Commingling Dairy Cows: Pen Moves, Stocking Density and Health

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Abstract

In modern confinement dairies, cows move between groups depending on management needs for special rations and special handling requirements. With each move, each cow must establish rank within the new group. Extended stays in pens characterized by new arrivals every day appear to present substantial health risks to some cows. Overstocked pens present challenges regarding both stall and feed bunk access. Provision of 30 inches (76 cm) of bunk space per cow in the weeks before and after calving, and minimizing pen moves, appears to be consistent with improved fresh cow health and productivity.

Résumé

Dans les fermes laitières confinées d'aujourd'hui, les vaches se déplacent entre groupes selon les besoins de régie pour des rations spéciales et quand des soins particuliers sont requis. La vache doit établir son rang dans un nouveau groupe après chaque déplacement. De longs séjours dans des enclos où de nouvelles vaches arrivent chaque jour semblent créer des problèmes de santé substantiels pour certaines vaches. Des enclos avec une trop forte densité accroissent les problèmes d'accès aux mangeoires et aux stalles. L'allocation de 30 pouces (70 cm) d'espace par vache dans les semaines précédant et suivant le vêlage et la réduction du nombre de déplacement entre enclos semblent promouvoir la santé et la productivité des vaches vêlées récemment.

A Changing Clinical Perspective of Fresh Cow Metabolic Disease

Over the past 17 years of herd investigations by our clinical service, the complex of ketosis, fatty liver and displaced abomasum has emerged as the most frequently investigated herd problem, and cow behavior and social factors have emerged as the primary risk factors in these herds. Where poorly formulated rations and inaccurate delivery systems were once the primary risk factors, we increasingly see poorly staged pen moves and overstocking as the key risk factors in our industry today. We hypothesize that the mechanism is disruption of dry matter intake for vulnerable cows, leading to ketosis or hepatic lipidosis followed by the cascade of related diseases, and resulting in high turnover rates in early-lactation cows.

The primary variant we observe in dairies today is Type II ketosis as summarized by Holtenius and Holtenius,[8] characterized by an onset of clinical disease at about five to 15 days in milk and usually triggered by negative energy balance in the pre-fresh period. In contrast, a majority of the herd ketosis problems seen 15 years ago were considered to be Type I, characterized by an onset of clinical disease at about 20 to 40 days-in-milk and associated with energy-related problems in the post-fresh groups. While both forms remain as problems, the relative importance of each has been reversed.

Over this same period of time, our clients have changed from predominantly tie-stall herds of 50-100 cows to freestall herds typically in the range of 300-3,000 cows. In the tie-stall herds, cows were familiar with their environment, remained in the same group of cows, and were subjected to management changes without leaving their stalls. The only changes they faced with a new ration were the nutrients themselves. In contrast, virtually any change in ration or management group in the larger freestall dairies requires introduction to a new pen, familiarization with new pen fixtures, stalls, and headlocks, and establishment of rank within a different group of cows. Each of these aspects can present significant challenges to low-ranking cows and if a sufficient minority of the pen succumbs to disease, a herd problem emerges.

This paper will summarize some behavioral research findings that provide useful perspectives on the clinical situation, and will present some of our evolving impressions as investigators of herd problems.

Basics of Cow Behavior Relative to Modern Dairy Systems

Our clinical experience suggests that regrouping and overstocking cows in the vulnerable weeks just before and after calving has the most adverse effects on cow health. While it is obvious that cows are social herding animals, there are several aspects of cow behavior that affect how well individual cows adapt to modern dairy systems. Behaviorists describe cows as crepuscular, meaning that they are particularly active in the twilight hours of dawn and dusk.[1] Cows are also categorized as allelomimetic, meaning that they all want to do the same thing at the same time.[1] These characteristics have consequences on stocking density regarding requirements for stalls and feeding space.

When a cow is moved into a new group in a large herd, she experiences stress and must establish her rank within the social order of the pen. Cows form dominance hierarchies, strongly associated with age, body size, and seniority in herd.[6] In general, cows resident in a pen tend to maintain their rank, compared to new arrivals.[18] While rank within a pen is relatively stable, Hook observed a complete reversal of rank in one study when the dominant cow was removed and a new cow added to a small group.[9] Konggaard and Krohn reported that early lactation cows were more affected by regrouping than mid-lactation cows.[11] Lamb cites a trial where cows were given access to different diets through Calan gates, some a high energy diet and others a low energy diet.[12] Cows losing weight also lost rank within a group, while the cows gaining weight tended to gain dominance. This may have impact on fresh cow health, as the early postpartum period is typically a period of significant weight loss for most cows.

Many of our concerns about cow behavior have emerged with the advent of grouped cows in confinement freestall barns. Miller and Wood-Gush compared the behavior of a herd of cows on a British pasture in spring to their behavior in freestall confinement in the winter.[15] Feeding, lying and agonistic behavior or conflicts were monitored throughout the day. While cows in both systems showed crepuscular behavior, almost all cows were observed feeding at the same time while on pasture, whereas a smaller proportion ate simultaneously in confinement. The allelomimetic tendency for lying behavior was more synchronized on pasture than in freestalls. Agonistic interactions occurred with about eight times the frequency in confinement compared to pasture, although all cows were familiar with each other and rank was well established.

Older work suggests that the reestablishment of rank takes perhaps a week,[18] but more recent studies indicate that stability is achieved in three to four days. Kondo and Hurnik established two new groups of 16 cows in each, and after five weeks removed eight cows from each group to form a third commingled group.[10] They monitored the number of agonistic interactions per day and characterized them as physical (bunting, pushing, fighting, etc.) or non-physical (threatening and avoidance posture and movement). The number of agonistic interactions was highest on the day of comingling and was reduced to approximately one-third within two days. On the days that the cows were mixed, approximately 80% of the agonistic interactions were physical, but two days later about 40% were physical and 60% were postural. This suggests that the groups are reasonably well stabilized within two days.

Moving Fresh Cows through the Pens of Modern Dairy Systems

Larger scale dairies have developed grouping systems of cows so that specialized management practices or rations can be implemented with simplified and minimized labor. A suggested series of pens or management groupings before and after calving (with time periods relative to calving date) might include a far-off dry cow (-60 to –21 days), close-up dry cow freestalls (-21 to –3 days), maternity pen – bedded pack (-3 to 0 days), colostrum pen – bedded pack (0 to 3 days), fresh pen freestalls (3 to 14 days), sick pen (variable), and various lactation groupings.[19] First lactation cows are typically commingled with mature cows for the first time in the far-off or close-up dry pens, but may be kept separate in some herds.

Each pen move entails some stress and requires the establishment of a rank order, but all pen moves should not be considered equal. Presumably there is some memory of rank in smaller herds. Movement from pens in close proximity to each other is likely to be easier, particularly if pen fixtures such as stalls, headlocks, water source and milking parlor are similar.

Social Turmoil Profile of a Pen

As we began to collect data on the duration of stay in pens, we found conflicting results. In some pens, long stays appeared to be very desirable, but in others, long stays appeared to be detrimental. It was not until we created the concept of a "social turmoil profile" of a pen, shown in Figure 1, that the findings made sense. The profile is constructed conceptually by superimposing two

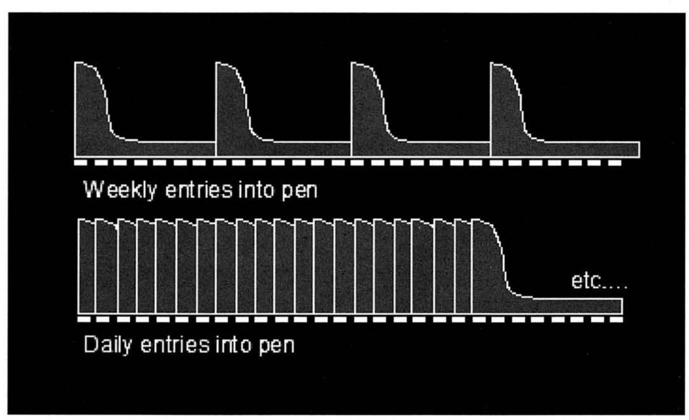

Figure 1. Graphic depicting the social turmoil profile of agonistic interactions in a pen characterized by weekly entries of new cows, compared to a pen with daily entries.

days of high rates of agonistic interactions, mostly physical, upon intervals of cow introductions into a pen. For example, close-up dry cow pens are usually characterized by weekly introductions, i.e., Tuesday, of new cows. The social turmoil profile of such a pen with weekly cow introductions on Tuesdays would be high turmoil on Tuesday and Wednesday, followed by five days of relative calm. We would speculate that short stays of a few days would be adverse, because all or most of the time in the pen would be in social turmoil, only to be followed by another move into another pen. In contrast, calving pens populated by cows expected to deliver calves in the coming three days would be characterized by daily additions and departures of cows. The social turmoil profile of a calving pen would have continuous high rates of agonistic interactions, and we would speculate that longer stays should be avoided.

Close-up Pens

Controlled prospective studies of the effect of duration of stay in close-up pens have not been found, but there is widespread clinical opinion that short stays in the close-up pen has an adverse effect on fresh cow health. A nutritional study by Robinson *et al* showed a subsequent production advantage for first lactation heifers exposed to the pre-fresh ration for five or more days, compared to shorter exposures.[17] Mature cows were not affected by days exposed to the ration. While the focus of this study was exposure to the ration, it is reasonable that the advantage of longer stays in a pen with intervals of several days to a week between cow additions would be particularly beneficial to younger, lower rank cows.

Maternity Pens

Our group has assembled data from several field investigations that suggests that extended stays in maternity pens has adverse consequences on subsequent cow health. In general, rates of culling in the first 60 days after calving; ketosis and displaced abomasum are doubled for cows that spend three or more days in the pen, compared to cows that calve within two days on the pack. There was no evidence of bias by herd managers moving problem cows into the maternity pen early. These observations are consistent with the idea that extended periods of time in pens with constant social turmoil would adversely affect fresh cow health.

There are several approaches to managing maternity pens to minimize cow stress and turmoil. One approach is to move cows at two days or less prior to actual calving, and there are dairies where records show that uncommonly skilled herdsmen are achieving this for 95% of cows. The more common practice in larger herds with round-the-clock labor is to move cows into a maternity pen only after the cow has started labor and/or the calf's feet are visible. Another approach would be to develop multiple-bedded pack areas managed as all-in, all-out groups. A group of close-up dry cows would enter as one group. As individual cows calve, a temporary movable fence would be used to separate them within the pen, allowing them to move for milking and be monitored as fresh cows. As more cows calve, the movable fence would be moved stepwise down the length of the pen. When all cows had calved and were judged ready, the entire group could be moved on to lactation pens.

Sick Pens

Sick pens are another group with daily entries of new cows and are in a state of constant social turmoil. Mastitis is usually the predominant reason that cows are in a sick pen. Sick pens have also been shown to be the most highly salmonella-contaminated spaces on dairies.[16] Because of the concentration of both mastitis pathogens and salmonella, these pens present substantial risks to cows that are introduced to these groups. Many dairies move all fresh cows through their sick pen until the colostrum has cleared. While grouping all "non-salable" milk producers may be convenient for labor, it is a high-risk practice that should be discontinued. It is preferable to keep the colostrum-producing cows separate or with other fresh cows, and separate their milk in buckets in the parlor. In the fresh cow group, metritis is typically the most common reason given for antibiotic treatment. With the advent of labeled antibiotic treatments for metritis such as Excenel RTU[a] (ceftiofur hydrochloride) that do not require milk withholding, cows with metritis can be left in the fresh cow pen, treated and not exposed to the concentration of pathogens in the sick pen nor the social turmoil of another pen move.

Stocking Density

Because of the cost of dairy housing, there has been substantial pressure to overstock pens and barns in our dairy industry.[2] While overstocking of barns is also a risk factor for lameness and respiratory disease,[4] this discussion will focus on feed intake, milk production and ketosis problems caused by overstocking.

In most discussions of stocking density, the focus is on cows per stall. As we work with our data from both field investigations and research with transition cows, we are shifting our emphasis to inches of bunk space per cow. It is our opinion that bunk space per cow is vastly more important as a risk factor for transition cow ketosis than stall stocking density, and the current focus on stall stocking density frequently misses the most important underlying factor in fresh cow disease: decreased dry matter intake.

As we consider the issues that determine crowding at a feed bunk, there appear to be three general factors. Figure 2 is a graph made from one of our video studies and illustrates the percentage of headlock spaces over the feed platform that are filled throughout the day in the high production pen of a commercial dairy. First, there is the allelomimetic tendency of cows to want to all eat at the same time. This is suggested by the three feeding peaks that occur in the day. Second, there appears to be a particular drive to eat after the delivery of fresh feed and after milking. This is illustrated where the peak number of occupied headlocks occurred after the delivery of fresh feed and the return from milking. The second and third-highest headlock fill periods occurred after the other two milkings, when the feed was not fresh. Third, the tendency to eat together is confounded by the physical width of the cows when bunk pressure is intense, a tendency to spread out while feeding, and the influence of dominant cows to clear out subordinate cows in competitive feeding situations. Note that the highest occupancy rate was approximately 80%, which translates to approximately 30 inches (76 cm) per cow. Based upon 24-hour video studies of 12 dairies, cows do not fill more than 80% of 24-inch (61 cm) headlocks except in the most unusual situations, such as manual forcing for palpation, etc. Mature Holstein cows are simply wider than the standard 24-inch headlocks of our industry. Also note that the peak feeding periods last a relatively short period of time, usually less than 90 minutes. Once the peak bunk pressure starts to subside, dominant cows can be seen forcing subordinate cows from the adjacent headlocks, repeatedly moving from space to space down the line, and sometimes taking up diagonal standing positions at the feedbunk.

Prior studies have suggested a wide range of acceptable bunk space per cow.[7] A widely referenced study by Menzi and Chase suggests that because there were few periods of full bunk use in a 24-hour period, bunk space of 14 to 16 inches (35.6 to 40.6 cm) per cow did not necessarily limit access to feed.[14] As shown in Figure 2, there are many periods of time when there is open space for cows to access the bunk. However, these conclusions reflect an assumption that cows are time-sharing animals content to eat in shifts and that dry matter intake (DMI) is not reduced in these conditions.

Field data collected by Buelow from two dry lot

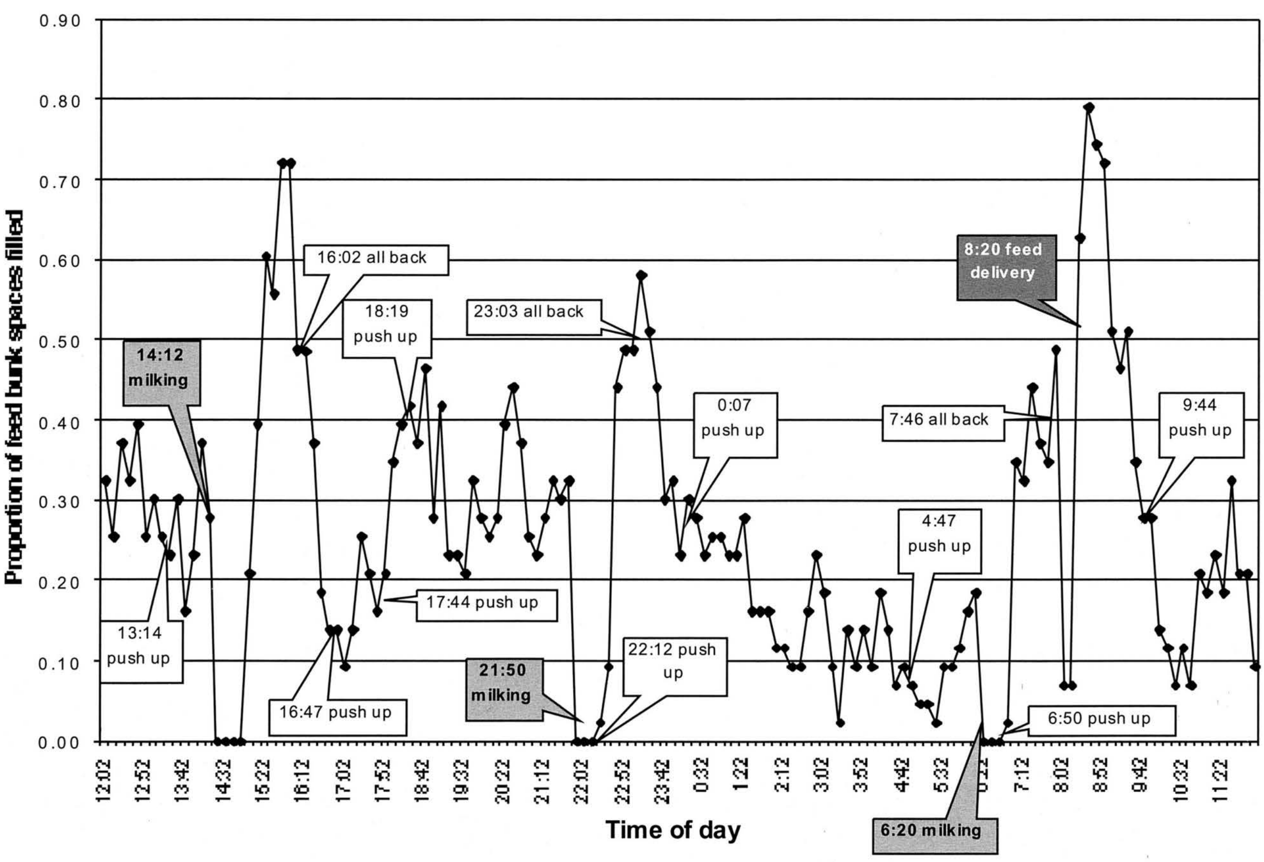

Figure 2. Graph of the % of headlocks filled through a period of 25 hours in the high-production group pen on a commercial dairy. The headlocks were spaced at 24 inches on center.

New Mexico dairies in Figure 3 supports the hypothesis that average dry matter intake is reduced when all cows cannot eat at the same time.[3] In two pens of dry cows, average daily dry matter intake was monitored by weighing feed delivery and refusals. As the number of cows per headlock increased, average dry matter intake decreased. It is likely that the maximal fill rate of wide pregnant cows would be less than 80%. As these were pens of dry cows with no activities outside of the pen, individual cows would have had many opportunities to find access to feed after the dominant cows had eaten. Two plausible explanations are that intake will be reduced if the allelomimetic behavior is suppressed or that the feed available to the secondary shifts of cows is less palatable.

Data collected by us demonstrates that overstocking of mixed first lactation and mature cows during the pre-fresh period has an adverse effect on production after calving. Over the period of several months during which a prepartum feed additive was being evaluated, the pre-fresh pen stall-stocking density ranged from 62 to 138%. Stocking densities greater than 80% of stalls in the pre-fresh group in a two-row pen adversely affected milk production of the primiparous cows through the first 83 days of the subsequent lactation. Modeling of data demonstrated that for each 10% increase in pre-fresh stocking density above 80%, there was a 1.6 lb (0.72 kg) per day decrease in milk production in the first lactation cows.

In this example, a stall-stocking density of 80% in a two-row pen yields approximately 30 inches of bunk space per cow. While individual cows were not ranked for dominance, the first lactation cows in mixed groups are generally lower in the dominance hierarchy. Even if lactation groups are separated, there will still be a subordinate group in each pen of cows, and we would expect the lowest-rank third of the pen to show reduced productivity when bunk space is limited.

In a recent study, DeVries reported on the effect of increasing feed space on feeding behavior within 90 minutes of fresh feed delivery.[5] Because individual cow intake cannot be monitored in group feeding situations, cows were fitted with devices that measure the number of downward motions to retrieve feed. Feeding "hits" were monitored when the cows were allowed 3.28 feet (1 meter) of bunk space per cow versus 1.64 feet (0.5 meters) per cow. Dominant cows tended to maintain the same feeding activity regardless of bunk space, but

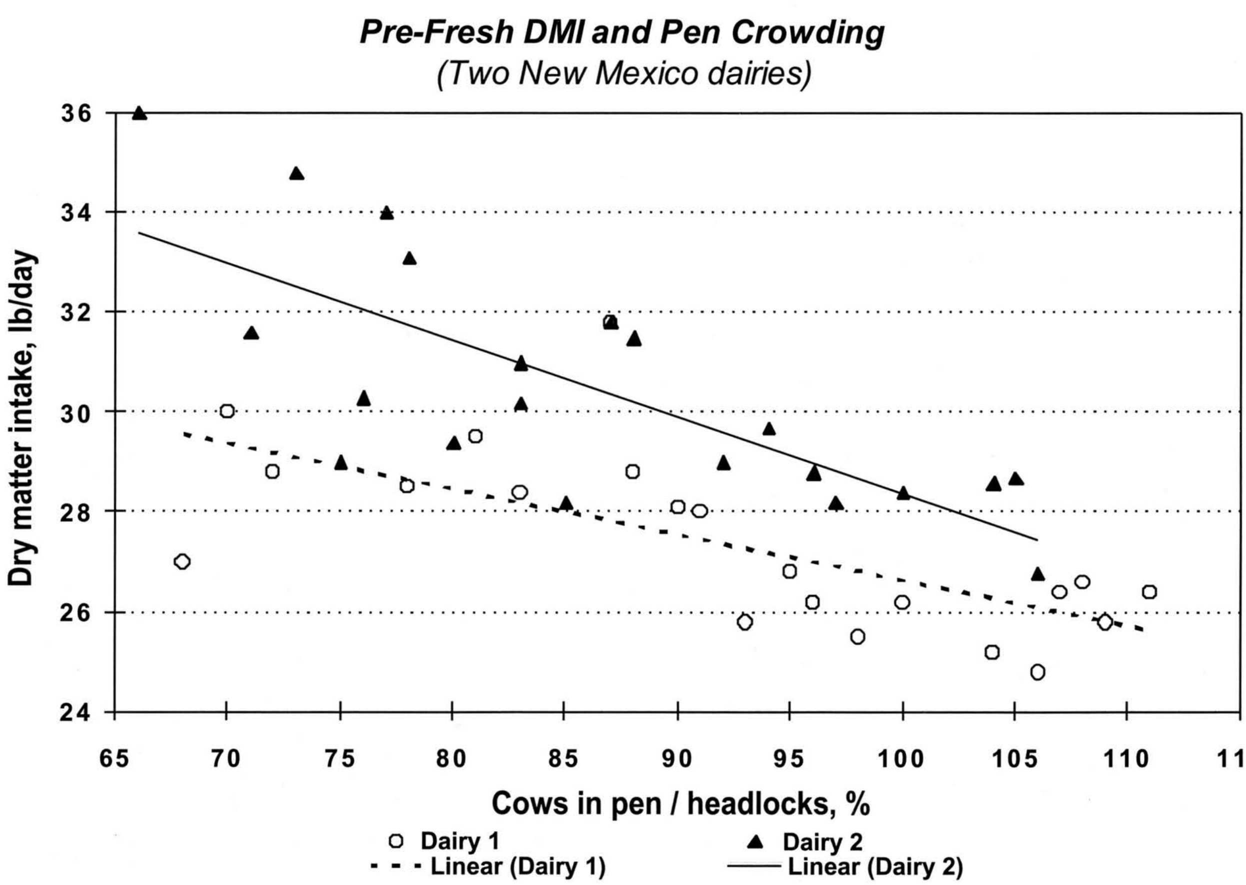

Figure 3. Group average dry matter intake of dry cows and stocking density of headlocks on 24-inch centers. Unpublished data from Kenn Buelow.

subordinate cows reduced feeding activity when bunk space was reduced.

Figure 4 is a scatter plot that presents the first-test 305-day projected milk plotted against days since freshening for individual cows in a Wisconsin dairy herd.[13] This particular dairy had acted on concerns about overstocked pens both before and after calving, and reduced both pens to an 85% stall-stocking rate. The highest first-test projections did not change, but the number of projected milk values below 20,000 lb (9,091 kg) disappeared. Clinicians who work with fresh cow production data know that 10,000 to 15,000 lb (4,545 to 6,818 kg) first test projected milk values reflect sick cows. In this example, reduction in stocking density was rewarded with tremendous reductions in fresh pen disease.

Our current recommendations to optimize fresh cow health include the provision of 30 inches of bunk space per cow in the close-up and fresh cow pens. Counting the number of stalls or headlocks does not adequately explain the available bunk space per cow. Obviously, fully stocked three-row pens of freestalls reduce the bunk space per cow substantially compared to two-row pens. However, pen stocking rate, number and width of crossover alleys and other factors make the actual bunk space per cow measurements highly variable. Perhaps the primary clinical recommendation when evaluating ketosis problem herds is to stop counting stalls and start counting cows and measuring inches of bunk space.

A Perspective on Fixed Pens, Variable Group Sizes, and Overhead Cost

Most of the problems related to pen moves and overstocking are driven by the goals of minimizing labor and building costs. Labor and overhead costs are simple to calculate. However, the impact on cow health and productivity is difficult to measure and evaluate. The prior discussions are offered to provide information for the disease cost side of the equation.

One of the ongoing problems in modern confinement dairies is the flow of irregular numbers of cows through special needs pens of fixed size. Dairy housing is usually designed to fit some "normal" expectations of numbers of cows in each management group. However, events occur that result in ebbs and flows in the numbers of fresh cows. Because the special needs pens for close-up cows, maternity pens, fresh pens and sick pens are usually designed for a very small proportion of the herd, these pens are easily overwhelmed by surges in numbers of calvings.

Our observations of management approaches to the ebb and flow of fresh cows show four general practices. Some simply move the cows on an established schedule, usually dictated by computerized move schedules, and allow overstocking to occur. Some managers reduce the

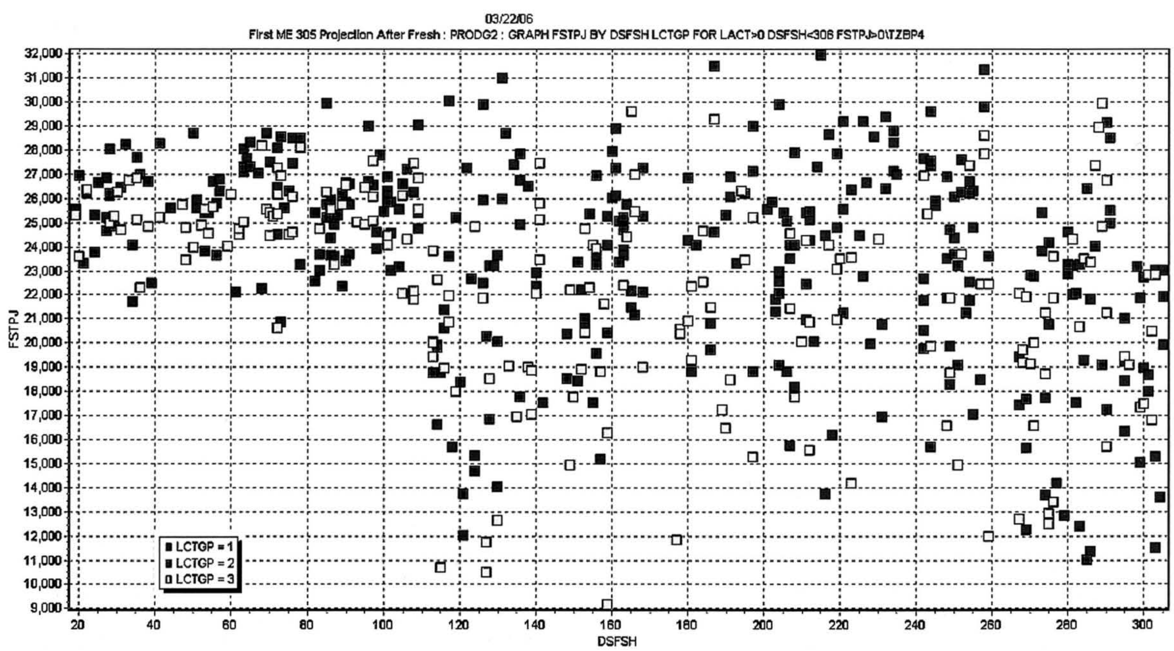

Figure 4. Scatterplot of first-test projected milk values and days since freshening for cows in a herd that constructed additional barn space approximately 110 days previously. The additional barn space allowed for a reduction of stall-stocking density in the pre-fresh pens from 120% down to 85%, and a reduction in the fresh cow pens from 100% to 85%. Unpublished data from Paul Meagher.

duration of stay in the close-up pen or fresh cow monitoring pen, choosing to avoid overstocking and accepting other negative consequences. Some managers develop temporary and additional groupings, such as an extra close-up group. This approach can work satisfactorily if the extra pen is managed as a separate and equal group, but is not successful if all cows are moved through the extra pen sequentially. Finally, some managers have facilities that allow them to expand the size of a particular pen, allowing them to maintain stocking density on the critical transition cow pens and transfer the pressure to other, perhaps less vulnerable, groups.

Perhaps the most successful approach is to build special needs pens to accommodate the extremes, rather than the average. Using costs offered by Smith, doubling the typical size of all special needs pens in a new dairy construction increased the annual total dairy facility cost by approximately $60 per cow, per year.[19] It is not difficult to calculate a combination of reduced death rate, early lactation culling, treatments and increased production to yield $60 per cow per year. As we accumulate data on disease and production costs related to compromised transition cow housing, we expect that sizing the special needs pens to handle the surges will become the sensible decision for both economics and welfare.

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