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Lameness in dairy cows in freestall barns with automatic milking systems.

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Summary

Five farms in Norway were surveyed for lameness under the assumption that the levels of lameness would be high due to changing of keeping conditions and milking system. The levels were found to be around 70% in the stables surveyed which is high compared with other studies. Some advice was given to the farmers to improve the conditions. Only some farmers implemented the changes suggested, so the decreases in lameness are uncertain. The main measures to be suggested to the farmers in the future, is regular, professional trimming, improving hygiene, and optimizing feeding.

Introduction

Lameness is a very important factor in dairy cattle, because of its huge impact affecting health and decreasing productivity (Enting *et al*., 1997). The disease is second only to mastitis in terms of its detrimental effect on herd productivity (Esslemont and Kossaibati, 1996). Vermunt and Greenough (1994) recommend that in order to relieve their feet and help reduce the prevalence and incidence of lameness, cows being kept on hard surfaces for long periods of time should be given access to areas covered with a softer surface. This method of housing was used for years in Norway when cows graze in the warmer part of the year and were kept indoors in winter. However, Norwegian dairy industry is moving rapidly into a type of farming novel to the Norwegian farmer, with large free keeping stalls, little or no pasture, and concrete floors. In contrast to the traditional tied stables combined with summer pasture. These conditions are very familiar to most of continental Europe, were this seems to be the dominant keeping system of dairy cows. Lameness has been underestimated and undertreated in the new keeping system and is a new challenge for the farmer, hoof trimmers and veterinary service. In Norway 85-90% of cattle have been kept in tied down systems. Due to changes in regulation, all cows must be in free keeping stables by 2024. (Sogstad, Fjeldaas and Østerås 2003.) All the involved personnel must be trained and prepared for the new challenges.

During regular veterinary practice in the area, a need for a proper assessment of the situation of lameness was found by the author. In the area were the investigation was performed the interest and knowledge on lameness was generally low, the farmers were not able to correctly spot the lame cow in their own herd. The local veterinary service also had an inadequate level of interest in tackling the high levels of lameness. The rather resent changes in keeping at investigated farms are probably the main cause for this lack of knowledge on the farmers' side. The general knowledge level on other issues like fertility, feeding, e.g. seems so be at a higher level both on farmers level and veterinary service.

This study focused on assessment of lame cows and looking into possible problems and their solutions together with the farmers at the time of the investigation. The importance of keeping lameness to a minimum is compounded by the fact that automatic milking systems (AMS) are becoming increasingly common in Norway. These systems require the cow to walk on her own will to the milking parlor. Therefore a cow that experiences pain from walking might be

more reluctant to go for milking. (Dearing) This will in turn reduce the yield of that cow, and predispose for udder problems.

The aim of the study was to minimize occurrence of lameness by visiting farms twice. During the first visit farmers' knowledge about treating lameness was checked and other possible solutions were explained. The second visit was carried to check how many solutions for minimizing lameness were successful. The following general hypothesis was tested: Farmers given training and possible solutions are able to minimize lameness in dairy cows in freestall barns with Automatic Milking Systems.

Literature Review

Lameness is a disturbance in the cows' locomotion. In 90 % of cases the lameness found in dairy cattle are caused by lesions on the claw. (Murray *et al*., 1996) Lameness is often a chronically painful and stressful condition for cattle (Walker *et al*., 2008). The pain and stress will by default lower the general welfare of the animals to a certain degree.

Lameness can be scored using different methods, among the common methods includes locomotion and posture scores. Systems were the lameness can be scored on a scale from 1-5, were 1 is a non lame animal and 5 is an animal that is putting no weight at all on the affected limb or claw have been developed. The back posture is also important, a curved back indication that the cow tries to relive weight form painful areas. (Sprecher *et al*., 1997)

65, 2% of the 66 cows in one study were found to be lame. (Sprecher 1997) 80% of cattle in Dutch study with high producing Holstein kept on concrete floor had at least one claw disorder at the time of observation. (Somers 2003) In 2002 a Swedish study involving 102 herds and 4899 trimmed cows, found 72% of the cows had at least one hoof lesion. In the same study only 5, 1 % was lame. (Manske 2002) The cows in the mentioned study were scored for lameness only when the cows were driven into the trimming box. This might explain the relative low level of lameness observed compared to the findings in the hoofs.

An English study, looking at the lameness in 37 dairy farms, found a mean of 54, 6 new cases of lameness per 100 cows annually. Using the 1-5 scale developed by Sprecher et al, they judged lame cows, to be cows with a score of 3 or more. (Clarkson, et al. 1996) In contrast, this paper chooses to judge all cows with a score of 2 or more to be lame.

There is a strong correlation of the gait scoring and the presence of pathological changes in the hoof. Subjective assessments of dairy cattle gait provide valid and reliable approaches to identifying cattle with sole ulcers. Even though they are subjective and there is room for error by the person scoring the cows. (Flower and Weary 2006) This makes locomotion scoring into a useful tool in the hands of the personell working with the cattle.

In modern dairy farming lameness is the third most important disease, measured by the economic loss caused by the disease. It is only mastitis and fertility problems that have higher costs connected with them. In percentage fertility have 45% of costs, mastitis, 35 and

lameness 20% among the top three diseases. In Europe, the cost of a lame cow is estimated to be around 250 Euro, including lost production, premature culling, veterinary costs etc. (Dearing n.d.) The costs of a lame cow in Norwegian conditions have not been calculated specifically as far as the author has found, but it is safe to assume the cost is significant.

Hoof health strongly influence the animals overall well being. Healthy hooves are important for the optimum performance and production of dairy cattle. (C. Bergsten 2001) Lame cows loose rank in the herd. They change their eating behavior; they spent longer times lying down and eat larger portions, making for suboptimal digestion.

The fertility goes down. They cannot jump, express climbing behavior and they have negative energy balance. The results show lame cows were 3.5 times more likely to experience delayed ovarian activity than non-lame herdmates and negative energy balance, because cows need to produce milk and for some time are using body reserves. (C. Bergsten 2001) In (Sprecher 1997) the cows with lameness were found to have an increased risk of culling in addition to their reduced reproductive efficiency. Lameness scores of three or more, on the Sprechers 1-5 scale, should trigger correct intervention to prevent the losses.

There are a number of different reasons for hoof lesions. There are infective agents, laminitis or traumatic in the background. Swedish studies found that the most prevalent lesions were sole ulcers, white line abscesses, digital dermatitis and interdigital phlegmon. (C. Bergsten 2001) In a similar Norwegian study by Sognstad where 1547 cow and 403 heifers in free stalls, were trimmed and scored by professional claw trimmers, the prevalence of lameness was low, 1, 6%. The distribution was 0, 3% on front limbs and 1, 6 on hind limbs. The prevalence of lesions in the hoof was significantly higher than the lameness found, Of the trimmed cows 39, 6% had heelhorn erosion, 20% had hemorrhages on the sole, 13, 6% had hemorrhages of the whiteline, 9, 4% had whiteline fissures, 6, 7 % had dermatitis in some form and 3% had sole ulcers. Herds in the mentioned study are assumed to be representative for freestall herds in Norway. (Sogstad ÅM 2005)

The occurrence of lameness have a complex background, time and place of the lameness varies. There are several important hazard point must be aware of. The quality of the floors, shape, hardness, friction and hygiene plays a role. The wall of the hoof is the strongest part and meant to bear the weight; the sole protects underside and the sensitive corium. The white

line is a weak horn structure (C. Bergsten 2001). This makes the hoof ill suited for life on concrete.

Typical flooring in stables includes solid concrete, slatted concrete and rubber mats. The yielding rubber mats have a positive effect on the locomotion both for lame and non lame cows.

The most slippery surfaces are the slatted concrete, on the other hand the solid concrete have the highest friction coefficient. (E. B. Telezhenko 2005). The concrete is both abrasive and slippery, when tested against two types of rubber mats, the cows showed a distinct preference for the soft floor. The lame cows did not show this preference as clearly most likely due to their lower social standing. The solid rubber mats were preferred by the cows over the slatted version. (E. L. Telezhenko 2007) Lameness is also connected to high production levels. (Manske 2002) This might be explained by the greater burden placed on the animals of the highest production levels.

In confined management systems lameness goes up and on concrete slatted floors there is significantly more whiteline hemorrhages than other floor types. Also keeping cows for prolonged periods on uncomfortable floor increase the risk of leg injuries (C. Bergsten 2001). The loose keeping housing system the level of lameness is 3 times higher than in tied down systems (Manske 2002). The reasons for these difference might be that cows are not forced to walk on uncomfortable surface, less dung and manure, more bedding is typically used and no stress to claws.

A Norwegian study, (Sogstad ÅM 2005) found that the short cubicles increase the risk of hemorrhages of the sole, and probably for heelhorn erosions. Automatic scrapers and solid floor gave a higher prevalence of heelhorn erosions versus stalls with slatted concrete. In solid floor stables there was also an increased risk of white line hemorrhage, but not for sole hemorrhages.

In the same study, walking on an uneven surface like slatted concrete was believed to subject more uneven forces on the claws. Since the mechanical influences are the most important components in the pathogenesis of whiteline fissures, this lead to higher numbers of whiteline fissures on slatted concrete. More corkscrew claws where found on solid concrete than on slatted concrete. Sole hemorrhages were more prevalent on primiparous cows. In general more lameness was found on older cows. This might be a result of aging effects and the

accumulation of damages to claw tissue. Corkscrew laws were associated with solid concrete floors.

Trimming was found to reduce the risk of lameness in Swedish conditions. (Manske 2002) It is harder to trim claws of cows that stand on concrete because they are already subjected to hard wearing. (C. Bergsten 2001)

Dirty hooves have a higher prevalence of foot diseases. In a tied down system, using rubber slatted floor, the cleanliness of the cows' hooves was improved and following this improvement, they experienced less disease than on concrete. (Hultgren and Bergsten 2001) Dirty cows were also by (Sogstad ÅM 2005) found to have more heelhorn erosion. In (Weaver, Jean og Steiner 2005) interdigital necrobacillosis are connected with dirty wet tracks and wet areas. The main prevention recommended is keeping the stable dry and give the cows regular footbaths. The same book associated the occurrence of sole ulcers with laminitis and the best prevention measure is regular trimming.

In the case of punctured soles, avoid laminitis and sharp hazardous points is the recommended preventive measures. In case of whiteline problems, again the avoiding of laminitis and regular trimming are the key points.

In brief on laminitis (Weaver, Jean og Steiner 2005) mentions the avoiding of large amounts of prepartum concentrates and high intake of concentrates in early lactation for prevention. Giving enough roughage before and after feeding concentrates, in turn avoiding lactic acidosis is vital. It is recommended to accustom calving heifers to concrete yards and cubicles, and avoid rough concrete are also very important. To ensure regular claw examination and trimming are essential to reduce lameness associated with laminitis. (Manson and Leaver 1988b)

Laminitis is related with several of other types of hooflesions, a comprehensive study by (C. Bergsten 2003) sole ulcers, whiteline lesions including hemorrhages and abscesses. Sole hemorrhages, double soles, toe ulcers, toe necrosis, and under running of the heel. Slaughtered cows with chronic recurrent laminitis have a concavity of the dorsal wall, associated with the permanent rotation of the claw bone and production of the corium predisposing for sole ulcers. Hard floors were found to increase the risk of subclinical laminitis and by that other hooflesions. Laminitis can be avoided with physiological digestion and careful feeding of concentrates, even though the connection between high concentrate

diets and laminitis is not as clearly established as in horses. The secondary lesions can be avoided by accurate and physiological loading on the claw. (C. Bergsten 2003) (C. Bergsten 2000)

Digital dermatitis (DD), a digital skin disease of cattle, was first described in 1974 in Italy and is characterized by inflammation of the skin, most times in the region of the bulb of the heel and coronet of the claw (Cheli and Mortellaro, 1974). Today, the disease has spread all over the world and has been reported at an endemic stage in the United Kingdom, The Netherlands, and most other countries in Western Europe and the United States. (Brizzi, 1993; van Amstel et al., 1995; Clarkson et al., 1996; Rodrigues-Lainz et al., 1996, 1999; Read and Walker, 1998a; Wells et al., 1999; Murray et al., 2002; Somers et al., 2003). In other countries, such as Japan, Australia, and New Zealand, DD is treated as an incidental lesion (Kimura et al., 1993; McLennan and McKenzie, 1996; Vermunt and Hill, 2004).

However, in Norway, DD is being considered increasingly problematic because of the switching from current tie-stall housing systems to free stalls (Sognstad et al., 2005). This is in accordance with the results of a recent Dutch study, where a clear influence of housing system on DD prevalence was found (Somers et al., 2003).

In the case of digital dermatitis, keeping the feet dry, scrap often and remove causes of micro trauma in the stable should help. With sand cracks trimming of the claws is the major point.

In a Norwegian study, (Sogstad ÅM 2005), a number of factor connected with the age and parity were found to have an impact on the hooflesions, in addition to the mentioned age factor, cow in the 5-7th month of lactation were found to have more heelhorn erosions and hemorrhages in the sole. In the 3-5th month the risk of hemorrhages in the white line were highest. The occurrences of asynchrony in the size of claws increased above the second calf.

In prevention, breeding will probably play a larger part in the future. With e.g. a steeper toe angle on heifers there is room for improvement. (Manske 2002)

The most often recommended method for trimming cows is the so-called Dutch 5step method even though there is some disagreement over details. E.g. some authors recommend leaving one claw slightly longer than the other, instead of strictly making the claws equal in size. (Blowey 2008). The goal of trimming is to reduce lameness, improve mobility and improving grip of the claw.

The following steps, outlining briefly the method, are taken from, (Bell 2009) part 1.

The first step is to measure the claw. It should be 7,5cm on an average Holstein cow. Then the sole is trimmed down so that the thickness at the tip of the toe measures 5-7cm. The heel should and must be saved as much as possible. With digital pressure the softness of the surface must be checked so that not too much horn is removed, exposing sensitive tissue.

The second step is to cut the opposite claw, so that it matches the trimmed claw.

The third step is dishing out the sole, helping to prevent dirt from sticking between the claws and relive weight of the area of the heel were the risk of heel ulcers are the greatest.

The forth step is to take weight of any lesions found. This is done by trimming down the heelhorn of the affected claw or applying a block on the healthy claw. This leaves the area with lesions to heal.

The fifth step is to remove any loose or under run horn and hard ridges.

Proper training of the hoof trimmer is very important. The hygiene of the work, the ability to treat any conditions exposed by cleaning and trimming is important.

Materials and methods

A survey of the lameness condition in 5 farms with loosekeeping and automatic milking system (AMS) was performed by the author.

The farms were chosen on the basis of the size of the herds, they are the 5 largest herds in the district of Hemne and Snillfjord in Norway, all having from 40 to 60 lactating cows. They all have free keeping system stables with Delaval fittings and Delaval AMS systems. All have been constructed or rebuilt into the current state during the period 2004-2010. The farms are assumed to represent the most probable type of stable dominating the local dairy industry. All these farmers have shown a willing to invest and build for future running of dairy farms.

The farms were asked in December 2010 for their participation in the survey. All the contacted farms agreed to participate in the study.

January visit

In January of 2011 the farms were visited for the first time. The cows were scored using the locomotion score 1-5. (Fig 1.).

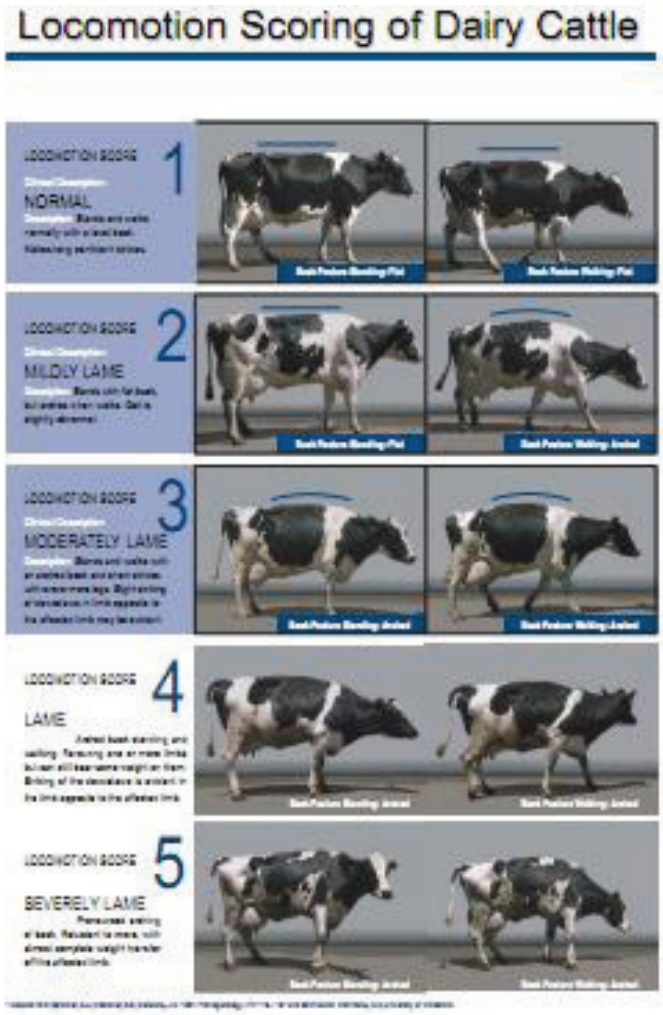

Figure 1. Locomotion score used in the survey (Sprecher et al., 1997)

The scores can be interprated as follows:

Lameness score 1 - Normal - Stands and walks normally with a level back. Makes long confident strides.

Lameness score 2 - Mildly lame - Stands with flat back, but arches when walks. Gait is slightly abnormal.

Lameness score 3 - Moderately lame - Stands and walks with an arched back and short strides with one or more legs. Slight sinking of dew-claw in limb opposite to the affected limb may be evident.

Lameness score 4- Lame - Arched back standing and walking. Favoring one or more limbs, but can still bear some weight on them. Sinking of the dew-claws is evident in the limb opposite to the affected limb.

Lameness score 5- Severely lame - Pronounced arching of back. The cow is reluctant to move, with almost complete weight transfer off the affected limb.

Data on milk production were recorded for the individual farms. The farms had an average production of 8140kg of milk per cow, ranging from 7000kg to 9500kg Their average fat percentage of 4,01, ranging from 3,82 to 4,55. The protein average is 3, 31, ranging from 3, 11 to 3, 58.

Special protocol was prepared containing performance data, management and housing measures. All data was processed using Microsoft Excel spreadsheet and SPSS 13.0 for Windows.

The cows were scored by observation in the alley of the stables so that they could be scored on the surface they walk on at a daily basis. All cows that were laying down in cubicles were driven into the alleys and scored after being given a certain time to stretch any sore muscles e.g. All the cows were given free area to walk on as relatively dry, flat and non slippery surface as possible. Out of 265 possible cows 221 were scored in January, giving percentage of 83, 4 of cows scored. All adult cows were scored disregarding their production level, stage of parity and age. In case of uncertain score, the highest score was always given.

The farmers were made aware of the findings and high levels of lameness during an interview in connection with the scoring. They were all given some information on the locomotion scoring and given a sheet for scoring walking cows. They were all given advice to make a trimming schedule for the whole herd. Areas of concern in the stables were pointed out. The economic factors with cost of lameness were especially discussed.

August visit

The scoring was repeated in August 2011. None of the farmers were present at this scoring due to harvesting and results were not discussed with the farmers. A total of 212 cows were scored out of 225 possible, giving a percentage of 94, 2 cows scored. One farm had only half the herd in the stable at the time of scoring comparing to January, due to drying of cows and sending them to pasture in the summer. Also the remaining cows had access to grass, and some were scored on the pasture. The remaining four farms had similar conditions like in/as in January's survey.

Results

Locomotion scores found in the survey

During the observation between 60, 47 to 88, 64% of cows were found to be lame in with different scores from mildly lame to severely lame. The average level of lame cows, score 2-5, was 76, 47%. On most of the farms, observing from the best score (1) to the worst one (5) percentage of lame cows is decreasing. Only on one farm there were no cows with locomotion score 5, however this was not the farm with the lower number of lame cows.

Table 1. Locomotion scores in January (%):

	Lame 2+3+4+5	Score 1	Score 2	Score 3	Score 4	Score 5
Farm 1	60,47	39,53	32,56	20,93	4,65	2,33
Farm 2	72,22	27,78	33,33	16,67	19,44	2,78
Farm 3	78,72	21,28	46,81	19,15	12,77	0,00
Farm 4	80,39	19,61	49,02	25,49	1,96	3,92
Farm 5	88,64	11,36	47,73	27,27	9,09	4,55
Total	76,47	23,53	42,53	22,17	9,05	2,71

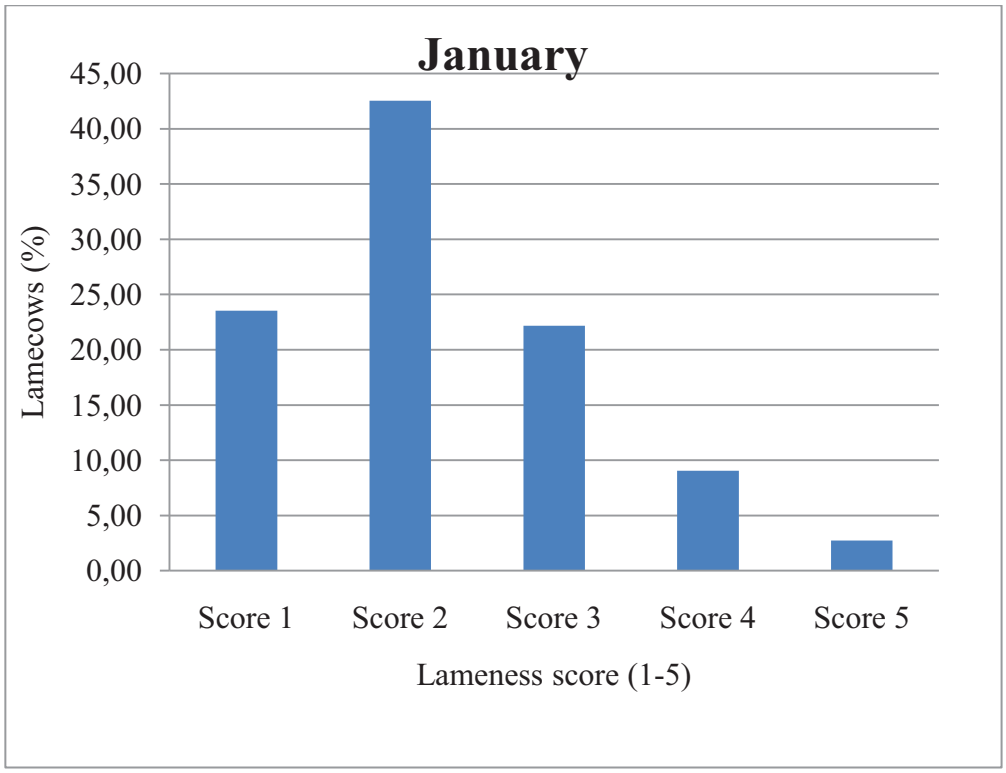

Figure 2. The distribution of the locomotion scores on all the farms.

Table 2. Locomotion scores in August (%):

	Lame 2+3+4+5	Score 1	Score 2	Score 3	Score 4	Score 5
Farm 1	59,09	40,91	31,82	18,18	9,09	0,00
Farm 2	64,58	35,42	29,17	27,08	8,33	0,00
Farm 3	65,38	34,62	34,62	11,54	19,23	0,00
Farm 4	71,43	28,57	45,24	19,05	4,76	2,38
Farm 5	77,08	22,92	31,25	25,00	14,58	6,25
Total	68,40	31,60	34,43	20,28	11,79	1,89

The total level of lame cows, score 2-5 was 68, 40%.

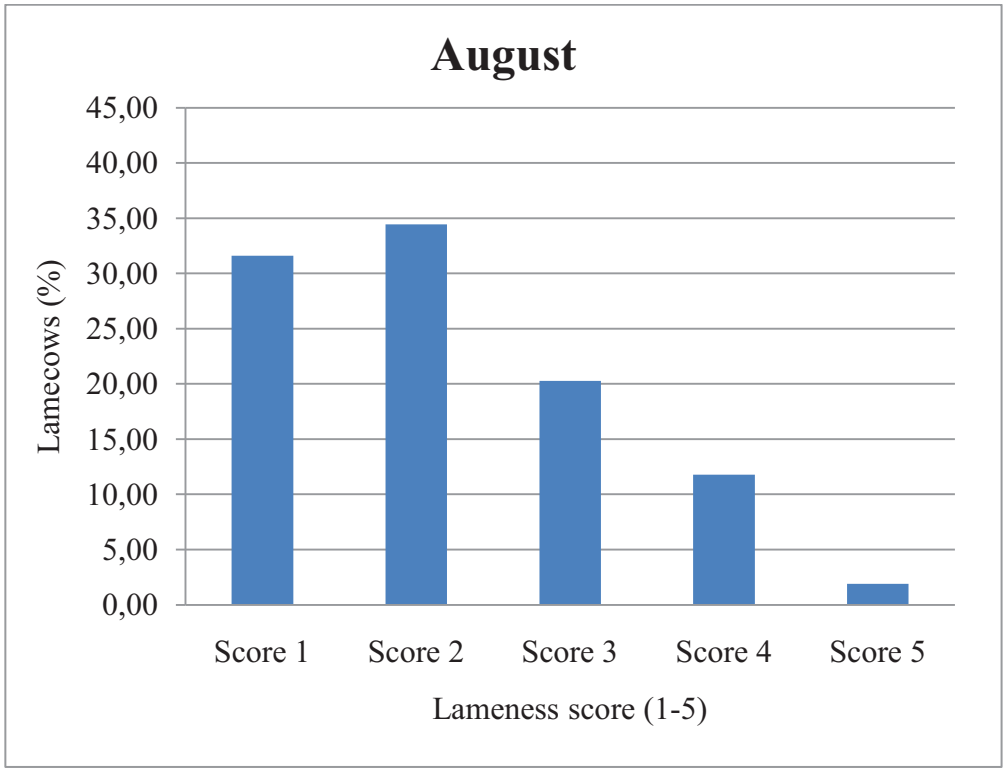

Figure 3. The distribution of the locomotion scores on all the farms.

Number of cows in each lame group was measured on scale from 1 to 5. Observations were randomly sampled from the population and each observation was generated by a different subject. Though, nonparametric Chi-square test for independence or relatedness was used between two categorical variables. Differences between distributions of lame and not lame cows observed in Jan and Aug were not significant on all farms. Results were not significant probably because of lack of power. The probable reason for this was the low number of cows scored.

Environmental findings

None of the farms applied footbaths to the cows. Trimming regimes varied, two farms trimmed all cows once a year, two farms trimmed as required and one did not trim at all. Two farms used a professional trimmer, at two farms all the cows were trimmed by the farmer himself. All kept records on all aspects of health of their cows, also the trimming and veterinary treatment of hoofs. Overgrown hoofs were common in all five stables, (Fig. 4).

Figure 4, typically overgrown hoof seen on all the farms.

All had free stables. One had grooved solid concrete alleys, one had solid concrete and three had slatted concrete alleys. The passageways were solid concrete in four stables, in one there was rubber mats in the passageways. In general all these areas was rather slippery, cows that were observed slipping several times during the visits, see figure 5.

Figure 5, notice the sliding marks left on the smooth passage ways.

One of the farms had all their cows on summer pasture; the other four had all lactating cows in the stable. All had some dry cows and heifers on pasture in varying degrees.

Two had automatic scrapers, two scraped manually twice a day, and one never scraped the alleyways. The lack of scraping causes a buildup of faces close to the cubicles, see figure 6. All the farmers scraped the cubicles manually daily.

Figure 6. Buildup of faces by the cubicles due to no scraping.

In the cubicles one farm had mattresses, the other four had rubber mats, and all used sawdust twice a day in the cubicles, but not more than a handful in a cubicle. All the fittings were metal profiles.

All stables had cubicles that did not have 1 meter lunge area in parts of the stable. The majority of the cubicles were facing other cubicles, providing the lunge space the cow needs for a comfortable way of getting up. See figure 7. None of the cubicles had brisket boards. The number of cubicles was build to be the same as the number of cows in all stables. Since none of the stables had the maximum number of animal, there was a small surplus of cubicles (2-6 free) in comparison to the number of cows.

Figure 7, a cubicle with inadequate lunge space.

The water in four farms was clean. One had dirty water. All had easy access to water for the cows.

All five farms had electric grooming brushes. All had mechanical ventilation.

The cows were fed concentrates individually in a feeder and in the AMS according to production. All fed grass silage three or more times a day. All had automatic feeding systems for grass silage. The farm with cows on pasture did not feed silage in the grassing season. At all five farms the cows stand in the alley when being fed silage. No moldy feed was found on the trough.

The holding areas by the AMS was slatted concrete in all stables, all had a 90 degree turn or more for the cows to get into the AMS. The parlor surface was a mix of solid concrete and slatted concrete. The surface in the AMS was a rubber mat in all cases. All had unnecessary steps higher than 2cm in connection with the milking parlor. And all had sharp turns in the parlor area. See figure 8 and 9.

Figure 8, a high step in a tight corner connected with the AMS

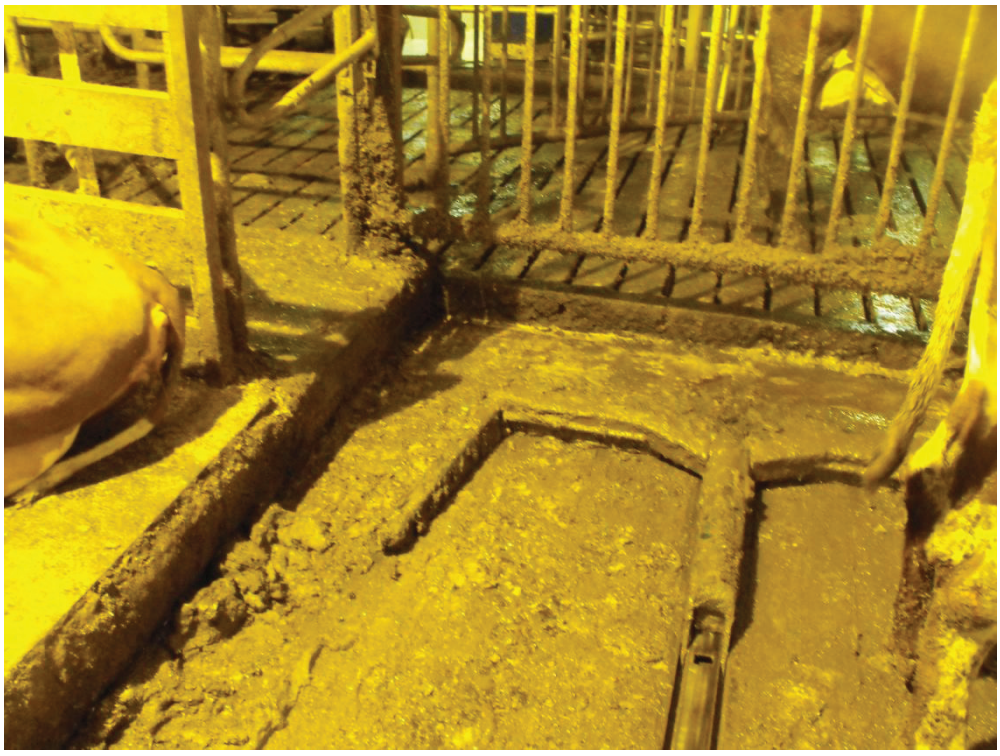

Figure 9, an unnecessary high step coming out of the sorting gate, straight onto the scraper.

Changes made after first visit

One farm had trimmed all cows, with a professional trimmer; two farms had trimmed a larger portion of the herds than originally planned, based on the findings in January. 1 is planning to trim all cows in put September. One had rubber mats in the passageways.

Figure 10, cleaning and using sawdust in the cubicles and passageway makes for a more hygienic environment and less slippery floor.

Conclusions

The aim of this survey was to get an accurate assessment of the level of lameness and hoof health in the 5 most modern farms in the district of Hemne and Snillfjord in Norway. Then advice was given to the farmers based on level of lame cows found and the hazard points. There is a great room for improvement. There was a slight decrease in lameness from January to August. This is a too small change to safely say that the measures done on the basis of recommendations from the author had any effect. There was a lack of power in the statistics, most likely due to the low number of cows.

The levels of lameness in the farms were disturbingly high, with 76, 5 % of cows being lame in January and 68, 4 % in August. In short terms measures, to improve the hoof health, a regular trimming schedule, with 2 or 3 trimming in a year is recommended, by a professional hoof trimmer. The improvement of hygiene in the alleys and cubicles to keep claws clean is a measure that is quick and easy to implement. Manual scraping twice a day, and the use of ample amounts of sawdust should improve the situation, see figure 10. Footbaths might be an option in stables struggling with infective causes of lameness.

To improve the friction on the floor, rubber mats in passageways or grooving of the concrete is advised. The slatted concrete was too smooth in most cases and would benefit of a getting grooved.

The unnecessary steps in the stable should be removed as much as possible especially in connection with the AMS. One farm had removed a large step going of the sorting gate connected with the AMS. The level of knowledge the farmers have of lameness and the possible measures must be increased. The recognition of lame animals, especially the milder grades, so they can be treated properly will be important for the farmers to avoid economic losses. The early recognition and treatment of the lame animals by the farmer should significantly decrease the duration of lameness in the cows. (Clarkson, et al. 1996)

In a longer term, the choice of bulls that gives good legs and claws on their daughters should be considered. Feeding must be optimized to not only increase the production, but also avoiding acidosis, which increases occurrence of laminitis. The keeping of calves must improved in some farms, especially the hygiene The author is of the opinion, that keeping

calves and heifers on deep litter of straw will improve the health state and level of joint infections in some of the farms.

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Appendix 1

Environmental data for farms:

Lameness – treatment and control

			Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
1	**Factor measured**	**Definition**					
2	**Footbath (No./week / N)**	No./week No	No	No	No	No	No
	Who's trimming?(SS+PT/ AS/APT)	SS+PT – Some cows trimmed by stockman and the rest by the professional trimmer			Ø		
		AS – All cows trimmed by stockman	AS		Ø	AS	
3		APT – All cows trimmed by professional hoof trimmer		APT	Ø		APT
4	**Records (Y/ N)**	Yes No	Y	Y	Y	Y	Y
5	**Building type (FS / SY)**	FS – Free stall SY – Straw yard	FS	FS	FS	FS	FS
		N – Nongrooved solid concrete		N		N	
6	**Floor type (NGC / GC / SC)**	G – Grooved solid concrete S – Slatted concrete	S		S		S
		T – Scraper mounted on vehicle (tractor, teleporter, etc)					
7	**Scraping method (T / S)**	S – Automatic hydraulic scraper W – water flow		S		S	
8	**123(DeEv/UnePatc/ Litt-NBed)**	Score 1 Deep and even Score 2 Uneven and patchy Score 3 Little or no bedding	3	2	3	3	3
9	**123(ClDr/LigSoiDr /HeaSoiWet)**	Score 1 Clean and dry Score 2 Lightly soiled but dry Score 3 Heavily soiled and wet	2	2	3	2	2
10	**Bedding mater.(STR/SAN/SAW)**	STR – Straw SAN – Sand SAW – Sawdust COR – corn/maize MAT – Mattress	MAT	SAW	SAW	SAW	SAW

11	**Free-stall design (M / W)**	M – Metal profiles W – Wooden bars	M	M	M	M	M	
12	**Lunge Area (Y / N)**	Yes / No	Yes	Yes	Yes	Yes	Yes	All stables miss lunge area i 1/3 of cubicles.
13	**Brisket board (Y / N)**	Yes	No	No	No	No	No	
		No						
14	**Water quality(C / D)**	C – Clean	C	C	C	C	D	
		D – Dirty						
15	**Access (E / L)**	E – easy	E	E	E	E	L	
		L -limited						
16	**Grooming brushes (Y / N)**	Yes	Yes	Yes	Yes	Yes	Yes	
		No						
17	**Ventilation (Y / N)**	Yes	Yes	Yes	Yes	Yes	Yes	
		No						
18	**Type of feeder (FL / FE)**	FL – Directly on the floor						
		FE – In the feeder	FE	FE	FE	FE	FE	
19	**Feed yard surf. (NGC / GC / SC)**	N – Nongrooved solid concrete		N		N		
		G – Grooved solid concrete						
		S – Slatted concrete	S		S		S	
20	**Surf. Quality (1 / 2 / 3)**	1 – relatively dry, no holes not slippery						
		2 – wet or some holes or slippery	2	2		2		
		3 – wet, some holes and slippery			3		3	
21	**Moldy food in trough (Y / N)**	Yes						
		No	No	No	No	No	No	
22	**Water - Surface (DC / WD)**	DC – dry and clean	DC	DC		DC		
		WD – wet and dirty			WD		WD	
23	**Slipperiness (1 / 2 / 3)**	1 – strong grip on the edge of the boot						
		2 – strong grip on the bottom of the boot	2	2	2	2	2	
		3 – no grip on any parts of the boot						
24	**Holding area surf.(NGC/GC/SC/R)**	N – Nongrooved solid concrete						
		G – Grooved solid concrete						
		S – Slatted concrete	S	S	S	S	S	

		R – rubber mat					
25	**Parlor type (45 / 90)**	the cow has to move around – 45° / 90° / 135°	90	90	90	90	90
		NGC – Nongrooved solid concrete	NGC				
		GC – Grooved solid concrete					
26	**Parlor surface (NGC /GC /SC)**	SC – Slatted concrete		SC	SC	SC	SC
		RU – Rubber					
27	**Parlor - step(s) >2cm (Y / N)**	Unnecessary steps>2cm – except the footbath – Yes / No	Yes	Yes	Yes	Yes	Yes
28	**Sharp turns in parlor (Y / N)**	Any steps damaging hooves or inconvenient for cows – Yes / No	Yes	Yes	Yes	Yes	Yes
		1 – relatively dry, no holes and not slippery		1			
		2 – wet or some holes or slippery	2			2	
29	**Surf. Quality (1 / 2 / 3)**	3 – wet, some holes and slippery			3		3
30	**Insem. place - sharp turns(Y /N)**	Any corners damaging hooves or inconvenient for cows – Yes / No	No	No	No	No	No
31	**Pasture**	Yes/No	Yes	No	No	No	No

Appendix 2

Scoring of lameness given in real number of cows.

January:

	Score 1	Score 2	Score 3	Score 4	Score 5	
Farm 1	17	14	9	2	1	43
Farm 2	10	12	6	7	1	36
Farm 3	10	22	9	6	0	47
Farm 4	10	25	13	1	2	51
Farm 5	5	21	12	4	2	44
Total nr cows	52	94	49	20	6	221

August:

	Score 1	Score 2	Score 3	Score 4	Score 5	
Farm 1	9	7	4	2	0	22
Farm 2	17	14	13	4	0	48
Farm 3	18	18	6	10	0	52
Farm 4	12	19	8	2	1	42
Farm 5	11	15	12	7	3	48
Total nr cows	67	73	43	25	4	212

Appendix 3

Milk data collected during study, data from Tine dairy:

Farm 1

Liter	3851
Test date	12.12.2010
Bacteria	8
Geomet middle last 3	
Ba	50
Somatic cell count	110
Geomet middle last 5	
Ce	138
Fat	3,85
Lactose	4,71
Protein	3,11
Urea	6,3
Free fatty acids	0,4
Freezing point	-0,532

Farm 2

Liter	2150
Test date	09.12.2010
Bacteria	23
Geomet middle last 3	
Ba	50
Somatic cell count	210
Geomet middle last 5	
Ce	207
Fat	4,01
Lactose	4,61
Protein	3,23
Urea	5,4
Free fatty acids	0,4
Freezing point	-0,527

Farm 3

Liter	2940,6
Test date	24.12.2010
Bacteria	26
Geomet middle last 4	
Ba	50
Somatic cell count	130
Geomet middle last 6	153

Ce	
Fat	4,55
Lactose	4,64
Protein	3,46
Urea	4,7
Free fatty acids	0,7
Freezing point	-0,531

Farm 4

Liter	3651,6
Test date	22.12.2010
Bacteria	16
Geomet middle last 4	
Ba	50
Somatic cell count	140
Geomet middle last 6	
Ce	127
Fat	4,22
Lactose	4,67
Protein	3,58
Urea	4
Free fatty acids	0,3
Freezing point	-0,528

Farm 5

Liter	3624,3
Test date	03.02.2011
Bacteria	12
Geomet middle last 4	
Ba	50
Somatic cell count	160
Geomet middle last 5	
Ce	120
Fat	3,82
Lactose	4,66
Protein	3,19
Urea	5
Free fatty acids	0,4
Freezing point	-0,527