ABSTRACT

Behavior studies with dairy cattle have shown at least three definite social hierarchies. These are dominance, leadership, and entrance order into the milking parlor. Furthermore, social standing plays an important role in the activity and performance of individual cows. Unquestionably, social behavior puts certain cows under stress. Knowledge of animal behavior can provide insights into developing management systems that can overcome at least part of these stresses. Continued research is needed on cattle behavior, and increased emphasis is needed on applied research to modify management. However, management changes to reduce stress should not introduce new and even more serious stresses.

INTRODUCTION

Previous reports in this symposium have dealt basically with effects of certain stresses on specific functions of a dairy cow. This report is a discussion of alleviating stress or its effects by using information on cow behavior to modify management systems. This is a topic of growing interest but limited knowledge. We do not have a tidy physiological explanation of stress. We know relatively little about physiological changes that take place in a normal or unstressed animal. Quantifying stress and determining specifically how to alleviate it is difficult without detailed understanding of normal physiological responses.

Most of the studies of animal behavior have dealt with exotic animals living in their wild state. Relatively little research concerning the behavior of domestic animals has been reported. Management of dairy animals is just beginning to emerge as a science. Thus, we are in the initial stage of being able to determine the effects of stress on functions of dairy cattle. Hopefully, this report will stimulate additional research on this increasingly important topic.

This report includes a review of what has been published on cow behavior patterns, a discussion of the application of this knowledge to management systems for dairy cows, and an attempt to relate this to potential reductions in stress or at least a reduction in the effect of stress.

COW BEHAVIOR PATTERNS

Cattle psychology is a fascinating study. Cows apparently have memories and the ability to learn. If cows have an undesirable experience in a certain area, they are unwilling to return to that area in the future. Cows can learn quickly an assigned stall in a barn or at a feed manger and will return to that stall at feeding time even though other similar stalls are available.

Cows exhibit a definite social standing in a group, a phenomenon most noticeable in dairy herds. The so-called "boss cow" in almost every herd is a commonly accepted fact, but below her every single cow takes a place on the social ladder, and cows will fight for their social position.

From a historical standpoint, the earliest mention of social dominance in dairy cattle was by Low (21) in 1853. Nearly a century later, Woodbury (30) described a social dominance order that he called hook or bunt order. He noted that the hook order, which was determined by size, shape, and effectiveness of the horns, could be changed by dehorning the boss cow. In a herd of dehorned cows, the bunt order was determined by the strength and tenacity of individuals.

The beginning of scientific studies of social dominance relationships in dairy herds was in 1955 by Schein and Fohrman (24). They described in detail the aggressive behavior of dairy animals, a system for determining social rank in a herd, and the effect of a social organization on the behavior of individuals.
within a herd.

Social dominance can be defined as a relationship where an animal through threat, force, or mere pleasure causes a subordinate animal to yield space. Social order is the rank within a herd based on social dominance. It is determined through a series of fights or threats among individual animals in the herd.

When a new animal is added to an established group, the boss cow generally will approach the new animal with head lowered, threatening to bunt. If the newcomer accepts the challenge, physical fighting occurs, generally with head pushing against head in a battle of strength. Once an animal gains advantage, it will then attempt to dominate completely its opponent. Sometimes a win occurs in just one encounter. Other times there may be a series of encounters lasting several days. Once a cow retreats, either from a threat or after a physical encounter, she becomes submissive to the other cow and ranks below her on the social scale.

In the early work of Schein and Fohrman (24), they hypothesized a linear social order in a herd. Other workers (9) have challenged this concept and have suggested a triangular or relationship of higher order. Apparently, the larger the group, the greater the deviation from the straight-line order. In large groups, there appears to be a definite relationship between each pair of animals with one dominant or superior, but no clear-cut linear order. For example, if A dominates B and B dominates C, C may dominate A, making a triangular arrangement. This observation has led to the practice of classifying social order on number of wins divided by the number of encounters. We can then assume that the cow with the highest percentage of wins is the dominant cow in the group. With this system, some cows are more active and engage in more encounters than others and, thus, yield a more stable dominance rank.

Research at Purdue (6) showed that dominance rank was stable for cows at either extreme in the group social structure whereas mid-dominant cows fluctuated widely from one observation period to the next. This fluctuation can be explained by the fact that the dominant cows win practically all of their encounters and submissive cows lose most encounters. However, if a mid-dominant cow encounters animals higher in the social strata, she seldom wins and her observed dominance rank is lowered whereas if she encounters animals lower in the social order, her dominance rank appears to increase.

There is conflicting evidence in the stability of social order in a group. Beilharz and Mylrea (9) found social order stable in a group of 41 heifers in which dominance rank did not change over 5 mo. Dickson et al. (10) obtained estimates of repeatability for dominance of .97 from day to day. They concluded that if animals were given sufficient opportunity for social contact, one day's observation could determine the social order. On the other hand, Arave (3) found a continually changing social pattern in a group of first lactation heifers in which some were individually fed higher than National Research Council requirements and some were underfed. Those heifers on a high energy diet gained weight and gained in strength and social dominance. The heifers on a low energy diet lost weight, became weaker, and lost social status.

When animals are moved from one group to another, a new social order is created, often upsetting the old established social order. Hook et al. (17) observed that the removal of the high ranking heifer and the simultaneous addition of a new one to a group of six could cause a complete reversal of the social order. However, Schein and Fohrman (24) found that previous dominance relationships were not disturbed by introducing new cows into a group. The new cows found their place somewhere in the established social structure.

Schein and Fohrman (24) also reported that estrus apparently has no effect on social order although cows generally have more encounters during estrus. The cow in estrus generally tries to mount any cow in the group with no concern for social order even though she may be threatened by more dominant cows. Maternal drive also causes cows to ignore the normal social behavior. The fresh cow is concerned only with the care of her calf. After the calf is taken away, the cow generally returns to social orientation and back to the regular herd pattern.

In several studies (4, 10, 16, 24), correlations between dominance rank and age or body weight have been significant. Research in Australia (9) found chest girth more highly correlated with social position than was wither
height. In contrast, McPhee et al. (23) found wither height was more important. There is no conclusive evidence that social dominance is related to productive traits (8, 23, 24).

Next to the "boss cow" there is another interesting personality in a dairy herd, the "public servant." Such a servant is found in almost every group of cows. Any animal in the herd, regardless of social standing, can come to this cow for grooming.

In a study with range cattle (26), a cooperative baby-sitting program was observed. When the calves were too young to accompany their mothers, the cows solved the problem by forming cooperatives of 7 to 11 cows. They then left all the calves in one spot with one mother staying behind to tend them while the others grazed. This nursemaid would never leave the calves, even for a drink of water. She would not allow her own calf to nurse during the day. This would be unfair to the others in the group. The next day a different cow would be on duty. There appeared to be a remarkable dedication to the duty schedule, regardless of social rank.

Although not studied as intently, there are aspects of cow behavior that relate to management control. For example, reducing space or crowding has increased antagonistic behavior (13). Dairy heifers confined to dry lot corrals had a stable social structure, but subordinate heifers were attacked when they violated the personal space of dominant animals (9, 19). Dominant animals reacted more to the presence of humans whereas submissive heifers were more concerned with avoiding attacks by dominant animals. In another study (7), reducing corral space from 9.3 to 2.3 m² per cow reduced the activity of cows. The least dominant cows were the most active, evidently to avoid the dominant cows, and cows on the extreme ends of the social scale had more encounters than the mid-dominant cows.

Housing can affect the behavior of dairy cattle. When given a choice (25), cows preferred loose housing and dry lots over free stalls. However, they stayed cleaner in the free stall housing. Cows housed in free stalls were more individualistic whereas cows in loose housing were more group oriented. When the boss cow laid down, the group followed. When the boss cow got up, the others got up also. This pattern was not as evident in free stall housing. Some cows preferred to use semi-open stalls in the center of the alley facing other cows whereas others used stalls at random (25). Friend and Polan (15) reported that lower ranking cows almost exclusively occupied the most interior and least desirable stalls whereas high ranking cows occupied the stalls near the entrance to the housing area. Subordinate cows apparently were reluctant to use a free stall frequented by a more dominant cow and, hence, went to a less desirable stall where they were less apt to be attacked.

Studies (1, 15) have shown a definite relationship between social rank and feeding behavior of cattle. The highest ranking cows spend the most time eating and are the first to eat all they want if feed is limited. Middle ranking cows spend the least time eating. The lower ranking cows spend considerable time at the feed bunk, but it is at night or when no other cows are there. When more dominant cows are present, the low ranking cows continually are being pushed out and may spend more time looking for bunk space than they do eating.

Albright (1) observed a lesser amount of aggressive behavior when cows were fed in a single, long, continuous bunk rather than several small bunks arranged randomly. He compared a fence line feed bunk with one in which the cows could eat all the way around it. Both feed bunks allowed .6 m per cow. During 1 h after feeding, he found that cows had 26% more feeding time and traveled less distance at the fence line bunk.

Friend and Polan (15) showed no association between social rank and the use of specific sections of the feed bunk. Nor was social rank associated with feed bunk neighbors or successors.

When on pasture, cows follow a different group pattern in which they do all things in unison. They all graze at essentially the same time. They lie down and rest at the same time. When the lead cow gets up and goes for water, usually they all get up and go for water. As milking time approaches, the lead cow will stop grazing and head for the barn. The other cows almost immediately will fall in line in a single file, and a pilgrimage to the barn begins. Interestingly, the lead cow is generally not the most dominant cow, and leadership is independent of dominance rank. More often, the lead cow is a mid-dominant cow. The dominant
cows usually are found somewhere in the middle of the line. The low dominance cows almost always bring up the rear (20). The author observed a herdsman who recognized this group behavior pattern and used it to his advantage. Rather than use a lot of help to move a herd of 100 to 150 cows from one pasture to another, he singled out the lead cow and enticed her to follow him. The herd fell in line and he led them to the new pasture with little effort except a leisurely walk.

The behavior of cows relating to their entering the milking parlor also has been studied. Within a herd, cows establish a definite order in which they enter the milking parlor (11), although there may be minor variations from this order from one milking to the next. No significant correlation was found between entrance order and social dominance of individuals (11). Correlation coefficients indicated little association between age and entrance rank. Correlations were low between entrance rank and body weight or milk production. Thus, young cows of lighter weights were entering the milking parlor at all segments of the entry order.

Feeding concentrates at various times before and after milking made no change in the order in which cows entered the milking parlor (11). However, when cows were milked and fed earlier than the regular milking time there was a significant change in cows' entrance order. This change may have been due to a decrease in intramammary pressure after milking which resulted in less udder stress and contentment to come into the milking line later. However, the milking and feeding of cows only once every day did not change cows' entrance order.

When a herd of 40 Jersey cows was trained for 25 days to enter the milking parlor in a specific order, approximately 85% of the herd responded to the call of their herd number and entered the parlor in their assigned order. At the end of the 25-day training period, the cows almost immediately reverted back to the original entrance order (2)

APPLICATION TO MANAGEMENT SYSTEMS

Although much of the research on behavior of dairy animals has related to social dominance, it mainly has determined social rank and evaluated factors affecting social dominance. Considerable research still is needed to determine whether social dominance can be altered and, if so, what beneficial changes can be made. Because a social order is a natural phenomenon, eliminating it could create more problems than it might solve.

Social interactions begin at an early age and may affect an animal throughout life. Donaldson et al. (12) compared calves raised individually for 4 mo with calves raised in groups. Calves raised in groups were more dominant. They also ignored or failed to nurse their first calves. They treated their own offspring as another competitive animal, and only after experiencing the nonthreatening aspects of the situation did they exhibit more normal maternal behavior at later calvings. These results suggest that additional research on the effect of calfhood management on adult behavior and performance may be profitable.

Evidence strongly suggests that changing the grouping of animals creates a stress both on the new animals in the group and on animals in the existing group. For example, when the most dominant cows in one group were exchanged for mid-dominant or low dominance cows in another group, both groups had a 5% decline in milk yield (6, 24). The high dominance cows dropped markedly in persistency. This appeared to be a consequence of a lower ranking in the new grouping. However, the low dominance cows in the original group became less oppressed with fewer high dominance cows and actually increased in persistency and yield. This increase suggests that removing the low dominance cows from a group and reestablishing a new grouping of timid cows might reduce stress in those cows without affecting the higher ranking cows.

Another approach to lowering stress is to reduce to a minimum the movement of cows between groups. Undocumented work at Utah suggests that once a grouping is established, that grouping should be continued, even if some cows are overfed, and cows should not be continually shifted from one group to another. Many large herds that are divided into strings or corrals are now adopting management programs in which a cow is assigned to a string at freshening and does not change throughout her lactation.

Arave et al. (6) reported that cows in early lactation tended to be less dominant. Adding a
recently fresh cow to an established group could cause her considerable trauma. As indicated earlier, these cows are maternally rather than socially oriented. Furthermore, they may be weakened from parturition and sudden change to lactation. Because a new cow added to a group is challenged for social position, this recently fresh cow may be challenged and intimidated by many cows before she reaches her social standing. This treatment could put considerable stress on a cow at a critical point in her lactation or, worse, result in physical injury to the cow. A possible management system to reduce stress would be to avoid putting fresh cows in a large group until at least 3 days after calving to allow them to rebuild strength. Gradually introducing fresh cows by degrees into larger groups, possibly by using adjoining pens with a high degree of visibility, may reduce the fighting necessary to establish social rank. The earlier suggestion of developing groups of all fresh cows would put together cows with less inclination to dominate and, thus, reduce social stress in the group. A system that might be tried would be to introduce new animals to a group at night when there is less social activity. By morning her newness might be less noticeable, and the fighting and stress would be reduced.

The optimum size of a group of dairy cows has not been determined. Larger groups seem desirable for labor efficiency, but smaller groups may be better socially, particularly for lowered stress. Macmillan and Watson (22) reported reduced fertility and short estrus cycles in young cows as a result of social stress in large herds of 200 or more cows in one group in New Zealand. Large groups may make it difficult for cows to remember other cows or where they fit socially and, thus, cause continued encounters to reestablish social rank. When grouping is possible, groups can be based on stage of lactation, age, size, or dominance rank. Because cows in first lactation are smaller and generally more timid, a separate grouping for these cows seems desirable. Stage of lactation appears to be a valid criterion. If further division is possible, then dominance rank should be considered.

Schein and Fohrman (24) suggested that estrus does not change the social order. Conversely, social order does not inhibit the expression of estrus. Cows in estrus seek other cows in estrus as mounting partners, regardless of social rank of either cow. When there is only one cow in estrus, she will mount or be mounted by any other cow, again regardless of social rank of either. Hurnik (18) noted that cooperation of cows not in estrus was limited mostly to mounting. Heavier and older cows took part in fewer interactions, and were mounted more frequently than mounting.

Hurnik (18) also reported that the number of agonistic interactions (threats and fights) per cow was approximately doubled during estrus as compared to periods before and after estrus. This creates a stress both on the cow in estrus and among other cows in the group. Moving the cow in estrus into an isolated holding pen will not only reduce stress, but also should reduce injuries that frequently occur from cows mounting others on hard-surface corrals.

Behavior studies could provide answers to the amount of corral space needed per cow. Because cows are less active socially in reduced space, one could surmise that limiting corral space per cow would reduce stress because of less conflict between cows. However, restricting space until submissive animals are forced into violating the personal space of their neighbors can cause an increased stress.

Arave and co-workers (5, 7) studied the effect of limited space and of total confinement on social behavior, stress, and milk production. Crowding had no apparent effect on milk yield. Cows in larger lots had the highest leucocyte counts in their milk. If leucocytes are a measure of stress as indicated by Whittlestone et al. (29) in cows with previous mastitis history, then these results suggest that crowding did not stress the cow. Limiting cows to a relatively small space does not appear to stress them as measured by total plasma corticoid (7).

Total isolation of cows did not have a consistent effect on milk yield or leucocyte count (5). One cow in estrus and two cows with a previous history of mastitis showed a significant increase in leucocytes during isolation. Three other cows did not change leucocyte counts. Even though cows in isolation were given feed and water, they appeared to be stressed as evidenced by considerable bellowing and shifting about in the small enclosure. Still unresolved is the management question of whether it is better to stress an individual cow in estrus by isolating her or to stress an entire
herd by leaving her in the group.

Research in Denmark (14) shows that cows housed in stalls 1.22 m × 2.13 m yielded .95 kg more milk/cow per day than cows housed in smaller stalls (1.07 m × 1.68 m). During 24 h, cows spent 10.2 h lying in the longer stalls and 8.8 h lying in the short stalls. Apparently, the smaller stalls are less comfortable, which implies a stress on cows using them. They also can give rise to more possible injury and stress from cows getting caught, stepping on teats and udders, and putting an unequal distribution of weight on the legs.

In a study (15) of free stall housing in which time-lapse photography was used, higher dominance cows were able to rest more than low dominance cows, probably because they were not driven from their stall by other cows. Dominant cows preferred to succeed each other and/or occupy adjacent stalls.

In a study of free stall usage, Wagnon and Rollins (28) found that 35 first lactation heifers did not favor either side when lying in stalls before the mid-morning feeding. But after feeding, they significantly favored the left side 56% of the time. The authors suggest that lying on the left side was due to greater comfort after consuming large amounts of feed. Yungblut et al. (31) compared level free stalls in which cows laid on their left sides 53% of the time with stalls sloped 1.5 to 2.0% in which cows laid with their dorsal side uphill 70% of the time. This observation suggests that stalls could be constructed to encourage cows to lie on the left side. A majority of cows lying on the left side would not only be more comfortable for the cows, but it would create less conflict between opposing cows' udders and feet.

Space, density, and distribution of feed also become tools of management to insure maximal productive efficiency. Accessibility of feed may be more important than amount. Some competition for feed is essential to stimulate consumption, yet efforts should be made to reduce competition for water, minerals, and shelter.

Although dairymen generally are concerned most with the female side of animal behavior and management, attention to the male side is in order for herds using natural service and for AI studs. Like cows, bulls that are kept together in groups develop social orders, fighting for seniority and dominance (27). Bulls used naturally in a single-sire herd often declare themselves master of the herd and control the lives of the cows completely.

Although this domineering behavior is natural and desirable in a single-sire herd, it should not be allowed in a multiple-sire herd. In this case, the aggressive bull keeps the other bulls away from the cows, and as a result, almost all of the calves are sired by one bull. Furthermore, the calving percentage may be lower because the dominant bull cannot service all the cows and actually may spend his time protecting his rights rather than acting as herd sire. Thus, if natural service is used, herds should be divided into single-sire sized groups.

Registered breeders and AI organizations raising large numbers of breeding bulls should consider natural behavior patterns in managing them. If bulls are raised and housed in all-male groups, they develop monosexual tendencies. The dominant bulls will try to force their attentions on weaker animals, which in their constant attempts to get out of the way become timid, lose masculinity, and become undesirable as breeding animals. Viljoen (27) suggests that bulls be separated into age groups until they reach maturity to avoid this problem. Perhaps many of the fertility problems encountered in bulls are caused by improper behavioral management rather than by physical or physiological problems.

REFERENCES
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