Flooring on Alberta dairy farms

The influence of type of flooring on gait score of dairy cows

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Keywords:

lameness, dairy cattle, housing, flooring

Abstract

The objective of this study was to determine the effects of pen flooring-type in front of the feed-bunk, the slipperiness and the flooring-type in the holding pen on gait of Alberta free-stall housed dairy cattle. Fifty-one dairy farms with at least 70 Holstein milking cows and no access to pasture were selected from a list provided by the hoof trimmers from the Alberta Hoof Health Project. On these farms slipperiness and flooring type in the feeding alley and in the holding pen was recorded. Forty focal cows were gait scored (limping, head bob, asymmetric steps and tracking-up). In order to calculate odds ratios, farms were divided in groups: Farms with < 15% of lame cows and farms with ≥ 15% lame cows. Farms with < 25% asymmetric cows and farms with ≥ 25% asymmetric cows. Farms with <60% under-tracking cows and farms with ≥ 60% under-tracking cows. Because of the small number of farms with other flooring than grooved concrete in the feeding area of the pen and in the holding pen, odds ratios could not be calculated. Slipperiness did not have a significant effect on gait of dairy cows.

Introduction

Alberta counts approximately 600 dairy farms, with an average herd size of 127 cows (1). Most of these dairy farms have no access to pasture, because of the environmental conditions, which might have a negative effect on the prevalence of lameness (2). Preliminary results from the Alberta Hoof Health project show that almost 50% of cows on Alberta dairy farms have one or more claw lesions (3), indicating that lameness could be a major health problem on these farms. Lameness causes reduced welfare (4-6) and also leads to economic losses, due to culling (7), reduced milk production (8,9) and delayed reproduction (10). Dairy producers seem to underestimate the prevalence of lameness in their herd (11) and therefore underestimate the economic losses caused by lameness.

Several studies have been conducted to determine the prevalence and risk factors for lameness in dairy cattle in different countries or regions. Examples of risk factors are, high milk production (10) and a number of features in stall design and management practices (12). Hereditary factors also have an influence on lameness: cows with low foot angle, hocking-in and wide rumps are more at risk for developing lameness. Correlation of lameness with body depth indicates that heavier cows are more likely to develop clinical lameness (13). Nutrition characteristics are another risk factor. Several nutrients, such as calcium and biotin are essential for the keratinization of epidermal cells, which determine horn quality. Essential fatty acids and sulphur-containing amino acids influence horn quality as well (14). Finally, flooring type in the walking areas is another risk factor for claw disorders and lameness (15,16).

Gait score

Lameness can be defined as a change in gait (clinical lameness), but also as the presence of lesions in the claw with or without the appearance of lameness. In this report, lameness will be defined as a change in gait. There are several ways to detect clinical lameness. Measuring lying time is one option, as lame cows spend more time lying down and have longer lying bouts (17). Another method is gait scoring. There are several methods of gait scoring. Numerological rating systems with detailed descriptions score the presence of gait attributes like: back arch, head carriage, tracking-up, joint flexure, symmetry of the gait and weight bearing of the limps. More signs of lameness, like arched back, head bob, under-tracking, joint stiffness, asymmetric steps and not bearing weight on one of the limps, result in higher gait scores. Continuous rating systems score the severity of the gait attributes. However, numerological rating systems seem more reliable for differentiating between healthy cows and cows with sole ulcers than continuous rating systems (18). Gait scoring can be used to detect some hoof lesions, like sole ulcers, at early stages (17-19), but not all lesions can be detected. Sole hemorrhages and mild forms of digital dermatitis for instance do not cause lameness as observed by a change in locomotion (17,18), indicating that these lesions are not that painful. Severe digital dermatitis and severe interdigital dermatitis can cause higher gait scores (20). Sole ulcers are found to be closely associated with higher gait scores (more back arch, head bob, shorter strides and limping) (18,19).

Flooring type

Flooring type in the walking areas is a risk factor for claw disorders (15,16) that might cause lameness. In Norwegian dairy herds housed in free-stall barns with solid or slatted concrete walking alleys, there were more cows with sole hemorrhages and white line fissures, than in herds housed in barns with solid rubber walking alleys. Cows housed on solid (rubber or concrete) floors showed more digital and interdigital dermatitis, than cows housed on slatted floors. Gait scores of cows housed on slatted concrete standing areas were higher than locomotion scores of those housed on solid concrete standing areas (16). So on solid floors infectious claw lesions (which do not always cause clinical lameness) are more prevalent and on slatted floors lesions that actually cause clinical lameness are more prevalent. There also seems to be a higher risk of high locomotion scores for cows housed on grooved concrete compared to cows housed on smooth concrete (20). According to both Flower et al and Telezhenko et al. cows made longer strides, were more tracking-up, were more symmetrical and walked faster when walking on rubber, than when walking on concrete floors (21,22). This difference in gait score between walking on rubber and walking on concrete seem to be higher for cows with sole ulcers, indicating that rubber flooring might reduce pain for cows with sole ulcers (21). Furthermore, cows seem to prefer soft surfaces to stand and walk on. They choose standing and walking on rubber over standing and walking on concrete. They also prefer solid rubber over slatted rubber (23). However, O'Driscoll et al. could not find a difference in walking speed and locomotion score between cows housed on rubber and cows housed on concrete (24).

Besides standing in the feeding alley of the pen, cows also spend quite some time standing in the holding pen. This might influence the presence of claw lesions and can cause altered gait, so type of flooring in the holding pen might influence the gait score of cows. However there is not much literature about this subject. Therefore this study will not only look at flooring type in the standing areas of the pen, but also at the flooring type in the holding pen.

Slipperiness

Slipperiness of the walking alley might affect gait score. Using a mechanical friction tester Telezhenko et al found that concrete is the most slippery surface. Slatted and solid rubber seem to be less slippery, whereas solid concrete seems to be the most frictional surface (all surfaces were covered with some manure) (22). Cows could experience this differently, because the mechanical way of measuring friction does not resemble the way cows walk. The presence of manure influences the slipperiness of a surface as well. Dry concrete gives less friction than wetted concrete and concrete covered with 5 cm of slurry (25). On higher friction flooring cows make longer strides and show more joint flexion, indicating that they walk more confident on high friction flooring (26). There is not much literature about the effect of slipperiness of pen flooring on locomotion score including tracking and asymmetric steps, so further research is needed.

Objective

The objective of this study is to determine the effects of pen flooring-type in front of the feed-bunk, slipperiness in the pen and the flooring-type in the holding pen on the general gait of Alberta free-stall housed dairy cattle.

Hypothesis

Pen flooring type in front of the feed-bunk, slipperiness in the pen and holding pen flooring type on Alberta dairy farms influences gait score in dairy cattle.

Feeding alley flooring type, holding pen flooring type and slipperiness influence the percentage of lame cows*, asymmetric walking cows and cows that are under-tracking on Alberta dairy farms.

- Farms with concrete flooring have a higher percentage of lame, asymmetric and under-tracking cows compared to farms with rubber flooring.
- Farms with slatted flooring have a higher percentage of lame and asymmetric cows compared to farms with solid flooring.
- Slippery floors increase the percentage of asymmetric and under-tracking cows on dairy farms, compared to farms with non-slippery floors.

*Lame cows are defined as cows that are limping and/or show head bob. Asymmetric cows are in the sound group. Furthermore, asymmetric cows are compared with non-asymmetric cows and cows that are under-tracking are compared with cows that are tracking-up. Slippery floors are defined as floors on which there are cows that slip or fall.

Materials and methods

For this research 51 dairy farms were selected from a list provided by the hoof trimmers from the Alberta Hoof Health Project. The selection criteria used were that farms needed to have at least 70 Holstein milking cows in free-stall housing and no access to pasture to be representative for the Alberta dairy population.

At each farm flooring type in front of de feedbunk of the pens and flooring type in the holding area were characterized as: concrete (smooth, textured, grooved or slatted) or rubber (smooth, textured, grooved or slatted).

For determination of the percentage of lame cows on the farms, 40 focal cows between 10-120 DIM were selected. These cows were videotaped laterally and from the back, while walking in a straight line. The aim was to record at least two consecutive strides. The videos were analyzed by trained researchers for head bob, not bearing weight on one of the limps (limping), symmetry of the steps and tracking-up. A cow is tracking up when it places its hind claw on the same spot or in front of the spot where its front claw was. Cows that are tracking on one side, but under-tracking on the other side are in the under-tracking group.

Slipperiness in the pen was estimated by Temple Grandins method for scoring slipperiness in abattoirs (27). The percentage of cows that slip or fall while they were being moved to the milking parlor was recorded. Pens received a score excellent if there was no slipping or falling, score acceptable if less than 3 % of the cows slipped, score not acceptable if 1% of the cows fell or more than 3 % of the cows slipped and score serious problem if 2% fell or 15 % slipped.

Statistical analysis

For statistical analysis farm percentages of lame cows, asymmetric cows and cows that are under-tracking are used, because pen flooring type is a farm-dependent variable: Cows from the same farm generally share the same flooring type, so they cannot be considered as independent units.

Farms with different flooring types in the pens are only used if they can be classified into one of the groups (for example: farms with both textured and grooved concrete are classified as concrete or solid). Farms with different scores for slipperiness in different pens were not used for calculations with this variable.

This study is a cross-sectional study, but data are arranged as if it was a case control study, so to determine if flooring type is a risk factor for lameness, odds ratios are calculated. In order to do this, data are converted to fit into two by two tables. Possible risk factors for lameness, asymmetric steps and under-tracking are flooring type of the feed alley in the pen (slatted =exposed versus grooved = unexposed, concrete = exposed versus rubber = unexposed), flooring type of the holding pen (slatted versus grooved, concrete versus rubber) and slipperiness in the pen (slippery = exposed, non-slippery = unexposed). The farms are divided into a group of farms with a low prevalence of lameness (less than 15% of lame cows per farm) and a group with a high prevalence of lameness (15% or more lame cows per farm). They were also divided in a group with a low prevalence of asymmetric cows (less than 25% asymmetric cows per farm) and a group of high prevalence of asymmetric cows 25% or more asymmetric cows per farm). For under-tracking farms were divided in a group of farms with less than 60% of the cows under-tracking cows and a group of farms with 60% or more under-tracking cows. These values were based on personal experience, because there was no literature about the prevalence of lame, asymmetric and under-tracking cows in Alberta.

Results

Four farms were excluded from this research because the gait was not scored correctly (there were a lot of limping cows that were not asymmetric, which is very unlikely). Not all farms were scored for tracking-up, so only 24 farms were used to determine the effect of flooring type and slipperiness on tracking-up.

Flooring

Most farms (77 %, 36 out of 47 farms) had grooved concrete flooring in the feeding alley of the pen (figure 1). In the holding pen there is more between farm variation (figure 2). Three farms did not have a holding pen. In the holding pen, 59 % of the farms had grooved concrete flooring, 16% had textured concrete and 18 % of the farms had rubber (grooved or textured) and 2% had slatted flooring. There were also some mixed flooring types. On 54% of the farms there were no cows slipping or falling in their pen as they walked towards the holding pen or milking parlor (figure 3).

Figure 1: Feeding alley flooring types on Alberta dairy farms

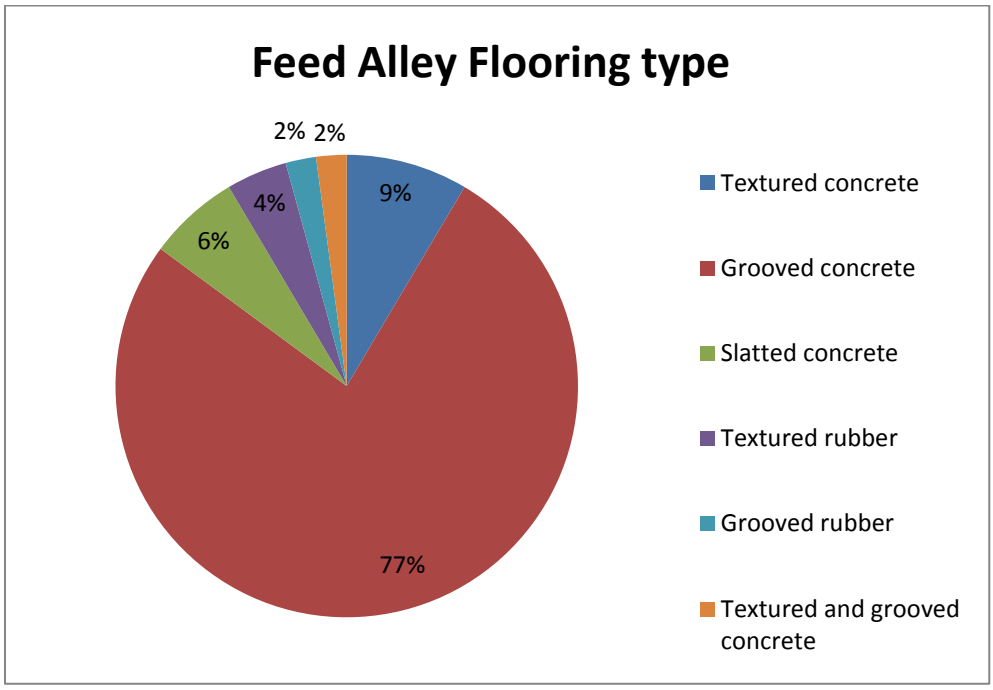


Figure 2: Holding pen flooring types on Alberta dairy farms

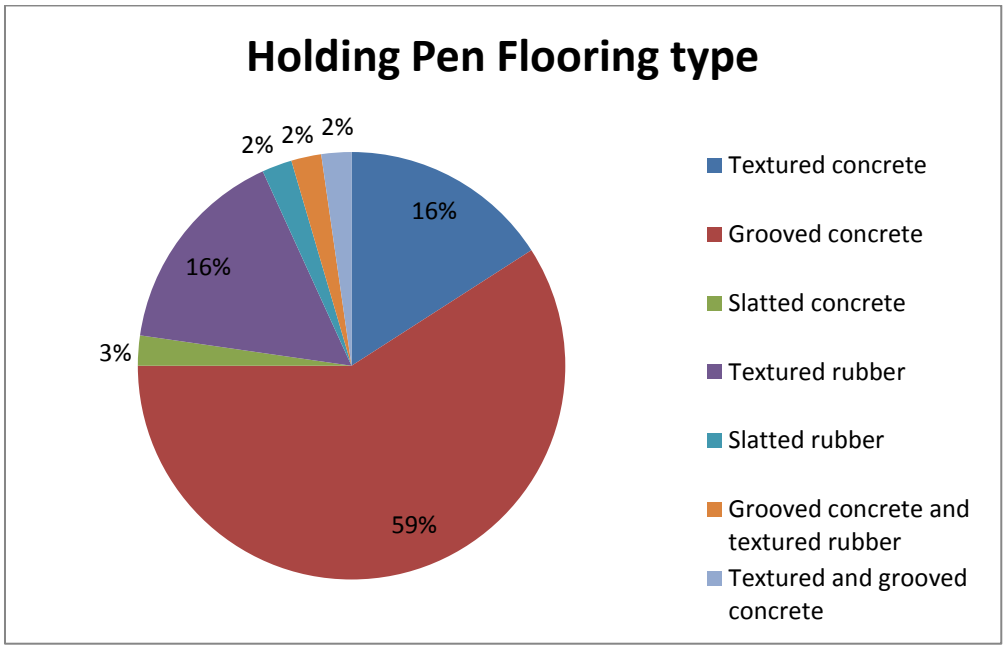


Figure 3: Percentages of cows slipping or falling when they are moved from the home pen to the holding pen on Alberta dairy farms

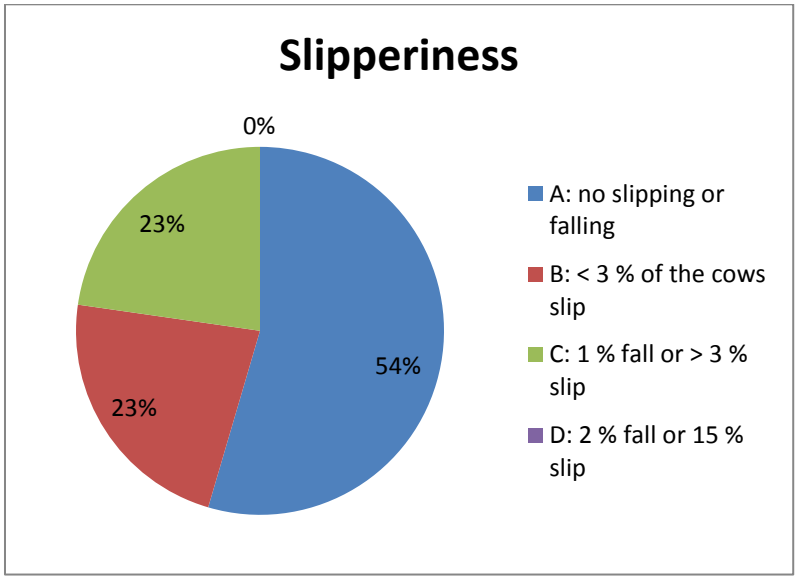
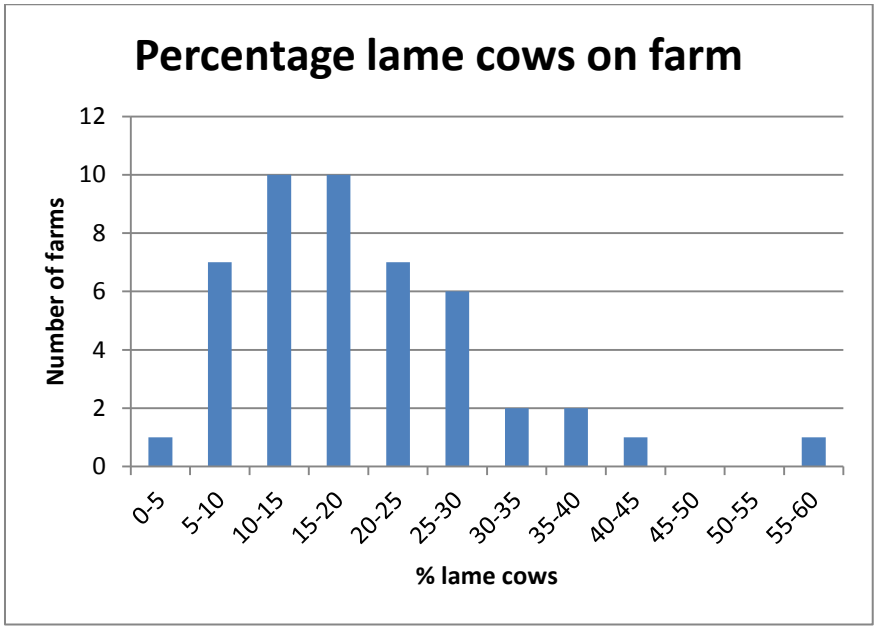


Table 1

	# farms	% Lame per farm (Range)	% asymmetric per farm (Range)	% undertracking per farm (Range)
Concrete feeding alley	44	19,71 (2,63 - 57,14)	55,10 (13,16 - 96,43)	74,98[1] (47,06 – 100)
Rubber feeding alley	3	7,77 (5,56 - 10,26)	57,34 (33,33 - 69,44)	[2]
Solid feeding alley	44	18,63 (2,63 - 57,14)	53,89 (13,16 - 96,43)	74,84[3] (47,06 – 100)
Slatted feeding alley	3	23,65 (20,51 - 28,21)	75,00 (43,59 - 91,67)	76,62[4] (74,29 - 78,95)
Concrete holding pen	35	19,93 (2,63 - 57,14)	53,65 (13,16 - 96,43)	
Rubber holding pen	8	18,42 (5,56 - 31,43)	52,41 (23,53 - 91,67)	
Solid holding pen	41	19,42 (2,63 - 57,14)	52,78 (13,16 - 96,43)	
Slatted holding pen	2	24,36 (20,51 - 28,21)	66,66 (43,59 - 89,74)	
Slippery floor in pen	20	19,09 (2,63 - 40,00)	55,11 (15,38 - 96,43)	75,83 [5] (55,56 – 90)
Non slippery floor in pen	24	18,21 (5,56 - 57,14)	53,63 (13,16 - 91,67)	74,38 [6] (47,06 – 100)

[1] only 24 farms with concrete feedingalleyflooring were scored for under-tracking
[2] 0 farms with rubber feedingalleyflooring were scored for under-tracking
[3] only 22 farms with solid feedingalleyflooring were scored for under-tracking
[4] only 2 farms with slatted feedingalleyflooring were scored for under-tracking
[5] only 10 farms with slippery floors were scored for under-tracking
[6] only 14 farms with non-slippery floors were scored for under-tracking

Figure 4



Gait score

There was a lot of variation in the percentage of lame cows per farm (figure 4). The average was 19% of lame cows per farm. The average percentage of lameness was higher on farms with concrete feeding alleys compared to farms with rubber feeding alleys. Farms with slatted feeding alleys had higher percentages of lame cows on average than farms with solid feeding alleys and farms with slatted holding pens had higher percentages of lame cows on average than farms with solid holding pens (table 1 and figure 5). On average, farms with slippery floors had slightly higher percentages of lame cows than farms with non-slippery floors. Because there were only three farms with rubber and only three with slatted flooring in the feeding alley it was not possible to calculate odds ratios and confidence intervals for the risk factors concrete (only the farms with rubber were not exposed) and slatted flooring in the feeding alley. In the holding pen only the odds ratio for concrete could be calculated. Concrete flooring in the holding pen did seem to be a risk factor for lameness (OR 3,2) but this was not significant, since the confidence interval contains 1 (table 2). A slippery floor does not seem to be a risk factor for lameness (OR 0,9 and confidence interval contains 1), but as the confidence interval is wide this is not very reliable.

Figure 5

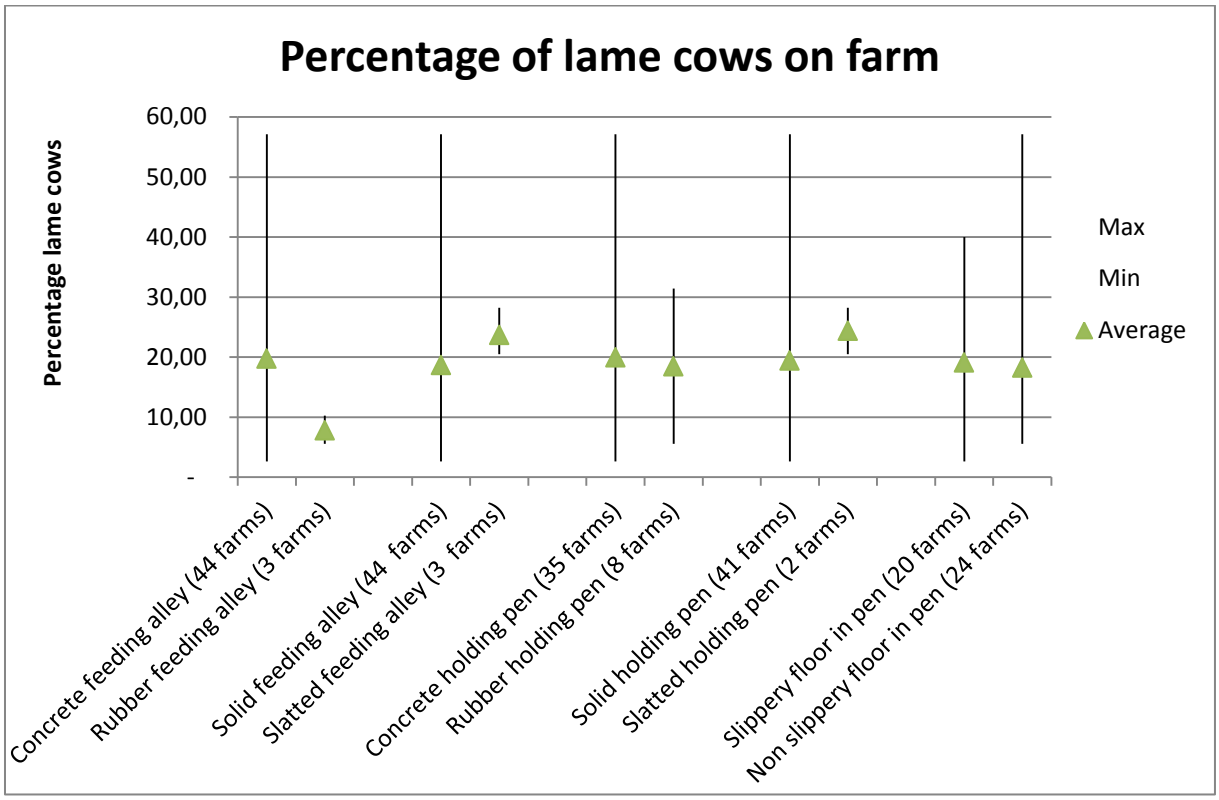
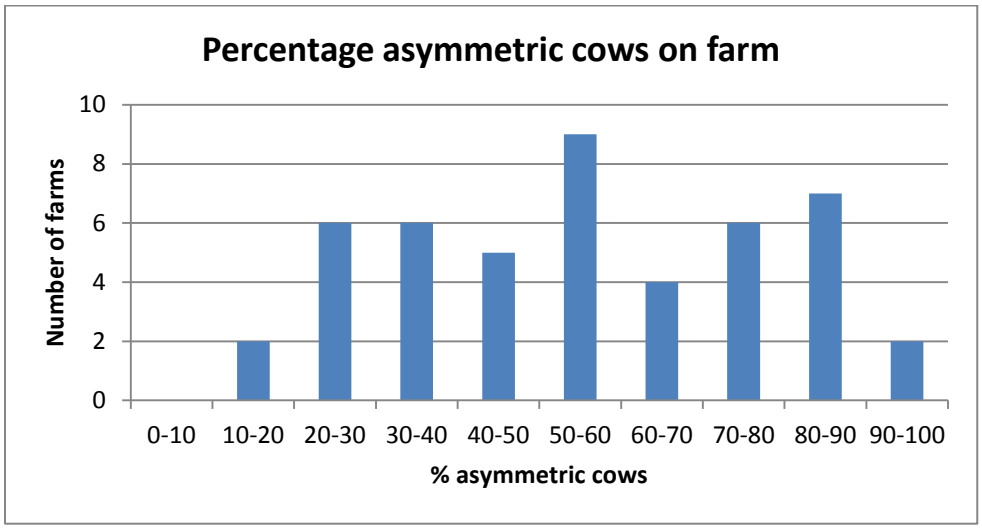


Table 2

	Lameness	
Risk factor	**Odds Ratio**	**95% Confidence interval**
Concrete feeding alley flooring	Group sizes too small	Group sizes too small
Slatted feeding alley flooring	Group sizes too small	Group sizes too small
Concrete holding pen flooring	3,2	0,6 - 15,7
Slatted holding pen flooring	Group sizes too small	Group sizes too small
Slippery floors	0,9	0,3 - 3,0

Figure 6



The percentage of asymmetric cows on farm varied even more than the percentage of lame cows (figure 6). The average was 55% of asymmetric cows per farm. On average, farms with solid feeding alleys had less asymmetric cows than farms with slatted feeding alleys. Farms with solid holding pens also had less asymmetric cows than farms with slatted holding pens. Farms with slippery floors have about the same percentages of asymmetric cows as farms with non-slippery floors (table 1 and figure 7). Concrete flooring in the holding pen and slipperiness seem to be risk factors for asymmetric steps, but again the confidence interval contains 1, so these are not significant findings (table 3).

Figure 7

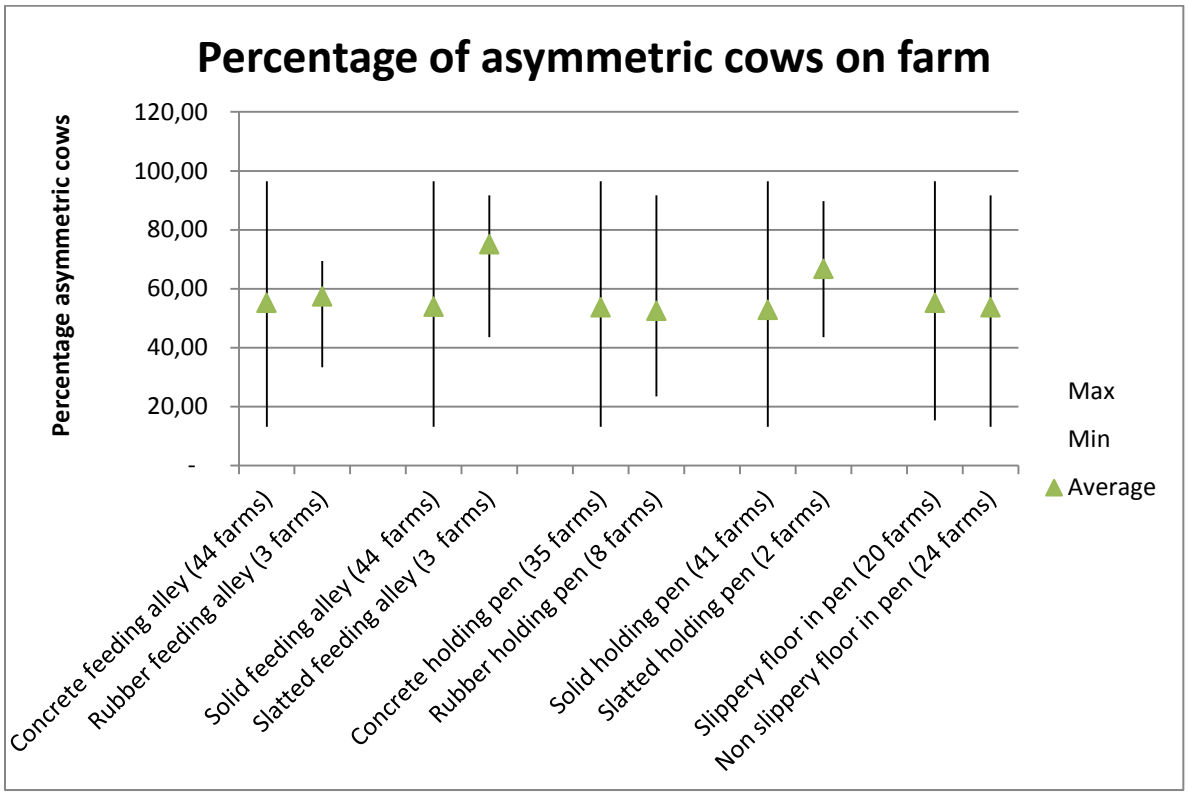
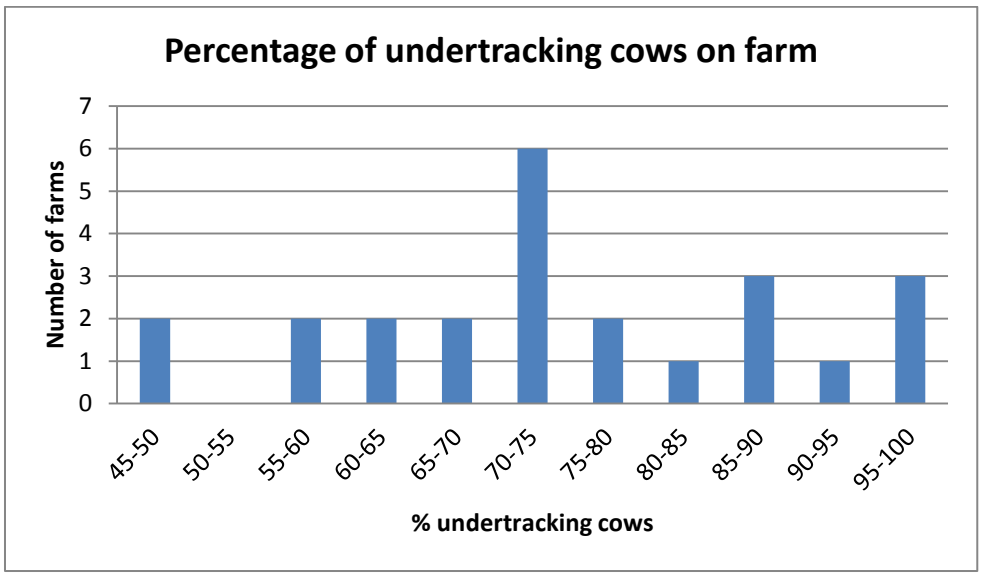


Table 3

Asymmetric steps

Risk factor	Odds Ratio	95% Confidence interval
Concrete feeding alley flooring	Group sizes too small	Group sizes too small
Slatted feeding alley flooring	Group sizes too small	Group sizes too small
Concrete holding pen flooring	2,6	0,4 - 17,4
Slatted holding pen flooring	Group sizes too small	Group sizes too small
Slippery floors	1,8	0,3 - 11,0

Figure 8



There was a wide variety in the percentage of under-tracking cows on farms, from 47% up to 100% under-tracking cows (figure 8 and table 1). The average of all farms was 75% under-tracking per farm. Farms with slippery floors had more under-tracking cows than farms with non-slippery farms. Slippery floors was the only risk factor that had enough farms in each group to calculate an odds ratio (1,8), but again the confidence interval contains 1, so it is not a significant risk factor (table 4).

Figure 9

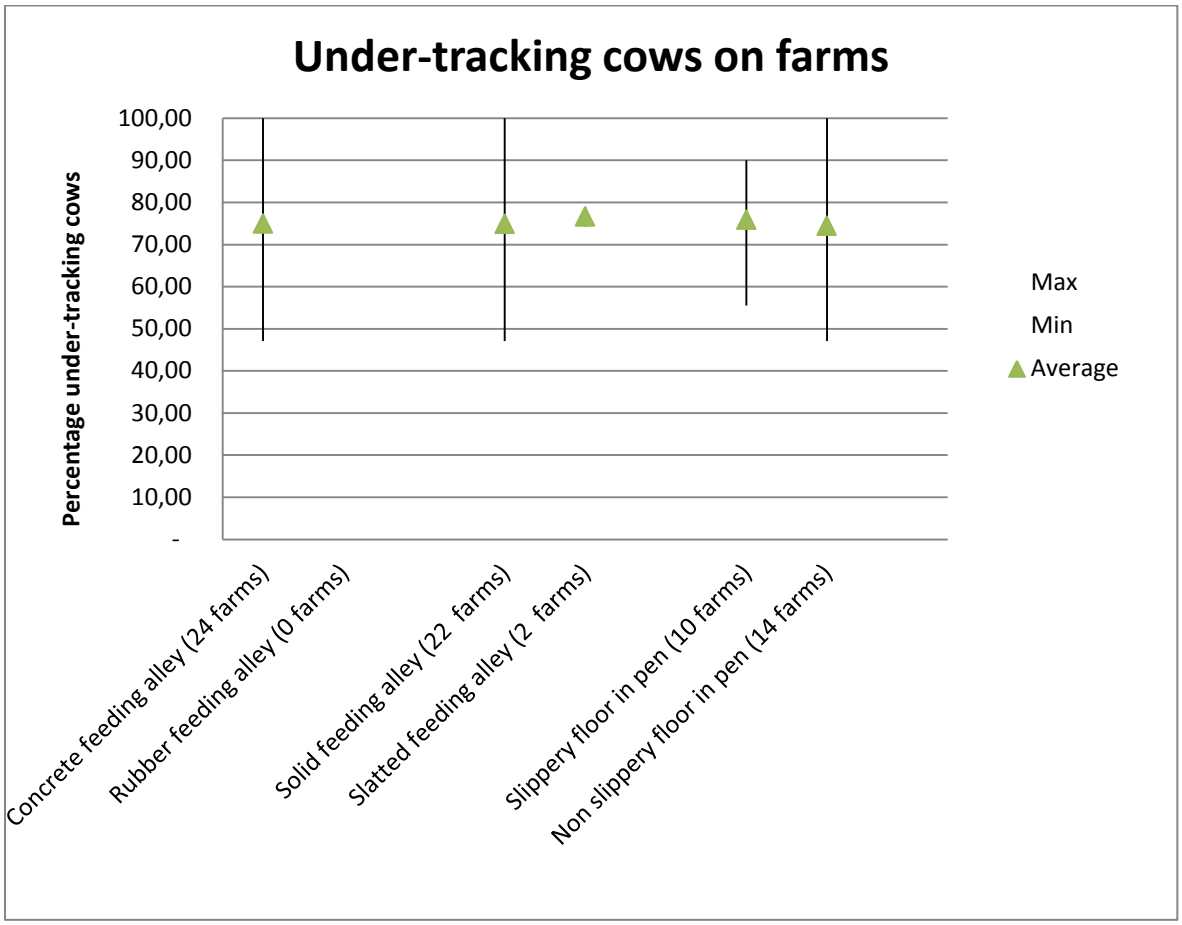


Table 4

	Tracking up	
Risk factor	**Odds Ratio**	**95% Confidence interval**
Concrete feeding alley flooring	Group sizes too small	Group sizes too small
Slatted feeding alley flooring	Group sizes too small	Group sizes too small
Slippery floors	2,5	0,2 - 27,8

Discussion

Different studies have shown that flooring type in standing areas of the pen is a risk factor for high locomotion scores (2,16,21,22,25). Unfortunately, most farms in this study had grooved concrete floors in the standing areas of the pen and there were only a few farms with rubber or slatted flooring and no farms with smooth flooring. Therefore, the study lacked power to do statistical test. In the descriptive statistics the wide ranges and some very small groups (table 1 and figures 5, 7, 9) makes interpreting the outcomes unreliable. Therefore, more farms with slatted and rubber floors are needed, but the question is if there are enough farms with rubber or slatted flooring in Alberta that reach the criteria set in this study. This study was designed

to identify a biological relevant difference between groups. It is not expected to find a large difference, as lameness is a multi-factorial condition and many risk factors play a role in developing lameness. Another option would be to do a experimental study, with controlled environmental and genetic factors, which would rule out multiple other risk factors. This would also make it possible to compare individual cows as independent unit instead of comparing farms. However, the question is if this would add any information to the findings of other studies. As there is not much information about the influence of holding pen flooring type, this experimental study might be a good option to determine that risk factor.

In holding pen flooring type there were a few more farms with rubber flooring, but still not enough to do statistical analysis, so odds ratios were calculated. To do so herds were divided in two groups: herds with ≥15% lame cows, ≥25% asymmetric cows or ≥60% under-tracking cows and herds with <15% of lame cows, <25% asymmetric cows or <60% of the cows under-tracking. However, these divisions could also be set higher or lower, because the prevalence of clinical lameness in Alberta is not yet known and the line could be drawn at a different percentage, which may result in different outcomes. For example, if the classification of asymmetry was ≥55% asymmetric cows and < 55% asymmetric cows instead of ≥25% asymmetric cows and < 25% asymmetric cows the odds ratio and confidence interval would have been 0,8 (0,2 to 2,7) instead of 1,8 (0,3 - 11,0). However, this is still not significant, as one is in the confidence interval. Furthermore, the time spend in the holding pen per day is not taken into account in this study, although it may influence results.

Slipperiness of the floor in the pen did not seem to affect the percentage of lame, asymmetric and under-tracking cows (table 1 and figures 5, 7, 9). The farms were more equally distributed among the groups slippery (20 farms) and non-slippery (24 farms), so the outcomes are more reliable to interpret than the outer risk factors that were observed, but it still no statistical analysis could be performed. Therefore, more farms are needed.

Another point that may have influenced the results is the method for measuring slipperiness. The method used in this study is not very accurate, as on farms where cows are more anxious they will make more sudden movements and therefore slip more than on farms where cows are very calm and walk slowly. There are other, more objective methods for measuring slipperiness. Telezhenko et al. measured friction with a portable friction tester, developed by the Swedish National Road and Transport Research Institute, for dry and contaminated surfaces (22). However, this method does not take any cow characteristics (for example way of walking or weight) into account. Pillips et al. measured friction of different floor surfaces with a tribometer that was modified to resemble a cows weight and size, while pulling it forward (25). This might be an objective way to determine floor slipperiness, although cows might still experience the slipperiness differently.

In this study the gait of some focal cows was not scored, because it was not always possible to let cows walk in a straight line on video. There were cows that ran in front of the camera and cows that just kept looking back (bending all the time). This could have had an effect on percentages of lameness on farm, because lame cows are easier to videotape and score (they are less likely to run) than sound cows and so the percentage of lame cows per farm could be

overestimated. Another factor that might influence the gait score is the flooring type and slipperiness of the transfer alley where the cows are videotaped on some farms. The gait score of a cow in the pen can be different from the gait score of that same cow in the transfer alley (21). So it might be a better option to do the gait scoring in the feed alley of the pen, as this is the flooring that is recorded.

Conclusion

The objective was to determine the effects of pen flooring-type in front of the feed-bunk, the slipperiness and the flooring-type in the holding pen on gait of Alberta free-stall housed dairy cattle. The average of lame cows per farm was 19 %. Because of the small number of farms with other flooring than grooved concrete in the feeding area of the pen and in the holding pen, the effects of feedalley flooring type and holding-pen flooring type could not be calculated or the effects are not statistical significant. Further research is needed, especially on holding pen flooring type, as there is not much in literature about this subject. Slipperiness did not significantly affect gait of cows, but still more research is needed.

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Appendix

Table 5

	Feeding alley flooring type		
	Concrete	Rubber	Total
15% lame cows or more	29	0	29
Less than 15% lame cows	15	3	18
Total	44	3	47

Table 6

	Feeding alley flooring type		
	Slatted	Solid	Total
15% lame cows or more	3	26	29
Less than 15% lame cows	0	18	18
Total	3	44	47

Table 7

	Feeding alley flooring type		
	Concrete	Rubber	Total
25% asymmetric cows or more	38	3	41
Less than 25% asymmetric cows	6	0	6
Total	44	3	47

Table 8

	Feeding alley flooring type		
	Slatted	Solid	Total
25% asymmetric cows or more	3	38	41
Less than 25% asymmetric cows	0	6	6
Total	3	44	47

Table 9

	Feeding alley flooring type		
	Concrete	Rubber	Total
60% under tracking cows or more	20	0	20
Less than 60% undertracking cows	4	0	4
Total	24	0	24

Table 10

	Feeding alley flooring type

	Slatted	Solid	Total
60% under tracking cows or more	2	18	20
Less than 60% undertracking cows	0	4	4
Total	2	22	24

Table 11

	Feeding alley flooring type		
	Concrete	Rubber	Total
15% lame cows or more	23	3	26
Less than 15% lame cows	12	5	17
Total	35	8	43

Table 12

	Feeding alley flooring type		
	Slatted	Solid	Total
15% lame cows or more	2	26	28
Less than 15% lame cows	0	15	15
Total	2	41	43

Table 13

	Feeding alley flooring type		
	Concrete	Rubber	Total
25% asymmetric cows or more	31	6	33
Less than 25% asymmetric cows	4	2	10
Total	35	8	43

Table 14

	Feeding alley flooring type		
	Slatted	Solid	Total
25% asymmetric cows or more	2	35	37
Less than 25% asymmetric cows	0	6	6
Total	2	41	43

Table 15

	Slipperiness		
	Slippery	Not slippery	Total
15% lame cows or more	12	15	27
Less than 15% lame cows	8	9	17
Total	20	24	44

Table 16

	Slipperiness		
	Slippery	**Not slippery**	**Total**
25% asymmetric cows or more	18	20	38
Less than 25% asymmetric cows	2	4	6
Total	20	24	44

Table 17

	Slipperiness		
	Slippery	**Not slippery**	**Total**
60% under tracking cows or more	9	11	20
Less than 60% undertracking cows	1	3	4
Total	10	14	24