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What is the optimal feeding level for calves?

Feeding dairy calves used to be a "two quarts, twice a day" proposition. For decades, this level of feeding – which usually incorporated one pound of solids per day when milk replacer was the liquid feed source – was almost universally employed.

But we now know young calves need more nutrition to promote growth, fuel their immune systems, and maximize their genetic potential for productivity.

For more than a decade, researchers have been investigating the long-term effects of feeding calves more than one pound of milk-replacer powder per day. The results of study after study have confirmed that feeding additional nutrients are beneficial to the calf and its future capacity to produce. Among those findings are:

- Increased available metabolizable energy (ME)[1]
- Increased average daily gain (ADG) and skeletal size[2]
- Healthy calves[3]
- Increased mammary development[4,5]
- Reduced age at first calving[6]; and
- Increased milk prodution[7]

This knowledge already is influencing the way U.S. dairy producers raise their calves. In the National Animal Health Monitoring System's (NAHMS) Dairy 2014 survey, 43% of all dairy operations reported feeding 6 quarts of milk or milk replacer to preweaned calves per day.[8] The largest dairies (500+ cows) fed an average of 1.77 pounds of milk solids per day, and all operations averaged about 1.58 pounds of solids per day (See Table 1).

Table 1. Daily dry matter fed from milk or milk replacer[8]

Herd Size (number of cows)	Very small (fewer than 30)		Small (30-99)		Medium (100–499)		Large (500 or more)		All Operations	
Amount consumed (qt)	Pct.	Weighted (qt)	Pct.	Weighted (qt)	Pct.	Weighted (qt)	Pct.	Weighted (qt)	Pct.	Weighted (qt)
Less than 4	5%		3%		3%		4%		3%	
4–5	56%		55%		54%		35%		53%	
6–7	17%		22%		21%		25%		21%	
8–9	13%		16%		16%		28%		16%	
10 or more	8%		5%		6%		9%		6%	
Total	100%	5.79	100%	5.83	100%	5.87	100%	6.58	100%	5.89
Daily Dry Matter Avg. (12.5 % solids @ 1.075 lb./gallon)		1.56		1.57		1.58		1.77		1.58

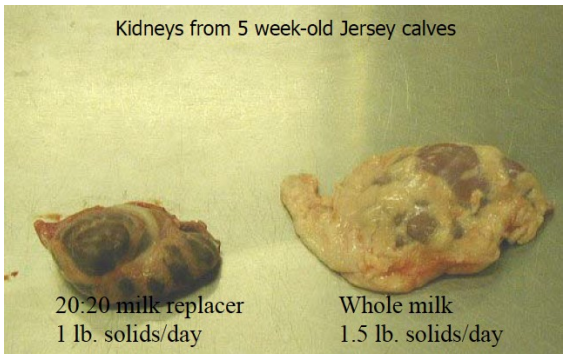
The value of feeding more

In keeping with these results, a new industry standard of 12 ounces or more per feeding is now gaining popularity. This feeding level represents an average of approximately 1.50 pounds of solids per day – a 50% increase from the previous industry standard.

The value in this level of feeding is reflected in:

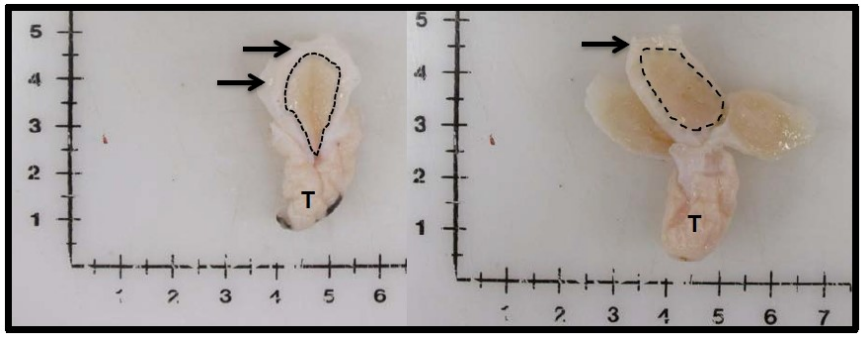
1) **Animal welfare** – The public's perception of production agriculture practices is under ever-increasing scrutiny. An increased feeding rate shows compassion for animals and choosing what is best for the calf.

2) **Immunity** -- Nutrients consumed will first support maintenance and then growth. If a calf needs to mount an immune response to fight a health challenge or adapt to environmental conditions, nutrients are reallocated from growth to the immune system. Because calves are born with just 5% body fat, they have low energy reserves upon which to fall back if they need an immune boost or must respond to cold or heat stress. Those extra resources must come from nutrition. A lower feeding rate does not supply enough energy to fuel immunity. The following image compares the fat stores around the kidneys of a calf fed 16 oz. of milk solids per day, versus a calf fed 20 oz. per day. In this example, the more abundantly fed calf clearly has more energy reserves to fight illness.



3) **Animal growth** – One of the key objectives of a lower feeding rate was to promote early consumption of starter grain, which is less costly than milk replacer. But calves do not consume any appreciable amount of starter grain until about 4 weeks of age, and grain is not as easily digestible as milk replacer. From birth until 3 to 4 weeks, calves are most vulnerable to disease challenges because their immune systems are not fully mature. In that same timeframe, they have a tremendous ability to digest milk and absorb nutrients[9]. Young calves fed at a lower level of nutrition may stay function normally, but they may not thrive and grow like calves fed more nutrients. As an illustration, the following photo shows two calves of the same age. In this example, the calf on the right was fed 16 oz. of solids per day; the calf on the left was fed a higher level of nutrition.

4) **Mammary development** – Early life tissue development can impact an animal's productivity later in life. This is especially true considering mammary tissue and a calf's future ability to produce milk as a cow. The following image is an example comparing the mammary gland of a calf fed 16 oz. of powder per day (left), versus a calf fed a higher level of nutrition (right). The outlined area indicates tissue that will produce and secrete milk in future lactation.



Feeding more nutrition

Delivering a higher level of nutrition requires more than just increasing the volume of milk replacer fed. Transitioning to a more nutrient-abundant program can be aided by:

1) **New feed delivery methods –** At the most basic level, feeding 2 quarts of liquid per feeding was driven by the standard, 2-quart calf bottle. Now, 3- and even 4-quart bottles are readily available to facilitate higher levels of feeding. The growing adoption of autofeeders and mob feeders also has supported ease in delivering more nutrients per calf.
2) **Higher protein levels –** Using Nutritional Research Council (NRC) guidelines, determining the intersection of net energy allowable gain and protein allowable gain will identify the ideal protein:fat ratio, and volume, of milk replacer to feed. Often, this calculation points to greater efficiency in choosing a 26:18 or 28:20 milk replacer, versus a standard 20:20 formulation.
3) **Starter grain compatibility –** Rumen development is crucial for successful weaning. Feeding more milk or milk replacer early in life does not negate the importance of starter grain in the preweaning diet. If a higher-protein liquid diet is in place, a higher protein grain ration – commensurate with the milk-replacer protein level -- is required to maximize the investment in the total nutrition plan. Starter grain should be introduced in the first week of life in very small quantities. This grain supply should be replaced daily, as fresh starter will encourage intake.
4) **Adjusting medication levels –** If using a medicated milk replacer or adding medication, be sure to adjust medication levels as feeding rates increase. This will prevent exceeding the maximum labeled dose of grams per head per day.
5) **Solids levels –** Be sure to calculate intake based on actual solids levels fed. A solids feeding level of 16% or less is recommended to avoid digestive upsets caused by high osmolality. Also, be sure to calculate the ration based on total solids fed, not total volume. For example, solids mixing rate of 10 oz. per head will yield 12 oz. of liquid feed.
6) **Abundant drinking water –** Calves fed higher levels of solids need abundant, fresh drinking water to help them process the additional nutrients. Access to clean water should be constantly available, starting in the first week of life.

The U.S. dairy industry already is embracing the concept of feeding higher levels of nutrients to preweaned calves. With strategic ration development, attention to feeding methods and excellent animal husbandry, the industry can produce healthier, more-well-grown calves that become more productive animals throughout their lifetimes.

References:

1 -- Quigley et al. 2006. "Effects of additional milk replacer feeding on calf health, growth, and selected blood metabolites in calves." *J. Dairy Sci.* 89:207-216.

2 – Bartlett et al. 2006. "Growth and body composition of dairy calves fed milk replacer containing different amounts of protein at two feeding rates." *J. Animal Sci.* 81:1641-1655.

3 – Ballou et al. 2015. "Genetic, epigenetic and management factors contribute to the risk of morbidity and mortality of Holstein feeder calves, American Dairy Science Association Annual Meeting 2015, #518.

4 – Geiger et al. 2016. "Growth, intake, and health of Holstein heifer calves fed an enhanced preweaning diet with or without postweaning exogenous estrogen." *J. Dairy Sci.* 99(5):3995-4004.

5 – Geiger et al. 2016. "Feeding a higher plane of nutrition and providing exogenous estrogen increases mammary gland development in Holstein heifer calves. *J. Dairy Sci.* In Press.

6 – Soberon et al. 2009. "Early life management and long term productivity of dairy calves." *J. Dairy Sci.* 92 (Suppl. 1):238. (Abstr.)

7 – Soberon et al. 2012. "Preweaning milk replacer intake and effects on long-term productivity of dairy calves." *J. Dairy Sci.* 95:783-793.

8 – National Animal Health Monitoring System 2014. "Dairy 2014 Study." United States Department of Agriculture.

9 – Ballou et al. 2014. "Plane of nutrition influences the performance, innate leukocyte responses, and the pathophysiological response to an oral *Salmonella typhimurium* challenge in Jersey calves." *J. Dairy Sci* 98 (3):1972-82