



HOW MUCH STARTER GRAIN SHOULD A PRE-WEANED DAIRY CALF BE EATING?

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Introduction

Pre-weaned dairy calves need starter grain to initiate rumen development. Bacteria in the rumen begin to utilize nutrients from the starter grain and produce volatile fatty acids that assist with rumen development and feed intakes (Heinrichs 2014). There are guidelines on how much grain a calf should be eating in order to have a functional rumen and be weaned. The rule of thumb is that calves should be consuming about 2 pounds (about 4 cups) of starter per day for three days in a row to be weaned onto all-solid feed (Jones, and Heinrichs 2017). Although calves can safely drink up to 20% of their body weight in milk or milk replacer, many dairy calves are still limit-fed their liquid diet and need to consume adequate amounts of starter grain in order to grow (Khan et al. 2011). To maximize starter grain consumption, it is essential to understand how much calves will eat and what factors might impede consumption of starter grain.

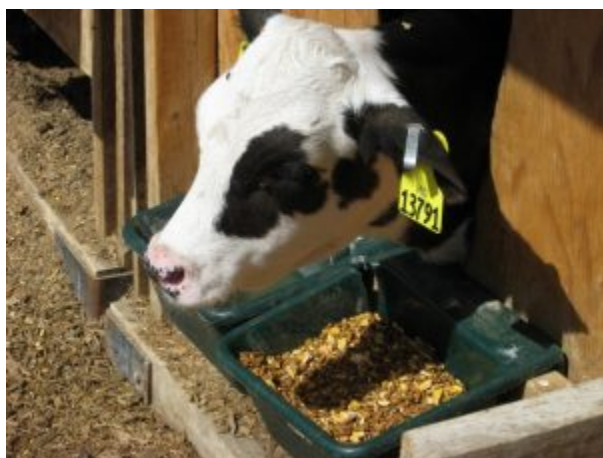


Figure 1. Holstein calf with a textured starter grain with rolled oats, rolled corn, and pellets.

Abbreviations

ADG: Average Daily Grain
CF: Crude Fat
CP: Crude Protein

Grain Consumption on Three Farms

To demonstrate differences in starter grain consumption, data on starter intakes from a large clinical trial to evaluate health effects of feeding a colostrum supplement to calves between 2 and 14 days of life on three farms were summarized (Berge et al. 2009). By three days of age a textured (Figure 1) calf starter (CP = 18%) was provided to calves after each morning milk feeding. One cup, equal to about one-half pound, of fresh starter grain was given to the calves every day. The grain remaining from the previous day was measured in cups and then discarded. Grain consumption from the previous day was recorded and fresh starter grain added to the calves' buckets.

More than 90 calves on each of the three calf ranches were assessed daily for 28 days. Farm 1 was a calf ranch raising dairy bull calves for beef and fed calves 2 quarts, twice daily of a medicated 22% Crude Protein (CP) and 18% Crude Fat (CF) milk replacer. Calves were observed from October through November. Farm 2 was a calf ranch raising dairy-sourced bull calves and heifer calves for replacements, in which calves were fed 2 quarts, twice daily, of a 22% CP: 22% CF medicated milk replacer. Calves were observed from January through February. Farm 3 raised dairy bull calves that were fed 2 quarts twice daily of a non-medicated milk replacer that was 22% CP and 18% CF. Calves 1 to 28 days of age on Farm 3 were observed in September. The average daily grain consumption for calves on each calf ranch (in cups) was calculated and plotted for each farm for 28 days of life (Figure 2). One cup of starter grain was equal to about 0.5 lb.

On Farm 1, starter grain consumption did not begin until about 8 days of age but rose over the next three weeks. By 4 weeks of age, calves were consuming about 3.5 cups (about 1.75 lb) per day. On Farm 2, calves had an earlier start in grain consumption, eating one-half cup (0.25 lb) of grain, on average, after 4 days of age but showed a slump in consumption between 10 and 14 days of age.

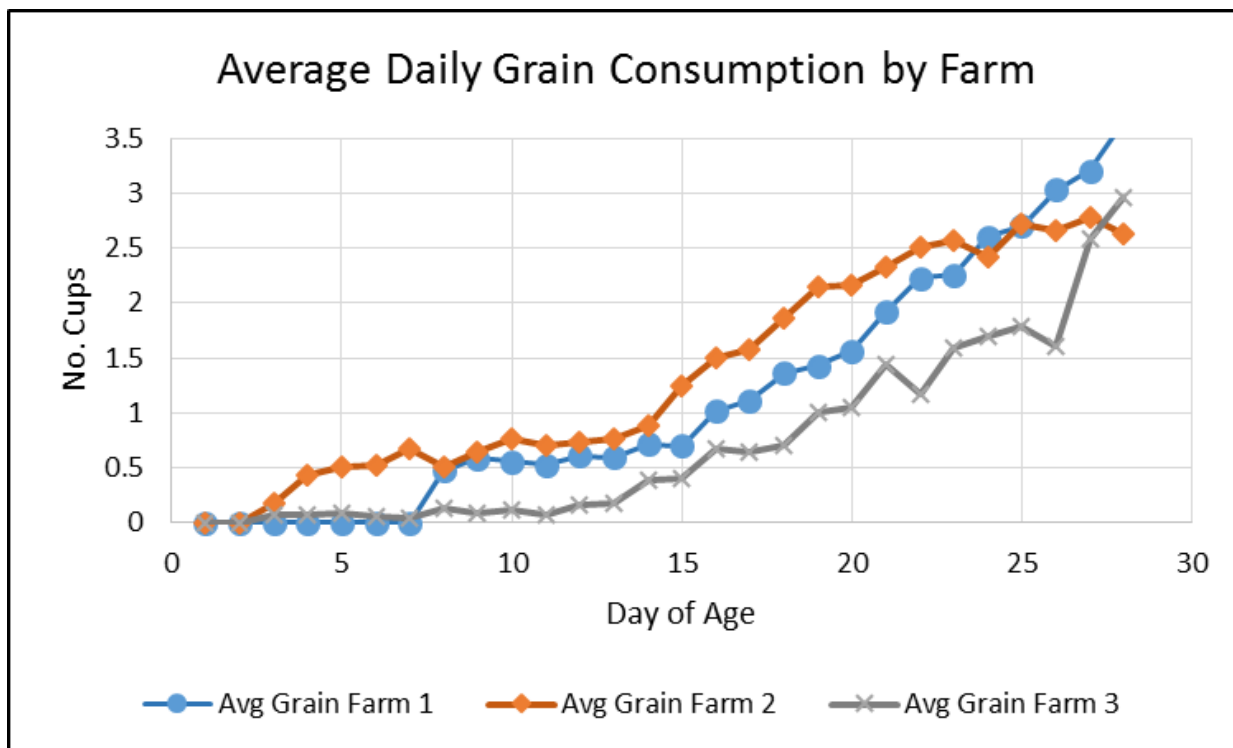


Figure 2. Average daily grain consumption in cups (1 cup = 0.5 lb) for dairy calves by farm for the first 28 days of life.

Although these calves increased grain consumption after two weeks, they again stalled but were consuming about 2.5 cups (1.25 lb) per day at 28 days of age. On Farm 3, calves ate little to no starter grain until 15 days and then increased to almost 3 cups (1.5 lb) per day by 28 days of age.

Calves should be consuming some grain by 2 weeks of age, but there are no guidelines on how much they should be eating (Heinrichs 2014). If not eating any grain by this time, the potential reasons should be investigated. A guideline is that calves should be eating about one-half pound (about 1 cup) by 4 weeks of age (Heinrichs 2014). In a study looking at different weaning strategies for calves that were fed unlimited milk and starter grain, at 28 days of age calves were only eating about 0.44 lb (less than a cup; extrapolated from their data) and by 48 days of age, they were consuming about 3 lb (about 6 cups) of starter grain (Sweeney et al. 2010). Calves that are limit-fed milk or milk replacer should eat considerably more.

Why are there Differences in Starter Grain Consumption Patterns between Farms?

Different liquid feeds and nutrients available. If calves were fed more nutrients from their milk replacer, they would eat less grain (Khan et al. 2011). Farm 1 and Farm 3 had liquid feeding programs that would have allowed a 100 lb calf to gain about 0.37 lb per day from energy and 0.6 lb from protein provided by the diet at an ambient temperature of 60°F (NRC 2001). Farm 2's liquid feeding program would have allowed for about 0.44 lb of gain per day from energy and 0.6 lb of gain from protein in the diet. If the ambient temperature dropped to 40°F for Farm 2 in January and February, there would have been no energy available for weight gain because of increased maintenance requirements (NRC 2001). More grain should have been consumed at this time on Farm 2, but this was not observed.

If a light-weight 100 lb calf consumed about 0.5 lb (1 cup) of starter grain dry matter in addition to the milk replacer provided, at 40°F they would only have enough protein or energy provided by the diet for about 0.4 lb of weight gain per day (NRC 2001). An important take-home message is that for the first three weeks of life, if limit-fed milk, starter grain intake is not adequate to provide enough energy in cold weather for maintenance nor much weight gain.

In a study by Sweeney and associates (2010), calves consuming more than 2 gallons of milk per day consumed very little starter grain. Raeth-Knight and others (2009) assessed daily starter grain consumption by calves on 6 different types of milk feeding programs. In the first 14 days of life, calves consumed, on average, about 0.09 lb (less than 1/4th cup) of starter per day with no observable differences among the liquid feeding programs. Between days 15 to 28, there was less starter consumed by the intensive milk replacer-fed calves that received a 28% CP:16% CF milk replacer at a higher feeding rate compared to all other liquid feeding programs (0.37 lb vs. 0.77 lb or 0.7 vs. 1.5 cups of starter consumed per day) and starter consumption was still lower in this group between 29 and 42 days of age. The conclusion from this is that when evaluating starter consumption, the liquid feeding system and total nutrients from the calf milk need to be taken into consideration.

Disease effects. In the clinical trial example, as part of daily observations, calves' feces were scored for consistency as 0 (normal), 1 (not fully formed), 2 (loose), 3 (watery), or 4 (watery with blood). A fecal score greater than 1 was considered a "case" of diarrhea and the percent of calves with diarrhea were plotted by farm and day of age to examine differences in the burden of disease among farms. In Figure 3, Farm 1 appears to have a greater "burden of diarrhea", particularly from days 5 to 14, compared to the other farms and could be related to the slump in grain intake seen during this time.

Figure 4 represents average daily grain consumption plotted by the percent of calves with diarrhea per day for each farm to identify potential relationships between these two factors. The percent of calves with diarrhea could explain about 42% to 51% of the variation in average daily starter grain consumption. As the percent of calves with diarrhea increased, the average daily grain consumption decreased for each farm. Therefore, disease appears to have an effect on grain consumption. If that holds true for other farms, it is vital to an individual calf with diarrhea to continue receiving its milk feeding for maintenance requirements because they will not be getting any nutrients from the starter grain. A previous study reported that a 2.2 lb per day drop in dry matter intake occurred between the day before diarrhea began and the day diarrhea started (Wenge et al. 2014). Grain and/or milk consumption can therefore be used as cues to identify sick calves.

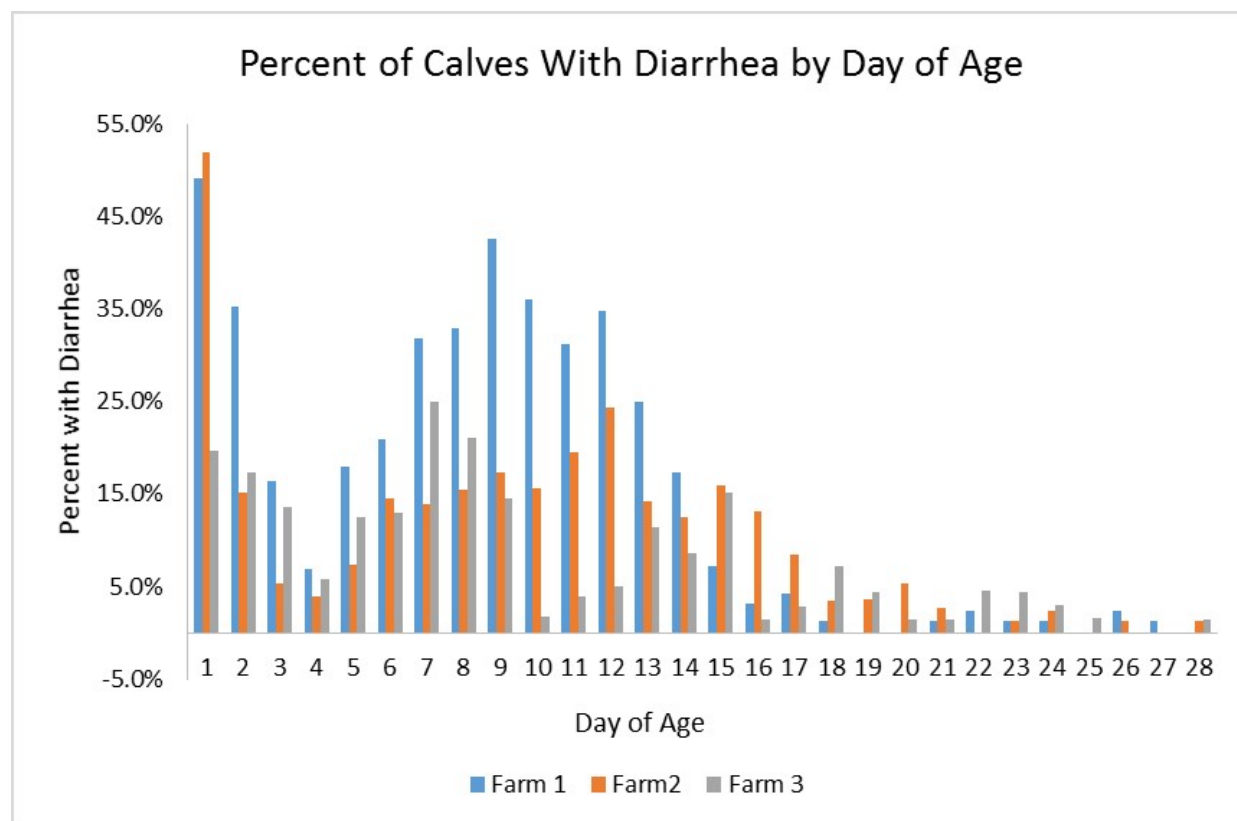
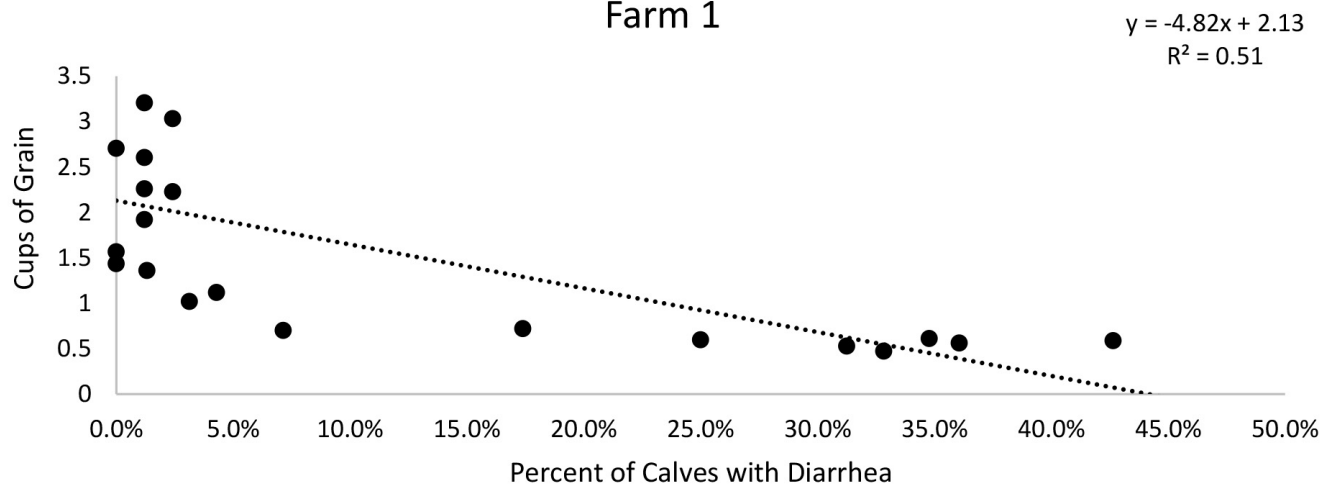
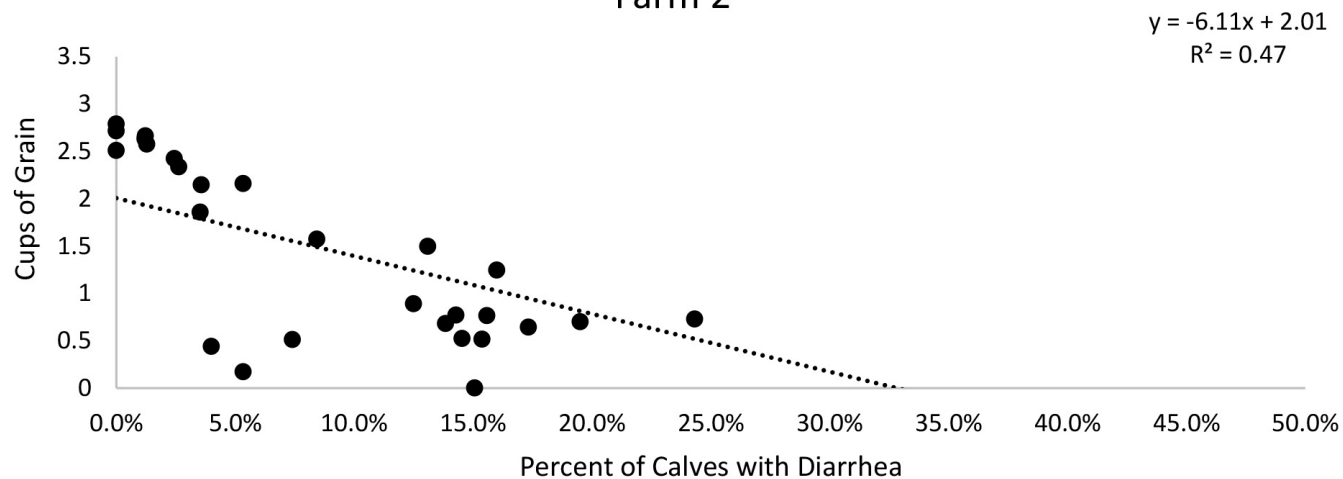


Figure 3. Percent of calves with diarrhea by day of age from 1 to 28 days on three farms.

Farm 1



Farm 2



Farm 3

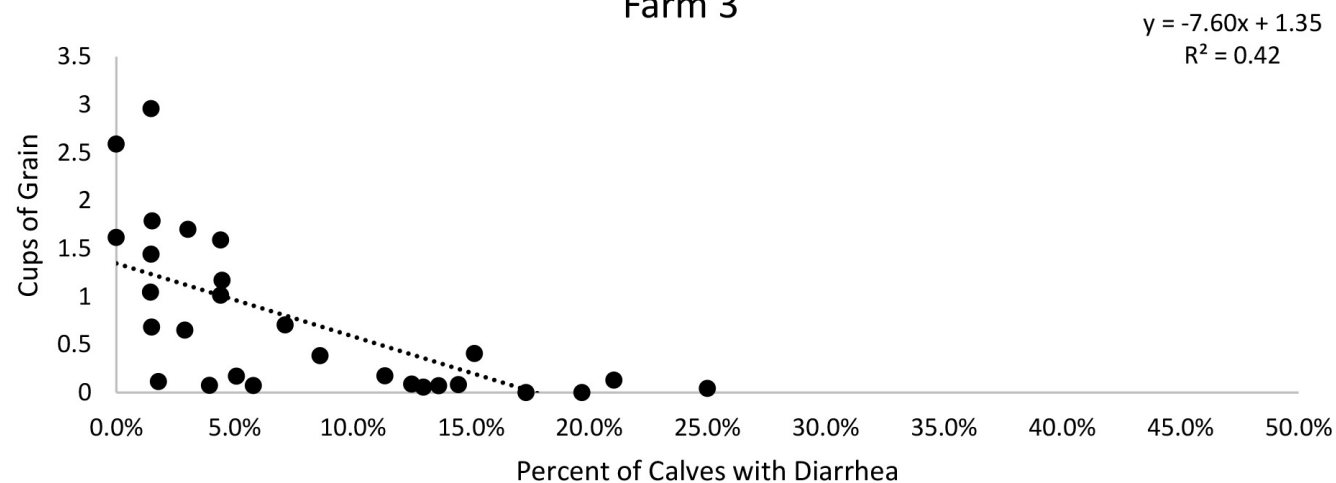


Figure 4. Average daily grain consumption by percent of calves with diarrhea on any day for three farms.

Calf size, gender, and breed. Calf size might be related to breed, calf sex, and birthweight. Birthweight might be considered something that could dictate starter grain consumption. For the example farm data, average daily grain consumption for 20 to 28 days of life was plotted by calf birthweight but there was no relationship between them. Most of the calves in the study were bull calves and all were Holsteins, so gender and breed differences could not be evaluated.

Water availability. Fresh water was provided daily to calves in the clinical trial. Water is necessary for rumen bacterial growth and is also necessary for dry feed consumption. Clean water provided daily encourages starter consumption (Heinrichs 2010). Calves deprived of water may experience a 31% decrease in starter intake and 38% reduction in weight gain (Kertz et al. 1984).

Starter grain texture, formulation, and freshness. Calves will consume more textured starter grain than a pelleted form or as a “mash” (Franklin et al. 2003). Feeding a multiparticle (textured) starter (Figure 1) may increase consumption, but pelleted starters (Figure 5) have been associated with higher feed efficiencies (Bach et al. 2007). Starch source also influences starter consumption, with corn-based starters being consumed more readily than oat or barley-based ones (Khan et al. 2007). In addition, the form in which the corn in the textured calf starter is provided (how it was processed) can affect starter consumption. Starter consumption was greater for calves eating whole or dry-rolled corn compared to roasted rolled corn or steam-flaked corn (Lesmeister, and Heinrichs 2004). However, calves eating starter with roasted rolled corn were better able to convert nutrients into growth than calves eating less-processed corn.

Calves will consume more starter grain if it is fresh, not dusty nor moldy. Molasses provides some energy and reduces the dustiness of grains. However, too much molasses (an increase of 5% to 12% dry matter molasses) added to textured starter grain decreased starter intake and growth (Lesmeister, and Heinrichs 2005). Adding water to calf starter will reduce dustiness and may increase consumption, particularly during warm weather (Beiranvand et al. 2016). However, spillage of milk or water into the grain bucket can result in moldy grain. Moldy feed may not be palatable to the young calf because of “clumping” or off-flavor, and may contain mycotoxins that can affect calf health (Gallo et al. 2015). Therefore, reducing water and milk contamination of starter grain and keeping grain fresh is essential to encourage consumption.



Figure 5. Pelleted calf starter grain with a small amount of whole, dry corn. Photo courtesy of J. R. Wenz.

Some feed additives might increase starter consumption. Adding yeast at 2% of the starter ration dry matter was shown to increase starter and total dry matter intake, resulting in a 15.6% increase in average daily gain (Lesmeister et al. 2004). Adding mannan oligosaccharide (a prebiotic) to milk replacer led to a faster rate of starter consumption, but not growth, in another study (Heinrichs et al. 2003).

Calf housing, weather, and management. Calves will require more nutrients in colder weather because of higher body maintenance requirements to keep warm. Many producers increase the total solids in milk replacer for winter feeding. If they do not, calves will need to consume more starter. However, calves will only be consuming measurable amounts of starter grain after 3 weeks of age, leaving the milk feeding of these very young calves as the only real source of energy and protein during cold weather.

Heat stress might reduce starter consumption overall (Jones, and Heinrichs 2017). One suggestion is to increase milk feeding during periods of heat stress. In one study, even heat stress in utero reduced starter consumption in calves (Monteiro et al. 2016). The calves of cows that were cooled during the dry period compared to those not cooled during summer ate 0.5 lb of dry matter intake more at 8 weeks of age and this higher consumption resulted in more weight gain.

Photoperiod (the amount of light hours per day) might also have an effect on starter intake. Calves provided extended lighting (18 hours per day) had higher starter intakes compared to those receiving less hours of light (10 hours per day) with intakes of about 0.88 lb vs. 0.44 lb (1.76 cups vs. 0.88 cups) per day by 4 weeks of age (Osborne et al. 2007).

How calves are housed may also have an effect on starter consumption. Calves housed as pairs ate more solid feed compared to those housed individually, but this consumption difference was not significant until after 5 weeks of age (Costa et al. 2015). In a study conducted by the University of British Columbia, calves raised in pairs ate more grain throughout the study than those raised singly (De Paula Vieira et al. 2010). Calves housed in groups after 3 days of individual housing ate more starter grain overall compared to individually-housed calves (Tapki 2007). In addition to housing, placement of the grain bucket may influence intake. Because most Holstein calves can only reach up to 24 inches, buckets placed too high will impede grain consumption (Hoskins 2016).

What are the Targets for Starter Grain Consumption?

Calves need to consume adequate amounts of starter for three main reasons. First, the grain helps them develop their rumens so they can be weaned onto all-solid feed. Second, the level of nutrients calves consume help them develop their immune systems. Third, calves need to grow at specific rates because high average daily weight gains (ADG) are associated with earlier puberty, lower age at first calving, and better first lactation milk production.

Calves are born immune naïve and require colostrum IgG antibodies for health, but they begin developing their own immune system in utero with rapid expansion after birth. Nutrition can influence their immune system development and reactivity. Ballou measured immune reactivity in Jersey calves fed different levels of nutrients and found those with greater levels of nutrients were better able to react to a bacterial challenge (Ballou 2012). Although he was evaluating milk feeding, any improvement in nutrition could aid the development of a calf's immune system (Khan et al. 2011).

Pre-weaning Nutrition, Growth, and Heifer Performance

Pre-weaning average daily gain can affect both age at puberty, age at first calving and first lactation milk yield (Raeth-Knight et al. 2009). In a study from Cornell University, for every 2.2 lb of preweaning ADG increase, heifers made an average of 1,870 lb more milk in their first lactation (Soberon et al. 2012). Although most studies investigating first lactation milk production focused on pre-weaning milk feeding, nutrition overall, including that from starter grain, plays a large part in heifer performance. From a summary of starter intake studies, average starter intake the week before weaning was significantly associated with Adjusted ADG after weaning (Bach 2014). For every 1 lb (2 cups) increase of starter grain intake the week before weaning, post-weaning ADG increased about 0.9 lb per day.

One goal for growth is to have heifer calves double their birthweight by weaning. Another rule of thumb for target body weights in heifers is for them to reach 55% of their mature body weight at breeding and 85% of their mature body weight at calving (Jones, and Heinrichs 2017). For a birthweight of 80 lb, the weaned heifer should be about 160 lb. For an average mature Holstein weighing 1,400 lb, the heifer should weigh 716 lb to begin breeding and 1,336 lb one week before calving. Holstein heifers should also be about 48 inches tall at the withers at puberty. If the goal is to have heifers calve at 22 months of age, there are two possible sets of ADG goals to achieve this, depending on whether the calves are fed milk or milk replacers conventionally or if they are intensively fed milk replacer (Table 1).

Table 1. Average daily gain goals at different stages for Holstein heifers using two different milk feeding programs to reach target weights at 22 months of age at first calf.

ADG Goals to get to 22 Months of Age at First Calf*		
	Conventional Milk Replacer Feeding Program 22% CP:20% Fat	Intensive Milk Replacer Feeding Program 28% CP:16% Fat **
Pre-weaning ADG	1 pound per day	2 pounds per day
Weaning to Conception ADG	1.98 pounds per day	1.81 pounds per day
Conception to Calving ADG	1.9 pounds per day	1.9 pounds per day

*Based on NRC, 2001.

**Hutjens 2002.

Conclusions

Calves need energy and protein along with other nutrients to grow and stay healthy. If limit-fed milk or milk replacer, they need to be encouraged to eat more starter grain. Calves that are limit-fed milk or milk replacer (2 quarts twice daily) will start consuming between 0.5 to 1.5 cups (0.25 to 0.75 lb) of starter grain by the second week of life. Calves on this regimen can be consuming over 2.5 to 3 cups (1.25 lb to 1.5 lb) of starter by 4 weeks of age but need to increase this to over 2 lb of starter grain to consider weaning. Monitoring grain consumption can give dairy farmers a way to evaluate the nutrients calves are actually consuming. There are many considerations when evaluating calf starter consumption in pre-weaned dairy calves. The nutrients calves get from their milk or milk replacer, weather, housing, and disease may all play a role in how much starter they will consume on a daily basis. Measurable starter consumption does not typically commence until about 20 days of age, even in calves limit-fed milk or milk replacer. However, initiating rumen development that leads to weaning requires a period of about 3 weeks. Therefore, providing fresh starter grain daily by day 3 of life will result in calves becoming more accustomed to it and, along with fresh water availability, encourages intake to meet the farm's goals for calf health and growth.

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