Transition - a headache or an opportunity?

F. Soberon, PhD; M. Soberon, PhD
Standard Dairy Consultants, LLC Canandaigua, NY 14424

Abstract

Dairy professionals have to proactively manage the areas that can become obstacles to a lifetime of high production in the pre-weaned heifer. Less data exists regarding the long-term effects associated with different weaning strategies and gut metabolism. While the immune system can be reinforced through nutrition, potential sources of gut stress may be present due to feed transitions, moldy feed, sorting, overcrowding and lack of quality water available. In addition to those potential sources of inflammation, it is important to proactively manage the body composition of gain in heifers in order to achieve a successful lactation.

Key words: weaning, body composition, heifers

Introduction

Regardless of the industry, area of expertise or discovery made, the difference between those whothat achieve greatness and those who that fail to succeed is undoubtedly linked to the disposition taken towards challenges. For those whothat achieve greatness, every challenge is seen as an opportunity, and therefore they are in a continuous state of improvement. While every livestock operation is filled with challenges or opportunities, a dairy operation is often uniquely endowed with these areas of opportunity since in most cases, dairies manage the full life cycle of the cow. Not only do dairies maintain their animals the longest compared to other industries, but they also manage a continuous flow of animals in each stage of life, thus presenting opportunities anew each day.

Through science, research, and animal husbandry, the dairy industry has successfully more than doubled milk production per cow while increasing feed efficiency. This can be seen most remarkably in comparing average milk production over time. This spring 2021, yet another record high in lifetime milk production was recorded, as a 16-yr-old cow in Wisconsin was reported to yield 460,000 pounds (209,091 kg) in her lifetime (Hilda of Stone-Front Farm in Lancaster, WI). When reaching towards the golden standard of a healthy cow, "'healthy'" is a long-term goal, a consistent expectation, which is why every dairy producer raising heifers should have this concept of a healthy, high-producing cow in mind, essentially working with the "'end in sight.'" In order to reach this end, producers and advisors have to proactively manage the areas that can become obstacles to a lifetime of high production.

Relating old challenges in the pre-weaning stage to new information

In terms of early life development, pre-weaning has received heavy attention due to the high mortality rates that traditionally accompanied this time period in the life cycle of the cow. Through colostrum management, nutrition and animal husbandry, we have improved animal performance, reduced mortality and seen long-term benefits in these animals' lifetime productivity.[7, 14, 16, 17, 21, 27-32] That said, while some focus has been placed on how to wean animals that are properly fed, [2-5, 15, 18, 22, 25, 33, 35] less data exists to elucidate the long-term effects associated with these different weaning strategies. In many cases, the root causes of the challenges these animals face are still hypotheses, and while they have been studied independently, it is worth investigating whether they have been considered in context of the immune system.

Start with better pre-weaning nutrition

Weaning, irrespective of age, was shown by Hulbert et al., to suppress many innate immune responses, and early weaning transiently suppressed L-selectin expression in neutrophils as well as decreased neutrophil oxidative bursts.[14] The vitality of the immune system can be reinforced through nutrition, as shown by Ballou when calves provided more milk replacer also had greater neutrophil oxidative burst intensities than calves fed a lower plane of nutrition.[1] Contrary to traditional thought where restricting milk intake in calves was thought to increase dry grain consumption and reduce the costs of growing dairy calves, feeding more milk during the pre-weaning period has been shown to ultimately result in higher feed intake and efficiencies.[7, 14, 17, 21, 30] Calves with restricted milk intake end up being more costly due to limited growth, increased mortality, morbidity, and decreased feed efficiency. Moreover, to potentially minimize the impact that gut-derived inflammation may have in heifers, it is not only important to provide adequate supply of energy and protein and the right balance of vitamins and minerals,8 but to also become aware of potential sources of gut stress including feed transitions, moldy feed, sorting, overcrowding and lack of quality water available.

Re-examine weaning strategies

In the case of the weaning process, where calves face a drastic change in diet, the gut environment deserves consideration. The challenge dairy producers face is the relatively short window of time to transition a dairy calf from milk to a full ruminant diet, especially when compared with the length of weaning that a typical beef heifer experiences. If one extrapolates from studies performed on adult lactating cows where induced gut changes resulted in inflammation that down-streamed into metabolic challenges,[19] it is natural to hypothesize that the pre-weaned heifer may suffer similarly due to changes in the pH of the gut or other possible gut irritants during the accelerated transition of the gut that the modern dairy calf experiences.

Despite the advantages of increased planes of nutrition pre-weaning, grain consumption at the time of weaning is delayed relative to calves on restricted milk diets.[22] It follows that the step-down weaning strategy, which results in calves transitioning to higher solid starter intake pre-weaning, has proven to be a reliable method for smoother transitions.[17, 33] The assumption may be made that this approach either reduces the inflammation of the gut by a more gradual increase of grain consumption or it presents inflammation at a time that the calf is still receiving sufficient nutrients from milk to better cope with the inflammation. Studies like Eckert et al[7] and McCoard et al[20] have also shown us that even step-down strategies cannot completely replace an appropriate age at weaning, and the challenges presented to calves weaned under 56 days may not be overcome

as easily. This study also shows the importance of water consumption, as DMI is directly correlated to water consumption, regardless of age.[7]

Re-evaluating housing strategies

Most of the research on performance animals are directly linked to the benefits of the animal or the producer. When it comes to housing calves, there is an aspect of social sustainability that often becomes relevant to producers as well. It may be encouraging to see that the socially acceptable housing methods of paired or group housing of calves also result in a benefit to the animal and corresponding increase in production parameters.[2, 3, 4, 15, 18, 22, 25] Compared with calves previously housed in single pens, paired calves visited the starter feeder more frequently, spent more time at the feeder, consumed more starter and presented higher weights than their individually housed counterparts. There have been studies evaluating the presentation of the feed and the type of ingredients used that show some short-term differences in behavior, but no sustained, long-term performance differences resulted.[22] However, none of these studies measured the effect of these treatments on the immune system.

Revisiting composition of growth post-weaning

When it comes to body composition of growth in a post-weaned heifer, research is clear that over-conditioning is not the "'end we have in mind'": over-conditioned cows at parturition have increased probabilities of metabolic problems; they have reduced DMI and lower production.[11, 12, 24, 26] By contrast, the "'end in mind'" for body composition in a heifer is 23% body fat and 17% protein.[35] Now that the goal has been clearly defined, it is important to establish when the growth should occur. There is a defined period of time from conception to parturition. Therefore, once the heifers are pregnant, age at first calving (AFC) is established and the energy demands of that heifer now include the developing fetus. Growth rates during this period should be between 1.5 and 1.8 lb/day (0.68 to 0.82 kg/d) depending on expected mature body weight.[35] If weight gain is greater than that, there will be an accumulation of adipose tissue that will lead to complications during calving.

Since the growth rate of pregnant heifers has been clearly defined, and it has already been established that pre-weaning growth should be maximized due to the long-term benefits of early nutrition,6, 29, 31, the period from weaning to breeding is the only period that offers the flexibility to adjust growth rates to meet the AFC expectations. Figure 1 graphically shows growth rates required to achieve similar body compositions at different AFC.

Early studies performed on heifer growth rates had concluded that accelerated growth rates pre-puberty had a negative effect on lifetime production;[8,9] however, when composition of the growth is considered in those studies, BCS, perhaps better defined as body fat percentage, can explain the differences in production.[35] It is also worth consideration that the difference in body weight gain within those treatments was achieved through the supply of corn or energy and not a combination of energy and protein; therefore the type of growth achieved was not the desired increase in frame size needed to be a productive dairy cow.

Table 1 shows estimated body composition based on different growth rates and different AFC.23. If growth rate is not properly match to AFC, then body composition will not be consistent with the goal of a productive dairy cow.

Summary and conclusions

Everything in the cow's life is interconnected and it muost be understood that any change in one aspect of the development of the calf will have implications in other aspects of her productive life. There are no studies that show all the interactions between health, nutrition, housing, and performance. However, with greater understandings of the downstream effects of disease and inflammation, it is imperative that we consider the immune system in the daily practices, or when trouble-shooting growth and performance. The industry has come a long way in the rearing of dairy heifers; the feeding of calves has moved from subsistence feeding to performance-driven programs. These changes allow us to make better culling decisions early in life by harvesting "'poor do-ers'". As we demand more from our animals and operations, it is important to remember the downstream effects of each practice and adjust other management practices accordingly so the animals can perform to their potential, and meet our expectations.

References

1. Ballou MA. Immune responses of Holstein and Jersey calves during the preweaning and immediate post-weaned periods when fed varying planes of milk replacer American Dairy Science Association®, 2012 *J Dairy Sci.* 95 :7319–7330 **http://dx.doi.org/ 10.3168/jds.2012-5970.**

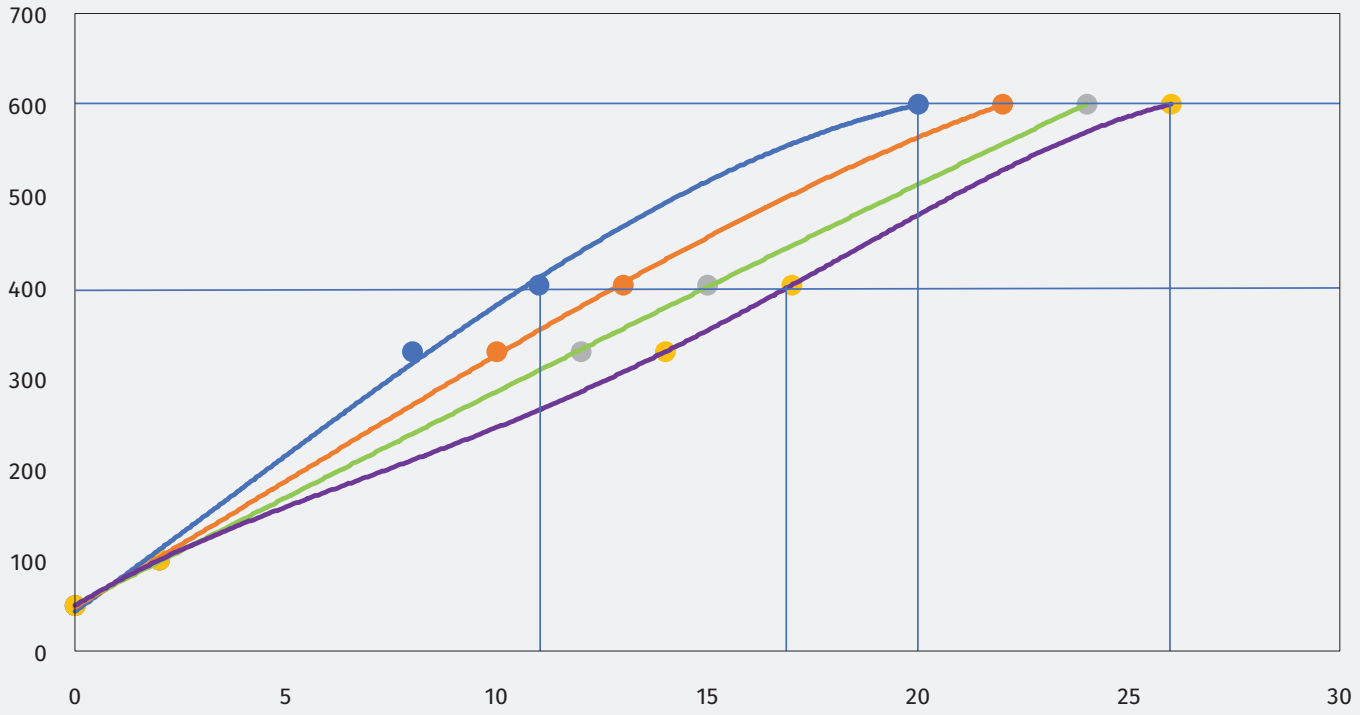
2. Bučková K, Šárová R, Moravcsíková Á, Špinka M. The effect of pair housing on dairy calf health, performance, and behavior. *J Dairy Sci*. Vol. 104 Issue 9p10282–10290 Published online: June 11, 2021.

Table 1: Estimated body composition at calving for heifers grown at different growth rates from weaning to breeding with different age at calving.

Pre-pubertal ADG	AFC	Body fat %	Body protein %
1.2 lb.	26 mo	23%	17%
1.4 lb.	24 mo	23%	17%
1.7 lb.	22 mo	23%	17%

Mature BW = 1,320 lb (600 kg); weaning weight 176 lb (80 kg); breeding weight 726 lb (330 kg) (55%); calving weight 1,082 lb (490 kg) (82%). Calculations made based on NRC (2001).

Figure 1: Growth rates required to achieve similar body composition at different ages at calving (AFC). Calculations based on 1,600 lb (730 kg) mature body weight animal utilizing NRC (2001) equations.



3. Costa JHC, Daros RR, von Keyserlingk MAG, Weary DM. Complex social housing reduces food neophobia in dairy calves. *J Dairy Sci*. Vol. 97 Issue 12p7804–7810 Published online: October 8, 2014.

4. De Paula Vieira A, von Keyserlingk MAG, Weary DM. Effects of pair versus single housing on performance and behavior of dairy calves before and after weaning from milk. *J Dairy Sci*. Vol. 93, Issue 7, P3079-3085, July 01, 2010.

5. De Paula Vieira A, von Keyserlingk MAG, Weary DM. Effects of pair versus single housing on performance and behavior of dairy calves before and after weaning from milk. *J Dairy Sci*. Vol. 93, Issue 7, P3079-3085, July 01, 2010.

6. Diaz MC, Van Amburgh M, Smith J, Kelsey J, Hutten E. Composition of growth of Holstein calves fed milk replacer from birth to 105-kilogram body weight. *J Dairy Sci*. 2001; 84 (11352160): 830-842.

7. Eckert E, Brown HE, Leslie KE, DeVries TJ, Steele MA. Weaning age affects growth, feed intake, gastrointestinal development, and behavior in Holstein calves fed an elevated plane of nutrition during the preweaning stage. *J Dairy Sci*. Open Archive Published: July 02, 2015 **DOI:https://doi.org/10.3168/jds.2014-9062** Vol. 98, Issue 9, P6315-6326, September 01, 2015.

8. Foldager J, Sejrsen K. Mammary gland development and milk production in dairy cows in relation to feeding and hormone manipulation during rearing. *Research in Cattle Production*. Danish Status and Perspectives. Landhusholdningsselskabet. Frederiksberg, Denmark1987 (Page 102).

9. Foldager J, Sejrsen K. Nutrition of replacement heifers affect mammary development and their ability to produce milk. In Proceedings [of the] XIIth World Congress on Diseases of Cattle, September 7-10, 1982, International Congrescentrum RAI, Amsterdam, the Netherlands/World Association for Buiatrics 1982. Utrecht, Netherlands: Dutch Section of the World Association for Buiatrics, 1982.

10. Goff JP. Major Advances in Our Understanding of Nutritional Influences on Bovine Health. *J Dairy Sci*. Vol. 89, Issue 4, P1292-1301, April 01, 2006.

11. Heuer C, Schukken YH, Dobbelaar P. Postpartum body condition score and results from the first test day milk as predictors of disease, fertility, yield, and culling in commercial dairy herds. *J Dairy Sci*. 1999; 82: 295-304.

12. Hoedemaker M. Prange D. Gundelach Y. Body condition change ante- and postpartum, health and reproductive performance in German Holstein cows. *Reprod Domest Anim*. 2009; 44: 167-173.

13. Horst EA, Kvidera SK, Baumgard LH. Invited review: The influence of immune activation on transition cow health and performance — A critical evaluation of traditional dogmas. *J Dairy Sci*. Vol. 04, Issue 8, p8380-8410, August 01, 2021.

14. Hulbert LE, Cobb CJ, Carroll JA, Ballou MA. The effects of early weaning on innate immune responses of Holstein calves1 American Dairy Science Association®, *J Dairy Sci*. 2011 94 :2545–2556 doi: 10.3168/jds.2010-3983.

15. Jensen MB, Duve LR, Weary DM. Pair housing and enhanced milk allowance increase play behavior and improve performance in dairy calves. *J Dairy Sci*. Vol. 98, Issue 4, p2568–2575, Published online: February 11, 2015.

16. Johnson JL, Godden SM, Molitor T, Ames T, Hagman JD. Effects of Feeding Heat-Treated Colostrum on Passive Transfer of Immune and Nutritional Parameters in Neonatal Dairy Calves. *J Dairy Sci*. 90:5189–5198 **doi:10.3168/jds.2007-2019** ©. American Dairy Science Association®, 2007.

17. Khan MA, Lee HJ, Lee WS, Kim HS, Ki KS, Hur TY, Suh GH, Kang SJ, Choi J YJ Structural Growth, Rumen Development, and Metabolic and Immune Responses of Holstein Male Calves Fed Milk Through Step-Down and Conventional Methods. *J Dairy Sci*. 90:3376–3387 **doi:10.3168/jds.2007-0104** © American Dairy Science Association, 2007.

18. Knauer WA, Godden SM, Rendahl AK, Endres MI, Crooker BA. The effect of individual versus pair housing of dairy heifer calves during the preweaning period on measures of health, performance, and behavior up to 16 weeks of age. *J Dairy Sci.* Vol. 104 Issue 3 p3495–3507 Published online: December 23, 2020.

19. Kvidera SK. Dickson MJ, Abuajamieh M, Green HB, Schoenberg KM, Baumgard LH. Intentionally induced intestinal barrier dysfunction causes inflammation, affects metabolism, and reduces productivity in lactating Holstein cows. *J Dairy Sci*. Vol. 100, Issue 5, p4113-4127, May 01, 2017.

20. McCoard S, Heiser A, Lowe K, Molenaar A, MacLean P, Johnstone P, Leath S, Hoskin SO, Khan MA. Effect of weaning age on growth, mammary gland development, and immune function in Holstein Friesian calves fed conserved alfalfa (FiberStart) American Dairy Science Association®, 2019. *J Dairy Sci*. 102:6076–6087 **https://doi.org/10.3168/jds.2018-15615**.

21. Miller-Cushon EK, Bergeron R, Leslie KE, DeVries TJ Effect of milk feeding level on development of feeding behavior in dairy calves. *J Dairy Sci*. Vol. 96, issue 1, p551-64, January 1, 2013.

22. Miller-Cushon EK, DeVries TJ Effect of social housing on the development of feeding behavior and social feeding preferences of dairy calves. *J Dairy Sci*. Vol. 99, Issue 2, p1406-1417, February 1, 2016.

23. NRC. Nutrient Requirements of Dairy Cattle. 7th Rev. Ed. Natl. Acad. Press, Washington, DC 2001.

24. Ospina PA, Nydam DV, Stokol T, Overton TR. Evaluation of NEFA and β- hydroxybutyrate (BHB) in transition dairy cattle in the northeast USA. Critical thresholds for prediction of clinical diseases. *J Dairy Sci*. 2010; 93 (20105526): 546-554.

25. Overvest MA, Crossley RE, Miller-Cushon EK, DeVries TJ Social housing influences the behavior and feed intake of dairy calves during weaning. *J Dairy Sci*. Vol. 101 Issue 9 p8123–8134, Published online: June 27, 2018.

26. Roche JR, Friggens NC, Kay JK, Fisher MW, Stafford KJ, Berry DP. Invited review: Body condition score and its association with dairy cow productivity, health, and welfare. *J Dairy Sci*. 2009; 92: 5769-5801.

27. Sharon KP, Liang Y, Burdick Sanchez NC, Carroll JA, Broadway PR, Davis EM, Ballou MA. Pre-weaning plane of nutrition and *Mannheimia haemolytica* dose influence inflammatory responses to a bovine herpesvirus-1 and *Mannheimia haemolytica* challenge in post-weaning Holstein calves. *J Dairy Sci*. Vol. 102, Issue 10, p9082-9096, October 1, 2019.

28. Soberon F, Meyer MJ, Van Amburgh ME. 2010. Expression of specific genes regulating mammary growth in pre-pubertal Holstein heifers. *J Dairy Sci*. Vol. 93.

29. Soberon F, Raffrenato E, Everett RW, Van Amburgh ME. 2011. Early life nutritional management and effects on long term productivity of dairy calves. *J Dairy Sci*. 95:783-793.

30. Soberon F, Van Amburgh ME. 2011 Effects of colostrum intake and preweaning nutrient intake on post-weaning feed efficiency and voluntary feed intake. *J Dairy Sci.* 94 (2011): 69-70.

31. Soberon F, Van Amburgh ME. 2013. The effect of nutrient intake from milk or milk replacer of pre-weaned dairy calves on lactation milk yield as adults: a meta-analysis of current data. *J Dairy Sci*. 91:706-712.

32. Soberon F, Van Amburgh ME. 2017. Effects of preweaning nutrient intake in the developing mammary parenchymal tissue. *J Dairy Sci*. 100(6), 4996-5004.

33. Steele MA, Doelman JH, Leal LN, Soberon F, Carson M, Metcalf JA. 2017. Abrupt weaning reduces postweaning growth and is associated with alterations in gastrointestinal markers of development in dairy calves fed an elevated plane of nutrition during the preweaning period. *J Dairy Sci*., 100(7), 5390-5399.

34. Swanson EW. Effect of rapid growth with fattening of dairy heifers on their lactational ability. *J Dairy Sci*. 1960; 43: 377-387.

35. Van Amburgh ME, Soberon F, Meyer MJ, Molano RA. Symposium review: Integration of postweaning nutrient requirements and supply with composition of growth and mammary development in modern dairy heifers. *J Dairy Sci*. Vol. 102, Issue 4, P3692-3705, April 1, 2019.

36. Whalin L, Weary DM, von Keyserlingk MAG. Short communication: Pair housing dairy calves in modified calf hutches. *J Dairy Sci*. Vol. 101 Issue 6 p5428–5433Published online: March 28, 2018.

