Design of walkway floors for dairy heifers and cows in loose housing systems

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Walkway floors have a significant effect on cattle locomotion and claw health, as well as on animal behaviour and general cattle house hygiene; and affected both animals’ welfare and dairy farmers’ profit. There are several qualities floors should fulfil, which contemporary walkway floors do not completely do. From an animal point of view, the most favourable of present passageway floorings in dairy cow cubicle housing systems seems frequently scraped solid rubber flooring to be, but should be improved further. Among other floor evaluation key factors, interaction between flooring systems of replacement heifers and lactating cows is to be considered.

Introduction

Floors in animal houses are the building elements animals will come into closest physical contact when they are walking, standing and lying. When they are standing and walking, floors in passageways in cubicle houses and straw bedding in straw yards interact with the animals’ feet; and will affect the claw health of cows and young stock. Claw lesions of dairy cows lead to enhanced cost as well as lessen income for dairy farmers. Treatment of the lesions itself is costly; additionally, there arise mostly indirect costs mainly because of yield reduction, increased work load, illness complication, diminished fertility, increased replacement rate, lameness and altered behaviour. In addition, the lesions are most often painful indeed; and foot health is just as much an animal welfare issue as question of business economics. Laminitis is the cause of the most common, most severe and most costly claw diseases, which have both metabolic and traumatic components. Traumatic challenges can be moderated; and one risk of trauma of the sole corium is exposure of inadequate floor design.

Additionally, unsatisfactory hygiene owing to dirty and wet floors can contribute in infectious or hygiene related claw lesions such as dermatitis and heel horn erosion. Insufficient hygiene in walkways can as well contribute in mastitis and lack of milk quality. Consequently, the floor design is important and especially of the animal point of view, the floor should promote the possibility to keep the surface clean and dry, give an appropriate grip but do not be too abrasive, and be sufficiently soft. However, it is hard to find floors with optimum design satisfying all demands enough.

Other factors such as environmental policies must also be considered, e.g. the necessity to control ammonia emissions from livestock houses; but will not be paid any attention in this paper.

Hygiene and drainage capacity

Floor hygiene is often a scraper issue or/and slatted floor. It has been shown [7] scraping slatted floor ameliorates the floor hygiene; and in particular scraping passageways along cubicle rows reduces transfer of dung from passageway to cubicle. Also enough high cubicle rear end kerb has the same effect [3]. The result is enhanced cleanliness of cubicle base, udder and teat [7]. Slatted floor, in particular with wide gaps, great void ratio and uneven surface, is however not animal friendly because of unfavourable pressure on the sole [8] and risk of claw injuries. If
scarping of slatted floors is advocated, there should not be any want to preserve the current slatted floor design. There is consequently a need of floor development combining solid floors' animal friendly design and slatted floors' drainage capacity; a process that is started for instance in Denmark and Sweden.

Feed-stalls could be looked upon as a special design of feeding alleys in cubicle houses, but feed-stalls are possible as well in two area straw yards (straw-bedded pen with unbedded feed stands). Feed-stalls are just feed stands but including partitions between every animal feed place, and seen for instance in Germany, Denmark and Sweden. The original reason for developing feed-stalls was to get a hygienic surface to stand on meanwhile cows eating. It has been shown that feed-stalls reduce the stress and displacement at the feeding table [2], especially for the low ranked animals, and reduce the bad consequences of too abrasive passageway flooring [4].

**Skid resistance and claw wearing**

The difficulties to obtain and to preserve the right balance between skid resistance and abrasiveness of walkway floor surface is well known. Required coefficient of friction (i.e. providing against slipping) for moving cows is dependent on the cow behaviour; i.e. if the animal is walking straight ahead, turning, fleeing (accelerating) or stopping (decelerating), etc., as well as dependent on stance phase (i.e. from claws hits the footing to push-off). The maximum required coefficient of friction, mostly required at the hitting and push-off stance phase, ranges from 0.3 to 0.85 for various behaviours according to van der Tol et al.. [18]. For dry and clean solid (concrete) floors in walking areas (kinetic) coefficient of friction 0.35 – 0.45 is recommended [19]; if the solid floor has greater friction the surface will be too abrasive. Additionally, the real slip resistance will be dependent on several factors such as slurry coating [15] on the floor and wearing of the floor material caused over time by grinding and polishing action of mechanical cleaning equipment and animal movements.

Grooving does not improve slip resistance of the surface between grooves but can help the claw to get grip, in particular when a foot is sliding. Some studies have given results that grooves *per se* do not ameliorate locomotion of cows indicating cows do not have any trust in just grooved floors’ gait security [12].

**Softness/hardness**


**Own study**

In our recently concluded study [1], about 150 heifers were followed from one year before expected calving throughout their first lactation. The study was carried out in a commercial dairy farm with 300 cows and own replacement heifers of Swedish Red and Swedish Holstein breed. The cows were housed in cubicles with soft mattresses, rubber equipped feed stalls and slatted passageways. After calving, the first calvers were blocked to breed and calving time, housed in cubicles and randomly allocated either to a section with pure concrete slats representing hard flooring or in a section equipped with slatted rubber mats representing soft flooring. All other management and feeding routines were identical.
Methods and materials

All claws were investigated and trimmed at calving and after four months of lactation. Locomotion and leg injuries were scored monthly during the housing periods. A logistic multivariable regression analysis (JMP 5, SAS Inst) was used for leg lesions and locomotion. In the statistical model used, correction was made for animal and managemental traits as well as for interactions in between them. The logistic regression coefficients were transferred to Odds Ratio (OR). Likelihood ratio test was done and the probability result is given ($P_{LR}$). Only the most frequent claw lesions were analysed and sole haemorrhage were analysed together with sole ulcer.

Results

The odds ratio for sole haemorrhages and sole ulcer, and for white line haemorrhages in first calvers on slatted concrete flooring compared to slatted rubber flooring was about 2 and 3 times higher, respectively. A tendency to more heel horn erosion was observed in animals with slatted rubber mats (Table 1). The odds ratio for lameness was even greater, 3.64 (Table 2). Surprisingly, also leg lesions (hock injures) differed between flooring systems, despite identical comfortable cubicles, probably because of more animal activity and less lying time with rubber flooring [10].

Table 1 – Effect on claw diseases in first calvers on slatted concrete floor compared to slatted rubber. Odds Ratio (OR) and results of likelihood ratio test ($P_{LR}$). N=118

<table>
<thead>
<tr>
<th>Claw disease</th>
<th>OR</th>
<th>$P_{LR}$</th>
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<tbody>
<tr>
<td>Heel horn erosion</td>
<td>0.49</td>
<td>0.08</td>
</tr>
<tr>
<td>Dermatitis</td>
<td>1.06</td>
<td>0.89</td>
</tr>
<tr>
<td>Haemorrhages of sole including sole ulcer</td>
<td>2.19</td>
<td>0.05</td>
</tr>
<tr>
<td>Haemorrhages of white line</td>
<td>2.82</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Table 2 – Effect on leg injures and lameness in first calvers housed on slatted concrete flooring compared to slatted rubber. Odds Ratio (OR) and results of likelihood ratio test ($P_{LR}$). N=118

<table>
<thead>
<tr>
<th>Leg injures</th>
<th>OR</th>
<th>$P_{LR}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hairlessness</td>
<td>2.37</td>
<td>0.21</td>
</tr>
<tr>
<td>Swellings</td>
<td>2.45</td>
<td>0.15</td>
</tr>
<tr>
<td>Sore</td>
<td>2.57</td>
<td>0.02</td>
</tr>
<tr>
<td>Lameness</td>
<td>3.64</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Discussion and conclusion

Leg and claw health, in particular concerning the more serious claw illness as laminitis related sole ulcer, haemorrhages of sole and white line, was mainly better among first calvers on soft floor. Soft passageways in cubicle housing systems reduce significantly painful claw diseases; consequently, soft passageways for dairy cows are recommended indeed.
Soft floor, skid resistance and abrasiveness

Beside improved claw health, soft floor gives increased skid resistance [9], and as mentioned above, improved animal locomotion [15]. Current rubber mats have however too less abrasiveness resulting in claw overgrowth and need for more frequent trimming [17]. On the other hand, rubber mats in walkways give more natural shaped claws and possibilities to correct defective claw conformation [17]. New rubber mats launched on the market are told to increase claw wearing. An alternative is to use different flooring with different abrasiveness in different areas of the cow house, e.g. rubber mats in the feeding alley and concrete in the passageway between cubicle rows.

Interactions between flooring systems of replacement heifers and lactating cows

In our own study mentioned above, soft flooring for heifers gave the same effect on leg and claw health compared to hard flooring as for first calvers. However, soft flooring meant in this case two area straw yards (deep straw-bedded pack and unbedded feeding alley/feeding stand). Notwithstanding, in cubicle systems for heifers rubber covered concrete walkways might be recommendable; even if investment in rubber mats for heifers probably is not profitable, or has less cost-benefit outcome in short run than for cows.

There is an additional aspect. Within advisory service, at any rate in Sweden, one means that heifers should be kept in same housing systems as they will be kept as adults, as lactating cows. The arguments are mainly animals’ need of learning the system used for the cows, as well as adaptation of legs and feet; i.e. to inure heifers’ extremities to most often hard walkway floors in the cows’ housing system. One might however raise additional questions; when, how and how long should or needs the adaptation be done? Accordingly, the training might not be only to the system per se, but also, or especially, to the footing used such as hard or soft flooring.

Our study mentioned above resulted in differences in prevalence and severity of claw diseases among the first calvers due to differences in flooring system during the heifer period. Especially the more serious diseases such as sole and white line haemorrhages were more often observed, but the differences were not significant. First calvers coming from soft floor had more severe and a greater prevalence of sole lesions if they had been moved to concrete than to rubber floor, whilst first calvers coming from hard floor and allocated to rubber flooring had least lesions.

The result indicated that softness/hardness of floors could have a long lasting effect. If the passageways in the lactating cow cubicle section have hard floor, which is still the common situation in practice, one should consider indeed not having soft floor for the heifers. At least, the changeover from soft to hard flooring should occur in good time, perhaps 3 – 6 month before calving. Another alternative to reduce leg and claw ill-health is to avoid shifting surface for calving heifers until several weeks or months after calving as shown by Laven & Livesey [6]. Anyhow, to take into consideration the interaction between heifers’ and the cows’ floor system regarding lameness and laminitis related claw diseases will give consequences in many dairy farm planning.
Hopefully, many more cubicle houses with soft, as well as skid resistant, just enough abrasive, clean and dry walkway flooring for both cows and replacement heifers, at least heifers in late pregnancy, will be realised in the near future.

References


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