Economics of Raising Dairy Replacement Heifers in Canada

Michael W. Overton

Elanco Animal Health, Greenfield, Indiana
Email: moverton@elanco.com

▪ Take Home Messages

- The estimated cost for raising a Holstein replacement heifer for Canadian dairies is C$2890.
- The highest cost per day occurs during the milk feeding phase and the second highest cost per day is during the immediate prepartum period.
- The cost of raising heifers from birth to first calving should reflect the impacts of initial calf value, mortality and culling, and the opportunity cost of these expenditures.
- The final cost reported here was similar but slightly higher than the cost estimated currently for a similar U.S. dairy after accounting for the currency conversion of C$1= US$0.76. Key differences included a higher labour cost, a higher cost per artificial insemination service, and higher cost/kg for calf starter grain and calf grower grain than those evaluated in the US.
- Individual results may differ, but in general, it appears that the costs of raising heifers in Canada are similar to the costs in the U.S. and in both cases are much higher than current market prices for springing or fresh heifers.

▪ Introduction

Dairy replacement heifers, much like dry cows, are often overlooked, undermanaged, and lamented as a large cost centre because there is little to no income generated from them until they enter the milking herd. While it is true that replacement heifer programs usually rank as the second or third largest cost of producing milk (trailing only feed costs and perhaps labour), these costs should more properly be viewed as an investment toward the future, and though raising costs can be significant, managing this process efficiently can yield large returns on this investment. Much like any other investment, money is spent up front for a return that will not be realized until much later, i.e., after the heifer calves and enters lactation. Careful attention to the correct kind and approach to this investing can influence the anticipated future returns.

Within the dairy heifer growing period, the highest daily expense is during the preweaning period and is a consequence of the liquid diet and the higher labour and housing costs associated with this time period. As a result of the large up-front costs, most producers historically have adopted management and feeding strategies that appeared to save money up front, but resulted in diminished performance and greater lost opportunity costs in the future. This traditional feeding approach provided low levels of milk replacer, commonly 3.5 to 4 L per day of a 20/20 milk replacer mixed to achieve 12% solids. Calf starter was usually fed ad libitum and contained only 16–18% crude protein on a dry matter basis (Drackley, 2008). This feeding approach encouraged earlier and higher levels of calf starter grain intake, thereby reducing the total amount and cost of liquid feed provided. As expected, this resulted in a lower daily feed cost but a longer total rearing time because of a slower rate of gain in height and weight leading to a delay in reaching breeding size.

Intensive feeding and management programs have received a lot of attention in the last decade or so with several studies showing that delivering more nutrients preweaning has been associated with improved health via reduced morbidity and mortality, greater weight and frame growth, earlier age at first service, earlier age at first calving, and increased milk yield during the first lactation (Jasper and Weary, 2002; Davis Rincker et al., 2011; Van Amburgh et al., 2011; Soberon et al., 2012; Soberon and Van Amburgh, 2013). Consequently, many farms have begun more aggressive nutritional approaches by providing more volume and more nutrient dense liquid feed, either by providing more saleable whole milk or pasteurized waste milk, or higher volumes of milk replacer, often mixed at higher solids levels. Typical milk replacers used for Holsteins in these intensive programs are 25–28% protein and 15–20% fat and are fed at 12–15% milk solids with a total of 4–10 L of fluid volume per day, depending upon the size and age of the calf and management preferences. Pasteurized waste milk or saleable whole milk also work well to improve calf health and growth. Feeding higher levels of nutrients will allow 0.8–1.1 kg/d (1.7 to 2.5 lb/d) or more of body weight gain, depending upon environmental conditions, volume of milk provided, and the quality and quantity of the calf starter grain mix consumed. Additionally, the higher level of nutrients can allow calves to withstand more environmental stressors without resulting in weight loss or spikes in morbidity.

Dairy farms often fall somewhere in between a completely conventional approach and a fully intensive one. The most successful programs that have impact well beyond weaning usually include starter rations, grower rations and subsequent rations that provide high levels of metabolizable protein to support rapid and efficient lean tissue gain and frame growth without promoting fattening (Van Amburgh et al., 2008; Van Amburgh et al., 2011; Soberon et al., 2012; Stamey et al., 2012; Van Amburgh, 2017).

The downside of the intensive approach is that the feed cost during the liquid feeding period is significantly higher than that of the conventional approach and calves sometimes are slow to begin eating calf starter. The weaning process is critical when feeding higher volumes of milk and calves must be properly transitioned from milk to feed. As calves grow and move through the various diet and pen changes, they are provided with rations that continue to be higher in metabolizable protein than comparable conventional rations; these larger heifers eat more feed per day because of their larger body size and higher growth rates. Consequently, the increased feed costs continue through the entire replacement rearing period. However, these well-fed heifers usually experience the advantages of a reduction in both morbidity and mortality, reduced impact of cold weather stress, an earlier age at first service and first calving, and improved feed efficiency because total days on feed is reduced but rate of gain is increased. Because of the faster rate of gain, there should be a reduction in the total inventory of heifers on farm at any given time due to the reduced time from birth to calving. Also, because fewer heifers are expected to experience disease or mortality due to the improved nutritional management, fewer calves need to be placed into the system to meet the targeted number for future replacement needs. Finally, there is also an improvement in the expected net present value of heifers at calving due to the projected improvement in production that has been associated with improved nutrition and management as heifers (Soberon et al., 2012).

The size and health status of heifers at first calving are highly associated with first lactation productivity and survivability. Heifers immediately postpartum should weigh approximately 85% of mature cow weight in order to achieve their genetic potential for first lactation milk production (Van Amburgh, 2017). Heifers prioritize growth during their first lactation in an effort to achieve approximately 92% of mature size by the start of second lactation. Undersized heifers at first calving will partition disproportionately more energy intake towards growth vs. production relative to heifers that are closer to the size goal. From a lifetime perspective, more milk in the first lactation should also generate greater lifetime productivity assuming the normal expected increases in projected 305d milk from first to second, second to third, and third to fourth lactation.

The objective of this presentation is to estimate the current cost of raising Holstein replacement heifers using current estimated Canadian economic values within a modelled approach representative of many commercial dairies today that have adopted a moderately aggressive feeding and management system from birth through calving.

▪ Economic Modelling

An existing partial budget model was modified to incorporate current Canadian economic values to estimate the cost of raising Holstein dairy replacement heifers (Overton and Dhuyvetter, 2017). Unless otherwise stated, all values used as inputs or reported as outputs are reflected as Canadian currency (C$). The model is divided into age groups based on feeding, housing and management needs and consists of six different stages. Each stage has its own unique features regarding nutrition, housing, vaccination, morbidity, and mortality. The feeding strategy within each stage is designed to provide sufficient metabolizable protein and metabolizable energy to ensure appropriate frame growth and weight gain without promoting excessive body condition. An age appropriate vaccination protocol covers the heifers from birth to calving. Mortality risk varies by stage but reflects typical levels expected in average to above average Holstein herds. Morbidity includes diarrhea in the first stage and pneumonia across all stages. Each disease has its own treatment protocol using age appropriate therapy with dosage based upon body weight of the heifer being treated. Housing type for each stage varies but usually represents a 50/50 blend of two different indoor housing options. In all cases, the estimated investment cost for housing is amortized over the projected lifetime of the facility in question and then, bedding costs are added to better represent the true economic cost and not just cash flow needs.

1) Stage 1: birth to 2 months of age
    a. An initial wet calf value of $75 is assumed
    b. All calves receive two feedings of colostrum
    c. A 28/20 milk replacer, mixed to 14% solids, and fed at the following rates: 5 L/day for 7 days; 7 L/day for 42 days; 3.5 L/day for 7 days
    d. Ad libitum 22% calf starter grain
    e. Calves are housed in individual calf hutches until 60 days of age
2) Stage 2: 2 to 4 months of age
    a. Post-weaning period with 20% grower grain and calf hay
    b. Heifers are housed indoors in small, bedded group pens
3) Stage 3: 4 to 10 months of age
    a. Total mixed ration (TMR)-based feeding
    b. Heifers are housed in either larger, bedded group pens (50%) or freestalls (50%)
4) Stage 4: 10 months through completion of breeding
    a. TMR-based feeding
    b. Six 21-day cycles of breeding opportunity with conventional semen assuming an average conception risk of 56% and an average insemination risk of 68%
    c. Heifers are inseminated starting at 57% of mature weight
    d. Artificial insemination (AI) cost/service is $40 and includes the semen, supplies and insemination fee
    e. 7% of the heifers that enter the breeding program are culled because of reproductive failure
    f. Heifers are housed in either larger, bedded group pens (50%) or freestalls (50%)
5) Stage 5: gestation and growth
    a. TMR-based feeding
    b. Heifers are housed in larger, bedded group pens (50%) or freestalls (50%)

6) Stage 6: springers (final two months prior to calving)
    a. TMR-based feeding
    b. 0.76 kg/d daily gain
    c. Heifers are housed in either bedded packs (50%) or freestalls (50%)

The growth curves used to generate the predicted daily gains from birth to calving were fit from multiple sources. Preweaning feed intake and growth was adapted from two published studies and an unpublished study from a large, private commercial herd that has been using a more intensive feeding system for 10 years or more (Raeth-Knight et al., 2009; Hengst et al., 2012). Postweaning growth curves were modelled from multiple sources with 50% of the contribution coming from unpublished commercial data, 25% of the source data adapted from the 75th percentile of older, published growth data from Penn State University, and the remaining 25% of the source data based upon the 95th percentile of the Penn State data set (Jones and Heinrichs, 2004). The 75th and 95th percentiles were used from the Penn State data instead of the median because the original growth data were captured prior to widespread adoption of more intensive feeding approaches.

Throughout each of the cycles, modelled costs include the upfront purchase cost or initial value of each heifer; the feeding, housing, equipment, reproductive management, labour, and health management costs of each heifer; and the interest or opportunity costs associated with mortality or alternative investment opportunity. All costs, including the costs attributed to the rearing expenses of the calves that die, are adjusted to the net present value expected at calving using an interest rate of 6% and are distributed over the heifers that actually survive to calving. In other words, all expected costs for every calf that enters the rearing enterprise is redistributed over the surviving heifers.

▪ Results and Discussion

The details for mortality, culling, costs, and gains for each stage are shown in Table 1. The cumulative mortality risk was 7.3% and together with the removal of heifers that experienced reproductive failure, the total removal risk from live birth through calving was 13.8%, resulting in a heifer completion risk of 86.2%. The costs incurred for each heifer that died or was removed was shifted onto the surviving heifers within each stage as the losses occurred. The value of heifers culled because of reproductive failure was set at $1.54/kg of live weight based on suggestions from my colleagues in Canada. Of course, individual results will vary and the value received for culls will also vary by region. Most herds will cull some heifers along the raising process based upon health and growth performance, but that cost was not modelled here. Based upon current economic values of cull heifers, the diversion of heifers at any stage from the dairy replacement population to a beef operation (culling) results in significant losses for each heifer removed. These losses must be shifted back onto the surviving heifers and result in an even greater cost per heifer calving.

Table 1. Summary of estimated mortality, costs (Canadian dollars), and weight gain by growth stage from birth to calving for Canadian Holsteins as modelled for a hypothetical dairy using strictly indoor housing.

Stage	Hutch	Post Wean	Growing	Breeding	Post-breeding	Close-up
Age in months	Birth to 2	2 to 4	4 to 10	10.0-16.0	16.0-21.6	21.6-23.6
Mortality	3.50%	1.75%	1.00%	0.50%	0.30%	0.25%
Culled (sold)	0.0%	0.0%	0.0%	0.0%	7.0%	0.0%
Colostrum*	$19	0	0	0	0	0
Milk*	$160	0	0	0	0	0
Starter*	$30	0	0	0	0	0
Grain*	0	$126	0	0	0	0
Hay*	0	$5	0	0	0	0
Feed (TMR)*	0	0	$261	$352	$410	$193
Total Feed*	$209	$131	$261	$352	$410	$193
Labor*	$169	$64	$69	$68	$69	$131
Vet Med/ Health*	$11	$3	$8	$3	$3	$16
Breeding & Culls*	$0	$0	$0	$73	($51)	$0
Housing and Other*	$29	$18	$56	$64	$80	$44
Interest*	$2	$5	$25	$39	$55	$24
Total Cost*	$421	$221	$419	$598	$565	$408
Cost/ Day*	$7.01	$3.58	$2.29	$3.28	$3.29	$6.71
Entering Weight (kg)	39	87	148	319	477	614
Exit Weight (kg)	87	148	319	477	614	661
Average daily gain (kg)	0.81	0.98	0.94	0.87	0.80	0.76
Cumulative ADG (kg)	0.81	0.90	0.92	0.90	0.88	0.87
Cumulative from birth						
Total Cost*	$421	$649	$1,075	$1,679	$2,375	$2,792
Cost/ Day*	$7.01	$5.33	$3.53	$3.45	$3.61	$3.88
Cost Including Wet Calf*	$499	$730	$1,159	$1,766	$2,472	$2,890

*Adjusted for death loss, with costs incurred by heifers that die within each stage shifted onto the surviving heifers.

Table 2 shows the estimated morbidity and treatment cost per heifer by stage. The cost per heifer was calculated as the total cost for each heifer treated within each stage divided by the total number of heifers present. The disease levels shown here are reflective of disease rates commonly recorded in on-farm records but likely underrepresent the true disease levels occurring on farms.

Table 2. Modeled morbidity risks and costs: these costs represent the cost per heifer present in each stage and were calculated by dividing the cost per case treated by the total population of heifers present.

Stage 1		Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
24 hrs – 2 mos		**2 – 4 mos**	**4 – 10 mos**	**10 mos - breeding**	**Post breeding**	**Close-up (final 2 mos)**
Diarr Dz.	Resp Dz.	Resp Dz	Any Tx	Any Tx	Any Tx	Any Tx
16.0%	10.0%	7.5%	3.0%	1.5%	0.8%	0.6%
$5.07	$1.53	$2.74	$1.54	$1.27	$0.80	$0.67

Diarr Dz = diarrhea; Resp. Dz = respiratory disease, Any Tx = any treatment

As expected, the highest cost per day was during the preweaning period (Stage 1), with an estimated cost of $7.01. During this phase, the milk feeding, housing approach, and labour requirements result in the highest feed, housing, and labour costs/day than at any other stage. The second highest cost/day is during the final stage where prepartum heifers are fed more costly TMR, and the labour and total vaccination costs are much greater.

Heifer growth across the entire growing period was curvilinear in nature. Growth was modest at 0.81 kg/day in the preweaning period, was maximized in the early postweaning period at 0.98 kg/day, and then declined slowly across the raising period for an average of 0.87 kg/day. Note, many herds are able to achieve much higher rates of gain across the entire raising period but higher rates of gain require even higher levels of nutritional management. The goal of this project was to mimic a current system used by a representative dairy herd, thus, the growth performance was more moderate in nature.

Within this model, attempts have been made to represent the true estimated costs using Canadian inputs and Canadian dollars where possible. While no model is perfect, valuable insights can be gained through modelling efforts. Usually, producers are surprised to learn of the estimated costs associated with raising replacement heifers. Some of the surprise comes from a failure by many to account for losses incurred because of culling or mortality. Some of the added expenses previously unaccounted for result from my attempt to capture the opportunity costs of capital invested in the raising period. Finally, another large source of cost often not fully evaluated are the labour and housing costs. In this model, housing costs are estimated by amortizing the initial construction cost for a facility over 25 years and adding in projected daily costs for bedding. Labour was estimated by use of survey results by the author across different herd sizes.

The final cost reported here was similar but slightly higher than the cost estimated currently for a similar U.S. dairy, after accounting for the currency conversion of C$1 = US$0.76. Key differences included a higher labour cost, a higher cost per AI service, and higher costs for calf grain than those used in my U.S. model. However, the TMR costs used here for older heifers were slightly less than my U.S. values. All Canadian inputs were provided by individuals working within the Canadian dairy industry and may or may not fully represent the true current values across Canada. Of course, individual results may differ, but in general, it appears that the cost of raising heifers in Canada are similar to the costs in the U.S. and in both cases are much higher than current market prices for springing or fresh heifers.

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