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A Study on the Occurrence of Sand Cracks in Commercial Beef Cattle

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Abstract: Data for the study were obtained over three years, from 2655 cows in 10 herds that had a history of sand cracks. The objectives were to establish the prevalence, intensity and severity of sand cracks, follow the same cows in successive years, and ascertain when cracks occur and if the severity changes over time. The prevalence of sand cracks on the forelimbs was 26.6% and on all limbs 27.4%. Older cows showed a higher ($P<0.01$) prevalence than younger cows and the Angus x Hereford crossbred and Red Angus had higher ($P<0.01$) prevalence than Shorthorn and Hereford. In general, 53-55% of the cows had a single crack and the number of cracks was independent of cow age, breed, year and cow condition score. Older cows had cracks that showed visible separation whereas more of the heifers had hairline cracks ($P<0.01$). The effects of year, breed and cow condition score had no effect ($P>0.05$) on severity score. Among the same cows represented in three consecutive years, the severity scores increased linearly ($P<0.05$) from the first to the third year, indicating a progressive increase in severity. It is therefore likely that the cracks become more severe with time and eliminating sand cracks by conventional management practices would be difficult.

Key words: Sand cracks, prevalence, severity, commercial beef cows, cow age

Introduction

Healthy hooves, feet and legs complement the ability of cows to walk long distances while grazing. In addition, healthy hooves negate the need to cull cows due to conditions such as foot rot and laminitis. It has been reported that 1.5% of the beef cows are culled due to foot and leg problems (Arthur *et al.*, 1992) and much of the lameness in dairy cattle is attributed to claw problems (Peterse 1987). Sand cracks usually appear to start at the coronary band of the hoof and extend vertically downwards into the hoof lamina (Greenough *et al.*, 1972 and Greenough, 1997). The prevalence of sand cracks has been reported to vary from 20 to 22% (Hand *et al.*, 1992 and Goonewardene and Hand 1995), although among some older cows herds in western Canada the prevalence is as high as 60% (Greenough, 1997). Although the exact cause or causes of sand cracks is yet to be determined, the prevalence has been shown to be associated with age, body weight and level of fatness (Hand *et al.*, 1992 and Goonewardene and Hand 1995). It was also shown that over 80% of the sand cracks occur on the forelimbs and that the prevalence and severity of cracks were significantly higher on the outside claws of the forelimbs (Westra, 1981; Hand *et al.*, 1992 and Goonewardene and Hand 1995). Although some cattle producers are of the opinion that the presence of sand cracks decreases daily weight gains, it was shown to have no effect on the average daily gain of cows and calves grazing summer pastures (Goonewardene and Hand, 1995). Sand cracks are reported to be more prevalent in beef herds with higher levels of production (Greenough, 1997). A genetic basis for sand cracks has been suggested, but this study used only a few animals (Brinks *et al.*, 1979). However, the questions of why and when sand cracks occur have not been answered. The objectives of this study were to establish the prevalence; intensity and severity of sand cracks follow the same cows in successive years and determine when cracks occur and if the severity changes over time.

Materials and Methods

The data for the study were obtained from cows in 10 commercial herds (n = 2655), over a three year period. Herd 1 contained SH (94), herd 2-HE (95), herd 3-AN (80), HE (183) and SM (244), herd 4-SH (162), herd 5-AN (299), Herd 6-AN (464), herd 7-AN (318), herd 8-RA (150), herd 9-AN x HE (47) and AN (215) and herd 10-CH (304) cows. Data for herd 2 were available in the first year only whereas, data for the herds 1, 4, 5 and 9 were available in the first two years only. Data for all three years were available in herds 3, 6, 7, 8 and 10. The fore and hind limbs of cows were examined for the presence, number and severity of sand cracks in September or October of each year, over three consecutive years by the same individuals. The prevalence (incidence), intensity (number) and severity were recorded on the basis of limb position (fore and hind), side (left or right) and claw orientation (inside and outside claw). Severity of the sand cracks were based on the degree of separation and scored as 1-hair-line, 2-separation of less than 3 mm and 3-separation of greater than 3 mm (Goonewardene and Hand 1995) and a total severity score for each animal showing a crack was calculated by adding the severity scores for each claw. Thus if a cow had one hairline crack and one type 3 crack, its total severity score would be 4. Body

condition scores, calf weaning weight and cow weight at calf weaning were also obtained at the time hooves were examined. The body condition scoring system developed by the East of Scotland College of Agriculture (Lowman *et al.*, 1976) was used.

The analyses were done separately for the forelimbs only and for fore and hind (all) limbs. The prevalence of cracks was analyzed by the CATMOD procedure of the Statistical Analysis Systems, Institute Inc., (1990) by which maximum likelihood estimates were generated. Prevalence was described as a dichotomous variable, either 'yes' when the cow had a crack or 'no' when there was no crack, and was irrespective of the number and severity of cracks. For the purpose of analysis cow age was described by three age group classes: heifer (2 yr), 3-5 yr old and 6 yr and greater. The main effects in the model included, age group, breed (AN x HE, AN, CH, HE, RA, SH and SM), farm nested in breed, year (1, 2 and 3) and cow condition score (2.5 to 5), and cow weight at weaning included as a direct effect. The intensity referred to the number of cracks on the claws and for the purpose of analysis was described in three classes: 1 crack, 2 cracks and 3 or more cracks. The CATMOD procedure was used for the analysis of the number of cracks grouped as 1, 2 or >2 and the severity of cracks grouped as 1, 2 or 3, and included age group, breed, herd nested in breed and year as main effects and cow weight as a direct effect. The total severity score was analyzed by the GLM procedure in SAS (1990) with age group, breed, farm nested in breed, year and cow condition score as fixed effects and cow weight at calf weaning as a covariate. The linear trend of age group was tested using a contrast statement (SAS 1990). The total severity score was tracked on cows that were in the study for all three years and for two consecutive years (yr 1 and 2 or yr 2 and 3) and subject to the MIXED procedure of SAS (Littell *et al.*, 1996) with year as a repeated main effect and age of the cow as a covariate. The linear trend of year was tested for the three year's of cow data. The GLM procedure of SAS (1990) was used to analyze cow body weight at weaning and calf weaning weight and the fixed effects in the model included prevalence (cracks or no-cracks), age group (heifers, 3-5 yr and 6 yr >), year (1, 2 & 3), breed, farm nested in breed, cow condition score and interactions of prevalence x age group, prevalence x year and prevalence x condition score. Only prevalence and the interactions of prevalence and the other main effects for cow weight at calf weaning were considered. The model for the analysis of calf weaning weight included sex of calf in addition to the fixed effects of prevalence, age, breed and farm nested in breed.

Results

A total of 706 cows had cracks on the fore limb out of a total of 2655 and the overall prevalence on the fore limb was 26.6%, whereas a total of 729 cows were recognized with cracks on the fore and hind limbs and the prevalence based on all limbs was 27.4%. The cracks on the forelimbs accounted for 97% of all sand cracks.

The distribution of sand cracks by position, side and orientation is shown in Fig. 1. The total number of cracks on the forelimbs was 1085 and on the hind limbs was 51. More cracks (82.4%) were observed on the outside claws of the forelimbs than the inside claws of the forelimb. Based on the forelimbs only, 55.2, 37.5, 5.5 and 1.7% of cows had one, two three or four cracks respectively. Based on both fore and hind limbs, 53.3, 37.0, 6.7, 2.1 and 0.8% of cows had one, two, three, four or five cracks respectively.

There were 19.3, 38.1 and 42.6% of cows with maximum severity scores of 1, 2 and 3 respectively, in the forelimbs and 19.3, 37.8 and 42.8% of cows with maximum severity scores of 1, 2 and 3 respectively, for all limbs. Although it appears from these data that the severity score 3 was the most frequent, it is not, as the cows with two or more cracks may have combinations of severity scores. Based on the total number of cracks in the fore limbs (n = 1085), 21.8% of the cracks were hair line, 40.1% were less than 3 mm in width and 38.1% greater than

3 mm in width. The total severity scores ranged from 1 to 12 (Fig. 2) and 74-76% of cows with sand cracks had scores between 1 and 4.

The maximum likelihood analysis for prevalence for the forelimbs and all limbs, by age group, breed, year and cow condition score is shown in Table 1. Age group and breed were significant ($P<0.01$) with older cows showing a higher prevalence than younger cows. The AN x HE crossbred and RA had higher ($P<0.05$) prevalence levels compared to SH and HE. Although the prevalence in year 3 was higher than in years 1 and 2, the difference was not significant ($P>0.05$). The prevalence of cracks on forelimbs and fore and hind limbs in cows increased linearly ($P<0.05$) with the increase in cow condition score, and fatter cows (high CCS) had a higher prevalence of sand cracks (Table 1).

The number of cracks on the fore and all limbs by age group, breed, year and cow condition score is shown in Table 2. In general, between 53-55% of the cows had a single crack and the number of cracks was independent of age, breed, year and condition score, although there was a trend ($P<0.07$) for year 3 to have more cows with a single crack and less cows with two sand cracks.

More of the older cows were associated with severity scores 2 or 3, whereas more heifers had hairline cracks (Fig. 3). The effects of year, breed and cow condition score were not significant ($P>0.05$) for severity scores. The effect of age group on severity score was similar for the fore limbs and all limbs. Total severity scores for the

Table 1: Prevalence of sand cracks by age, breed, year and cow condition score (CCS) in cattle

		Forlimbs					Fore and hind limbs			
Effect	Level	N	Cracks	%	X^2	P	Cracks	%	X^2	P
Age	Heifer	1088	74	6.8	143.8	<0.01	76	7.0	151.4	<0.01
Group	3-5 yr	925	329	35.6			337	36.4		
	6 yr>	642	303	47.2			316	49.2		
Breed	AnxHE	365	142	38.9	42.2	<0.01	142	38.9	41.0	<0.01
	AN	1058	295	27.9			310	29.3		
	CH	304	88	28.9			90	29.6		
	HE	278	44	15.8			44	15.8		
	RA	150	48	32.0			51	34.0		
	SH	256	22	8.6			25	9.8		
	SM	244	67	27.5			76	27.5		
Year	1	1077	262	24.3	2.2	0.33	267	24.8	2.6	0.27
	2	1080	274	25.4			285	26.4		
	3	498	170	34.1			177	35.5		
CCS	2.5	130	25	19.2	4.9	0.43	26	20.0	5.8	0.33
	3.0	569	121	21.3			126	22.1		
	3.5	1065	257	24.1			263	24.7		
	4.0	670	206	30.7			213	31.8		
	4.5	180	80	44.4			84	46.7		
	5.0	41	17	41.5			17	41.7		

AN-Angus, HE-Hereford, CH-Charolais, RA-Red Angus, SH-Shorthom, SM-Simmental

Table 2: Intensity (number) of sand cracks by age, breed, year and cow condition score (CCS)

		Percent and number of fore limb cracks					Percent and number of fore and hind lim cracks				
Effect	Level	1	2	>2	X2	P	1	2	>2	X^2	P
Age	Heifer	63.5 (47)	28.4 (21)	8.1 (6)	5.0	0.29	63.2 (48)	28.9 (22)	7.9 (6)	5.6	0.23
Group	3-5 yr	56.2 (185)	37.7 (124)	6.1 (20)			54.0 (182)	38.0 (128)	8.0 (27)		
	6 yr>	52.2 (158)	39.6 (120)	8.3 (25)			50.3 (159)	38.0 (120)	11.7 (37)		
Breed	ANxHE	43.6 (62)	49.3 (70)	7.0 (10)	16.8	0.15	43.7 (62)	47.9 (68)	8.5 (12)	17.2	0.14
	AN	57.3 (169)	33.2 (98)	9.5 (28)			54.8 (170)	32.9 (102)	12.3 (38)		
	CH	61.4 (54)	35.2 (31)	3.4 (3)			58.9 (53)	32.2 (29)	8.9 (8)		
	HE	59.1 (26)	40.9 (18)	0 (0)			59.1 (26)	38.6 (17)	2.3 (1)		
	RA	62.5 (30)	27.1 (13)	10.4 (5)			58.8 (30)	29.4 (15)	11.8 (6)		
	SH	54.6 (12)	40.9 (9)	4.6 (1)			56.0 (14)	40.0 (10)	4.0 (1)		
	SM	55.2 (37)	38.8 (26)	6.0 (4)			50.8 (34)	43.3 (29)	6.0 (4)		
Year	1	55.3 (145)	35.5 (93)	9.2 (24)	9.0	0.06	54.3 (145)	35.6 (95)	10.1 (27)	8.7	0.07
	2	51.1 (140)	43.3 (116)	6.6 (18)			48.4 (138)	43.2 (123)	8.4 (24)		
	3	61.8 (105)	32.9 (56)	5.3 (9)			59.9 (106)	29.4 (52)	10.7 (19)		
CCS	2.5	76.0 (19)	20.0 (5)	4.0 (10)	1.2	0.61	76.9 (20)	19.2 (5)	3.9 (1)	2.3	0.43
	3.0	56.2 (68)	33.9 (41)	9.9 (12)			54.0 (68)	34.1 (43)	11.9 (15)		
	3.5	56.0 (144)	35.4 (91)	8.6 (22)			54.8 (144)	35.4 (93)	9.9 (26)		
	4.0	51.5 (106)	42.2 (87)	6.3 (13)			49.3 (105)	40.4 (86)	10.3 (22)		
	4.5	58.8 (47)	38.8 (31)	2.5 (2)			54.8 (46)	40.5 (34)	4.8 (4)		
	5.0	35.3 (6)	58.8 (10)	5.9 (1)			35.3 (6)	52.9 (9)	11.8 (2)		

AN-Angus, HE-Hereford, CH-Charolais, RA-Red Angus, SH-Shorthom, SM-Simmental

forelimbs and all limbs by age group, breed, year and condition score is shown in Table 3. The sand cracks became more severe as cows got older and a linear increase ($P<0.01$) in severity score was observed with increasing age. Total severity scores were not influenced ($P>0.05$) by breed, year and cow condition score.

The severity scores on the same cows measured in either three or two consecutive years for the fore claws and all claws is shown in Table 4. Among the same cows represented in three successive years, the severity scores increased linearly ($P<0.05$) from the first to the third year, suggesting a progressive increase in severity. This trend was observed for both fore claws and all claws.

Cow weight at calf weaning was similar ($P>0.05$) for cows with or without sand cracks on the forelimbs (cracks = 688.0 ± 4.5 kg, no cracks = 680.5 ± 3.0 kg). However, the interactions of prevalence with age group and prevalence with cow condition score were significant ($P<0.01$) for cow weight at weaning (Figs. 4 and 5

Table 3: Total severity score for sand cracks by age, breed, year and cow condition score (CCS)

		Fore limbs			Fore and hind limbs		
Effect	Level	Score	P	Linear[z]	Score	P	Linear
Age	Heifer	2.7 ± 0.28a	0.02	<0.01	2.8 ± 0.29a	<0.01	<0.01
Group	3-5 yr	3.2 ± 0.16ab			3.3 ± 0.17ab		
	6 year >	3.5 ± 0.15b			3.6 ± 0.16b		
Breed	AN x HE	3.9 ± 0.44	0.40	NT[Y]	3.9 ± 0.49	0.51	NT
	AN	3.3 ± 0.31			3.4 ± 0.34		
	CH	2.4 ± 0.43			2.5 ± 0.48		
	HE	2.9 ± 0.56			2.9 ± 0.62		
	RA	3.3 ± 0.54			3.4 ± 0.59		
	SH	3.2 ± 0.77			3.3 ± 0.83		
	SM	3.1 ± 0.46			3.2 ± 0.52		
Year	1	3.3 ± 0.17	0.39	NT	3.4 ± 0.18	0.61	NT
	2	3.1 ± 0.17			3.2 ± 0.18		
	3	3.0 ± 0.22			3.1 ± 0.23		
CCS	2.5	2.6 ± 0.42	0.27	0.15	2.8 ± 0.43	0.30	0.14
	3.0	3.2 ± 0.22			3.3 ± 0.23		
	3.5	3.2 ± 0.17			3.2 ± 0.18		
	4.0	3.1 ± 0.17			3.2 ± 0.18		
	4.5	2.8 ± 0.24			2.9 ± 0.25		
	5.0	4.0 ± 0.50			4.0 ± 0.52		

[Z]P linear effect [Y]noth tested

AN-Angus, HE-Hereford, CH-Charolais, RA-Red Angus, SH-Shorthon, SM-Simmental

a,b.. Means with different letters within an effect denote significance (P<0.05)

Table 4: Progression of the severity of sand cracks in the same cows in consecutive years

			Total severity score				
Test	Position	n (cows)z	Year 1	Year 2	Year 3	P	Linear[Y]
All 3 years	Fore limbs	174(58)	2.8 ± 0.26	3.1 ± 0.26	3.6 ± 0.28	0.10	0.03
Year 1 & 2	For limbs	304(152)	3.1 ± 0.21	3.3 ± 0.31	-	0.33	-
Year 2 & 3	For limbs	200(100)	-	2.8 ± 0.20	3.3 ± 0.20	0.06	-
All 3 years	All limbs	174(58)	2.9 ± 0.28	3.2 ± 0.28	3.8 ± 0.29	0.07	0.02
Year 1 & 2	All limbs	304(152)	3.2 ± 0.22	3.5 ± 0.22	-	0.21	-
Year 2 & 3	All limbs	200(100)	-	3.0 ± 0.21	3.5 ± 0.21	0.05	-

[z]number of cows [Y] P linear effect

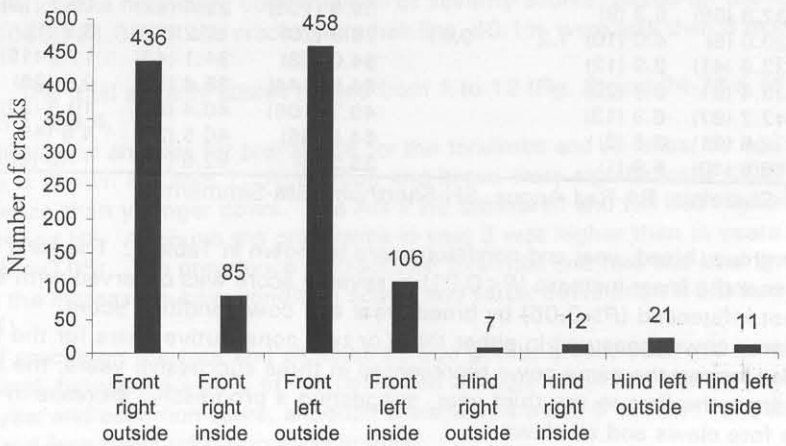

Fig. 1: Distribution of sand cracks by position, side and orientation

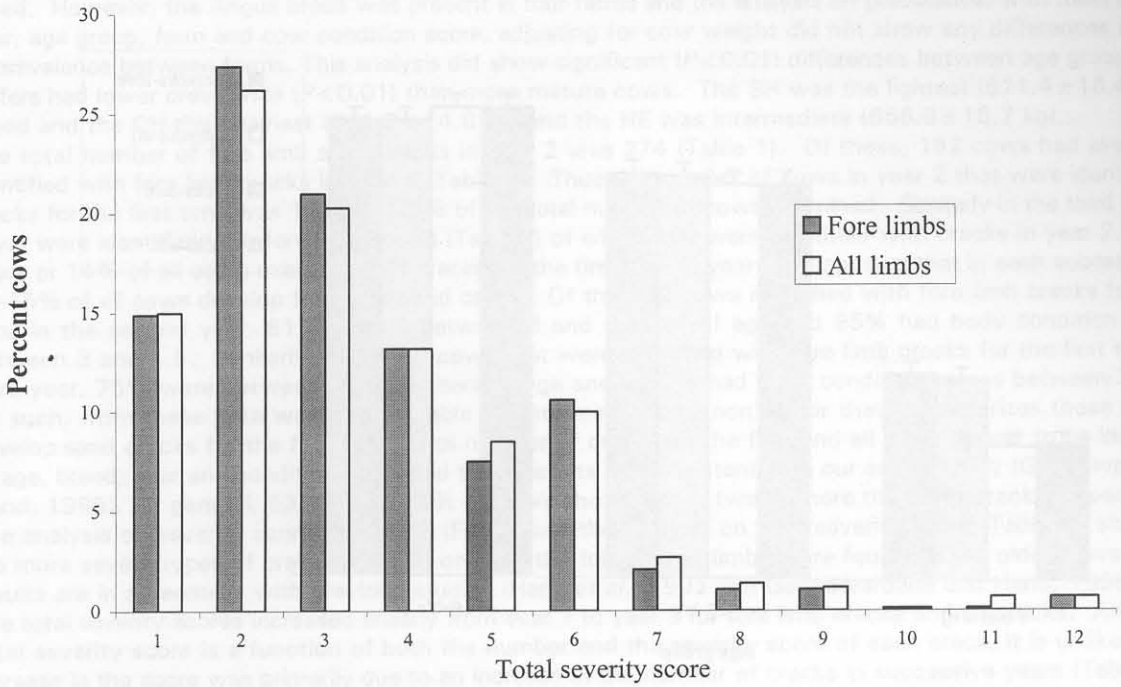

Fig. 2: Total severity scores for the fore limbs and all limbs of cows showing sand cracks

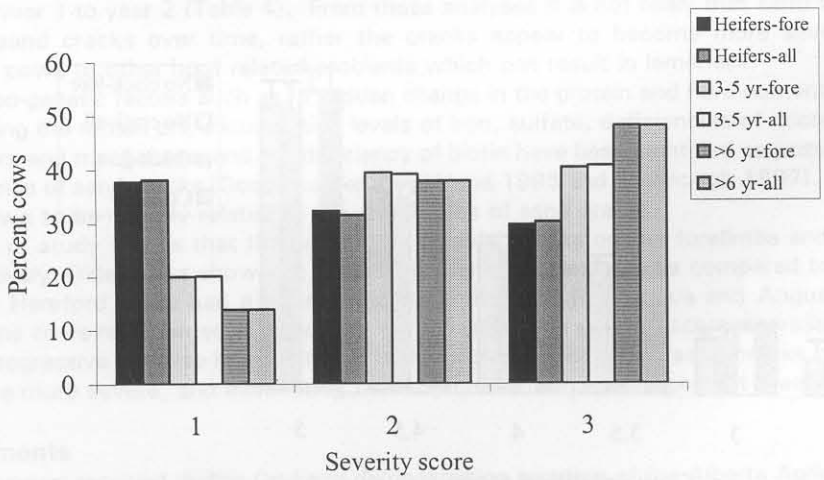

Fig. 3: Severity of sand cracks in cows by age group

respectively). Cows calving for the first time that had sand cracks were heavier at the time they weaned their calves compared to cows with no cracks. However among the older cows (>3 yr), there was no difference in cow weight at weaning between cows with and without cracks. Cows with sand cracks in CCS categories <4.5 were generally heavier at the time they weaned their calves but the CCS 5 cows that had sand cracks were lighter at the time they weaned their calves. The presence or absence of sand cracks on cows had no effect ($P>0.05$) on calf weaning weight, but the sex of the calf was significant ($P<0.01$). The male calves weighed 309.5 ± 8.3 kg and females weighed 279.5 ± 8.5 kg at weaning.

Discussion

The prevalence of sand cracks on the forelimbs estimated in this study is slightly higher (26.6%) than in our previous study (Goonewardene and Hand 1995) which calculated prevalence to be between 20-21%. The herds in the present study were all known to have sand cracks as one of our objectives was to determine the inheritance of sand cracks. As such, the 26% prevalence may be slightly higher than what one would normally expect among

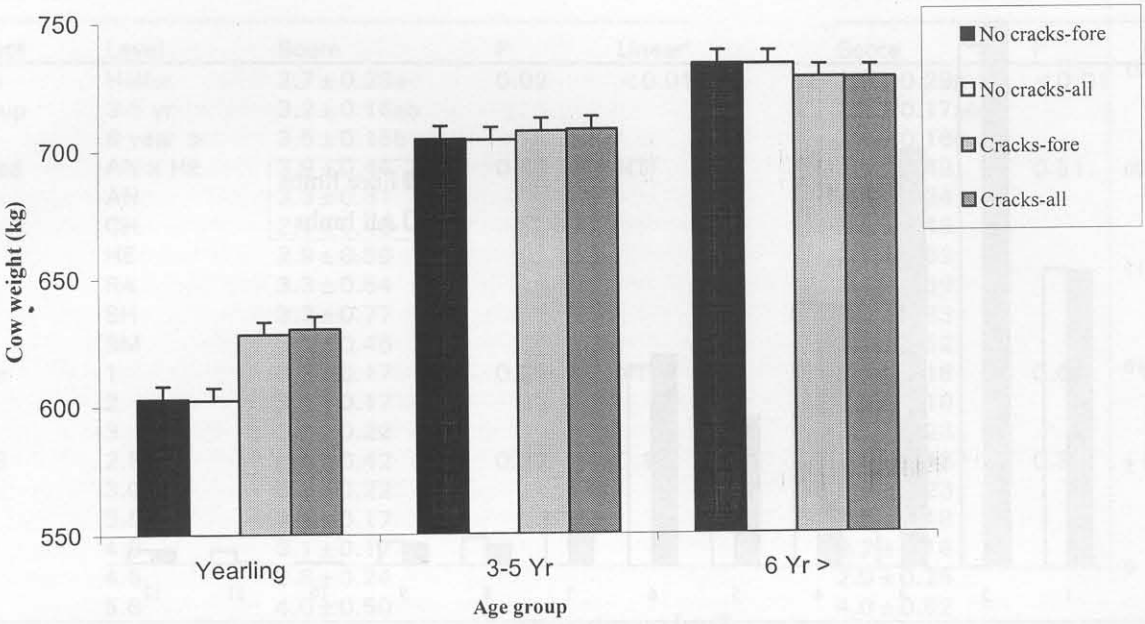

Fig. 4: The interaction of prevalence and age group for cow weight at calf weaning $P<0.01$

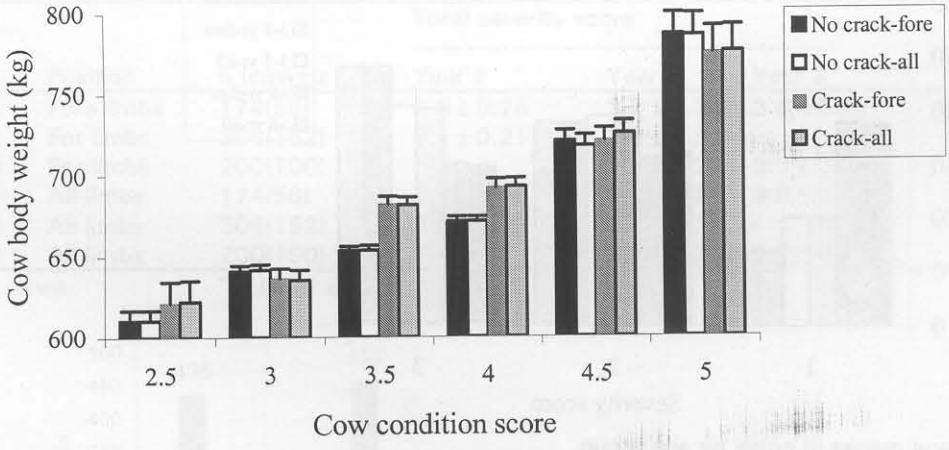

Fig. 5: Interaction of prevalence and cows condition score for cow weight at calf weaning $P<0.01$

commercial beef cows. The significant association of cow age with prevalence is supported by previous studies (Brinks *et al.*, 1978 and Westra 1981) and the prevalence of cracks at 47.2% for older cows in this study is similar to our previously reported value of 47.9%, although more heifers showed cracks in the present study (Goonewardene and Hand 1995). In a previous study, 86% of sand cracks were reported to occur on the fore limbs (Westra 1981) but in this study 97% of the cracks occurred on the fore limbs. The prevalence has also be reported to be higher on the outside claw of the fore limbs (Hand *et al.*, 1992 and Greenough 1997), and weight, load and the contact of the outside claw with the ground surface has been postulated as predisposing factors for the increased prevalence of sand cracks on the outside claw.

The prevalence of cracks was lower in the Shorthorn and Hereford cows compared to the other breeds evaluated (Table 1), although there is no evidence in the literature to indicate that certain breeds are more susceptible to sand cracks than others. Furthermore, as all the breeds were not represented in every farm and though farm nested in breed was used to compare differences between breeds, yet there may be some confounding effect of farm and

breed. However, the Angus breed was present in four farms and the analysis on prevalence, with main effects of year, age group, farm and cow condition score, adjusting for cow weight did not show any differences ($P>0.05$) in prevalence between farms. This analysis did show significant ($P<0.01$) differences between age groups, where heifers had lower prevalence ($P<0.01$) than more mature cows. The SH was the lightest (611.4 ± 16.4 kg) cow breed and the CH the heaviest (801.8 ± 14.6 kg) and the HE was intermediate (666.9 ± 15.7 kg).

The total number of fore limb sand cracks in year 2 was 274 (Table 1). Of these, 152 cows had already been identified with fore limb cracks in year 1 (Table 4). Thus the number of cows in year 2 that were identified with cracks for the first time was 122 or 11.3% of the total number of cows examined. Similarly in the third year, 170 cows were identified with fore limb cracks (Table 1) of which 100 were identified with cracks in year 2. Thus 70 cows or 14% of all cows examined had cracks for the first time in year 3. It appears that in each successive year, 10-15% of all cows develop fore limb sand cracks. Of the 122 cows identified with fore limb cracks for the first time in the second year, 61.3% were between 3 and 6 years of age and 95% had body condition scores of between 3 and 4.5. Similarly, of the 70 cows that were identified with fore limb cracks for the first time in the third year, 75% were between 3 and 6 years of age and 97.2% had body condition scores between 3 and 4.5. As such, from these data we were not able to determine a common factor that characterizes those cows that develop sand cracks for the first time. The number of cracks on the fore and all limbs appear to be independent of age, breed, year and condition score and these results are consistent with our earlier study (Goonewardene and Hand, 1995). In general, 53, 37 and 10% of cows showed one, two or more than two cracks respectively.

The analysis on severity scores 1, 2 or 3 (Fig. 3) and the analysis on total severity score (Table 3), showed that the more severe types of cracks (type 3) on both the fore and all limbs were found on the older cows and these results are in agreement with previous studies (Hand *et al.*, 1992 and Goonewardene and Hand, 1995).

The total severity scores increased linearly from year 1 to year 3 for fore limb cracks and all cracks. Although the total severity score is a function of both the number and the severity score of each crack, it is unlikely that the increase in the score was primarily due to an increase in the number of cracks in successive years (Table 2). It is more likely that the original cracks increased in severity score each year. There was a trend ($P<0.06$) to indicate that the severity scores increased in the fore claws and all claws of cows from year 2 to year 3 but it was not observed from year 1 to year 2 (Table 4). From these analyses it is not likely that sand cracks heal or that cows recover from sand cracks over time, rather the cracks appear to become more severe and could therefore predispose the cows to other hoof related problems which can result in lameness.

A number of non-genetic factors such as, a sudden change in the protein and fibre content of the diet during spring turn-out changing the rumen pH, climate, high levels of iron, sulfate, deficiencies of micro-minerals such as, zinc, copper, selenium and manganese, and the deficiency of biotin have been identified as possible pre-disposing factors for the occurrence of sand cracks (Goonewardene and Hand 1995 and Greenough 1997). However, none of these have been shown to be directly related to the occurrence of sand cracks.

In conclusion, or study shows that the prevalence of sand cracks on the forelimbs and all limbs was 26.6 and 27.4% respectively. Older cows showed a higher prevalence of sand cracks compared to younger cows, and the Shorthorn and Hereford cows had a lower prevalence than the Red Angus and Angus x Hereford crossbreds. Among the same cows represented in three consecutive years, the severity scores increased linearly over the years suggesting a progressive increase in severity. It is therefore not likely that sand cracks heal over time, rather the cracks become more severe, and eliminating them by conventional management practices would be difficult.

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