# AABP FACT SHEET

## NUTRITIONAL MANAGEMENT OF THE PREWEANED CALF

*Authored by the AABP Youngstock Committee*

*Ensuring the optimal growth and health of calves is paramount for any dairy operation's future. Healthy, well-grown calves will grow into healthy cows with high milk production potential. A structured milk feeding program, appropriate starter grain management, water management and considerations for forages form the pillars of calf nutrition. This guide outlines the best practices for each of these areas, offering practical recommendations based on industry standards and scientific research.*

## MILK FEEDING PROGRAM

### INTRODUCTION

It is important to understand that it is impossible to design a single milk feeding program that will work on every dairy or calf ranch. Physical facilities, environmental conditions, available feeds, and management practices must all be taken into consideration when designing a feeding program for a specific facility. Therefore, it is necessary to establish a set of guidelines that must be taken into consideration when designing a calf feeding program.

It is a common practice to calculate feed costs on a cost-per-calf-per-day basis. However, this encourages the calf owner to buy the least expensive milk replacer (MR) and calf starter and has a negative impact on the average daily gain (ADG). It also results in an increased cost per pound of gain. Instead, feed costs should be calculated on a cost-per-pound-of-gain basis (Overton et al., 2013). Improved nutrition results in an increase in ADG with a corresponding decrease in cost per pound of gain. Achieving high ADG is crucial for the calf's health and future performance (Soberon et al., 2012; Soberon and Van Amburgh, 2013; Gelsinger et al., 2016). These improvements in future milk production are observed for rates of gain exceeding 0.5 kg/d (1.1 lb/d), where every additional 100 g/d (0.2 lb/d) in pre-weaning average daily gain is associated with predicted increases of 66.2 kg (145 lb), 3.5 kg (7.7 lb), and 2.8 kg (6.2 lb) in milk, fat and protein production during the first lactation, respectively (Gelsinger et al., 2016). However, current recommendations are to achieve at least 800 g/d (1.76 lb/d) of ADG (DCHA, 2023). The Canadian Dairy Code of Practice and the U.S. FARM 5.0 program recommend monitoring ADG to ensure optimal growth and development. Birth weights and weaning weights are essential for the accurate calculation of ADG.

### MILK VOLUME

The goal is to design a program that will come as close as possible to what the calf would receive if left on its mother. Calves that receive adequate amounts of colostrum early in life may not want to drink much of their first, and sometimes second, regular milk feedings. These calves should not be force fed the remainder of these first few feedings.

If the newborn Holstein calf is allowed to drink milk ad libitum, it will often be consuming 8 liters of milk by the time it is 4-5 days old (Jasper and Weary, 2002). It may not be practical on many dairy operations to gradually increase the amount of milk fed on a daily basis during the first week of life. For this reason, it may be more practical to feed a specific amount of milk for the first week of life and then increase it at 8 days of age. If milk is fed at 15% of body weight at birth, the average Holstein calf would receive approximately 6 L (1.6 gal) of milk per day in divided feedings. By 8 days of age, the majority of Holstein calves will easily consume 8 L (2.1 gal) of milk per day, which is approximately 20% of their birth weight. This amount is also in accordance with the recommendations of the Canadian Dairy Code of Practice and Farm 5.0 programs. Further, calves offered < 8 L/d (2.1 gal/d) display signs of hunger (Rosenberger et al., 2017). When calves are offered higher volumes of milk (10 and 12 L/d; 2.6 gal and 3.2 gal/d), they gain more during the preweaning phase and maintain the weight advantage during and after weaning, with no difference in post-weaning starter intake (Rosenberger et al., 2017) and no negative effects on rumen development (Khan et al., 2007; Silper et al., 2024). Additionally, calves fed higher planes of nutrition have improved health (Borderas et al., 2009; Bach et al., 2013). Milk volume feeding rates should be adjusted according to the weight of the calf and when feeding Jerseys or beef-on-dairy-cross calves.

Consistency in the feeding program will minimize gastrointestinal upsets.

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Maintaining the same volume of milk being fed throughout the milk feeding period will allow the calf to gradually increase starter consumption as they increase in body size and weight. The ideal program would allow each calf to maximize its genetic potential in growth. If this type of program is being used, then each calf is essentially receiving the maximum amount of fat and protein to optimize ADG. However, if nutrient intake is not already maximized year round, then additional milk volume, fat, and protein may need to be added to compensate for the increase in thermogenesis needed during periods of cold stress. The thermoneutral zone of a newborn calf is 10 °C to 25 °C (50 °F to 77 °F), while the thermoneutral zone of a one-month-old calf is 0 °C to 23 °C (32 °F to 73 °F; NASEM 2021). Adding an additional milk meal, increasing meal volume, or increasing percent total solids when temperatures are well outside the thermoneutral zone will help meet calves' increased energy needs. These additional nutrients are also necessary to maintain the desired ADG as well as proper function of the immune system.

## WHOLE MILK

Whole milk from the Holstein cow is approximately 26 to 28% protein and 30 to 32% fat on a dry matter basis and approximately 12.5% total solids. In almost all cases, it will have a higher nutrient content than MR when mixed at the same percent solids. However, the percent solids should still be tested on a regular basis to ensure a consistent product. A Brix refractometer can be used to monitor percent solids when feeding whole milk to calves by adding a correction factor of 2 percentage points to the Brix reading (Moore et al., 2009). Ideally, expert opinion recommends that total solids in a calf's milk diet should vary less than 1% from feeding to feeding.

To prevent diseases such as *Mycoplasma spp*., Johne's disease, bovine influenza virus (H5N1), and *Salmonella* Dublin from being transmitted to calves, it is recommended that whole milk be pasteurized before being fed to calves. Routinely monitoring standard plate counts in whole milk that will be fed to calves is also good practice. Whole milk being fed to calves should not exceed 20,000 cfu/ml. This is the legal limit for human milk consumption.

Feeding hospital or non-saleable milk to calves is a common practice, but research indicates it can present certain animal health risks, so it's worth considering alternative options where possible. Pasteurization will effectively kill the pathogens in the milk but will not destroy any antibiotics. Antibiotics will negatively affect the normal microbiota of the calf and are associated with increased dysbiosis and diarrhea (Penati et al., 2021), as well as a higher proportion of resistant fecal *E. coli* isolates than calves fed saleable bulk tank milk (Aust et al., 2013). This in turn will have a negative impact on the immune system of the gut, the mucous layer lining the gut, competitive inhibition of pathogens, and increase the chances of leaky gut. The potential of developing antibiotic resistance is also a concern. The percent solids of hospital milk may vary significantly from one day to another (Moore et al., 2009), especially if the dairy is experiencing problems with mastitis.

If the dairy has a successful mastitis control program, it should not be producing enough non-saleable milk to feed all its calves, even if the bull calves are being sold at birth. The dairy should either use saleable milk to make up the difference or add a milk balancer or MR. While adding a milk balancer to whole milk can improve ADG, the percent solids should be monitored when these products are added (Glosson et al., 2014) and should not exceed 15%.

## MILK REPLACER

Milk replacer is often lower in nutrient content than whole milk. Some formulas may contain a similar amount of protein when compared to whole milk, but the fat content is almost always lower. Depending on the MR, whole milk may contain more energy at comparable volumes due to its higher fat content (Wilms et al., 2022) and greater digestibility (Lodge et al., 1973; Diaz et al., 2001; NASEM, 2021), which may contribute to improved ADG. An increase in ADG may be seen when switching from MR to whole milk simply because the fat and protein content is higher than the majority of MRs available on the market. The protein content of MR ranges from 20 to 28% and the fat content from 15 to 25%, unless a specific formulation is requested.

The quality of MRs can vary significantly. Less expensive MRs will often contain soy proteins to reduce the cost. However, the neonatal calf cannot utilize soy proteins very well during the first 2 to 3 weeks of life. Therefore, MRs that contain soy protein should not be fed to calves younger than 3 weeks of age. Hydrolyzed (soluble) wheat gluten protein (SWGP) can be used to replace up to 5% of the total MR or approximately 20% of the protein. Bovine plasma protein may also be used at this same rate. However, there is general agreement among veterinarians and nutritionists that an "all milk" MR, containing proteins only from milk sources, yields the best results in growth and health of the calf. The other ingredients commonly found in MRs are available from multiple sources and varying degrees of quality. Low-cost MRs may source their products from companies that sell lower quality ingredients. This may result in reduced digestibility along with a reduced ability to stay in suspension.

The most common sources of fat in MRs are tallow or lard (Wilms et al., 2024). These fats must be homogenized and emulsified to stay in suspension and improve digestibility. Emulsifiers such as mono and diglycerides and lecithin should be listed on the label. In addition to this, a process called agglomeration can be used to increase the surface area of small fat particles thus allowing them to be easier to mix into water and to stay in suspension once mixed and easier for calves to digest. This process is often referred to as "instantized".

The most important enzyme involved in fat digestion is lipase. There are several management procedures that result in an increase in the amount of lipase produced by the calf. The first is the ingestion of adequate amounts of colostrum immediately after birth (Blättler et al., 2001). This results in higher amounts of lipase being excreted into the gastrointestinal tract. This increased amount of lipase persists through weaning and beyond. The second factor is utilizing a nipple to feed milk to the calf. Saliva is an important source of lipase, and nipple-fed calves produce more saliva than bucket-fed calves. The other main source of lipase is the pancreas, but maximum pancreatic lipase secretion does not occur until the calf is 8 days of age. The calf depends heavily on salivary lipase the first 8 days of life so using a nipple at least during this time will significantly enhance fat digestion.

Lactose plays an important role in the osmolality of the MR. If the osmolality is too high, then it will cause fluid to cross the intestinal wall into the lumen of the intestine to reduce the concentration of particles to a more physiological level. This will result in diarrhea and occasionally other motility-related disorders such as abomasal bloat. The amount of lactose in whole milk is approximately 30%. However, the amount of lactose in a 20:20 MR is approximately 48%. This is a 60% increase in the amount of lactose. This has a profound effect on the osmolality of the MR.

The higher the percent protein and percent fat in MR, the lower the percent lactose. The MR formulas that contain more protein and fat come closer to achieving the normal amounts of these nutrients found in whole milk and have lower amounts of lactose, thus decreasing the chances of developing diarrhea due to high osmolality. The optimal macronutrient composition of the MR depends on the overall diet, including the starter feed and milk volume, as well as the desired weight gain. However, providing a MR with a high fat content (≥ 23%) is associated with reduced mortality (Urie et al., 2018), improved fecal consistency (Amado et al., 2019), and a lower incidence of disease (Berends et al., 2020).

The isotonic osmolality of the calf's gut is approximately 280 to 300 mOsm/L. Whole milk is usually in the range of 300 to 350 mOsm/L (Wilms et al., 2019) but MRs are often higher because of the increased lactose content. There are other ingredients as well that may affect osmolality. It is a fairly common practice to increase the solids of the MR to increase nutrient intake and improve the growth of calves. However, if the MR being used is already high in osmolality, this may result in loose stools or diarrhea (Wilms et al., 2019). Caution should be taken when offering fluids with osmolarities > 600 mOsm/kg, as it may lead to reduced calf health (Wilms et al., 2019) and digestive upset (Floren et al., 2016). If the calf facility wants to feed an increased amount of solids in their MR, the mixed product should be sent to a diagnostic lab that can test for osmolality.

Whether using MR by itself or in combination with whole milk, the percent solids should be carefully monitored to ensure a consistent product, resulting in fewer gastrointestinal upsets. A Brix refractometer can be used to estimate the level and consistency of total solids in MR. However, since the osmolality of one MR may be different from another, a standard curve of the Brix reading vs. the percent solids should be calculated when switching to a different MR. Directions for calculating this curve are described by Dr. Sheila McGuirk and are available on the University of Wisconsin School of Veterinary Medicine website (https://www.vetmed.wisc.edu/fapm/wp-content/uploads/2020/01/BrixRefrac.pdf). Poor quality MRs will often settle out after mixing. The percent solids should be tested immediately after mixing, when the first calf is fed, and when the last calf is fed. Poor quality products may have a difference of 2 to 3% solids from mixing until the last calf is fed. MR should be mixed at around 12.5% solids. Regular assessment of total solids of MR and whole milk, as well as calibration of automated milk feeders (AMFs) are important critical control points, as feeding milk with < 10% total solids has been associated with an increased prevalence of BRD (Medrano-Galarza et al., 2018). Although exact recommendations for total solids are difficult to find in the published literature, in general abomasal bloat problems are often seen with total solids above 15% (osmolality values over 650 mOsm/L) (Burgstaller et al., 2017). When assessing the total solids in MR using a Brix refractometer, an adjustment factor must be applied. For optical refractometers, a value of 1.08 must be added to the Brix reading and 1.47 added for digital refractometers (Floren et al., 2016).

Newborn calves have little to no reserves of vitamins A, D and E. Good quality colostrum has high levels of these vitamins and can provide adequate levels to the calf provided he has received sufficient colostrum. Good quality MRs should also contain vitamins A, D and E in the appropriate levels, and NASEM (2021) recommends MRs should have a minimum of 11,000 IU of Vitamin A per kilogram of MR, 3,200 IU of Vitamin D per Kilogram of MR, and 200 IU of Vitamin E per kilogram of MR.

## TRANSITION MILK

It has been shown that feeding transitional milk (milkings 2 to 6) or milk supplemented with colostrum or colostrum replacer to young calves for the first 3 weeks of life is beneficial to the calf. These benefits can include decreased antimicrobial treatments in the first 60 days of life, increased ADG, and stimulated early intestinal development (Van Soest et al., 2020; Van Soest et al., 2022; Uyama et al., 2022). This practice, although beneficial, can be difficult to practically and economically implement on farms. However, if the collection of transition milk is not feasible, colostrum replacement powder can be used to mimic transition milk using a 50/50 blend of milk or MR and colostrum replacement powder (Pyo et al., 2022).

## MILK FEEDING MANAGEMENT

An ideal feeding schedule would be to feed the calves 3 times per day 8 hours apart. However, this is rarely observed because of the labor cost and difficulty in having employees available at the right times. If there are 2 shifts per day, one shift ends up feeding the calves twice. Even with 2 times a day feeding, the feeding times are often less than 12 hours apart with one feeding early in the morning and the other mid-afternoon to be finished by 5 p.m. to 6 p.m. The next morning, the calves are hungrier and tend to consume their milk rapidly, commonly resulting in digestive upsets. The goal is to get the feeding intervals as close to equal as possible. The average Holstein calf should be able to consume 4 liters per feeding without digestive upset.

## BOTTLES

Bottle should be used for at least the first 8 days as previously described. The advantages of using bottles for feeding milk are as follows:

- Picked up and cleaned after each feeding for improved sanitation
- More accurate in the delivery of specific quantities of milk
- Less wastage of milk due to spilling during filling and drinking
- Less spillage of milk results in fewer flies in the calf's environment
- Do not have to train calves to drink out of a bucket
- Milk intake is slower compared to drinking from a bucket. This reduces the incidence of rumen drinkers and associated bloats

Even though milk bottles are marked according to volume, they are often filled with equipment that will cause foaming of the milk. This may result in the calves not receiving the desired volume. Thorough cleaning of the bottles between feedings is essential to decrease the microbial load ingested.

## BUCKETS

The main disadvantage of buckets is poor sanitation, as buckets are rarely picked up on a frequent basis for cleaning. The advantages of using buckets for feeding milk are as follows:

- Larger volumes of milk can be fed without having to purchase additional bottles that have a larger volume capacity

- Less time required for cleanup since it is rarely done
- Can use the same bucket for water and milk if needed
- No investment in bottles or bottle trailers
- No investment in filling and cleaning systems

As dairies expand and calf operations increase in size, it is common to purchase different types of calf hutch systems. These often include their own design of a bucket that fits their system. These buckets come in different shapes and sizes. If not using calf hutches, it is still common to purchase additional buckets, often from different manufacturers. These buckets come in different shapes and sizes so the total fill volume may vary. Filling one bucket ¾ full may result in an amount significantly different than another style bucket filled to the same level. The filling level for each style of bucket used should be determined and explained to the employee responsible for filling the buckets. Feeding equipment is available that will dispense a specific amount of milk with each pull of the trigger. This is an important management tool if bucket feeding is being utilized.

## AUTOMATIC FEEDERS

Computerized feeders are often programmed to gradually ramp up the milk intake of calves as they get older. This often results in inadequate milk intakes early in life. If the young calf does not receive enough milk early in life, it will consume more calf starter, which is mostly indigestible at this stage of rumen development. Calves should reach their maximum intake by the time they are 5 to 7 days old and maintain that level of intake until they are consuming enough calf starter to start reducing the daily allowance of milk in preparation for weaning. Do not assume that the equipment will always mix the correct concentration. Percent solids, temperature, and volume consumed should be monitored on at least a weekly basis. Auto feeders have several potential reservoirs of bacteria that can be a major concern regarding the intake of pathogens by calves on auto-feeders (Jorgensen et al., 2017). Bacterial counts should be monitored on a monthly basis to ensure delivery of a consistently clean product. Care must be taken to make sure that new calves are trained to use the auto feeder, and that there is minimal waiting time to enter the feeding station. Ideally, there should no more than 12 to 18 calves per nipple (Svensson and Liberg, 2006), but manufacturers often recommend much higher numbers to justify the cost of the system. Reduced access to the nipple as a result of too many calves is associated with greater number of competitive interactions, decreased feeding time and decreased milk intake (von Keyserlingk et al., 2004).

## MILK TEMPERATURE

The water used to mix the MR in should be warm enough to facilitate the suspension of the powder into the water and is often between 43 to 66 °C (110-150 °F). Follow label directions for optimal mixing temperature. If the hardness of the water is high, it may add significantly to the osmolality of the final mixture. The temperature of the prepared milk should be such that it is close to the body temperature of the calf at the time of delivery. This will usually be in the range of 101 to 105 °F (38.3 to 40.5 °C). If the milk is cooler than body temperature, the calf must expend energy to warm the milk prior to the process of digestion, thus reducing the feed efficiency. Mixing and delivery temperatures may need to be seasonally adjusted to account for heat loss due to environmental conditions, such as milk being dispensed into cold buckets or transported from a warm preparation area to colder calf pens.

## WEANING CRITERIA AND METHOD

The first criterion for weaning the calf is that the rumen must be functioning well enough to efficiently digest the dry feed that the calf will be totally relying on for its source of nutrients after weaning (Klopp et al., 2019; Welk et al. 2024). Feeding higher volumes of milk will not interfere with rumen development (Rosenberger et al., 2017). The calf must have the ability to consume enough calf starter to meet its nutritional requirements while the milk is being reduced during the weaning process (Quigley et al., 2019). The goal is to achieve a gradual transition from milk to a total dry feed, without a reduction in dry matter intake, while maintaining a similar rate of gain. Quigley and Schwab (1988) reported a high correlation between calf starter intake and percentage of nitrogen (N) as microbial N in abomasal contents of calves from 2 to 11 weeks of age, suggesting that the key driver to changing the nature of abomasal N was intake of dry feed. In the 8th edition of the *Nutrient Re-*

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*quirements of Dairy Cattle*, a meta-analysis was conducted using studies that reported the ratio of microbial N to total N in abomasal or duodenal content of calves from 2 to 20 weeks of age. Microbial N as a proportion of total N increased with increasing DMI to 1.3 kg/d. Thus, once starter intake reaches 1.3 kg/d, the proportion of total CP reaching the intestine for digestion that is of microbial origin will be maximized (NASEM, 2021).

Overall, there is a lack of research surrounding weaning methods. But, weaning at a later age and over longer durations (i.e. 2 weeks) via a step-down reduction in milk has positive effects on growth. Additional work is needed to better understand how different weaning protocols affect calf behavior at weaning (Welk et al., 2024). It is not advisable to discontinue one of the feedings when initiating the weaning process but rather decrease meal size. Discontinuing a feeding can result in the calf being extremely hungry when the milk feeding is discontinued and consume a higher volume of calf starter. The starch in the calf starter is rapidly fermented and lowers the rumen pH, resulting in subclinical or clinical acidosis. The calf will back off on feed consumption for a few days and then repeat the same process. Stools will often become loose due to acidosis. Reducing each feeding the same amount during the weaning process will help maintain a more consistent intake of calf starter and reduce the chances of developing acidosis.

Once the calf is weaned, it should stay on only calf starter for 1 to 2 weeks to ensure an adequate intake of nutrients post-weaning. This will decrease the incidence of a post-weaning slump and improve the ADG and health of the calf. The calves can then be moved to the next stage of raising (ideally small groups with calves of similar size). They should remain on starter for about 3 days before changing to a grower ration so there is not a social change and a nutritional change occurring at the same time. Calves should not be vaccinated, dehorned or castrated at or around the time of weaning.

## WATER MANAGEMENT

Early access to free choice water improves starter grain intake and growth rate. Calves should be allowed free access to water by 3 days of age. The water should always be fresh and clean. Calves will drink more water when it is offered warm verses cold (Huuskonen et al., 2011). Because of this, it is recommended that warm water be offered year round. During cold weather, the calves should receive warm water as often as possible, with the goal of always having access to water throughout the day. Free access to water will not decrease the desire to consume milk.

Calves will consume more calf starter and have improved ADG compared to those with delayed or restricted access (Kertz et al., 1984; Wickramasinghe et al., 2019). The water source should be tested for hardness and mineral content as well as nitrates. Minerals such as iron, manganese and sulfur can affect the smell and taste of water leading to lower water intakes. Water containing high levels of sulfur (> 2,000ppm) could predispose the calf to polioencephalomalacia. High levels of iron and manganese (> 0.3 ppm and > 0.05 ppm, respectively) can interfere with digestion of nutrients and lead to biofilm build up in water systems. Especially when mixing MRs, sodium levels need to be watched closely, as levels over 1,000 ppm can cause diarrhea and sodium toxicity. Water should have less than 1 CFU/100 ml total coliform bacteria (Beede, 2005).

## STARTER GRAIN MANAGEMENT

Starter intakes pre-weaning determine post-weaning growth (Stamey et al., 2012). Proper rumen development is needed for a smooth weaning transition and starter intake drives rumen development.

## NUTRIENT COMPOSITION GOALS

Calf starter has traditionally been formulated to contain 18% crude protein (CP) on an as fed basis. However, more recent research has shown the benefits of feeding a higher protein calf starter, (Kazemi-Bonchenari et al., 2022). Some starters are now available with 25% CP on a dry matter basis. This would be 22 to 23% CP on an as fed basis. These formulas have been shown to improve ADG and feed efficiency, while reducing the cost per pound of gain. Starch levels in calf starter are usually in the range of 30 to 35% of a highly digestible starch. Calves should have access to starter by 3 days of age. However, calves are unable to consume large amounts of starter early on and starter digestibility is low in these young calves and thus it should not be the primary energy source (Quigley et al., 2019). Early starter consumption is a sign

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that the calves are not receiving adequate volumes of milk.

### QUALITY

There are tremendous differences between the quality of calf starters on the market today. Most labels do not indicate the exact sources of protein or starch in the formula. It is commonly stated as processed grain by-products which includes almost every potential source. The protein quality is extremely important to maximize the protein utilization by young calves. Soybean meal is the highest quality protein source that is commonly used. However, some manufacturers will use cheaper protein sources such as dried corn distillers, which will have a negative impact on growth as well as rumen function. Calves do not need to have bypass protein in their starter grain.

### CONSISTENCY AND PRESENTATION

Calf starter is available commercially in 20 different forms. A textured form which is a pellet plus corn or sometimes other ingredients and usually includes molasses. The other form is a complete pellet. In either form, it is extremely important that the pellet is hard enough to maintain its integrity and soft enough that the calf can chew it up. If too soft, there will be fines in the calf starter which will significantly reduce consumption and can cause bloat. Textured products may be more likely to attract rodents, birds and flies because of the corn and molasses. Calves tend to consume more texturized starter overall and earlier in life compared to pelleted starter (Porter et al., 2007). The physical form and nutrient makeup of a calf starter can affect performance and digestibility (Quigley et al., 2018). There is still some debate about the concentration of protein in starter grain, optimal ingredients for calf starter, and the physical form that results in the greatest intake and the industry requires more research to settle this debate (Kertz, 2017).

### STARTER CONSUMPTION

Even though calf starter is offered to calves at 3 days of age, they should not be consuming much of it. It is there for the calf to become accustomed to it and to consume small amounts of it which will encourage rumen development. If the calf is receiving adequate volumes of milk, there will not be a major increase in starter consumption until 3-4 weeks of age. Then a steady increase in starter consumption will be observed. The calf should consume at least 1 kg (2.2 lbs) of a high-quality starter containing 22 to 23% CP on an as fed basis, before reducing the daily milk volume in preparation for weaning (Benetton et al., 2019; Welk et al., 2022). Once completely off milk, the intake of calf starter should increase to 2.7-3.6 kg (6 to 8 lbs) per day within 7 to 10 days post-weaning.

### FORAGES

The majority of those involved in calf nutrition research recommend that the calf not be fed any forage until after weaning. Studies show that rumen development occurs normally without the introduction of forages while on milk. Smaller amounts of forage mixed in with calf starter results in sorting and most of the forage is not consumed. The calf does not have sufficient rumen function to digest the forages efficiently until around 4 weeks of age, and even then, the ability to efficiently digest forages is limited. Forages are generally introduced in the grower ration about 2 weeks after the weaning process is completed. The grower ration will commonly contain 15 to 20% high-quality forage usually in the form of grass hay. While alfalfa hay often provides more protein than grass hay, its rough, stemmy texture sometimes isn't as enticing to young calves as a soft grass hay.

However, recent research has supported offering chopped forages alongside starter in pre-weaned calves. Some research has shown that offering forages to pre-weaned can promote solid feed dry matter intake and rumen development (Khan et al., 2011). Forage has the potential to affect starter feed intake and performance of dairy calves, but its effects depend on source, level and method of forage feeding and physical form of starter feed (Imani et al., 2017). Further research is warranted to identify an optimal balance between physically effective fiber and readily degradable carbohydrates in starter diets to support development of a healthy gut and rumen, rumination behavior and growth in young calves (Khan et al., 2016).

### CONCLUSION

Implementing a structured and balanced nutrition program for calves is essential for their health and productivity. By following these guidelines for milk feeding, starter grain management, water management, and forage introduction, the dairy calf will have an improved rate of growth, health, and future performance.

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## NUTRITIONAL MANAGEMENT OF THE PREWEANED CALF

*Continued*

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