THE CASE FOR A QUALITY DAIRY REPLACEMENT PROGRAM

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INTRODUCTION

Replacements are an investment in the future of a dairy, and they are significant, often representing 15 to 20% of the total cost of milk production, which is second only to dairy feed costs. The likelihood of a positive payoff on those investments is dramatically improved when the management team has a system in place that generates quality heifers. A quality heifer is one that can successfully calve and enter the lactating herd with a strong likelihood of consistently contributing to dairy profitability over her productive lifetime with limited extraneous input from the management system. A quality dairy replacement system is a management system that consistently generates quality heifers. While there is a multitude of literature on the biological management of raising heifers, there is considerably less literature addressing the economic impact that a well-executed replacement strategy has on the overall dairy operation. This paper will attempt to describe the basic components of quality management and a quality management system, and will also discuss the economic factors of replacement management, including a discussion on the magnitude of impact that excellent management can have on a dairy.

WHAT IS QUALITY MANAGEMENT?

Quality Management has become a buzzword topic in the dairy news over the last year or so, yet it is not a new concept. Quality management systems focus on delivering products that achieve high performance standards with a high degree of consistency. Dr. Walter Shewhart developed the concepts around performance and consistency standards in the 1920’s and 1930’s for application in the rapidly growing manufacturing sector. Dr. W. Edwards Deming took these concepts to Japan, where they were applied to both the automobile and electronics manufacturing industries. Today, quality management systems are ubiquitous in virtually every major manufacturing industry around the world. Application in production agriculture has been somewhat slower, although they are used in the vertically integrated swine and poultry industries, and first generation dairy quality management concepts and tools have
been developed for application in feeding, milking systems, and milk quality management. Components of a quality dairy replacement program would include goal setting and monitoring systems for:

- the nutrition program, focused on achieving growth milestones that meet timing objectives,
- health management, to ensure minimization of disease impacts and address biosecurity concerns,
- reproductive programs, ensuring timely insemination so that groups calve on time, and
- calving management, focused on getting live calves from undamaged cows.

**WHAT IS A DAIRY REPLACEMENT WORTH?**

The maximal value of any investment is simply the sum of the expected cash flows from that investment discounted into the present time. For a dairy heifer, that would entail the costs associated with getting that animal to 24 months of age, and the discounted cash flows expected from that animal’s milk production, calf sales and salvage value over the course of her productive life. As a result, market value is largely uncoupled from the cost of actually raising a heifer with the greatest sensitivity of market price being the expected milk price over the animal’s productive life (Table 1). As a result, there is likewise an uncoupling of the ability to capture value through effective replacement management, such that custom heifer raisers and producers who raise their own replacements have the ability to capture that value, while producers who rely on the market as the source of their replacement animals cannot.

Table 1. Relationship of milk production level and the market price of heifers to the mailbox price of milk that allows producers to add cows (Lormore and Cady, 2003).

<table>
<thead>
<tr>
<th>Heifer Price</th>
<th>16,000</th>
<th>18,000</th>
<th>20,000</th>
<th>22,000</th>
<th>24,000</th>
<th>26,000</th>
<th>28,000</th>
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<tr>
<td>$1,100</td>
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<td>$10.17</td>
<td>$9.52</td>
<td>$8.99</td>
<td>$8.55</td>
<td>$8.17</td>
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<td>$11.58</td>
<td>$10.71</td>
<td>$10.00</td>
<td>$9.43</td>
<td>$8.95</td>
<td>$8.55</td>
<td>$8.20</td>
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<td>$11.24</td>
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<td>$9.87</td>
<td>$9.36</td>
<td>$8.92</td>
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<td>$11.78</td>
<td>$10.97</td>
<td>$10.31</td>
<td>$9.76</td>
<td>$9.29</td>
<td>$8.89</td>
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<tr>
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<td>$14.01</td>
<td>$12.86</td>
<td>$11.94</td>
<td>$11.19</td>
<td>$10.57</td>
<td>$10.04</td>
<td>$9.58</td>
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<td>$2,300</td>
<td>$14.61</td>
<td>$13.40</td>
<td>$12.43</td>
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<td>$12.91</td>
<td>$12.07</td>
<td>$11.37</td>
<td>$10.78</td>
<td>$10.28</td>
</tr>
</tbody>
</table>

**Adapted from Excel spreadsheet ‘Adding Cows’ by John Fetrow, DVM, MBA**
For the last 20 years, discussions on replacement programs have correctly focused on the need to reduce age at first calving (AFC) as a means to improve herd profitability, but only more recently has the discussion begun to recognize not only the additional rearing expense associated with additional days, but also the lost income opportunity from not having milk in the tank sooner, as well as the time value associated with those cash flows.

An analysis by St.Pierre (2002) estimated that the economically optimal pre-pubertal average daily gain was between 1.98 and 2.42 lbs/d, and the optimal AFC was between 20.6 and 22.4 months.

Of critical importance to such a system that reduces AFC considerably over the industry average 26 mo is getting heifers to an adequate body weight that puts them beyond undue risk of dystocia. While every animal that calves assumes some risk, inadequate body weight is highly correlated with negative outcomes across the spectrum of health, reproduction, and survivability measures (Erb et al., 1985, Thompson et al., 1983). Keown and Everett (1986) and Van Amburgh et al. (1998) estimated that the optimal postpartum body weight in Holsteins to maximize first lactation milk yield was approximately 1210 lbs.

As Van Amburgh et al. (1998) reported no effects of AFC or prepubertal ADG on first lactation milk yield when adjusted for post-calving body weight, it does appear that reaching the optimal post-calving body weight by 22 months of age is not an unrealistic goal. While the adjustment would indicate that the goal is attainable, it is not often met, and current data would indicate that expectations of first lactation milk yields for groups calving at 21.9 months might often lag those calving at 24.7 mo by a rate of 4.8% (Meyer et al., 2004). Ettema and Santos (2004) reported that animals calving at 23.7 months and 25.9 months derived adjusted incomes of $119.73 and $9.08 over a group of animals calving at 22.3 months after considering income from 310 day lactation milk, newborn calves, cow salvage income, costs associated with stillbirths, diseases, days open, cow mortality, labor, and differential rearing expenses, with no statistically significant differences in incomes among the groups. By their own admission, however, these authors did not consider the opportunity cost of milk from animals that calved earlier, the time value of money, nor the differential in capital employment necessary to maintain a larger heifer inventory.

STALLS OR COWS?

While many studies are designed to elucidate the biological impacts of specific management factors, these types of research results are often not readily applicable for determining appropriate management strategies at the commercial dairy level. While biological research is typically performed on cows, management research that aims to clarify the economic implications of an intervention really needs to consider the systematic impacts, not just the impacts on a single cow. In essence, the impact needs to be measured on a milking stall, not a cow.

In reassessing the results from Ettema and Santos (2004) (table 2) looking solely at the net present value of milk income over feed costs at 22 months of age, without adjusting
for all the aforementioned factors, there was a marked shift in profitability. By the beginning of the 26th month, the group calving at 22.3 months had amassed an estimated cumulative discounted IOFC of $662 per cow, vs. $186 and -$109 for the 23.7 and 25.9 mo groups, respectively. Likewise by the time the 22.3 mo calving group completed their lactations at 310 DIM (approximately 32 months of age), their cumulative discounted IOFC stood at $1801, vs. $1466 and $1184 for the medium and late AFC groups, respectively. At the end of the lactation for the late group, cumulative discounted IOFC stood at $1724 for the late AFC group, but if assumptions are modeled in regarding the second lactation productivity of the early and medium AFC groups at 25,000 lbs of milk per 310 d lactation, with a 60 day dry period at a feed cost of $1 per day, those stalls would have generated $2211 and $1772, respectively. Those incomes would increase to $2590, $2151, and $1839 for the early, medium, and late AFC groups by the end of the 38th month, 17 months after the first group originally calved, and approximately one month after the late AFC group calved for the second time. While this model likely overestimates the true differences that may exist, particularly because it doesn’t account for the cost associated with cow removal or variable reproductive performance, it demonstrates clearly that getting milk early is a significant financial advantage over any slight productivity advantage on a per cow per day in milk basis that might be obtained by delaying AFC even as little as two months.

Taking these same concepts one step further, additional modeling of the results put forth by Meyer et al. (2004) was undertaken. This dataset consists of over 2.5 million first lactation cows from 937 herds in California and the Northeast, and was accumulated between 1985 and 2002. Cows were divided, within herd, into quintiles by AFC, and then assigned across herds into opportunity groups for age classes 3, 4, 5, 6, 7 and 8. This type of analysis permits the evaluation of total milk produced and total productive days at a given age across treatment groups (i.e., AFC) while simultaneously discounting the treatment groups for any treatment associated differences in early death loss. Critical portions of the original results showing productive days, milk production, and stayability are shown in tables 3, 4, and 5. While the stayability results (table 5) would seem to indicate that during the first lactation, cows in lower AFC groups are more likely to be removed in the first year, the results are deceptive because they do not account for the differences in days at risk for removal, which are shown in table 3. By combining the information, it can be seen (table 6) that on a per day of

<table>
<thead>
<tr>
<th>AFC Group</th>
<th>310 d Milk Yield</th>
<th>End of Low AFC lact</th>
<th>End of 310 d lact</th>
<th>At 39 mo of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>22779</td>
<td>$1,801</td>
<td>$1,801</td>
<td>$2,590</td>
</tr>
<tr>
<td>Medium</td>
<td>23461</td>
<td>$1,466</td>
<td>$1,804</td>
<td>$2,151</td>
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<tr>
<td>High</td>
<td>23665</td>
<td>$1,183</td>
<td>$1,724</td>
<td>$1,839</td>
</tr>
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</table>

Table 2. 310 day Milk Yields and discounted Income over Feed Costs estimated from Ettema and Santos (2004).
Table 3. Average number of productive days for 5 AFC treatment groups and 6 age opportunity groups. [Meyer et al., 2004]

<table>
<thead>
<tr>
<th>Age, yr</th>
<th>Age at First Calving Treatment Groups, Months</th>
<th>Productive Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>23.3</td>
<td>354.8</td>
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<td>4</td>
<td>24.3</td>
<td>328.5</td>
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<td>252.4</td>
</tr>
<tr>
<td>7</td>
<td>30.3</td>
<td>165.7</td>
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<td>8</td>
<td>23.3</td>
<td>19,758</td>
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<tr>
<td>9</td>
<td>24.3</td>
<td>34,659</td>
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<tr>
<td>10</td>
<td>25.6</td>
<td>45,445</td>
</tr>
<tr>
<td>11</td>
<td>27.2</td>
<td>52,483</td>
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<td>17</td>
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<td>91,555</td>
</tr>
</tbody>
</table>

Table 4. Average total milk production across 5 AFC treatment groups and 6 age opportunity groups. [Meyer et al., 2004]

<table>
<thead>
<tr>
<th>Age, yr</th>
<th>Age at First Calving Treatment Groups, Months</th>
<th>Average Total Milk Productions, lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>23.3</td>
<td>19,758</td>
</tr>
<tr>
<td>4</td>
<td>24.3</td>
<td>34,659</td>
</tr>
<tr>
<td>5</td>
<td>25.6</td>
<td>45,445</td>
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<td>27.2</td>
<td>52,483</td>
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<td>59,424</td>
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<td>36</td>
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Table 5. Average stayability (percent survival) across 5 AFC treatment groups and 6 age opportunity groups. [Meyer et al., 2004]

<table>
<thead>
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<th>Age, yr</th>
<th>Age at First Calving Treatment Groups, Months</th>
<th>Survival, %</th>
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<td>23.3</td>
<td>80.2</td>
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<td>31</td>
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Table 6. Average risk of removal per day of productive life (percent) across 5 AFC treatment groups within 6 age opportunity groups. (adapted from Meyer et al., 2004)

<table>
<thead>
<tr>
<th>Age, yr</th>
<th>23.3</th>
<th>24.3</th>
<th>25.6</th>
<th>27.2</th>
<th>30.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of Removal per Day of Productive Life, %</td>
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<td>0.056%</td>
<td>0.059%</td>
<td>0.057%</td>
<td>0.060%</td>
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<td>0.056%</td>
<td>0.056%</td>
<td>0.059%</td>
<td>0.057%</td>
<td>0.060%</td>
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<tr>
<td>4</td>
<td>0.091%</td>
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<td>0.076%</td>
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<td>0.107%</td>
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<td>0.121%</td>
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<td>0.133%</td>
<td>0.132%</td>
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<td>7</td>
<td>0.155%</td>
<td>0.149%</td>
<td>0.147%</td>
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<td>0.148%</td>
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<td>8</td>
<td>0.147%</td>
<td>0.159%</td>
<td>0.165%</td>
<td>0.162%</td>
<td>0.159%</td>
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Table 7. Average Income over feed costs discounted to a year 2 (24 mo.) AFC across 5 AFC treatment groups within 6 age opportunity groups. (adapted from Meyer et al., 2004)

<table>
<thead>
<tr>
<th>Age, yr</th>
<th>23.3</th>
<th>24.3</th>
<th>25.6</th>
<th>27.2</th>
<th>30.3</th>
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<td>Discounted Income over Feed Costs</td>
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<td>$1,237</td>
<td>$1,138</td>
<td>$1,003</td>
<td>$578</td>
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<td>$1,237</td>
<td>$1,138</td>
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<td>$578</td>
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<td>4</td>
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<td>$313</td>
<td>$325</td>
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<td>$175</td>
<td>$168</td>
<td>$165</td>
<td>$173</td>
<td>$179</td>
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</tbody>
</table>

Table 8. Cumulative Income over feed costs discounted to a year 2 (24 mo.) AFC across 5 AFC treatment groups across 6 age opportunity groups. (adapted from Meyer et al., 2004)

<table>
<thead>
<tr>
<th>Age, yr</th>
<th>23.3</th>
<th>24.3</th>
<th>25.6</th>
<th>27.2</th>
<th>30.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discounted Income over Feed Costs</td>
<td>$1,349</td>
<td>$1,237</td>
<td>$1,138</td>
<td>$1,003</td>
<td>$578</td>
</tr>
<tr>
<td>3</td>
<td>$1,349</td>
<td>$1,237</td>
<td>$1,138</td>
<td>$1,003</td>
<td>$578</td>
</tr>
<tr>
<td>4</td>
<td>$2,590</td>
<td>$2,497</td>
<td>$2,385</td>
<td>$2,230</td>
<td>$1,850</td>
</tr>
<tr>
<td>5</td>
<td>$3,445</td>
<td>$3,366</td>
<td>$3,251</td>
<td>$3,100</td>
<td>$2,749</td>
</tr>
<tr>
<td>6</td>
<td>$3,977</td>
<td>$3,908</td>
<td>$3,798</td>
<td>$3,651</td>
<td>$3,316</td>
</tr>
<tr>
<td>7</td>
<td>$4,293</td>
<td>$4,215</td>
<td>$4,112</td>
<td>$3,977</td>
<td>$3,645</td>
</tr>
<tr>
<td>8</td>
<td>$4,467</td>
<td>$4,382</td>
<td>$4,277</td>
<td>$4,150</td>
<td>$3,823</td>
</tr>
</tbody>
</table>
productive life basis there is no difference in risk removal during the first year, nor any subsequent year, associated with early AFC. As a result, there is a significant economic advantage (table 7) to the earlier calving groups, with the earliest AFC group delivering discounted IOFC during year 1 of $1349 with the 23.3 mo group, followed by $1237, $1138, $1003, and $538 for AFC groups 24.3, 25.6, 27.2, and 30.3 months, respectively. There were no differences in discounted IOFC following year 1 for any AFC group, but on a cumulative basis, no group ever numerically recovered the economic loss suffered in year 1 compared to the earliest AFC group (table 8).

INVENTORY COSTS

Another important economic aspect of quality heifer management is inventory control. It has long been recognized that herds with later AFC require more heifers in their inventory than herds with earlier AFC. Karszes (2004) has quantified this issue well in terms of heifer numbers in table 9. If we consider that every additional heifer requires, on average, $650 in capital expenditure at any specific point in time that is not simultaneously generating revenue, a 1000 cow dairy with a 26 mo AFC and a 36% removal rate will require an additional investment of over $80,000 more than a similar herd with a 22 mo AFC. The opportunity cost of employing those funds elsewhere only compounds the situation.

Lengthened AFC and increased inventory also impacts asset turnover ratios (ATO) of a heifer operation, such that every one month increase in AFC beyond 22 months slows ATO by approximately 4.5%, negatively impacting financial efficiency and overall returns.

Table 9. Number of heifers maintained, all ages, for various calving ages and replacement rates. Average herd size, milking and dry animals: 1000. Non-Completion rate*, dairy replacements: 8.0%

<table>
<thead>
<tr>
<th>Calving Age, Months</th>
<th>20</th>
<th>23</th>
<th>26</th>
<th>29</th>
<th>33</th>
<th>36</th>
<th>39</th>
<th>42</th>
<th>45</th>
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</thead>
<tbody>
<tr>
<td>18</td>
<td>313</td>
<td>360</td>
<td>407</td>
<td>454</td>
<td>517</td>
<td>563</td>
<td>610</td>
<td>657</td>
<td>704</td>
</tr>
<tr>
<td>20</td>
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<td>452</td>
<td>504</td>
<td>574</td>
<td>626</td>
<td>678</td>
<td>730</td>
<td>783</td>
</tr>
<tr>
<td>22</td>
<td>383</td>
<td>440</td>
<td>497</td>
<td>555</td>
<td>631</td>
<td>689</td>
<td>746</td>
<td>803</td>
<td>861</td>
</tr>
<tr>
<td>24</td>
<td>417</td>
<td>480</td>
<td>543</td>
<td>605</td>
<td>689</td>
<td>751</td>
<td>814</td>
<td>877</td>
<td>939</td>
</tr>
<tr>
<td>26</td>
<td>452</td>
<td>520</td>
<td>588</td>
<td>656</td>
<td>746</td>
<td>814</td>
<td>882</td>
<td>950</td>
<td>1017</td>
</tr>
<tr>
<td>28</td>
<td>487</td>
<td>560</td>
<td>633</td>
<td>706</td>
<td>803</td>
<td>877</td>
<td>950</td>
<td>1023</td>
<td>1096</td>
</tr>
<tr>
<td>30</td>
<td>522</td>
<td>600</td>
<td>678</td>
<td>757</td>
<td>861</td>
<td>939</td>
<td>1017</td>
<td>1096</td>
<td>1174</td>
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<tr>
<td>32</td>
<td>557</td>
<td>640</td>
<td>723</td>
<td>807</td>
<td>918</td>
<td>1002</td>
<td>1085</td>
<td>1169</td>
<td>1252</td>
</tr>
</tbody>
</table>

* Non completion rate represents the percent of heifers that start the replacement system that don’t enter the dairy herd.
Prepared by: Jason Karszes, Senior Extension Associate, PRO-DAIRY, Cornell University
CONCLUSIONS

Quality dairy replacement management is a large opportunity for heifer growers and for dairy producers raising their own replacement animals. The single most important benchmark for achieving maximal economic return from a replacement program is a low AFC. Every month that AFC is delayed beyond the 22 month target costs producers approximately $100 per animal, primarily because of lost milk production opportunity and a loss in the number of days in an animal’s productive life. Based on our current understanding of growth biology, it appears that good management can attain post-calving body weights exceeding 1210 lbs under conditions that should allow many groups to calve at 22 months of age. Due to the well-defined negative relationship between inadequate body weight and calving-associated morbidity and mortality, it is of utmost importance that critical bodyweight milestones be established, monitored, managed, and achieved.

REFERENCES


St-Pierre, N. R. 2002. Application of mixed model methodology to the determination
of the economic optimal pre-pubertal rate of gain in dairy heifers. J. Dairy Sci. 85:(Suppl. 1), 42. (Abstr.)
