Nutritional Development of Beef Heifers

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Abstract: In order calve at approximately 24 months of age and to reach puberty the equivalent of three heat cycles before the start of the mature cow breeding season, heifers must become puberal by 11 to 13 months of age. Once puberty is attained, nutrition must be at a level that allows the heifer to continue cycling, ovulate a viable oocyte, and establish pregnancy. Nutritional demands of heifers during pregnancy exceed that of mature cows because the heifer is partitioning nutrients for her own growth as well as fetal growth and development. This increased demand for nutrients continues through early lactation, when the beef female has her highest nutritional requirements. Deficiency of energy or protein for extended periods of time during any production phase during the first two and one-half years of life will have a negative impact on: fetal development, calf viability, milk production, and/or rebreeding for the next pregnancy.

Keywords: heifer development, nutrition, puberty

Development of Beef Replacement Heifers

Replacement heifer development is a critically important because productivity for beef cattle herds has been shown to be increased when a high percentage of heifers become pregnant early in the first breeding season, and subsequently conceive for a second pregnancy.[1-4] Heifer development should result in most heifers in the replacement pool reaching puberty prior to the start of breeding.[5,6] Putting additional pressure on heifers to reach puberty at a young age is the fact that many producers breed heifers three to four weeks earlier than the mature cow herd because the length of time from calving to the resumption of cycling is longer in heifers than in cows.[7] Therefore, calving heifers earlier than mature cows gives the heifers the extra time they need to return to estrus and be cycling at the start of the subsequent breeding season.

Start with end in mind

- I want nearly all first-calf heifers to have the opportunity to conceive during the first 21 days of the breeding season for their 2nd pregnancy
- Length of average first-calf heifer post-partum anestrus is 80-120 days
    - Add 20 days for 90% of first-calf heifers to be cycling (100 to 140 days post-calving for 90% to be cycling)
- Therefore, to expect 90% of first-calf heifers to be cycling by the 21st day of the breeding season requires that heifers are bred to calve 0 to 40 days prior to the start of mature cow calving season

How old do heifers have to be to reach puberty?

Puberty in the beef heifer is reached when she is able to express estrous behavior, ovulate a fertile oocyte, and obtain normal CL function.[8] As puberty approaches, the gradually increased frequency of LH pulses results in increased secretion of LH which enhances development of ovarian follicles that produce enough estradiol to induce behavioral estrus and a preovulatory surge of gonadotropins.[9]

- The onset of puberty is primarily influenced by age and weight within breed.[10-12]
- Other factors can also have some influence on the onset of puberty and include: exposure to bulls[13,14] time of year,[15] and exposure to progestogens.[16-19]
- The average age at which cohorts of beef heifers reach puberty has been reported to range from 292 days to 678 days (9.6 to 22 months); with the average age at puberty for cohorts of *bos taurus* breed and *bos taurus*-crossbred heifers commonly utilized in North America reported to be from 303 days to 429 days (10 to 14 months).
    - While reporting average age at puberty provides valuable information, this value represents a level at which approximately 50% of the heifers have reached puberty. Usually a percentage of the replacement heifer cohort reaching puberty much higher than 50% is desired by the time of the start of the breeding season
    - Add about 30-40 days to the cohort's average age at puberty to achieve 90% having fertile cycles
    - My expectation is that 90% of heifers in many cohorts of crossbred beef heifers reach puberty by 13 months of age – however, some herds have earlier puberty, and some herds have later puberty because genetics and nutrition combine to influence age at puberty

How much to heifers have to weigh to reach puberty?

- Real question is…

"What ration should I feed cohort of replacement heifers to result in the desired number reaching puberty and becoming pregnant at the desired date?"

Need to know target weight in order to determine desired average daily gain from weaning to breeding

ADG = (Target weight – Starting weight) / Number of days

I would rather know yearling wt. (not % of mature wt) that meets the herd's goals

- What is herd goal?
    - Nearly all heifers in replacement pool reach puberty?
        - Set a high target weight (actual lbs. or 65% of mature wt.)
    - Only small-framed heifers (low mature wt.) or early maturing heifers reach puberty?
        - Use herd average mature weight – and set a low target weight (actual lbs. or 55% of mature wt.)

Weaning to breeding

The 2016 Nutrient Requirements of Beef Cattle estimations of Mcal and metabolizable protein (MP) requirements for beef heifers from weaning through early pregnancy should be used as a guideline in formulating rations for developing heifers but adjustments may need to be made to achieve the desired gains.[20] Factors such as amount of activity required for grazing, environmental temperature, breed and compensatory gain may decrease or increase the actual animal requirements when compared to the NRC estimates. Using NRC estimates plus any adjustments, one can calculate requirements to meet a desired "target-weight" at a specific time during development. If the target-weight is not met, adjustments can be made so that the desired weight at the start of the breeding season is achieved.

The target-weight concept is based on reports that *Bos taurus* breed heifers such as Angus, Hereford, Charolais, or Limousin are expected to reach puberty at about 60 percent of mature weight.[21,22] Dual purpose breed heifers such as Braunvieh, Gelbvieh, or Red Poll tend to reach puberty at about 55 percent of mature weight, and *Bos indicus* heifers, most commonly Brahma or Brahma-cross, are older and heavier at puberty than the other beef breeds; about 65 percent of mature weight.[23-27] However, in well-managed herds, opportunities may exist to lower heifer development costs by lowering traditional target breeding weights. Funston et al. (2004) found that spring-born composite (MARC II: ¼ Gelbvieh, ¼ Simmental, ¼ Angus, ¼ Hereford) heifers reaching 53 or 58% of mature body weight at breeding had similar reproduction and first calf production traits.[28] Similarly, Clark et al (2005) showed that MARC II heifers that were targeted to achieve 50 to 55% of mature body weight at first breeding had equal reproductive performance and superior economic performance when compared to heifers targeted to achieve 65% of mature body weight.[29]

Overfeeding heifers before breeding has also been demonstrated to have detrimental effects on pregnancy percentages. Heifers that gained 0.45 kg to 0.68 kg/d (1 to 1.5 pounds/day) had higher ($P<.01$) pregnancy percentages during a 45 day breeding season than did heifers with gains above or below this range.[30] Body condition scores in the same group of 1,863 heifers showed the same result with improving first-service conception rates as body condition increased up to a score of 6 and then declining in fat heifers.[30]

Although hitting a targeted weight by the start of the breeding season is important, weight gains do not need to be consistent throughout the weaning to breeding period. Researchers have shown that heifers that are fed to gain slowly followed by a period of more rapid rate gain but that reached the same target-weight and body condition score pre-breeding as heifer fed to gain at a consistent rate from weaning to breeding had the same reproductive performance.[31,32] Some studies have indicated that less feed was used to develop heifers that were fed for compensatory gain than was used by heifers that had a steady rate of growth,[31,33] but others report that a similar amount of feed is required to raise heifers to a common body weight.[34,35] This difference is probably related to the fact that increase in efficiency during a refeeding phase is not constant – the efficiency of gain is higher during the early periods of the refeeding phase and decrease over time.

Ration formulation and delivery

Social interaction within beef herds dictates a lower status to smaller, younger animals such as replacement heifers. If harvested forage or supplements are fed to groups that contain both mature cows and replacement heifers, the intake of heifers is negatively affected by dominance aggression displayed by mature cows. In addition, mature cows are able to consume 27% more alfalfa and 50% more brome hay per unit of metabolic body weight than 10-month-old heifers.[36] Improved forage utilization in cows seems to be partially due to increased digestive function, with cows have a faster rate of *in situ* NDF degradation and digestibility than heifers.[36] These constraints illustrate that higher-quality diets are required for heifers than for cows, and the need to feed heifers separately from mature cows.

Conclusions:

- Heifers fed diets deficient in energy reach puberty later, have more difficulty conceiving and calving, have lighter calves at birth, rebreed later, and wean lighter calves than adequately fed contemporaries.
- Increased pulse frequency of LH prior to puberty appears to be the critical factor in pubertal onset.
- Inhibition of GnRH secretion prevents onset of puberty when dietary energy and postweaning growth are too low.
- Provided prebreeding target weights are met, the timing and rate of post-weaning gains are not critical to reproductive performance – this may be an avenue to cost savings.

Situation with moderate weight gain (1.5 lbs/day) needed:

Situation (animal requirement / forage quality)	Outcome (Supplement Required)
Heifers that need to gain 1.5 lbs. (0.68 kg) daily with good quality forage	Need ≈4.5 lbs (2.0 kg) *as fed* DDG to meet targeted gain
Heifers that need to gain 1.5 lbs. (0.68 kg) daily with average quality forage	Need ≈5.5-6.0 lbs (2.6 kg) *as fed* DDG to meet targeted gain
Heifers that need to gain 1.5 lbs. (0.68 kg) daily with poor quality forage	Need ≈7.5-8.0 lbs (3.5 kg) *as fed* DDG to meet targeted gain

Situation with slow weight gain (0.9 lbs/day) needed:

Situation (animal requirement / forage quality)	Outcome (Supplement Required)
Heifers that need to gain 0.9 lbs. (0.4 kg) daily with good quality forage	Need ≈2.0 lbs (0.9 kg) *as fed* DDG to meet targeted gain
Heifers that need to gain 0.9 lbs. (0.4 kg) daily with average quality forage	Need ≈3.0 lbs (1.4 kg) *as fed* DDG to meet targeted gain
Heifers that need to gain 0.9 lbs. (0.4 kg) daily with poor quality forage	Need ≈5.1 lbs (2.3 kg) *as fed* DDG to meet targeted gain

Situation with rapid weight gain (2.5 lbs/day) needed:

Situation (animal requirement / forage quality)	Outcome (Supplement Required)
Heifers that need to gain 2.5 lbs. (1.1 kg) daily with good quality forage	Need ≈11.0-11.5lbs (5.1 kg) *as fed* DDG to meet targeted gain (not much forage)
Heifers that need to gain 2.5 lbs. (1.1 kg) daily with average quality forage	Need ≈11.5-12.0 lbs (5.3 kg) *as fed* DDG to meet targeted gain (not much forage)
Heifers that need to gain 2.5 lbs. (1.1 kg) daily with poor quality forage	Need ≈12.5-13.0 lbs (5.8 kg) *as fed* DDG to meet targeted gain (not much forage)

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