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Cost of Replacing Cows and its Effect on Profitability of Dairy Farms

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Summary

A dairy's assets create a certain number of cow slots (places for cows on the dairy). The question is which cows should be kept in these slots to make the most profitable use of the available assets. It is generally very expensive to leave a slot permanently open. Fixed costs have to be paid anyway and a cow's revenues minus variable costs are high, even with low milk prices and high heifer prices.

The strong seasonality in the Southeast causes cow performance in the winter to be much better than in the summer. It is optimal to have many heifers entering the herd in the fall so their peak milk production and breeding occurs in cooler season. However, it generally does not pay to leave a slot open until the fall when a cow is culled in the summer. But the loss from temporarily leaving a slot open in the summer is very small, provided all slots are filled in the fall.

Introduction

A dairy farm's assets are its land, facilities, machinery, milking parlor, available labor, etc. The combination of these assets defines the number of cow slots (places for cows) on the dairy. The question is which cows should be kept in these slots to make the most profitable use of the available assets. The profit generating capacity of every cow on the dairy should constantly be compared to the profit generating capacity of the next best alternative for that slot. In this paper I assume that the next best alternative is to cull the cow and enter a heifer in her slot. Optimal replacement of dairy cows is necessary for the dairy to make the most profitable use of the slot.

Consider the Florida Marlins baseball team. The manager's job is to find the best player for each position so the team is as successful as it can be. Just because someone can catch or pitch a ball now and then does not mean that the person should remain on the team if somebody else could do a better job in that position.

This paper is not about when to (voluntary) cull the cow and replace her with a heifer. In general, a cow should be kept as long as her expected future profitability is higher than that of a replacement heifer, if that heifer would enter the slot today. Basically, cash flow projections of both the current cow in the slot and a potential replacement heifer must be compared. Good cash flows projections are difficult because one needs to consider lactation curves, feed intakes and costs, the chance of getting pregnant over time, the chance of involuntary culling over time, the time value of money, some labor cost etc. Prices, such as for milk, heifers, and cull cows, affect these cash flows and therefore affect the optimal time to replace the cow with the heifer in the same slot. In this paper, I assume that voluntary culling of cows happens at the optimal time.

Sometimes, a decision we make for one slot has an effect on the optimal decisions for the other slots on the dairy. For example, if milking parlor capacity is limited, the decision to keep milking a cow may mean that another cow must be sold or dried off. Another example is the situation where a milk quota is the limiting factor. In general, it is difficult to find the best decision for a slot when all decisions for all slots should be considered at the same time. Typically, and in this paper, I assume that the best decision for the cow in the slot is independent of the best decision for other slots.

In this paper I'll look at two other replacement issues: 1) how much dairymen can afford to pay for heifers, and 2) whether culled cows should be replaced immediately or whether the slot should be left open temporarily, considering the seasonality in cow performance and therefore cash flow projections in the Southeast.

How Much Can You Afford To Pay For Heifers?

With heifer prices high or milk prices low, dairymen wonder sometimes if they can afford to purchase heifers to fill open slots in their herd. The principle to answer this question is the same as comparing the current cow with the heifer to determine voluntary culling: calculate future cash flows for the slot with the (expensive) heifer and without the heifer.

It is important to consider that if the slot is left open (no heifer is purchased and entered), the dairy still faces costs associated with the slot. These costs don't vary with or without a cow in the slot and are therefore fixed. Fixed costs are for example depreciation of buildings, machinery, and equipment, utilities such as electricity and water, and most of the labor. I cannot think of revenues resulting from leaving the slot open.

With a heifer in the slot, revenues come from the sale of milk, heifers, and ultimately her cull price. Variable costs (those that vary because the cow is in the slot) are feed costs, veterinary costs, breeding costs, heifer purchase costs, and perhaps some labor.

Only variable revenues and costs must be included when a purchasing decision for a heifer is made. The variable revenues and variable costs associated with the purchasing decision for the last slot, after decisions for all other slots have been made, are called marginal revenues and costs. The portion of the variable costs in the total costs gets larger when more slots are considered simultaneously. For example, labor costs associated with purchasing the heifer for the last slot may be considered all fixed (nobody gets paid more or less). But when the purchase of a group of heifers is considered, some labor cost could be variable (somebody may get paid more or less).

Consider a very simple and hypothetical example of the effect of fixed and variable costs on the purchasing decision and maximum heifer price a dairyman can afford to pay. The variable revenues (milk and cull value) in all three situations are $7100 during the life of the cow. Heifer price is $1500. In situation I, the other variable cost are $3000, fixed costs are $2500. Profit (revenues – all costs) is $100 and revenues – all variable costs are $2600. Clearly, the heifer should be purchased. The maximum heifer price one can afford to pay is $2600 + $1500 = $4100. In situation II, with variable costs $3200 in stead of $3000, the loss is $100, but the heifer should still be purchased: the loss would have been $2500 if the slot was left open. The maximum heifer price is $3900. Situation III has $5700 variable costs and no fixed costs. Loss is still $100 but the heifer should not be purchased because the loss would be $0 if the slot was left open. A heifer price of less then $1400 would make the heifer purchase profitable.

Dairy Business Analysis Project (DBAP) data for 2001 show that in Florida and Georgia on average roughly 44% of all cost may be considered fixed when all labor costs are assumed fixed. When labor costs are assumed variable, fixed costs are about 29% of all costs.

Realistic and reliable projections of revenues and costs associated with the heifer purchasing decision are not simple to make. We need to consider lactation curves, milk prices, seasonality in milk production and reproduction, some risk of involuntary culling, feed costs, breeding costs, veterinary costs, labor costs, other costs, and the cash flows associated with the consecutive cows that enter the slot after the heifer that is now considered is culled. Furthermore, we need to determine how long the heifer is expected to stay in the herd. Different milk and heifer prices affect how long cows stay on average in the herd. I developed a spreadsheet to take all these effects into account to mimic cash flows and other results in a real herd. First, I'll describe some necessary assumptions and inputs. Later I'll use this spreadsheet to calculate the maximum price one can afford to pay for heifers and whether culled cows should be replaced immediately or not in the summer

Lactation curves were estimated per month of calving from Florida and Georgia DHI data (Figure 1). Clearly, cows that calve in the summer have lower peaks than cows that calve in the winter. Lactation curves for first and second lactation cows show similar trends, but have slightly less seasonality, and are more persistent.

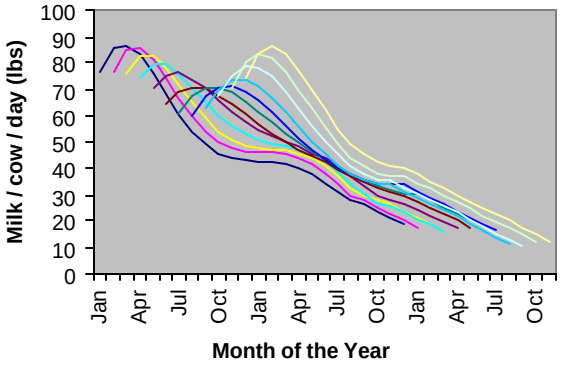

Figure 1: Lactation curves of 3rd and later lactations

Pregnancy rates estimated from the same DHI data showed seasonality as well, with a high of almost 20% in the winter and a low of 10% in some summer months (not shown). Cows were bred in the spreadsheet whenever they were seen in heat (40% heat detection rate).

The spreadsheet assumed a monthly risk of involuntary culling, that is, culling for reasons other than low production and reproduction. Seasonal effects on the risk of involuntary culling were not included, because no reliable estimates were available at the time of this study. The risk of involuntary culling per month in lactation, estimated from the DHI data, is shown in Figure 2. Cows have a high risk of involuntary culling early in lactation and then again later in lactation if she did not get pregnant in time. The risk of involuntary culling also increased with lactation number. Cow culling for voluntary reasons was economically optimal as calculated by the spreadsheet.

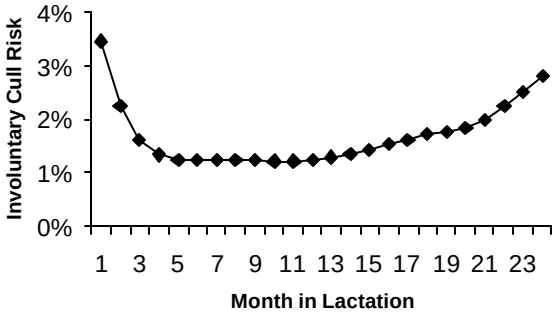

Figure 2: Risk of involuntary culling

Other assumptions for the spreadsheet calculations were that all calves born in the herd were sold and all heifers were purchased at the time they calved. Furthermore, I assumed that plenty of heifers were available. I made many other realistic assumptions about feed intake, body weights (for cull prices), and prices such as for inseminations. In the default situation, milk prices were $16 per cwt and heifer prices were $1400 per head.

Labor costs were either considered fixed (in the default situation) or variable. Fixed labor costs were $1.15 per slot per day. Variable labor costs were $1.15 per cow per day. "Other" fixed costs were assumed to be $1.75 per slot per day. These are fixed costs for utilities, depreciation of buildings, machinery etc. Variable "other" costs were $0.50 per cow per day (for example including some parlor supplies).

Table 1. Results of the default situation

	Per Slot / Year	Per cwt
Milk Sales	$3115	$16.00
Calf Sales	$ 119	$ 0.61
Cow Sales	$ 173	$ 0.89
Total Revenue	$3407	$17.50
Feed Cost	$1422	$ 7.31
Breeding + Vet. Cost	$ 116	$ 0.60
Heifer Purchase Cost	$ 500	$ 2.57
Fixed Labor Cost	$ 421	$ 2.16
Variable Other Cost	$ 183	$ 0.94
Fixed Other Cost	$ 641	$ 3.29
Total Costs	$3283	$16.86
Profit = Revenue - Costs	$ 124	$ 0.64

The spreadsheet then calculated average results given all these inputs (Table 1). A comparison with DBAP data shows that these results may be realistic for herds in the Southeast. Revenues – all variable costs was $1185 per slot per year and $6.09 per cwt milk sold. The ratio of fixed to all costs was 36%. The cost of maintaining the herd was $327 per slot per year, or $1.68 per cwt. Average cull rate was 36%, with a 23% involuntary cull rate and 13% voluntary cull rate. Average days to conception were 136.

Spreadsheet results in Figure 3 show that it is most profitable to enter most heifers in the fall, just at the start of the more favorable cooler season. Many low producing cows should be culled in the fall to make room for these heifers. Entering many heifers in the fall also increases the involuntary cull rate because the risk of involuntary culling is greater early in lactation.

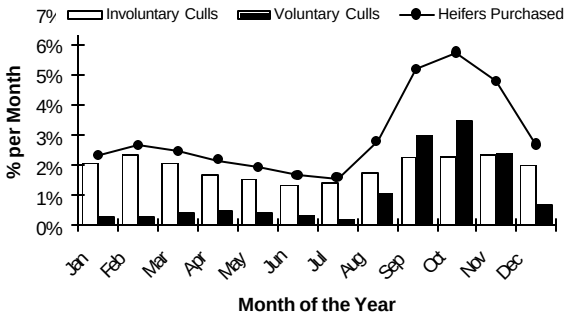

Figure 3: Percent cows culled and heifers entering the herd by month of the year (optimal situation).

Few cows should be voluntary culled in the summer. If you voluntary cull cows in the summer, it almost always pays to put a heifer in the slot the cow just vacated. But this heifer that enters in the summer reaches a lower peak milk production and is more difficult to get pregnant. Moreover, she probably still occupies a slot in the cooler season when she is past her peak production and thus contributes less to the slot than a fresh heifer in that slot would.

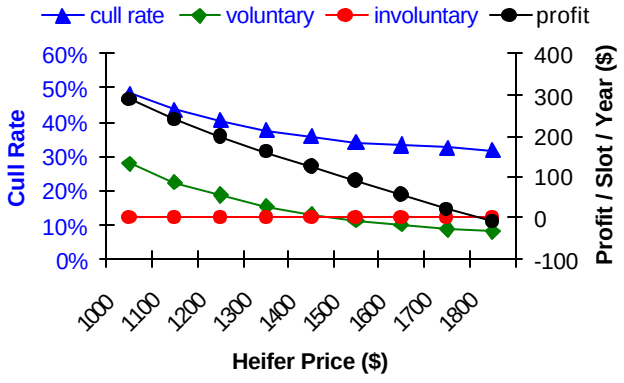

Figure 4: Effect of various heifer prices on cull rates and profit per slot per year.

Figure 4 shows that the total cull rate should drop when heifers become more expensive. Dairymen should hang on to their cows longer if they can, which shows in lower voluntary cull rates. Profit per slot per year decreases from $288 at $1000 heifer prices to a loss of

$9 at $1800 heifer prices. Even at $1800 heifer prices, it is optimal to immediately replace every culled cow with a heifer.

Table 2. Maximum heifer prices for various fixed costs and milk prices

	Default			
Fixed Labor / slot / d	1.15	1.15	0.00	0.00
Variable Labor / cow / d	0.00	0.00	1.15	1.15
Fixed "Other" / slot / d	2.25	1.75	1.75	1.00
Variable "Other" / cow / d	0.00	0.50	0.50	1.25
Total Fixed / slot / d	3.40	2.90	1.75	1.00
Total Fixed / cwt	˜ 6.62	˜ 5.63	˜ 3.38	˜ 1.92
Max. Heifer Pr. ($14/cwt)	˜ 4600	˜ 4000	˜ 2600	˜ 1700
Max. Heifer Pr. ($16/cwt)	˜ 5900	˜ 5300	˜ 3900	˜ 2900

The spreadsheet can also determine how much one could afford to spend on heifers. If heifers were more expensive than this maximum, the slot should be permanently left open. As we have seen in the simple example, only variable cost must be considered. Making the same cost either fixed or variable shows the large effects fixed costs have on the maximum heifer price one could afford to pay (Table 2). Revenues – variables costs is just above $0 in these cases. Even with very little fixed costs (˜ $1.92 per cwt) and $14 milk prices, one could afford to pay up to $1700 for a heifer. The dairy would loose money in all these situations, (see Figure 5) but the loss would be even higher if the slot was left permanently open due to the fixed costs that have to be paid anyway. Of course, if such high heifer prices continued for a longer period of time, no one could afford dairying and the dairy would be sold. Basically, it is almost always a profitable decision to purchase a heifer and fill the slot. But if heifer prices are known to come down a bit, it may be well worth to leave the slot temporary open. Furthermore, with constant reasonable heifer prices, when milk prices are very low or cow performance is very seasonal, it may be a profitable decision to delay filling empty slots in the summer until the fall.

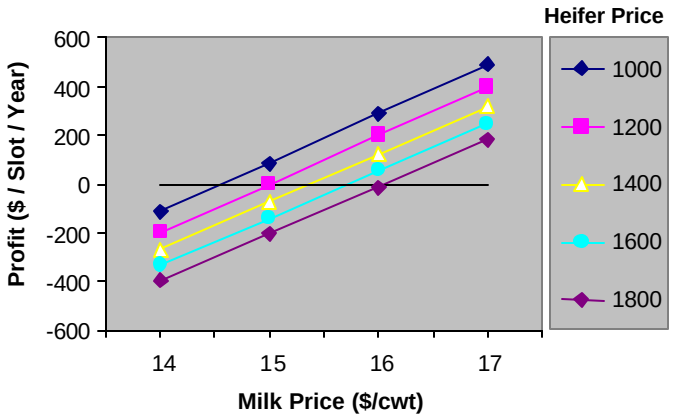

Figure 5: Effect of heifer prices and milk prices on profit / slot / year

When To Replace Culled Cows?

Figure 3 showed that it is most profitable to enter many heifers in the fall in the Southeast (making slots available through increased voluntary culling) because of the large effects of seasonality on cow performance.

Assuming the default situation (with $1400 heifers, $1061 fixed costs per slot per year, and $16 per cwt milk price), every culled cow should be replaced immediately by a heifer. Immediate replacement is optimal until milk prices become less than $11.50 per cwt (with total loss more than $750 per slot per year). It would then be more profitable to not immediately replace cows culled in July and August, but wait until September (Figure 6). Not immediately replacing cows would leave 2% of all slots open in July and 4% of all slots in August. It would increase the number of heifer purchases in September. With milk prices around $11 per cwt, it is the best decision to not replace culled cows in May through September until October. In September, 11% of slots would be empty.

If some fixed costs are shifted to variable costs (assuming $641 fixed costs per slot per year and $420 more variable cost per cow per year), delayed replacement in July and August becomes optimal below about $14 per cwt milk (loss still $264 per slot per year). Again 2 and 4% of the slots would be open. At $13.50, no heifers should be entered in May through August, with 8% of slots open in August. A peak in the heifer purchases in September results. In general, delayed replacement becomes the best option at higher milk prices when heifer prices are higher, fixed costs are lower, and seasonality is stronger.

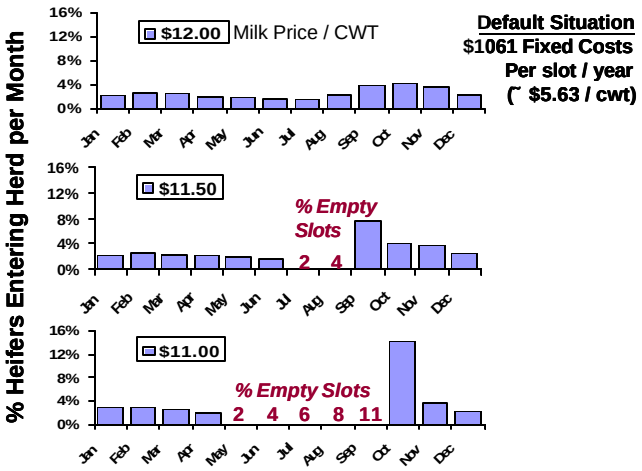

Figure 6: Optimal delayed replacement

Although immediate replacement of culled cows is generally the best decision, the question is how great the loss is if heifer purchases are delayed until the fall. Using the default situation ($1400 heifer price, $1061 fixed cost per slot per year), the loss resulting from not entering heifers in July and August, but instead filling all open slots in September, is very small (only $2.66 per slot per year). The knowledge that heifers cannot be purchased in July and August resulted in very few voluntary culls in those months. Only 1 and 3% of the slots were open. Furthermore, more heifers were entered in the more profitable September (Figure 7). Variations in the milk price from $13.5 to $17.5 per cwt showed that the loss was never more than $3.48 per slot per day. Delaying the entry of heifers until the fall is not very expensive, provided all slots are filled in the fall.

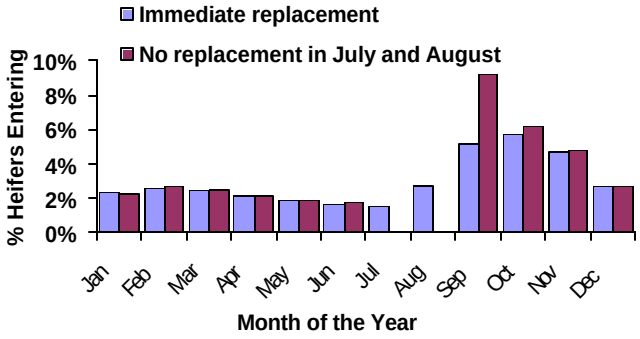

Figure 7: % Heifers entering herd by month of the year