Dairy replacement heifer economics

Kevin C. Dhuyvetter, PhD
Technical Consultant–Dairy, Elanco Animal Health, Manhattan, KS 66503; kdhuyvetter@elanco.com

Abstract

The cost of replacements for dairy operations is a major expense in the production of milk. Thus, efforts to understand and manage this expense are important to remain competitive in the industry. A first step is to simply identify how many heifers are needed and then make semen selection and breeding choices targeting that number. Additionally, knowing what the costs of raising a heifer are and how various factors impact this cost is critical. Once producers have a target for replacement heifers needed and an understanding of what it costs to produce them, they will be able to better manage this part of their operation. The exact number of replacements needed in the distant future is never known with certainty; therefore, from a risk management perspective it may be prudent to produce slightly more heifers than anticipated needs. As the number of heifers produced and future replacement needs are known with better certainty, excess heifers can be culled at various stages in the production process. Basing culling decisions on early growth metrics and genetic potential of heifers, relative to their herd mates, appears to have merit in identifying first-lactation performance.

Key words: replacement heifers, costs, inventory, culling

Introduction

The cost of developing replacement heifers for dairy operations reflects a major cost in the production of milk, and thus it is imperative that producers manage this part of their operation in an effective manner. Replacement costs are typically the third-largest cost on dairies behind feed and labor.[1] Based on a survey of 17 New York dairy farms in 2012, Karszes reported that the average investment in a replacement animal was $2,232, and the interquartile range was $2,010 to $2,413.[2] The author points out that this study was not designed to represent the average raising costs for dairy replacements in New York, rather it was intended to represent what the costs were for the participating farms. Importantly, these data show that not only are replacement costs a major expense, but also that there is a wide variation in costs across operations.

Historically, replacement heifer management decisions were relatively straightforward – produce as many heifers as you can such that you have ample replacements available. However, with improved reproduction programs and sexed semen, producers have more management decisions to make today. Specifically, they now have to decide how many heifers they should produce and how that should be done (e.g., sexed vs conventional semen, which cows bred to dairy vs beef semen, etc). Additionally, if more heifers are produced than anticipated needs, what is the optimal thing to do? Should they be raised and simply replace cows, or should they be culled prior to freshening? The bottom line is that the advancements in dairy breeding and selection have created both opportunities and challenges for managers.

While there are many factors that ultimately influence heifer replacement decisions, for simplicity they are categorized into 5 areas: 1) number of heifers needed annually, 2) number of heifers produced annually, 3) cost of raising a heifer, 4) heifer market prices, and 5) culling heifers. The number of heifers needed and produced annually are related as they will depend primarily upon herd-specific production information (and business growth objective). Likewise, the cost of raising a heifer along with heifer market prices are potentially important factors when making heifer culling decisions.

Heifers Needed and Produced Annually

The number of heifers needed annually is a function of many factors – stillbirths, mortality, heifer culling, growth rate, fertility, abortions, etc. Table 1 provides an example of how many heifer births are needed annually for a hypothetical 1,000-cow dairy. Given an annual herd turnover rate of 37%, this dairy will need to freshen 370 heifers annually to maintain a static herd size; an operation with a growth objective will need more replacement heifers. However, to achieve those 370 heifers, this dairy would need to have 486 heifer births per year after accounting for DOAs and heifer culls (sold and died) prior to and after breeding. Based on the values used in this example, slightly over three-quarters (76.1%) of heifer births ultimately go on to freshen. In a convenience sample of 45 herds, the average for this metric in 2018 was 76.1%, but ranged from 63.2% to 88.9%.

Once producers know how many heifer births they need per year, they can consider various semen strategies (e.g., conventional, sexed, and beef) that will help them meet or exceed heifer needs. The bottom part of Table 1 shows the number of heifers that would be expected given that conceptions occur based upon various semen use strategies, and assuming there are 1.15 calvings per cow in the herd on an annual basis. The various scenarios, ranging from 100% conventional semen to mostly sexed and beef semen, demonstrate that the industry can easily produce more heifers than needed and why many producers currently are using beef semen. That is, due to the availability of sexed semen and the improved reproduction and heifer rearing that exists today, it is much easier for many dairy operations to produce more heifers than needed for a static herd size today than

Table 1. Number of heifers needed and produced annually.

Herd size (milking and dry), cows	1,000
Annual herd turnover, %	37.0
Cows culled = heifers needed to calve, hd	370
Heifers culled by 14 months, %	10.0
Heifers culled after 14 months, %	5.0
Heifers that conceive, %	85.0
Pregnant heifers that calve, %	95.0
Heifers calving, %	80.8
Needed live heifers born, hd	458
DOA risk, %	5.7
Total heifer births needed, hd	486
Heifers calving as percent of heifer births	76.1
Fresh events per cow in the herd per year	1.15

Conception rate	Scenario #1		Scenario #2		Scenario #3	
by semen type*	% sires	Heifers	% sires	Heifers	% sires	Heifers
Conventional, %	100	552	75	414	10	55
Sexed, %	0	0	25	253	50	506
Beef, %	0	0	0	0	40	0
Total	100	552	100	667	100	561

*Percent of females semen types of 48% for conventional, 88% for sexed, and 0% for beef.

it was in the past. If a strategy is used that produces more heifers than needed, producers need to determine if they will sell "excess" heifers, and at what point they might do that, if they will replace cows with heifers, or if they will grow their herds. The decision to replace a cow with a heifer is a complex decision, but prematurely culling healthy cows is likely not the best economic decision. While identifying the best strategy with regards to how many heifers should be produced is complex, a critical factor in making this decision will be knowing the costs of raising a heifer.

Cost of Raising Heifers and Market Prices

Because replacement costs are one of the major costs of producing milk, it is important for producers to know what their cost is, as well as understanding some of the key drivers. More importantly, to make good management decisions about how many heifers to produce and when to potentially cull some of them, it is important to know heifer raising costs by stage of production and how they compare with expected market values of the heifers that might be culled. Whether an operation raises their own heifers or hires a custom grower, understanding the following economic concepts is important in order to make sound management decisions:

- Variable vs fixed costs
- Cash costs vs economic costs
- Price = cost
- Time value of money

Many of these principles are interrelated, and help explain both behavior of decision makers and trends that we observe. Below is a short explanation of each of the concepts.

Variable vs fixed costs – variable costs are defined as those costs that vary with additional production, and fixed costs are those that are constant regardless of production. Fixed costs are directly related to the concept of economies of size (scale). Classic examples of fixed costs are things such as facilities, management, overhead, etc. Variable costs are those costs that increase proportionately to production. For example, if heifers are culled before becoming springers some costs will be reduced (e.g., feed, supplies, medications), but other costs will still be incurred (e.g., depreciation, interest) and will thus need to be covered by fewer animals, effectively increasing the cost of raising the remaining heifers.

Cash costs vs economic costs – managers easily can relate to cash costs, i.e., those costs that require a direct cash outlay (e.g., feed bill, vet bill, yardage charge); whereas, economic costs are more difficult for many people to grasp. Put another way, cash costs are those things that show up on a cashflow statement with a lender. Cash and economic costs can be exactly equal (and in many cases are), but they can also vary considerably. Economic costs reflect the fact that all inputs (feed, supplies, labor, facilities, capital) need to be repaid or else they will shift to another use in the long run. Cash and economic costs tend to differ for those things typically considered "fixed". Economic costs incorporates the concept of "opportunity cost" which may be different from what is actually paid (i.e., cash cost). Economic costs also incorporate the useful life of an asset as opposed to loan payments (or lack thereof), which is another reason economic costs can vary considerably from cash costs. Budgets looking at the economic cost of raising replacement heifers are often in the $2,000 per head range, but many producers believe their costs are considerably lower than that. While that is a possibility, likely in many of these cases the producers are not including their full economic costs.

Price = cost – this concept indicates profits are equal to $0. It is important to recognize that the definition of profit here is "economic profit" which means that all costs have been accounted for. A couple of additional qualifiers are needed regarding this statement -- profit equals zero, on average, in the long run, in a competitive industry. While this concept might very well hold for many commodity markets (e.g., milk, fed cattle, corn, wheat), it is likely less accurate for a "thin market" like dairy replacement heifers where there is much less buying and selling of heifers at various ages. Put another way, the price of cull heifers may not be equal to the cost of raising them on average even in the long run.

Time value of money – anybody that has ever borrowed money recognizes this concept, as banks always want the money you borrowed returned with interest. While people understand the concept of paying interest on borrowed money, the time value of money is often not accounted for properly in many analyses. This concept is related to the cash costs vs economic costs concept discussed previously. If time value of money is not appropriately accounted for, cash-based decisions will always look better than those involving borrowed capital. Raising a heifer from birth to calving will generally take about 2 years, and thus it is important to account for the time value of money when analyzing costs, whether it is interest on borrowed money or lost opportunity on equity.

Table 2 shows a projected budget that was developed for raising a heifer from birth through calving by stage of production. The following are some of the key assumptions: newborn calf value = $100/hd, birth weight = 85 lb (39 kg), 75% milk replacer and 25% waste milk, breeding weight = 884 lb (401 kg) (57% of mature weight), AI cost of $18/service, labor cost of $15/hr, and interest rate of 6%. Of heifers starting in hutches, 86.2% end up as springers due to mortality (7.3%) and repro culls (6.5%). In this example budget, the total cost of the springer is $1,841 excluding the value of the wet calf and $1,971 including the value of the wet calf. These values include the cost of interest incurred over the raising period as well as the costs incurred by any heifers that died or were culled. Feed (including liquid feed) accounts for approximately 70% of the total cost when calf value is included and 75% when it is excluded. While the prices of feed ingredients obviously impact feed costs, it is just as important to focus on production factors that have a major impact on feed costs, e.g., growth rate and efficiency, as well as morbidity and mortality.

There are very little publicly-reported market data for dairy replacement heifers of various ages and weights. Progressive Dairy magazine does include a report of various auctions by region of the US that includes values for springers, heifer calves, and several other categories.[2] Unfortunately, the data in this report are somewhat inconsistent over time and the volume of trade is likely quite low in many instances. USDA reports a quarterly series for milk cow prices by state that reflects animals for dairy herd replacement (no reference to age) on their Quick Stats website.[3] Over the last 3 to 5 years, prices reported for springers and milk cow replacements from these sources have ranged from approximately $1000 to $2000, but averaging only $1250 to $1500. Thus, raising heifers to springers with the intention of selling them for a profit is questionable, unless an operation has costs significantly lower than those presented in Table 2.

Culling Heifers

A lot of discussion has been going on in the industry about "right-sizing your replacement heifer program" in recent years. This is in response to the ability to produce

Table 2. Estimated cost of raising heifer by stage of production.

Stage of production **Age in months**	**Hutch** **Birth to 2**	**Post-wean** **2 to 4**	**Growing** **4 to 10**	**Breeding** **10.0-15.7**	**Post-brd** **15.7-21.4**	**Close-up** **21.4-23.4**	**Total** **0-23.4**
Cost category*							
Total feed	$176.58	$80.16	$231.01	$287.74	$338.43	$185.37	$1,374
Labor	47.92	10.49	12.29	33.43	14.43	31.12	$160
Vet med/health	10.22	2.36	8.03	2.89	2.65	16.15	$45
Breeding & culls	0.00	0.00	0.00	35.87	-57.90	0.00	-$19
Housing and other	17.59	10.95	33.66	36.67	47.73	26.58	$183
Interest	1.21	3.06	14.99	24.00	36.19	15.73	$99
Total cost	$254	$107	$300	$421	$382	$275	$1,841
Cost/day	$4.23	$1.73	$1.64	$2.41	$2.23	$4.52	$2.59
Entering weight (lb)	85	192	325	702	1,037	1,341	85
Exit weight (lb)	192	325	702	1,037	1,341	1,443	1,443
Average daily gain (lb)	1.78	2.17	2.06	1.92	1.77	1.68	
Cumulative ADG (lb)	1.78	1.97	2.03	1.99	1.93	1.91	1.91
Cumulative from birth							
Total cost	$254	$365	$669	$1,093	$1,561	$1,841	$1,841
Cost/day	$4.23	$3.00	$2.20	$2.28	$2.40	$2.59	$2.59
Cost including wet calf	$358	$473	$781	$1,209	$1,689	$1,971	$1,971

* All costs are adjusted for death loss

considerably more heifers than are needed given the use of sexed semen, improved reproduction, and improved heifer rearing. The primary way producers have reduced the number of heifers produced is to use beef semen on older and/or lower genetic cows (i.e., simply produce fewer heifers). However, many producers still might find themselves in the situation where they have produced more heifers than they will ultimately need for replacements, and thus are questioning how to make choices about culling some heifers. One approach a number of producers take is to genomic test their calves and then use that information to identify heifers to be culled. Many producers are reluctant to do this because of the cost associated and because they are uncomfortable making the culling decision that early without knowing how well the calf does from a health and growth standpoint. Thus, a question that exists is, can we use production data in our record system to make improved culling decisions? And, if so, what are the economics associated with these decisions?

In an attempt to answer the above questions, data from 2 large dairy herds from geographically diverse areas of the US were used (referred to as MW and WC). Specifically, heifers born during 2013 were evaluated using records from the herd software (DC305®). To be included in the analyses, a heifer had to have current daily gain 2 and 3 (CDG2 and CDG3), which reflect the daily gain adjusted to 61-d and 91-d of age, respectively, and predicted transmitting ability of milk (PTAM). In the initial data set there were 1,358 (MW) and 2,306 (WC) heifers for the 2 dairies with average CDG2 values of 1.87 and 1.66 and average PTAM values of 284 and 327, respectively, with considerable variation around both measures for both dairies as would be expected.

Various "culling rules" were examined, but the discussion here will focus on a specific rule. The first step was to eliminate any heifers that were removed by the farm (sold or died) prior to 63 days of age. After this step, calves were identified as "wean culls" if they were in the lower quartile for both CDG2 and PTAM. This same process was done again looking at CDG3 and PTAM of remaining heifers, and any that fell in the lower quartile for both of these measures were identified as "grower culls". These 2 categories of potential cull candidate heifers were combined and categorized as "performance culls"; keep in mind that most of these heifers were not actually culled by the farm prior to calving. After this 2-step process of identifying potential culls, first-lactation data were analyzed for milk (2nd test 305), pregnancy status by 250 DIM, and culling risk by 300 DIM. Of the 1,358 initial heifers for dairy MW, 1,193 (87.8%) were available for first-lactation analysis as 165 were removed (either sold or died) by the farm prior to calving. Of these 1,193 heifers, 162 (13.6%) were identified as performance culls and 1,031 were classified as not culled. Similarly, of the 2,306 initial heifers for dairy WC, 2,228 (96.6%) were available for first-lactation analysis, as 78 were removed by the farm prior to calving. Of these 2,228 heifers, 238 (10.7%) were identified as performance culls and 1,990 as not-culled heifers.

Data from the 2 herds were analyzed separately with OLS regression models for milk production and Cox-Proportional Hazards models for time to pregnancy and time to removal. In addition to the binary Performance cull vs Not culled variable, age of fresh, and month of fresh variables were included in the models (305ME was also included in the time to pregnancy model).

Table 3 shows the first-lactation results for milk production, pregnancy, and removals for heifers identified as performance culls compared to not-culled heifers for MW and WC dairies, as well as the average of the 2 dairies. On average, the performance culls produced slightly over 1,000 lb (454 kg) less milk compared to not-culled heifers, they had a 1.66 times higher culling risk by 300 DIM, and were 18.2% less likely to become pregnant by 250 DIM. The reduced performance of these heifers in their first lactation equates to slightly over $500 lower value compared to an average heifer (data not shown). However, the relevant comparison is to consider how much higher value the not-culled heifers would be vs if no heifers were culled, i.e., what is the improvement in the remaining heifers. For example, while the milk production was 1,067 lb (484 kg) less for culled heifers compared to not-culled heifers, removing these heifers would only increase the average for the remaining heifers by 128 lb (58.1). The value of the improvement per heifer not culled (i.e., remaining heifer basis) averaged $64.41 per head for the 2 herds (details of all the calculations and assumptions not shown).

The results shown in Table 3 clearly indicate that culling heifers based on their relative performance (CDG2 and CDG3) and genetic potential (PTAM) early in the growing period can improve the performance of the remaining heifers (i.e., early growth and genetic information does translate into first-lactation performance). However, if there are significant fixed costs associated with heifer rearing such that removing some heifers adds additional cost to the remaining heifers, then the benefit of this culling decision may be offset by a higher cost. Additionally, if the revenue received from selling heifers as culls is significantly below their cost of production up to that point, that loss also would add to the cost of the remaining heifers. To estimate the impact culling heifers early would have on the total cost of raising heifers, the projected budget (Table 2) was modified to reflect an additional 12% of heifers culled (5% after weaning, 4% after grower, and 3% after reproductive program). It was assumed that housing costs were fixed and labor costs were partially fixed such that culling some heifers effectively increased the cost for the remaining heifers. The value of culls at the various stages of production (weight) were estimated from published market data from 2018-2019. Given the market prices during this time period, culling heifers at any stage of growth resulted in a loss (i.e., the revenue [cull price x cull weight] was less than the cumulative costs to that point) and thus culling added to the cost of the remaining heifers. Given the assumptions made, the total cost per heifer calving (i.e., "not-culled" heif-

Table 3. First lactation performance.

	Herd		
	MW	WC	Average
Performance culls, % of cows	13.6	10.7	12.1
First lactation results (vs not culled)			
305 milk production, lb*	-1,104	-1,030	-1,067
Culling risk ratio†	2.07	1.25	1.66
Pregnancy risk, %‡	17.4	19.1	18.2
Economic improvement of removing performance culls§			
Increased milk value, $/hd	46.93	34.52	40.72
Benefit of reducing culling risk, $/hd	9.27	12.89	11.08
Benefit of reducing days open, $/hd	11.77	13.44	12.60
Total increased value, $/hd	67.97	60.85	64.41

* Values reflect difference in predicted 305 milk (based on 2nd test)
† Values reflect times higher culling risk by 300 DIM
‡ Percent less likely to become pregnant by 250 DIM
§ Increased value per heifer calving with Performance culls removed

ers) increased from $1,971 to $2,042 (cost including value of wet calf). Thus, the increased cost per remaining heifer increased $71 per head, which is slightly greater than the increased value shown in Table 3.

At first glance this might appear to suggest that identifying heifers that should be culled does not pay; however, that is not an appropriate interpretation. The results in Table 3 clearly indicate that the culling rule used identified heifers that performed worse in their first lactation compared to the rest of the heifers, and if they were not culled but rather replaced mature cows prematurely, that likely would be even more costly. Other factors that will affect these results are assumptions made regarding fixed costs in the heifer-rearing program and market prices for cull heifers. As the fixed costs decrease (as they might be for heifers being custom grown) and as market prices of cull animals increase, the impact on cost for remaining heifers will increase less than was the case in this example.

Conclusions

The cost of producing and raising replacements for dairy operations is a major expense in the production of milk. Thus, efforts to understand and manage this expense are important to remain competitive in the industry. The introduction of sexed semen coupled with improved reproductive and heifer rearing programs have given many dairy operations the luxury of being able to produce more heifers than they need for their operations (assuming a static herd size). However, the increased supply of heifers available has led to reduced prices, and thus raising heifers with the intention of selling them at a profit is not a possibility for most producers given current market conditions. A first step producers need to do is to identify how many heifers they need on their operations and then make semen selection and breeding choices targeting that number. As evidence that this is being done, many producers have increased the amount of beef semen they use as 1 method to reduce the number of dairy heifers they produce. Knowing the exact number of replacement heifers needed in the future is never known with certainty, and thus it may be prudent to produce slightly more heifers than anticipated needs to avoid a shortage as a form of risk management. In this case, as the number of heifers produced and future replacement needs are known with better certainty, excess heifers might be culled at various stages in the production process. Basing culling decisions on early growth metrics and genetic potential of heifers, relative to their herd mates, appears to have merit in identifying first-lactation performance.

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