FACTORS AFFECTING DRY MATTER INTAKE BY LACTATING DAIRY COWS

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Summary

Feed intake is the single most critical factor of dairy production, and performance of dairy cattle can be enhanced or hindered by environmental factors that affect it. These environmental factors can by divided into physical and climatic conditions. On modern dairies, the physical factors may be of more concern. Modern facilities provide the cow with protection from the natural elements. However, these same facilities can enhance or hinder dry matter intake. Facilities should provide adequate access to feed and water, a comfortable resting area, and adequate protection from the natural elements. Critical areas of facility design related to feed intake include access to feed and water, stall design and surface, supplemental lighting, ventilation, and cow cooling. The total system should function to enhance cow comfort and intake. It is important to remember that choices made during construction of a facility will affect the performance of animals for the life of the facility, which is generally 20 to 30 yr. Producers, bankers, and consultants too often view the additional cost of cow comfort from the standpoint of initial investment rather than long-term benefit.

(Key Words: Facilities, Cows, Environmental Stress.)

Introduction

One of the keys to success in dairy production is to design and manage facilities to maximize the dry matter intake of dairy cattle. Intake is impacted by environmental and management factors. Environmental concerns include the physical facilities and climatic conditions to which the cattle are exposed. Management factors include feeding, grouping, and cow flow patterns that may be influenced by facility design. The goal of the system should be to provide adequate cow comfort that includes: 1) adequate access to feed and water; 2) a clean and dry bed that is comfortable and correctly sized and constructed; 3) acceptable air quality; and 4) adequate protection from the natural elements.

Access to Feed and Water

4-Row vs 6-Row Barns

One of the critical decisions to make is the type of freestall barn to build. The most common types are either 4- or 6-row barns. Often the cost per cow or stall is used to determine which barn should be built. Table 1 illustrates the typical dimensions of the barns, and Table 2 demonstrates the effects of overcrowding on per-cow space for feed and water. Research indicated that feed bunk space of less than 8 inches per cow reduced intake and bunk space of 8 to 20 inches per cow resulted in mixed results. Even at a 100% stocking rate, the 6-row barn offers only 18 inches of feed-line space per cow. When overcrowding occurs, average feed-line space is reduced significantly. Four-row barns, even when stocked at 140% of the stalls, still provide more than 18 inches per cow of bunk space. In addition, when water is provided only at the crossovers, water space per cow is reduced by 40% in the 6-row barn compared to 4-row barns. Much of the current debate over the effect of 4- and 6-row barns on intake likely is related to presence or absence of management factors that either reduce on increase the limitations of access to feed and water in 6-row barns.

Feed Barrier Design

The use of self-locking stanchions as feed barriers is currently a debated subject in the dairy industry. Data reported in the literature are limited, and conclusions differ. One study (1996) reported that cows restrained in self-locking stanchions for 4 hr had milk production and dry matter intakes similar to those of cows not restrained. Other researchers observed similar results in another study. However, a third study reported similar intake but a 6.4 lb decrease in daily milk production when cows were restrained during a 4-hr period (9 AM to 1 PM) in the summer. Increases in concentrations of cortisol also were noted during the summer but not in the spring, indicating a greater amount of stress during the summer. All of these studies compared restraining cows for 4 hr to no restraint, and all animals were housed in pens equipped with headlocks. The studies did not compare a neck rail barrier to self-locking stanchions or address the effects of training upon headlock acceptance. Some have interpreted these results to mean that self-locking stanchions reduce milk production and only the neck rail barrier should be used. More accurately, the results indicate that cows should not be restrained for periods of 4 hr during the summer heat. The argument could be made that 4 hr of continuous restraint is excessive, and much shorter times (1 hr or less) should be adequate for most procedures. These studies clearly indicate that mismanagement of the self-locking stanchions, not the stanchions themselves, resulted in decreased milk production in only one of three studies but had no effect on intake in all three studies.

Another study compared lockups to neck rails in a 4-row barn under normal and crowded (130% of stalls) conditions. Results of the short-term study showed a 3 to 5% decrease in dry matter intake when headlocks were used. No differences were observed in milk production or body condition score. The overcrowding also reduced the percentage of cows eating after milking compared to no overcrowding. In this study, use of headlocks reduced feed intake but did not affect milk production.

Freestall Design and Surfaces

Freestall Design

Cows must have stalls that are sized correctly. As early as 1954, research demonstrated increases in milk production when larger cows were allowed access to increased stall sizes. Today, construction costs often encourage producers to reduce stall length and width. This may reduce cow comfort and production. Cows will use freestalls that are designed correctly and maintained. Refusal of cows to utilize stalls likely is related to design or management of the freestall area. Table 3 provides recommendations for correctly sizing the stall. In addition, the stall should be sloped front to back, and a comfortable surface should be provided.

Freestall Surface Materials

Sand is the bedding of choice in many areas. It provides a comfortable cushion that conforms to the body of the cow. In addition, its very low content of organic matter reduces risk of mastitis. In many cases, it is readily available and economical. In some areas, it is not economical, and other producers may choose not to deal with the issue of separating the sand from the manure. Because 25 to 50 lb of sand are consumed per stall per day, it should be separated from manure solids to reduce the solid load on the manure management system. Producers choosing not to deal with sand bedding often choose from a variety of commercial freestall surface materials. Research has shown that when given a choice, cows show a preference for certain materials. Occupancy ranged from >50 to <20%. An increase in occupancy rate likely was influenced by the compressibility of the covering. Cows selected freestall covers that compressed to a greater degree over those with minimal compressibility. Sand and materials that compress likely will provide greater comfort, as demonstrated by cow preference.

Supplemental Lighting

Lactating Cows

Supplemental lighting has been shown to increase milk production and feed intake in several studies. One study reported a 6% increase in milk production and feed intake when cows were exposed to a daily photoperiod of 16 hr of light and 8 hr of dark (16L:8:) compared to natural photoperiods during the fall and winter months. Median light intensities were 462 1ux and 555 1ux for supplemental and natural photoperiods, respectively. Another study reported a 5% increase in feed intake when proper ventilation and lighting were provided. Other researchers reported a 3.5% increase without bST and 8.9% with bST when photoperiod was increased from 9.5-14 to 18 hr. Increasing daily photoperiod to 16-18 hr of light increased feed intake. Additional research showed that 24 hr of supplemental lighting did not result in additional milk production over 16 hr of light. These studies utilized different light intensities in different parts of the housing area. In modern freestall barns, the intensity varies greatly depending on the location of the light source. Thus, additional research is needed to determine the intensities required for different locations within pens to increase intake.

Another issue with lighting in freestall barns is milking frequency. Herds milked 3× cannot receive 8 hr of continuous darkness. This is especially true in large freestall barns housing several milking groups. In these situations, the lights may remain on at all times to provide lighting for moving cattle to and from the milking parlor. The continuous darkness requirement of lactating cows may be 6 hr according to one report. Thus, setting milking schedules to accommodate 6 hr of continuous darkness is recommended. The use of low intensity red lights may be necessary in large barns to allow movement of animals without disruption of the dark period of other groups.

Dry Cows

Dry cows benefit from a different photoperiod than lactating cows. Recent research showed that dry cows exposed to short days (8L:16D) produced more milk in the next lactation than those exposed to long days (16L:8D). An earlier study reported similar results. Based on these results, dry cows should be exposed to short days and then exposed to long days after calving.

Heat Stress

Effects of Heat Stress

Heat stress reduces feed intake, milk production, health, and reproduction of dairy cows. Missouri researchers reported that lactating cows under heat stress decreased intake by 6 to 16% compared to those in thermal neutral conditions. Arizona workers also observed that cows cooled during the dry period produced more milk in the subsequent lactation than cows that were not cooled. The cow environment can be modified to reduce the effects of heat stress by providing for adequate ventilation and effective cow cooling measures.

Ventilation

Maintaining adequate air quality can be accomplished easily by taking advantage of natural ventilation. Researchers showed that a 4/12 pitch roof with an open ridge resulted in lower afternoon respiration rates of cows that a reduced roof pitch or covering the ridge. They also observed that eave heights of 14 ft resulted in lower increases in respiration rates than shorter eave heights. Designing freestall barns that allow for maximum natural airflow during the summer will reduce the effects of heat stress. Open sidewalls, open roof ridges, correct sidewall heights, and the absence of buildings or natural features that reduce airflow increase natural airflow. During winter, it is necessary to allow adequate ventilation to maintain air quality while providing adequate protection from cold stress.

Another ventilation consideration is the width of the barn. Six-row barns are typically wider than 4-row barns. This additional width reduces natural ventilation. Summer ventilation rates are reduced 37% in 6-row barns compared to 4-row barns. In hot and humid climates, barn choice increases heat stress, resulting in lower feed intake and milk production.

Cow Cooling

During periods of heat stress, it is necessary to reduce cow stress by increasing airflow and installing sprinkler systems. The critical areas to cool are the milking parlor, holding pen, and housing area. First, these areas should provide adequate shade. Barns built with a north-south orientation allow morning and afternoon sun to enter the stalls and feeding areas and may not adequately protect the cows. Second, as temperatures increase, cows depend upon evaporative cooling to maintain core temperature. The use of sprinkler and fan systems to effectively wet and dry the cows will increase heat loss.

The holding pen should be cooled with fans and sprinkler systems, and an exit lane sprinkler system may be beneficial in warmer climates. Holding pen time should not exceed 1 hr. Fans should move 1,000 sq ft/min per cow. Most 30- and 36-inch fans will move between 10,000 and 12,000 sq ft/min per fan. If one fan is installed per 10 cows or 150 sq ft, adequate ventilation should be provided. If the holding pen is less than 24 ft wide with 8-10 ft sidewall openings, fans can be installed on 6- to 8-ft centers along the sidewalls. For holding pens wider than 24 ft, fans are mounted perpendicular to the cow flow. Fans are spaced 6- to 8-ft apart and in rows spaced either 20 to 30 ft apart (36-inch fans) or 30 to 40 ft apart (48-in fan). In addition to the fans, a sprinkling system should deliver .03 gal water per sq ft of area. Cycle times generally are set at 2 min on and 12 min off.

Heat abatement measures in freestall housing should include feed-line sprinklers and fans to increase air movement. Sprinkling systems should deliver water similar to the holding pen system, except they should wet only the area occupied when the cow is at the feed bunk. The hair coat of the cow should become wet and then be allowed to dry prior to the beginning of the next wetting cycle. Fans can be installed over the feed-line to provide additional airflow and increase evaporation rate.

Table 1. Average Pen Dimensions, Stalls, Cows, and Allotted Space per Animal in 4-Row and 6-Row Barns

					Per Cow		
Barn Style	Pen Width	Pen Length	Stall per Pen	Cows per Pen	Area	Feedline Space	Water Space
	– ft –	– ft –	– no. –	– no. –	– sq ft –	- inches -	- inches -
4-Row	39	240	100	100	94	29	2.4
6-Row	47	240	160	160	71	18	1.5
2-Row	39	240	100	100	94	29	2.4
3-Row	47	240	160	160	71	18	1.5

Adapted from Smith et al., 2000. Relocation and Expansion for Dairy Producers. Kansas Cooperative Extension Service, MF2424, page 8.

Table 2. Effect of Stocking Rate on Space per Cow for Area, Feed and Water in 4- and 6-Row Barns

	Area, sq ft/cow		Feedline Space, linear inches/cow		Water Space, linear inches/cow	
Stocking Rate, %	4-Row	6-Row	4-Row	6-Row	4-Row	6-Row
100	28.5	21.3	29	18	2.4	1.5
110	25.9	19.4	26	16	2.2	1.4
120	23.8	17.8	24	15	2.0	1.3
130	21.9	16.4	22	14	1.9	1.1
140	20.4	15.2	21	13	1.7	1.1

Adapted from Smith et al., 2000. Relocation and Expansion for Dairy Producers. Kansas Cooperative Extension Service, MF2424, page 8.

Table 3. Freestall Dimensions for Cows of Various Body Weights

Body Weight	Free Stall Width	Side Lunge	Forward Lunge[a]	Neck Rail Height above Stall Bed	Neck Rail and Brisket Board Bed, Distance from Alley Side of Curb
– lb –	– inches –	– inches –	– inches –	– inches –	– inches --
800-1,200	42 to 44	78	90 to 96	37	62
1,200- 1,500	44 to 48	84	96 to 102	40	66
Over 1,500	48 to 52	90	102 to 108	42	71

[a]An additional 12 to 18 inches in stall length are required to allow the cow to thrust her head forward during the lunge process.

Adapted from Dairy Freestall Housing and Equipment,1997. 6th Edition. Midwest Plan Service, Publication MWPS7, page 2. Iowa State University, Ames.