

From Birth to Puberty

Michael Murphy

Lantmännen Animal Feeds Division, Box 301 92, S-104 25 Stockholm, Sweden,
Email: michael.murphy@lantmannen.se

■ Take Home Messages

- ▶ The calf should weigh over 80 kg at weaning and over 110 kg at three months of age. Special diets can help achieve this.
- ▶ The heifer must increase in body size, volume, as well as weight for successful calving at 22 –24 months of age
- ▶ It is possible to achieve this with good quality silage if specific protein needs are met.

■ Introduction

The feeding strategies for young cattle, raised as are more varied than for the dairy cow. Economic and successful milk production is dependent on a healthy heifer who calves at about 24 months old and whose growth demands are nearly fulfilled. This requires different periods of fast and slow growth from birth to calving.

Wild ruminants of similar size as dairy cows, need about 8 months before the calves have developed sufficiently so that they stop nursing their mothers completely. In rearing dairy calves this is to be accomplished in 8 weeks. The feeding and care of the calves must be 4 times as effective as in nature. After 8 weeks the calf should be weaned and the rumen developed to the point that the calf can start functioning as a ruminant. Up to five months of age the calves' full potential for growth should be utilized. After that there should be a more controlled growth up to puberty. While there are many important aspects of heifer rearing, especially health, this presentation focuses mostly on feeding strategies to help achieve the desired growth pattern.

■ The Newborn Calf

Development of a Microbial Ecology

We must recognize that the calf is not a ruminant for the first several weeks of life and cannot be fed as one. At birth the rumen is essentially sterile and is only a small portion of the entire stomach-intestinal system. This is very different from the cow in which the rumen is the largest organ and together with the contents can be nearly 20 % of the cows live weight. The rumen of the calf is proportionally smaller than that of the cow. The rumen is nearly immediately colonized by different microbes directly after birth but these are not the same microbes that are later dominant in the rumen. Some of the first microbes that appear in the rumen are Lactobacillii, Clostridia and Streptococci (Hobson and Jouany, 1988). That lactobacilli are present is natural as the diet should be predominantly milk. Some of the clostridia are fibre digesters but only very weakly and these are not generally found at latter stages of development. The numbers of fibre digesting bacteria are only about 0.01 % of the numbers found in the mature cow (Dehority and Orpin, 1988). Streptococci are found, however, even in the mature ruminant but should not be dominant (Van Gylswyk and Murphy, 1993). While colostrum is necessary for the calf's immune system it will not contribute to rumen development. It is only by consuming solid feeds that the rumen microbial system can develop but all feeds are not equally effective in doing this

Rumen Development

To develop and maintain a normal rumen ecology and even for the supply of nutrients to the animal the fermentation products must be continually absorbed from the rumen. The rumen membrane can absorb volatile fatty acids (VFA) and other small compounds but in order to increase the total surface area for maximal absorptive capacity the papillae must be stimulated to increase in size. The production of volatile fatty acids, VFA, stimulates the growth of the papillae. No VFA are produced from milk by lactobacilli. It is primarily through the fermentation of solid feeds that the VFA are produced. The papillae are also stimulated by large feed particles, while small feed particles can be detrimental as they can cause entanglement of the papillae.

While hay certainly contains large particles it is not very good for the development of the rumen in a young calf. Roughage, preferably in the form of hay, is a good feedstuff to promote rumen muscular development but should not be relied on to supply nutrients. As the fibre digesting bacteria have not established themselves in sufficient numbers there is little digestion of the fiber fraction in the hay and consequently little VFA production. There is a need for a fiber fraction so that the ecology can develop but the fiber fraction must be easily digestible. By-products from sugar beets and soybean hulls are

examples of easily digestible fiber. The papillae must also be held in trim by abrasion from feed particles. Feeds composed of easily digestible fiber are generally not very good at this. Other more abrasive feeds are needed such as bran.

■ Feedstuffs

For rapid development of rumen function it is necessary to supply a wide array of digestible carbohydrates, including beta-glucans, neutral detergent soluble fiber, and starch. The starch fraction from cereal grains functions very well. Large quantities of VFS are produced from fermentation of starch by the microbes already present in the rumen and significant quantities of propionate are produced which is beneficial for the calf's growth. Oats with its low starch and high fiber content is a beneficial feed for rumen development. However, it is best to combine several different starch sources. Starch also has positive effects further down in the intestinal system tract, however, too much starch will cause problems, e.g. diarrhea. To guarantee a positive development of intestinal functions it is beneficial to include acidifiers in the diet.

Because the young calf's rumen is not fully functional there is not extensive degradation of proteins to ammonium in the rumen. There is also very little microbial protein, produced by fermentation, flowing to the intestines. Therefore, the diet must supply more amino acids, in proper balance, the young calf. Due to limited feed intake with such young animals, it is often easier to use synthetic amino acids, especially for the critical ones, lysine and methionine.

It is not simple to achieve such typical characteristics with the limited number of feedstuffs that the farmer has. However, the concept is not very different from what would be occurring in nature. The calf starts eating highly digestible plant matter in the early spring, which becomes increasingly harder to digest as the plants mature over the summer. In the fall the calves would be eating a diet with more storage carbohydrates and a fiber with low digestibility. It is, however, common practice to give the calves the same concentrate mixes, or protein supplements with grain, that is given to the cows. Our recommended calf starter should contain, on a dry matter (DM) basis, 18 % crude protein (CP), 26 % neutral detergent fibre (NDF), 24 % starch, 18 % easily soluble carbohydrates of which 11 % is sugar. The NDF fraction can be further divided into 14 % digested in the rumen and 12 % not digested in the rumen. About 80% of the starch will be digested in the rumen. The percentages of carbohydrates in the feed that are actually fermented in the rumen are about 14 % fiber, 20 % starch, 11 % sugar and 7 % other soluble carbohydrates.

■ **Body Weight**

At weaning the calf should be consuming about a kilogram of concentrates with the qualities mentioned above. At eight weeks after birth the calf should weigh at least 70 kg but a live weight of about 85 kg would be preferred. This would mean an average daily gain (ADG) of about 800 g per day (assuming 40 kg at birth). At three months old the calves should weigh over 100 kg, preferably over 110 kg. This is generally 15 – 20 kg heavier than what is normally observed in herds with no specific calf-feeding program. An increase in growth of 20 kg during this period will generally mean that the heifer can freshen one month earlier. This in itself will be a significant cost reduction in feed costs by about \$55 Cdn., which allows greater investments during the calf period. The required ADG of approximately 1 kg requires a good diet. During the fourth month the ADG of the calf should be over 1 kg, preferably about 1.3. After this time the calf should be able to utilize a concentrate similar to mature ruminants but is still not able to fully utilize the fiber fraction in roughages.

■ **The Heifer**

The average age for calving for heifers is 29 months in Sweden. A more appropriate calf feeding program can do much to shorten this but even after the calf period more controlled feeding is needed. It should be possible for a heifer to calve 5 to 6 months earlier. Often growth has been defined by gains in live weight. A heifer should weigh 85 % of her adult weight at her first calving. This can be misleading. If the heifer has large fat reserves the prognosis for good production is not the best. It is more important that the heifer has the right size. Neither is age a good indicator. Even 30-month old heifers can be too small.

Volumetric Growth

Size is an indicator of body volume. The larger the body volume is at calving the less the risk for problems during the first lactation. The larger the body volume is the more milk will be produced. This is predominantly explained by the lower nutrient demand by the heifer for growth that results in more nutrients being available for milk production. With a greater body volume there will be an increase in feed consumption as the rumen and other organs should also be larger. A simple measure of size is rump height. A Holstein heifer should have a rump height of about 103 cm when she is 4 months old and a height of 140 cm when she calves (Figure 1.). For other breeds like the Swedish Red and White or Ayrshire the rump height should be at least 130 cm. For many producers with large cows these heights might appear quite small but this is a minimum for a cow that shall weigh 625 –640 kg when full grown. If the average cow in the herd is larger, but not fatter, then proportional increases can be assumed to be necessary.

The difficulty in feeding, stems from the allometric growth pattern of the heifer, i.e. different organs grow at different rates. From weaning to puberty the alveolar system in the udder develops. Lipid storage in the udder will impair growth of these systems. The tissues that will later on in life, produce milk, will not be fully developed. Fat will be stored in the udder if the heifer is fed too intensively. However, growth will also be impaired if there is not a sufficient supply of amino acids, minerals and vitamins. The goal is to go from allometric growth to a growth pattern where the total volume is stimulated. If the heifer becomes 5 cm taller and 2 cm broader at the rump between 5 and 10 months of age, then the body volume will have increased by 10 %. This relationship will not hold as the heifer gets older which is why it is important to ensure large body frames early in life.

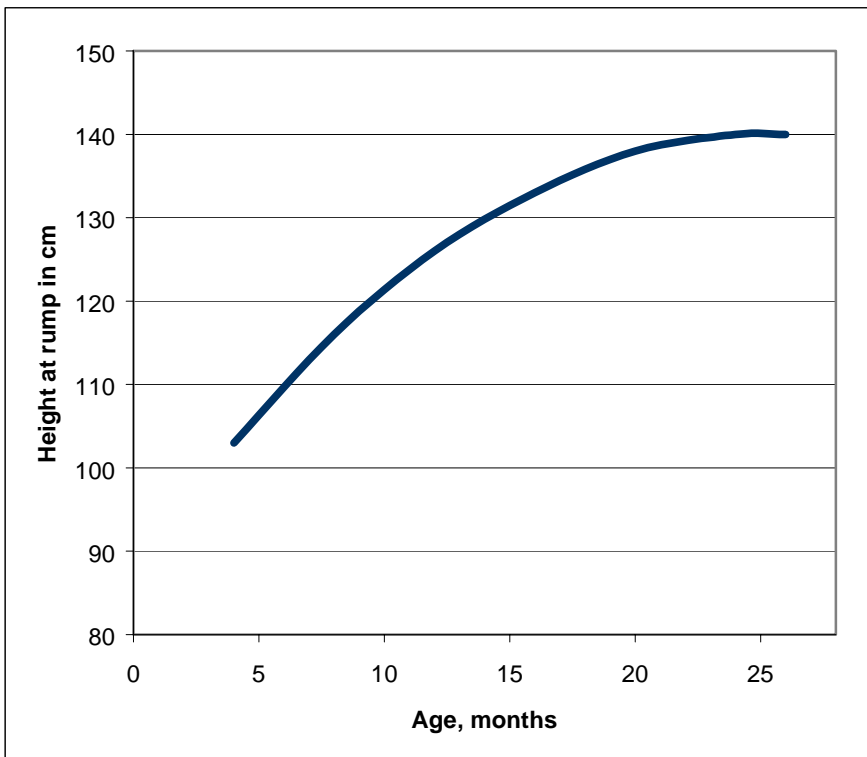


Figure 1. The desired rump height in replacement heifers at various ages.

Typical Diets

At 5 months of age the calves should weigh more than 150 kg. After this stage the calf can be fed a roughage diet but with some concentrates up to 6 months

of age. Prior to 5 months of age, the calf should have been offered forages but two-thirds of her feed intake, should come from concentrates. After 6 months of age the heifer can eat a roughage diet if the roughage is of the right quality. This would be roughage with an in vitro organic matter digestibility greater than 84% or more than 10.5 megajoules of metabolizable energy (ME) per kg of DM. For heifers older than 6 months the roughage should have at least 50 % NDF and the ME should be about 10.2. This can be fed ad libitum. The recommendation for energy and NDF is designed to reduce the risk for intakes greatly in excess of needs.

We recommend that the heifer be fed a concentrate that promotes size development. We use a by-product from lysine production, called Fermenten® (Church and Dwight). This has been proven to increase size in several field trials. Results from Swedish experiences are presented in Table 1. We have been feeding this at a slightly lower amount than that suggested by the manufacturer. There is a small problem with palatability but feed consumption returns to normal in 2 –3 days.

A fairly common situation is that there is a short supply of suitable silage to feed to the heifers. In those cases it is normal to feed more concentrate mix. We recommend a calf grower concentrate mix with the following characteristics: rumen degradable protein, 11 %, rumen undegradable protein 6 %, starch 28 %, and NDF 29 % (DM basis). This would be added together with the product containing Fermenten®. No difference in growth response has been noted.

Table 1. Increases in rump heights and breadths with heifers fed Fermenten compared to control groups on 5 different farms. Increases expressed as percent of the control groups' measurements.

	<i>Research farm</i>	<i>Farm 1</i>	<i>Farm 2</i>	<i>Farm 3</i>	<i>Farm 4</i>
Rump Height	+ 22 %	+ 13 %	+ 27 %	+ 37 %	
Rump Breadth	+ 22 %		+ 17 %	+ 17 %	+ 13 %
Weight		+ 16 %		+ 20 %	+ 8 %

■ Puberty

Puberty is driven by weight or size/physiological maturity and for big breeds such as the Holstein and Ayrshire it occurs around 300 kg (275-350 kg). Several conditions have been reported to affect live weight at first heat. These include feeding intensity, day length, birth season, lighting, ADG, etc. Foldager et al (1998) reported that the average weight at first heat for Danish Red heifers was 275 kg and most heifers (85 %) had their first estrous before achieving 300 kg live weight. The first heat appears to occur at a specific weight within each breed. Age seems to be of lesser importance. Heifers of large dairy breeds have their first heat at around 280 kg live weight.

At insemination the heifer should weigh 325 - 350 kg. With normal heat detection and conception rates one should start inseminating when the heifers are around 13.5 months old in order to achieve an average age of 24 months for first calving. If the heifer weighed 150 kg at five months of age it follows that ADG of 700 – 750 g is sufficient. This assumes that everything is in balance as described above and the growth is volumetric. Otherwise the heifer will just become fat. A higher growth rate increases the risk for obese heifers (BCS > 4) especially if the diet is not balanced. After puberty and insemination the growth rate can be increased slightly. At calving the heifer should weigh 85 % of her mature weight. This should be achieved primarily by offering better quality roughage.

The period up till puberty is most critical. If feeding during this period is successful, the heifer will continue to grow as desired provided that she is given good quality forage.

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