Factors affecting heifer completion rate and the impact on replacement herd

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Factors Affecting Heifer Completion Rates and Future Lactation Success

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Dairy cow culling is often viewed in a negative light by many but perhaps a fresh perspective is needed. First, cows are not simply “culled”, but rather, they are replaced, most commonly by a newly calved heifer. Making better and timelier replacement decisions should boost profitability by optimizing production per slot and by improving the salvage value of the cow being replaced. Thus, a better term would be dairy herd replacement rate. For herds that raise their own replacement heifers and do not purchase any, the number raised is the determinant of the maximum replacement rate for that herd. Unfortunately, many producers have found themselves with an insufficient supply of replacement heifers, resulting in delayed replacement of cows and measurable negative production and health outcomes (Overton and Eicker, 2025).

There are many potential reasons for a failure to produce enough replacements including a conscious decision to lower production of dairy heifers in favor of producing more beef cross calves or errors in estimating true replacement needs. Typically, the first step in estimating future needs begins with predicting how many cows will need to be replaced. While an exact number is impossible to predict, a common approach is to begin by counting how many were replaced each year over the past few years and then adding a bit of a margin for unanticipated needs. To illustrate, an upper Midwest herd requested help in estimating how many heifers they needed to produce. This herd had been stable in size for over ten years. The annual replacement rate was calculated for each year over the past 10 years. From these results, the average and standard deviation was determined. In this herd of 1,000 cows (milking and dry), a 10-year lookback revealed an average annual replacement rate of 37% and a standard deviation of 2%. Thus, this herd would need to produce 370 + 20 = 390 fresh heifers just to meet expected replacement needs, accounting for normal variation. Next, an additional buffer of 2-4% of the average milking and dry herd size is advised to ensure sufficient replacement availability, barring some major disruption. Thus, a final target would be 410-430, depending on the risk tolerance and management preference of the producer.

The herd’s chosen target of 410 for this example represents the number of heifers needed to calve. However, there are significant, normal and expected “dropouts” or losses of heifers along the raising period. Heifers may be removed from the replacement pool for many reasons such as death, chronic disease, poor growth, failure to conceive, or abortion. But heifers may also be removed due to sale to another dairy or selective removal due to genomic values or predicted future performance.

The proportion of heifers that complete the raising period is often called “heifer completion rate” and there are many challenges or issues associated with this metric. First, many people look at this value as some sort of goal or benchmark and assume that higher is better, but this approach is very problematic. Losses due to death are always a bad outcome but removals from the replacement pool could be the result of excellent economic opportunities or appropriate ongoing decisions given certain health outcomes or growth performance. Striving for a high completion rate can lead to incorrect management decisions. For example, herds may keep heifers with chronic disease issues, or they may allow heifers excessive opportunities for achieving pregnancy. The consequence of both decisions would be a higher completion rate but most likely result in future economic losses and negatively impact the dairy herd’s future profitability due to the retention of inferior animals. Additionally, actual completion rate for a cohort of heifers could require a follow up period of 28 months or longer to correctly calculate; thus, this is a terrible metric for evaluating historical performance due to the tremendous lag. Alternatively, monitoring should focus on careful attention to each stage of growth and development to make more timely decisions.

A second issue with heifer completion rate is the difficulty for many to accurately derive this metric. Underestimating heifer removals during the raising period will result in underestimating how many heifers need to be placed into the replacement pool as newborn calves. To help describe typical heifer completion rates and the variation commonly observed in the field, a convenience sample of 65 herds representing 251,000 cows was collected. This set contained 13 Jersey herds and 52 Holstein herds from across the U.S. Heifer completion was determined using several defined stages of the heifer replacement pool. These endpoints were stillborn risk, % liveborn sold or died by 90 days of age, % liveborn sold or died from 91 to 365 days of age, % of heifers that reached 365 days of age that then successfully conceived, and % of heifers conceiving that actually calved. For each endpoint, the median and interquartile range was calculated, and these results are shown in Table 1.

Table 1. Stage-specific risks that contribute to heifer completion rate

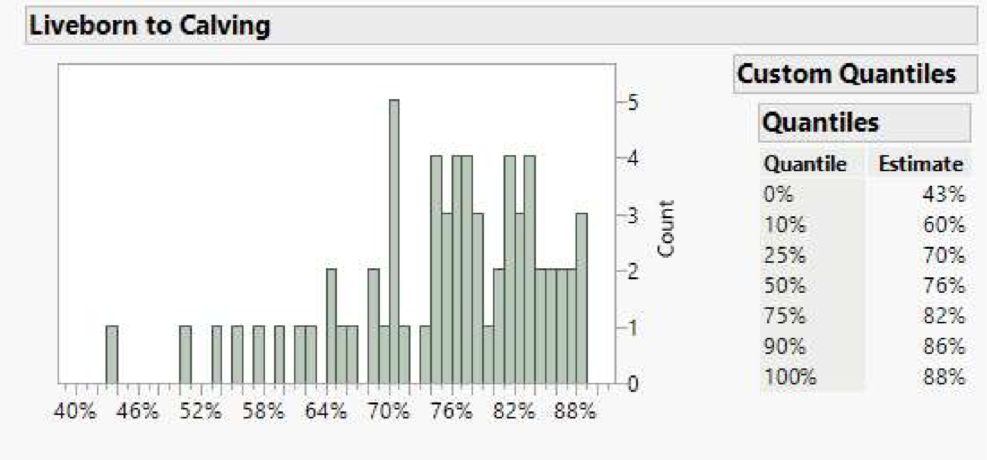
	Median	Interquartile Range			Number	# Needed: 410
% of heifers that conceive that subsequently fail to calve	4%	2%	-	6%	17	427
% that fail to conceive (≥365 days of age)	6%	4%	-	8%	27	454
% Died from 91 to 365 days	4%	2%	-	6%	19	473
% Sold from 91 to 365 days	2%	1%	-	3%	10	483
% Died by 90 days	4%	3%	-	8%	20	503
% Sold by 90 days	0%	0%	-	3%	0	503
%Stillborn	3%	2%	-	4%	16	519
% Heifers (pregnancies) lost before calving	11%	9%	-	18%	64	583

The approach shown in Table 1 reflects the performance for each “stage” for the most recent 12 months across each herd. When calculating these outcomes, it is absolutely critical that each animal included in the denominator must have sufficient time at risk to reach the stage’s endpoint and only animals within this defined population at risk are eligible for inclusion as a “case” in the numerator. When these stage-specific results are then combined sequentially, an estimate of heifer completion rate is produced that is a much timelier estimate versus calculating the true completion rate for a cohort born 2.5 to 4 years ago. However, it is not appropriate to simply add up each proportion failing since the risk for each category is derived from varying numbers of heifers at risk. For example, 4% Died by 90 days = 20 heifers (4% * 503) but 4% of pregnant heifers that fail to calve = 17 (4% * 427) since the population at risk changes across the raising period. Thus, it is helpful to work backwards from the initial target needed by use of the following approach. # of pregnant heifers needed = 410/(1-.04) = 427.

Three different versions of completion rate can now be calculated: % completion from liveborn-to-calving = 410/503 = 82%; % completion from birth-to-calving = 410/519 = 79%; and % completion from heifer pregnancy-to-birth-to-calving = 410/583 = 70%. Each of these final values represent reasonable expectations for many herds but do not include any allowance for selective removal, they do not account for the actual herd-to-herd variation commonly observed, and they should not be used as “benchmarks” or goals. If 5% of heifers that survive to 90 days are selectively removed due to poor genomic test results, the final completion rates decline to 77%, 75%, and 67%, respectively.

Figure 1 shows the herd-to-herd variation for % liveborn-to-calving completion rate. Within this 65-herd dataset, there is significant variation between herds. For some advisors and producers alike, having less than 75% of liveborn heifers actually calving would be alarming, but upon further investigation, these herds did not differ in terms of early or late mortality risk. Instead, the completion rate was lower due to more heifers sold prior to breeding (12% vs. 2%), fewer heifers that conceived (91% vs. 94%), and fewer pregnancies that went on to calve (91% vs. 96%). Those “low completion rate” herds sold more heifers prior to breeding and sold more pregnant heifers, primarily for dairy purposes. Also of interest, operating from a relative surplus of heifers may have allowed these herds to be a bit more restrictive in terms of the allowable breeding window (i.e., 5 21-d cycles of breeding opportunity vs. 7 21-d cycles) though this was not specifically evaluated. In general, the primary differences between the Holstein herds and the Jersey herds were mortality risk in the Jersey herds which was approximately double that of the Holsteins prior to 90 days (8.6% versus 4.4%) and mortality risk from 91 to 365 days (7.3% versus 3.5%). Of course, caution is warranted due to the relatively small sample size.

Figure 1. Frequency distribution of Liveborn-to-calving Completion rate and quantile values for 65 U.S. dairy herds.



Quantile	Estimate
0%	43%
10%	60%
25%	70%
50%	76%
75%	82%
90%	86%
100%	88%

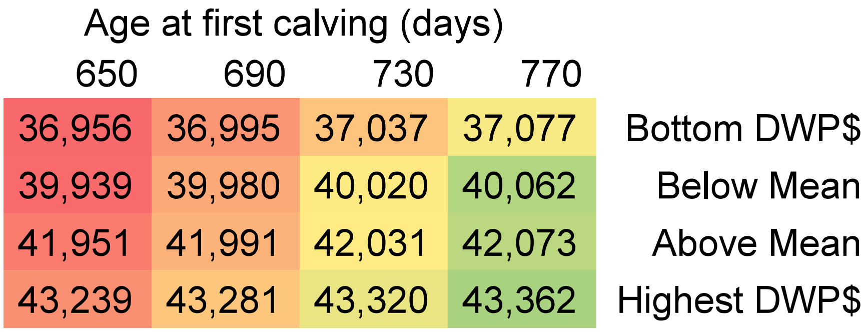
Producers and consultants alike often must be reminded that the replacement population represents the future of the dairy herd. These heifers should be fed properly at each stage of development, managed to achieve pregnancy in an efficient and timely manner, and ultimately calve at an appropriate age and size to optimize productivity and profitability. Forced retention of poor performing heifers or heifers possessing very low genetic potential as a consequence of not producing a few extra can result in significant lost opportunity and lead to greater risk of premature removal as future lactating animals.

A separate project was performed to examine relationships between variables available around the time of first calving from the on-farm record system for production, reproduction, and survival through their second lactation (Overton and McNeel, 2024). Genomic data collected as heifer calves and subsequent production from the first 2 lactations from 53,333 cows first calving in 2019–2021 were extracted from 28 Holstein herds. First lactation performance outcomes included projected 305-d milk, time-to-pregnancy through 250 DIM, time-to-removal and cumulative milk through 450 DIM. Additionally, cumulative milk and cumulative survival through 305 DIM of second lactation were also evaluated. All outcomes were analyzed using multivariable statistical approaches. Milk production was evaluated using mixed models with herd, birth month, birth year, calving month, and calving year as random effects. Cox proportional hazards models were used for reproduction and survival analyses. Logistic regression was used for cumulative survival through second lactation. For each model, fixed effects included age at first calving, age at first calving squared, Dairy Wellness Profit Index (DWP$®) either as a continuous or categorical outcome, genomic body size composite (gBDC) either as a continuous or categorical outcome, calf outcome (male, female, or twins), calf status (live or dead), previous gestation length, and previous gestation length^2. Herd, birth, and calving variables used as random effects within the mixed models were used as fixed effects in the other models.

Age at first calving was associated with varying effects depending upon lactation and outcome. In the first lactation, an older age at calving was associated with greater milk production, reduced reproductive performance, and a higher probability of removal. However, when evaluating the cumulative performance through second lactation, age at first calving was not a significant predictor for either milk production or survival. Genomic values were also important predictors of performance. Increasing DWP$ was consistently associated with greater milk production, improved reproductive performance, and improved survivability across both lactations.

To illustrate the combined relationship between age at first calving and total production through 305 DIM of the second lactation, model derived results are shown in Table 2 accounting for calf status, calf outcome, previous gestation length, and genomic body size composite (BDC). There is a small, but non-significant increase in milk as age at first calving increases (1 lb cumulative milk per additional day of age). However, there was over 6,000 lb more milk for the highest versus lowest quartile for DWP$. Delivering a liveborn calf was associated with 3,320 lb more cumulative milk versus a stillborn and heifers delivering a heifer calf vs. bull calf produced 553 lb more milk. Having twins was associated with almost 4,000 lb less milk. Each point of increase in BDC was associated with 756 lb more cumulative milk through second lactation but based upon the additional projected maintenance requirements of larger body size (~80 lb more projected mature body weight per point of BDC), this milk comes with a higher expected feed cost; consequently, larger body size may not be economically optimal.

Table 2. Modeled results for cumulative milk from first calving through 305 DIM of second lactation, arranged by age at first calving and by DWP$ quartile, accounting for calf status, calf outcome, previous gestation length, and genomic body size.



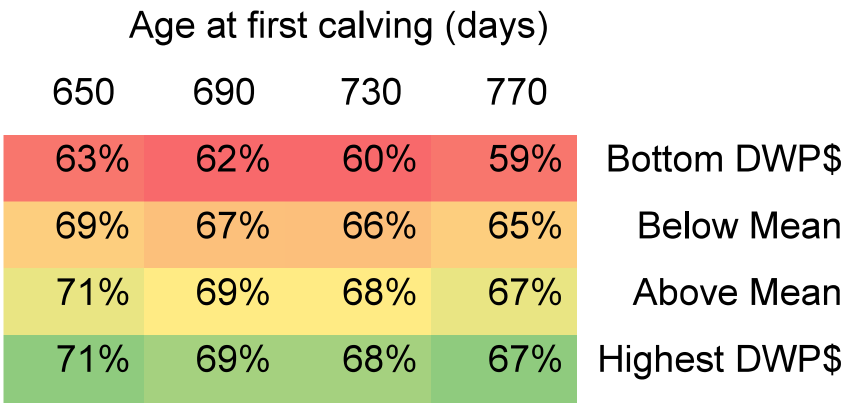
Age at first calving (days)

650	690	730	770	
36,956	36,995	37,037	37,077	Bottom DWP$
39,939	39,980	40,020	40,062	Below Mean
41,951	41,991	42,031	42,073	Above Mean
43,239	43,281	43,320	43,362	Highest DWP$

In the evaluation of time-to-pregnancy in first lactation, older age at first calving was associated with a decline in the likelihood of pregnancy of 0.04% per additional day of age, e.g., 770 days of age at first calving was associated with 5% reduced likelihood of pregnancy as compared to calving at 650 days. Heifers in the highest DWP$ quartile were 12% more likely to become pregnant as compared to the bottom quartile animals.

The results of the logistic regression model for survival through second lactation were exponentiated to produce simple proportion surviving after accounting on the aforementioned explanatory variables. Table 3 shows these results. Older animals at first calving were less likely to survive to the end of second lactation and higher DWP$ values were associated with greater survivability.

Table 3. Modeled results for cumulative survival from first calving through 305 DIM of second lactation, arranged by age at first calving and by DWP$ quartile, accounting for calf status, calf type, and genomic body size.



Age at first calving (days)

650	690	730	770	
63%	62%	60%	59%	Bottom DWP$
69%	67%	66%	65%	Below Mean
71%	69%	68%	67%	Above Mean
71%	69%	68%	67%	Highest DWP$

Summary

Producing a sufficient supply of high-quality dairy replacement heifers is critical to achieving optimal production and profitability. Understanding your heifer completion rate is important for planning purposes but is not an appropriate measure of heifer management. Significant variation is present in heifer completion rate across herds, but caution is advised before assuming that higher completion is better or lower is worse. The production of a few extra heifers creates opportunities for producers to selectively remove genetically inferior animals, remove poor performing heifers, and to limit breeding opportunities. Each of these options is likely to produce superior lactating animals but these options do not exist without the production of some level of surplus. In general, based upon this limited sample size, Jersey herds have slightly lower completion rates relative to Holstein herds, and the biggest differences are in the mortality risk from birth through breeding. Once heifers enter lactation, there are some important factors related to total productivity and profitability. Increasing age at first calving is associated with more milk in first lactation but is not a sound strategy to improve production and survivability through the first 2 lactations. Delivery of a liveborn heifer calf was associated with the highest level of milk. Finally, breeding and managing for high genetic potential is very important. Heifers with higher DWP$ values were associated with greater cumulative milk production, improved reproductive performance, and greater survival through these the first two lactations.

References

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