HEIFER DEVELOPMENT
Lesson 4
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GROWING PHASE

PUBERTY

Puberty is defined in heifers as the time when they first ovulate and show an estrus or heat period. The process involves sensitivity to and regulation of hormones and receptors in the brain (specifically the hypothalamus) and the sex organs or ovaries in females.

Heifers born early in the calving seasons are usually heavier at weaning and reach puberty earlier than heifers born late in the calving season. Heifers must reach puberty by 13-14 months of age to calve as two-year-olds. Puberty is influenced by age, weight and breed.

Yearling beef heifers conceiving early in their first breeding season, will have increased lifetime production and efficiency. It is critical that these heifers attain enough weight to initiate their first estrous cycle before the onset of the breeding season. Puberty occurs when heifers reach about 60-65% of their mature weight. Montana research indicates that conception rate is higher on the third estrus compared to the first. Getting heifers to target weights a month prior to the breeding season may increase the percentage conceiving early in the breeding season. Recent research has suggested that development of heifers to 50 to 57% of mature body weight may present an economic advantage over developing heifers to 60 to 65% of mature body weight (for review see Endecott et al., 2013). However further research is necessary to assess the relative effects of these two strategies on cow longevity and economic efficiency.

The following weights should be attained for puberty about a month prior to breeding (Table 9).

Table 9. Relationship of frame score to estimated weight at first estrus.

	Frame Score				
	1	3	5	7	9
Estimated weight at first estrus, lb	580	623	728	803	880

Source: Fox, D. G., C. J. Sniffen, and J. D. O'Connor. 1988. Adjusting nutrient requirements of beef cattle for animal and environmental variations. Journal of Animal Science 66:1475.

Puberty: Individual Weights vs. Group Weights: Individual weights rather than group weights should be considered for replacement heifers. If a group of similar breed-type heifers averages 650 pounds, that may mean some only weigh 500 pounds and are not ready for breeding. Heifers born in a short calving season should be relatively uniform in weight and would not need to be fed in different groups to reach the desired weight. North Dakota data suggests that deworming can improve uniformity of performance.

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Puberty: Scrotal Circumference

Research shows that bulls with a larger scrotal circumference tend to sire heifers that reach puberty at an earlier age than bulls with a smaller scrotal circumference. In those breeds that have a scrotal circumference EPD, breeder should use them to improve age at puberty.

Numerous studies have reported both between-breed and within-breed differences in age and weight at puberty as well as subsequent reproduction in beef cattle. To achieve optimum production levels, it is important to know the relationships between puberty traits and measures of productivity for effective use of selection, heterosis and complimentarity. Breed differences, sire and dam effects within a breed, and heterosis, or hybrid vigor, contribute to genetic control of age at puberty.

Age at puberty can be decreased in three ways:

- By selecting a breed with younger age at puberty.
- By selecting within a breed for younger age at puberty.
- By crossbreeding with another breed that has a similar or younger age at puberty.

Puberty: Diversity among breeds

Table 10 groups breed crosses according to their biological type and four other criteria. The table summarizes data from the Meat Animal Research Center for 19 F1 crosses grouped into seven biological types based on relative differences (1 = lowest, 6 = highest) in growth rate and mature size, lean-to-fat ratio, age at puberty, and milk production. Faster-gaining breed groups of larger mature size reach puberty at later ages than do slower-gaining breed groups of smaller mature size. Breeds that have had a history of selection for milk production (e.g., Gelbvieh, Brown Swiss and Simmental) tend to weigh less at puberty than do those with the same genetic potential for growth and mature size that are not selected for milk production (e.g., Charolais, Limousin and Chianina).

Table 10. Breed crosses grouped in biological type on the basis of four major criteria.

Breed group	**Growth rate & mature size**	**Lean:fat ratio**	**Age at puberty**	**Milk production**
Jersey	1	1	1	5
Hereford-Angus	2	2	3	2
Red Poll	2	2	2	3
Devon	2	2	3	2
South Devon	3	3	2	3
Tarentaise	3	3	2	3
Pinzgauer	3	3	2	3
Brangus	3	2	4	2
Santa Gertrudis	3	2	4	2
Sahiwal	2	3	5	3
Brahman	4	3	5	3
Brown Swiss	4	4	2	4
Gelbvieh	4	4	2	4
Holstein	4	3	2	6
Simmental	5	4	3	4
Maine-Anjou	5	4	3	3
Limousin	3	5	4	1
Charolais	5	5	4	1
Chianina	5	5	4	1

Note: 1 = lowest, 6 = highest

Source: Cundiff, L. V. 1986. The effect of future demand on production programs-biological versus product antagonisms. Beef Improvement Federation Proceedings. Pp. 110—127.

Table 11. Age and Weight at Puberty for Crossbred Heifer of Different Breeds.

Breed	Age, days	Weight, lbs.
Jersey – X	308	518
Gelbvieh – X	326	626
Brown Swiss – X	332	615
Pinzgauer – X	334	611
Red Poll – X	337	580
Tarentaise – X	349	622
South Devon – X	350	639
Hereford-Angus – X	357	622
Main-Anjou – X	357	672
Simmental – X	358	666
Limousin – X	384	679
Chianina – X	384	699
Charolais – X	384	703
Sahiwal – X	414	642
Brahman – X	429	712

Heifers sired by breeds with a large mature size tend to be older and heavier at puberty than heifers sired by breeds with a smaller mature size. The relationship between mature size and age at puberty can be offset by associations with milk production (i.e., heavier milking breeds or lines within a breed will reach puberty at younger ages and lighter weights). When these interpretations are expanded to mature cows, it is evident that the additional nutrient requirements of cows of large size and higher milk production potential must be met or the intervals from calving to first estrus will increase and conception rates will decline.

Bull Exposure: University of Nebraska research indicates that exposing heifers (from weaning to breeding) to surgically altered (gomer) bulls can reduce age at puberty and increase the number of heifers bred during the first 21 days of the breeding season. However, other results have been variable.

TARGET WEIGHT CONCEPT: The Target Weight Concept is a method to control the amount of gain. We thereby assure the heifers attain enough gain to attain puberty but also avoid getting them too fat. Rates of gain not lower than 1 lb. or greater than 2.O lbs. per day reflect the needs of most of our current cattle population. For example, a heifer weighs 450 lbs. at weaning and has a target puberty weight of 675 lbs. There are 200 days between

weaning and breeding. We would actually prefer her to reach puberty weight at least 2 to 3 cycles before breeding (160 days).

(675-450)/160 = 1.4 lbs of gain per day

Rations can be formulated to meet the nutritional requirements for this amount of gain. The rate of gain need not be constant over the entire period, as long as the target weight is reached. Typical gain targets from weaning to breeding are 1.25 to 1.5 lbs per day for British breed type heifers and 1.5 to 1.75 lbs per day for Continental breed types. Some research identifies advantages to developing heifers in stages of reduced energy and gain followed by periods of compensatory growth. A slight reduction in feed expenses has been shown for heifers developed at fairly slow rates of gain early followed by a period of accelerated growth just prior to breeding.

Table 12. Target weights and gains for developing replacement heifers

Stage of development	**Age, months**	**Target weight, lbs**	**% of mature**	**Target gain lbs/day**
Weaning period	8	450	41	1.75
Post-weaning to breeding	9	500	45	1.25
Breeding to calving	14	684	62	.8
Calving to rebreeding	23	880	80	.4
Second breeding season	27	927	84	.4
Second calving	36	1012	92	.2

The gain can be increased through supplementation during the winter feeding period if previous experience on the farm tells us that heifer gains on pasture just prior to the breeding season are less than adequate. Heifers going to adequate pasture, prior to breeding can be expected to gain from .75 to 1.4 pounds daily. Knowing forage quality means knowing whether protein, energy or both must be supplemented. Computer ration balancing services are available through the county extension offices and probably through the local feed dealer.

Table 13. Minimum Nutrient Requirements of Heifers
(100% Dry matter basis, NRC-1996)

Body Wt. (lbs)	ADG (lbs)	Intake (lbs/day)	TDN (%)	Nem (Mcal/lb)	Neg (Mcal/lb)	CP (%)	Ca (%)	P (%)
Medium Frame								
400	1.0	10.4	59	.57	.31	10.4	.39	.20
	1.5	10.7	64	.64	.37	12.1	.50	.24
	2.0	10.7	69	.72	.44	14.1	.62	.29
500	1.0	12.2	59	.57	.31	9.8	.34	.18
	1.5	12.6	64	.64	.37	11.2	.42	.22
	2.0	12.7	69	.72	.44	12.8	.52	.25
600	1.0	14.0	59	.57	.31	9.4	.30	.17
	1.5	14.4	64	.64	.37	10.6	.38	.20
	2.0	14.6	69	.72	.44	11.9	.44	.22
700	1.0	15.8	59	.57	.31	9.0	.28	.16
	1.5	16.2	64	.64	.37	10.1	.33	.19
	2.0	16.3	69	.72	.44	11.4	.39	.21
Large Frame								
400	1.0	10.3	58	.56	.30	10.4	.39	.20
	1.5	10.6	63	.63	.36	12.2	.51	.25
	2.0	10.7	68	.70	.42	14.1	.63	.30
500	1.0	12.2	58	.56	.30	9.8	.34	.18
	1.5	12.6	63	.63	.36	11.2	.43	.22
	2.0	12.6	68	.70	.42	12.9	.53	.26
600	1.0	14.0	58	.56	.30	9.3	.31	.17
	1.5	14.4	63	.63	.36	10.6	.38	.20
	2.0	14.4	68	.70	.42	12.1	.46	.23
700	1.0	15.7	58	.56	.30	9.0	.29	.17
	1.5	16.2	63	.63	.36	10.1	.34	.19
	2.0	16.3	68	.70	.42	11.3	.41	.21

Energy Requirement - Listed requirements are for cattle under thermoneutral conditions. Increasing listed requirement for TDN by 1% for each 1 degree drop below 10øF for cattle in winter hair should be

sufficient in adjusting for cold temperatures. Under dry cold conditions to -10°F intake may increase to compensate.

Protein Requirements - Listed requirements should be adequate in 50% of cases. Increasing listed requirement by 15% should be sufficient in 85% of cases. Increasing listed requirement by 30% should be sufficient in 100% of cases.

Mineral Requirements - In addition to listed calcium and phosphorous requirements, the following are suggested minimum requirements for trace minerals: sodium chloride .08%, potassium .65%, magnesium .10%, sulfur .10%, cobalt 10 ppm, iodine .5 ppm, iron 50 ppm, manganese 40 ppm, selenium .20 ppm, zinc 30 ppm.

Vitamin Requirements - Suggested requirements for growing heifers per pound of dry ration are 1000 IU/Vit A, 125 IU/Vit D, and 5-25 IU/Vit E.

Heifers are commonly developed most economically on high forage rations supplemented with grains and grain by-products, protein concentrates, and minerals. Table 14 gives example rations based on varying forage quality, heifer weight, and gain.

Table 14. Example rations for developing replacement heifers.

Hay Quality			
Heifer Weight	Low	Average	High
Medium Frame – 1.5 Target ADG			
400 lbs.			
Hay, lbs	9.0	11.0	12.5
Grain Mix, lbs	5.0	3.5	2.0
Protein suppl., lbs	.5	.1	-
Mineral suppl., lbs	.2	.1	-
600 lbs.			
Hay, lbs	13.0	15.0	18.0
Grain Mix, lbs	7.0	5.0	2.0
Mineral suppl., lbs	.1	-	-
Large Frame – 1.75 Target ADG			
500 lbs.			
Hay, lbs	10.5	13.0	15.0
Grain Mix, lbs	6.5	4.5	2.5
Mineral suppl., lbs	.2	-	-
700 lbs.			
Hay, lbs	17.0	19.5	23.5
Grain Mix, lbs	10.0	7.5	3.5
Mineral suppl., lbs	.2	-	-
* The Grain Mix is 84% TDN, 13% CP			

Forages vary considerably in level of protein and energy and should be analyzed in order to accurately balance rations. Corn silage typically is higher in energy than most forages but only moderate in protein and will produce adequate heifer growing gains with little or no grain feeding if protein levels are balanced. There is limited opportunity for use of crop residues such as straw or corn stover in the growing heifer's diet, since these

products are generally low in energy, protein, vitamins, and minerals. Gains of about 1 to 1.5 pounds per day might be anticipated by heifer calves grazing corn stalks in late fall and early winter when supplemented with protein, vitamins, and minerals.

Insufficient energy intake results in poor growth and can have devastating effects on breeding performance of heifers as yearlings and on their subsequent performance in the cowherd. Table 14 shows the results of research which examined the effect of winter nutrition level on heifer development, reproductive performance and calf production.

Table 15. Effect of winter nutrition level during heifer development on subsequent performance of replacement heifers.[1]

	Pounds of Grain per Head per Day		
	0	2.7	5.4
Number of heifers	112	113	112
Initial weight , lbs	496	502	493
ADG, winter period, lbs	0.07	0.50	0.80
Breeding weight, lbs	506	577	613
% bred as yearlings (60 days)	69.2	73.9	83.5
Subsequent Production			
% rebred after first calf	67.3	75.4	87.1
Weaning weight of first calf, lbs	405	433	443

[1]*Adapted from Lemenager et al., 1980*

Producers should consider splitting the heifers into two or more feeding groups (based on weight) if a large group of heifers will be developed. This will allow more precise feeding of each group based on necessary target breeding weights and daily gains.

Weaning and first appearance of the heifer into the growing lot is a critical period. Calves which have not been creep fed must be trained to eat harvested forage and grain from a bunk. It is important that first feeds are highly palatable, safe, and high in nutrients. Complete commercial starter feeds are convenient choices.

Water, minerals and vitamins are sometimes the forgotten nutrients. Feed analysis will help assure you are meeting their needs. Remember, the supplement you use for forage-based diets and grain-based diets probably are not the same. Work with someone knowledge able of nutrition in meeting these nutritional needs.

Table 16. General recommendations for mineral needs.

Mineral	Range in Mineral Level	Recommended Level in TM Salt[1]	4 oz mix[2]	Maximum Tolerable[3]
Copper	10 ppm-15 ppm[4]	.50 %	.13 %	100 ppm
Zinc	30 ppm-20 ppm	.72%	.18%	500 ppm
Selenium	.1 ppm-.3 ppm	.01%	.0026%	2 ppm
Manganese	20 ppm-40 ppm	.72%	.18%	1000 ppm
Iodine	.3 ppm-.5 ppm	.01%	.0026%	50 ppm
Cobalt	.1 ppm-.2 ppm	.0072%	.0018%	10 ppm
[1]Consumed at 1 oz/hd/day.				
[2]Supplement with target intake of 4 oz/day per animal unit.				
[3]Maximum level that can be tolerated in the diet.				
[4]Recommend 10 ppm for British breeds and 15 ppm for continental breeds				

If a scale is available, it is helpful to weigh the heifers every 30 to 60 days to insure they are on target. If all heifers cannot be weighed, 10 to 20 percent that are representative of the group could be weighed to estimate how the whole group is performing. Diets can be slightly modified in response to observed performance.

COST OF PRODUCTION THROUGH GROWING PHASE: The cost of production through the growing phase will be approximately $400 to $550. However, the producers own costs of production are more accurate.