


Intensified Dairy Operations and Their Effect on Periparturient Diseases and Postpartum Reproduction

W. C. WAGNER
Veterinary Medical Research Institute
Iowa State University
Ames, Iowa 50010

The title of this paper assumes a casual relationship between intensive dairy operations and periparturient problems. The validity of this assumption rests, in part, on how we define an intensive operation and factors included in such a definition.

An intensive program usually means an increase in animals/unit of space, an increase in nutritional input, an increase in production per animal unit, and, therefore, an increased labor efficiency. This last characteristic usually suggests that one worker can take care of a greater number of animals and may decrease attention to the individual animal.

Perhaps one should first consider whether there is an increased incidence of certain periparturient diseases such as hypocalcemia, ketosis, displaced abomasum and metritis, and postpartum infertility associated with such enterprises. Although specific data are scarce, there seems to be general agreement that there has been an increase in some of these conditions during the past few years. There has been a multitude of papers on the problems of periparturient fertility and possible causes. One must keep in mind that other factors change as intensity of the operation increases. Milk production tends to rise. There may be changes in nutritional regimen. Thus, it becomes difficult to separate these various causative agents as to their effect on disease problems. Most studies are fragmentary at best, and much of the evidence on the effects of increased population density is based on studies in small animals.

What are the effects of population density, i.e., increased animals/unit of space? Haynes and Nicoletti (12) reported an increased incidence of brucellosis and salmonellosis in large herds. The problems of sanitation with high concentrations of animals are self evident and may contribute to an increase in diseases of infectious origin. This might also be true of such problems as metritis and mastitis. High bacterial populations in the environment could easily result in contamination of the reproductive tract at the time of calving and cause subsequent infertility. Other factors such as endocrine imbalance contributing to increased disease problems will be commented on later.

Of major concern in high population densities is availability of nutrients and feeding space. The phenomenon of the dominant animal assuming control of the feeding area may create problems if insufficient feeding space is available. Since social dominance rating and milk production are not necessarily related (9), this may mean that subordinate animals become relatively underfed.

Kilgour (16) reported that cattle do become accustomed to routines, and alterations of such routines can cause decreases in milk production and other changes. In one case cited by Kilgour (16), a change in milking pattern and handling of cows caused a 20% drop in milk
production for 3 days after the change.

Animals tend to want a minimum space around them. Subordinate animals tend to avoid dominant animals if sufficient space is available (3, 28). In close confinement, subordinate animals will even prefer proximity to human handlers rather than to dominant animals. Thus, crowding of animals for entry into a milking parlor unavoidably may create social stresses and increase the strain on subordinate animals. This also means adequate paddock or yard space must be available so that subordinate animals are not forced into close association with dominant ones.

Another important behavioral factor is the presence of a stable social group. This allows all animals to become familiar with and accustomed to their place or role in the group. Kilgour (16) has indicated that this requires a group in which each cow can recognize every other cow and give the appropriate response. If the group goes beyond this size, social stress increases and problems of disease and lowered production may begin. Unfortunately, there seems to be little information on the optimum upper limit of animal numbers. Similar problems arise when new animals are continually being introduced into the group. Although one might expect the problem to lessen if the most subordinate animals are removed, this usually results in other animals becoming the most subordinate and the problems continue.

The effects of social structure and population density on endocrine and reproductive function have been examined primarily in smaller mammals although some evidence is available in other species. Jensen et al. (15) reported that tethering of gilts increased the incidence of infantile reproductive tracts at 10 to 12 mo of age and caused a significant increase in adrenal weight. However, ovulation rate, conception rate, and embryonic survival were normal in the tethered gilts that were mated. MacMillan and Watson (20) have reported an increased number of short (8 to 10 day long) estrous cycles as size of the dairy herd increased. It was most prevalent in second calving (3-yr old) cows but was not related to a failure of estrus detection.

Champlin (7) has reported that grouping of female mice can cause suppression of estrus and a lengthening of the diestrous phase of the cycle. This phenomenon could be demonstrated by placing the females in cages previously housing other females, and it suggested the possible presence of a pheromone. There were strain differences in the degree of suppression of estrus and not all females in a group were affected to the same degree.

Some investigators studying small rodents have found that the dominant type animals seem to perform almost normally in spite of the adverse environment. Andrews and Strohbehn (2) studied in vitro steroid production of adrenal tissue from lemmings in a high population density area. They reported a significant increase in synthesis of corticoids, progesterone, estrogen, and androgens in stressed individuals. The major exception was a group of pregnant females who had near normal adrenal steroid production. These were dominant females which appeared to be less affected by the population density stress and were continuing to function in a relatively normal fashion.

Similarly, movement of animals to a new environment may cause an increase in adrenal function. Holcombe (14) reported an increased urinary excretion of reducing corticoids in cattle for periods of 30 days after they had been moved to a new environment. Willett and Erb (33) have reported that even small changes in routine can result in increased plasma corticoid. In their study, feeding, turning out part of the group of animals, and similar stimuli all caused a significant increase in corticoids.

A change in adrenal function could result in substantial changes in the physiologic state of the animal. Christian et al. (8) have thoroughly reviewed the role of the endocrine system, especially the adrenal, in population control. An increased incidence of disease occurs in stressed animals of various species and apparently results from suppression of the immune response by the hyperadrenal state in these animals.

Stress and/or hyperadrenal function can also cause changes in lactation and mammary gland. Everyone undoubtedly is familiar with the important role of glucocorticoids in stimulating lactation. However, increased adrenal function is detrimental to milk output (11).

Whittlestone et al. (32) have studied the effects of stress, i.e., isolation from the herd or chasing with a dog, on measures such as cell count in milk. They observed an increased milk viscosity (higher California Mastitis Test (CMT) score) following isolation of a cow from the herd or after chasing with a dog. Increased cell counts, measured as deoxyribonucleic acid (DNA) content, were recorded in groups of cattle following an unusually severe cold storm. A similar reaction could be pro-
duced by intravenous injection of 50 units of adrenocorticotropic hormone (ACTH). Their results further indicated that such increases in cell count (viscosity) or DNA generally occurred only in those quarters with a previous history of infection.

The role of hyperadrenalism or stress in infertility is still poorly defined. Reports by du Mesnil du Buisson and Signoret (10) and Braden and Moule (5) have confirmed that the stress of moving animals caused alteration of estrous cycle patterns. In their study cited earlier, MacMillan and Watson (20) felt that the group with the highest incidence of short estrous cycles (3-yr old cows) got less preferential treatment and were subject to harassment by other animals. Subsequently, Brunner et al. (6) reported that daily administration of an ACTH gel (100 units) on days 2 to 8 of the cycle decreased the size of the corpus luteum (CL) and, therefore, reduced the total amount of progesterone produced.

Recently, we have demonstrated that intramuscular administration of 100 U ACTH in saline/day on days 1 to 8 of the cycle caused a decrease in the concentration of progesterone in the CL (Table 1) at day 11 and also significantly reduced the peripheral plasma progesterone concentration on days 8 to 10 of the cycle (Fig. 1) (31). On days when ACTH was administered, there was a significant increase in peripheral plasma progesterone (Fig. 1) and corticoids (Fig. 2). Further studies in ovariecotomized heifers suggested that this progesterone was probably produced by the adrenal gland since a similar increase in progesterone could be elicited.

Almost inherent in our concept of increased intensity is the probability of an increase in milk production per cow. When this occurs, can we legitimately criticize the intensive nature of the operation for problems that may be related to the higher milk production?

There seems to be little question that the preponderance of hypocalcemia, ketosis, and

Table 1. Effect of adrenocorticotropic hormone (ACTH) on corpus luteum (CL) function in heifers.

<table>
<thead>
<tr>
<th>Animal</th>
<th>CL weight (g)</th>
<th>Progesterone μg/g</th>
<th>Total μg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.0 ± 0.5c</td>
<td>67.2 ± 10.2</td>
<td>333.2 ± 34.1</td>
</tr>
<tr>
<td>ACTH</td>
<td>5.6 ± 0.5d</td>
<td>35.6 ± 3.5d</td>
<td>214.3 ± 26.2d</td>
</tr>
</tbody>
</table>

a 100 units ACTH given intramuscularly per day at 0800 on days 1 to 8 of the cycle.

b From Wagner, Strubbehn, and Harris (31).

c Mean ± SE.

d Different from control group (P<.05).
udder edema cases occur in higher producing cows. This seems reasonable due to heavy metabolic demands which are placed on the high producing dairy cow. This relationship may account for the increase in these conditions in intensive dairy operations. The other possibility is that the loss in individual attention results in less alteration of the general program to fit the individual animal's requirements. This is particularly true with regard to nutritional requirements.

There are several studies dealing with the effect of milk production on reproductive performance. Morrow et al. (23) found that there was a positive correlation between milk production and the interval from calving to conception as well as services per conception. This was especially true for animals which were above 7,272 kg milk.

Aehnelt, Konermann, and Lotthammer (1) also reported lower fertility in high producing cows. They commented that the higher economic returns anticipated may not occur because of the reproductive problem. They suggested more attention should be given to the high producing cow to permit adequate fertility, especially with regard to the nutritional program.

Hewett (13) has reported on the incidence of repeat breeders in Sweden. He defined repeat breeders as animals which required more than three services to become pregnant. Based on 212 paired comparisons with nonrepeat breeders, Hewett's data showed that repeat breeders averaged 86.4 kg more milk during the first 120 days of lactation when compared to contemporary paired controls. A further study of milk records on 60 pairs revealed that the repeat breeder cows had averaged 78.6 kg more milk during the first 120 days of their previous lactation.

Lotthammer and Ahlers (19) found that increased milk production was related to a decrease in fertility. They also related nutritional intake to the interval from calving to the first insemination.

However, Simpson (29) reported that he could not demonstrate that infertility was associated with increased milk production. He further suggested that the relationship of high production and infertility has been observed by veterinarians because poor producers are less likely to be presented for treatment. Thus, the population of infertile cows could be biased toward the high producing cow.

King (18) reported a correlation between body weight change and conception rate. He commented that any relationship between milk production and fertility may depend on the energy intake.

A further difficulty of interpretation results from the fact that certain metabolic diseases are also highly correlated with high milk production. Morrow et al. (23) reported that abnormal cows (dystocia, retained placenta, metritis, hypocalcemia, ketosis, mastitis) had a significantly higher milk production. These animals then represent the group with the greater share of reproductive problems. One can only speculate as to the correct cause-effect relationships and the relative importance of each for the animal's reproductive performance.

Peichev (28) studied two herds with a high incidence of ketosis. He reported a decrease in conception rate and number of calves produced during 1 yr. He also observed an increase in dystocia, placental retention, and metritis for cows with a history of ketosis.

As has become evident from previous comments, the importance of adequate nutrition cannot be minimized as an underlying factor in this whole picture. Inadequate or imbalanced mineral intake might be involved in the etiology of hypocalcemia. Keto sis may also have a complex etiologic basis, and inadequate energy intake could be involved.

For the problem of infertility, there is substantial evidence of a specific relationship between an inadequate energy intake and poor reproductive performance. McClure (21) has reported on the occurrence of anestrus and lowered fertility in dairy cattle on pastures. He later reported that fertility was decreased by reducing the dietary intake of cattle (22). In both instances the poor fertility was related to a hypoglycemia.

Oxenreider and Wagner (26) studied the effect of three energy intakes and lactation vs. nonlactation on postpartum ovarian function. Lactating cows had a longer interval parturition to ovulation over all energy levels. The diets (133% NRC (25), 100% NRC, and 66% NRC) resulted in significant differences in blood glucose. There was a significant negative correlation between blood glucose and the parturition to ovulation interval. There was some indication that the energy recommended for lactation was insufficient as milk production increased. This was reflected in a larger body weight loss for lactating cows as compared to the nonlactating cows. McClure (21) has also reported that body weight loss during the postpartum period is related to infertility.
Thus, one might consider the advisability of weighing cattle regularly during the postpartum period as a better guide to nutritional intake to meet all of the requirements of the animal (lactation, reproduction, and maintenance). Group feeding of large numbers of cattle makes it difficult to determine or control intake of individuals. In some instances, e.g., fattening of beef animals, this may not be critical. However, it appears that some effort must be in this direction if we are to have optimum lactation and reproduction in an intensive operation.

There is another side to the nutrition question that also deserves mention. As milk production has gone up and the intensity of dairy operations has increased, the diet of the dairy cow has changed to a higher percentage of concentrates. In many cases there has been a change to silage (grass or corn) and concentrates with little or no hay fed. Substantial controversy has arisen as to the effect such diets may have on the general health and reproductive performance of cattle.

Reliable data are scarce. The condition known as displaced abomasum seems to have become more prevalent and has been related to the decreased fill of roughage in the rumen which allows the abomasum to slip under it. Understandably, this has been difficult to document.

Morrow et al. (24) reported on reproductive function in cattle on a liberal concentrate feeding program for 3 consecutive yr. In this study cows were fed grain ad libitum after a graded increase of intake during the first few days postpartum. Milk production was reasonably high since the mean of all groups was 7,588 kg of 4% fat-corrected milk (FCM) per lactation. Liberal grain feeding did not affect the interval calving to first ovulation nor any other measures of ovarian physiologic performance except for a slight increase in follicular cysts in liberal grain fed cows. However, cows fed the liberal grain diet did have a significantly longer calving interval than control cows. From these data one might conclude that liberal grain feeding may cause a slight elongation (20 to 25 days) of calving interval.

In an earlier portion of this paper reference was to the decrease in individual attention for each animal in intensive management schemes. One area where this has great importance is estrus detection. Undoubtedly, everyone realizes the importance of thorough observation to detect estrus in any successful breeding program. In a large group of animals, as usually in intensive systems, adequate estrus detection becomes more difficult. As previous studies have indicated, inadequate estrus detection is frequently involved in breeding problems (4, 30).

Williamson et al. (34, 35) recently reported on estrus detection methods for a 160-cow dairy in Australia. They reported that herdsmen detected only 56% of the cows that actually were in estrus as determined by an expert team of observers. The herdsmen observed the cattle in conjunction with their normal activities and had previously reported that a severe anestrus problem existed in the herd.

Williamson and coworkers (35) also studied the usefulness of various signs or behavioral activities for estrus detection. They reported that standing-to-be-mounted, mounting other cows, and abrasions on the rump were most useful. Other signs such as vaginal discharge and vulval erythema were useful in some specific animals. A major finding of their study was that the poorest time to detect estrus was in the holding yard or on the way to the milking area. Cattle were either too crowded to permit easy identification, or an excess of activity occurred which tended to confuse results. They indicated that it was important to identify the sexually active group and then give concentrated attention to them. They further stated that the use of heat mount detectors seemed to be a useful adjunct to good observation of the herd.

An obvious conclusion is that the management in an intensive operation must devote the time necessary to detect estrus in the cattle. Furthermore, the groups must be kept sufficiently small to permit identification of animals. A further simultaneous requirement is development of record systems that permit the easy identification of those animals that may show estrus.

I have presented some of the potential difficulties that we face. I have also alluded to some possible solutions as we proceeded through this discussion. I would like to conclude by briefly summarizing some factors that I feel are important for a low incidence of periparturient diseases and optimum fertility subsequent to parturition. First and foremost, I think that we must think more in terms of the animal’s happiness or contentedness. We have seen some recent situations with intensive swine operations where the social climate was definitely antagonistic and reproductive performance was poor. Housing or management
situations that force animals of different social standing into continual close proximity may result in a very real impairment of the performance of subordinate animals.

From the data, the correct cause-effect relationships between intensive operations, milk production, altered feeding regimens, and reproductive performance are difficult to discern. At this moment it appears that high milk production and infertility during the early postpartum period (45 to 90 days) are closely associated. The depressing effect which high milk production exerts on early fertility might be direct through the endocrine system or indirect as a result of inadequate nutrient intake. To my knowledge the definitive experiment has not been done. We currently do not have adequate data on hormones such as adrenal steroids, thyroxine, growth hormone, prolactin, luteinizing hormone, and follicle stimulating hormone in high and low producing cows to permit an assessment of their possible involvement.

Evidence has been presented on the occurrence of infertility associated with hypoglycemia and the effect of reduced energy intake in delaying postpartum ovulation. With the rather routine postpartum body weight losses that occur in dairy cattle, it seems reasonable to assign part of the fertility problem of the high producing cow to inadequate nutrition.

Prevention of periparturient diseases is difficult. No completely satisfactory prevention of hypocalcemia (milk fever) has yet been devised. Although many methods have been put forth as preventives of ketosis, none seems foolproof. An attempt to provide more energy to the animal may be as beneficial as any other procedure. The other major parturient problem, placental retention and subsequent metritis, can perhaps be diminished by careful sanitation of the calving facility. Avoidance of contamination of the reproductive tract after calving is vital, and systemic treatment of retained fetal membranes in lieu of manual removal and local therapy should be considered seriously.

Scrupulous attention to cleanliness is a must in intensive systems. Prevention of stress, whether social, environmental, or man induced, is vital. Adherence to routines to which the animals become accustomed is also important. As has been evident, I have probably raised more questions than I have solved. I hope that further research on this vital area is forthcoming in the near future.

References

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(18) King, J. O. L. 1968. The relationship be-


Effects of Season, Climate, and Temperature on Reproduction and Lactation

W. W. THATCHER
Dairy Science Department
Institute of Food and Agricultural Sciences
University of Florida, Gainesville 32611

Introduction

Tropical and subtropical areas of the world are becoming more important in contributing to the world's food supply (31). Considerable research has been initiated to determine the role of heat stress on milk production and reproduction and to develop methods of alleviating its effects. Climatic laboratory studies have demonstrated the effects of ambient temperature extremes (50) and environmental control (20, 25) on milk production of dairy cows. From these controlled studies, climatological interrelationships have been defined which now allow for prediction of milk production losses during summer within some geographical areas of the United States (19).

Several recent reviews have been published on the influence of season and temperature on reproductive performance (4, 17, 18, 39, 40, 41, 43, 45, 47). However, there is a sparsity of information relating controlled environmental conditions to reproductive efficiency (48).

Dairy systems in Florida fall under the classification of large herds. Only about 20% of...