How the Environment Affects Cow Longevity

Nigel B. Cook, *BVSc Cert CHP DBR MRCVS and* **Ken Nordlund** *DVM*
University of Wisconsin-Madison
School of Veterinary Medicine
Madison, WI 53706

Herd Turnover Rates

An established dairy herd must be able to maintain its size using its own replacements. If culling exceeds supply, then the farm must purchase replacements to maintain herd size. If there is a plentiful supply of cheap replacements this sin goes unpunished. However, if replacements are in short supply and of high cost – due either to breeding decisions or poor fertility, then turnover rate and cow longevity become hot topics for discussion.

Herd turnover is dependent on having replacements available to come into the herd, and on cow health and longevity:

- Replacement Availability

It is common practice on a UK dairy herd to use dairy bulls on half the herd and beef bulls on the other half. In general, US dairy herds breed all cows to dairy bulls. This single breeding decision has a dramatic effect on the number of replacement animals available and hence the number of cows that can be removed per year. One might suggest that the reason why US farmers have a higher turnover rate is because they can! It is unlikely that a farmer will avoid removing a mature cow from the herd if he has a healthy heifer waiting to replace it.

- Longevity

If cows are healthy and have long and productive lives, then removal from the herd is driven solely by genetic progress. Some of the older cows may be sold as mature replacements for other herds and in certain circumstances, springing heifers maybe sold when they are not required. This is the optimal situation to be in and it is clear that this is not common on US dairy herds.

Reason for removal from the herd, rather than actual rates of turnover or mean herd life, is the key fact that we require in order to analyze the state of the industry. Unfortunately, reason for removal is very poorly monitored in most herds. Studies in the literature commonly cite infertility, mastitis and lameness as the most significant reasons for removal (Whitaker et al., 2002). Examination of DHI coded removal reasons would agree with this assessment (Table 1), but death and injury also appear as major reasons for disposal also. It is likely that the degree of removal for lameness reasons is underestimated, as many of these cows will be coded as fertility culls due to failure to conceive.

Table 1: Reasons for removal from herds of different size coded by DHI expressed as a % of the herd (JDS 83 2980-2987, 2000)

	Large Herds >300	High medium 150-299	Low medium 100-149	Small 25-99
Turnover Rate	37.9	36.0	34.2	33.1
Reproduction	6.8	7.2	7.3	8.0
Mastitis	4.4	4.6	4.5	5.0
Udder	0.09	0.07	0.07	0.07
Died	7.2	7.4	6.7	6.3
Low production	7.0	5.6	5.6	4.6
Injury/ Other	8.4	8.0	7.5	6.9
Dairy	1.6	1.8	1.9	2.3
Feet & legs	2.8	2.8	2.4	1.9
Disease	1.8	1.9	1.6	1.5
Not reported	3.9	2.3	2.3	2.1

In considering the ways in which the environment in which we place our dairy cows affects their longevity, I will restrict my discussion to lameness and udder health.

Lameness in Wisconsin

A University of Wisconsin-Madison lameness survey was carried out on 30 well recorded dairy herds – 15 stanchion/tie-stall and 15 free-stall, with a variety of stall bases. Each herd was visited twice – once in the spring/summer of 2000 and once in the winter of 2001. On both occasions, all milking cows were locomotion scored 1 through 4 with cows scoring 3 or 4 classified as lame.

The proportion of cows that were lame varied widely between herds from 7.9% to 51.9%, but scoring was consistent within a herd between the two visits. Mean lameness prevalence was higher during the winter at 24.8% than during the spring/summer at 21.8%.

On average, around 23% of dairy cows are lame on US dairy herds at any one time. This number is higher than previously reported in North America, but consistent with the findings in the UK over recent times. Eleven of the thirty dairy herds kept lameness treatment records and on average, there were 73 lameness treatments per 100 cows per year – three times the recorded prevalence for these herds.

What is the cause of Lameness?

Types of lameness recorded by the eleven herds in the study are presented in Table 2. By far the most common cause of lameness in dairy cattle is the heel wart or papillomatous digital dermatitis. This is an infectious condition resulting from the spread of one or several species of *Treponeme.* Sole ulceration was the second most important category and white line disease the third. These last two conditions result from laminitis – a common condition believed to be triggered by ruminal acidosis.

Table 2. Frequency of lameness types from 1395 lameness events recorded on 11 Wisconsin Dairy herds. (Cook, 2000)

Type of Lameness	Proportion of Cases
Foot Rot	2.0
Heel Warts	52.6
Corns	1.2
Heel Horn Erosion	2.1
Sole Hemorrhage	8.4
White Line Disease	11.8
Sole Ulcer	21.1
Toe Ulcer	0.8

Hygiene and Lameness

Cattle housed in wet, manure contaminated conditions are more likely to suffer infectious diseases of the foot, such as interdigital necrobacillosis (foot rot), heel horn erosion (HHE) and papillomatous digital dermatitis (heel warts; PDD), (Bergsten, 1997; Cook & Cutler, 1995; Philipot et al., 1994). Wells et al. (1999) in a survey of a large number of dairy herds across North America, concluded that 43.5% of herds were affected with PDD. The authors experience in Wisconsin is that 85% of the herds are now affected and PDD is responsible for 53% of all lameness treatments.

The cleaner and drier we can maintain the foot, the lower will be the prevalence of PDD. In tiestalls, foot hygiene will be determined by:

- The frequency of scraping the manure from the exercise area
- The adequacy of bedding management and the moisture level at the rear of the stall
- Whether or not the manure gutter is cleaned before the cows exit the barn, or whether it is covered by a grate.

Electric cow trainers are commonplace in stanchion and tiestall barns throughout the Mid-west, yet they have been prohibited in Sweden since 1995 for welfare reasons. Bergsten and Pettersson (1992) found that trainers were beneficial in terms of improved hygiene and claw health and Alban et al. (1996) found that trainers decreased the risk of hock lesions. However, Oltenacu et al. (1998) showed an increased risk of silent heats, mastitis, ketosis and culling in 33 herds with trainers, compared with 117 herds without. Many things impact the welfare of our dairy cows and the authors experience with managing stanchion cows, would suggest that “humane” trainers are an integral part of maintaining clean stalls and reducing the rate of clinical mastitis – which is in disagreement with the finding from the latter Swedish survey. A study involving within herd controls is required to shed more light on this area.

Foot and leg hygiene in freestall barns is usually worse than in tiestalls, largely because of the quantity of manure present in the alleys and the frequency that the cows have to walk through it. Major factors influencing the degree of leg contamination in lactating cow pens are:

- Pen design – two rows or three rows of freestalls

- Frequency of alley scraping
- Stocking density in the pen
- Stall comfort and lying times

Two vs Three rows

A three row freestall pen with three crossovers, designed to house 100 cows, will have approximately 4070 square feet of alleyway and crossovers. A two row freestall pen, also designed to house 100 cows tail to tail, with the same number of crossovers, will have approximately 5004 square feet of alleyway area. That equates to 20% less surface area for the same quantity of manure; approximately 11,000 lbs per day. Unless we scrape more frequently, the manure level in the pen will be deeper, resulting in dirtier feet and legs and an increased risk of PDD (Cook, 2001).

Frequency of removal

Frequency and type of alley scraping will have a major impact on manure accumulation. Currently there are four main options:

- Slatted floors
- Flushing
- Manual scraping
- Automatic scrapers

Slatted floors are common place in Europe, but they are coming under increasing scrutiny due to poor air quality and high ammonia concentration levels in barns. A recent study suggested that cows have no preference for grooved concrete or a slatted area (Stefanowska et al., 2002). However, with the varied climate in the US, slatted barns are unlikely to become commonplace. Flushing and manual scraping are usually performed when the cows are in the collecting yard for milking, hence normally 2 or 3 times per day. Guidelines for the frequency of removal of manure based on hygiene and health assessments are unavailable. Data from seven dairies in Wisconsin, scraping between 1 and 4 times a day, would suggest that three times a day should be viewed as a minimum frequency for the control of infectious foot disease. Automatic scrapers have the potential to keep freestall cow's lower limbs cleaner, only if they are operated continuously and over a short distance, so that cows do not have to walk through a large wave of manure as it progresses through the pen.

Overstocking

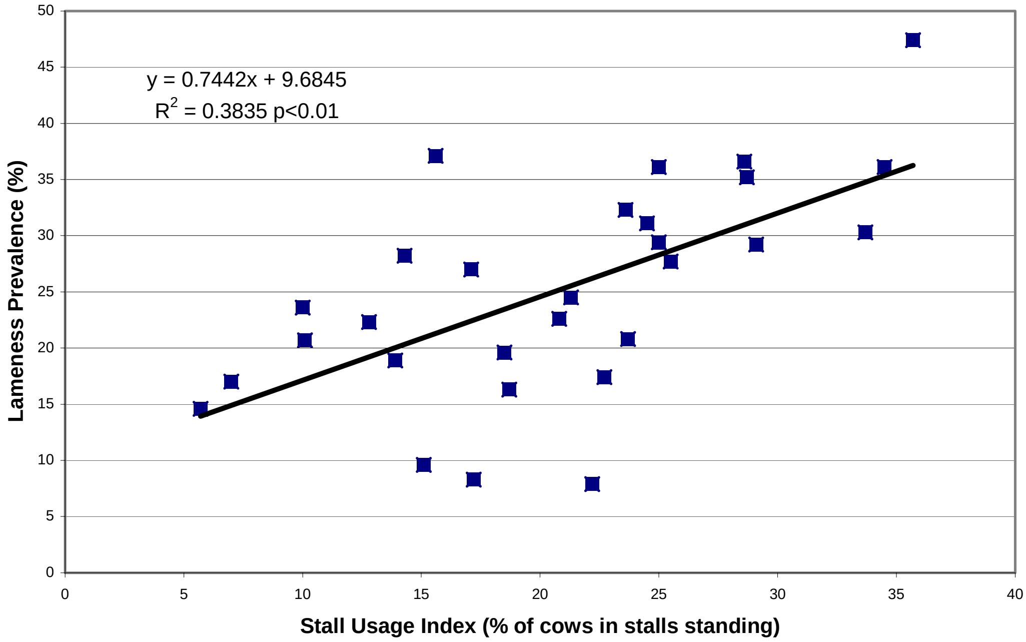
Overstocking will lead to more manure being deposited per square foot of alleyway and exacerbate existing problems, particularly in six row freestall barns, milked and scraped twice daily. It will also impact lying time and potentially increase the risk of laminitis if maintained over a long period. (Leonard et al., 1996).

Cow Comfort and Lying Times

There is a growing body of evidence that increased lying times have a beneficial effect on lameness prevalence and claw health, and obviously increased time spent lying down in a clean dry comfortable stall will mean less time walking up and down alleyways and lead to cleaner drier feet. However, there are surprisingly few studies that document lying times, claw lesions and lameness prevalence. Leonard et al., (1994) noted that decreased lying times and increased periods spent standing half in and half out of stalls with a more restrictive divider style, were associated with reduced claw health and Galindo and Broom (2000) showed that cows low in the hierarchy spent more than 45% of the time standing in alleys and suffered significantly more sole, interdigital and heel lesions.

Cook (2002) demonstrated that a Stall Usage Index, measured as the proportion of cows in stalls that were standing either completely in or half in stalls one hour before milking, was significantly related to lameness prevalence in a recent Wisconsin lameness survey (Figure 1).

Figure 1. The relationship between Stall Usage Index and Lameness Prevalence In Wisconsin Freestall herds



Targets for appropriate daily lying time must come from studies of dairy cow behavior in an unencumbered environment. Singh et al. (1994), studying resting time for cows housed in deep straw bedded yards, suggested that 10 hours per day should be considered adequate lying time and more recently, Phillips and Rind (2001) recording lying times of cattle at pasture found lying times of 10.9 to 11.5 hours per day. A lying time of around 11 hours per day would therefore be considered an appropriate target for all cows. We believe that sub-optimal environments increase the proportion of cows which do not regularly lie down for at least 11 hours per day, and it is these "outlier" cows that are at risk of developing lameness and other health problems.

Freestall Assessment

We have developed a system of assessing freestalls from a cow's perspective, getting into, lying down, standing and leaving the stall (Nordlund and Cook, 2002). The five points we need to consider are:

- Adequacy of surface cushion
- A defined resting area of appropriate area for the size of the cow using the stall
- Adequate room for lunge and an unobstructed bob zone
- Adequate height below and behind the neck-rail
- A curb height no higher than 8 inches

We believe that the most important factor determining stall usage is surface cushion. It is the author's opinion that cows will tolerate many inadequacies of design, to lie on a cushioned surface. Work by Wandel et al. (2002) elegantly showed daily lying times increase with increasing surface cushion in the same stall and Gebremedhin et al. (1985) demonstrated a cow preference for a deep soil bed over a rubber mat or concrete. In the Wisconsin lameness survey, sand base stall housing achieved a significantly improved Stall Usage Index score and a lower prevalence of lameness (Cook, 2002) (Table 3).

Table 3. The effect of stall base on Lameness Prevalence, Stall Usage Index and the Proportion of cows with hock abrasions on 30 Wisconsin Dairy Farms

	Sand Stall Base Herds (n=8)	Other**Stall Base Herds (n=22)
Mean (SE) Lameness Prevalence		
Summer	13.6 (3.2)*	24.2 (2.0)*
Winter	16.9 (4.0)*	27.2 (2.3)*
Freestall Stall Usage Index (%)	15.0*	25.0*
Proportion of cows with hock abrasion (%)	5.4*	38.8*

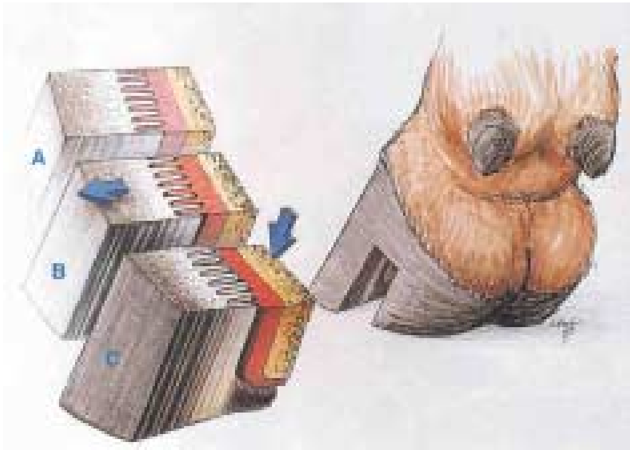
* Denotes statistical significance across rows at P<0.05, one way ANOVA
** Other refers to stall bases made of bedded concrete, rubber mats and rubber filled mattresses

Mattresses have the distinct disadvantage over sand in that they carry a much greater risk of hock damage. In one study, 91% of cows on mattresses and only 24% of cows on sand had evidence of hock abrasion (Weary and Tazskun, 2000).

How does improved Cow Comfort Reduce Laminitis?

Current theories on the pathogenesis of laminitis clearly demonstrate an interaction between events around parturition, diet and the environment (Livesey et al., 1998; Webster, 2001). In the authors opinion, excessive weight bearing may facilitate the loosening and elasticity of tissues at the dermal epidermal lamellar junction, triggered by the activation of metalloproteinases and other similar enzymes from either hormonal events around calving time (Tarlton & Webster, 2002), or from the action of *Streptococcus bovis* exotoxin (Mungall et al., 2001) released during an acidotic event. Increased duration of weight bearing may facilitate the transport of the exotoxin to the capillary beds of the dermal tissues, and also stress the connections between the dermis and epidermis, facilitating sinking of the pedal bone within the horn capsule, subsequently producing clinical signs of laminitis at the sole surface.

Figure 2: Sinking of the pedal bone within the claw (Ossent, 1996)



Increased time spent lying per day will ultimately reduce the severity of the damage caused to the hoof by these processes.

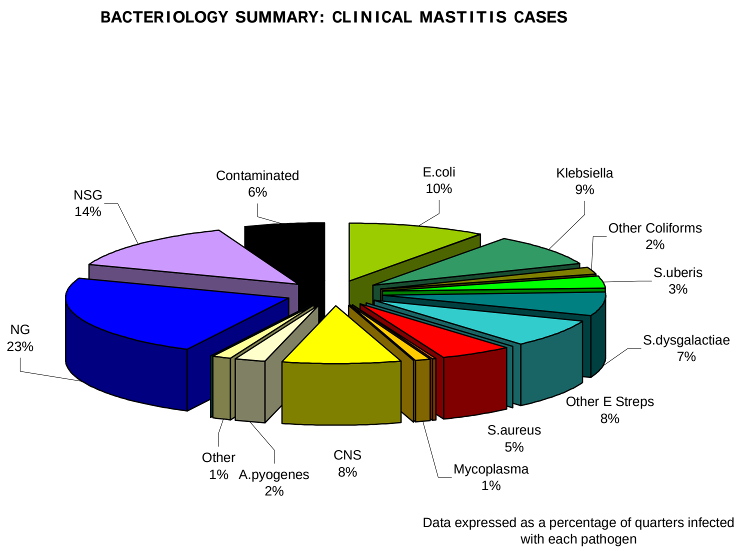
Lameness and Walking Surface

Rough walking surfaces have been shown to increase lameness prevalence (Faye and Lescourret, 1989) and excessive exposure to concrete may result in excessive wear of the claws. However, the benefits of installing rubberized walking surfaces in the feed alleys of freestall barns have yet to be proven. Vokey et al. (2002) found no overall significant effect of rubber alleys on claw lesions and lameness, but did highlight the many complex interactions between stall base type and walking surface. Use of such surfaces on return alleys from the parlor, and any other high traffic areas is recommended.

Environmental Effects on Udder Health

Culture of clinical cases on the last 22 herds investigated by the Production Medicine group at the UW-SVM demonstrates that coliforms and environmental streptococci are the major udder pathogens involved (Figure 3). Clinical case rate on these herds averaged 70 cases per 100 cows per year.

Figure 3. Distribution of Udder Pathogens in 439 clinical mastitis cases on Wisconsin dairy farms.



Keeping cows clean is an essential part of environmental mastitis control – and this applies to dry cows and heifers in addition to lactating cows!

Figure 4 shows a hygiene scoring system developed and used on Milk Quality Control Investigations for over two years. It charts the degree of manure contamination in three main zones; the udder, the lower leg (rear only) and the upper leg and flank. The chart has evolved over time and a color version can now be downloaded at www.vetmed.wisc.edu/dms/fapm/forms.htm. Typically, all of the milking cows in a tiestall barn and 25% of the cows in each pen in a freestall barn are scored, along with dry cows and heifers.

Figure 4. A chart for hygiene scoring cows on a scale of 1 - 4 for three zones of the body; udder, lower leg and upper leg and flank.

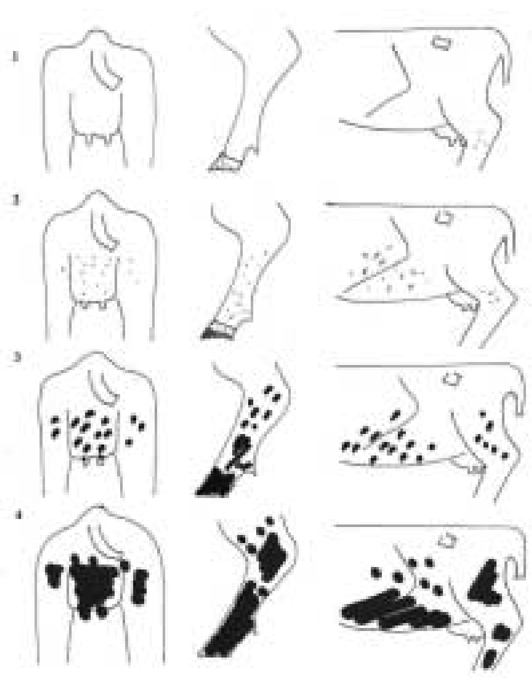


Table 4 summarizes data collected from 27 Wisconsin dairy farms suggesting benchmarks for the proportion of each zone designated too dirty for freestall and tiestall herds.

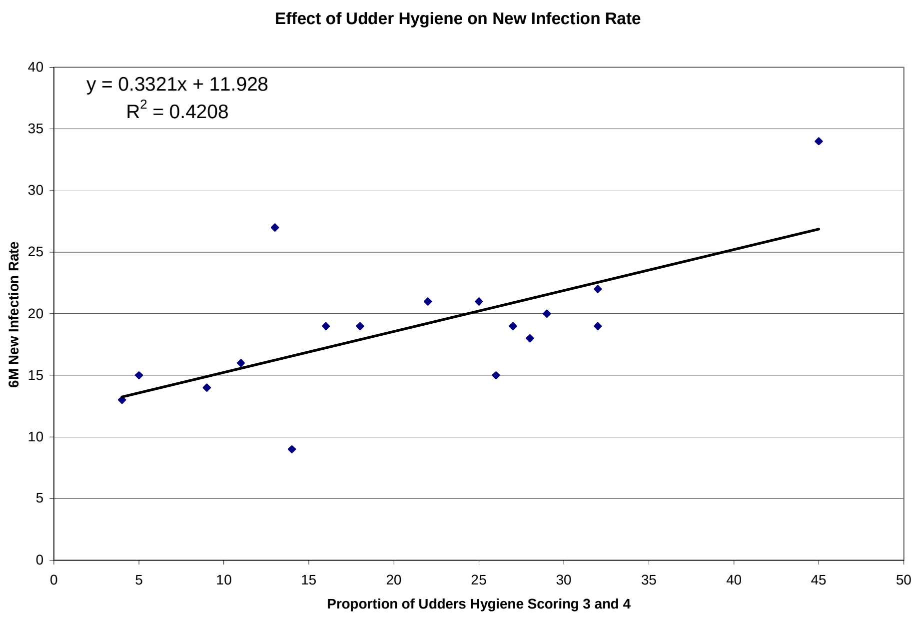
Table 4. Mean proportion of hygiene scores 3 and 4 for udder, lower leg and upper leg and flank zones for 27 Wisconsin dairy farms.

Barn Type	Proportion of Hygiene Scores 3 and 4		
	Udder	Lower Leg	Upper Leg and Flank
Mean Freestall herd	20	54	17
Best Zone Scores	5	24	6
Mean Tiestall herds	18	25	26
Best Zone Scores	0	9	5

The acceptable level of manure contamination of cattle appears to vary between countries and between regions within a country. As a veterinarian visiting the farm, it is difficult to tell a farmer that their cows are "too dirty" and that improved cleanliness is required. Use of a quantitative approach, rather than a qualitative opinion, is a more effective means of delivering the message and by scoring in zones we can give more structured advice on how to keep cows cleaner.

Data from Milk Quality Control Investigations (Figure 5) made by the author, demonstrates a significant ($R^2 = 0.42$) relationship between the proportion of udders scoring 3 and 4 on each farm and a monthly mean udder new infection rate derived from Somatic Cell Count analysis. These data confirm the significance of keeping cows and udders clean and lend support to the system of scoring presented.

Figure 5. The Association between Udder Hygiene Score and Monthly New Infection Rate on 17 Wisconsin dairy farms



It is however, important to realize that the presence of large bacterial numbers at the teat end may not always be obvious. Bey et al., (2002) have described a commercially available method of assessing the number of bacteria in bedding samples and the author has personal experience of several instances where apparently clean bedding harbored many millions of potential udder pathogens, which may have contributed to new udder infections.

In general, the finer the bedding particle the more bacteria the material will be able to sustain once it becomes warm and moist. Bedding should not be stored at the front of the stall and scraped to the back as it will have incubated on the stall surface beneath the cow and will contain vast numbers of potential pathogens. Instead, we recommend more frequent application of bedding, once daily. Bedding additives aimed at controlling bacterial growth, such as hydrated lime need to be added to the stall daily as their length of action is little more than 24 hours.

Sand stalls should receive fresh bedding every 7 days. Flatten the bed each milking with the flat side of a garden rake. Sand which clumps in the hand when compressed, and stays in a ball as it is thrown from hand to hand for more than 2 or 3 throws contains too much organic matter and should be removed from the stall.

Conclusion

The environment in which we place the dairy cow has an impact on hygiene status, lying time and in some situations, it may be responsible for trauma and injury. If our dairy cows are to have longer and more productive lives, we must improve the environment in which we keep them in order to reduce levels of lameness and mastitis. Use of well managed sand bedded stalls in both tiestall and freestall barns carries distinct benefits in terms of foot and udder health. In the author's opinion, these health benefits far exceed any extra expense incurred by manure handling. Stall design and mattress surfaces are improving, but further development is needed if they are to compete with the health benefits of sand.

References

Alban L, Agger JF, Lawson LG: Lameness in tied Danish dairy cattle: the possible influence of housing systems, management, milk yield, and prior incidents of lameness. *Prev Vet Med* 29:135-149, 1996.

Bergsten C and Pettersson B: The cleanliness of cows tied in stalls and the health of their hooves as influenced by the use of electric trainers. *Prev Vet Med* 13: 229-238, 1992

Bergsten C: Infectious diseases of the digits. p 89-100. In *Lameness in Cattle. 3rd Edition*. WB. Saunders Co. Philadelphia, 1997

Bey RF, Reneau JK, Farnsworth RJ: The role of bedding management in udder health, 45 – 55 In *41st Annual Meeting Proceedings of National Mastitis Council, Inc*. February 3-6, Orlando, Florida, 2002.

Cook NB, Cutler KL: Treatment and outcome of a severe form of foul-in-the-foot. *Vet Rec*136: 19-20, 1995.

Cook NB: How good is sand bedding for your cows? *Hoard's Dairyman* October 25th, 2001

Cook NB: Lameness prevalence and the effect of housing on 30 Wisconsin dairy herds. p 325-327, *Proc 12th Int Symp Lameness in Ruminants*, Orlando, 2002

Cook NB: Two row barns or three-row – that is the question! *UK Vet* 7: 1-3, 20

Faye B, Lescourret F: Environmental factors associated with lameness in dairy cattle. *Prev Vet Med* 7: 267-287, 1989

Galindo F and Broom DM: The relationships between social behaviour of dairy cows and the occurrence of lameness in three herds. *Res Vet Sci* 69: 75-79, 2000

Gebremedhin KG, Cramer CO, Larsen HJ: Preference of dairy cattle for stall options in freestall housing. *Transactions of ASAE* 28: 1637-1640, 1985.

Hultgren J: Observational and experimental studies of the influence of housing factors on the behaviour and health of dairy cows. *Doctoral thesis*. Uppsala, Sweden, 2001.

Leonard FC, O'Connell JM, O'Farrell KJ: Effect of different housing conditions on behaviour and foot lesions in friesian heifers. *Vet Rec* 134: 490-494, 1994

Leonard FC, O'Connell JM, O'Farrell KJ: Effect of overcrowding on claw health in first-calved friesian heifers. *Br Vet J* 152: 459-472,1996

Mungall BA, Kyaw-Tanner M, Pollitt CC: In vitro evidence for a bacterial pathogenesis of equine laminitis. *Vet Microbiol*. 79:209-223

Nordlund K, Cook NB: A flowchart for evaluating dairy cow freestalls. *Comp Cont Ed*. (Submitted for publication), 2002.

Oltenacu PA, Hultgren J, Algers B: Associations between use of electric cow-trainers and clinical diseases, reproductive performance and culling in Swedish dairy cattle. *Prev Vet Med* 37: 77-90, 1998

Phillips CJC, Rind MI: The effects on production and behaviour of mixing uniparous and multiparous cows. *J Dairy Sci* 84: 2424-2429, 2001

Singh SS, Ward WR, Hughes JW, Lautenbach K, Murray RD: Behaviour of dairy cows in a straw yard in relation to lameness. *Vet Rec* 135: 251-253, 1994.

Tarlton JF, Webster AJF: A biochemical and biomechanical basis for the pathogenesis of claw horn lesions. p 395-398. Proc *12th Int Symp Lameness in Ruminants*, Orlando, 2002

Vokey FJ, Guard CL, Erb HN, Galton DM: Effects of alley and stall surfaces on indices of claw and leg health in dairy cattle housed in a freestall barn. *J Dairy Sci* 84: 2686-2699, 2002

Wandel H, Jungbluth T, Benz B: Cow comfort in losse house systems. p313 *Proc 12th Int Symp Lameness in Ruminants*, Orlando, 2002

Weary DM and Taszkun I: Hock lesions and freestall design. *J Dairy Sci* 83: 697-702, 2000

Whitaker DA, Kelly JM Smith S, Burrough E: Disposal and disease rates in 400 British dairy herds over three years. XXII World Buiatrics Congress, Abstract. 2002