Cow Culling Decisions: Costs or Economic Opportunity?

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Agriculture is a competitive industry which means that economic profits will be close to zero in the long run. That is, market participants can expect an average return for their resources (i.e., capital, labor, and management), where the average returns reflects the risks in the particular industry or enterprise. For example, average returns on money invested in certificates of deposit are considerably lower than average returns in the stock market, but the risk is also much lower. However, almost all agricultural enterprises are also characterized by having a tremendous variance in profitability across producers. Generally, this is true regardless of the type of enterprise we might consider (e.g., dairy, beef, swine, field crops, hay, vegetable crops). Because of the large variation in profitability, the many different people within an industry (i.e., producers, consultants, lenders, educators, input suppliers) constantly are trying to identify those key factors that drive profitability differences between producers. In other words, we all want to identify those traits or management styles that are profitable so we can capitalize on them. Just as important, we want to identify those characteristics or management styles that might be indicators of not being profitable. By adopting management styles and practices that are associated with increased profitability, probability of business survival is improved within a competitive industry. On the other hand, failing to recognize what drives profitability will likely lead to a business failing to be able to compete in the long run and thus the business will eventually be forced to exit the industry (usually after losing considerable amounts of equity).

Profitability in the dairy industry is not only extremely variable, but also is influenced by many factors making it very difficult to quantify exactly what led to an operation being profitable or unprofitable in any given time period. Thus, it is common to establish benchmarks or "rules of thumb" as profitability proxies. For example, producers and their lenders might focus on debt/cow as a measure to watch as an indicator of how well the dairy is performing financially. Production measures, such as milk/cow/day, pregnancy rate, and cull rate are also often used as indicators of both production performance and ultimately economic performance. However, a critical question to ask is: ‘Are these proxy measures that people often rely upon useful?’ That is, how well do measures such as these relate to profitability? Many of these measures have been used for a long time indicating they have stood the test of time and thus they must have some merit. However, as the dairy industry continues to consolidate and face tighter margins, producers and those people working with them should constantly evaluate the effectiveness of using these measures for making decisions. In other words, it will become increasingly important to recognize the relationship that exists between benchmark measures and profitability.

Are high culling rates good, bad, or can we even say? The answer to this very difficult question depends upon many factors and in order to answer it, one must understand the potential impact that the interaction of culling and many other factors has on dairy herd profitability. The objective of this paper is to examine the impact that culling rate has on profitability as this is a measure on which producers, lenders, and others often focus. Thus, it should be pointed out that the intent of this analysis is not to identify an optimal culling rate as that will depend on many dairy-specific factors. Rather, the intent is to quantify how varying culling rate along with other production and economic factors impacts profitability so that producers can make better informed production and economic decisions.

Method of Analysis

There are numerous ways to analyze financial decisions (Dhuyvetter and Smith, 2005) ranging from relatively straight forward partial budgets to more complex analyses that account for the time value of money such as net present value (NPV). Because culling decisions impact both current and future costs and returns, it is important to account for the time value of money when analyzing these decisions. Thus, a NPV analysis approach is used for this study where income and costs are considered on a daily basis over the course of seven lactations. The NPV analysis discounts future returns such that all results are in “today’s dollars” and thus the interpretation of results is relatively straight forward. In our analysis, a static herd size is assumed and thus the calculated NPV is interpreted as the current value of a cow in the herd ($/head) where higher NPV values are preferred to lower values.

The analysis conducted for this paper is based on a representative herd and thus the calculated NPV of a cow represents a typical cow in the herd, given the various assumptions used in the analysis. It is important to recognize that this is not the same as if the analysis were done on an individual cow basis where every single cow will have a different NPV based on her unique information (i.e., milk production, pregnancy status, days in milk). Therefore, the results of this analysis are useful for making decisions regarding culling rates for an operation (i.e., whole herd cull rate) as opposed to deciding whether a specific cow should be culled or not.

Assumptions

As with any economic analysis, numerous assumptions were required pertaining to both production factors as well as economic variables in order to examine the impact culling rate has on profitability. Table 1 shows the key production factor assumptions that were used for the initial analysis (baseline scenario). Many of the production values were extracted from DairyComp for a commercial dairy operation in California. Production information for cows in their third or greater lactation (i.e., lactations 3 through 7) were aggregated and held constant across lactations. This was also done for culling risk by 30-day time period, but these rates were adjusted to account for higher total culling rates for the later lactations. Where specific information was lacking from the representative herd, values were used that we believe are reasonable averages for the dairy industry (e.g., marketable culls and pregnancy rates). The lactation length of 402 days is a calculated valued based on the pregnancy rate, voluntary wait period, and dry period. As pregnancy rate is varied in an alternative scenario, the lactation length varies accordingly (discussed later). Based on the culling risk by 30-day time period, it can be seen that there would still be 1.2% of the cows in the herd after seven lactations. Rather than continue on with an eighth lactation for this very small percentage of cows remaining in the herd, it was arbitrarily assumed these cows would be sold as they are dried off.

Table 1. Production assumptions (for base scenario)

	Lactation							
	1	2	3	4	5	6	7	Average[1]
Parity distribution	36.1%	26.0%	17.7%	11.0%	5.8%	2.4%	1.0%	100.0%
Milk production, 305 ME, lbs	24,866	26,657	25,939	25,939	25,939	25,939	25,939	25,738
Expected future cull rate, %	28.0%	32.0%	38.0%	47.0%	58.0%	58.0%	58.0%	35.7%
Marketable culls, %	83.9%	84.4%	78.9%	81.9%	85.3%	85.3%	85.3%	83.0%
Pregnancy rate, %	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Voluntary wait period, days	50	50	50	50	50	50	50	50
Dry period, days	60	60	60	60	60	60	60	60
Lactation length, days	402	402	402	402	402	402	402	402
Milk production (assuming no culls)[3]								
Entire lactation	26,694	27,992	29,517	29,517	29,517	29,517	29,517	28,102
Pounds/day	70.2	73.6	79.1	79.1	79.1	79.1	79.1	74.4
Milk production (accounting for culls)[3]								
Entire lactation	22,638	24,272	23,855	22,514	20,875	20,875	20,875	23,101
Pounds/day	66.4	70.6	74.6	75.0	75.5	75.5	75.5	70.7
Culling risk by 30-day time period								
0-30	7.3%	4.1%	7.4%	9.1%	11.3%	11.3%	11.3%	
31-60	2.6%	2.0%	3.2%	3.9%	4.8%	4.8%	4.8%	
61-90	1.3%	1.7%	2.3%	2.9%	3.5%	3.5%	3.5%	
91-120	1.0%	1.4%	2.2%	2.7%	3.4%	3.4%	3.4%	
121-150	1.1%	1.5%	2.1%	2.6%	3.2%	3.2%	3.2%	
151-180	0.9%	1.5%	1.8%	2.3%	2.8%	2.8%	2.8%	
181-210	0.8%	1.6%	2.2%	2.7%	3.3%	3.3%	3.3%	
211-240	1.1%	1.7%	1.7%	2.1%	2.6%	2.6%	2.6%	
241-270	1.0%	1.9%	2.2%	2.8%	3.4%	3.4%	3.4%	
271-300	1.1%	2.1%	1.6%	2.0%	2.4%	2.4%	2.4%	
300+	9.9%	12.5%	11.3%	14.0%	17.3%	17.3%	17.3%	
Total	28.0%	32.0%	38.0%	47.0%	58.0%	58.0%	58.0%	
Remaining in herd	72.0%	68.0%	62.0%	53.0%	42.0%	42.0%	42.0%	
Remaining in herd, cummulative[2]	72.0%	49.0%	30.4%	16.1%	6.8%	2.8%	1.2%	

[1] Parity-weighted average (value in Parity distribution row is a total)

[2] Any cows remaining in herd at end of seventh lactation are sold following the last day of milking

[3] Milk production is for a lactating cow (i.e., it does not account for dry cows)

Critical to the analysis is the assumptions made pertaining to milk production (i.e., lactation curves). Groenendall et al. (2004) estimated lactation curves according to:

(1) $Y = A(DIM)^{b}e^{cDIM}e^{gDP}$,

where, Y = daily milk production (kg),
A = (305 ME milk/100 – a)/2.96,
DIM = days in milk,
DP = days pregnant,
e = base of natural logarithm, and
a, b, c, and g are parameters to be estimated.

For this analysis lactation curves were estimated using a model similar to (1) except without the days pregnant term (i.e., e^{gDP} was not included). Lactation curves were estimated separately for lactation 1, lactation 2, and lactation 3+ cows with data from the representative dairy. This resulted in lactation curves for parities 1, 2, and 3+ being estimated from 1079, 652, and 1067 observations (cows), respectively. Figure 1 shows the estimated lactation curves for the three parity groups. For alternative scenarios considered where milk production varied from the base scenario (i.e., that reported in Table 1), lactation curves were proportionately adjusted to determine daily milk production.

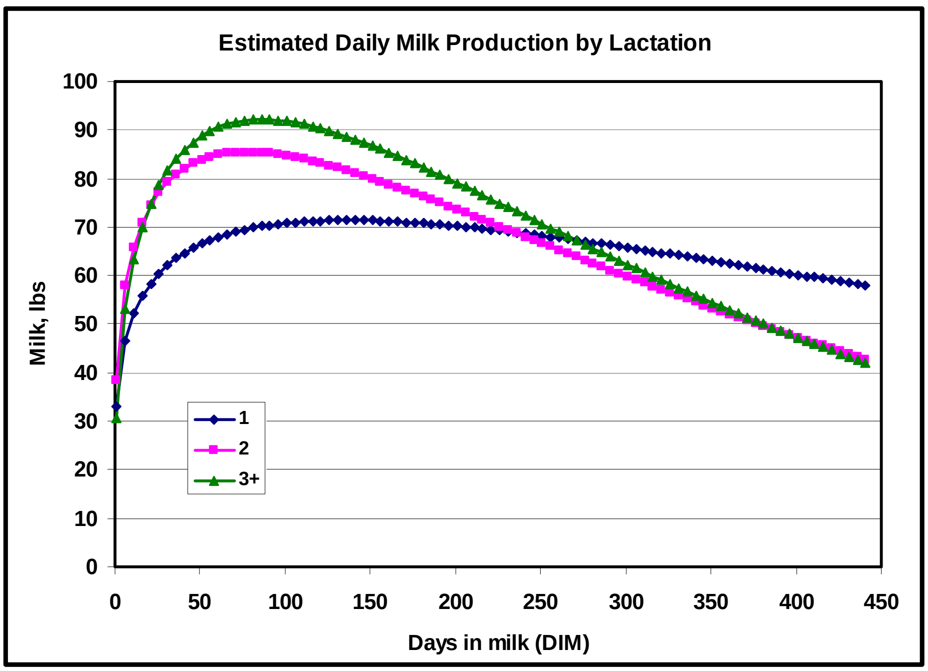

Figure 1.

In addition to the assumptions pertaining to production, a number of assumptions were required pertaining to income and costs. Table 2 shows the key economic assumptions that were used for the baseline scenario. Replacement heifers (those purchased in the future as opposed to current cows in the herd) were assumed to cost $1800 per head and are brought into the herd 21 days before calving and incur a feed cost of $2.50 per day.[1] Cull cows were assumed to be worth $580 per head; however, only 83% of culls are marketable on average (Table 1). Price for cull cows was based on a long-run average for beef cows (Kastens et al., 2006) with a slight adjustment for quality. Schroeder et al. (1988) found that cull dairy cows received comparable prices as beef cows, but they also found that significant discounts can apply to thin cows. Thus, the historical average beef cow cull price was arbitrarily reduced by 10% to account for dairy cows tending to be thin when they are culled. It was assumed that 47% of the calves born would be heifer calves with 93% of them surviving past 24 hours that could be marketed compared to 88% of bull calves surviving and being marketable. All calves are assumed to be sold at birth with heifers being valued at $400 per head and bull calves at $100 per head.

Lactating cows are assumed to consume 13 lbs of feed per day for maintenance plus 0.44 pounds of feed per pound of milk production (i.e., 2.25 lbs of marginal milk per pound of marginal feed) at a cost of 8¢ per pound. Feed cost for dry cows is assumed to be $1.75 per day. Per cow operating costs (e.g., supplies, labor, breeding) and per dairy annualized ownership costs (e.g., depreciation, interest) were based on projected budgets for a 2,400 lactating cow freestall dairy (Dhuyvetter et al., 2006a). These costs were converted to a daily cost per cow and were equal to $1.23 (operating) and $2.39 (ownership) for a total of $3.62 per cow per day for non-feed costs.[2] Milk price, net of hauling costs and any promotion fees, was assumed to be $12.50 per cwt. Finally, a discount rate of 15% was used to discount future returns and costs. Often a discount rate is used that is comparable to the interest rate on debt. However, in this case a higher rate was used to account for risk and also because this is consistent with dairy owners expecting a higher rate of return than what they can borrow money for.

[1] Kastens et al., 2006 report a short-run price for replacement heifers of $1900 and a long-run average price of $1750. The value used here is assumed to be somewhere between these two forecasts, but slightly closer to the long-run forecast.

[2] As a point of comparison, projected costs for a 2,400 lactating cow drylot dairy are $1.24 (operating) and $1.94 (ownership) for a total non-feed cost per cow per day of $3.18 (Dhuyvetter et al., 2006b).

Table 2. Economic assumptions (for base scenario)

Replacement heifer cost, $/head	$1,800
Genetic improvement over time, annual %	0.00%
Days heifer is owned before freshening	21.0
Heifer feed cost prior to freshening, $/day	$2.50
Cull value, $/head	$580
Weight of cull cows, lbs/head	1,375
Price of cull cows, $/cwt	$42.16
Calf value, $/head	$221
Value of heifer calf	$400
Value of bull calf	$100
Percent female calves	47.0%
Liveborn female, %	93.0%
Liveborn male, %	88.0%
Feed, maintenance, lb/day	13.0
Feed, milk production, lb feed/lb of milk	0.4444
Feed cost, $/lb	$0.080
Dry cow feed cost, $/day	$1.75
Operating cost (e.g., labor, supplies) per cow per day	$1.23
Annualized ownership cost (e.g., facilities) per cow per day	$2.39
Net milk price, $/cwt[1]	$12.50
Discount rate, %	15%

[1] Net of hauling costs and promotion, coop fees

NPV Results

Based on the assumptions used and reported in Tables 1 and 2, income over costs was calculated each day over seven entire lactations (3,196 days) for both a cow and a "partial cow." The value per cow reflects a cow that remains in the herd through seven lactations and then is immediately culled. While only 1.2% of the cows are expected to last this long in the herd (see Table 2), the NPV of this series along with the replacement heifer cost is used to approximate the value of a series of replacement heifers that enter the herd as cows are culled. The NPV of the income over costs series per cow accounting for culls (i.e., the "partial" cow) reflects the current value of a cow in the herd, but does not account for replacements. Thus, a combination of these two series, based on when cows are culled, is used to calculate the relevant NPV. The calculated NPV for the baseline scenario is $1,821 per head. This value will vary considerably between operations due to the many highly variable factors it is based on. Thus, the focus of this paper is not so much on the absolute value of NPV, but rather on how NPV varies under alternative assumptions and as culling rate changes.

Based on the individual cull rates by lactation and the parity distribution, the parity-weighted average cull rate is 35.7% for the baseline scenario. The expected future cull rates in Table 1 were proportionately adjusted from 70% to 130% of the original values in 10% increments to examine how NPV varies with cull rate. The corresponding whole-herd cull rates analyzed were 26.9%, 29.9%, 32.9%, 35.7% (base), 38.4%, 41.0%, and 43.6%. As cull rates change, parity distribution also changes and this will impact profitability. Figure 2 shows the percentage of the herd in parity 1, parity 2, and parities

3 and above (3+) at the various herd cull rates. By definition, as the herd cull rate increases, the percent of first and second lactation cows increases while the percent of higher lactation cows decreases.

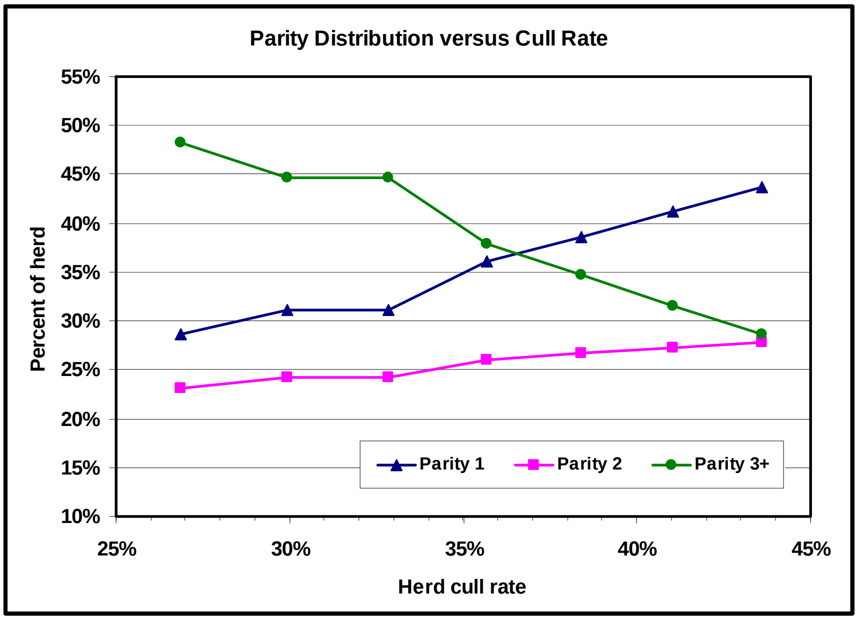

Figure 2.

Figure 3 shows the NPV versus cull rate at the baseline scenario assumptions and allowing cull rate to vary from 26.9% to 43.6% (mid-point value of 35.7% (base) equates to a NPV of $1821). As would be expected, profitability (i.e., NPV of a cow) decreases as cull rate increases. In other words, higher cull rates lead to lower profitability *all else equal*. Thus, if this is the case, i.e., all else is equal, then using cull rate as a proxy for profitability and benchmarking with it would be appropriate.

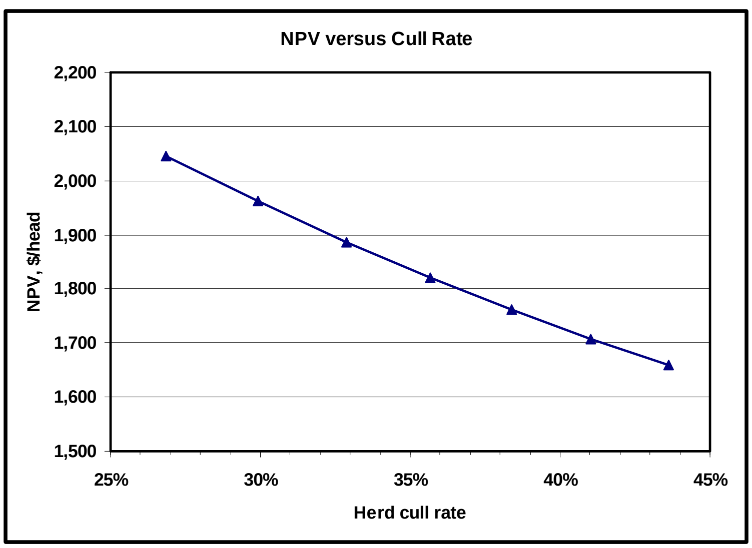

Figure 3.

Because of the many reasons for culling and the many interactions between production variables, the likelihood of all else being equal as culling rate varies is extremely low. Thus, it is important to consider how NPV varies by cull rate while allowing other variable(s) to change. The following scenarios are considered in this paper:

Alternative Scenarios

1) Genetic improvement
2) Milk production
3) Operating cost
4) Replacement heifer price
5) Pregnancy rate

It should be pointed out that the list of alternative evaluated here is not an all inclusive list as there are many additional scenarios that could be considered. However, we believe that the scenarios considered do provide good examples as to some of the profitability relationships that exist and why using cull rate as a proxy for profitability may, or may not, be appropriate. The calculated NPVs for each of the alternative scenarios and a brief discussion of the results are discussed below.

Genetic Improvement

If future generations of cows are more productive than current cows due to better genetics, it may be that higher cull rates are more profitable as this increases the speed at which the improved genetics enter the herd. The impact of improved genetics is accounted for by increasing the value of heifer calves and the returns over costs of replacement heifers by a given percentage per year. Annual growth rates of +1% and +2% are considered and compared with the baseline scenario, which assumes no genetic improvement. Figure 4 shows the NPV for the genetic improvement alternatives compared with the baseline. It is important to recognize that the NPV decreases as cull rate increases for all scenarios because, as stated previously, this reflects all else being equal. Thus, the relevant comparison in figure 4 is to compare the various lines horizontally. Comparing where the NPV lines intersect $1900 it can be seen that a herd that realizes a 2% improvement in genetics can support a cull rate of over two percentage points higher than a herd with no genetic improvement (~32.3% vs. ~34.7%). In other words, for every 1% improvement in genetics expected with future generations of cows, a producer can justify a cull rate slightly greater than 1% higher compared to herds with no genetic growth. Keep in mind though this does not mean that a producer who expects genetic improvement is better with high cull rates – they still are better off with lower cull rates all else equal.

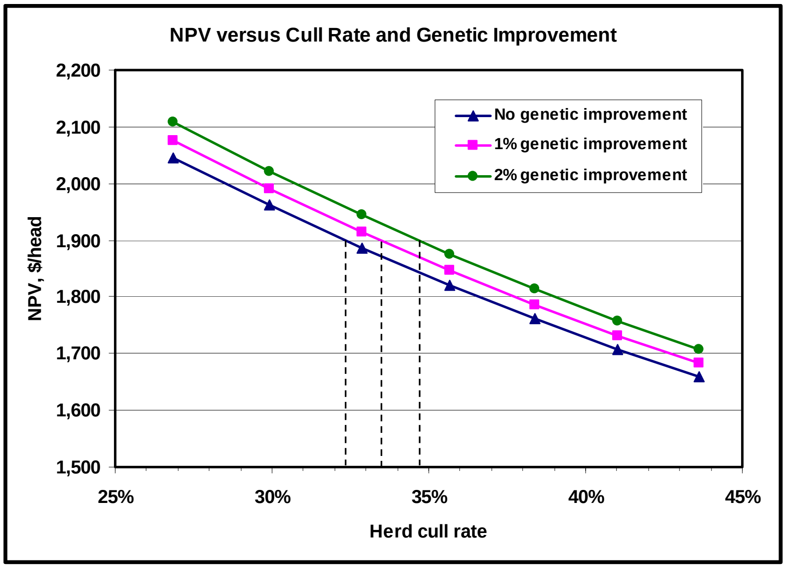

Figure 4.

Milk Production

If culling is done based on production, then higher cull rates might be associated with higher average production levels as poor producing cows are replaced with more productive cows. The impact milk production has on NPV is accounted for by changing 305 ME milk pounds proportionately for all lactations. Alternative production levels considered are 99% and 101% of baseline level (a 1% change in 305 ME milk leads to approximately a 600 pound change in the parity-weighted milk production over the entire lactation (accounting for culls)). Figure 5 shows the NPV for the higher and lower milk production alternatives compared with the baseline (305 ME = 25,738). This figure makes it clear that a 1% change in milk production in either direction has a huge impact on profitability (i.e., NPV of cow in herd). Looking at where the baseline scenario and the +1% scenario (305 ME = 25,996) NPV lines intersect with $2000 it can be seen that the higher producing herd can support substantially higher cull rates (~39.5% vs. ~28.5%). Likewise, this figure makes it clear that lower producing herds need much lower cull rates than average producing herds to be economically competitive. This relationship between production and cull rate makes it very obvious why simply benchmarking on cull rate can be dangerous. That is, if a producer is good at identifying low producing cows and thus culls based on production, high cull rates should not be viewed as a negative. Similarly, low cull rates should not be viewed as a positive from a management perspective if these low rates result in lower total herd production. The key point is that decision makers recognize this relationship and thus make production and culling decisions accordingly.

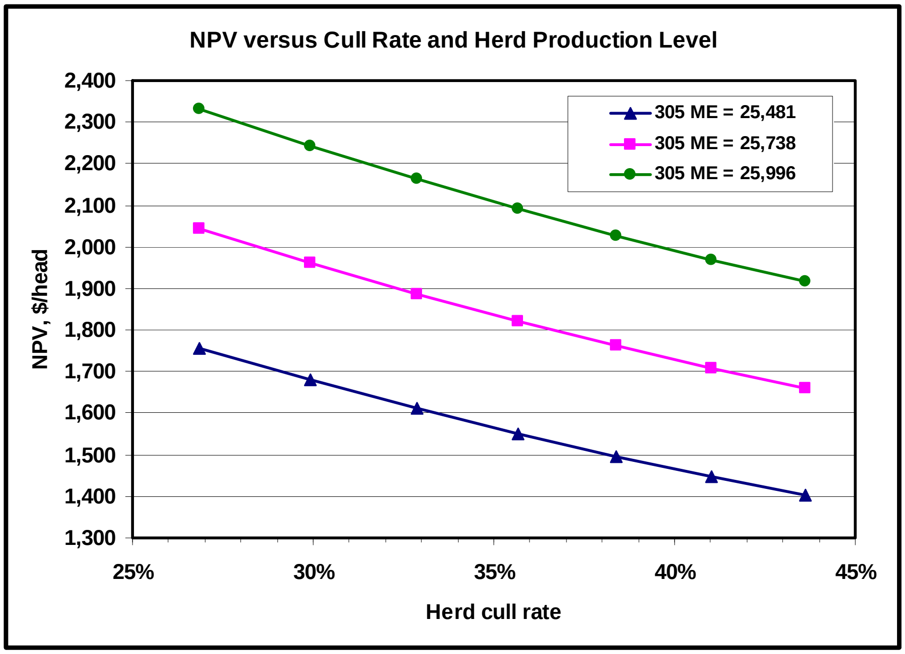

Figure 5.

Operating Costs

If one of the ways to maintain lower culling rates without sacrificing milk production is to spend more money on operating inputs such as labor, supplies, veterinary, etc., then lower cull rates might be associated with higher costs and vice versa. To examine this relationship, the impact of a change in operating costs of +/– 5% (approximately 6¢ to 7¢ per cow per day) on NPV was considered. Figure 6 shows the NPV for the baseline scenario (operating costs of $1.23/cow/day) with scenarios where costs are $1.16/cow/day and $1.29/cow/day. Comparing the high cost scenario with the baseline it can be seen that the high cost operator needs cull rates almost 10 percentage points lower than the average producer (~26.9 vs. ~36.6 at NPV of $1800) to offset his higher costs, all else equal. Likewise, the producer with lower costs has a comparable NPV with the average producer ($2000) at cull rates that are approximately seven percentage points higher (~37.5 vs. ~28.6). Once again, this information points to the risk of simply looking at cull rates and using that as a proxy for profitability. For example, at the same baseline cull rate of 35.7%, there is a difference of over +/–$200 in NPV for the low and high cost operations relative to the average herd. Clearly, if a person considered the high cost operation to be doing "okay" based on his cull rate, they would be failing to recognize how much less profitable this operation is. Similarly, using only cull rate as a crude benchmark, one might conclude that the low cost operation was "about average" when clearly this operation is considerably more profitable than average.

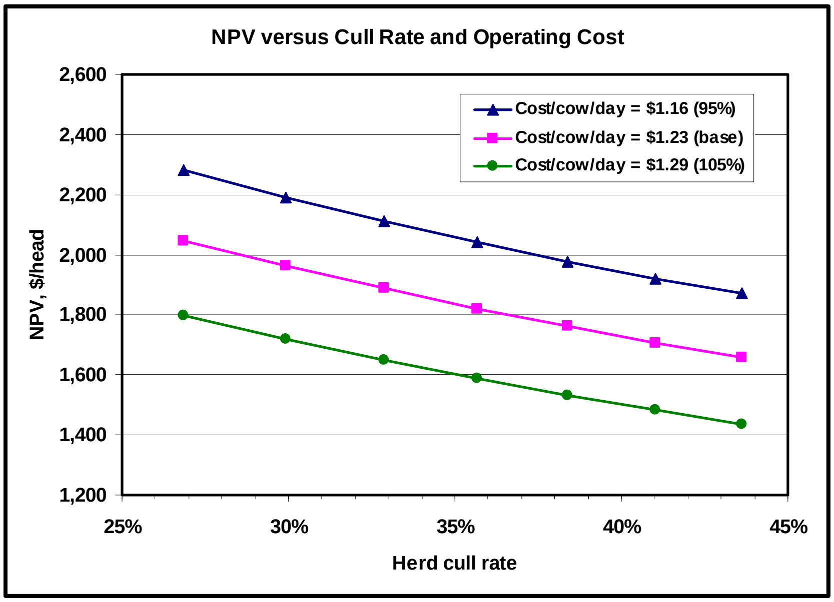

Figure 6.

Replacement Heifer Price

The impact higher replacement heifer prices ($2200 and $2600 versus base of $1800) were considered. In addition a combination of a higher heifer price ($2200) along with either a +2% genetic improvement or a +1% increase in 305 ME were considered together. This would reflect the case where a producer pays a premium to purchase (or raise) heifers but gets a higher quality replacement in return. Figure 7 shows the NPV for the baseline scenario ($1800 replacement) with scenarios where replacement heifers are either $2200 or $2600. As expected, the higher priced replacements lead to significantly lower NPVs and the need to have a much lower cull rate in order to be equally profitable (difference between $1800 and $2600 cannot even be equated over the range of cull rates considered). While the information depicted in figure 7 is correct, it is not particularly useful from a management perspective. That is, higher priced replacements lead to lower NPVs and lower cull rates can help offset this impact but not near as much as needed in some cases.

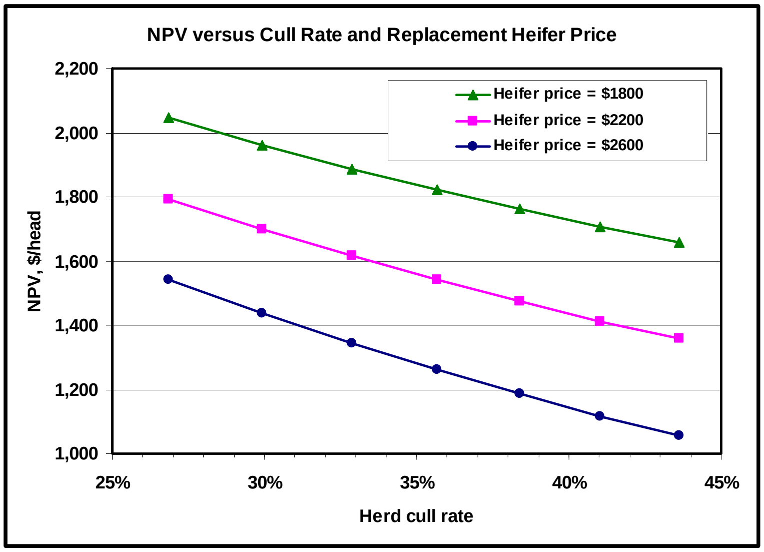

Figure 7.

Figure 7 basically depicted an *all else equal* except purchase price scenario which is somewhat of a no-brainer from a management perspective. What is more interesting is the scenario where I might pay more for replacements (or spend more developing them if raising them myself) because of expected better genetic improvements for the future or better production immediately. Figure 8 shows the NPV for the baseline scenario ($1800 replacement) compared to the situation when a replacement costs $2200 and assuming all else equal (i.e., same information as in figure 7), a 2% genetic improvement, and a 1% increase in 305 ME production. These last two alternatives reflect paying a higher price than average due to a higher quality replacement. First consider the alternative with a 2% genetic improvement for future generations, it can be seen that this increases the NPV relative to no genetic improvement, but it still results in a considerably lower NPV than the baseline scenario. That is, paying a $400 premium for replacements with the expectation of future gains is not as profitable as the average priced replacement. However, when the higher priced replacement is associated with a 1% improvement in milk production (immediate as opposed to future), the $400 premium is warranted. While this is not exactly a "cull rate" result, it does indicate that somebody paying more for higher quality replacements is basically as profitable as somebody with the averaged priced and average quality replacements (at low cull rates they are slightly better off and at higher cull rates they are slightly worse off).

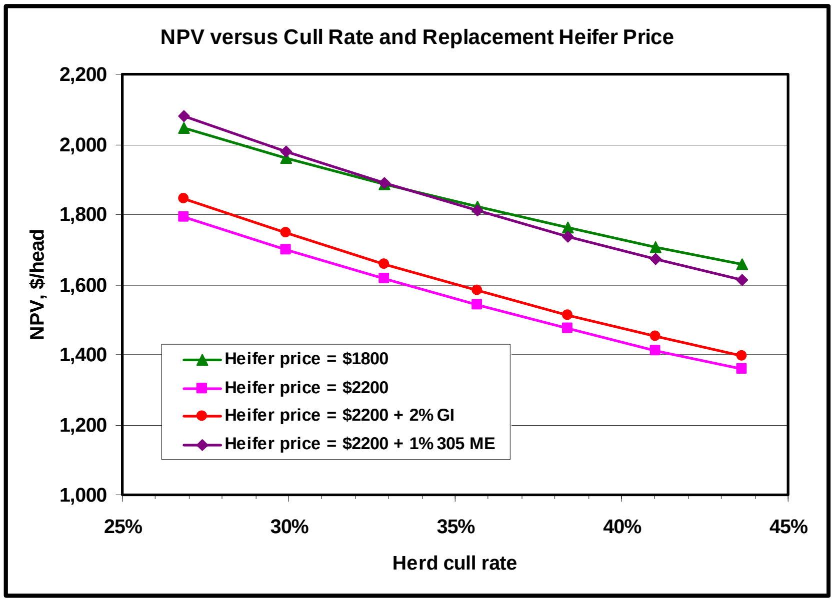

Figure 8.

Pregnancy Rate

Increasing (decreasing) pregnancy rates through either better (worse) conception risks or improved (reduced) breeding submission risks will impact lactation days and thus milk production and NPV. Pregnancy rates of 12, 15 (base), 18, and 21 percent are considered for their impact on NPV. The corresponding daily milk production for the different pregnancy rates is 69.3, 70.7, 71.6, and 76.2, respectively. In addition, the combined effect of an improved pregnancy rate (18% or 21%) and a 5% higher operating cost was considered to reflect a situation where the increased pregnancy rate comes about due to spending more money (e.g., labor, supplies). Figure 9 shows the NPV as culling rate varies at the four pregnancy rates considered. Also shown are the lactation length for cows that are not culled during the lactation, where higher pregnancy rates are associated with shorter lactations.[3] NPV increases as pregnancy rate increases and thus higher cull rates can be supported. For example, a NPV of $2000 is attained in the baseline pregnancy rate (15%) with a cull rate of approximately 28.5% compared to a cull rate of about 36.5% when the pregnancy rate is 18%. It also is obvious from the results in figure 9 that operations that might have low cull rates but also low pregnancy rates, hence long lactations, are likely considerably less profitable than operations with higher pregnancy rates even if they also have higher cull rates.

[3] Net present values (NPV) are all equated to a common time period of 3,196 days (days for baseline scenario) regardless of lactation length so the values in figures 9 and 10 are directly comparable.

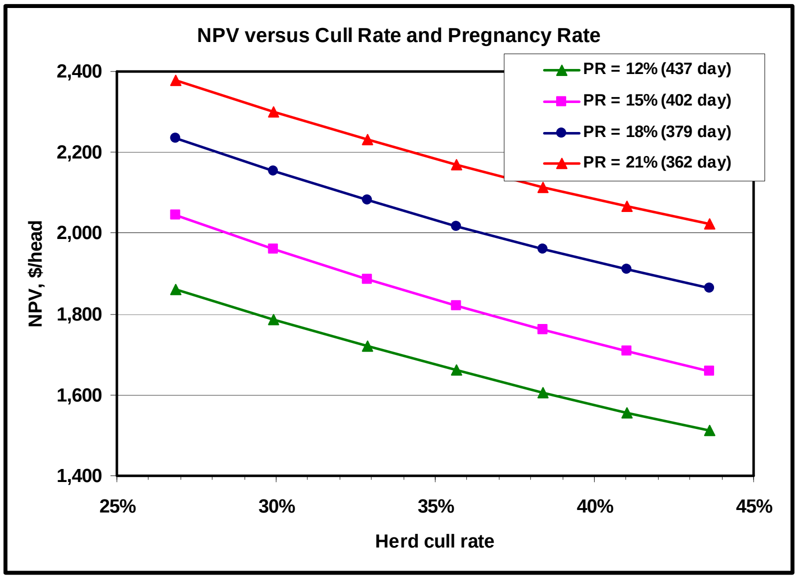

Figure 9.

Figure 10 compares the NPV of the baseline scenario (15% pregnancy rate) with that of higher pregnancy rates (18% and 21%) when the higher pregnancy rate scenarios also have 5% higher operating costs (+6.1¢ per cow per day). By definition, the higher pregnancy rate scenarios with higher operating costs (i.e., those depicted in figure 10) have lower NPVs than when operating costs were at baseline values (i.e., those depicted in figure 9). It can also be seen that if a producer says the only way he can achieve higher pregnancy rates is to increase costs the magnitude of the increase in pregnancy rate is relevant as the 21% pregnancy rate scenario is better than the baseline, but the 18% pregnancy rate is worse. For example, a NPV of $1900 is attained in the baseline pregnancy rate (15%) with a cull rate of approximately 32.3% compared to a cull rate of about 36.8% when the pregnancy rate is 21% and operating costs per day are 5% higher. However, if the 5% costs are incurred and the pregnancy rate only increases to 18%, a NPV of $1900 is only attained at a lower cull rate (30.2%). Thus, it is clear that producers need to consider both the benefit of increasing pregnancy rates as well as the cost of achieving these higher rates. While results such as this are intuitive and not necessarily surprising, being able to quantify these relationships can be very helpful for dairy managers as they are faced with making production and economic decisions.

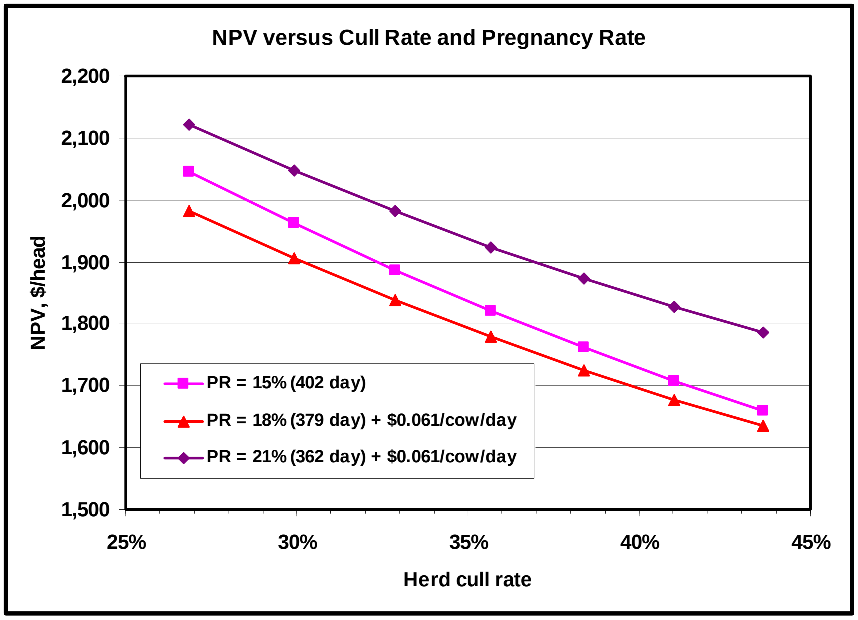

Figure 10.

Summary and Conclusions

As the dairy industry continues to consolidate, margins will likely become tighter meaning it will be imperative that producers know their businesses' strengths and weaknesses. One of the methods of identifying strengths and weaknesses is to benchmark against other dairies. However, a concern when doing this is that proper benchmarks are used. Ultimately, the benchmark of interest is a measure of profitability, such as return on assets or return on equity, but these measures do little for understanding why an operation was or was not successful. Thus, production benchmarks are often used because they can serve as reasonable indicators of profitability. While production benchmarks can be indicators of a production strength or weakness of an operation, they should be used with extreme caution because of the many interacting relationships that exist in milk production.

The results of the analysis conducted here reinforce that higher cull rates are associated with lower net present values (NPV), which is an indicator of profitability, when all other factors are equal. Unfortunately, whether comparing multiple dairies (external benchmarking) or the same dairy over time (internal benchmarking), all other factors are seldom equal. A dairy operation that increases milk production due to higher culling rates might very well be more profitable than a dairy with lower cull rates and thus focusing on cull rate differences between the two dairies might lead to incorrect conclusions. Differences in factors such as milk production, non-feed operating costs, and pregnancy rate can have as large or larger impact on profitability than cull rate. It is important that dairy managers understand these relationships so that they focus their efforts on those factors that have the biggest impact on profitability in their operations.

The results depicted in figures 8 and 10 begin to hint at how complex the optimal cull rate for an individual dairy operation is and why benchmarking solely on cull rate, or some other single factor, can be very misleading. Dairy owners and managers are constantly faced with trade-offs similar to those depicted in figures 8 (heifer price versus milk production) and 10 (operating costs versus pregnancy rate) and many others that are much more complex than these; consequently, there is a very wide variation in profits across operation and from year to year within operations. The key point is that decisions need to be made that impact many variables that all interact with each other and thus benchmarking on one measure should be done with extreme caution. Ideally, dairy managers will employ economic models such as the one developed for this paper so that they can quantify the impact of varying different production and economic factors for their unique operations.

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