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TIMING OF THE CULLING EVENT

Roger Cady, PhD; Monsanto
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The traditional approach to culling treats the occurrence of the cull event as something that should be minimized. The terms “voluntary” and “involuntary” have been essentially used to describe culling that occurs by choice, usually for low production, and culling that was unavoidable, typically because of disease, injury or death, respectively. By minimizing the number of involuntary (bad) culls, there is an opportunity to gain control by having a higher proportion of voluntary (good) culls. The historical approach to culling has been to measure the incidence of culling events, classify them into one of these two categories, and focus on reducing culling overall, primarily through reduction of the involuntary culls. This approach is insufficient to adequately describe the culling event because it oversimplifies the economics of culling by ignoring the timing of the cull event.

The fact is, all cows are eventually culled. Thus, it is not a question of “if” a cow will be culled, but rather when she will be culled. Culling is primarily an economic risk management practice, moderated by existing economic conditions, both internal and external to the dairy operation, and further moderated by the risk tolerance of the dairy management team. The only exceptions to this would be loss due to death, theft, or cows that are simply too difficult to manage (eg. kickers).
There are three pieces of information necessary to successfully manage culling: 1) how often does the event occur (rate), 2) when does the event occur (timing), and 3) why the event occurred at that time. The cow’s life is a time continuum from birth to death, divided into a growth and maturation process followed by a series of several lactation events. Consequently, the risk of cull is more than a simple function of increasing risk with increasing with age (lactation number) because the initiation of each new lactation increases the risk of cull every time it occurs. Getting the cow pregnant again reduces her likelihood of being culled. Thus an understanding of the changing risk of the cull event and factors influencing the timing of the final cull event are essential to profitably managing the culling process.

Factors influencing the timing of culling are both external and internal, and controllable and uncontrollable. An example of an uncontrollable risk is the increased risk of culling associated with age. An example of an external and uncontrollable factor is beef price. Many factors however, are controllable thus making culling manageable.

**Primary Factors Influencing the Timing of the Cull Event**

- Age
- Initiation of lactation
- Economic environment
  - Expansion plans
  - Milk price
  - Beef price
  - Replacement availability (price or within herd repro performance)
  - Herd debt level
- Replacement quality (within herd replacement performance or biosecurity of purchases)
- Reproductive status relative to DIM
- Disease incidence
- Risk tolerance level of the management team
- Production level (cow and herd)
- Seasonality (both calving and culling event)

Culling management is much more complex than simply reducing the herd turnover rate. There is an optimum time to cull a cow based on her productive, reproductive and health status and probability for future economic success. Culling too early limits profitability through the loss of the ability to recover costs of investment. Culling too late limits profitability because of lost opportunity to gain higher profits with a more profitable cow. Opportunity exists to better manage the timing of cull events.

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**FREE STALL BARN DESIGN AND ITS INFLUENCE ON THE DAILY TIME BUDGETS OF DAIRY COWS**

**Nigel B. Cook MRCVS.**

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With only 24 hours in a day, there is only a finite amount of time for cows to perform essential activities such as resting, feeding, drinking, socializing and milking. Until recently, the importance of standing activity in the stall, and elsewhere, has been poorly documented and misunderstood, due to a failure to understand the complex interaction between lameness and stall surface type.

We have studied daily activity time budgets of 120 high producing dairy cows in 12 free stall housed dairy herds filmed for a single 24 h period. Times spent performing resting, standing, feeding and milking activities were output variables in a mixed model with a variety of herd and cow level fixed effects, and farm as a random effect. Effects of locomotion score for each individual animal were apparent for lying time, time spent standing in the stall and time spent standing in the alley. Whether the stall base was a mattress or sand had a significant effect on time spent standing in the stall. It would appear that lame cows on mattress surfaces struggle to rise and lie down, and stand for prolonged periods in the stall between lying bouts. Lame cows on sand surfaces do not show this modification in behavior.
An expansion of time spent performing one activity leads to a reduction of time spent performing other activities. Moderately lame cows in mattress herds spend more than 6h/d standing in the stall, leading to less time spent in the alley, less time feeding, and a 2h/d reduction in lying time (Fig 1). Time spent standing when the cow would rather be resting may influence the duration of the lame event, leading to increased hoof damage and a failure to cure. This may be reflected in higher turnover rates documented in mattress herds compared to those using sand stall surfaces.

**Figure 1.** Daily time budgets for 120 cows, including time lying down in the stall (TDIS), time standing up in the stall (TUIS), time up in the alley (TUIA), time up feeding (TUF) and time up milking (TUM) for cows with locomotion score 1 (non-lame), locomotion score 2 (slightly lame) and locomotion score 3 (moderately lame), in both sand (SAND) and mattress (MAT) free stall barns.

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**The Importance of Cow Health on Culling Rates in Dairy Herds**

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There are numerous studies that have documented the influence of individual cow diseases on the subsequent risk of culling. Many of these are metabolic diseases or diseases that occur with more frequency in early lactation. The major periparturient diseases of concern with respect to culling are: milk fever, retained placenta, metritis, milk fever, mastitis, ketosis, and abomasal displacement. In addition, consideration could be given to lameness. However, this condition might occur with similar frequency throughout lactation. In general, all of these diseases tend to increase the risk of culling in early lactation. Mastitis appears to be a risk factor for culling throughout lactation. Metritis has been found to be important as a risk factor for culling in early lactation in some studies but not in others. This discrepancy could be related to the lack of a standard case definition. Retained placenta and ketosis may be risk factors for culling later in lactation. Although it is well known that these periparturient diseases have a complex interrelationship, few studies have investigated the combined impact of these diseases on culling. In addition, there is little information on the association of metabolic parameters as predictors for culling.

Two datasets (1995, 1999) each involving approximately 1000 cows, were evaluated retrospectively. Both studies contained data on metabolic parameters for the first week postcalving and disease and culling data for early lactation. The 1999 study contained precalving serum biochemistry data. In the 1995 analysis there was an association between milk fever, mastitis, displaced abomasum and metritis on the risk of culling by 95 days. In the 1999 study milk fever, mastitis, lameness, and displaced abomasum were associated with early lactation culling risk. Rates of mortality and culling in both studies increased linearly with increasing numbers of diseases. Precalving serum NEFA $\geq 0.4$ in the last week precalving was associated with 2.0 X increased risk of
culling in the 1999 study. Both studies identified a cutpoint of 1.8 mmol/L of serum calcium in the first week postcalving being associated with a 3X increased risk of culling after all of the clinical milk fever cows were deleted. Finally, beta-hydroxybutyrate ≥ 1400 umol/L was associated with two-fold increased risk of early lactation culling in both studies. This suggests that high precalving NEFA and both subclinical hypocalcemia and subclinical ketosis are important predictors for the subsequent risk of early lactation culling.

This information reinforces the concept that dry cow management is important for reducing health related culling risk. In addition, it suggests that the risk of cow culling can be predicted with serum indicators around the time of calving. Monitoring and intervention strategies using this information may be helpful in reducing early lactation culling risk.

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A Prospective View of Replacing Dairy Cows
Steve Eicker
Valley Agricultural Software

The traditional approach to culling has been to examine historical data to decide if a dairy farm has management deficiencies. For many years, dairy farmers have been encouraged to record a reason why a cow left the dairy. Unfortunately, both those efforts have been misguided. Culling reasons are usually incorrect, but more importantly, there are now much better tools that provide more specific management diagnosis in a far more timely manner. Culling rates are even more suspect, as the decision to replace a cow should be made on economic reasons alone. There is no optimal culling rate; rather there is merely the correct decision on each individual cow.

The recording and analysis of culling reasons has no place on a well-run, modern dairy farm. A more prospective approach requires different tools.

First, a dairy should use decision aids that more rapidly and more specifically identify management problems on a dairy, be they reproductive, transition cow, mastitis, lameness, or other economic issues. Clearly, replacing broken cows without fixing the underlying problem is an error. The careful monitoring of disease incidence and pregnancy rate will alert a dairy to a problem far sooner than waiting for cows to actually leave the facility.

Second, decision aids can now estimate the net present value of each cow, so that the decision of whether and when she should be replaced is optimized. Once a cow has lost enough future value that replacing her with a more productive animal is warranted, she needs to be replaced. In most cases, this replacement should occur regardless of whether the replacement comes from the farm or as a purchased animal. In short, culling is a wise decision when the incremental income from additional milk from a higher producing animal exceeds the costs of replacement.

In summary, the attendees of this conference should:

1. Increase their attention to management problems that lead to diseases on dairies. Prompt detection, proper treatment, and cost-effective prevention are all needed.
2. Discourage the recording of "culling reasons", lest someone later spend time examining those reasons instead of using more pro-active monitors of cow health and dairy management.
3. Encourage the adoption of prospective tools that help dairies to more appropriately replace cows once they have reached the point where the future profitability is less than her replacement.

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Overview of Transition Cow Issues  
Jesse Goff, NADC-USDA, Ames, IA

At least for the present, efficient milk production continues to require the dairy cow to experience gestation and parturition each yr. The transition from pregnant, non-lactating to non-pregnant, lactating is too often a disastrous experience for the cow, accounting for the relatively high number of cows culled from dairies before they have finished the first 30 days of lactation. Most of the metabolic diseases of dairy cows that might eventually lead to their being culled - milk fever, ketosis, retained placenta, and displacement of the abomasum - occur within the first 2 wk of lactation. The etiology of many of those metabolic diseases that are not clinically apparent during the first 2 wk of lactation, such as laminitis, can be traced back to insults that occurred in early lactation. In addition to metabolic disease, the overwhelming majority of infectious diseases, especially mastitis, but also diseases such as Johne's disease and Salmonellosis, become clinically apparent during the first 2 wk of lactation. The well-being of the cow and her profitability could be greatly enhanced by understanding those factors that account for the high disease incidence in periparturient cows.

The bovine feto-placental mass and its demand for energy, protein, and minerals increases dramatically with increasing gestational age. By the end of gestation, daily development of the fetus requires about 0.82 of Mcal NeL, 117 g of protein, 10.3 g of calcium, 5.4 g of phosphorus, and 0.2 g of magnesium (NRC, 2001). However, the metabolic demands imposed on the cow by the formation of colostrum far exceed the demands of the fetus. The production of just 10 kg of colostrum the d of calving will require that 11 Mcal NeL, 140 g of protein, 23 g of calcium, 9 g of phosphorus, and 1 g magnesium be supplied from the diet or brought in to the mammary gland from body stores. The high demand for nutrients imposed on the body by the increased activity of the mammary gland cannot always be met, resulting in development of such metabolic diseases as milk fever and the ketosis-fatty liver complex.

The act of parturition and the onset of lactation impose tremendous physiologic challenges to the homeostatic mechanisms of the cow. This review will attempt to describe what is known and, maybe more importantly, what is unknown about the physiologic changes occurring in the periparturient dairy cow and their relationship to development of those diseases likely to force the cow from the herd.

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ADSA Discover Conference - Understanding Culling  
Impact of Implementing Cow Comfort on a Large Dairy  
Gordon A. Jones, Fair Oaks Dairy Farms

Applying cow comfort features to the dairy cow’s life and her environment can both increase her milk production and help in reducing her involuntary removal from the dairy herd.

By applying cow cooling to a large Midwestern dairy farm. The dairy farm was able to maintain their milk production through a hot Indiana summer and also maintain the breeding efficiency without suffering a summer drop in pregnancy rates. Fans were added to the feed lanes and over the freestall beds of an 11,400 cow dairy facility along with soakers every eight (8’) ft. on the feed lane. Milk production was 9.6 pounds of milk per cow over the uncooled cows for a period, of 90 days.

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REPRODUCTION AND ITS IMPACT ON CULLING AND SURVIVAL  
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Successful reproduction is a requirement of dairy production. Ultimately, dairy cows that fail to become pregnant again will be culled. The economics of reproductive performance depend on the occurrence and timing of pregnancy. Opportunity costs are incurred when cows fail to become pregnant by approximately 100 days in milk (DIM), and when cows that otherwise have a net present value greater than an average replacement animal are removed from the herd due to inability to achieve pregnancy. At the individual cow level, the economic loss due to failure to achieve pregnancy is generally greater than the loss due to non-optimal timing of pregnancy. However, for the whole herd, the components of economic opportunity are more variable, and both elements depend on herd-specific variables as well as prices for milk, cull cattle and replacements.

The association of reproduction with culling is complex. Simplistically, any cow that fails to become pregnant will be culled in the present lactation. Reproductive diseases are risk factors for failure to become pregnant within practical or economic limits set by producers. However, the web of associations among dystocia, retained placenta, metritis, and endometritis complicates partitioning the contribution of specific diseases to risk of culling. Additionally, the possible effects of disease on reproductive performance are confounded by many intervening variables, and the timing of a decision to stop breeding a cow does not correspond with the date of removal from the herd. Furthermore, individual-level culling decisions depend on cow age, milk production, and other health disorders, as well as herd-level economic and management considerations that vary over time. For example, high producing cows are likely to be inseminated over a longer period of time, even if they experienced peripartum health problems. There is a variety of inputs, outcomes, assumptions, covariates and statistical techniques used to model the effects of disease events on reproduction and culling, producing conflicting or piecemeal results in the published literature. However, among problems in the postpartum period, endometritis and prolonged anestrus are increasingly recognized as prevalent, and these conditions merit continued research into their causes, prevention, and treatment.

Much attention is paid to the association of various diseases with pregnancy and culling, and in many cases affected individuals have economically important reductions in the probability of pregnancy within a desirable time interval. However, focus on treatment or even prevention of individuals with problems may fail to address the reproductive performance of the 60 to 80% of cows in each lactation that do not experience disease. In many herds, the first limitation on generating an adequate number of cows pregnant by 100 to 200 DIM is insemination rate. For herds with a typical 21-day pregnancy rate of approximately 14%, it is likely that implementation of systematic programs to increase insemination rate, in particular to ensure that all cows are bred by approximately 80 DIM, will result in economic benefit to the herd. At the same typical pregnancy rate, approximately 1 cow in 5 that enters the breeding period will not be pregnant at 250 DIM, at which point breeding may be abandoned, leading to further opportunity cost or eventual removal. Broadly speaking, this more often reflects failures of management rather than fundamental infertility.

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Pen Moves and Stocking Density as Factors Affecting Risk of Culling

Ken Nordlund, DVM
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Dairy cows are social animals that establish individual rank within groups. Increasingly, the Food Animal Production Medicine group in the School of Veterinary Medicine at the University of Wisconsin is identifying social issues as risk factors in their investigations of herds with high rates of disease and culling of cows in the first months after calving. In tie-stall and stanchion herds, cows are subjected to multiple management changes without leaving a familiar space and group of herdmates. As herd size has increased, management changes are delivered with movement of the cow to a different location or pen with a new group of herdmates. In addition to the management change (ration, dry off, calving, medical treatment, etc.), the cow must familiarize herself with the space and fixtures as well as establish rank within the new group. Sometimes, these processes are further complicated if the new pen is overstocked with more cows than stalls or feeding space.
There is little research on the health and production effects of pen moves and much of it is focused upon milk production losses when mid-lactation cows are moved to new groups. However, behavioral literature exists that may be extrapolated to potentially explain some of the disease risks observed in large, modern dairy herds. Both the number of conflict interactions and the physicality of them decrease dramatically after the first 48 hours following a move. Residents of a pen tend to be dominant to the new arrivals. Cows losing weight tend to lose rank. When cows leave a group, the rank order of the remaining cows may or may not remain intact.

Clinically, pen moves appear to be highly variable in effect, partly dependent upon the schedule of activity into the pen. Pens characterized by daily entries and exits appear to be very detrimental to health of periparturient cows with extended stays. Clinical data suggests that that cows that stay 3 or more days on maternity packs with daily entries are almost 2-3 times as likely to die or be culled within 60 days of calving as herdmates that stay less than 3 days. Conversely, a case can be made that longer stays are beneficial in pens with less frequent, weekly changes in the pen population.

Increased stocking density appears to amplify the negative effects of a pen change. Increasing stocking density increases the number of conflict interactions and low rank cows are the most adversely affected in overstocked pens. Limited research data shows that overstocking before calving reduces production in the subsequent lactation.

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A HISTORICAL REVIEW OF CULLING OF DAIRY COWS FROM US DAIRY HERDS
H. Duane Norman, Animal Improvement Programs Laboratory, ARS, USDA

Dairy producers must be competitive to survive. They strive to improve milk output of the herd through animals that produce efficiently over a long life. Longer-term milk production is often regarded as a biological index of production, health, and reproduction traits; dairy cows have to stay alive, calve, and produce well to be of value. Decisions to replace cows are based mainly on economic considerations; the producer expects higher profit from replacing a cow than by keeping her in the herd. Historically, Holsteins have averaged a herdlife of 3.25 lactations.

Interpretation of longevity measures differ depending on whether the measure includes voluntary or involuntary culling. True longevity refers to ability to delay culling, whereas functional longevity refers to ability to delay involuntary disposal. No direct measure of functional longevity is available because of lack of information on why cows were removed from the herd.

About half of all culling occurs involuntarily because of health disorders, especially reproductive and udder problems. Culling because of health disorders may either be decided quickly (e.g., downer cow) or delayed (e.g., reproductive problem) because of impact on the milking routine. A limitation to improving US dairy cattle health and determining specific reasons for culling is lack of reliable health information. Other factors that affect culling rates include management style, herd expansion, replacement costs, and culling decision software.

First-lactation milk yield and longevity measures are positively related genetically, which led to the conclusion that high milk yield during first lactation should result in longer productive life. However, a decreased lifespan has been observed with substantial yield increases. Because the economic value of longevity comes from potential for lowering replacement costs and obtaining higher yield from mature cows, producers often find little reason to keep older cows in the herd longer when productive young heifers were available as replacements.

To make permanent improvement in long-term productivity, direct selection is preferable. However, direct selection for productive life can be a dilemma because culling dates for all animals would have to be recorded and information would be known for ancestors but not for the current herd. Actual herdlife of current animals...
can be interpreted as the lower bounds of the final value, which provides valuable information for genetic decisions, especially for sires.

In 1994, evaluations for productive life were initiated in the United States. A weight of 11% was given to productive life in the economic index for lifetime net merit. Other countries also provide genetic estimates of dairy longevity. The International Bull Evaluation Service plans to provide international evaluations for longevity based on national rankings of bulls from 26 countries.

Sound information must be uncovered and communicated effectively to producers so that they can minimize cow losses. An overall breeding strategy that includes but is not limited to longevity should be promoted. Norman, H. Duane, Research Leader, Animal Improvement Programs Laboratory, ARS, USDA, Beltsville, MD 20705, 301-504-8334 (voice), 301-504-8092 (fax), disnorman@aipl.ars.usda.gov

Understanding Culling: Effect of Mastitis on Culling Decisions
Michael W. Overton, DVM, MPVM and William M. Sischo, DVM, PhD

Culling of dairy cattle is a very complex and often misunderstood matter. All cattle are eventually removed from the herd either by sale, slaughter or death. Cow health status and productive level interact along with management goals and market prices to influence the replacement decision. Ideally, culling occurs when a manager determines that farm-level profitability will be improved by the removal and replacement of a less productive, diseased or non-pregnant cow with another healthy animal.

Diseases such as mastitis may increase the risk for herd removal due to either direct losses (death due to an overwhelming coliform infection, for example) or indirectly through the impact on profitability due to the loss of milk quality premiums, high treatment costs, or decreased production potential. In addition, culling is often the most practical method of eliminating chronically infected cows, or to reduce the risk of transmission of contagious pathogens in herds that currently have a low prevalence of these organisms.

A retrospective analysis of data from six large herds located in California was performed to examine the impact of mastitis on culling decisions. Approximately 12,000 lactations were utilized from cows that calved between January 1, 2003 and December 31, 2003. Cows were followed until they completed the lactation or until August of 2004. Two Cox Proportional Hazards regression models were used to examine the effect of recorded mastitis occurrence on risk of removal from the herd, adjusting for effects of herd (1-6), parity (1, 2, 3 and 4+), 305 day mature equivalent milk production (split into quartiles), and pregnancy status (yes, no). The first model examined the effect of number of mastitis cases (1, 2, 3 or 4+) as compared to no recorded mastitis. The second model was a time-dependent model and examined the effect of days-to-first recorded mastitis case (split into quartiles of 0-30, 31-90, 91-172, and >172 days in lactation) as compared to no mastitis.

The results suggest that dairymen consider many factors when deciding whether to cull a cow including milk production, pregnancy status and parity, in addition to disease status. Cows were more likely to be culled due to mastitis, but only after experiencing four or more cases. Mastitis increased the risk of culling for cows producing at or below the herd average for 305 day mature equivalent milk. Time to first mastitis case did not alter the risk of culling.

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Supply of Heifers and Herd Equilibrium: Impact of Culling on Needs for Replacements
Mike Schutz, Purdue University, W. Lafayette, IN

This presentation summarizes historical trends in cow and heifer numbers for the US, geographic regions, and key states. Annual culling rates are presented on a national and regional basis, and factors affecting heifer supply and replacement rates to maintain herd size are discussed. Culling rates and percentages of heifers relative to the cow herd has increased over time, and heifer production has followed the westward movement in the dairy industry. Though small relative to overall inventories, numbers of imported heifers tend to follow the annual milk-feed price ratio. Relationships between heifer inventory and milk cow prices may be related, but associations are not obvious. For individual farms, numbers of replacements depend on many factors, but conception rate, calving interval, and age at first calving appear to have largest effects on availability of replacements in a closed herd. Herd culling rates of over 30% may lead to deficits in replacements to maintain herd size.
Although lameness has always been an important health problem in dairy cattle, it has become an increasingly prominent disorder in today’s modern dairy operations. Despite its effects on performance and profit, it represents one of the most important animal welfare issues in the dairy industry. Because of the pain and discomfort cows must endure to walk to a feed or water trough, or the milking parlor (in loose housing systems), for moral or ethical reasons (if none other) their care should be of the highest priority in the dairy’s daily health management program. “In a nutshell” there has been a gradual change in the US dairy industry to larger herd systems, better performance and more confinement housing. While there are many benefits to confinement housing, the negative feature of these systems (relative to foot health) is the prolonged exposure of cows to concrete. Cows are, of course, land animals and not accustomed to constant standing or walking on hard flooring surfaces. Despite being less comfortable, hard floors promote claw horn overgrowth and weight bearing disturbances that in combination with laminitis predispose to claw disease. Beyond the effects of hard flooring surfaces on feet are the consequences imposed by constant exposure of feet to moisture and manure slurry in confinement housing. These predispose cows to the infectious skin disorders of the foot: digital dermatitis, interdigital dermatitis and foot rot. Consequently, changes in housing as well as feeding and management, have resulted in a gradual change in the prevalence and incidence of lameness in dairy herds throughout the US, and indeed the world. Lameness prevalence rates vary from 0% to more than 50% depending upon level of detection. Trained observers detect 2.5 to 4 times as many cows as herd owners according to published studies. Incidence of clinical lameness is often based on calculations from individual herd records which vary according to whether treatment was performed by the dairymen, veterinarian or hoof trimmer. Detection of lameness itself is complicated by the method of detection. Locomotion scoring systems according to Manson and Leaver or Sprecher et al. are methods that provide an objective assessment of gait abnormalities. The direct effects of lameness account for 15% of culling in US dairy herds. Indirect effects of lameness on milk production and reproduction are estimated to be responsible for an additional 49% of culling. Lameness reduces feed intake, milk production, estrus behavior and fertility which results in increased days open. Recent research indicates that lameness conditions in cattle have significant effects on ovarian function that predispose to cystic ovarian disease and delayed cyclic activity in postpartum dairy cows. In short, evidence is accumulating that the predominant effects of lameness on reproductive performance may be related to direct effects on ovarian function. The primary causes of lameness are associated with laminitis which predisposes to ulcers and white line disease. Add to these, the infectious skin disorders of the foot, and more recently thin soles, a major problem throughout the US believed in part to be a consequence of excessive wear from housing on abrasive flooring surfaces. Managing lameness requires an understanding of it’s pathogenesis as it relates to cow comfort, feeding and management. In addition, all herds need to establish foot care programs whereby cows are provided prompt care for lameness disorders and routine maintenance examination and trimming to prevent lameness problems or correct lesions at an early stage.

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Financial Impact of Culling on Return on Capital Investment
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The culling and replacement decisions made in a commercial dairy herd, dramatically impact the profitability, viability and sustainability of the dairy business. These decisions influence both the operational efficiency and capital efficiency of the business. Herd replacement decisions should be viewed as asset replacement decisions that will directly influence the profitability (Return on Assets (ROA) and Return on Equity (ROE) which in turn will impact the businesses ability to grow sustainably, over time. When we take a more holistic or systems approach to analyzing the key performance drivers and in
particular, the constraints to throughput (# stalls, overstocking, parlor capacity, pasture stocking rate, etc.) we should consider the dairy cow replacement decision within the context of these constraints. If our objective, for example, was to maximize the milk output per free-stall, we would keep stalls full of high producing cows during their peak of lactation performance, only. While we often manage cows in groups based on milk production, stage of lactation, reproductive status or parity, we need to consider the barn(s) capacity, for example, as a constraint while we focus on the combination of operations and capital management decisions that drive profitability. Since the dairy herd occupies this constrained number of stalls (barn capacity), and the dairy cow is the primary revenue generating asset on the dairy, we can allocate her replacement costs, which change as a function of the replacement or culling rate, to her total asset value within the business. If we then hold constant the operational costs associated with a given level of milk output per cow, we can compute the profit margin, asset turnover, ROA and ROE across a range of asset replacement (culling) rates. This approach illustrates the need to identify the relevant constraint or constraints and only then can suitable measures of business performance be obtained and thereby provide additional guidance to the replacement decision-making process. While the dairy system is complex, this proposed approach provides a framework for analyzing the impact of dairy replacement decisions on the profitability of the enterprise. The Theory of Constraints, originally developed in the 80s, by Dr. Eliyahu Goldratt, , seeks to strive towards the global objective, or goal, of a system through an understanding of the underlying cause and effect dependencies and variation of the system in question. Addressing the dairy replacement decision context as it impacts overall dairy business performance will be critical to improving our understanding and development of optimized dairy animal replacement (culling) strategies and focusing needed changes on an improved decision process.

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Impact of Increased Milking Frequency on Health and Performance in Early Lactation in Multiparous Dairy Cows

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Effects of increased milking frequency (IMF) on production parameters are poorly understood. Three hundred multiparous cows were randomly assigned to one of five treatments at parturition to investigate IMF (6X vs. 3X) and rbST during early lactation on subsequent milk yield persistency. Treatments were 6X milking for 0 (control; milked 3X) or the first 7, 14, 21 DIM (all 4 trts initiated rbST at 63 DIM), or 6X for the first 21 DIM (no bST administration throughout the entire lactation). Individual milk yields were collected daily and milk components were obtained monthly. All cows were body condition scored at parturition and every 4 wks thereafter. Blood was collected from the coccygeal vein at parturition and wkly for 5 wks thereafter using a subset of cows (n=15/trt from control and the cows assigned to the 21 d 6X trt with rbST). During the first 9 wks (prior to rbST administration) milk yield tended ($P = 0.07$) to differ between trts but effects were small (41.2, 39.8,
From wk 10 to 37 there was no difference \((P > 0.30)\) in milk yields between trts 1, 2, 3 and 4 (38.9, 38.0, 38.5, 38.3 kg/d respectively). However, cows milked 6X for 21 d receiving rbST produced more \((P < 0.01)\) milk (38.3 vs. 35.0 kg/d) compared to those milked 6X for 21 d that did not receive rbST. No differences \((P > 0.59)\) were observed for milk fat and protein content (3.63 and 2.87) or circulating plasma NEFA levels 467 \(\mu\)eq/l. Cows milked 3X or 6X for 21 d (rbST administered at 63 DIM) had higher \((P < 0.05)\) SCC than cows milked 6X for 14 or 21 d (no rbST) (523, 350, 238, 505, and 223). Data suggest that 6X milking of multiparous cows immediately post partum does not improve average, peak, or total lactation milk yield over 3X milking during the first 9 wks of lactation. rbST increased \((P < 0.05)\) milk yield in all trts. Reproduction (%pg within 65 d of the VWP, DIM at pg, and service/conception) and health (mastitis, digestive, respiratory, lameness) parameters were not affected by trts. In this study there was no production, performance, health, or economical advantage to 6X milking in early lactation compared to 3X.

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GENETICS OF LONGEVITY AND PRODUCTIVE LIFE
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Dairy cow longevity is critically important, economically speaking, but adding this trait to genetic selection programs is anything but easy. Each step, including trait definition, data collection, data validation, and statistical analysis, has several pitfalls. Challenges in trait definition are evident in the variety of names for this trait, such as "longevity", "survival", "productive life", and "herdlife". These may be prefaced by "true" or "functional", in an attempt to differentiate voluntary (good) culling and involuntary (bad) culling. What is the meaning of statements such as "the average culling rate is 38%"? One herd may have a 40% turnover rate, but 20% are sold as dairy replacements, and 20% are slaughtered due to low production. Another may have a 30% turnover rate, but 15% die in the barn, and 15% leave due to mastitis, lameness, or infertility. Economic consequences and animal welfare implications differ greatly. Collection of longevity data is unlike that of any other trait. The trait is farmer-recorded but has no measurement error (the cow is either standing in the barn, or she's not). However, the trait is highly susceptible to bias, and a cow’s risk of culling is influenced by many factors beyond her control, such as availability of replacement heifers, plans for expansion, competence of the herdsman, and milk quota restrictions. Data validation also poses challenges, many of which are limitations of the DHI milk recording system. For example, culling codes (i.e., sold for dairy, sold for beef, sold due to mastitis, sold due to infertility) lack specificity and flexibility. Furthermore, cows culled before first test in first lactation may not enter the system, and cows culled before first test in later lactations may have incorrect culling dates. Statistical analysis is hampered by a skewed, non-normal distribution of survival times and a high percentage of censored records (from cows sold for dairy or cows still alive). Time-dependent explanatory factors are also a challenge – one must account for management changes within and between lactations. Factors such as disease exposure, modernization of facilities, and milk prices change frequently, and all affect a cow’s risk of culling at a given time. Proper analyses of culling data should feature two components. First, data should be analyzed using failure-time methodology that can account for non-normality, multiplicative relationships, censored records, and time-dependent covariates. In this way, the instantaneous risk of culling for a given cow can be calculated at any specified time for any set of explanatory variables. Second, inference should be based on the ratio of culling risk for high-producing cows, versus average cows, and the ratio of culling risk for low-producing cows, versus average cows. Optimal management schemes, and optimal sires for genetic selection, should yield a low risk of involuntary culling among high-producers and a high risk of voluntary culling among low-producers. Lastly, genetic selection for the primary components of longevity, namely health and fertility, should augment (or even replace) direct selection based on culling data. Recording of health disorders and/or veterinary treatments is common on large commercial farms, and mechanisms for validating and storing such data (across herds) should be explored. Traits such as pregnancy rate, body condition score, lameness, mastitis, and ketosis...
can be measured early in life, and substantial genetic variation exists between sires in the health and fertility of their daughters.

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