Success of a heifer-rearing program can be evaluated by monitoring height and weight of heifers and comparing the results against the herd’s growth goals.

Photo credit: Jill Kopfer

Introduction

Raising dairy heifers is often the second or third largest contributor to the total cost of producing milk. The time between birth and first-calving is a long-duration, high-cost period that creates a lag in the return on investments of feed, labor, and everything else related to developing the lactating dairy cow. Since many cows complete three or fewer lactations, these dairy animals spend nearly half of their life as growing and non-productive heifers. In fact, if cows are culled before the end of their second lactation, they will spend more than half of their life as heifers. Therefore, the outcome and cost effectiveness of heifer rearing practices deserve careful attention.

While there are many factors that go into raising heifers, the primary goal is to produce well-grown heifers that are ready to calve at 22 to 24 months of age. It is important to balance the cost of inputs with later returns of a heifer program. There are many approaches that may be used to raise dairy heifers, but they all should strive to raise heifers in a cost-effective manner that allows them to maximize their potential lifetime production.

Monitoring heifer growth is one strategy that can help you achieve success in raising heifers, and it is one of the most important ways to gauge the performance of a heifer program. It is also one of the best ways to determine if rearing costs are in line with the results you are achieving and to ensure that future production is not impaired by poor management or nutrition.

On many dairy farms, heifer management is not the most critical part of the day-to-day activities; however, chronic neglect of nutrition, feeding management, and preventive health care can lead to stunted growth. This results in heifers that calve much later than 24 months of age and that produce considerably less milk during their lifetime than those that are properly fed and well grown. Undersized heifers not only are smaller and less productive, but they also are prone to more problems at calving.

On the other hand, accelerating the growth of heifers until they become fat also reduces their lifetime milk production and longevity. Overfeeding concentrates or high-quality forages such as corn silage can cause this condition. Research studies show that excessive energy intake (140% of the National Research Council’s recommended amount) before breeding can decrease the rate of development of the secretory tissue in the cow’s mammary gland and thereby reduce the number of alveolar cells available for milk synthesis. Feeding to achieve accelerated growth rates after breeding does not appear to hinder mammary development. Optimal secretory tissue development also can be aided by ensuring that heifers receive an adequate level of protein before breeding.
Measuring Heifers

The success of a heifer-rearing program can be evaluated by monitoring the height and weight of calves and heifers and comparing the results against breed averages for a specific age group or against individual herd targets matched to the herd's age at first calving and mature size. Although most dairy producers, consultants, feed industry representatives, and veterinarians can recognize underconditioned or overconditioned animals, it is difficult to visually determine whether a heifer's height or weight is normal for her age. A study from England found that veterinarians underestimated the weight of dairy cows 65% of the time, and on average their estimate was off by 140 pounds. In the same study dairy farmers underestimated body weight in 81% of their attempts, and the weights were off by an average of 214 pounds. Clearly, visual estimation of body weight can be very unreliable. Measuring and weighing heifers allows them to be compared to objective standards that can indicate a problem in the heifer program. The more frequently measurements are made the more heifers' progress toward goals for age and size at first calving can be controlled and adjusted.

Body weight can be measured using a scale or estimated using a weight tape. Weight tapes allow quick estimation of an animals' weight by measuring the heart girth and are accurate to within 3 to 5% of the actual body weight for animals over 330 pounds. The weight tape is slightly less accurate for calves weighing 110 to 330 pounds (within 5 to 8% of actual body weight). Variation in repeated tape measurements by a single person or between different people is relatively small, making this method valid even when multiple people take the measurements over time. When using a weight tape, make certain that the animal is standing on a level floor surface with her head upright. Pull the tape snug, but not too tight, around the heart girth just behind the front legs and shoulder blades. Watch for excess manure and dirt on the underside of the heifers which could bias the tape measurements.

Penn State research was used to design weight tapes for Holstein dairy calves and for older dairy cattle. The calf tape was designed especially for calves from 80 to 282 pounds and is more accurate than the conventional tape as a result. The Holstein dairy cow tape can be used on animals up to 2,125 pounds. To purchase weight tapes, visit The Coburn Company, Inc. Be aware that there are weight tapes that were developed using cattle measured in the late 1800s, and some of these tapes are still being marketed. They represent an animal conformation very different from modern dairy cattle. Use of these older tapes will yield very inaccurate values and is not recommended. There is also a tape designed to be placed on the coronary band of the hoof to estimate calf weight. A recent study found this method was accurate for estimating the weight of calves between 69 and 99 pounds, but below this range the coronary band (hoof circumference) tape overestimated body weight and above this range it underestimated body weight. Depending on the average size of calves in a herd, this tool may be useful for estimating calf birth weights.

When measuring the height at the withers, be sure the heifer is standing on a hard, level surface, hold her head upright, and make sure that she is standing comfortably and not pulling against the halter. Measure the animal at the highest point of the withers. Hip height or width can be measured with less concern about the orientation of the animal's head. Measure body length with the animal straight and with its head held forward and upright. The Hipometer can be used to estimate body weight from hip width; however research shows this method is most accurate for heifers from approximately 3 to 15 months of age, which limits its usefulness. Indirect methods of measuring body weight will always be less accurate than a scale.

Figure 1. Diagrams showing proper placement of the weight tape and height measuring stick used to measure heifer growth.

Growth Charts

Growth charts should be used to evaluate the performance of a heifer management program and to spot any major problems that may be occurring. These charts will show problem areas where individuals or whole groups of animals are either undersized, underweight, or overweight—all good indicators of improper feeding or management.

Traditionally, heifer growth has been compared to breed standards to determine 'normal' progress. We have developed the Growth Monitor spreadsheet series to aid in collecting and analyzing heifer growth data for each dairy breed. In addition, we designed breed-specific, printable Growth Charts that may be used to plot heifer growth by hand. Both the spreadsheet series and the printable charts are based on the results of measuring a large number of heifers of various breeds throughout the United States during 1991 and 1992. Most of the data was collected from herds in which the average age at first calving was slightly greater than 24 months (see Table 1). As a result, the heifers probably were smaller for any given
age than those found on today's well-managed dairy farms that calve heifers at 22 to 24 months of age.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Age</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holstein</td>
<td>25.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Ayrshire</td>
<td>27.6</td>
<td>1.8</td>
</tr>
<tr>
<td>Brown Swiss</td>
<td>27.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Guernsey</td>
<td>26.2</td>
<td>2.0</td>
</tr>
<tr>
<td>Jersey</td>
<td>24.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Milking Shorthorn</td>
<td>26.5</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Table 1. Average heifer age at calving.

The Holstein heifer growth charts indicate several percentiles of the U.S. population, allowing a producer to compare an individual heifer to all others and to set growth goals. Previous research has shown that heifers large enough to calve at 22 to 24 months old with acceptable levels of milk production must be near or above average in size. Growers should keep in mind that producing extremely large heifers may not result in increased levels of lifetime milk production and is expensive from a feeding perspective because of the larger animals' increased daily caloric requirements. It also is important to realize that calving age is highly correlated to the profitability of the animal and that body weight after calving (1,250 pounds for Holsteins) is highly correlated to first lactation milk production. For Holsteins, keeping a majority of heifers near the 75th percentile and the entire herd between the median and the 95th percentile is highly correlated to first lactation milk production. For Holsteins only. The range in each graph represents the population average plus one standard deviation above the average. Growers should keep in mind that producing extremely large heifers may not result in increased levels of lifetime milk production and is expensive from a feeding perspective because of the larger animals' increased daily caloric requirements. It also is important to realize that calving age is highly correlated to the profitability of the animal and that body weight after calving (1,250 pounds for Holsteins) is highly correlated to first lactation milk production. For Holsteins, keeping a majority of heifers near the 75th percentile and the entire herd between the median and the 95th percentile is an achievable goal.

For all other breeds, the recommended growth ranges shown are between the average and the top 67th percentile of the population. To achieve early calving (24 months or less) and high production potential, individual heifers should fall near the top of or slightly above the range shown.

It can be interpreted from these data that the height at the withers is more variable for younger heifers and that, in general, variability in weight increases as age increases. Breed standards developed from the measurements are listed in the recommendations worksheet of each of the spreadsheet files and printed as a separate page in the printable growth chart files.

The Growth Monitor spreadsheet for Holsteins also includes the ability to record measurements of hip width and hip height. Recommendations for hip height and width were compiled from USDA and Pennsylvania data sets and are available for Holstein heifers only. The range in each graph represents the population average plus one standard deviation above the average.

An improved method of monitoring heifer growth is to compare current measurements to mature size of a given herd, which can account for herd-specific genetic and management outcomes and results in a more reliable comparison of how heifers are progressing toward herd goals. We have created a Customized Growth Chart spreadsheet that facilitates this comparison and generates a customized growth curve for an individual herd based on that herd's goal for age at first calving and the mature size of animals in the herd.

Evaluating Growth Charts

Growth charts can help in evaluating the performance of a heifer management program and can alert the producer to problem situations such as those in which entire groups of animals are undersized, underweight, or overweight. Low- or poor-quality forages (hay and silage) generally are responsible for inferior growth performance in young heifers, but lack of a balanced grain supplement and overcrowded housing can add to the problem. Underfed calves typically do not receive adequate energy and protein to meet their growth requirements. Inadequate housing and ventilation can contribute to poor growth by causing subclinical respiratory problems, and can negate a good feeding program. The level of management and sanitation also can affect heifer growth.

Adequate weight but restricted skeletal growth may occur in a particular age group. This problem usually is caused by relying on poor quality hay and corn silage for all or most of the heifers' diet. Both of these forages typically have low protein, mineral, and vitamin levels. Feeding cereal grains with very little protein, mineral, and vitamin supplementation along with these forages may exacerbate the problem. Feeding 2 to 4 pounds of grain per day and balancing the diet for protein, energy, minerals, and vitamins can solve a feeding problem, often within several months. Rations must be more than adequate, however, if heifers are to compensate with increased growth rates.

Another common scenario involves overweight animals with fairly normal skeletal growth for a specific age group. Heifers as young as 6 to 8 months of age may appear fat, but the problem generally is more common in breeding-age heifers. This condition most often is caused by marginal to adequate dietary protein but excessive energy intake. This can result from free-choice corn silage feeding along with moderate levels of supplemental grain, and arises on farms where good-to-excellent-quality forages are produced and unrestricted amounts are fed to the heifers. Restricting the heifers' intake of these high-quality forages usually will correct the problem.

Optimizing Heifer Growth Rates

In the past many studies have looked at heifer growth rates both before and after puberty using a variety of treatments and rates of growth. These studies reached different conclusions depending on how the experiment was done, the growth rates used, and even the treatments imposed. It is possible to achieve a very large range of average daily gain by changing the heifer nutrition program. As a result, no single study could possibly include enough treatments to cover the range that is needed to fully understand heifer growth.

To address this problem and attempt to determine the optimum rate of gain for prepubertal dairy heifers, we combined and analyzed all the Holstein heifer growth studies published.
around the world from 1990 to 2005. This study looked at the effects of prepubertal body weight gain and average body weight at calving on milk production in the first lactation. The analysis allowed us to study Holstein heifer growth rates independent of genetic or management differences that were evident between the trials.

We didn't find a straight-line relationship between average daily gain and milk yield as many experiments had assumed, but rather we found a curvilinear effect (Figure 2). Growing heifers at reduced average daily gain reduced milk production, and growing too fast also reduced production. In the prepubertal period from 2 to 10 months of age, growing heifers at 1.75 pounds per day resulted in the highest first lactation milk production and milk protein yield. Looking at Figure 2, the optimal range of growth is the top of the curve, and while it has a single best point (at 1.75 lb/d), the line is quite flat, showing that going somewhat below or above this optimal point has little consequence. Therefore, a recommended range for average daily gain in the prepubertal period is 1.6 to 1.9 lbs/day. Secondly, the figure shows that going well below the optimum, or especially going above this point, has serious and important impacts on first lactation milk production and should be avoided.

![Figure 2](image)

Figure 2. A meta-analysis found the relationship between prepubertal average daily gain and first-lactation milk production was not linear. The optimum rate of gain was 1.75 pounds per day, and a range of 1.6 to 1.9 pounds per day is considered ideal.

Since first lactation animals represent a large percentage of the herd, and since there is some evidence that first lactation differences due to mammary development will continue for the life of the animal, it is extremely important to grow heifers at the proper rate—about 1.75 pounds per day (with an acceptable range of 1.6 to 1.9) from 2 months to puberty.

Heifers should reach 55% of mature body weight (often 750 to 800 lbs for Holsteins) and 90% of mature structural growth (often 48 to 50 inches for Holsteins) by the desired breeding age of 13 to 15 months. After calving, heifers should weigh 85 to 90% of mature body weight (for Holsteins, 1,137 to 1,296 lbs) and should have achieved 95% of mature structural growth (for Holsteins, 52 to 55 inches tall at the withers). Approximate breeding height and weight targets for all breeds are shown in Table 2.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Body Weight (pounds)</th>
<th>Withers Height (inches)</th>
<th>Hip Height (inches)</th>
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</thead>
<tbody>
<tr>
<td>Jersey</td>
<td>525 to 575</td>
<td>43 to 45</td>
<td>45 to 47</td>
</tr>
<tr>
<td>Ayrshire</td>
<td>700 to 750</td>
<td>46 to 48</td>
<td>48 to 50</td>
</tr>
<tr>
<td>Guernsey</td>
<td>700 to 750</td>
<td>46 to 49</td>
<td>48 to 51</td>
</tr>
<tr>
<td>Milking Shorthorn</td>
<td>750 to 800</td>
<td>46 to 48</td>
<td>48 to 50</td>
</tr>
<tr>
<td>Holstein</td>
<td>750 to 800</td>
<td>48 to 50</td>
<td>50 to 52</td>
</tr>
<tr>
<td>Brown Swiss</td>
<td>750 to 800</td>
<td>48 to 51</td>
<td>50 to 53</td>
</tr>
</tbody>
</table>

Table 2. Suggested weights and heights for breeding-age heifers.

After puberty, which occurs at about 45% of mature body weight (usually between 9 and 11 months of age in Holsteins), growth rates can be altered with the primary objective being body weight at calving. Body weight at calving has a strong direct effect on first lactation milk production unrelated to growth rates in the prepubertal period. Set target weights for breeding and pre-calving; then use heifer weights at breeding to determine the average daily gain needed to achieve your target body weight at calving. Regular measurement of heifer growth will allow you to adjust rations to meet these goals.

**Compensatory Growth**

Compensatory growth is a term used to describe a period of increased growth rate that follows a growth restriction imposed early in the heifer’s life. These restricted-growth periods may have been caused by poor diets fed for short periods of time. Compensatory growth can allow poorly grown young heifers to reach breeding age on time (13 to 15 months), and can be achieved by feeding heifers diets high in energy, protein, and other required nutrients.

Increasing diet nutrient density by 10 to 20% will stimulate compensatory growth, but care must be taken to ensure that dry matter consumption does not limit nutrient intake. Compensatory growth also can help older bred heifers to calve at the proper weight and to produce quantities of milk nearer to their genetic potential, rather than to make up the growth difference during their first lactation. Three to four months of compensatory growth may be necessary to assure that animals reach the desired weight and skeletal growth by one of the benchmark time periods (breeding or calving).

**Body Condition of Dairy Heifers**

Body condition scoring is an additional tool that can be used to evaluate the overall nutrition and management of a heifer program. Some limitations in conducting heifer body condition scoring include long winter hair coats (in colder climates) and the problem of catching heifers to closely observe fat over the ribs and tailhead.
The recommended range of body condition scores for heifers is presented in Table 3. We have also designed a spreadsheet tool to track heifer body condition. Young calves generally are thin by nature (2.0 to 2.5 on the five-point scale), but their body condition score should increase to or near 3.0 by breeding age. A body condition score of 3.5 to 3.7 is considered ideal for heifers calving at age 22 to 24 months. This score allows a moderate amount of stored body fat to be used in early lactation when dietary energy is insufficient for milk output.

<table>
<thead>
<tr>
<th>Events</th>
<th>Age (months)</th>
<th>BCS Goal</th>
<th>BCS Min</th>
<th>BCS Max</th>
</tr>
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<tbody>
<tr>
<td>0 to 4</td>
<td></td>
<td>2.25</td>
<td>2.00</td>
<td>2.50</td>
</tr>
<tr>
<td>4 to 10</td>
<td></td>
<td>2.50</td>
<td>2.25</td>
<td>2.75</td>
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<tr>
<td>Pre-Breeding</td>
<td>10 to 12</td>
<td>2.75</td>
<td>2.50</td>
<td>3.00</td>
</tr>
<tr>
<td>Breeding</td>
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<td>3.00</td>
<td>2.50</td>
<td>3.25</td>
</tr>
<tr>
<td>Bred</td>
<td>15 to 20</td>
<td>3.25</td>
<td>3.00</td>
<td>3.50</td>
</tr>
<tr>
<td>Calving</td>
<td>&gt; 20</td>
<td>3.50</td>
<td>3.50</td>
<td>3.75</td>
</tr>
</tbody>
</table>

Table 3. Suggested Body Condition Scores for Growing Heifers by Age in Months.

**Summary**
Healthy, productive herd replacements are the result of good management that starts before the calves are conceived and continues until they enter the milking herd. The only real way to tell how heifers are growing is to weigh and measure them several times a year and compare them to objective standards. Keep accurate records to ensure that a sound breeding program is followed. The entire process ensures that genetically superior animals will enter the herd with the maximum potential for milk production.

**References**