Growth Management of Dairy Replacement Heifers

A.L. Skidmore
Department of Animal Science
Michigan State University

With milk prices becoming market-driven and profit margins more variable, the dairy industry is changing and becoming more competitive every day. As in the past, the objective of any heifer rearing operation is to produce high quality heifers at a reasonable cost. The cost of raising dairy replacement heifers is an even more significant consideration for the producer.

GROWTH

- Growth rate varies with time
- Puberty is body size not age dependent
- Prepubertal high rate of gain, no detriment with balanced diet
- Fat accumulation must be controlled

First, it is important to distinguish between true growth and fattening. True growth is an increase in structural tissues such as muscle, bone, and vital organs. It also is important to remember that the adult milking cow is not merely an enlarged version of the newborn calf. The body's structure, proportions, and composition all change as the heifer matures.

A fundamental principle of true growth is represented by an S-shaped (sigmoid) curve.[3] (See Figure 1.) For a period of time after birth, an animal goes through a phase of very slow growth, followed by an accelerated growth of structural tissues. During latter stages, growth rates of muscles, bones, and vital organs slow and fattening accelerates. The concept of variable growth rates is easily visualized by looking at an average daily gain curve, which illustrates the daily change in body weight. (See Figure 2.)

It also is important to distinguish between chronological age and physiological age in heifer growth management. Chronological age is defined in days, weeks, months, or years. Physiological age is dependent on mature body size and not on time. It can be described as a percentage of mature body size. Heifers should be managed so they achieve a certain percent of mature body size by a given period of time. For example, heifers reach puberty at approximately 45% of their mature body size. If mature weight will be 1,470 pounds, then puberty would occur at about 600 pounds. Puberty can occur as young as 7-8 months or as late as 15 months, depending on the growth rate. Heifers should be bred at approximately 55% of mature body weight and have a postcalving weight at approximately 85% of mature body size. For the same 1,470 pound mature size, heifers should be bred at about 800 pounds and postcalving body weight should be about 1,250 pounds. Therefore, it is necessary to develop a growth strategy to achieve the desired weight and size at specific points in time.

From the concept of mature body size, energy and protein requirements for optimum growth and development can be determined because body composition at a given weight is predictable. Avoid maximum retention of energy because it results in fat tissue

EXTENSION BULLETIN E-2580 • SEPTEMBER 1995
This bulletin accompanies videotape VT-52

Figure 1. A typical growth curve for a Holstein heifer.

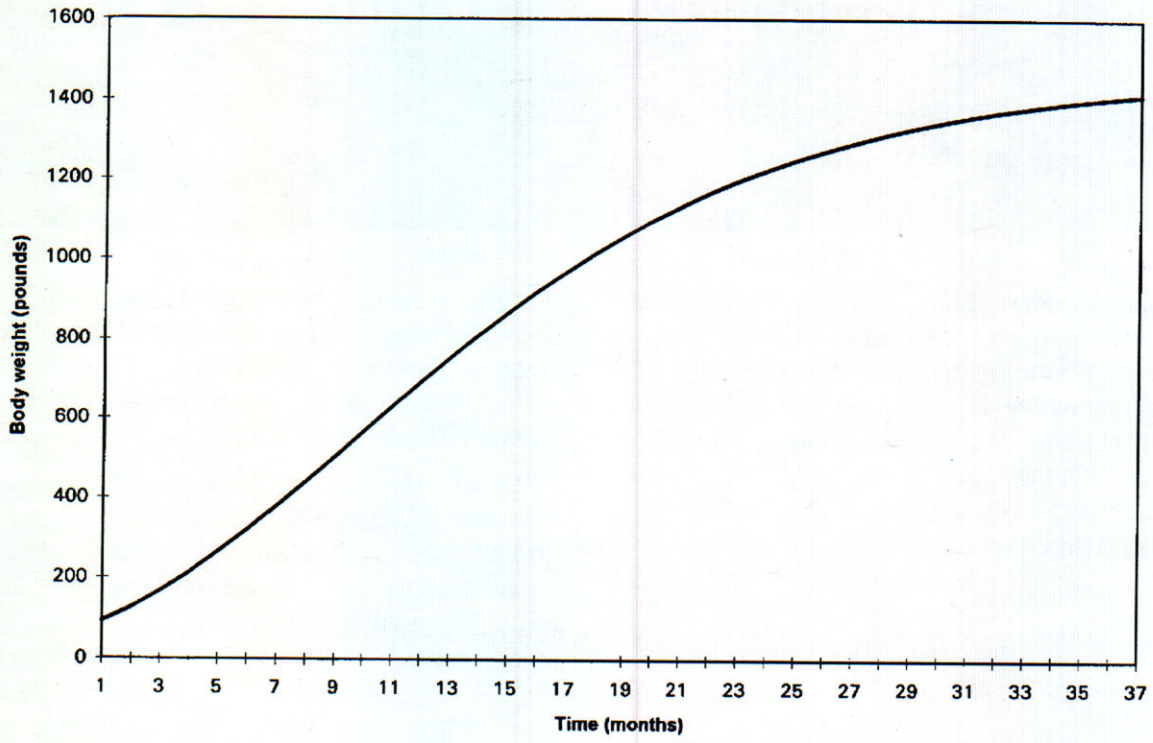
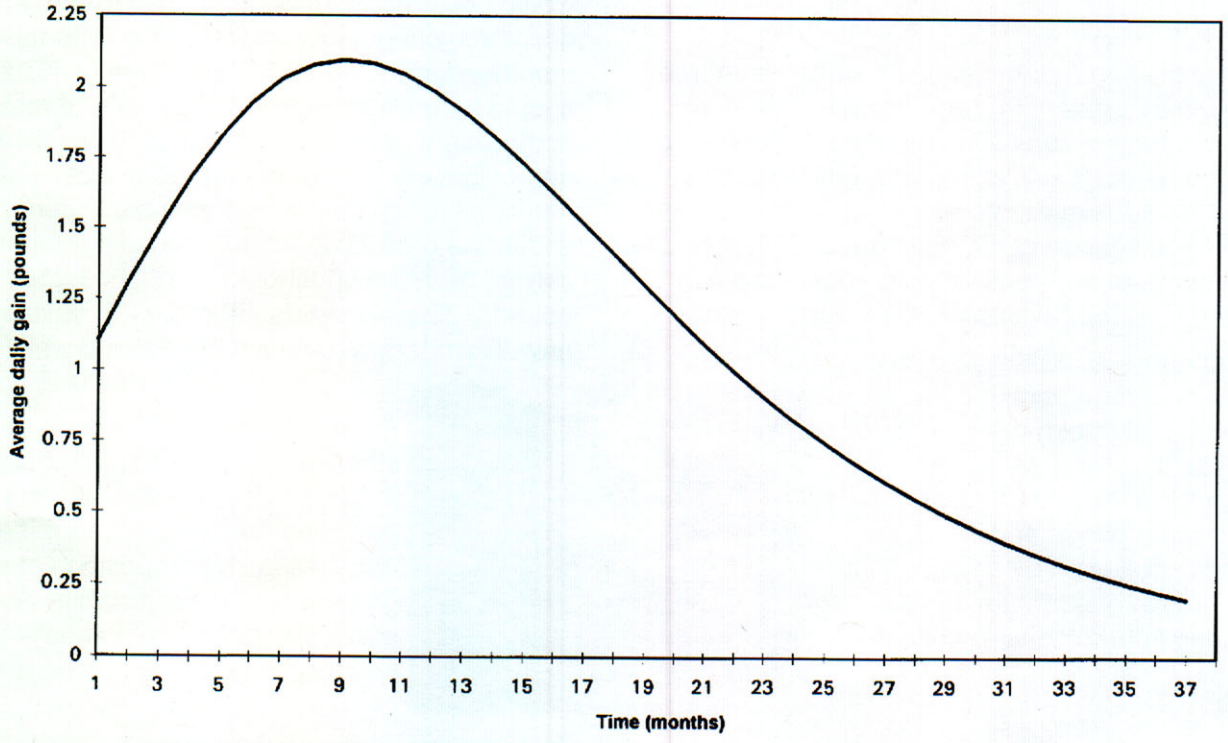


Figure 2. A typical average daily gain curve for a Holstein heifer.



accumulation which must be controlled for optimal growth.

The concept of optimal growth also is related to how rates of gain during the prepubertal growth period affect mammary gland development. In 1994, Michigan State University conducted an experiment to study how optimum growth rates affect mammary gland development. The first stage of the experiment dealt with fat deposition in the mammary gland. Feeding prepubertal heifers a diet balanced for protein and energy at a high rate of gain (2.65 pounds/d) did not detrimentally affect mammary tissue growth.[5] A second experiment is being done by MSU to determine the optimum growth rates that will maximize mammary development and milk production.

Although genetic potential dictates the maximum amount of growth and development that are possible, nutrition and other environmental factors govern the actual rate of growth and development attained. Nutrients are utilized among various tissues and organs according to their metabolic rate and physiological importance. If the nutrient supply is limited, tissues are affected in reverse order of physiological importance. Table 1 lists the priorities and partitioning of nutrients among body systems, tissues, and physiological function.[3]

When nutrition levels are low and then increased, there is a marked recovery in growth rate known as compensatory growth. Because growth recovery is greater for fat than for muscle (protein)and bone, especially after puberty, the heifer can become excessively fat. If undernutrition occurs early in the growth period, long-lasting effects are greatest on the earliest maturing tissue (bone) and least on the latest maturing tissue (fat).[3]

NUTRITION

- Balanced quality forage based diets increase intake and growth
- Animal, environmental and management factors affect nutrient requirements
- Protein supplementation is dependent on forage source and quality
- Use ionophores when indicated

Heifers in commercial herds are often fed a restricted amount rather than free choice. While this is seldom done intentionally, restricted diets often cause inconsistent growth. Heifers that are fed balanced, quality forage-based diets tend to eat more than predicted and grow faster without getting fat. It has been demonstrated that heifers from 3 to 10 months of age can gain 2 to 2.2 pounds per day without getting excessively fat.[6] Accurate dry matter intake predictions or actual known intakes are critical in establishing dietary recommendations. In Table 2 are general dietary requirements for heifers to grow 2 to 2.2 pounds per day and calve at 21 months of age and weighing more than 1,200 pounds postcalving.[7] Holstein heifers should weigh 1,300 to 1,400 pounds precalving.

Dietary energy level is very important in managing heifer performance. Environmental and management conditions impact energy requirements. Table 3 lists animal, environmental and management factors that may affect replacement heifer nutrient requirements.[2] Table 4 illustrates the change in energy requirements due to varying environmental conditions.[2] Avoid excessive energy intake and maintain a minimum dietary fiber level (25% NDF).

Dietary energy level is not the sole factor for improving heifer performance. Dietary protein level also is very important. Protein or nitrogen supplementation should be dependent on forage source and quality. The animal requires adequate degradable protein and/or nonprotein nitrogen to provide the rumen with adequate N for microbial protein synthesis. Maximizing rumen microbial output by supplying protein or nitrogen in forms that match carbohydrate fermentation rates is the simplest and least expensive type of supplementation. At the growth rates expected for dairy replacement heifers, rumen microbial synthesis should be adequate to supply body tissue demands for amino acids, provided the diet is balanced for protein and energy and contains relatively high quality forages.

Animals cannot synthesize tissue proteins beyond their genetic potential by consuming excess protein, but the rate of tissue accretion (growth) is reduced readily by inadequate dietary protein. If an animal consumes a surplus of protein, the excess is broken down and used as energy, or stored as fat and the nitrogen is excreted in the urine.

The use of ionophores in heifer rations also is an accepted and advisable management practice in many rearing systems. When used in dairy heifer rations, ionophores prevent coccidiosis and can increase rate of gain and feed efficiency.[4] However, there are situations when the use of an ionophore may not be desirable. For instance, high energy diets may not benefit from an ionophore, especially if the heifer is increasing in body condition beyond a reasonable level. When ionophores are used in situations where body condition is increasing, more accurate feed intake and body growth monitoring are required. In this case the manager must target the growth rate, much the same as targeting milk production, and then feed to that rate of gain. This may require limit feeding or dietary energy concentration reduction. Limit feeding will not decrease subsequent milk yield or limit subsequent dry matter intake as long as adequate growth is maintained.[6] Dietary energy concentration reduction can be accomplished by adding lower quality forage to the diet. Either strategy permits rapid gains and avoids overconditioning, but heifers must be closely monitored.

A common mistake made by dairy producers is that they design their replacement heifer feeding program with sufficient energy and protein to support rapid gain and, in addition, supplement with an ionophore. This results in more energy being available than needed and heifers may become excessively fat. Adding an ionophore increases the energy derived from the diet by approximately 10%, thereby increasing efficiency and decreasing the amount of energy required.[1] Ionophores are a good management tool but will not replace excellent quality feeds and other good management practices.

MONITORING GROWTH

- Regular weighing necessary
- Body condition scores or wither or hip heights necessary
- Establish growth strategy

Regular growth monitoring of heifers is critical to the success of any heifer growth program.

Regular body taping or weighing is advised to ensure that proper rates of gain are being achieved. The most expensive part of raising replacement heifers is feed. A good weighing program can provide accurate information about daily gains, which allows the producer to formulate diets specifically for optimal growth.

Because wither or hip heights are sometimes difficult to obtain, body condition may be used as an alternative. From birth to 4 months of age, a score of 2 - 2.5 is acceptable. From 4 months until the last 2 months of gestation, a score of 2.5 - 3.5 is acceptable. In the last 2 months of gestation as the heifer builds up reserves for lactation, a score of 3.5 - 3.75 is acceptable.

There are many different published growth standards for replacement heifers. Table 5 contains the calculated growth standards or strategies to achieve three different ages at first calving for Holsteins with post-calving weights of 1,250 pounds. The average daily gain values in Table 5 do not include the weight of the pregnancy. The weight of pregnancy should not be included in the average daily gain used to derive nutrient requirements for growth. The nutrients needed for pregnancy are already added when nutrient requirements are adjusted for days pregnant. In Table 5, the weight of the pregnancy and total body weight have been included in the 21 month age at first calving growth strategy. The weight of pregnancy can be added to any other growth strategy to get total body weights. Managers need to decide on a growth strategy that is appropriate for their situation or calculate a more appropriate strategy.

Optimum growth of replacement heifers requires knowledgeable management of protein and energy levels in the ration. Diets balanced to ensure proper rumen function lead to proper body growth and health. Forage analysis and consistent monitoring of growth and body condition allows producers to raise heifers at optimal growth rates and maximize lifetime profitability.

ACKNOWLEDGEMENT

The author acknowledges the editorial assistance of Nancy Ransom.

REFERENCES

[1]Elanco Animal Health. 1978. Rumensin Technical Manual for Pasture and Range Cattle. Elanco Animal Health, Indianapolis, IN.

[2]Hoffman, P.C. 1994. Nutrition and environment - improving heifer growth. Proceedings of the Missouri Dairy Conference, Columbia, MO. University of Missouri-Extension, Columbia.

[3]Judge, M.D., E.D. Aberle, J.L. Forrest, H.B. Hedrick, and R.A. Merkel. 1989. Principles of Meat Science. 2nd ed. Kendal/Hunt Publishing Company, Dubuque, IA.

[4]Meinert, R.A., C.M.J. Yang, A.J. Heinrichs and G.A. Varga. 1992. Effects of monensin on growth reproductive performance and estimated body composition in Holstein heifers. J. Dairy Sci. 75:257.

[5]Radcliff, R.P., M.J. Vandehaar, A.L. Skidmore, R.L Fogwell, L.T. Chapin, E.P. Stanisiewski, and H.A. Tucker. 1995. Effects of prepubertal diet and exogenous bST on mammary development of dairy heifers. J. Dairy Sci. 78:(in press) (Suppl. 1).

[6]Van Amburgh, M.E. and D.M. Galton. 1994. Accelerated growth of Holstein heifers - Effects on lactation. Cornell Nutrition Conference for Feed Manufacturers. Page 147. Cornell University, Ithaca, NY.

[7]Van Amburgh, M.E., D.M. Galton, D. Fox, and D. Bauman. 1991. Optimizing heifer growth. Cornell Nutrition Conference for Feed Manufacturers. Page 85. Cornell University, Ithaca, NY.

[8]Skidmore A.L. 1990. Development of a Simulation Model to Evaluate Effectiveness of Dairy Herd Management. Ph.D. Dissertation. Cornell University. Ithaca, New York.

Table 1. Priority and partition of nutrients among body systems, tissues and physiologic functions.

Priority	Systems	Tissues	Physiological function
Highest	Nervous	Skeletal	Maintenance
↑	Circulatory	Muscle	Pregnancy
	Respiratory	Adipose	Growth
	Digestive	Mesenteric	Lactation
	Reproductive	Perirenal	Body Reserve Repletion
		Subcutaneous	
		Intermuscular	
		Intramuscular	
Lowest			

Adapted from Judge et al. 1989 and Skidmore 1990.

Table 2. Dietary guidelines for accelerated heifer growth (2 to 2.2 lbs/d, 1,200 lbs post calving at 21 months of age).

Weight (lb)	DMI (lb/d)	CP (% of DM)	UIP (% of CP)	NEm (Mcal/d)	NEg (Mcal/lb)	TDN (%)
200 - 400	7 - 9	17	35 - 45	2.5 - 4.25	.52 - .56	70 - 74
400 - 600	10 - 14	16 - 17	35 - 40	4.25 - 5.75	.48 - .52	68 - 70
600 - 800	15 - 18	15 - 16	25 - 35	5.75 - 7.15	.42 - .45	64 - 68
800 - 1,000	19 - 24	14 - 15	15 - 20	7.15 - 8.45	.38 - .42	60 - 64
1,000 - 1,350	25 - 35	12 - 14	10 - 15	8.45 - 10.6	.30 - .35	60 - 64

DMI = dry matter intake
CP = crude protein
UIP = undegraded intake protein
NEm = net energy for maintenance
NEg = net energy for gain
TDN = total digestible nutrients

Adapted from Van Amburgh et al., 1991.

Table 3. Animal, environmental and management factors that may affect nutrient requirements of replacement heifers.

Animal Factors	Management Factors
body size	housing type
age	ionophore use
days pregnant	feed stability
body condition	feed quality
hair coat (thickness, length)	feed bunk space
Environmental Factors	dietary forage to concentrate ratio
ambient temperature	animal density
amount of mud on the body	pasture quality
ventilation	pasture stocking rate
wind speed	water quality
humidity	water availability
cold stress	disease
heat stress	parasites
precipitation	bedding/resting area

Adapted from Hoffman, 1994.

Table 4. Effect of temperature and body mud on NE_m requirements of dairy replacement heifers.

		Heifer weight (lbs)											
		300			600			900			1200		
°C	°F	None[1]	Medium[1]	Heavy[1]	None	Medium	Heavy	None	Medium	Heavy	None	Medium	Heavy
					NE_m mcal								
30	86	3.1	3.1	3.1	5.3	5.3	5.3	7.2	7.2	7.2	8.9	8.9	8.9
25	77	3.3	3.3	3.3	5.5	5.5	5.5	7.5	7.5	7.5	9.3	9.3	9.3
Summer[2]													
20	68	3.4	3.4	3.5	5.8	5.8	5.8	7.8	7.8	7.8	9.7	9.7	9.7
15	59	3.6	3.6	3.6	6.0	6.0	6.0	8.1	8.1	8.1	10.1	10.1	10.1
10	50	3.7	3.7	3.7	6.2	6.2	6.2	8.4	8.4	8.4	10.5	10.5	10.5
Fall/Spring													
25	41	3.8	3.8	3.8	4.0	6.5	6.5	8.8	8.8	8.8	10.9	10.9	10.9
0	32	4.0	4.0	4.0	6.7	6.7	6.7	9.1	9.1	9.1	11.3	11.3	11.3
-5	23	4.1	4.1	4.2	6.9	6.9	6.9	9.4	9.4	9.4	11.7	11.7	11.7
Winter[2]													
-10	14	4.3	4.3	5.3	7.2	7.2	8.4	9.7	9.7	10.6	12.1	12.1	12.1
-15	5	4.4	4.7	6.3	7.4	7.4	9.9	10.0	10.0	12.8	12.5	12.5	13.9
-20	-4	4.5	5.7	7.2	7.6	8.9	11.4	10.4	11.2	14.7	12.8	12.8	16.3
-25	-13	4.8	6.6	8.1	7.9	10.2	12.9	10.7	13.0	16.9	13.2	14.4	18.7
-30	-22	5.6	7.4	9.0	8.1	11.5	14.7	11.0	14.7	20.1	13.6	16.5	22.2
-35	-31	6.4	8.2	10.0	9.1	12.7	17.1	11.8	16.4	24.6	14.0	18.6	27.5
-40	-40	7.1	8.9	11.1	10.3	14.2	20.3	13.7	18.6	31.0	15.2	21.1	35.7

[1] Mud condition: None = no mud; Medium = mud on legs/abdomen; Heavy = mud on legs, abdomen, sides, and/or flanks.

[2] Average seasonal temperatures at Marshfield, WI.

The stairstep line represents the temperature at which cold stress is induced. Values below the stairstep line represents NE_m requirements for cold stress situations. Adapted from Hoffman, 1994.

Table 5. Monthly frame size body weights (nonpregnant and body condition score of 3.0 to 3.5), average daily gains, pregnancy weight, and total weight for heifers calving at 1,250 pounds and 21 months of age. Monthly frame size body weights and average daily gains for heifers calving at 24 and 27 months of age.

	21 Months AFC				24 Months AFC		27 MonthsAFC	
AGE	BW	ADG	PW	TW	BW	ADG	BW	ADG
0	90		0	90	90		90	
1	128	1.3	0	128	123	1.1	119	1.0
2	175	1.5	0	175	163	1.3	153	1.1
3	229	1.8	0	229	208	1.5	192	1.3
4	290	2.0	0	290	259	1.7	236	1.5
5	356	2.2	0	356	315	1.9	284	1.6
6	426	2.3	0	426	374	2.0	334	1.7
7	499	2.4	0	499	436	2.1	388	1.8
8	572	2.4	0	572	500	2.1	444	1.9
9	644	2.4	0	644	564	2.1	500	1.9
10	716	2.4	0	716	628	2.1	557	1.9
11	784	2.3	0	784	691	2.1	614	1.9
12	849	2.2	0	849	752	2.0	671	1.9
13	910	2.0	5	915	810	2.0	726	1.8
14	967	1.9	10	977	866	1.9	779	1.8
15	1,020	1.8	33	1,053	919	1.8	830	1.7
16	1,068	1.6	57	1,125	969	1.7	879	1.6
17	1,112	1.5	80	1,192	1,015	1.5	926	1.6
18	1,152	1.3	103	1,255	1,058	1.4	970	1.5
19	1,189	1.2	127	1,316	1,098	1.3	1,011	1.4
20	1,221	1.1	150	1,371	1,134	1.2	1,050	1.3
21	1,250	1.0	150	1,400	1,168	1.1	1,086	1.2
22					1,198	1.0	1,119	1.1
23					1,226	0.9	1,150	1.0
24					1,251	0.8	1,179	1.0
25							1,206	0.9
26							1,230	0.8
27							1,252	0.7
AVG ADG		1.8				1.6		1.4

BW = Frame size body weight (pounds), ADG = Average daily gain (pounds).
PW = Pregnancy weight (pounds), TW = Total weight (pounds)
AFC = Age at first calving

9:95 - 2M - TCM - BP - Price $1.00, For Sale Only. File 20.312 (Livestock–Dairy)