Culling Dairy Cows

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Culling decisions present a serious challenge, both for the dairyman and for the veterinarian who provides service to the farm. Culled cows represent a substantial expense to the producer. The cost of rearing youngstock averages approximately 20 percent of the overall operating expenses of a dairy. Rearing excess heifers to replace cows unavoidably lost from production addes a significant burden to the financial load borne by the dairyman.

There are many different facets to the decision to cull a cow, including economic, circumstantial, and emotional factors. The decisions about culling policy have far reaching impact on the operation of a dairy. Culling policy will affect capital investment strategies, young-stock rearing programs, mastitis and disease control, reproductive programs, genetic program planning, and purchse of animals from off of the farm, to mention some of the more obvious aspects.

This paper will review the question of culling, consider which cows are culled and the proximate reasons for their disposal, and address the predisposing factors that lead to cows being culled. The paper will also take a brief look at the conceptual and economic questions surrounding culling.

How Many Cows Are Culled?

The literature is remarkably sparce regarding the total culling rate in dairy herds. Table 1 presents some of the available data. There are several ways to express the rate at which cows are culled, principally culls per year and culls per lactation. An excellent study of culling in Ontario dairy herds found that 19.3 percent of the cows were culled per lactation or 20.1 percent per year (1-2). Data from 4923 herds participating in the Dairy Records Processing Center at Raleigh for 1986 averaged 34 cows culled per year in herds averaging 108 adult cows. Thus the culling rate for these herds in 1986 was 31.5 percent (3). Data from Canada in 1982 reported an overall culling rate of 23.6 percent (4). Typically, herds can be expected to cull from 20 to 35 percent of their cows each year. The average cow completes approximately 3.5 lactations prior to culling (4) and lives to be 5.6 years old (1).

TABLE 1. Proportion of cows that are culled

(% of lactation or % cows / year)	
31.5%	U.S. Southeastern DHIA at Raleigh, 1986
20.1%	Canada: Dohoo et al, 1984
23.6%	Canada: Westell et al, 1982

How Are Culls Classified?

One of the major difficulties in considering the problem of culling in dairy cows is that there is no consistent system for classifying the reasons why dairy cows are culled. Typically, culling in dairy cows is classified into two major categories, voluntary and involuntary.

Voluntary culling:

Generally, voluntary culls are considered to be those animals that leave a dairy either because of low production in the absence of known underlying disease or because the dairy has excess animals and elects to sell animals to other dairies for productive purposes.

Involuntary culling:

Involuntary culls are loosely defined as those cows that leave the herd against the wishes of the dairyman. The presumption is that if the cause/event had been avoided, then the cow would have had sufficient productive merit to stay in the herd. A variety of sub-categories are used under involuntary culls. The exact breakdown varies from author to author. Table 2 presents one such classification, an amalgam of the categories used by DHIA and published reports (1-7).

Dairymen generally regard voluntary culling as desirable and involuntary culling as undesirable. Voluntary culling is aimed at improving overall herd production level or adding to cash flow by the sale of animals of genetic merit. The generally held perception is that voluntary culls are made for productivity or profitability reasons, contributing to the financial health of the herd. Regardless of how involuntary culls are broken apart, involuntary culls presumably are forced upon the dairyman rather than chosen by him/her. The presumption is that these animals would have been kept had not some external force, disease, injury, or death driven the dairyman to part with the cow. The assumption is that involuntary culls are financial detriments to the herd.

Categories of involuntary culling:

The commonly used categories for involuntary culling include:

Reproduction
Disease and injury
Death
Mastitis and udder conformation and injury
Feet and legs
Temperament
Miscellaneous

TABLE 2. Reasons cows are culled (% of total culls).

Reason	Average	a	b	c	d	e	f	g
dairy sales	13.7%	8.8%	20.3%	32.5%	10.4%		14.3%	9.7%
low production	25.4%	23.5%	25.4%	16.6%	16.1%	32.0%	27.2%	36.8%
TOTAL VOLUNTARY	39.1%	32.4%	45.7%	49.0%	26.5%	32.0%	41.4%	46.5%
reproduction	22.9%	23.5%	17.1%	25.5%	34.9%	27.0%	16.8%	15.8%
mastitis/udder	15.0%	11.8%	15.1%	7.8%	14.7%	22.0%	14.5%	19.3%
disease/injury	10.4%	17.6%		10.2%	11.5%	8.0%	20.0%	5.2%
death	3.3%	11.8%	7.9%				0.6%	2.9%
feet and legs	1.8%	2.9%	5.0%	1.8%			2.9%	
temperment	0.2%		0.9%	0.5%				
miscellaneous	7.3%		8.3%	5.2%	12.8%	11.0%	3.4%	10.4%
TOTAL INVOLUNTARY	60.9%	67.6%	54.3%	51.0%	73.9%	68.0%	58.3%	53.5%
	100%	100%	100%	100%	100%	100%	100%	100%

a) Southeast U.S.: DRPC Raleigh 1986
b) Canada: Dohoo et al, 1984
c) Canada: Westell et al, 1982
d) Ohio: Allaire et al, 1977
e) New York: Van Vleck et al, 1972
f) New York: O'bleness et al, 1962
g) Pennsylvania: White et al, 1965

Regardless of the categories, the segregation of culls into subclasses is a subjective process at best. Generally, the assignment of a cull cow to a particular class is made by the dairyman. There is a significant risk of bias in the reporting due to misclassification and because typically only one "cause" is allowed for a cull cow. Cows that are poor producers due to chronic subclinical mastitis may be misclassified as a voluntary cull due to low production. Cows may be classed as a reproductive cull that in realty are culled due to low production. The dairyman is less willing to invest time, semen, and effort on a low producing cow, increasing her risk of being culled due to "reproduction." A cow may be lame, increasing her risk of developing mastitis, reducing her chance of standing to be seen in estrus, and reducing feed intake that leads to reduced milk production and poor body condition. The cause of the lameness may be mismanagement of fiber in the cow's diet. When the cow is culled, is it because of low production, reproduction, mastitis, or feet and legs, or miscellaneous (metabolic disease)? Despite these obvious difficulties with the classification of culls, it remains instructive to examine the reported reasons for culling cows.

Reasons for Culling Cows

Table 2 details several literature reports on the reasons for culling dairy cows. The percents in the table are proportions of culled animals broken down by cause. They are not proportions of the herd culled per year. Averages for these reports are also presented. The figures are derived from several different regions in North America and include reports from 1962 to 1986. No two reports break culls into the same categories, and some categories presented in the reports have been merged into either the disease or miscellaneous categories for presentation in the table.

On average, approximately 40 percent of culls leave the herd for voluntary reasons while 60 percent are culled involuntarily. The figures vary ± about 10 percent depending on the report. If 30 percent of a herd is culled in an average year, then approximately 12 percent of the herd is culled for voluntary reasons and 18 percent for involuntary ones.

The major reason for involuntary culling is reproductive failure, averaging 23 percent of all culls and 38 percent of involuntary culls. The next largest category is mastitis and udder problems, accounting for 15 percent of all culls and 25 percent of involuntary culls. These two categories account for more than half of all involuntary culling. The other categories and their contribution to total culls are: disease and injury (10.4%), death (3.3%), feet and legs (1.8%), temperament (0.2%) and miscellaneous (7.3%). There is considerable variation within each category, depending on the report and its classification scheme. The variation in reported death rates of cows is notable; some reports do not include deaths while those that do report levels varying from 0.6 percent to 11.8 percent. It is interesting that recent papers that included death as a category report substantial rates of death as a cause of exit from a herd. A particularly careful study in 32 commercial herds in Canada reports that 7.9 percent of all culls are a result of death (1) while 1986 DHIA records from the Dairy Record Processing Center at Raleigh report an 11.8 percent rate (3). It seems unlikely that the death rate has increased on dairies in recent years; it seems far more plausible that deaths have been under-reported in the past.

Factors that Predispose Cows to Being Culled

Age

Cows have differing risks of being culled depending on their age. Recent Canadian work found that cows were at highest risk of being culled between 3 and 4 years old and after 7 years (1). The same paper shows a significant peak in culling risk 300 to 400 days after first calving. This would correspond to culling during and at the end of the first

lactation. Work in Ohio in 1977 showed a more even risk of culling during early lactations, but also showed an increased risk in cows past 7 years old (5).

TABLE 3. Influence of age on culling in dairy cows.

Age range (yrs.)	mean age at calving (a)	annual cull rate (a)	(b)
0 — 2.9	2.4	15.7%	9.6%
3 — 3.9	3.4	24.1%	17.9%
4 — 4.9	4.5	21.0%	21.5%
5 — 5.9	5.5	15.9%	23.1%
6 — 6.9	6.5	18.2%	24.7%
> 7	8.5	28.7%	30.2%

a) Canada: Dohoo et al, 1984
b) Ohio: Allaire et al, 1977

Table 4 shows how the reasons for culling change at various ages (5). For first calf heifers, the largest reason for culling is reproduction. Reproductive culling becomes relatively less important as cows grow older, but this relative reduction is due to increases in overall culling rate in older cows and an increase in culling for other reasons rather than being due to an absolute decrease in culls due to reproduction. Culling for mastitis increases with age. Culling for low production peaks after second lactation, supporting the observation that many dairymen are loath to cull first calf heifers for production, preferring instead to "give them a second chance." It would appear from the table that first calf heifers and cows greater than 7 years old are at greatest risk of culling from disease, injury and miscellaneous causes.

Table 4. Influence of Age on Reasons for Culling in Dairy Cows.

	Age range (yrs.)					
Reasons	**2-2.9**	**3-3.9**	**4-4.9**	**5-5.9**	**6-6.9**	**>7**
low production	15.3%	26.3%	24.4%	21.8%	19.6%	12.6%
reproduction	53.4%	43.1%	39.9%	38.6%	36.3%	30.5%
mastitis & udder disease	6.8%	11.2%	15.5%	19.1%	20.8%	17.5%
& injury	11.4%	9.1%	9.9%	9.6%	11.8%	29.6%
miscellaneous	13.1%	10.3%	10.2%	10.9%	11.5%	9.8%
total cull rate	15.3	17.9	21.5	23.1	24.7	30.2

Allaire et al, 1977

Level of production

It should be no surprise to anyone that low producing cows are more likely to be culled. First calf heifers have been shown to have 2.3 more months of total life and to have 0.15 more lactations per 1000 pounds of first lactation milk production (8). When cows are ranked based on their deviation from herd average fat corrected milk production the risk of culling increases significantly with negative deviations. The numbers are: < 90 percent of herd average production: 29% culled, 90 to 110 percent production: 19.7% culled, and > 110 percent production: 17.4 percent culled. Thus the worst producers in a herd are roughly twice as likely to be culled as the herd's best producers.

Of perhaps more interest is whether the reasons for culling vary in herds with differing average milk production. Table 5 shows the variation in culling rate for 4923 dairy herds served by the Dairy Records Processing Center at Raleigh stratified in 1,000 pound increments by herd average milk production (3). The overall pattern of culling is remarkably similar regardless of the level of production in the herd. Within the voluntary culling category, high producing herds tend to sell more animals for dairy purposes and low producing herds tend to cull more cows for poor production. The two areas of involuntary culling that seem to vary by herd production are

TABLE 5. Reasons for Culling by Herd Production Level.

	avg. all herds	Herd average milk production (1,000 lbs.) 20	19	18	17	16	15	14	13	12	11	10
heifer dairy sales	3%	6%	6%	6%	3%	3%	3%	3%	3%	3%	3%	3%
heifer low producer	6%	6%	6%	6%	6%	6%	6%	8%	6%	7%	6%	5%
cow dairy sales	6%	9%	9%	6%	6%	6%	6%	5%	3%	3%	6%	5%
cow low producer	18%	9%	12%	15%	15%	17%	17%	16%	18%	23%	16%	16%
TOTAL VOLUNTARY	32%	30%	32%	32%	29%	31%	31%	32%	30%	37%	31%	30%
reproduction	24%	24%	24%	21%	24%	23%	22%	24%	24%	23%	25%	24%
mastitis	12%	15%	15%	15%	15%	14%	14%	11%	12%	13%	9%	8%
disease/injury	18%	18%	18%	21%	21%	20%	19%	19%	18%	17%	16%	22%
death	12%	9%	9%	9%	9%	9%	11%	11%	12%	10%	16%	14%
feet/legs	3%	3%	3%	3%	3%	3%	3%	3%	3%	0%	3%	3%
TOTAL INVOLUNTARY	68%	70%	68%	68%	71%	69%	69%	68%	70%	63%	69%	70%
% of herd culled/yr.	31%	34%	34%	35%	32%	32%	33%	32%	31%	31%	30%	29%
cows in the herd	108	96	99	98	107	108	110	116	108	97	106	127
number of herds	4923	166	240	450	656	729	713	624	498	297	230	320

Southeast U.S.: DRPC Raleigh 1986

mastitis (high producing herds cull more cows for mastitis) and death (low producing herds have more cows die).

Disease

Disease has already been considered as a cause for culling in the above discussion, but only in the context of the final "reason" for the animal's departure from the herd. This approach to considering disease as the cause for culling has the obvious problem that it often only considers the final disease event prior to culling rather than the more fundamental role of disease as a predisposing factor for a "cullable event." A more sophisticated approach would be to consider whether presence or absence of a disease in the cow's lactational history increases her chance of being culled.

An epidemiologic investigation in Canada found that several common disease of dairy cows increased the likelihood that a cow would be culled in the first 150 days of lactation (1). After factoring out age and farm effects, the following disease syndromes were shown to increase the chance that a cow would be culled: clinical mastitis, feet and leg problems, milk fever, teat injury, and respiratory disease. The relative risk attributable to each disease is presented in Table 6. Relative risk is the increased odds that a cow that has had a particular disease will be culled when compared to a cow that has had no disease. The relative risks for culling with some diseases is quite high; mastitis requiring systemic therapy increases the chance approximately 80 times that a cow will be culled in the first 150 days of lactation. Milk fever increases the chance of culling 29 times.

TABLE 6. Disease as a Predisposing Factor for Culling (relative risk of culling in the first 150 days of lactation).

Relative risk *	Disease
90	Mastitis requiring system therapy
4	Mastitis requiring only local therapy
29	Milk fever with cow down
31	Disease of feet or legs
35	Teat injury
9	Respiratory disease

* relative risk: the increased odds that a cow with the disease will be culled when compared with a cow with no disease. Thus a cow with milk fever is 29 times more likely to be culled in the first 150 days of lactation than a cow with no disease.

(Dohoo et al, 1984)

The only "disease" found to increase the risk of culling after 150 days of lactation was high somatic cell counts. High somatic cell count was associated with a higher risk of being culled even after age and the level of a cow's production were factored out. Thus high somatic cell counts were associated with culling even excluding the impact of subclinical mastitis on milk production.

Type

The appraisal of dairy type does not appear to be significantly associated wtih risk of culling (9). Type traits evaluated before four years of age were not particularly effective in predicting the time or reason for a cow being culled.

Economic Evaluation of Culling

In the simplest (and inaccurate) sense, the cost of culling a cow is merely the difference between the cost of the replacement cow or heifer and the value received for the culled cow as salvage income. A better approximation, albeit harder to actually determine, would be to compare market values of the culled cow as a dairy replacement animal versus the price of her replacement. The presumption in such a calculation would be that the difference in price would derive from market forces that consider the future productive capability of the two animals. For most cull cows, no such replacement market demand exists so that avenue for economic appraisal is not available.

For involuntary culls, another approach to determining the cost of the premature culling would be to consider the loss of income as a result of needing a replacement heifer earlier than would have been the case had the cow lived a normal life span in the herd. At 8 percent interest, if the cow were culled one year earlier than might have been and if a replacement heifer is valued at $1,000 (market value or cost of rearing), then the involuntary cull cost $80. There are obviously several significant simplifying assumptions in such an approach, in particular the actual productive capacity of the culled cow relative to her replacement.

A number of more sophisticated approaches to modelling the economics of the culling decision have been developed (10-13). Each depends on a set of beginning assumptions about the biological status and behaviour of a herd and about the economic values input into the model. Such models can test the impact of various culling decisions strategies on the profitability of a dairy, and can investigate the sensitivity of the modeled outcome to the input assumptions. No model is complete, i.e. able to consider all of the possible variables that impact on the culling decision. Each does shed light on the scale of the culling problem. In table 7, for example, a model of the level of production required to continue breeding cows at several levels of days open under Dutch conditioning

TABLE 7. Critical Production Level Below Which Further Attempts at Breeding is Not Economically Justified (Dutch dairy conditions, Dijkhuizen et al, 1985).

	Calving interval				
	365	405	445	485	525
Lactation number	Days open at decision				
	85	125	165	205	245
1	86%	88%	90%	92%	95%
2	86%	88%	90%	93%	95%
3	88%	90%	92%	95%	98%
4	91%	93%	95%	98%	101%
5	92%	94%	97%	99%	102%
7	97%	99%	103%	105%	109%
10	111%	113%	117%	120%	124%

provides an idea of the impact of productive and reproductive performance on optimal culling strategy. As one would expect, one should spend less time attempting to breed low producing cows than high producers. Similarly, older cows should be higher producers in order to be retained in the herd. It is not clear that the Dutch numbers can be transferred to the United States and it is quite likely that the cut points vary between herds, but one at least has a sense for the order of magnitude of the problem. Based on this model, it would appear conservatively to make no sense to breed a cow to remain in the herd that makes less than 80 percent of the average herd production. Breeding such a cow for dairy sales in a high producing herd is an entirely different question.

Another paper modeling the interaction of culling policy and reproduction found that the optimal policy for breeding varied between two options (11). At relatively good estrus detection and poor conception rates, the best policy was to breed all cows up to 250 days open for any cow, regardless of production. At better conception rates, cows below 80 percent of the herd's mature equivalent production were not bred, those from 80 to 90 percent were bred up to day 165, and those above 90 percent were bred up to day 250. These should not be viewed as absolute recommendations; they illustrate the results of such modeling and provide a sense of scale for the economics of culling. These models do suggest that the cost of culling may be substantial enough that longer attempts to breed cows may be justifiable than is commonly practiced by dairymen.

Economic models for culling are likely to become more readily available in the near future. It will be important to understand their underlying structure, assumptions, and limitations. Their ultimate value will be determined by the results of their application under field conditions. The value of the models will improve as we become more able to predict the behavior of the dairy's biological and economic systems. "Model calculations may be used to quantify the significance of gaps in veterinary and zootechnical knowledge, while knowledge obtained from this technical research increases the reality of economic models. This interaction contributes to a fundamental approach to the whole issue of disease and disease controls at the farm level." (10)

An Alternative View of Culling Dairy Cows

The traditional approach to categorizing culls into voluntary and involuntary groups has been effective in focusing the dairyman's attention on proximate reasons for culling in a herd. Sub-classifying involuntary culls by general class of causes can be quite useful in revealing problem areas in a herd when actual events are compared to goals or industry averages. The categories are inadequate, however, when prospectively attempting to determine which cows should be culled from a herd. The "voluntary/involuntary" paradigm for classifying cows is essentially reactive; it explains past events but provides only limited guidance about future policy and managerial decision making. What is needed is a paradigm that can be applied proactively on a dairy to select the individuals that are to be culled. This is an extremely complex issue that is dependent on the farm's present and planned status, on industry conditions, and market conditions. In most circumstances culling policy decisions will continue to be made mostly subjectively on most dairies. It is very likely that computer models will soon become available to provide economic evaluations that will make the analytic process more objective.

I would propose that there are three categories of culls:

1. *Emotional culls:* These are animals culled for essentially emotional reasons, such as culls because the dairyman dislikes white cows or culling heifers for excitable temperament. On most dairies these are rare.

2. *Forced culls:* These are cases where the dairyman truly has no reasonable choice but to cull an animal, such as cows with broken femurs or lymphosarcoma of the uterus, brucella positive cows, and on-dairy deaths. Ignoring the category of death, these too are rare events on most dairies.
ents on most dairies

3. *Economic disposal:* This includes essentially all culling of live animals on dairy. As Dijkhuizen, et. al. said in a paper on the economic aspects of culling: "The disposal of cows due to disease is considered to be forced replacement, but in most of these cases the decision is also an economic one: the cow concerned is not culled because she is no longer able to produce, but because a replacement cow is expected to yield more." (10) The economic analysis is generally done on a very subjective or even unconscious basis, but it is still economic.

The first calf heifer sold for dairy purposes is usually sold with the expectation that her sale will net more profit than would be the case if she were retained as a productive animal in the herd. The low producer is culled to make space for a more profitable animal. The reproductive cull is shipped on the assumption that continued attempts to achieve a pregnancy and the extended time in late lactation or dry period increase costs to the point that it is cheaper to replace her. A high somatic cell count cow is culled to avoid the direct losses from her mastitis and to remove her as a source of infection for the rest of the herd. The thin cow with bad feet is judged to be an economic drain on the herd and is culled.

Each of these is an economic decision. In a rational world with perfect information, one would compare the present value of the future profitability of each candidate for culling against that figure for either a replacement animal or for simply not having the any cow. If the present value of a cow's profit were less than that of her potential replacement, the cow would be culled. Economic models will shift this process from subjectivity toward objectivity. One system for rational culling decision making might be:

1. Determine desired herd size. If less than current herd size, then the difference is one portion of the extra replacements needed.

2. From the ideal herd size, subtract the projected number of emotional and forced sales over some future period. This plus any extra animals needed from step 1 is the number of

replacement animals absolutely needed.

3. Determine the net present value of the future profits of potential replacement animals available to the herd.

4. For each cow in the herd, determine the net present value of each cow's future profits. This and step 3 above are admittedly the hardest to do, but one can subjectively approach this on most dairies by asking whether a replacement heifer due to calve will be more profitable in the long run than the cow in question. At the very least, milk production, reproduction and mastitis status should be considered.

5. Designate all cows for culling that do not have profit futures at least as great as a replacement heifer (or purchaseable replacement animal).

6. Excess heifer inventory beyond that needed to replace cows designated in steps 2 and 5 can be sold, or alternatively heifers born to poor producing dams can simply not be raised.

While not easily implemented, perhaps the above paradigm for thinking about culls and for planning culling strategy can shift the way dairymen and veterinarians think about culling cows. While awaiting the perfect economic model, dairymen and their veterinarians can begin the process of shifting their point of view of culling from reaction to forward economic planning. The first step is to view essentially all culling as an economic decision.

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