

A GUIDE TO DAIRY CALF FEEDING AND MANAGEMENT

OPTIMIZING RUMEN DEVELOPMENT AND EFFECTIVE WEANING



INTRODUCTION

This guide is published by the Bovine Alliance on Management and Nutrition, which is composed of representatives from AABP (American Association of Bovine Practitioners), ADSA (American Dairy Science Association), AFIA (American Feed Industry Association), and USDA (United States Department of Agriculture). The objective of this publication is to outline what current research by nutritionists and veterinarians has shown to be the most effective feeding and management programs for raising healthy productive dairy calves.

The National Dairy Heifer Evaluation Project (NDHEP), conducted by USDA/APHIS during 1991 and 1992, surveyed 1,811 farms in 28 states. Results showed that many calf raisers are not following what are generally considered the optimal nutrition and management guidelines to produce healthy calves that are weaned from milk or milk replacer in a timely and cost-effective way.

The NDHEP survey showed:

1. **Criteria used to determine dairy calf weaning time.** Age is the primary factor for 43% of the producers, grain intake for 26.9% of the producers, and weight for 26.4% of the producers.
2. **Weaning age.** Over 60% of producers are weaning calves at eight weeks of age or more. Less than 30% of producers are weaning calves by six weeks of age. (National Animal Health Monitoring Systems {NAHMS} Dairy 2002 Study)
3. **Grain.** While the majority of producers are offering grain within the first 14 days, a small percentage do not offer grain until week four or after.
4. **Forage.** More than half the producers offer calves forage within two weeks of birth.
5. **Water.** Forty percent of producers are not offering calves water free-choice (ad libitum) until they are three weeks of age or more.

It is clear from these data that there needs to be a greater understanding of the factors involved in deciding when and how to wean the calf off a liquid diet and onto dry feed.

Extending the milk replacer feeding period beyond what is necessary to develop a healthy calf can increase costs, as illustrated in Table 1.

Table 1. Economics of Growth to 8 Weeks Using Two Different Weaning Systems (Example): (Based on total feed per calf to eight weeks of age)

8-Week Weaning		Cost
Milk Replacer	70 pounds per head x 80¢/pound	\$56.00
Calf Starter	100 pounds per head x 18¢/pound	<u>\$18.00</u>
Total Feed Fed	170 pounds	Total Cost \$74.00
5-Week Weaning		
Milk Replacer	44 pounds per head x 80¢/pound	\$35.20
Calf Starter	130 pounds per head x 18¢/pound	<u>\$23.40</u>
Total Feed Fed	174 pounds	Total Cost \$58.60

(Note: Milk replacer feeding rate of 1.25 pounds per calf daily through weaning. Assuming 100 pound calf at initiation of milk replacer feeding.) (Calf starter intakes are based on University of Tennessee calf research.)

In this example, a five week weaning program versus eight week weaning reduces feed cost approximately \$15 per head. Earlier weaning of calves can be cost effective by reducing cost and labor expense of milk replacer or milk feeding. In order to successfully wean calves at 5 weeks of age, optimum nutrition and management practices **must be followed**.

The principles of producing a healthy calf at weaning require a basic understanding of the digestive process in the calf and changes that occur from birth to maturity.

I. DEVELOPMENT OF THE DIGESTIVE SYSTEM

From birth to approximately two weeks of age, the calf is totally dependent on liquid milk or calf milk replacer diet for its nourishment. This is followed by a period of varying length where a combination of milk and calf starter is required to nourish the calf and promote development of the calf's rumen until it is functioning efficiently to provide the calf with energy and protein derived from fermentation of dry feed. Therefore, there are three phases of development as shown in Table 2.

Table 2: Stages of Development of the Calf Digestive System		
Stage	Duration	Diet Required
<p><u>Pre-Ruminant Phase</u></p> <p>The abomasum is the main compartment of the stomach involved with digestion at this stage.</p>	<p>Birth until at least the 2nd to 3rd week of life.</p> <p>This phase will last longer if no dry feed (calf starter) is offered.</p>	<p>MILK OR HIGH QUALITY CALF MILK REPLACER*, FRESH, HIGH QUALITY CALF STARTER & WATER.</p> <p>The calf is dependent on a liquid diet to provide the nutrients for maintenance and growth.</p>
<p><u>Transition Phase</u></p> <p>Once the calf starts to eat dry feed, rumen fermentation begins. Production of VFA (volatile fatty acids) from the fermentation of carbohydrates is responsible for the rate of rumen development.</p>	<p>2nd or 3rd week of life to weaning.</p> <p>This phase will continue as long as milk is offered to the calf.</p>	<p>MILK OR HIGH QUALITY CALF MILK REPLACER PLUS HIGH QUALITY CALF STARTER & WATER.</p> <p>The calf will start consuming significant quantities of dry feed during the 2nd and 3rd week, depending on several factors, including health status, availability of fresh, clean water, and calf milk replacer feeding programs.</p>
<p><u>Ruminant Phase</u></p> <p>Dry feed is the sole food source. The rumen becomes an important component of the digestive tract. Rumen microorganisms break down feedstuffs to produce microbial protein and VFA.</p>	<p>From weaning onwards.</p>	<p>DRY FEED AND WATER.</p> <p>Once the calf is weaned, it is dependent on fermentation of feedstuffs in the rumen to provide the majority of its energy and protein.</p>

* See BAMN Publication: A Guide to Modern Calf Milk Replacers (see last page)

Prior to weaning, most of the energy and amino acid needs of calves are derived from intestinal digestion of milk or calf milk replacer. When the calf begins to consume water and calf starter, bacterial fermentation begins to produce larger amounts of the volatile fatty acids (VFA) acetate, propionate, and butyrate. Production of VFA is responsible for rapid rumen tissue development allowing for early weaning of calves. The VFA primarily responsible for developing the metabolic activities of the rumen are butyrate and propionate.

Research has demonstrated that readily fermentable carbohydrates, such as those in a high quality calf starter, result in a higher production of VFA than the complex carbohydrates in forages. This research shows that feeding forage prior to weaning does not prepare the calf for early weaning.

Hay fed to young calves prior to weaning, may slow rumen development and reduces energy available in the ration. While feeding hay to young dairy calves before weaning is a common management practice on some farms, rumen development will be optimized if hay is reserved for weaned calves, preferably after 8 to 10 weeks of age. Small amounts of fiber in calf starters may help prevent bloat when calves are consuming large amounts of calf starter.

II. FEEDING PROGRAM

To achieve a smooth transition through the three stages of digestive system development (Table 2), it is essential that a sound and well-managed feeding program is begun immediately after birth. The goal of this program is to give the calf a healthy start for the rest of its life. The first steps are assuring that the immune system can start functioning and that the necessary nutrients for good growth are provided.

A. COLOSTRUM

Despite all that has been written about the necessity of colostrum, it is evident that poor quality and inadequate quantities are being fed in many cases. Colostrum has a vital role in supplying antibodies that give the calf immunity against diseases until its own immune system is active. Equally important, however, is the nutritional role of colostrum. It contains a high concentration of many nutrients that are essential to starting digestive processes in the intestine. A separate BAMN publication on colostrum addresses these points in detail.

B. MILK OR CALF MILK REPLACER

Until the rumen can start supplying energy and microbial protein in quantities sufficient for maintenance and growth, the calf must have a high quality liquid milk or calf milk replacer diet. Emphasis must be placed on both the qualities of the milk or calf milk replacer as well as the quantities that are offered. Sanitizing feeding and mixing equipment along with the proper handling and storage of milk and calf milk replacer are essential to avoid bacterial contamination that may lead to calf health problems.

It is not economical to use a lower cost and lower quality calf milk replacer, and argue that feeding it for a longer period will produce a better result than feeding a high quality calf milk replacer or whole milk for a shorter period. Research in this area has demonstrated that feeding a high quality liquid feed will lead to better early growth, higher rates of calf survival and earlier dry feed intake.

Too frequently, poor quality calf milk replacers are offered in low quantities during the all critical first two weeks of life. This practice results in poor growth and poor health. Without adequate nutrition, the calf and its immune system will not grow. Thus it is predisposed to disease, particularly scouring and respiratory problems. The calf must begin to grow if it is to have an adequate calf starter intake to promote the necessary VFA for rumen development.

Many calf milk feeding programs suggest a specific quantity of milk or calf milk replacer be fed twice daily for a period of up to six to eight weeks. Check quantities of solution that your bottles hold. Milk replacer daily feeding rate should be based on the desired calf weight gain, calf weight, health of calf and climatic conditions. An example for a holstein calf would be a minimum of 1.25 lbs of milk replacer powder per calf per day. Use of the 2001 Nutrient Requirements of Dairy Cattle (National Research Council, calf section chapter 10) is a useful tool to fine tune daily feeding rates of calf milk replacer. It is vitally important that milk feeding programs be adjusted for climatic conditions, particularly severe cold when calves are housed outside in hutches. Feeding only two quarts of calf milk replacer twice daily is inadequate when environmental temperatures fall below 50-60°F. Below this temperature the calf starts using energy to maintain its body core temperature; consequently, that energy is not available for growth or possibly for maintaining other body functions such as the immune system. In cold weather feed 25-50% more whole milk or reconstituted milk replacer solution in a third feeding thus providing more dry matter. Ensure that free choice water is available for adequate growth. While feeding too little calf milk replacer at an early stage depresses growth, too much calf milk replacer for too long will depress calf starter intake. Recently developed calf feeding and management programs are designed to meet the biological growth potential of the calf. Specifically designed calf milk replacers, calf starters and feeding and management procedures must be followed to optimize calf performance on these programs. For more detailed information on calf milk replacers refer to BAMN publication, "A Guide to Modern Calf Milk Replacers."

III. GUIDE TO FEEDING AND WEANING INSERT

FEEDING PROGRAM:

AGE	TRADITIONAL FEEDING PROGRAM
Day 1	High Quality Colostrum. Water available. Do one of the following options. A. Feed 3 quarts of high quality colostrum (green range on colostrometer) via nipple bottle as soon after birth as possible (within 1 hour) and repeat 12 hours later. B. Feed 4 quarts of high quality colostrum (green range on colostrometer) by esophageal feeder as soon after birth as possible (within 1 hour).
Day 2- 27	Milk/Calf Milk Replacer. Calf Starter. Water available. Introduce small quantities of high quality calf starter on Day 4. Keep it fresh and available at all times. Adjust the milk feeding program based on desired daily calf weight gain, calf weight, calf health and climatic conditions. Under normal climatic conditions, feed 12-14% of body weight as milk or reconstituted calf milk replacer. An example for a holstein calf would be a minimum of 1.25 pounds of calf milk replacer powder per calf per day. In cold weather feed 25-50% more whole milk or reconstituted milk replacer solution in a third feeding.
Day 28-35	A healthy calf should be consuming 1.5 -2 pounds of calf starter per day. Water available.
Day 28-56	Reduce or discontinue milk feeding once the calf meets the criteria in the table below. Water available. New research shows that calves have higher energy and protein requirements than was previously thought. Thus higher protein calf milk replacers along with higher daily feeding rates may be needed to ensure adequate calf weight gain & health.

WEANING:

CRITERIA	DO	DON'T
Age	<u>Minimum 4 weeks (28 days).</u> Wait until the calf is at least four weeks before discontinuing milk feeding. If fed properly and managed correctly, weaning a healthy calf should usually occur between the 4th and 6th week.	Do not attempt to wean the calf before four weeks. The digestive system will not be mature enough to handle sufficient quantities of dry feed for proper growth.
Milk Feeding	Feed high quality milk or <u>calf milk replacer for at least 4 weeks.</u> An ideal feeding program is one where milk intake is based on the desired daily calf weight gain, calf weight, health of the calf and climatic conditions. Good growth and health during the first two to three weeks of life is most important.	Do not assume that using a poor quality milk replacer and feeding it for a longer period will benefit the calf.
Method of Weaning	Calves can be abruptly weaned from milk or milk replacer. If calf starter intake is low, discontinue one feeding of milk or calf milk replacer for the last week prior to weaning. Keep in same housing for 1 week after weaning to reduce stress.	Don't stop feeding calf starter and water. Do not overstress the calf.
Calf Starter	<u>Offer high quality dry calf starter from Day 4.</u> Offer small handfuls at each feeding the first few days to keep the starter fresh. Wean when calves are consuming at least 1.5-2 pounds per day for 2-3 consecutive days. Milk can be discontinued.	Do not offer large quantities of calf starter to individual calves at the outset. Offer small amounts regularly. Keep starter fresh.
Health	The calf MUST be healthy before it is weaned	Do not wean calves that show any signs of poor health. Removing liquid feed will only add further stress. Calves which have been ill during their first 4 weeks may require calf milk replacer for a longer period.
Hay	Hay has its place in the diet once the rumen is fully functional, after weaning. Small amounts of fiber in calf starters may help prevent bloat when calves are consuming large amounts of calf starter.	Do not feed hay until after weaning, when calves are consuming adequate amounts of dry starter (possibly best to wait until the calf is 8-10 weeks of age).

C. WATER

Water is critical for the calf's rumen development and health. The calf's body is 72% water. In hot weather calves can die without water. Drinking water encourages the calf to eat dry feed early. A research trial comparing the performance of calves receiving free choice water versus none is shown below.

Effect of Free Choice Water on Calf Performance*

	Water	
	Free Choice	None
Daily Gain, lbs.	.68	.40
Calf Starter Intake, lbs.	26	18
Scour Days Per Calf	4.5	5.4

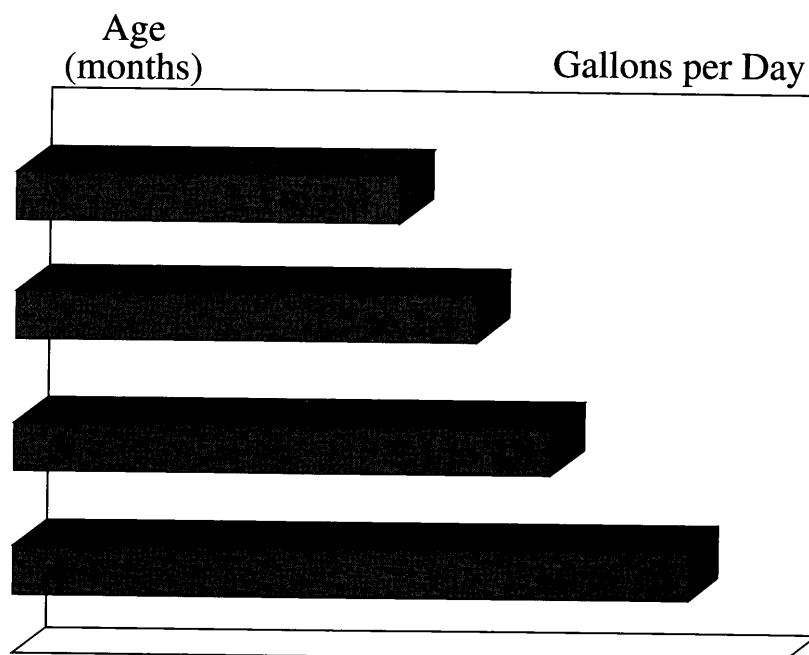
*Kertz, A.F. 1984. Journal of Dairy Science 67:2964-2969.

Calves receiving free choice water from birth to 4 weeks of age had a higher daily gain, consumed more calf starter, and had fewer scour days than those calves not receiving free choice water.

Feeding milk or calf milk replacer is not a substitute for water. Calves have a requirement for water in addition to what is received from milk or calf milk replacer. It should be available free choice at all times, and it should be fresh, clean, and of good quality. In some areas water quality can result in intake or health problems in calves. For example, high sulfates, iron, nitrates, or bacterial contamination of water sources can cause calf health problems. Other problem areas include water not available, or frozen. In cold weather, it is important to frequently provide calves with warm water (warm to the touch), if possible.

Guidelines - Drinking Water For Calves

(These amounts are in addition to milk or calf milk replacer)



Source: Penn State Extension Circular 387

D. HIGH QUALITY CALF STARTER

Calf starter comes in a variety of different types, from pelleted complete rations to proprietary coarse-textured mixtures that often consist of cereal grains and pelleted protein concentrate. Unfortunately, there is no simple test for measuring the quality of calf starter. Calf starter freshness is important. Offer small handfuls at each feeding the first few days to keep the calf starter fresh. Discarding unconsumed calf starter between feedings each day helps to maintain starter freshness. The calf starter must be palatable, contain minimal fines and provide sufficient energy in the form of readily fermentable carbohydrates to provide rapid rumen development. Typically, good calf starters contain 16-22% crude protein and .52-.56 Mcal net energy for gain/lb. Remember, the calf does not grow on “percent of protein” but rather on the amount of protein and other nutrients it actually consumes. That is why intake is so important. Small amounts of fiber in calf starter may help prevent bloat when calves are consuming large quantities of calf starter. A guide for feeding is included on the insert page.

E. FORAGE (HAY)

Research has shown that the rate of rumen development is related to production of VFA from readily fermentable carbohydrates, which are high in good calf starters, but are low in forages or hay. In the past, it was often considered important to have hay available either ad libitum or in restricted quantities during the first days of life. **THIS IS NOT BENEFICIAL.** While calves will indeed eat good quality hay if it is available, it does not contain either the nutrient density or nutrient profile necessary to stimulate rapid rumen development. Allowing calves access to hay prior to weaning may slow rumen development and slow growth compared to giving the calf only a high quality, properly balanced calf starter. Hay and forages have their place in ruminant feeding programs after the calf is weaned and healthy. Forages should be introduced into the feeding program as needed to achieve the desired ration energy density for the desired growth rate.

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1. BAMN Publication: A Guide To Modern Calf Milk Replacers, 1993, Revised 2002.
 2. BAMN Publication: A Guide to Colostrum And Colostrum Management For Dairy Calves, 1994, Revised 2001.
 3. BAMN Publication: An Introduction To Infectious Disease Control On Farms (Biosecurity), 2001.
 4. BAMN Publication: Biosecurity On Dairies, 2000.
 5. BAMN Publication: Biosecurity Of Dairy Farm Feedstuffs, 2001.

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