Cow Flow Through the Dairy: Culling Decisions

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Introduction

Dairy cow culling decisions have an important influence on the financial success of the dairy. Culling decisions can function as a component of genetic improvement and selection programs designed for long term gain and improved production efficiency. At the same time, culling may also represent failure or limited success of production medicine programs due to cows leaving the herd prematurely because of disease or health-related problems.

Culling decisions are important from several different perspectives. Costs for replacement heifers may represent up to 20% of the dairy budget.[13] Negative cash flows occur when a cow is sold as non-fed beef and a heifer is added to the lactating herd as a replacement. Cows retained in the herd represent capital investments, which are subject to various forms of risk that may alter the earnings from those investments. Perhaps wrong decisions are being made regarding which cows to keep, and choosing different cows for culling might increase profits. The perceived importance of culling decisions is also demonstrated by the observation that owners of particularly large herds, who otherwise are not involved in making individual cow management decisions, often directly participate in the routine decision-making process for selecting cows to cull.

Annual culling rates for dairy herds in the US range from less than 25% to more than 35%, with 30% being average.[2] Cows have different risks of being culled depending on their age.[1,13] Although there is a tendency for increased culling rates with advancing age, management constraints and biases can modify this relationship. The typical cow remains in the milking herd less than 4 years[13] even though peak milk production related to maturity ordinarily does not decline until 8 or 9 years of age for most cows.[31] The reluctance of some producers to cull first calf heifers and choosing instead to give them a second chance is an example of management bias affecting culling policy.

How Are Culling Decisions Made?

Significant advances in dairy herd management have been made in recent years through development of computerized record systems for cow health and production. These record systems have improved the quality and quantity of data available for making many different dairy cow management decisions. For most producers, however, minimal change has occurred in the way these data are presently analyzed to determine which cows are to be culled from the herd.[24]

Many producers start with a list of cows producing less than some specified daily milk production level based on the most recent test day information. This production level may or may not be related to a calculated minimum value for "break-even" daily milk production for that dairy. Usually the stage of lactation, reproductive status, and age of the cow is examined next. Low producing cows that are pregnant and approaching a stage of gestation that would provide a reasonably normal length of the dry period are often retained in the herd. Further consideration is typically given to some measure of genetic worth or contribution to herd value, such as pedigree information, percentage of herd mature-equivalent production,[32] or ranking of the particular cow in a listing of estimated relative producing ability.[37] Additionally, individual cow attributes are often taken into account, such as existence of chronic health problems or specific conformational defects. Finally, careful thought is often given by the decision-maker to current dairy herd dynamics over both the short term and long term. This would typically include consideration of significant variations during the next several months in the number of dry cows and pregnant heifers expected to calve as well as any long-term goals for herd expansion or contraction. These herd-level factors often determine to some extent the actual number of cows to be culled at any given time. Most importantly, nearly all of this analysis occurs by an informal, *ad hoc* process that usually incorporates speculative methods by the decision-maker for reaching conclusions about which cows to cull. This process has also been described as non-programmed, depicting variable or unpredictable results being obtained at different times under similar conditions.[8]

After culling decisions are made, the records of culled cows and reasons for culling, such as DHI termination codes,[41] can be analyzed. This information is useful for monitoring herd health and performance of the dairy, but it provides little guidance for making better culling decisions about individual cows in the future. Herd owners, managers, and consultants must make a paradigm shift, if they have not already done so, from viewing culling management as retrospective analysis of reasons why cows were culled to consideration of essentially all culling as economic decisions.[13]

Financial Aspects of Culling Decisions

The concern for profit must serve as a foundation for culling decisions. Profit is defined as the difference between total revenues and total costs. Every dairy must be profitable if it is to survive long-term as a business. In addition to maximizing profits, however, other components of financial performance must also be taken into account when making dairy cow culling decisions.

Cash flow determines to a large extent the feasibility of the business venture, particularly in the short term, and the ability to service debt.[24] Cash flow considerations figure into culling decisions as the prudent manager contemplates the difference in market values between the prospective cull cow as a non-fed beef animal and the potential replacement heifer. A decision to make an investment today to achieve expected future increases in profit has reduced importance if the dairy cannot afford the anticipated short-term negative cash flows required to obtain that future profit.

The producer's attitude toward risk is another important factor that affects culling decisions.[24] Besides increasing profits, a coexisting goal of the producer is generally to preserve the equity capital or ownership in the business. Risk aversive behavior implies that an individual will exhibit a diminishing marginal utility of wealth or that obtaining an extra dollar adds less to enjoyment as total wealth increases.[30] The risk-aversive producer may decide to forego an additional gain in profit if obtaining that profit increase requires extension of risk to an uncomfortable level. The decision-maker may have to decide between competing desires of retaining cows in the herd and more aggressive culling or replacement policies focused on increasing profits. Culling decisions influenced by these conditions of uncertainty or increased risk regarding outcome may produce results that appear to depart from profit maximizing behavior.[25] Reduction of risk may be achieved through application of portfolio theory by diversifying or strategic mixing of decision choices.[14,26] Diversification within a culling context, for example, could refer to variation in response of different cows to extrinsic factors such as weather and housing constraints. An older cow might have greater projected average returns compared to a younger cow if typical weather patterns were experienced during the planning period. However, if more severe weather conditions occurred, the younger cow might have an economic advantage related to avoidance or reduced effect of certain health problems associated with severe weather. In this example, including both older and younger cows in the culling strategy would help to reduce risk associated with variation in normal weather patterns. Inadequate consideration of risk may account for the tendency of economic models to predict more risky behavior than what is in fact observed.[25]

The fundamental principle is to recognize that a dairy cow is a business asset that is owned and operated for profit. A significant challenge is to evaluate objectively the projected cash flows related to the production traits of dairy cattle and to the lactation cycle. Information from these cash flows provides a means of evaluating the potential for profit.[24]

Culling Decision Economics

Individual dairy producers have limited opportunity for increasing the price they receive for milk. They participate mostly as price takers in a competitive market. As a result, individual dairy producers must focus on cost management and efficiency of production to improve their economic situation. These opportunities for increasing profits can be described in terms of reducing the cost for each unit of milk that is produced, increasing the units of milk production that are generating a profit, or a combination of these two approaches. Culling strategies can obviously influence these factors affecting profitability.

When considering the economics of culling dairy cows, the decision-maker must distinguish between fixed and variable costs of production. By definition, fixed costs do not change with the level of milk production. For example, interest payments on a construction loan for a new dairy facility do not change depending on how much milk might be produced during any particular month. Likewise, the cost of management will have small variation over a wide range of production and is often considered as a fixed cost during the short term. By contrast, feed costs typically vary in relationship to the amount of milk being produced, and, therefore, are considered as a variable cost. It is also important to understand that the distinction between fixed and variable costs varies depending upon the period or length of the planning horizon. In the short term (e.g., during the next month), the cost of labor might reasonably be regarded as fixed because of limited ability, for example, to expand the herd sufficiently so that additional labor would be required. However, over a longer period of time, plans could be developed and implemented that would include expansion of the herd and the occasion to hire additional personnel to meet these planned labor needs. During the immediate short term, many costs can be considered as fixed, but during a sufficiently long planning horizon spanning several years or longer, almost all costs can be considered as variable, even to the point of the producer deciding whether or not to continue in the dairy business. This distinction between fixed and variable costs is important when making culling decisions based on the comparison of the economic worth of individual cows and their potential replacements. Only the relevant variable costs apply toward the estimation of the value of any particular cow or replacement for culling decisions during the specified planning horizon. If certain costs during this time span are viewed as fixed by management, then these costs, by definition, do not change whether or not a particular cow is culled, kept, or replaced in the herd.

From a conceptual viewpoint, any cow in the herd which is likely to enhance the economic status of the dairy through her contribution over the relevant time period, either through increasing profits or minimizing losses, should potentially be kept in the herd and not culled. This view assumes that any cow being kept in the herd will produce income exceeding, at least, the variable costs of production over the relevant future planning period. Final analysis that evaluates the competition for space on the dairy by other cows and potential replacements ultimately determines whether or not a cow meeting this general criterion of providing positive cash flow over variable costs should actually be kept or culled. It is very important for the decision-maker to determine whether or not the herd size is presently maximized or if the facilities will allow additional cows to be added before the facilities are at full capacity. Because dairy facility costs are often considered as a fixed cost for culling decisions, there is an advantage to operating the facilities at full capacity to dilute out these and any other fixed costs over each unit of milk that is produced. However, the manager has to be careful in determining what full capacity is for the existing facility and management capability. Anecdotal evidence, particularly from dairy support programs sponsored by USDA during the 1980's that provided for voluntary reduction in total farm milk production over a specified time period, suggests that overcrowding a facility with marginal cows can diminish total production and intensify management deficiencies compared to a smaller herd of more efficient cows.

The implication that facility utilization has for culling decisions is related to the changes in the opportunity cost for postponed replacement.[24] When facilities are under-utilized, a decision to keep a cow in the herd does not preclude or cause the producer to forego the opportunity of increasing profits by adding additional heifers or cows until full capacity is reached. Otherwise, the theory related to a dairy at full capacity implies that a replacement animal can only be added if a decision is made to cull an existing animal from the herd. This decision would be made if evidence indicated that, over the long term, adding the replacement would be more profitable than keeping the cow. Under the assumption of a fixed or maximum herd size, the producer must forego the potential profits from keeping the current cow being evaluated in order to gain hopefully greater profits by culling the cow and substituting the replacement. Whenever circumstances on the dairy allow heifers to be added without requiring existing cows to be culled, whether this situation is due to planned, long-term expansion or short-term fluctuations in cattle numbers, then opportunity costs for postponed replacement do not exist. When expansion in herd size is planned or allowed, the manager should consider keeping any cow (or heifer) as long as projected average revenues exceed average relevant variable costs for that cow because the opportunity costs for postponed replacement become insignificant. For situations in which the herd size is static (i.e., at a maximum or optimum level), then a policy of immediate replacement of the culled cow with the competing heifer is followed due to the associated opportunity costs of postponed replacement. In this situation, the manager should ideally identify the cows and heifers for retention in the herd which are likely to be the most profitable in the future during the appropriate planning horizon, and cull the remaining animals to maintain the herd size at the fixed or optimum level.

Decision Support for Dairy Cow Culling

To gain economic efficiency, better analytical tools are needed for objective decision making of cows to be culled. Research efforts utilizing sophisticated mathematical and computer programming techniques for analyzing the dairy cow replacement problem have been reported since the early 1960's.[20] However, reports of the results of these types of decision aids under field conditions have been limited.[9] Significant challenges exist to obtain the needed data for making accurate projections about individual dairy cow future performance and for developing robust models utilizing this data to provide culling decision support. The most sophisticated model design for improved decision making cannot compensate for inadequate or faulty components representing the biological aspects of cow performance and milk production. With the recent gains in affordable computer capacity needed to solve these complex problems, the development of culling decision support systems for managing herds at the individual cow level is feasible.

Predicting Cow Performance for Culling Decision Support

The future performance of individual cows is the focus for deciding which cows to keep or cull. The only value that past cow performance or herd history has for making culling decisions is to provide guidance about expectations of future performance of cows in the herd. The concern when making culling decisions is about future net returns. Present culling decisions will not alter performance or returns of cows from prior time periods.

After culling for low milk production, which is traditionally considered as voluntary removal from the herd, culling for reproductive failure and mastitis are the most frequent reasons for involuntary culling.[33] Therefore, considering the biological areas related to cow performance, milk production, reproduction, and mastitis appear to offer the greatest economic potential for analysis and incorporation into a culling decision support system. Appropriate emphasis also needs to be placed on including important seasonal factors affecting production and reproduction. Evaluation of these factors affecting dairy cow performance must occur over a sufficiently long planning horizon so that both older and younger cows can be fairly evaluated. Most culling decision support systems have reported planning horizons ranging from 10 to 20 years.[9,17,34,38-40] Relevant cash flows occurring during this time span must be discounted using an appropriate discount (interest) rate to adjust for the time-value of money. Using the technique of discounted cash flows is necessary to provide equitable comparisons between values of current and future production of different dairy cows that are being evaluated.

Milk Production

Improved culling decisions rely heavily upon accurate predictions of individual cow milk production in current and future lactations.[22,42] The sale of milk accounts for more than 90% of the total dairy income for dairies in various regions of the United States, emphasizing the important contribution milk production makes toward determining the economic value of a cow to the producer.[16]

Various methods for predicting milk production for current and future lactations have been used in culling models. In an earlier study, improved information for predicting cow performance had more effect on the payoff from culling decisions than more accurate prediction of milk prices.[7] Any improvements in accuracy of prediction of future milk production for individual cows should have a significant impact on evaluation of the cow for culling decisions. Recent research has proposed using specific statistical methods that make better use of herd-level information for improving accuracy of milk yield estimates of individual cows in those herds.[21]

Reproduction

Compared with most other kinds of disease or illness, reproductive inefficiency deserves special attention because of its prevalence and distinct role in determining lactation length for cows that are not culled because of other health problems or low production. Adjustment for reproductive status provides the opportunity to improve prediction of net cow returns during future periods.[33] Survival analysis techniques, which consider information from cows that successfully conceive as well as those that are bred but leave the herd before being diagnosed pregnant, may be used to model reproductive performance of dairy cows. These techniques have the advantage of providing results in the form of time-specific probabilities of conception that can be readily adopted for use in economic and decision analyses.[23] More importantly, when reproductive efficiency is measured by parameters based on conception as an outcome, performance may be overestimated if information is excluded from analysis for cows that otherwise would be eligible for breeding and were culled or left the herd prior to conception (Table 1).[12,23,36] Table 1 shows thataverage days open based only on data from cows with a confirmed pregnancy diagnosis had values that were more than one month less compared to calcula-

Table 1. Comparison of mean days open between Kaplan-Meier product limit survival analysis and arithmetic techniques based on analysis of >18,000 lactation records from 10 California dairy herds. Survival analysis included data from cows that left the herd prior to a confirmed pregnancy diagnosis. The arithmetic method was limited to only those cows that had a confirmed pregnancy diagnosis needed to establish a conception date. The arithmetic mean produced a biased value that overestimated reproductive performance by excluding data from culled, non-pregnant cows.

	Days Open				
	Product limit survival analysis		Arithmetic		Difference between
Category	Mean	SEM[1]	Mean	SEM	means
All Cows	152	1.1	116	0.5	36
1st Lactation	138	1.4	115	0.8	23
2nd Lactation	149	1.6	116	0.9	33
≥ 3rd Lactation	167	2.3	118	0.8	50

[1]SEM = Standard Error of the Mean

tions that also included data from cows leaving the herd prior to a confirmed pregnancy diagnosis. By including data from censored (culled) cows, survival analysis has been shown to produce better quality estimates of reproductive performance with less bias compared to conventional methods.[12]

Mastitis

Although reduced milk production accounts for up to 70% of the economic losses of mastitis,[5] other significant losses are related to culling and increased replacement costs in addition to treatment costs.[4,5,11,19,27] Mastitis has been associated with an increased risk of future culling.[10] In a review by Fetrow of several previous reports analyzing reasons for culling, mastitis was second only to reproduction as the largest involuntary culling category.[13]

Although culling strategies with increased emphasis on mastitis control provide reduced mastitis incidence and prevalence, these policies do not achieve maximum financial gain and do not appear to be justified economically compared with policies emphasizing production.[6,18,29] However, culling policies based on objective criteria that include increased risks and costs associated with mastitis in addition to milk production potential may be economically viable.[35] Previous research has suggested that the ability to predict recurrence of clinical mastitis and associated costs may play a key role in future dairy culling models and such methods should be incorporated into dairy farm management practices.[28] The present lack of consistent and accurate clinical mastitis records for cows in many herds, however, would likely limit general implementation of culling analysis programs requiring this type of information. As an alternative, information provided by monthly somatic cell count measurements could be used to provide guidance on increased risk of reduced productive life because of mastitis, especially with persistently elevated counts (Figure 1).[3] This increased risk of culling reduces the likelihood of a cow with elevated somatic cell counts, providing the same return or payback over time as a cow with similar production in the absence of mastitis.[15]

Application

Various cow culling criteria based on Dairy Herd Improvement (DHI) values and calculations implementing discounted cash flows associated with milk production, reproductive performance, and udder health simulated over a 10-lactation planning horizon are presented in Table 2 as an example of a comprehensive cow culling analysis compared to traditional cow evaluations.[24] Annuity values derived from the culling decision support system ranged from $390 to $538 for income over feed and cow costs although relative values were equal to 100% of herd average mature equivalent on a fat-corrected milk basis. This culling decision support system analysis provided a range in values of 38% comparing the top ranking cow to the lowest valued cow. These results emphasize the potential economic differ-

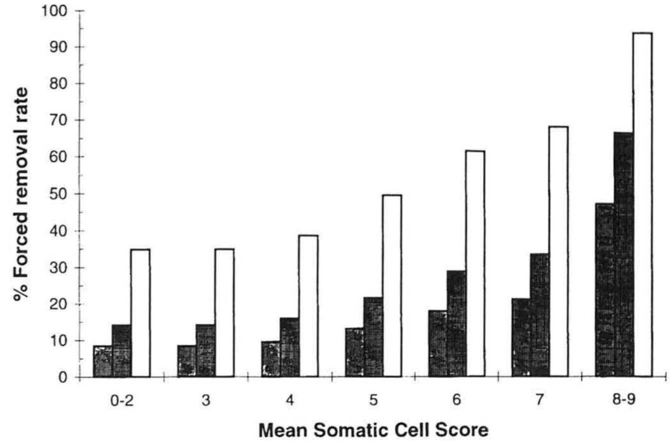

Figure 1. Comparison of projected forced removal rates by mean somatic cell score for third lactation cows with different levels of milk production. Milk production level was categorized as high (▨), medium (⊞), or low (□). Lactation records with mature equivalent basis (ME305) production < 9,500 kg were classified as low; those > 11,000 kg were considered high with records between these two points classified as medium.

Table 2. Lactation, reproductive, udder health, and economic information for culling evaluation of selected cows and potential replacements. All lactating cows in this comparison had equivalent relative values (100%) for milk production. The culling DSS (decision support system) analyzed seasonal effects, reproductive performance, and udder health in addition to differences in milk production ability.

Chain number	Lactation	LTD[1] milk	DIM	DCC	Mean SCS	Extended 305-d FCM	Relative value[2]	Culling DSS annuity value[3]
	(no.)					(kg)	(%)	($)
3187	1	55	326	134	1.6	8,941	100	538
Replacement	1	NA[4]	NA	NA	NA	8,618	NA	515
1278	2	82	73	0	0.3	9,886	100	510
3236	1	71	171	102	1.7	8,920	100	508
702	6	118	52	0	0.9	10,801	100	476
Replacement	1	NA	NA	NA	NA	8,165	NA	471
3044	4	69	147	0	5.6	11,215	100	460
625	5	18	362	185	1.3	11,187	100	453
38	3	90	50	0	2.2	10,149	100	447
1406	1	49	361	0	1.0	8,841	100	390

1 LTD = Last test day, DIM = days in milk, DCC = days carrying calf, SCS = somatic cell score, and DSS = decision support system.
2 Percentage of herd average mature equivalent fat-corrected milk.
3 Annuity values derived from simulation over a 10-lactation planning horizon based on discounted income over feed costs and cow costs associated with risks for death and severe diseases, reproductive failure, and chronic mastitis.
4 NA = Not applicable.

ence in cow values that can occur even though criterion such as relative value may be equivalent. These differences are due to evaluation of additional factors besides milk production such as seasonal reproductive performance or pregnancy status, which affect the potential economic merit of the cow being considered. The two cows with the greatest difference in annuity values (#3187 and #1406) demonstrate the impact that reproductive performance has on cow value even though these two cows are both first-lactation animals and have similar calving dates and lactation performance. The first cow has been milking nearly 11 months and is approximately 41/2 months pregnant. The last cow has nearly a 12-month lactation record and has not yet been diagnosed pregnant. The difference in annuity values for these two cows was $148. Evaluations of these various factors are complex, requiring computer analysis, and cannot be reliably accomplished based on subjective evaluation by the decision-maker.

Summary

Traditional methods of analyzing culling decisions are often inadequate in providing guidance for future culling decisions. To improve financial performance of the dairy, all culling should consider the economic impacts of the decision. The decision-maker must be aware of the significant change in opportunity costs for postponed replacement whenever available facility capacity exists on the dairy. Decision support systems designed to assist culling decisions should include critical components for adequately describing biological factors related to milk production, reproduction, and mastitis. Estimates of these parameters must be incorporated into an appropriate economic framework with a suitable planning horizon for comparison of expected cash flows generated by cows presently in the herd. This information should assist the manager in making economical culling decisions. **More research and development are needed to make these systems more widely available to producers, managers, and veterinarians. The ultimate value of any culling decision support system for developing economic culling strategies will be determined by its results under field conditions.**[13]

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Abstract

Diagnostic reliability of clinical signs in cows with suspected bovine spongiform encephalopathy

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The clinical findings in 50 cows with suspected and subsequently confirmed bovine spongiform encephalopathy (BSE) (group A) were compared with the clinical signs in 22 cows with suspected BSE, but with no histological evidence of the disease (group B). The chi-square test for association was used to compare the frequencies with which diagnostic signs or combinations of signs, were positive in the cows of groups A and B. When the frequency of a sign differed significantly, its sensitivity, specificity, efficiency and positive and negative predictive values were calculated. With respect to changes in behaviour the cows in group A more frequently showed increased excitability, nervous ear and eye movements, increased salivation and increased licking of the muzzle than the cows of group B. With respect to changes in sensitivity the cows in group A were more frequently hypersensitive to touch, noise and light than the cows of group B. With respect to changes in locomotion the cows in group A were more frequently ataxic than the cows in group B.

Exploratory study on the economic value of a closed farming system on Dutch dairy farms

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A closed farming system may prevent the introduction of infectious diseases on to dairy farms and could be a good starting point for the eradication of these diseases. In order to introduce a closed farming system, farmers need to be made aware of how these are introduced into the herd. Farmers will be more likely to implement a closed farming system when the economic value is quantified and attractive. An exploratory study was carried out to investigate the technical and economic results of closed dairy farms. Farms that purchased cattle and/or shared pasture (defined as 'open' farms) differed in technical results from farms that did not ('closed' farms). The results of the discriminant analysis showed that the 'closed' farms incurred lower costs for veterinary services, had a lower average age at first calving and a higher birth rate per 100 dairy cows. A linear regression analysis was carried out to investigate the influence of the farming system on economic performance. Being 'closed' was found to increase the net profit by £0.31 per 100 kg of milk, or approximately £25 per cow per year or 5 per cent of the typical net return to labour and management (£1 = Dfl 2.80 in November 1996).