise replacements is a valid consideration, especially when the cattle operation is not the primary source of income or operator time or labor is limiting. Custom heifer development centers have become a support-business of the cow-calf sector. Consigning heifers to a custom developer is the best way to retain herd genetics while not using limited environmental resources from the cow herd to raise heifers.

## Timeline and Objectives

The period of time most often indicated by the term “heifer development” is from weaning to confirmed pregnant after the first breeding season. For this discussion, that term refers to the period of time from weaning until confirmed pregnant as a two-year-old after the second breeding season. There are several factors that influence development and longevity prior to birth and between birth and weaning. Those factors are usually accounted for during selection or result in early culling during development.

In addition to the significant cash cost for retaining/purchasing and developing heifers, there is a tremendous amount of opportunity cost and time invested. Consider the time from a mating that

results in a retained heifer until that heifer is confirmed pregnant the second time as a two-year-old (Figure 1). That adds up to well over three years and one season of lost cash flow from the heifer's dam. It is easy for cattlemen to lose track of this investment because it is masked by the everyday tasks of maintaining the herd. But, losing that investment when a young cow is culled and average longevity reduced, adds up to enormous losses of sunk costs. Herein lies the importance of selecting, developing, and breeding heifers with longevity in mind.

| Time Period | Days |
|---|---|
| Sixty day breeding season | 60 |
| Gestation period for brood cow | 285 |
| Birth to weaning | 210 |
| Weaning to breeding | 240 |
| Gestation period for heifer | 280 |
| Calving until re-breeding | 80 |
| Rebreeding until pregnancy exam | 45 |
| Total time in days | 1200 Days |
| Total time in months | 40 Months |

**Table 1: Time investment from mating that results in a retained heifer until it is confirmed pregnant the second time as a 2-year-old.**

To help safeguard the time and resource investments, basic heifer development objectives that help ensure longevity include:

- Reach puberty prior to the first breeding season
- Breed early in the first breeding season (ideally in the first 20 days)
- Minimize calving difficulty
- Breed early in the second breeding season
- Improve genetics for production goals

## Puberty and the First Postpartum Interval

Anestrus (not having estrous cycles) has long been recognized as the primary factor reducing reproductive efficiency in beef cow-calf operations (Short, 1990). Unfortunately, anestrus occurs annually in productive females; heifers are anestrus prior to puberty and cows undergo a period of anestrus after each calving. The length of the anestrous period is governed by many factors including presence of a calf, nutritional status, cow age, and degree of calving difficulty. First-calf heifers normally experience a longer postpartum anestrus than mature cows because they have the additional energy requirements of still growing during the first lactation.

To calve at 24 months of age, heifers must reach puberty and conceive by approximately 15 months of age. Several factors influence the age at puberty including breed composition, nutrition, body weight, bull exposure and the environment (Patterson et al., 1992). Lifetime productivity of a female is affected by age at puberty. Heifers that conceive early in the first breeding season are more likely to conceive early in subsequent seasons and thus become more productive cows (Lesmeister et al., 1973).

Similar to postpartum anestrous in cows, the proportion of heifers that are pubertal at the beginning of the breeding season influences reproductive rate. Patterson and coworkers (1992) indicated that approximately 35% of heifers were prepubertal at the onset of the breeding season. In more recent studies, 88% (Larson et al., 2004), 83% (Lamb et al., 2004), and 57% (Lucy et al., 2001) were prepubertal on the first day of the breeding season.

Anestrus, whether prepubertal or postpartum, greatly influences successful reproduction in beef cow-calf operations. Protocols have been developed that effectively induce a fertile estrus in anestrous females. Incorporation of these protocols and managing heifers with the goal of reducing their first postpartum interval will enable beef cow-calf operations to maximize reproductive potential and longevity.

**Selection**

Selecting early born heifers has long been the first rule of thumb since older heifers will be more likely to attain puberty prior to the first breeding season. A less aggressive nutritional program may be used for heavier weaning heifers and possibly reduce feed costs. However, genetically superior heifers born later in the calving season can be managed to reach proper target weights by breeding and could be considered as replcements over older heifers with less performance potential. Realize that selecting only the largest heifers at weaning can result in larger mature cows that are less efficient.

Temperament should be another key selection criterion. Many beef producers have adopted a "chute scoring" method to keep temperament records. When heifers are restrained in the working chute, they can be assigned a score from 1 to 4 (1 = calm; 2 = restless shifting; 3 = squirming; 4 = twisting and rearing). Temperament is a heritable trait and removing temperamental heifers from the herd will improve farm safety. Furthermore, temperament can negatively affect feeding behavior and reproductive performance of not only the individual heifer but the group it is fed with as well (Cooke et al., 2012).

All heifers selected for development as breeding females should be structurally sound. Hoof structure should be closely evaluated as the heifers mature and can be guided earlier in selection by knowledge of hoof structure of the sire and dam. Udder conformation is key to longevity but requires as much evaluation of the heifer's dam, paternal grand dam, sibs, and half-sibs, as evaluation of the heifer itself. Heifers that do not fit ranch specifications for breeding females will be better suited for post-weaning programs that ultimately result in harvest prior to advanced maturity.

Genetic selection for Seedstock producers is generally guided by EPDs, sometimes gnomically-enhanced, of individual heifers mated for specific goals. Even though Seedstock producers tend to more aggressively improve genetics year-over-year and voluntarily market cows at a younger average age, longevity should still be a primary driver of selection with their commercial clientele in mind. Technologies for genomic selection in commercial herds have made considerable advances in recent years. The market is quickly finding the most appropriate use for including genomic analysis in more traditional benchmarking and indexing tools for commercial herds. Carcass ultrasound is a useful tool for improving carcass merit selection in purebred and commercial herds and is important for validating genomic tools in replacement heifers that will not be harvested as fed cattle.

With all the tools and technologies available to aid heifer selection, the most important phenotypic trait for replacement heifers is pregnancy. In that light, retaining all the heifers from a calf crop, which meet minimum basic requirements, to be exposed to either a single timed AI or one cycle (roughly 20-30 days) with natural service sires is a great option where resources permit. Then, pregnancy is diagnosed early via ultrasonography or blood-based testing and open heifers marketed or retained as heavy feeders. This method ensures selection based on the most important criterion but, it might not be feasible for smaller herds.

**Nutritional Management**

The traditional approach to feeding replacement heifers has been the "target weight" method (Varner et al., 1977). For heifers to breed at 13 to 15 months of age and calve for the first time as two-year-olds, they should achieve approximately 65 to 70 percent of their mature weight by the start of the breeding season. This helps ensure that the metabolic signals are in place to trigger puberty before the start of the breeding season.

As reviewed by Endecott et al. (2014), more recent reports have suggested that the "target weight" system for developing heifers has become outdated and costly. As beef cattle producers switched from calving heifers as three-year-olds to calving as two-year-olds, more emphasis has been placed on selecting heifers that reach puberty at an earlier age and lighter weight in relation to their expected weight as a mature cow. In support of this idea, field trials have demonstrated that heifers developed to lighter weights relative to their mature weight achieved similar pregnancy rates and longevity in the herd over four years compared to traditionally fed heifers (Funston and Deutscher, 2004 and Mulliniks et al., 2012).

When designing a nutritional program to develop heifers to target breeding weights, evaluate pasture/hay quality and supplies ahead of time. Supplemental feed requirements can be determined by examining weight gains needed to reach target breeding weights, animal nutrient requirements, and forage program deficiencies. The plane of nutrition for reaching the target weight can be altered to match forage availability or feed cost. For instance, if forage is abundant or supplemental feed is relatively inexpensive early in the development period, heifers can be fed to maintain a high ADG early and reach the target weight faster. Then, when forage or supplemental feed availability declines, they can be maintained on a maintenance (or slightly above maintenance) diet until breeding. On the other hand, if forage is limited and supplemental feed cost is high during early development, heifers can be maintained on a low ADG and then

pushed to reach the target weight as forage becomes available or supplemental feed cost decreases. If supplemental feed and forage availability are not a concern, a steady ADG can be maintained.

Regardless of the nutritional program used, it is important to remember that the heifers should not be allowed to lose weight ("back up") or become too fat during the developmental period. Losing weight can alter the age at puberty even if the target weight is reached at the desired time. If heifers are overfed, fat accumulation in the udder will inhibit milk production as a first-calf-heifer and mature cow. Furthermore, multiple feeding groups should be used because individual heifers will require different nutritional inputs.

When cost of production outpaces revenue, developing heifers to a lighter target weight may be appropriate. Using the flushing affect (increasing plane of nutrition approaching the breeding season) seems to be a key component of reproductive success in this system. However, even if the heifers breed well, they should still be managed to calve with additional condition to ensure a shorter postpartum interval. Management practices should not be changed suddenly and implementation of low-input development should be done with careful attention to detail and when genetic potential of the specific group of heifers is known.

Some feed additives or specific feed ingredients can be used to improve heifer development and reproductive performance. Heifers fed an ionophore during development will likely reach puberty at an earlier age and lighter weight. The effect of an ionophore is most obvious in less intensively managed herds. Dietary fat supplementation increases the energy density of the diet and can help improve reproductive function. Additionally, fat supplementation seems to have a direct impact on reproduction independent of the added energy. Additional starch (corn, for example) not only adds energy to the ration but might also shit to a more favorable type of energy from the rumen that advances puberty.

**Reproductive and Health Management**

Puberty in heifers can be characterized as the first estrus (standing heat). Keep in mind the silent ovulation mentioned in the section above on attainment of puberty and the postpartum interval. A long-held acceptance has been that heifer fertility increases approximately 20 percent from the first to third estrus after puberty (Byerly et al., 1987). However, more recent reports indicate that the magnitude of that improvement is less in modern beef heifers (Robets et al., 2013). Nevertheless, nutrition still plays a large role in the attainment of puberty for heifers. If the nutritional management outlined in the previous section is practiced with adjustments based on input costs relative to benefit, heifers should display estrus prior to the breeding season.

Breed differences, sire and dam effect within breed, and heterosis (hybrid vigor) all contribute to heifer age at puberty and should be considered when selecting heifers at weaning or when making breeding decisions for cows that will potentially produce replacements. Crossbred heifers with less than 75 percent of one breed have a significantly reduced age at puberty compared to purebred heifers. Additionally, overall fertility is increased in crossbred heifers.

Three management practices to be completed one month before the breeding season begins:

1. Pelvic area measurements
2. Reproductive tract scores
3. Vaccination and parasite control

Pelvic area measurements are simply a measurement of the size of the birth canal (Deutscher, 1987). The original use of pelvic area measurements was to relate the size of heifer, size of pelvic area, and potential size of an easily deliverable calf. Because the ratios used to determine size of a deliverable calf are only approximately 80 percent accurate, most heifer development programs set a minimum threshold ("cutoff") to cull heifers with a pelvic area too small to allow delivery of a 70- to 75-pound calf. For example, an 800-pound long yearling heifer with a pelvic area of less than 160 square centimeters would be culled to reduce the opportunity for calving difficulties to high-accuracy, low birthweight sires.

Reproductive tract scores are used to determine a heifer's sexual maturity (Anderson et al., 1991). This procedure was developed because directly measuring puberty in a group of heifers is time consuming and labor intensive. The score can range from 1 (immature) to 5 (cycling). It is simply an estimate of sexual maturity based on ovarian follicular development and palpable size and tone of the reproductive tract. It is critical to use an experienced, reliable technician for reproductive tract scoring. This measurement is usually taken at the same time pelvic area is assessed. If estrus synchronization is not going to be used, consider culling heifers with a reproductive tract score less than three, especially if the genetic value is marginal. If estrus will be synchronized by using melengestrol acetate (MGA) or a Controlled Intervaginal Drug Releasing device (CIDR**)**, heifers with a tract score of 2 could be retained.

The third practice to be completed one month prior to the breeding season is vaccination. Heifers should be vaccinated against *Vibrio fetus*, Leptospirosis, and a respiratory complex that includes Parainfluenza Type 3 ($PI_3$), Bovine Respiratory Syncytial Virus (BRSV), Bovine Viral Diarrhea (BVD), and Infectious Bovine Rhinotracheitis (IBR). A modified-live vaccine is generally considered to stimulate a better immune response. However, that assertion has been challenged recently (Daly, 2016). It is also suggested to test each heifer for persistently-infected bovine viral diarrhea virus (BVD-PI). Heifers should also be dewormed at this time and effective fly control used as needed.

The next step in heifer development is breeding. Using estrus synchronization and/or artificial insemination (AI) present advantages. The advantage of using estrus synchronization is increased pregnancy rates, a more uniform calf crop at weaning, and increased labor efficiency at breeding and calving. The major benefit offered by AI is access to proven calving ease sires with superior growth and carcass performance genetics. Because most calving problems occur when heifers calve for the first time, special attention should be given to make sure the sire has a desirable and high-accuracy calving ease and/or birth weight EPD. Calving ease should also be considered when selecting a "clean-up" or natural service sire to be used for the remainder of the breeding season after AI. Choosing an estrus synchronization protocol that uses some form of progestin (MGA or CIDR) can stimulate heifers that are on the threshold of puberty to begin to cycle and have a better chance to breed within the breeding season (Anderson et al., 1996).

Pregnancy detection should be performed as early as possible after the end of the breeding season; transrectal ultrasonography and blood-based pregnancy tests are ideal options for early

detection. This will enable a quicker and more informed decision for obtaining salvage value from non-pregnant ("open") heifers. If performed early enough, open heifers can be sold as heavy feeder cattle or moved to a finishing phase. A tremendous amount of revenue potential is lost when open heifers are maintained through the first calving season without producing a calf. They consume more resources and cash and are marketed as non-feds at a much lower value.

If the number of bred heifers exceeds the required replacements, market those bred late in the breeding season. Search for a beef cattle producer that uses a later calving season to market these heifers at a larger profit than heavy open heifers. Further culling should be based on performance data and genetic potential. Keep heifers that grew well and were more efficient during the development phase or that have a dam and/or sire with proven valuable EPDs, genomic analysis results, and/or performance records.

**Post-breeding Heifer Management**

Management of heifers from the end of the breeding season until calving often receives less attention and fewer resources than development from weaning to breeding. Yet, it is as important to longevity as any other time period in the development phase. Nutritional management, conformation of pregnancy, and calving should be the focus.

If the initial pregnancy diagnosis was performed at less than 60 days post-breeding, late embryonic and early fetal loss can still be significant. Pregnancy loss carries a greater negative economic impact the later it occurs because more resources are consumed without return beyond salvage value of the heifer itself. Technologies that predict the probability of pregnancy loss are in development but have not yet reached full application and market potential. Continue to look for those capabilities and implement them as soon as they are economically feasible to reduce the number of pregnancies lost in the second and third trimesters.

Cows and heifers use energy for maintenance, growth, lactation and reproduction; in that order. A heifer's energy needs for maintenance, growth and lactation must be met before energy is used to begin normal estrous cycles after calving. Adequate nutrition is critical during the last two months of gestation since much of the fetal growth occurs during this time. Separating heifers from the mature cow herd limits competition for bunk space and allows them to be placed on a separate nutritional program that better meets their requirements. Reproduction is regulated by nutrition. Having cattle in proper body condition at calving will positively impact rebreeding rates. Cows and heifers in thin body condition at calving time are slower to rebreed, produce less desirable colostrum, and are less likely to wean a live calf seven to eight months later.

Body condition scoring (BCS) is useful in evaluating heifer nutritional status as calving approaches. It can be easily evaluated in the pasture. Heifers are still growing and have higher nutrient requirements than mature cows, so they should be managed to calve at a body condition score of 6 (where 1 = extremely thin and 9= extremely fat). In addition, calves born to heifers with a BCS of five or six stand sooner after birth than calves out of heifers with a BCS of three or four (. Ideally, heifers should not lose more than one BCS after calving.

While BCS is an important tool, realize that it is an evaluation of nutritional status at the point it is taken and does not indicate plane of nutrition unless it is evaluated at multiple points over time. For example, a heifer losing weight just before calving might appear to be in good

condition at a given point in time. But, it will biologically perceive that its environment if not favorable for quickly establishing another pregnancy after calving; consequently extending the postpartum period.

**Conclusions**

Both selection and development of replacement heifers impact eventual longevity and productivity as mature cows. Even when all the tools for selection have been effectively implemented, management from weaning to breeding and then rebreeding as a first-calf heifer can negate many of those positive genotypic and phenotypic traits. The basic principles of management that make a good heifer into a productive cow remain the same – breeding early as a virgin heifer and rebreeding in the second season. New technologies and improved genetics have enabled different approaches to replacement heifer development. Staying current with these new concepts will allow progressive cattlemen to stay true to those basic principles more efficiently.

**Literature Cited**

Anderson, K. J., D. G. Lefever, J. S. Brinks, and K. G. Odde. 1991. The use of reproductive tract scoring in beef heifers. Agri-Practice 12(4):19.

Anderson, L.H., C. M. McDowell, and M. L. Day. 1996. Progestin-induced puberty and secretion of luteinizing hormone in heifers. Biol. Reprod. 54:1025-1031.

Byerly, D. J., R. B. Staigmiller, J. G. Berardinelli, and R. E. Short. 1987. Pregnancy rates of beef heifers bred either on pubertal or third estrus. J. Anim. Sci. 65:645-650.

Cooke, R. F., D. W. Bohnert, B. I. Cappellozza, C. J. Mueller, and T. DelCurto. 2012. Effects of temperament and acclimation to handling on reproductive performance of Bos taurus beef females. J. Anim. Sci. 90:3547-3555.

Daly, R. 2016. Unintended consequences: Could MLV vaccines be harming reproduction? Proc. Applied Reproductive Strategies in Beef Cattle. 223.

Deutscher, G. H. Pelvic measurements for reducing calving difficulty. Nebraska Cooperative Extension Service. NebGuide G88-895.

Endecott, R. L., R. N. Funston, J. T. Mulliniks and A. J. Roberts. 2014. Beef heifer development and lifetime productivity. Proc. Beef Improvement Federation.

Funston, R. N., and G. H. Deutscher. 2004. Comparison of target breeding weight and breeding date for replacement beef heifers and effects on subsequent reproduction and calf performance. J. Anim. Sci. 82:3094–3099

Mulliniks, J. T., D. E. Hawkins, K. K. Kane, S. H. Cox, L. A. Torell, E. J. Scholljegerdes, and M. K. Petersen. 2012. Metabolizable protein supply while grazing dormant winter forage during heifer development alters pregnancy and subsequent in-herd retention rate. J. Anim Sci. 3:1409-1416.

Lesmeister J. L., P. J. Burfening, and R. L. Blackwell. 1973. Date of first calving in beef cows and subsequent calf performance. J. Ani. Sci. 36:1-10.

Lamb, G .C., J. A. Cartmill, and J. S. Stevenson. 2004. Effectiveness of Select Synch (gonadotropin-releasing hormone and prostaglandin $F_2$ for synchronizing estrus in replacement beef heifers. The Prof. Anim. Sci., 20:27-33.

Larson, J. E., G. C. Lamb, J. S. Stevenson, S. K. Johnson, M.L. Day, T. W. Geary, D. J. Kesler, J. M. DeJarnette, F. N. Schrick, and J. D. Arseneau. 2004. Synchronization of estrus in suckled beef cows using GnRH, prostaglandin F2a, (PG), and progesterone (CIDR): a multi-location study. Proc. Amer. Soc. Anim. Sci., July 25-29, St. Louis, MO.

Lucy, M. C., H. J. Billings, W. R. Butler, L. R. Ehnis, M. J. Fields, D. J. Kesler, R. P. Wettemann, J. V. Yelich, and H. D. Hafs. 2001. Efficacy of intravaginal progesterone insert and an injection of PGF2α for synchronizing estrus and shortening the interval to pregnancy in postpartum beef cows, peripubertal beef heifers, and dairy heifers. J. Anim. Sci. 79:982-992.

Patterson, D. J., R. C. Perry, G. H. Kiracofe, R. A. Bellows, R. B. Staigmiller, and L .R. Corah. 1992. Management considerations in heifer development and puberty. J. Anim. Sci. 70:4018-4035.

Roberts, A. J., J. Ketchum, R. N. Funston, and T. W. Geary. 2013. Impact of number of estrous cycles exhibited prior to start of breeding on reproductive performance in beef heifers. Proc. West. Sec. Amer. Soc. Anim. Sci. 64:254-257.

Short, R. E., R. A. Bellows, R. B. Staigmiller, J. G. Bernardinelli, and E. E. Custer.1990. Physiological mechanisms controlling anestrus and infertility in postpartum beef cattle. J. Anim. Sci. 68:799.

Varner, L.W., R. A. Bellows and D. S. Christensen. 1977. A management system for wintering replacement heifers. J. Anim. Sci. 44:165.