



Heifer Development

Lesson 5

Introduction

Development and selection of replacement heifers is probably one of the most important performance selections you have to make. Data collected by the Minnesota CHAPS processing center indicates that there is an average replacement rate of 17 percent. This data would indicate that the number of replacement heifers entering the herd is 17 percent of the herd or 17 heifers in a 100-head herd. The goal of these replacements is to produce a live calf every 365 days that is heavier than the average calf in the herd.

How heifers are developed can increase the economics of the beef operation. Over and under feeding heifers increase feed cost and reduce future heifer performance. Research has demonstrated that heifers that calve early in their first calving season continue to do so all their lives. In addition, heifers that calve early their first season will produce as much as 150 pounds more calf during their lifetime. Properly managed heifers can also result in a decreased incidence of calving difficulty. Calving difficulty reduces the annual calf crop as well as lowers rebreeding percentage and increases labor and veterinary costs.

Factors Affecting Puberty

Experiments conducted at USDA research stations demonstrated a 20 % increase in conception rates in heifers bred at their third estrus compared to heifers bred on their first (puberal) estrus. This means heifers need to be cycling at least 45 days before the breeding season for maximum early conception.

Research conducted at the Meat Animal Research and several Universities has clearly shown that genetics can influence age at puberty (first heat). Results vary depending on the breed crosses and location. However, there are some generalizations that hold true across experiments. Crossbred heifers reach puberty earlier than straight-bred heifers. Both the breed of sire and breed of dam can effect age at puberty. The next table shows breed group averages for age and weight at puberty based on data from the US Meat Animal Research Center.

Age and weight at puberty are moderately to highly heritable traits. This means that producers can use selection to improve these traits within a given herd. An easy method of selection for age at puberty in replacement heifers is to select daughters of bulls with large scrotal circumference. In general, bulls with larger scrotal circumferences have daughters that reach puberty earlier.

Breed group averages for age and weight at puberty¹

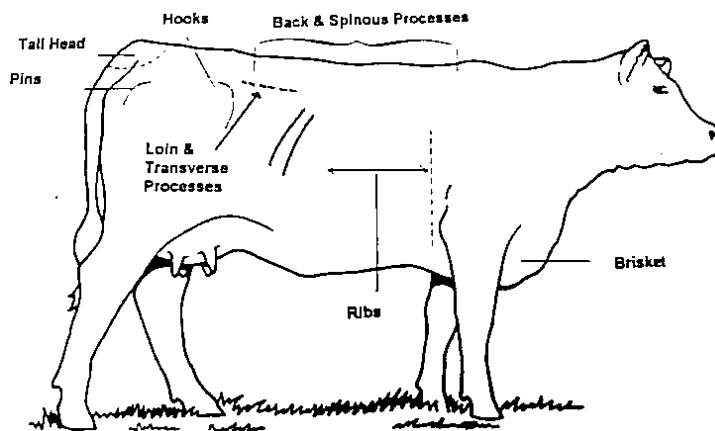
Breed Group	Wt at Puberty	Age at Puberty
Jersey – X	518	308
Hereford-Angus – X	622	357
Red Poll – X	580	337
South Devon – X	639	350
Tarentaise – X	622	349
Pinzgauer – X	611	334
Saihwai – X	642	414
Brahman – X	712	429
Brown Swiss – X	615	332
Gelbvieh – X	626	326
Simmental – X	666	358
Maine-Anjou – X	672	357
Limousin – X	679	384
Charolais – X	703	384
Chiania - X	699	384

¹ From Beef Research Report No. 2: Roman L. Hruska, U.S. Meat Animal Research Center and University of Nebraska College of Agriculture.

Melengestrol acetate (MGA) is a feed additive commonly used by the feedlot industry to suppress estrus in heifers being fed for slaughter. It can also be used to induce cyclicity in some pre-puberal heifers that are close to, but have not reached, sexual maturity (possibly due to insufficient weight or age). Melengestrol acetate also can be used as part of an estrous synchronization program as described in lesson 4. The CIDR, an intravaginal progesterone insert will also induce cyclicity in some pre-puberal heifers and first postpartum estrus cows. Additional CIDR information is available in lesson 4.

Body Condition (Nutrition)

Nutrition has a tremendous impact on developing heifers. Diets should be formulated to contain 11 to 12 percent crude protein and sufficient energy to achieve gains of 1.5 to 2.0 pounds per day, depending on weaning weight and expected mature weight of the animal. Diets also should include a balanced mineral supplement that contains trace minerals. Avoid over feeding protein as it is expensive. Grossly overfeeding energy should be avoided because of cost and fat heifers have reduced fertility rates and will deposit excess fat in the udder and potentially reduce future milk production.



Therefore it is important to monitor heifers closely during their development. An excellent evaluation method is to estimate their body condition score. Ideally, heifers should be in a

body condition score of 5-6 at breeding. Please refer to the diagram and the table listing characteristics of each body condition score.

BODY CONDITION SCORING SYSTEM

SCORE	DESCRIPTION
1	Severely emaciated. All ribs and bone structure easily visible and physically weak. Animal has difficulty standing or walking. No External fat present by sight or touch.
2	Emaciated. Similar to 1 but not weakened.
3	Very thin. No palpable or visible fat on ribs or brisket. Individual muscles in the hind quarter are easily visible and spinal processes are very apparent
4	Thin. Ribs and pin bones are easily visible and fat is not apparent by palpation on ribs or pin bones. Individual muscles in the hind quarter are apparent.
5	Moderate. Ribs are less apparent than in 4 and have less than 0.2 inches of fat on them. Last two or three ribs can be felt easily. No fat in the brisket. At least 0.4 inches of fat can be palpated on pin bones. Individual muscles in hind quarter are not apparent.
6	Good. Smooth appearance throughout. Some fat deposition in brisket. Individual ribs are not visible. About 0.4 inches of fat on the pin bones and on the last two to three ribs.
7	Very good. Brisket is full, tail head and pin bones have protruding deposits of fat on them. Back appears square due to fat. Indentation over spinal cord due to fat on each side. Between 0.4 and 0.8 inches of fat on last two to three ribs.
8	Obese. Back is very square. Brisket is distended with fat. Large protruding deposits of fat on tail head and pin bones. Neck is thick. Between 1.2 and 1.6 inches of fat on last two to three ribs. Large indentation over spinal cord.
9	Very obese. Description of 8 taken to greater extremes.

Overfeeding replacement heifers can result in increased feed costs and reduced reproductive performance. Typically heifers should be gaining from 1.5 to 2.0 pounds per day during their developmental period. Data collected from the Southwestern Minnesota Heifer Development program indicated a reduced 1st cycle conception rate on heifers with a body condition score of 6.5 or more at or shortly after weaning. Creep feeding to produce fleshier, faster gaining calves may not be advisable when developing heifers.

Under feeding heifers can also reduce reproductive performance. Research data from North Dakota indicates a reduced reproductive performance (first service conception) of heifers gaining one pound or less per day. Therefore, trying to reduce body fat shortly before breeding (reducing gain to less than one pound per day) can result in less reproduction performance.

First service conception rate based on March 26, 1999 body condition score for the 1998/1999 Southwestern Minnesota heifer development program.

Body Condition Score ^a	Number of Heifers	1 st Service Conception
5.5 or less	8	75.0
6.0	58	74.0
6.5	53	64.0
7.0 or more	63	63.0

^a 1 to 9 body condition score scale, Whisnant, 1975.

Most beef cattle today have little trouble reaching a target breeding weight. Actually it is more difficult to hold or limit heifers to 1.5 to 2.0 pound daily gain as recommended. The Southwestern Minnesota heifer development program reported lower 1st service conception rates for slow (2.25 pound or less daily gain) and fast (2.71 pounds or more daily gain) gaining heifers up to delivery date. Therefore, when selecting replacement heifers avoid the extremes (fast and slow gaining).

First service conception rate based on heifer delivery weight per day of age for the 1998/1999 Southwestern Minnesota heifer development program.

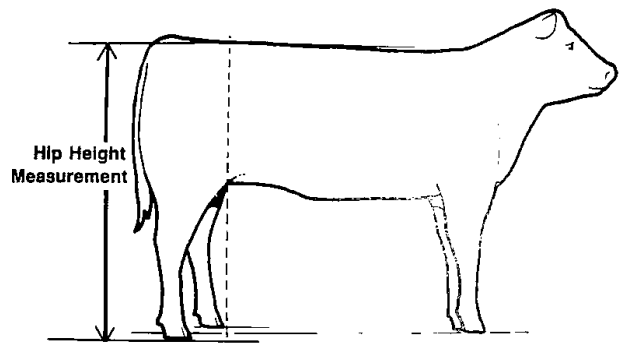
Weight per day of age ^a	Number of Heifers	1 st Service Conception
2.25 or less	36	63.9
2.26-2.40	36	69.4
2.41-2.50	30	76.6
2.51-2.70	44	75.0
2.71 or more	36	52.8

^a Weight per day of age at delivery.

Target Breeding Weight

Research has indicated a target breeding weight of 65 percent of their mature body weight to maximize reproductive performance. Heifer below this threshold will have reduced reproductive performance because there will be an increased percentage of non-cycling heifers. Little reproductive advantage is given to heifers that weigh more than the threshold of 65 percent of their mature body weight. If anything, heavy overly conditioned heifers will have a decrease in reproductive performance.

To calculate this target breeding weight you need to estimate or calculate mature body weight. Weight of mature cull cows can be used to estimate typical mature cow weight. Frame score can also be used to estimate mature body weight. To calculate frame score you need to have the age of the heifer along with measuring the hip height. The following table and formula listed at the bottom of the table can be used to calculate heifer frame scores. There is a different table and formula for male calves.



Hip Height (inches) and Frame Scores for 5 – 21 Month-Old Heifers

Age (months)	Frame Score								
	1	2	3	4	5	6	7	8	9
5	33.1	35.1	37.2	39.3	41.3	43.4	45.5	47.5	49.6
6	34.1	36.2	38.2	40.3	42.3	44.4	46.5	48.5	50.6
7	35.1	37.1	39.2	41.2	43.3	45.3	47.4	49.4	51.5
8	36.0	38.0	40.1	42.1	44.1	46.2	48.2	50.2	52.3
9	36.8	38.9	40.9	42.9	44.9	47.0	49.0	51.0	53.0
10	37.6	39.6	41.6	43.7	45.7	47.7	49.7	51.7	53.8
11	38.3	40.3	42.3	44.3	46.4	48.4	50.4	52.4	54.4
12	39.0	41.0	43.0	45.0	47.0	49.0	51.0	53.0	55.0
13	39.6	41.6	43.6	45.5	47.5	49.5	51.5	53.5	55.5
14	40.1	42.1	44.1	46.1	48.0	50.0	52.0	54.0	56.0
15	40.6	42.6	44.5	46.5	48.5	50.5	52.4	54.4	56.4
16	41.0	43.0	44.9	46.9	48.9	50.8	52.8	54.8	56.7
17	41.4	43.3	45.3	47.2	49.2	51.1	53.1	55.1	57.0
18	41.7	43.6	45.6	47.5	49.5	51.4	53.4	55.3	57.3
19	41.9	43.9	45.8	47.7	49.7	51.6	53.6	55.5	57.4
20	42.1	44.1	46.0	47.9	49.8	51.8	53.7	55.6	57.6
21	42.3	44.2	46.1	48.0	50.0	51.9	53.8	55.7	57.7

Frame Score = $-11.7086 + (0.4723 \times \text{Ht}) - (0.0239 \times \text{Age}) + (0.0000146 \times \text{Age}^2) + (0.0000759 \times \text{Ht} \times \text{Age})$, where Age = days of age and Ht = hip height.

An easy way to measure hip height is to collect that information during weighing. A board marked in inch increments can be placed on the side of the scale approximately where the heifers hip would be located. As each heifer crosses the scale place a stick, board, or level across the hips to determine the hip height. The formula or table can then be used to calculate a frame score. After a frame score is determined the following formula can then be used to calculate an estimated mature body weight for a body condition score 5 cow.

$$\text{Estimated mature body weight} = (\text{frame score} \times 75) + 800 \text{ pounds}$$

An example, a 12 month old heifer that is 51 inches tall (hip height) would be a frame score of 7.0 and would have an estimated mature body weight of 1325 pounds $[(7 \times 75) + 800]$. This is an estimate so it should be used along with typical cull cow weight to get a clear picture of mature body weights. Body condition scores can also have an effect on body weight. For each addition body condition score a cow will increase its weight 75 – 100

pounds. After the estimated mature body weight has been determined the target breeding weight (65% of mature body weight) can be calculated.

Example: 1325 pound estimated mature body weight
 Target breeding weight: 1325 x 0.65 = 861 pounds

Frame score can also be used to predict reproductive performance. Data from the Southwest Heifer development program indicates a decreasing 1st service conception rate trend as heifers increase in frame size from 5 or smaller to 7 or larger.

First service conception rate based on heifer frame score for the 1998/1999 Southwestern Minnesota heifer development program.

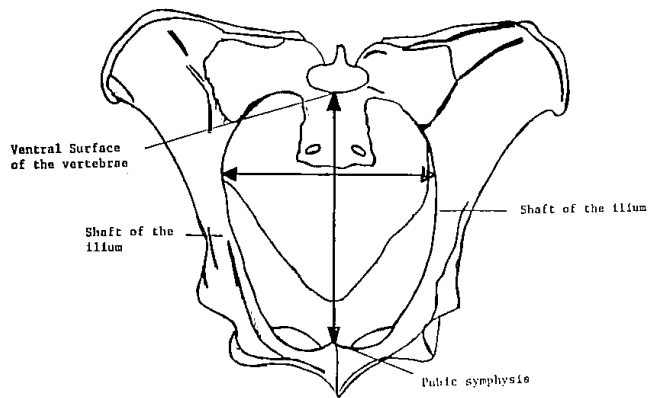
Frame Score ^a	Number of Heifers	1 st Service Conception
5 or smaller	91	70.3
6	71	66.2
7 or larger	20	60.0

^a Beef Improvement Federation Standards

Yearling Pelvic Area

Most calving difficulty or dystocia occurs in two-year-old, first-calf heifers. Research indicates that disproportion between calf size (birth weight) and size of the female birth canal (pelvic area) is a major contributor to calving difficulty. As a result, producers may use yearling pelvic measurements as a culling tool to reduce the potential incidence and severity of calving difficulty among first-calf heifers in their herds.

Pelvic measurements, as shown, should be taken between 320 and 410 days of age. Estimated pelvic area is the product of vertical and horizontal measurements. To evaluate yearling bulls and heifers, it is adjusted to 365 days of age according to the following formulas:



Bull Adj. 365-Day Pelvic Area = Actual Pelvic Area (cm²) + [0.25 x (365-Age in days)]

Heifer Adj. 365-Day Pelvic Area = Actual Pelvic Area (cm²) + [0.27 x (365-Age in days)]

Pelvic measurements should be used as a tool to help identify outliers. An absolute pelvic area varies from one specialist to the next. Compare the age adjusted pelvic measurement of a contemporary group and cull the extremely small pelvic area heifers or at least breed them to high accuracy calving easy bulls. Producers who annually evaluate pelvic area will be able to set a minimum pelvic area that works for their individual operations. Culling heifers with extremely small pelvic areas can be a useful tool to reduce dystocia. However, selecting heifers based on pelvic area will ultimately lead to larger heifers that have bigger

calves and potentially more calving difficulty. Consequently, avoid the extremes and select what works in your beef operation.

Reproductive Tract Score

Heifers must reach puberty by 15 months of age if they are to conceive and calve by 24 months, but as many as 35 percent of all beef heifers fail to reach puberty by this time. We know that first-service conception rates for heifers that are bred on their first heat are lower than those of heifers bred on a second or subsequent heat. Earlier age at puberty in relation to breeding is to ensure that a high percentage of heifers are cycling and that the effects of lowered potential fertility at the first estrus are minimized.

Because age at puberty in beef heifers is difficult and labor intensive to measure directly, a method for evaluating the reproductive tract of yearling heifers has been developed. The reproductive tract scoring (RTS) system was designed to estimate pubertal status by rectal palpation of the uterine horns and ovaries. Scores are subjective estimates of sexual maturity, based on ovarian follicular development and palpable size of the reproductive tract. Each heifer is assigned a score of 1 (immature) through 5 (cycling) as described below.

The RTS values can be used to predict reproductive performance of yearling heifers, especially for pregnancy rates to synchronized breeding and to pregnancy rates at the end of the breeding season. Heifers with more mature reproductive tracts have higher pregnancy rates and calved earlier. Preliminary data indicates that tract scores can be used to evaluate the status of heifer development and time synchronization programs and the start of the breeding season. Scoring can be done as part of a yearling heifer evaluation and health program in conjunction with collection of yearling weights, condition scores, pelvic measurements and general processing.

Reproductive tract scores	Ovaries (Size and characteristics)				
	Uterine Horns	Length (mm)	Height (mm)	Width (mm)	Ovarian Structures
1	Immature <20 mm diameter, no tone	15	10	8	No palpable follicles
2	20 – 25 mm diameter no tone	18	12	10	8 mm follicles
3	25 – 30 mm diameter no tone	22	15	10	8-10 mm follicles
4	30 mm diameter good tone	30	16	12	>10 mm follicles, Corpus luteum possible
5	>30 33 diameter good tone, erect	>32	20	15	>10 mm follicles, Corpus luteum present

Note: Reproductive tract score was determined approximately 1 month prebreeding by rectal palpation
Source: Anderson et al., 1991, *The use of reproductive tract scoring in beef heifers*. Agri-Practice 12(4):19.

Summary

Developing replacement heifers is more than just selecting heifers and turning them out with a bull. Heifers should be fed to gain 1.5 to 2.0 pounds per day for optimum reproductive

performance. Over or under feeding heifers can reduce reproductive performance and ultimately cost more money. To accomplish this goal producers need to feed heifers in a separate pen and not feed with steers or cows. To reduce dystocia pelvic measurements should be taken and careful selection of high accuracy calving ease bulls should be used. Use MGA to synchronize heifers so that they calve early in the calving season. The MGA synchronization protocol works well with an artificial insemination program and will help induce cyclicity in some pre-puberal heifers that are close to, but have not reached, sexual maturity. To maintain future reproduction feed pregnant heifers to calve in body condition score six.

Additional References and Further Reading

Developing Replacement Heifers: Birth to Breeding, NDSU, John Dhuyvetter and Greg Lardy. www.ext.nodak.edu/extpubs/ansci/beef/as1169w.htm

Developing Replacement Beef Heifers (Weaning – Breeding), NebGuide, Gene H. Deutscher. www.ianr.unl.edu/pubs/beef/g493.htm

Management Considerations in Beef Heifer Development, Univ. of Missouri, David J. Patterson, William O. Herring and Monty S. Kerley. www.muextension.missouri.edu/xplor/agguides/ansci/g02041.htm

Managing Considerations in Beef Heifer Development, Univ. of Kentucky, D.J. Patterson, K.D. Bullock, W.R. Burris, and J. T. Johns. www.uky.edu/agriculture/animalsciences/extension/beefpub.html

Replacement Heifer Development Programs, University of Nebraska, Gene Deutscher, Andy Applegarth, Dave Colburn, Rex Davis. www.ianr.unl.edu/pubs/beef/beefrpt.htm

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Lesson 5 Quiz

Heifer Development

1. True or False Crossbred heifers reach puberty earlier than straight-bred heifers?
2. True or False Age and weight at puberty are low heritability traits?
3. What feed additive can be used to induce cyclicity in some pre-puberal heifers?
4. Typically from weaning to breeding replacement heifers should be fed to gain:
 - a) 1.00 - 1.25
 - b) 3.25 - 3.75
 - c) 1.50 - 2.00
 - d) 2.50 - 3.25
5. Typically, from weaning to breeding replacement heifers should be fed diets containing what percent crude protein?
6. What is the frame score of a 12 month old heifer that has a hip height of 49 inches?
7. What is the estimated mature body weight for a frame score 5 heifer?
8. What would be the target breeding weight for the frame score 5 heifer?
9. True or False A reproductive tract score (RTS) of 1 the heifer has an immature reproductive tract and a score of 5 the heifer is cycling.
10. Pelvic Measurements should be taken when the heifers are how old?

Please list any questions you may have that weren't answered in this lesson:

Name _____ Phone _____

Address _____

(Optional) Fax _____ E-mail _____

Lesson 5 Quiz Answers

Heifer Development

1. **True** or False Crossbred heifers reach puberty earlier than straight-bred heifers?
2. True or **False** Age and weight at puberty are low heritability traits?

Age and weight at puberty are moderately to highly heritable traits

3. What feed additive can be used to induce cyclicity in some pre-puberal heifers?

Melengestrol acetate (MGA)

4. Typically from weaning to breeding replacement heifers should be fed to gain:
 - a. 1.00 - 1.25
 - b. 3.25 - 3.75
 - c. **1.50 - 2.00**
 - d. 2.50 - 3.25
5. Typically, from weaning to breeding replacement heifers should be fed diets containing what percent crude protein?

11 to 12 % Crude Protein

6. What is the frame score of a 12 month old heifer that has a hip height of 49 inches?

From the table the 12 month old heifer that is 49 inches tall is a frame score 6 heifer. More accurate frame score can be calculated using the formula and the exact heifer age.

7. What is the estimated mature body weight for a frame score 5 heifer?

Estimated mature body weight: $(5 \times 75) + 800 = 1175$ pounds

8. What would be the target breeding weight for the frame score 5 heifer?

Target Breeding weight: $1175 \times 0.65 = 764$ pounds

9. **True** or False A reproductive tract score (RTS) of 1 the heifer has an immature reproductive tract and a score of 5 the heifer is cycling.

10. Pelvic Measurements should be taken when the heifers are how old?

Pelvic measurements should be taken between 320 and 410 days of age and adjusted to 365 days of age.