

# Improving management of weaning for dairy calves

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## Abstract

The transition from a milk-based diet to solid feed presents nutritional and physiological challenges for dairy calves. Proper weaning management is critical to minimizing growth slumps and optimizing long-term performance. Research supports feeding a higher milk plane preweaning to enhance growth, reduce hunger, and improve welfare, with minimal impact on disease risk. Strategies to support weaning success include gradual weaning, maximizing early solid feed and water intake, and implementing social housing. Additionally, colostrum supplementation during weaning shows potential benefits. This review synthesizes current evidence on weaning strategies, highlighting practical approaches to support calf growth, health and welfare while optimizing postweaning performance.

**Key words:** dairy calves, weaning, nutrition, solid feed intake

## Introduction

The transition from a milk-based diet to solid feed presents significant nutritional and physiological challenges for dairy calves. During this period, calves shift from functioning as pseudomonogastrics, relying primarily on milk, to developing a fully functional ruminant digestive system capable of processing solid feed. This transition typically occurs in less than a week,<sup>1</sup> a stark contrast to natural conditions where weaning takes place over several months.<sup>2</sup> If not managed properly, weaning can be a stressful process, leading to signs of hunger and weight loss. Therefore, implementing best management practices is essential to minimize the weaning slump and support optimal growth and development. The objective of this narrative review is to examine the challenges associated with weaning in dairy calves and to evaluate management strategies that support a successful transition to solid feed while optimizing growth, health and welfare.

## Plane of milk nutrition matters

To achieve high rates of growth and ensure calves double or triple their birth weight by weaning, the plane of milk offered is a critical factor. Research has consistently shown that feeding an accelerated or biologically normal plane of nutrition (20% of body weight or more) significantly improves preweaning growth.<sup>3</sup> This enhanced early growth is particularly important, as it has been linked to greater future milk production, likely through epigenetic programming or improved mammary gland development.<sup>4,5,6</sup>

Beyond growth benefits, higher milk allowances support calf welfare by reducing hunger and increasing play behavior.<sup>3</sup> From a health perspective, most studies report no consistent evidence linking higher milk intake to a greater incidence of disease conditions like diarrhea.<sup>3</sup> Some studies even suggest health improvements with higher milk intake. For example,

when challenged with *Cryptosporidium parvum*, calves fed a higher plane of nutrition maintained hydration, recovered from diarrhea faster, grew more quickly, and showed improved feed efficiency<sup>7</sup>.

One potential drawback of higher milk intakes is a reduction in starter feed consumption.<sup>3</sup> However, with effective weaning management, calves can gradually increase their starter intake, ultimately matching the consumption levels of those fed lower milk allowances.<sup>8</sup> Importantly, this adjustment occurs while preserving the growth advantages associated with higher milk intake, ensuring long-term benefits in overall development and productivity.

## Achieving weaning success

To effectively manage the challenges of weaning, several key strategies should be considered. The most critical is maximizing solid feed intake to support growth and development. Additionally, weaning at an older age, gradually reducing milk intake, and utilizing social housing can further ease the transition and improve overall calf productivity.

## Maximizing consumption of solid feed

Solid feed rich in easily fermentable carbohydrates is essential for ruminal development, particularly in driving structural changes in the forestomach epithelium.<sup>9,10</sup> As reviewed by Khan et al.,<sup>1</sup> feeding concentrate increases rumen weight, volume and papillae growth, primarily due to the stimulatory effects of volatile fatty acids (VFAs) on epithelial proliferation. Among these, butyrate is the most influential, promoting ruminal epithelial development and reinforcing the importance of grain-based starter feeds.<sup>9</sup> Early solid feed consumption is critical and can be encouraged by offering starter before two weeks of age and monitoring intake to ensure adequate provision.

## Where does water fit in?

Water provision has long been linked to increased starter intake. Data from 346 calves with weekly water and grain intake records showed that for every 1 L of water consumed over an 84-day period, starter intake increased by 0.24 kg.<sup>11</sup> The importance of early water access has also been demonstrated in previous studies. Kertz et al.<sup>12</sup> found that offering water at birth, rather than at 28 days of age, resulted in higher growth rates, likely due to increased starter intake. More recently, Wickramasinghe et al.<sup>13</sup> reported that calves provided water from birth consumed more milk and tended to gain more body weight during the preweaning period compared to those receiving water at 17 days of age. Additionally, postweaning (50-70 days), calves with early water access had greater hip height, body length, feed efficiency, and apparent total-tract digestibility of acid detergent fiber and neutral detergent fiber than those receiving water later. When followed to 5 months of age,

calves receiving water at birth also had greater body weight. Collectively, these studies highlight that early water provision not only supports solid feed intake but also enhances overall growth and productivity.

### Type of starter

The physical form of starter feed is an important factor influencing intake. Feeds with excessive fines are typically consumed less than pelleted or texturized starters, potentially reducing overall intake.<sup>14,15</sup> However, comparisons between pelleted and texturized starters show minimal differences in total intake and feed efficiency, as studies using the same ingredient composition have yielded inconclusive results.<sup>16</sup>

### What about forage?

Forage provision is another important consideration in calf nutrition. Studies have shown that offering chopped hay or straw alongside starter during the preweaning period can enhance average daily gain and dry matter intake.<sup>16</sup> For instance, Castells et al.<sup>17</sup> reported that providing starter with chopped oat hay or barley straw, compared to starter alone, improved starter intake and average daily gain while also reducing non-nutritive behaviors such as tongue rolling and surface licking. Similarly, Pazoki et al.<sup>18</sup> found that supplementing starter with chopped alfalfa hay increased starter intake and average daily gain, helped maintain ruminal pH, reduced plaque formation on the rumen wall, and promoted greater muscularization of the rumen. However, caution is needed when forage intake exceeds 10-15% of total dry matter intake, as excessive forage consumption may contribute rumen fill and limit intake of concentrates due to satiety.<sup>16,19</sup>

### Age at weaning

A systematic review examined various outcomes related to the age at which calves were weaned or fully transitioned off milk.<sup>20</sup> Overall, later weaning was associated with increased average daily gain and final body weight, along with reduced signs of hunger (e.g., vocalizations, unrewarded visits to the automated milk feeder) (Table 1). However, a negative effect on starter intake was observed (Table 1). The authors concluded that while the optimal weaning age remains unclear, among the ages evaluated, weaning after 8 weeks supports greater average daily gain compared to weaning before 8 weeks, provided that preweaning milk intake exceeds 6 L per day.

**Table 1:** Summary of findings from Welk et al.<sup>20</sup> on the effects of weaning age in calves.

Variable	# of studies	Weaning at later vs. earlier age		
		Negative	Equal	Positive
Starter intake	12	6	5	1
Average daily gain	12	1	4	7
Final body weight	14	0	7	7
Signs of hunger	3	0	0	3

## Weaning strategy

When high volumes of milk are fed, gradual weaning programs can be used as a method to ensure starter intake, support growth over the weaning period, and may improve feed efficiency, support natural behaviours and reduce the incidence of disease.<sup>1</sup> A systematic review evaluated 13 studies that looked at the duration of weaning programs<sup>20</sup> found largely positive findings in terms of starter intake if the duration over which calves were weaned was extended; however, many of the other parameters evaluated were not different, including growth performance (Table 2). This is largely related to issues with study design where confounding variables, like milk allowance, weaning initiation, and weaning age, likely impacted the results. Further, many of the studies did not follow calves for extended periods of time following weaning. Hence, based on starter intake alone, using a gradual weaning program over a period of at least 2 weeks is likely to maximize gain during and after weaning.

### Does colostrum fit in as a weaning strategy?

Colostrum contains a diverse array of bioactive molecules, including growth factors and antioxidants, that influence immune, metabolic and endocrine pathways.<sup>21</sup> In both humans and animals, bovine colostrum supplementation has been shown to support gastrointestinal health and immunity, likely due to its rich composition of growth factors.<sup>22,23,24</sup> Bovine colostrum replacer has been used in weaned piglets for decades around the time of weaning. Studies have demonstrated that its supplementation increases villus height, improves intestinal integrity, and enhances feed intake, weight gain and feed efficiency.<sup>24,25,26</sup> In dairy calves, a single study found that supplementing colostrum over the weaning period resulted in calves being 3 kg heavier at the end of the trial.<sup>27</sup> However, no significant differences were observed in intestinal permeability or other physiological measures, leaving uncertainty regarding the exact mechanisms of action.

## Social housing

Social housing has been shown to provide benefits, even when calves are housed in pairs. As reviewed by Costa et al.,<sup>28</sup> social housing improves solid feed intake and weight gain before and after weaning (Table 3). Additionally, calves reared in social environments demonstrate enhanced cognitive ability and behavioral development.<sup>29</sup>

From a health perspective, there is little evidence to suggest that individual housing offers better health outcomes than group or pair housing.<sup>28</sup> However, health differences have been observed when calves are housed in large groups (> 8-10 calves). For example, one study found that housing calves in pens of 12-18 increased the incidence of respiratory disease and reduced growth compared to groups of 6-9.<sup>30</sup> Another study reported higher odds of respiratory disease in large group pens (6-30 calves) compared to smaller pens with 3-8 calves.<sup>31</sup> Conversely, a study comparing group sizes of 2, 4 and 8 calves found no differences in health,<sup>32</sup> suggesting that small group sizes do not negatively impact health.

**Table 2:** Summary of findings from Welk et al.<sup>20</sup> on the effects of weaning duration in calves.

Variable	# of studies	Prolonged weaning duration vs. short		
		Negative	Equal	Positive
Starter intake	11	0	4	7
Average daily gain	11	0	8	3
Final body weight	9	1	8	0
Signs of hunger	4	0	4	0

**Table 3:** Summary of findings from Costa et al.<sup>28</sup> on the effects of social housing in calves.

Variable	# of studies	Social housing vs. individual		
		Negative	Equal	Positive
Starter intake	12	6	6	7
Average daily gain	11	0	5	6
Body weight	7	0	2	5

## Summary

Weaning presents significant nutritional and physiological challenges for dairy calves, requiring careful management to minimize stress and optimize growth. Feeding a higher milk plane preweaning supports improved growth, welfare, and feed efficiency with minimal health risks. However, ensuring a smooth transition to solid feed is essential. Gradual weaning helps sustain growth while reducing signs of hunger. Providing early access to water and high-quality starter feed further supports rumen development and postweaning performance. Social housing can enhance solid feed intake and behavioral development without negatively impacting health in small groups. Additionally, colostrum supplementation during weaning shows potential benefits for growth and gut health, though more research is needed.

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