Extension
University of Missouri

Nutritional Management of Developing Heifers: Intensive Versus Extensive Systems

Replacement females are the lifeblood of beef cow herds, and heifers that conceive early in the first breeding season have greater lifetime production. Not all heifers are created equal when it comes to their potential as replacements. Identifying the best replacements from the cow herd and managing properly boosts the profit potential of the operation. Nutrition is an important management tool for influencing when heifers attain puberty (Figure 1), and nutritional management should result in heifers initiating estrous cyclicity prior to the start of their first breeding season. However, many producers invest excessive feed resources in striving to maximize heifer pregnancy rate. In severe cases, investment in feed can be a drain on long-term profitability. Feed costs account for 60–70% of heifer development costs. This publication aims to provide insight on prudent nutritional management of developing heifers while discussing the pros and cons of various heifer development systems.

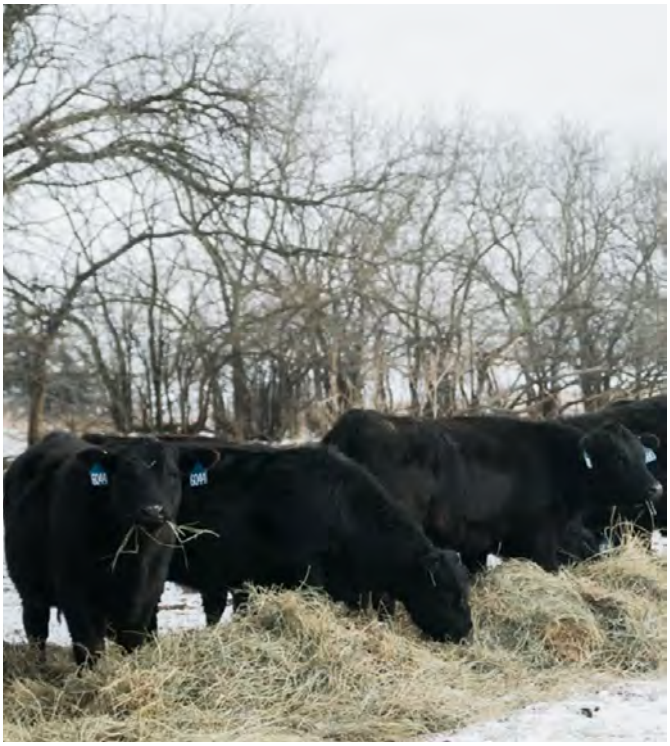

Figure 1. Nutrition is an important management tool for influencing when heifers attain puberty.

Target weight

Animal scientists have long known that nutrition influences the onset of puberty and the ability of heifers to achieve pregnancy. Early research identified the value of developing heifers to a "target weight" (percentage of mature cow body weight) by breeding to reduce the risk of underdeveloped heifers not achieving puberty. Proponents of using target weights to develop heifers have typically advocated for heifers to reach 65% of mature cow weight at the start of the breeding season. However, in recent years, a healthy debate has emerged about the ideal target weight for beef heifers.

Because 65% was the first target weight promoted by animal scientists, it has been tested across numerous cattle breeds in many different production environments. It has proven to be effective across heifers from a wide range of breed compositions and biological types. Also, a number of research projects reported that heifers developed to a 65% target weight had fewer calving issues than heifers developed to lighter target weights.

The cost of feed required for heifer development can be an issue when using a 65% target weight, as this often requires additional feed inputs beyond grazing. In areas of the country where concentrate feeds are plentiful, this may not be perceived to be an issue. But in the more arid parts of the country, where cereal grains are not grown locally or readily available, others question the merit of developing heifers to a 65% target weight.

Research efforts at the University of Nebraska have evaluated systems in which heifers are developed to a lower target weight of 50 to 55% of mature body weight. In those data, similar reproductive performance was attained while reducing feed costs by over $80 per heifer developed. This is a substantial decrease in feed costs incurred, although it should be noted that feed prices are location-dependent (much of this research

Written by
Eric Bailey, Assistant Professor, Animal Sciences
Jordan Thomas, Assistant Professor, Animal Sciences

Table 1. Factors to consider when selecting a target weight (percentage of mature cow body weight) for replacement heifers to attain by the beginning of the breeding season.

65% of Mature Weight	55% Mature Weight
Purebred or straightbred heifers	Crossbred heifers
Later-maturing breeds	Earlier-maturing breeds
Large-frame cows	Moderate-framed cows
Limited cow numbers	Larger herds
Good forage resources	Limited forage resources
High replacement heifer value	Average replacement heifer value
Limited marketing options for open heifers	Ability to profitably retain ownership of open heifers through harvest

Adapted from Hall, J. B. 2013. Nutritional Development and the Target Weight Debate. Veterinary Clinics of North America: Food Animal Practice. 29:537–554. doi:10.1016/j.cvfa.2013.07.015.

was conducted in the Sandhills region of Nebraska, where there is abundant forage but relatively little cereal grain farming). In contrast to the earlier research, no differences were reported in calving difficulties or subsequent rebreeding of heifers following a development protocol aiming for a lower target weight.

The optimal target weight for which to manage will vary based on several factors. Before making the decision to invest less in developing heifers by using a lower target weight, take a moment to consider the factors listed in Table 1. Breed composition and biological type of cattle could be an issue. Most of the work reporting economic benefits of developing to a 55% target weight were done with crossbred heifers of British breeding (e.g., Angus x Hereford). British breeds generally reach puberty at younger ages than do higher growth breeds from continental Europe. Likewise, heifers with some percentage Bos indicus (e.g., Brahman) influence may especially struggle to reach puberty at lighter target weights.

Ration formulation

Building a ration to develop heifers to an acceptable weight by breeding can seem like a daunting task. Understand that time is on your side, as the period between weaning and breeding is 6 to 7 months assuming a conventional weaning age. Having that much time allows for a modest average daily gain target during heifer development. Heifers should be fed to achieve 1.5 lb average daily gain (ADG) throughout the heifer development period. To achieve 1.5 lb ADG in developing heifers, the total diet must contain at least 12.5% crude protein and roughly 65% total digestible nutrients (TDN), a proxy for energy in the diet.

Protein

Whereas protein is often the limiting nutritient in western states, it is energy that is often the major limiter in Missouri cool-season forage systems. However, feeding of stored forages (e.g., poor quality hay) or poor grazing management can result in protein being nutritionally limiting in heifer development programs. One scenario in which producers may miss this target is when the feeding program consists of hay plus a supplement. Note that the entire diet (hay plus supplement) must have an average crude protein concentration of 12.5%, not just the grain. While tall fescue hay often contains greater crude protein than many other species of grass hay, it is still possible to formulate a diet that has less than 12.5% crude protein when poor quality hay is used. Producers feeding a commodity mix that is 14–16% crude protein should be aware of this and need to 1) have hay tested for nutritive value and 2) consider changing the supplement to one with greater crude protein concentration to balance the diet.

Bypass protein, or rumen undegradable protein (RUP), has been researched for developing heifers, due to the composition of protein in most forage-based diets. Some research has demonstrated benefits of RUP supplementation for backgrounding and stocker cattle, although other research labs have failed to document a difference in performance of adding RUP to growing cattle diets. However, at present, little benefit to increasing RUP in developing heifer diets has been demonstrated.

Energy

The diet also needs to balanced for energy, typically expressed as TDN. Generally, it is not necessary to

change the specific commodity or mix of commodities, as most common concentrate feeds used in Missouri (corn, soyhulls, gluten, distillers grains) all contain 80–90% TDN. However, the quality of forage consumed has a large impact on the TDN concentration in the total diet. Use higher quality forage if at all possible. Feeding low-quality forage to developing heifers will require a greater amount of concentrate supplement to balance the diet for 65% TDN. In other words, the higher the quality of forage used, the less concentrate feed that must be purchased (and used).

If relying on hay as the forage source, know that hay quality is going to drive performance. We recommend feeding high-quality hay if possible. Base your supplementation program on hay quality, specifically energy concentration in the hay. A common rule of thumb is to supplement heifers at 1% of body weight per day in concentrate if hay is <55% TDN. If hay is 55–65% TDN, feed heifers 0.5% of body weight per day. If the heifers flesh up quickly, do not hesitate to reduce that feed level, especially if hay quality is on the higher end of the TDN range listed above. Do not forget that heifers' requirements for maintenance and growth are increasing as they increase in age and weight, so it will be necessary to increase the quantity of feed provided as the heifers grow.

Fat

It is popular to discuss targeted nutrients to improve reproductive outcomes. Source of calories in developing heifer diets have been studied because, while starch, fiber and fats provide calories to heifers, each source of energy is utilized differently in the body and could produce different physiological effects. However, multiple studies where the energy intake was held constant while the source of calories (corn-soybean meal vs. soyhulls; starch vs. fiber) was altered. No differences in AI conception or overall pregnancy rate were reported between treatments.

Fat supplementation has been a focus of considerable research because, in addition to potentially serving as an energy source in the diet, fats are important for hormone synthesis and other physiological processes. A common cattle diet contains 2–3% fatty acids, and total fat in a balanced ration formulated by a nutritionist will rarely exceed 8% because fat is toxic to rumen microbes. Research results on the reproductive effects of fat supplementation to developing heifers have been mixed. Increased follicular growth has been reported in response to fat supplementation in relatively small-scale experiments, and recent results with specific fatty acids have reported modest improvements in reproductive performance. However, across the literature, fat supplementation in general had minimal impacts on the reproductive performance of heifers at a large scale.

Still, it is common to see feed supplements marketed as high-fat products, specifically for feeding to breeding stock. The unfortunate aspect of these supplements is that they do not provide enough calories to meaningfully impact energy balance, as they are commonly designed to be consumed at a modest rate (0.5–1.5 lb per head per day). The authors do not recommend paying a premium for high-fat self-fed feed supplements, based on current literature.

Mineral and vitamin requirements

Mineral and vitamin supplementation is a highly debated topic when developing heifers. In general, mineral and vitamin supplements are highly marketed are high-profit margin products. While the sheer number of minerals and vitamins required by beef cattle need further research, it appears that the mineral and vitamin requirements for growth are also sufficient to support reproduction by beef heifers. Much of our current knowledge of minerals and vitamins come from scenarios in which a severe deficiency or antagonism (e.g., one mineral binding another and rendering it unavailable to the animal) resulted in compromised health or performance. Little peer-reviewed research supports the idea of enhanced reproductive performance if minerals and vitamins are supplemented above established requirements.

Feed additives

Other feed additives and tools stimulate cattle growth and have been investigated for use in developing heifer protocols. This work has occurred because of the reduction in age at puberty demonstrated when growth rates are increased in heifers.

Addition of ionophores to diet formulations or feed supplements provided to developing heifers is encouraged by the authors. Ionophores change the microbial population of the rumen and promote greater feed efficiency. Research demonstrates that the improved feed efficiency from adding ionophores to developing heifer diets can reduce age at puberty by 2 to 4 weeks. Note, however, that it is unlikely ionophores will enhance feed efficiency to a point at which lower nutritive value feeds can be considered sufficient to meet growth requirements.

Growth-promoting implants

Although not a feed additive, growth-promoting implants are another tool producers may see marketed for use in replacement heifers. Growth implants are exogenous hormones that influence the rate and composition of an animal's growth. Growth-promoting

implants enhance lean gain (i.e., muscle and bone), and generally result in less storage of energy in the form of adipose tissue (i.e., external fat cover). While this is typically considered favorable for growing cattle intended for harvest, there is debate among animal scientists as to whether shifting toward lean gain rather than deposition of fat is advantageous for replacement heifers. Energy reserves in the form of external fat cover are important for reproduction. Additionally, consider that replacement females often need only attain modest rates of gains during the development period in order to reach development targets prior to breeding and, ultimately, calving. Likewise, the literature is mixed on whether implanting heifers results in earlier attainment of puberty or meaningfully greater pelvic area at calving. Given these considerations, the authors do not encourage use of growth-promoting implants at any point in life for heifers intended to be used for breeding.

Moreover, implants can have severe and permanent negative effects on reproductive performance of heifers depending on the type of implant and the period of life in which heifers are implanted. As an example, when heifers were implanted at birth with implants containing zeranol, pregnancy rates were reduced by 35% due to impaired glandular development within the uterus. Note that these effects are lifelong. If deciding to use growth-promoting implants in heifer calves that are intended for breeding, consult with your veterinarian about the specific product and pay careful attention to the label-approved use. Do not use any implants in replacement heifer candidates unless they have a label claim for use in replacement heifers. If purchasing weaned heifer calves for development as replacement candidates, it is wise to inquire about implant history. Likewise, if implanting heifer calves not intended for development on your operation, be conscientious and communicate their implant history when marketed, as prospective buyers might be considering exposing heifers for breeding.

Intensive versus extensive development systems

Two alternative approaches for development of replacement heifers will be discussed below: intensive development systems versus extensive development systems.

Intensive development systems

The authors define an intensive heifer development system as one that seeks to maximize the probability of every developed heifer becoming pregnant. While this sounds like a reasonable goal, it is important to consider the costs of developing heifers. Should we strive to get every heifer pregnant, regardless of cost? Do some of our interventions mask poor fertility of females when managed under lower-input systems as they will be in the cowherd later in life? Nutrition profoundly influences reproduction. If we provide ample nutrition to developing heifers, some argue that we could be masking poor productivity of some females that are less suited to pasture or range production systems.

To understand why intensive development systems have been researched, it is important to recognize the importance of managing heifers so that they calve for the first time at two years of age (i.e., reaching puberty and conceiving at approximately 15 months of age). An early research effort reported that heifers calving at 24 months of age produced 0.7 more calves over their lifetime than those calving at 36 months of age. This finding has been validated numerous times in the literature over the years since, with a large effort by the U.S. Meat Animal Research Center reporting that heifers bred to calve at two years old produced 303 lb more weaned calf in their lifetime than those bred to calve at three years old.

Because plane of nutrition has a strong influence on puberty onset, many operations manage heifers intensively in order to ensure adequate weight gain post weaning. The most predictable and accurate feeding program for heifers is a drylot setting with a total mixed ration (TMR) delivered. In this system, we control the amount of feed offered and the nutritional composition of the diet. It is recommended to work with a nutritionist to help build the ration to ensure adequate but not excessive growth (e.g., 1.5 lb average daily gain) at a reasonable cost.

For smaller operations, it may be common to develop heifers on a forage plus supplement management system. The forage is either grazed from pasture or hay is fed. Forage quality and quantity drive the success of this type of program. It is important to provide heifers access to high-quality forage if possible to support growth and achieving the desired target weight. The first place to start is to have forage tested for nutritive value. Then, feed supplements based on the quality of hay. Refer to the ration formulation section above for more detailed guidance.

Another option producers consider is putting heifers on a self-fed concentrate during development. These are often complete feeds developed by companies seeking to provide convenience for producers. In areas where concentrate feeds are not readily available, this is an attractive option for some producers. There are a number of pitfalls that lead the authors to discourage this practice under most circumstances. Cost can be a large factor. The rations developed are often priced at a premium due to the convenience of not having to deliver feed regularly. Heifers manage intake of concentrates on their own, and nutritional disorders can easily occur if feed delivery

is interrupted and heifers go without supplement for a period of time before the next delivery. This system also changes forage utilization. Heifers spend more time concentrated around feeders and, as a result, graze pastures less uniformly. Consider also that grazing is a learned behavior, and long-term grazing efficiency of heifers is an under-researched and hotly debated topic. How will heifers perform on pasture later in life if all they did was eat readily available concentrates during development?

Other aspects of the nutrition of heifer development have been investigated in efforts to improve management. Due to the cyclic nature of forage production in most pasture systems, heifer growth can be uneven, meaning periods of rapid growth are mixed with periods of little to no growth. In one study, heifers were developed to gain rapidly during the first 60 days postweaning followed by little to no growth, developed to gain steadily throughout development, or developed with little to no growth before rapid growth during the last 60 days before breeding. No difference was reported in age at puberty, conception rate, or calf performance from heifers managed under these diverse systems. Thus, it is possible to utilize moderate to low quality forages during a period of the development phase, so long as this period of little to no heifer growth is made up for with higher quality feed during another phase of development. Producers are advised to avoid abrupt changes in management or diet composition shortly prior to and during the breeding season, however, as such abrupt changes have been reported to cause reductions in pregnancy rate. As an example, turnout of heifers from a drylot development system to pasture immediately following artificial insemination was found to result in reduced pregnancy rates, even though pasture quality was high and met heifers' requirements. The authors attributed this largely to the increased activity of drylot-developed heifers that were naïve to grazing.

Extensive development systems

The idea of an extensive heifer development system is simple: put the heifers in an environment similar to the one they will face as mature cows, and let the environment identify fertile heifers. Traditionally, it is estimated that a beef cow needs to produce 3–5 calves to recover heifer development costs. Unfortunately, attrition from the beef herd is non-linear, and often the most severe fall-out of females from the herd occurs during the first three calving seasons. Some have estimated that as few as 20–40% of replacement heifers remain in the herd by the fifth calving season. Thus, if using typical replacement rates and typical cow culling and marketing criteria, heifer development is an expense-generating activity rather than a profit-generating enterprise.

A logical question is, "Should I buy heifers rather than develop?" The authors encourage producers to evaluate the profitability heifer development as though it is an independent enterprise from the cow-calf operation. For more guidance on selection and management of replacement heifers, see MU Extension publication G2028, Selection of Replacement Heifers for Commercial Beef Cattle Operations (https://extension.missouri.edu/publications/g2028). Extensive heifer development systems are not a silver bullet to reduce replacement costs for the cow herd, but integrating a profitable heifer development enterprise can improve the overall profitability of the operation. Many producers find that, when using more extensive heifer development systems, heifer development is such a profitable enterprise that more heifers should be developed and retained annually (i.e., a higher replacement rate) so that cows can be marketed before they have lost significant value (e.g., at younger ages). This can allow the operation to sustain the desired cow herd inventory but significantly reduce costs associated with cow depreciation. For more on the topic of cow depreciation, see MU Extension publication G2048, Cow-Calf Systems that Minimize Cow Depreciation Costs (https://extension.missouri.edu/publications/g2048).

It is common for feed costs to be $50–$80 per head less in an extensive development system compared to an intensive development system while maintaining reproductive performance. When considering a more extensive, lower-input system, consider whether the model results in profit potential for heifers that fail to become pregnant. Recall, feed costs are 60–70% of development costs. If the cost per lb of weight gain (COG) is greater than the value of gain, then adding weight to heifers is not profitable, unless you are being compensated for a pregnancy. For example, a 500 lb heifer purchased in November for $1.50 per lb ($750 per head) and sold in May for $1.30 per lb at 800 lb ($1,040 per head). You are compensated $290 for adding 300 lb to the heifer. Thus, your value of gain is $0.96 per lb gained ($290 / 300 lb gain). Can you feed the heifer for less than $0.96 per lb of gain? Remember, feed is not the only cost to consider. The value of your labor "yardage" should be factored in at $0.30–$0.50 per head day and the costs of breeding should be factored as well ($30–$80 per head). While it may seem impossible to put weight gain on heifers profitably in an extensive heifer development system, many operations across the country are finding success with these systems every year.

Extensive development systems may not be truly low-cost in every case, however. Forage resources used for heifer development can easily be undervalued. It is

also important to note that a lower target weight model can work effectively in drylot settings if cost of gain can be held to reasonable levels. Depending on feed costs and the performance of heifers, costs of gain can in fact be lower in a drylot setting than on pasture in many cases. There is no one right answer for all farms across Missouri. Understanding the factors at play and how they relate to your operation is key.

Example comparison of intensive versus extensive development systems

The following is an example comparison of intensive versus extensive heifer development systems using a 100-cow herd. In this system, assuming a typical replacement rate, we need to replace 15 cows per year with bred heifers. A conventional thought might be to develop 20 heifer calves as replacement heifer candidates. Often, this would be based on phenotypic evaluation at weaning. Let's assume an 85% weaning rate, with roughly half females and half males. In essence, you are selecting 20 out of 42–44 heifers.

In an extensive development system, you might develop 38–40 of the heifer calves, only culling any obviously unacceptable females (illness, injury, age, etc.). The heifers would likely be developed on forage with minimal supplement—perhaps 0.5% of body weight per day in concentrate. At a pre-breeding examination, another 2–4 heifers might be eliminated and marketed as feeder heifers due to obvious fertility issues (e.g., lack of pelvic area). The remaining 35–37 heifers would be exposed to artificial insemination or a short natural service breeding season. In the early stages, one could expect the end-of-season pregnancy rate to be less than the 80–85% one might obtain with a more intensive development system. However, even if 50% conception is achieved in the extensive system, you have created enough bred females (~18) to easily meet cow herd replacement needs. Moreover, you have added value (weight and age) to 18 non-pregnant females that can be sold at a profit.

The authors encourage producers to consider extensive heifer development systems in most cases, largely due to the positive effects extensive heifer development can have on the whole system. There are benefits to an extensive system that are not obvious at first glance but can dramatically influence the overall profitability of the farm or ranch. Bred heifers sell at a premium in the market. If your system produces an excess of high-quality bred females, they could be sold for profit. Open heifers can often be sold for a profit. Marketing bred cows prior to significant depreciation of their value can result in decreased costs and therefore increased profit margins per calf produced. These are important considerations. Additionally, producers can be more responsive to market conditions and environmental conditions (e.g., drought) when their systems involve more developing heifers and somewhat fewer cows. Growing animals are easier to market during periods of drought. Alternatively or additionally, developing more replacement heifers could allow more cows to be marketed proactively in advance and severe market declines in cow value that often result as drought worsens. The resiliency provided by these systems should be considered. It is estimated that a drought occurs twice a decade in Missouri. Far too many producers are too slow to recognize drought coming and too stubborn to reduce stocking rates to match their reduced carrying capacity, instead choosing to feed through the drought. Feeding through a drought is very expensive and often detrimental to long-term farm profitability.

Summary

The nutritional development of heifers intended to become herd replacements is a critical component of beef cowherd management. Use target weights to design a feeding program that will allow for puberty attainment without breaking the bank. Producers vary widely in opinions on intensive versus extensive management systems for the nutritional development of replacement heifers. This is to be expected, since the feed resources available to operations can likewise vary widely. The authors encourage producers to evaluate heifer development as an enterprise that must be independently profitable, while also considering the long-term impacts that can stem from heifer development decisions. Converting heifer development from an expense-generating activity to a profit-generating enterprise will have a dramatic impact on the profitability of the overall operation.

Extension
University of Missouri

Issued in furtherance of the Cooperative Extension Work Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Director, Cooperative Extension, University of Missouri, Columbia, MO 65211 • MU Extension provides equal opportunity to all participants in extension programs and activities and for all employees and applicants for employment on the basis of their demonstrated ability and competence without discrimination on the basis of race, color, national origin, ancestry, religion, sex, sexual orientation, gender identity, gender expression, age, genetic information, disability or protected veteran status. • 573-882-7216 • extension.missouri.edu