Too many? Not enough? Costs and opportunities associated with dairy replacement heifer inventory

Michael W. Overton,[1] DVM, MPVM; Steve Eicker,[2] MS, DVM

[1]Zoetis Animal Health, Blairsville, GA 30512
[2]Valley Ag Software, King Ferry, NY 13081

Abstract

Replacement rate (RR), also commonly called cull rate or herd turnover, is the proportion of the adult herd that enters the herd every year, and in a steady-state herd, the number of animals exiting equals the number of animals that enter; thus, the RR is determined by replacement availability. Failing to produce an adequate number of replacements will lower replacement cost but negatively impact profitability by delaying the replacement of inferior producers. The appropriate number of heifers to produce varies by herd but is dependent upon the herd's anticipated replacement needs plus any buffer allowance. Focusing on genetic composition and improvement of feeding and management strategies will yield higher quality heifers with higher predicted milk production that impact cow replacement decision making. A sufficient and steady flow of replacement heifers will enable dairies to replace problem cows or soon-to-be problem cows earlier, thus improving not only economic performance, but also animal welfare and market values.

Key words: replacement rate, dairy replacement heifers, opportunity cost

Introduction

Replacement rate (RR), also commonly called cull rate or herd turnover, is a topic that often elicits strong negative emotions due its large influence on the cost of production and its problematic, yet incorrect association with animal health and productivity. It is not a true rate, but rather the proportion of the adult herd (milking and dry) that enters the herd every year, most commonly as a newly calved heifer. Assuming a stable herd size, the number of animals exiting the herd should be equal to the number of animals that enter the herd; thus, the RR is driven by replacement availability and can be calculated by dividing the number of animals that calved for the first time over a 12-month period by the average number of milking and dry cows for the same period. Alternatively, the number of animals that were sold or died can serve as the numerator, but this approach places the emphasis on the effect (cows removed) vs. the cause (replacement heifer availability).

Twenty years ago, many dairies routinely struggled to produce an adequate number of dairy heifers to meet their replacement needs. At that time, 21-d pregnancy rates commonly ranged from 12 to 20% using conventional semen in AI programs or natural service sires. Given the female calf production associated with this level of reproductive efficiency, and the traditional youngstock management programs in place at the time, most herds would periodically have to purchase additional heifers to meet replacement needs with RR of 33-37% commonly observed; consequently, cows targeted for replacement often were retained longer than optimal due to the lack of available replacements.

The introduction of sexed semen, ovulation synchronization strategies, activity monitoring systems, and increased awareness of the economic value of pregnancies, along with greater attention paid to the importance of genetics, have combined to increase the total herd reproductive performance and the potential number of dairy replacements. These advances initially lead to what some have termed as an overproduction of heifer calves. A higher national inventory of replacement heifers soon resulted, and coupled with poor milk prices, the market for heifers crashed, with heifer prices at public auction usually far below the estimated average cost of raising. Soon thereafter, producers rapidly adopted the use of beef semen to try and increase their herds' cash flow and reduce their inventory of replacement heifers. Unfortunately, the industry appears to have overreacted yet again and appears to be headed towards tighter heifer inventories and potentially, an inadequate supply of heifers. The objective of this manuscript is to highlight both the costs and the opportunities associated with varying a herd's replacement rate and to highlight a few important concepts about the importance of producing an adequate supply of high-quality heifers.

Cost vs. value of replacement

A herd's replacement rate conveys a lot of information about the ability to procure replacement heifers, but does not necessarily correlate with disease risk, mortality risk or fertility challenges in their cows. Many cows are replaced simply due to economic decision making – an incoming replacement animal is projected to be more valuable to the herd than the existing cow, and this may or may not be attributable to the occurrence of a disease, lameness or infertility. It is critical to understand that in a herd that is neither increasing nor decreasing in size, the sole driver of the number of animals that leave the herd is the number of replacements available to enter the herd. In other words, managers try to keep their available cow slots full in order to improve economic efficiency and generally do not sell a cow until there is another to take its place. It is not biologically rational to imagine that a cow leaving today somehow triggers a heifer to become pregnant 9 months ago and freshen today. And yet, many people approach the issue of replacement rate in this manner.

It is common for dairy farms and their advisors to focus on short-term costs rather than long-term profits. Of course, we can save a great deal of money by purchasing cheaper feed, cheaper semen, cheaper equipment, not pay employees, etc., but hopefully, the futility of this approach is obvious. There are two issues with this train of thought. First, most expenses on a dairy farm are really investments in the future. The return on better feed, better semen, better equipment, better employees, etc. is eventually recognized by most farmers. Second, trying to estimate and use the average heifer raising expense is problematic. Whenever average costs of raising a heifer are

estimated, included in the estimate are fixed costs which do not get refunded if fewer heifers are raised. Raising fewer heifers can save variable costs such as feed, medicine, preventatives, semen, etc., but the average cost of raising heifers is greater than the marginal cost. Additionally, replacing a cow generates revenue from the salvage value of that cow, assuming that she is indeed sold for a positive value (i.e., she does not die and is not condemned at the plant). The replacement cost is more correctly assessed as the marginal raising cost minus the expected net salvage value for farm-raised heifers. For contract-reared or purchased heifers, one must use the current market value or contract price minus projected net salvage value.

This confusion has led to the falsehood that a cow should not be replaced until she covers her raising cost. But one using raising cost instead of "replacement cost" is making a serious economic error. In addition, that replacement cost is a "sunk" cost. The funds are already spent. They are gone. Failing to replace an inferior animal with what promises to be a better producer is managing to lower cost instead of considering the increased revenue potential of the incoming replacement. In other words, the mistake here is in failing to recognize the lost opportunity cost of more timely replacement, regardless of whether the animal has paid for herself. The best decision is to optimize future decisions. Having an accident with a new car is awful, but the best decision is to replace the car despite whatever may still be owed on that car.

Current economic estimates regarding the average cost of raising a replacement heifer, including the initial calf value, mortality losses, interest costs, housing, feed, reproductive management and preventive care often total $2200 to over $2600 depending on housing style, feeding philosophy and approach, as well as labor efficiencies. Given the current high cost of feed and other inputs, the marginal raising cost is still approximately $1800 to $2100 for many farms. As a consequence of this large cost of raising replacement heifers, consultants and producers alike tend to focus their efforts on reducing this cost. However, overzealous focus on cost reduction without regard to its impact on the revenue potential can and often does lead to incorrect decision making. For example, consider the following comments: "Heifers are expensive, I need to raise fewer…" or "My replacement rate is higher than other dairies in my peer group and I plan to replace fewer cows over the next year". Taken literally, the comments seem reasonable, but underscore a large problem, namely, an incorrect focus on the wrong target as a means to reaching their goal. If a herd manager produces and/or places fewer heifers into the replacement inventory, he or she has decided that in 2.5-3 years, replacement rate will be lower, regardless of what has occurred in terms of disease, lameness or fertility within the herd. Additionally, assuming that these biological reasons for replacement are not changed, the manager has decided that each cow targeted for replacement will be retained longer than optimal.

To examine this issue more carefully, consider the following economic assumptions: replacement heifer cost of $2000 and is projected to produce 22,500 lb 305M in the first lactation and have a productive life of 795 days in the herd as a combination of lactating and dry days; an annual mortality risk of 5%; a milk price of $0.22/lb; a future market value of $996 if sold alive; and a feed cost of $0.14/lb dry matter. This incoming average replacement heifer is projected to cost the herd $1.50/d of productive life after its initial calving, accounting for mortality losses, condemnation losses, and a discount rate (cost of capital) of 7%. Imagine for a moment that in this same herd, there is a 3rd lactation cow currently producing 65 lb of milk and is identified as "Do Not Breed". In other words, this older cow has been designated as a cow for replacement in the current lactation and the only question is when she should be replaced. Working through the mathematical comparison of the potential replacement's value, cost to bring her into the herd, her projected productive life, and accounting for the different component-based milk values between the two animals, the older cow should be replaced with the younger cow at approximately 60 lb of milk. At this point, the income over feed, variable and replacement cost of the incoming replacement and the current cow's income over feed and variable cost is essentially the same.

However, now assume that due to management decisions made over the past 2.5-3 years, there are insufficient heifers available to serve as replacements, and the owner is unwilling to purchase a replacement; as a result, the current mature cow must be retained longer, and her daily milk production continues to decline. How much longer she is retained depends upon a variety of factors, but in this case, although the herd has historically maintained a 39-40% RR, the herd produced only enough replacements to support a 35% RR. Consequently, each cow destined for replacement must be retained approximately 100 days longer. If the previously described mature cow is declining in milk at 0.18 lb/d, over the course of the 100-d prolongation of its lactation, the herd loses an average of $1.94/d or $194 due to delayed replacement. This "loss" represents a lost opportunity cost relative to more timely and appropriate replacement, and though it is often difficult to estimate or conceptualize this loss, the impact on profitability is real. Examining this scenario in another way reveals that yes, the net replacement cost was reduced from $1.50/d to $1.32/d due to retention in the herd for an additional 100 days. So, the goal of the dairy to reduce cost was accomplished, but the negative impact on potential revenue not made was much greater, negating all of this "savings in cost".

Many advisors today are recommending that herds achieve greater than "X" months of productive life or that the average age of cows in the herd be greater than "Y". This sounds appealing, but the logic is flawed. Again, this approach focuses on extracting more value for each cow, thus lowering the replacement cost, but the correct approach should be to focus on extracting greater value from the slot occupied by the cow and not the cow herself. Instead of focusing efforts directly as RR or length of productive life, efforts should be focused on reducing the risk that cows lose value sufficiently to warrant replacement, i.e., reducing the risk of disease, reducing lameness, and improving fertility. Efforts directed at improving the housing, feeding, environment, and genetics of the herd should be the target. Then, examine each individual animal frequently to evaluate her economic value to the herd relative to the incoming replacement animals and ensure that adequate numbers of replacements are available to meet ongoing herd replacement needs.

Earlier replacement can have a dramatic effect on salvage value and carcass quality. Ideally, every salvaged cow should provide high-quality nutrition, and the body condition of the cow will help document the excellent welfare that cow has had while she was producing milk. If a dairy does not have enough heifers, they need to keep cows longer than optimal and this might result in waiting for a cow to show more advanced signs of lameness, get another case of mastitis, decline further in milk production, lose additional body condition, etc. This approach is not optimal cow care; it affects salvage value; and it presents a poor view to the public for whom we are producing food.

However, if a dairy has extra heifers, it has the luxury of replacing those diseased cows sooner with a much healthier heifer. This dairy has the luxury of producing more milk by replacing poor-producing cows with average heifers. They have the luxury of improving the current (and future) genetics of the herd by replacing lower genetic cows with superior heifers. Thus, for multiple reasons, selling a slight excess of unneeded replacement heifers as springers or fresh cows is far better than failing to have enough to meet ongoing needs. This option is likely to become even more attractive in the near future as the market for replacements likely improves due to declining heifer inventories across the country.

How many heifers?

How does one determine the "correct" number of heifers? Before delving into this topic further, one needs to remember the tremendous lag between the breeding decision that is made today and the resulting replacement heifers that calve into the herd in 2.5 to 3 years from now. There is no foolproof way to determine how many cows will warrant replacement, especially given such a long time into the future. Consequently, estimates are made usually based upon past performance. Consider the following example: Herd A has averaged 1000 cows (milking and dry) for the past 2 years with very little variation month-to-month in cow numbers. During this time, there have been an average of 390 heifers that calved each year; thus, the average annual RR for Herd A is 39%. For planning purposes, 39% RR is a reasonable place to start but additional considerations are warranted.

As the standard stock market warning goes, "Past performance is no guarantee of future results". Planning for 390 heifers to calve is a great starting point for Herd A, but the authors suggest adding in a bit more cushion. Over the past 10 years, Herd A averaged 39% RR but varied from 36% to 43% with a very consistent average herd size. Adding 5% to the average needs, which represents 1 standard deviation for the past 10 years, adds a bit more insurance for unforeseen needs. Now that we have the targeted, historical RR needs (390 + 20 = 410), an additional 5-10% cushion is suggested to allow for greater flexibility should market conditions or disease risks change. Adding 10% to the 410 target results in approximately 450 heifers to calve as a target and this goal would support a 45% RR for Herd A. Of course, if the additional heifers are not needed, they can be marketed around calving time. Even if their sale results in a small, short-term cash flow loss, the extra heifers served as a relatively inexpensive form of insurance.

One may look at this and think, "that is a lot of extra heifers – is it really prudent to raise so many?" However, in examining Herd A's herd records, despite being an excellent herd with well above average milk production, health and genetics, a very stable herd size with very consistent RR over the past 10 years, based on their herd management software's economic evaluation tool, there are approximately 1.5% of the current cows in production that should be replaced soon.

People commonly stated that, "I am breeding better cows and, in the future, I should not need to replace them as frequently". The rate of genetic gain has dramatically increased in recent years thanks in large part to genomic testing, and while the future animals should be more disease resistant, more fertile, etc., the next generation after them will likely continue their improvement. Remember, herds are or should be striving for continuous improvement. Genetic gains occur across a wide variety of areas including not only disease and lameness resistance, fertility improvements, and greater potential longevity, but improvements in milk production potential as well. Thus, there will continue to be value derived from careful selection and replacement due to continued genetic improvement. Producing a few extra replacement heifers creates the luxury of deciding whether to keep these cows a bit longer or replace them sooner.

Once the ultimate target for heifers to calve has been determined, one needs to work backward to determine how many heifers to place into the replacement inventory. Table 1 shows a potential approach using the information previously estimated for Herd A. Again, assumptions are being made across the range of heifer age categories that the stage-specific risk used will continue for subsequent groups of heifers.

Based upon these inputs that were derived from the farm records, 80% of heifers born alive and 68% of heifer pregnancies (including both heifers and cows) actually calved and entered the herd as replacements. Many people try to benchmark the percent of liveborn heifers that actually calve and target values higher than 80%. However, while it is important to reduce the risk of death, chronic disease and reproductive failure, this approach of benchmarking "completion rate" is misguided. Herd A shown above produces enough heifers to allow for additional selective removal of heifers prior to breeding. By removing heifers that suffer from chronic disease issues or clearly inferior genomic values, the resulting final population of replacement heifers is enhanced in quality and predicted future productivity, but based on some "benchmark", they might be considered as below average. Additionally, because the herd accounts for this margin in preparing its breeding and heifer management plan, it also has the ability to selectively remove additional heifers either just before or just after calving. In other words, the presence of extra heifers creates options and provide additional insurance, reducing the potential for delayed replacement and lost opportunity cost.

One additional note regarding heifer needs. Many people use the concept of heifer inventory to describe replacement needs, but this approach does not adequately capture the potential flow of heifers into the herd as replacements. Inventory usually expresses the total number of heifers in a herd on a given date as a percent of the total milking and dry cows. However, what is more important than total heifers in inventory is the projected flow of heifers. In very seasonal herds, heifer inventory can dramatically shift based on the season of the year. Also, inventory will be lower for herds with earlier age at first calving relative to a herd with identical heifer production but with more advanced age at first calving. The key for the dairy is will there be sufficient and timely entrance of heifers into the milking herd in order to replace inferior cows as needs arise?

Quality is important

As previously mentioned, managers should constantly evaluate their herds to determine if an incoming heifer might be a better economic option for the herd vs. the current lowest value cow. In nearly all herds, there is an additional cow (or many) that should be replaced if a fresh heifer were available. This approach makes a comparison between the predicted performance for an average incoming heifer for that herd, but what if the quality of the incoming heifers improves? In the example discussed above, the expected average production on the incoming heifer was 22,500 lb 305M and the targeted production level for replacement of the Do Not Breed cows was about 60 lb.

Table 1: An illustration of the use of historical removal or survival risks by stage of heifer development to estimate how many heifer pregnancies are needed in order to generate the targeted number of replacements to calve.

# at start	% Realized	Stage specific result (#)	Variable or stage	Adjusted total
			Need to calve	450
464	3%	14	Pregnant heifers that abort, die or culled prior to calving	450
488	95%	464	Breeding heifers that conceive	464
561	87%	488	Heifers enter breeding pens	488
	10%	56	Heifers sold prior to breeding	
	3%	17	Heifers dead prior to breeding	
585	4%	24	Heifer stillborn risk	561
657	89%	585	Heifers born out of female pregnancies achieved	585
			Pregnancies achieved (heifers and cows)	657

But, if the herd found that the predicted performance for heifers dramatically increased due to better genomics, better feeding and management, or for whatever reason, and the predicted milk in first lactation rose to 24,000 lb, the new target for milk production has increased to 64 lb. In other words, better incoming heifer quality places extra selective pressure on the existing cows for earlier replacement. In fact, instead of 1.5% of current cows having low enough economic values to warrant replacements, the new total is 3% of the milking herd due to the increased competition of the new incoming heifers.

A higher quality heifer could be described as possessing a high genetic potential, weighing 82-85% of expected mature weight just after first calving at approximately 23 months of age, and not affected by chronic calfhood disease issues. Better heifer quality extends beyond milk production to also include improved reproductive potential, improved health, improved disease resistance, and many other areas. But these other areas are characteristics that enable animals to remain in the herd in a productive and profitable manner. Selective pressure will, or should, still be applied on the basis of production, including fat and protein components, in order to get the best cows occupying each slot on the dairy.

Conclusion

People have commonly used herd turnover or cull rate as one important variable in the evaluation of herd performance, but most fail to understand that the replacement rate, i.e., how many heifers are produced, is the sole driver of the number of animals that leave the herd in steady-state herds. Managers should be careful to consider not only the short-term cashflow impact of breeding decisions, but also ensure that the herd is producing adequate numbers of good-quality replacement heifers to support ongoing replacement opportunities that will help to optimize economic efficiency. Focusing on lowering cost without regard to its impact on revenue, or on extracting maximum value from an individual cow, will lead to incorrect decision making. Instead, efforts should be directed at the slot and making sure that the dairy is deriving the best value possible from each slot. Only when adequate replacement heifers of sufficient quality are available, and the correct and timely decisions are made, will dairies reach their economic potential. Additionally, a sufficient and steady flow of replacement heifers will enable dairies to replace problem cows or soon-to-be problem cows earlier, thus improving animal welfare and market values.