Assessment of welfare on 24 commercial UK dairy goat farms based on direct observations

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Papers

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The preliminary findings from an investigation into the health and welfare of goats on commercial dairy goat farms in the UK are described. An assessment protocol involving direct observations of the goats was developed in order to assess their welfare. Twenty-four dairy goat farms in England and Wales were visited and assessed during the period autumn 2004 to summer 2005. The main welfare issues identified were lameness and claw overgrowth, udder and teat lesions, skin lesions and pruritus.

WELFARE assessment has been undertaken in several species of animals commonly farmed in the UK, including cattle (Ofner and others 2003, Whay and others 2003b, Winckler and others 2003), pigs (Whay and others 2003a, 2007, Scott and others 2007) and laying hens (Whay and others 2003a). Farm animal welfare schemes are becoming increasingly important as a means of marketing produce and bolstering consumer confidence in the ethical standards of food production (Main and others 2001, Veisser and others 2008). At present, there is very little information as to the welfare of goats on which to base farm assurance schemes or welfare assessment protocols, despite there being approximately 33,000 goats commercially farmed on 127 dairy farms in the UK (J. Stanley, personal communication).

To date, studies into the health and welfare of dairy goats have focused on udder health (Sanchez and others 1999, Menzies and Ramanoon 2001, Contreras and others 2007), diet and feeding behaviour (Baumont and others 2000, Morand-Fehr 2005), with an emphasis on production in particular. There have been a smaller number of studies examining lameness and/or foot lesions (Hill and others 1997, Eze 2002, Mazurek and others 2007, Christodoulopoulos 2009). Some studies have examined social behaviour, including dominance and hierarchy, and aggressive behaviours in herds (Fournier and Festablanchet 1995, Keil and Sambraus 1996, Barroso and others 2000, Jorgensen and others 2007, Tolu and Savas 2007). A few studies have described the effect of the provision of resources on behaviour in small groups of goats (Andersen and Boe 2007, Jackson and Hackett 2007, Aschwanden and others 2008a, b, 2009a, b). Mazurek and others (2007) suggested that behavioural measures of welfare could be developed for use in assessment protocols. However, as far as the authors are aware, there are no published general overviews of farmed dairy goat health and welfare anywhere in the world. Certainly, the only published study of welfare of dairy goat herds in the UK is an investigation into lameness and foot lesions on four commercial farms in the south-west of the country (Hill and others 1997).

A variety of approaches for assessing animal welfare on-farm have been described. Many are based on the 'Five Freedoms' framework (Webster and others 2004). Some welfare assessment protocols focus more on the provision of resources, such as trough space and bedding quality (Ofner and others 2003). Although resources are very important, they often provide an incomplete picture of animal welfare (Main and others 2003). To date, little has been published about the effect of resources on dairy goat welfare. Observations of the behaviour and physical condition of animals are a more direct method of evaluating welfare (Main and others 2007) and hence are more useful for the initial identification of welfare problems in dairy goats. Several studies have compiled outcome measures into practical protocols to assess welfare on-farm in other farmed species (Whay and others 2003a, b, 2007).

This study describes a protocol for assessing the welfare of farmed dairy goats and quantifies the main welfare problems affecting dairy goats on 24 farms in England and Wales.

Materials and methods

Farm recruitment

Commercial farms were recruited in England and Wales via the Goat Veterinary Society, the British Goat Society and local goats' milk producer groups. A commercial farm was defined as any farm, of any size, producing goats' milk or milk products for sale for human consumption. Twenty-four dairy goat farms were visited between November 2004 and August 2005. The welfare assessment protocol was designed for, and applied to, adult female goats only.

Development of the protocol

A standard protocol of direct animal observations was developed. The protocol was constructed from a review of the published literature on goat health and welfare by consulting the Goat Veterinary Society and by extrapolating principles of welfare assessment for other species. Observations were performed in a way that caused minimal disruption to the normal farm routine. Measures included in the protocol are listed in Table 1 and described below.

On-farm assessments

A single observer (KA) performed all observations on a farm over the course of 24 hours and two routine milkings. A checklist was used to ensure all the observations were completed in a standard order. This checklist was laminated in order to be durable and less vulnerable to

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TABLE 1: Details of parameters in a welfare assessment protocol for observations on individual dairy goats

Welfare parameter	Description
Teat abnormality	
Teat end lesion	Obviously damaged or prolapsed teat sphincter
Irregular swellings	Any visible swellings or lumpiness of the teat tissue
Skin inflammation	Any general reddening, crusting or scabbing of teat skin
Skin wounds	Well-defined break or cut in teat skin surface, or discrete scar
Udder abnormality	
Moderate asymmetry	Any udder where one-half is obviously smaller than the other half by up to one-third of the height of the udder septum
Severe asymmetry	Any udder where one-half is smaller than the other half by more than one-third of the height of the udder septum
Irregularity	Visible irregular swellings of mammary tissue
Skin lesion	General reddening, crusting or scabbing of an area of udder skin affecting up to one-eighth of the udder surface
Severe skin lesion	General reddening, crusting or scabbing of an area of udder skin affecting one-eighth or more of the udder surface
Conformation trait	
Accessory teats	More than two teats per udder
Moderately pendulous udder	Ventral surface of udder is below the level of the hocks by up to one-third of the distance from the hock to the fetlock
Very pendulous udder	Ventral surface of the udder is below the hock by more than one-third of the distance from the hock to the fetlock
Head, limb and body skin lesions	
Lower limb skin lesion	Hair loss or skin damage in the area distal to the carpal and tarsal areas of one or more limbs
Neck skin lesion	Hair loss or skin damage in the area from shoulders to base of head
Periorbital skin lesion	Hair loss or skin damage in the area immediately around one or both eyes
Nasal skin lesion	Hair loss or skin damage in the area of the nares
Ear tear	Full-thickness tear of ear tissue, extending to involve the edge of the ear
Mild knee callusing	Goat has hair loss and skin thickening over the carpal area of one or both limbs, skin does not appear damaged. Neither limb has a more severe callus
Moderate knee callusing	Skin over the carpal area appears broken and/or reddened on one or both limbs. Neither limb has a more severe callus
Severe knee callusing	Large areas of scabbing or skin damage, or thick callus material over the carpal area on one or both limbs
Body skin lesion	Hair loss or skin damage in the area other than the head, neck, lower limbs, udders, teats and knees
Cleanliness	
Dirty udder	Any visible udder dirt covering up to one-eighth of the udder surface
Very dirty udder	More than one-eighth of the udder surface is dirty
Dirty teats	Any visible teat dirt covering up to one-quarter of the teat surface
Very dirty teats	More than one-quarter of the teat surface, of one or both teats, is dirty
Dirty limbs	Any dirt on one or more limbs covering part of the area distal to the knee or hock
Very dirty limbs	Dirt covering the majority of the area below the knee or hock of one or more limbs
Dirty head	Dirt visible in the head area
Dirty body	Dirt covering areas of the body other than those listed above, excluding 'anal soiling'
Anal soiling	Area immediately around the anus is covered in faecal material
Discharges	
Vulval discharge	Any discharge from the vulva
Nasal discharge	Any discharge from the nose
Ocular discharge	Any discharge from the eyes
Swellings	
Lymph node swelling	Swellings in the area of the superficial lymph nodes
Joint swelling	Swellings of the lower limb joints
Body condition score (BCS)	
Obviously thin	BCS 1.5 or less on palpation
Obviously fat	BCS 4 or more on palpation
Claw overgrowth	
Moderate claw overgrowth	Claws on one or more feet are overgrown by less than 2.5 cm
Severe claw overgrowth	Claws on one or more feet are overgrown by more than 2.5 cm
Lameness score	
Score 0	Goat places full weight on all four limbs, moves forward freely with an even gait
Score 1	Goat has a definite limp on one or more legs, but bearing weight and moves forward freely
Score 2	Goat has some difficulty moving forward, severe limp, bearing little weight on one or more legs, may be a degree of goose-stepping
Score 3	Goat has some difficulty moving forward, not bearing weight on one or more legs, or may 'goose-step' high or walk on the knees
Horns	
Full horns	Both horns present and complete
Partial horns	Either one or both horns deformed or damaged in some way, excludes small, flat spurs of horn flush with the surface of the head

destruction by the goats. All observations were recorded using a handheld tape recorder (Dictaphone; Panasonic) and transferred on to paper records away from the farm. All the farm visits started mid-morning, after the morning milking and feeding routines. Pen-level observations were recorded for every pen of adult goats (both milking and dry) on the farm, and were completed before afternoon milking. Observations of individual animals were then performed in the parlour during the afternoon milking, with the same goats being gait scored at the morning milking the following day.

Group assessments

Group assessments began with observations of the undisturbed behaviour of groups of goats housed in their pens. Every pen of goats was observed for a period of 10 minutes and a number of welfare indicators were assessed. Welfare indicators were obviously sick or dull animals, excessive scratching and rubbing, oral behaviour directed at the bars and walls of pen structures or at the teats, dyspnoea, coughing, kneeling in the pen, and whether goats were kneeling at the trough or in the main pen area away from the trough. The observer then made a slow walk through the pen, ensuring that all the goats stood up and moved, and the prevalence of lameness was estimated. All pens of adult goats were observed, irrespective of whether the goats were dry or lactating.

Individual goat observations

Detailed individual observations were performed at the afternoon milking using a systematic sample of goats from the entire milking herd, with every second to sixth goat sampled. The sampling regimen for each farm was determined by the time available, which, in turn, was determined by the speed of milking on that farm. Individual observations were performed on lactating goats only, as animals could only be examined in detail by a single observer while restrained in the parlour during routine milking. A small, handheld cosmetic mirror was used to examine the teats and the ventral surface of the udder for dirt and lesions without the need for handling. Each goat observed in the parlour was individually identified using a unique symbol drawn on the udder using a permanent marker pen and a coloured spray mark

on the tail base to allow re-identification at lameness scoring at the subsequent milking. The goats were scored for body condition using a standard approach for goats (Harwood 2006a). Goats that appeared obviously thin (body condition score [BCS] 1.5 or less) or fat (BCS 4 or more) were palpated to assign a BCS.

Lameness scoring

The goats observed and marked within the parlour were later assessed for lameness as they exited the parlour, and were assigned a score according to the descriptors in Table 1.

Data handling and statistics

Data were entered on to a spreadsheet (Excel; Microsoft) and analysed using SPSS v11 (SPSS). The interactions between different observations were examined using non-parametric tests. Spearman's rank correlations were used to relate herd-level and pen-level measures. Chi-squared tests were used for within-goat comparisons. Significance was set at $P<0.01$. The prevalence for each welfare indicator was calculated at farm level.

Results

Twenty-four farms were visited, comprising 19 per cent of the dairy goat farms in the UK. On these farms, 11,403 adult female goats were present, representing 37 per cent of adult dairy goats in the UK. The goats were predominantly British Saanen breed on 15 (62.5 per cent) farms and mixed breeds on nine (37.5 per cent) farms. The median herd size was 496 adult female goats (interquartile range [IQR] 254 to 690, range 80 to 910). The ratio of adult female goats to stockpersons ranged from 21 to 260 (median 173, IQR 110 to 228). All the goats were milked twice daily. The median number of lactating goats per farm at the time of the visit was 289 (IQR 158 to 491). Reported milking rates ranged from 50 to 400 goats per hour (median 200, IQR 100 to 290). Farm size (total number of adult female goats) and milking rate were significantly correlated ($r=0.844$, $P<0.001$). The reported average milk yield for each farm ranged from 300 to 1600 litres/goat/year (median 825, IQR 640 to 904). Regarding routine milking practices, the foremilk was checked on two farms (8.3 per cent), teats were cleaned before applying the clusters on six farms (29.2 per cent), and gloves were worn by the person milking the goats on seven farms (29.2 per cent). On nine farms (37.5 per cent), a teat dip was used after milking, and 12 farms (50 per cent) had parlours with automated cluster-release systems. Goats were milked in herringbone parlours on eight farms (33.3 per cent), rapid-exit parlours on 12 farms (50 per cent) and rotary parlours on four farms (16.7 per cent). Four farms provided outdoor grazing for their goats. These farms had herd sizes of 85, 115, 212 and 255 goats. The remainder of the herds were housed all year round in groups in pens, bedded on straw. The median group size was 85 goats (IQR 61 to 124).

Detailed individual observations were performed on 1520 lactating goats. Pen-level observations were carried out on 116 pens. Thirty-nine pens contained dry goats, 65 pens contained lactating goats and 12 pens contained a mixture of dry and lactating goats. Table 2 shows the prevalence of different welfare indicators in the 1520 goats that were examined individually. Table 3 shows the prevalence of behaviours in 116 pens of goats. Table 4 shows significant correlations between measures of welfare of the goats (reported at $P=0.01$). Estimates of lameness made in the pens were significantly lower than the estimates from observations of individual goats (Wilcoxon signed-rank test, $Z=-5.840$, $P<0.001$).

TABLE 2: Prevalence of welfare parameters in 1520 individual dairy goats examined on 24 farms in the UK

Parameter	Number (%) of Goats	Number (%) of Farms	Variation in sample prevalence (% of goats) across the farms: Median	IQR	Maximum
Total lameness (score >0)	292 (19.2)	21 (87.5)	15.2	7.7-30.2	52.5
Score 1	196 (12.9)	21 (87.5)	13.9	6.8-20	32.4
Score 2	47 (3.1)	13 (54.2)	1.2	0-6.9	11.8
Score 3	49 (3.2)	9 (37.5)	0	0-3	27.1
Total claw overgrowth	1213 (79.8)	24 (100)	72.5	60.5-91.5	100
Moderate claw overgrowth	727 (47.8)	24 (100)	43.6	28.5-53.5	100
Severe claw overgrowth	486 (32)	22 (91.7)	24.6	10.2-61.2	92
Any udder abnormality	513 (33.8)	24 (100)	28.6	22.8-35.2	47.1
Moderate udder asymmetry	238 (15.8)	24 (100)	19.5	13.5-25.5	40
Severe udder asymmetry	94 (6.2)	18 (75)	4.9	0.4-9.2	16.7
Udder irregularity	50 (3.3)	19 (79.2)	3.3	1-6	9.2
Udder skin lesion	116 (7.6)	23 (95.8)	6.3	4.1-10	28.6
Severe udder skin lesion	15 (1)	8 (33.3)	0	0-0.9	2.1
Any teat abnormality	116 (7.6)	23 (95.8)	7.5	3.3-11.7	23.2
Teat skin wound	36 (2.4)	16 (66.7)	1.8	0-5.3	16.7
Teat skin inflamed	38 (2.5)	14 (58.3)	1.3	0-2.9	15.9
Teat irregular swelling	33 (2.2)	13 (54.2)	1.3	0-4.2	7.7
Teat end lesion	9 (0.6)	5 (20.8)	0	0-1	5.8
Accessory teats	20 (1.3)	10 (41.7)	0	0-2.2	5.5
Moderately pendulous udder	77 (5.0)	20 (83.3)	4	2.3-7.8	27
Very pendulous udder	4 (0.3)	4 (16.7)	0	0-0	3.8
Neck skin lesion*	216 (14.2)	20 (83.3)	8.6	3.9-26	89.5
Body skin lesion†	302 (19.9)	18 (75)	14.6	0.5-32.1	44.1
Lower limb skin lesion‡	94 (6.2)	16 (66.7)	2.1	0-7.3	47.8
Periorbital skin lesion	96 (6.3)	12 (50)	0	0-5.2	51.3
Nasal skin lesion§	140 (9.2)	16 (66.7)	3.2	0-11.3	47.9
Ear tear¶	83 (6.2)	16 of 21¶	2.9	0.3-6.8	27.7
Mild knee callus**	304 (23.8)	18 of 20**	19.2	14.1-34.9	81.8
Moderate knee callus**	725 (56.8)	20 of 20**	57.8	46.7-71.4	87.5
Severe knee callus**	234 (18.3)	17 of 20**	10.5	3.8-23.5	64.2
Dirty teats	193 (12.7)	23 (95.8)	10.8	5.3-17.6	49
Very dirty teats	27 (1.8)	13 (54.2)	1	0-3.2	7.6
Dirty udder	247 (16.3)	23 (95.8)	14	5.3-22.3	54
Very dirty udder	22 (1.4)	13 (54.2)	1	0-2.4	3.9
Dirty limbs	553 (36.4)	21 (87.5)	46	17.5-60.5	75
Very dirty limbs	105 (6.9)	14 (58.3)	3.2	0-10.2	58.8
Dirty body	111 (7.3)	19 (79.2)	3.9	1.5-10.7	20.4
Dirty head	26 (1.7)	14 (58.3)	0	0-2.7	17.9
Anal soiling	149 (9.8)	21 (87.5)	8	3.3-17.7	31.3
Obviously thin	52 (3.4)	10 (41.7)	0	0-3.3	25
Obviously fat	41 (2.7)	4 (16.7)	0	0-0	18.5
Joint swelling	11 (0.7)	3 (12.5)	0	0-0	5.1
Lymph node swelling	6 (0.4)	6 (25)	0	0-0	3.1
Nasal discharge	9 (0.6)	3 (12.5)	0	0-0	7.9
Ocular discharge	91 (6)	17 (70.8)	3	0-7.8	40.5
Vulval discharge††	76 (5)	17 (70.8)	3.8	0-7.8	15
Full horns	23 (1.5)	21 (87.5)	0	0-2.7	7.4
Partial horns	97 (6.4)	18 (75)	2.9	0-10.3	35.7

* 90.9 per cent of all neck lesions consisted of hair loss only
† 79.4 per cent of all body skin lesions consisted of hair loss only
‡ 87.3 per cent of lower limb skin lesions involved both skin damage and hair loss
§ Nasal skin lesions consisted of black scabs and crusts
¶ Ear tears could be recorded on only 21 farms (1338 goats)
** Knee callusing could be recorded on only 20 farms (1276 goats)
†† 92 per cent of cases of vulval discharge were haemorrhagic

Discussion

Larger commercial farms were overrepresented in this study as they were easier to recruit via goat milk producer groups. This meant that a substantial proportion (37 per cent) of the UK goat population was represented by the sample used in this study. However, this may mean that the findings of this study do not accurately reflect the problems observed in smaller commercial herds and hobby farms in the UK.

TABLE 3: Prevalence of behaviours from observations of 116 pens of dairy goats on 24 farms in the UK

Behaviour	Number (%) of farms	Proportion of goats in herd showing this behaviour during a 10-minute observation period: Median	IQR	Maximum
Obviously sick/dull	9 (37.5)	0.6	0.4-1.2	1.5
Pruritus	22 (91.7)	5.8	3.6-15.4	44.9
Coughing	19 (79.2)	2.8	2-4	7
Dyspnoea	2 (8.3)	0	0-0	0.8
Oral behaviour	23 (95.8)			
Directed at bars	22 (91.7)	2.1	1.2-3.3	10
Directed at walls	20 (83.3)	1.8	1.2-3.1	12.7
Directed at teats	0 (0)	0	0-0	0
Kneeling	21 (87.5)	1.8	0.5-3.7	18.5
In pen area*	18 (75)	1.1	0.3-1.6	3.7
At trough	19 (79.2)	0.5	0-2.3	18.3

* Goats kneeling in the pen area away from the trough, and transitory kneeling in between standing and lying positions were excluded

TABLE 4: Significant correlations (P=0.01) between measures of welfare of the goats

		Correlation coefficient (Spearman rank)	P (two-tailed)	Cramer's V
Welfare measures significantly correlated over 24 farms				
Lameness	Severe claw overgrowth	0.548	0.006	
	Any dirt	0.520	0.009	
	Teat irregular swelling	−0.541	0.006	
Dirty limbs/very dirty limbs	Dirty udder	0.746	<0.001	
	Teat skin inflamed	0.556	0.005	
	Dirty body	0.726	<0.001	
Dirty body	Dirty udder	0.580	0.003	
	Severe knee callus	0.567	0.004	
Ocular discharge	Dirty head	0.544	0.006	
	Severe udder asymmetry	0.638	0.001	
Udder irregular	Pendulous udder	0.574	0.003	
Lameness score 2	Ear tear (21 farms*)	0.619	0.003	
Moderate claw overgrowth	Severe claw overgrowth	0.875	<0.001	
Welfare measures significantly correlated over 75 pens†				
Dull/sick (%)	Lameness score ≥2	0.45	<0.001	
Lameness score 2/score 3	Goats kneeling in pen area (%)	0.54	<0.001	
	Severe knee callus	0.36	<0.001	
	Obviously thin	0.417	<0.001	
Pruritus	Body skin lesion	0.54	<0.001	
Total claw overgrowth	Severe claw overgrowth	0.875	<0.001	
Welfare measures significantly correlated in 1520 goats				
Dirty udder	Dirty teats	102.528§	<0.001	0.262
	Dirty limbs/very dirty limbs	62.333§	<0.001	0.205
Dirty limbs/very dirty limbs	Dirty teats	18.152§	<0.001	0.111
	Some claw overgrowth	23.421§	<0.001	0.127
	Severe knee callus (n=1276)‡	30.95§	<0.001	0.144
Anal soiling	Lameness score ≥2	20.727§	<0.001	0.118

* Ear tears could be observed on 21 farms only (1338 goats)
† 75 of the 116 pens contained goats that were in milk and hence observed in detail in the parlour
‡ Knee callusing could be observed clearly on only 20 farms (1276 goats)
§ Associations (chi-squared)

All observations were performed on all 24 farms, with two exceptions. On four farms, the parlour design prevented clear observation of knee calluses (two rotary parlours, one herringbone and one rapid-exit), and full-thickness ear tears were not measured on three farms. Because of their high levels of occurrence, lameness and claw overgrowth, udder and teat lesions and cleanliness, skin lesions and pruritus were the main welfare issues identified in this study. Behaviours such as oral manipulation of inert objects are potential welfare issues worthy of further investigation on some farms. These observations are discussed below.

Lameness is an important behavioural indicator of pain (Whay and others 1997, O'Callaghan and others 2003) and may lower productivity in dairy goats by reducing their milk yield (Christodoulopoulos 2009) and fertility (Eze 2002). The prevalence of lameness varied greatly across the farms. The absence of lameness on three farms indicates that this condition can be avoided in commercial dairy goat farming. No association between lameness and farm size was found.

The prevalence of lameness in the dairy goats studied initially appears similar to that of UK dairy cattle herds, which has been reported to range from 15 to 37 per cent over the past 15 years (Clarkson and others 1996, Whay and others 2003b, Barker and others 2010). However, in contrast to dairy cattle, there are no well-developed, established gait scoring systems for goats. Existing cattle scoring systems enable the observer to distinguish animals that are sound from those that are tender or mildly lame (Bell and others 2009), whereas the scoring systems used in the present study, and other goat studies referenced, only detect animals that are obviously lame. Hence, the true prevalence of dairy goats whose welfare is affected by lameness may be higher than the figures quoted in this survey.

There are few published studies of dairy goat lameness. Those studies reported similar findings to the present study. Eze (2002) examined 484 goats kept on 71 farms in Nigeria, mainly under intensive management conditions, and found that 15 per cent of them were lame. Mazurek and others (2007) reported a prevalence of lameness of 12.5 per cent in a herd of 108 goats in France, and Christodoulopoulos (2009) found 24 per cent of a herd of 170 goats to be lame. The only published study on lameness in dairy goats in the UK (Hill and others 1997) found 9.1 per cent of goats on four farms to be lame; the highest herd prevalence was 23.4 per cent (95 per cent confidence interval 14.5 to 34.4 per cent).

One notable finding was that the prevalence of lameness estimated while the goats were in their pens was usually much lower than that observed when the goats exited the parlour. This could have been due to improved visibility when the goats were exiting the parlour, although all the goats were assessed carefully while in their pens. Another possible explanation is that the goats' locomotion was better when they were walking on soft straw surfaces in their pens, or that any lameness worsened when they walked on hard surfaces while travelling to and from the parlour. In dairy cattle, the type of floor surface significantly alters locomotion (Telezhenko and Bergsten 2005, Van der Tol and others 2005, Rushen and De Passillé 2006). Telezhenko and Bergsten (2005) and Flower and others (2007) found that the locomotion of cows, both lame and non-lame, improved on floor surfaces that were yielding, and was worst on slippery concrete. This finding is important, as veterinarians and farmers often assess goats for lameness while they are housed in their pens, and hence may be underestimating lameness. Hill and others (1997) assessed lameness while goats were walking on straw in their pens, and this could partly account for the lower prevalence reported in that study compared to the present study.

The prevalences of severely lame goats (score 2 and above [Table 1]) and goats kneeling in the pen area correlated significantly. This appears to support the findings of Mazurek and others (2007), who demonstrated a significant correlation between restriction when rising and lameness in a dairy goat herd. The lack of correlation between lameness prevalence and goats kneeling in the trough area is unsurprising, as troughs are likely to be positioned at floor level in some pens, forcing both sound and lame goats to kneel to access food.

Claw overgrowth is a major problem, and was detected at varying prevalence on all the farms. The high overall prevalence is in line with the findings of Hill and others (1997), in which 91.2 per cent of dairy goats examined on UK farms had overgrown claws, and supports reports in goat texts that claw overgrowth is a common problem, probably due to a lack of hoof wear when animals are housed on straw bedding (Smith and Sherman 1994a). Different farmers will

have trimmed the goats' feet at varying times before the visit. Hence, the results do indicate that, whatever management strategies are employed, claw length is generally poorly controlled. At herd level, the prevalence and severity of claw overgrowth were correlated, suggesting that where there is a high prevalence of claw overgrowth, the feet of animals are allowed to become severely overgrown. Unlike the study by Hill and others (1997), the present study found that the prevalences of severely overgrown claws and lameness were correlated, possibly reflecting general overall poor management on some farms.

This is the first overview of udder and teat abnormalities on UK dairy goat farms. Farms varied considerably in the prevalence, type and severity of different abnormalities, with teat abnormalities being less prevalent than udder abnormalities. Udder and teat lesions can affect both welfare and production in dairy goats (Perrin and others 1997, Contreras and others 2007, Leitner and others 2008). However, there is little published information about the welfare significance and aetiology of different lesions (Menzies and Ramanoon 2001). A certain amount of extrapolation of information from dairy cattle is logical but differences between the species must be borne in mind. Some lesions are better understood than others. For example, in dairy goats, udder asymmetry has been associated with intramammary infection (Alawa and others 2000). Ameh and others (1993) and Ameh and Tari (1999) found teat injuries, such as teat wounds, to be associated with mastitis.

Udder asymmetry is by far the most prevalent udder abnormality in UK dairy goats. Possible reasons include udder asymmetry being a chronic change that remains even after an udder has recovered from infection (Klaas and others 2004) or injury. Inflamed skin is likely to be a significant source of mastitis pathogens (Bergonier and De Cremoux 2003), as is the case in dairy cattle. The present study suggests that there are fewer dairy goats in the UK with inflamed udder skin than with udder asymmetry. However, skin inflammation may be a more transient lesion, and measures of the incidence of these conditions may be more useful in future investigations. Certain lesions might be unique to goats. For example, teat wounds and scars may result from 'teat biting' behaviour that is mentioned in goat texts (Harwood 2006b). There are no published studies of teat biting in goats and the aetiology is unknown. Even less is known about other lesions. For example, clinical goat texts suggest that irregular teat swellings might be cysts in the walls of the teat tissue (Smith and Sherman 1994b), but it is not known whether these are harmful, and further investigation is needed.

The present study also describes conformation traits that may be important for goat welfare. Pendulous udders were commonly observed on the farms, although few goats had very pendulous udders. Some studies of dairy goats have found pendulous udders to be associated with mastitis (Deinhofer and Pernthaner 1995, Alawa and others 2000), partly due to the increased risk of injury to the udder and teats when there are short distances between the teat ends and the floor. However, other studies have not found these associations (Ameh and Tari 1999). Further work is needed to clarify how pendulous an udder must be to affect the welfare of dairy goats.

It is important to note that the udders and teats were not palpated in this study, for logistical reasons. Hence, the reported prevalences of udder/teat lesions may underestimate the full extent of udder and teat damage in the herd, as palpation could reveal additional pathologies in udders that appear to be clinically normal on visual inspection (Menzies and Ramanoon 2001).

Certain unique aspects of dairy goat farming may contribute to the development of teat and udder lesions, for example, rapid milking rates, large herd sizes, high goat:stockperson ratios and minimal hygiene routines at milking (Menzies and Ramanoon 2001). It may be difficult for the stockperson to detect early lesions or lesions in certain locations, particularly if little time is spent preparing each individual goat in the parlour. The researcher found the handheld mirror used in this study very effective for detecting and clearly observing teat lesions in udders that were pendulous or had teats that were angled cranially; whereas the stockpersons did not use this tool. Farmers may perceive milking hygiene routines as being less important in goats than in cattle, as goats are generally cleaner than cows. However, there is evidence that most of the practices that are relevant for udder health in dairy cattle, including strict hygiene, significantly improve udder health in dairy goat herds too (Menzies and Ramanoon 2001, Bergonier and De Cremoux 2003, Contreras and others 2007). Practices and protocols that work in the context of commercial dairy goat farming need to be developed.

Generally, the herd prevalence of obviously sick/dull goats was very low (often only one or two goats per herd) and was similar to the prevalence of 1.6 per cent sick/dull cows per herd found by Whay and others (2003b) on dairy cattle farms. However, the welfare of these individual animals will be particularly poor, and they may also pose a health risk to other members in the group. The reasons for these animals not being swiftly identified and dealt with need to be investigated.

Animal cleanliness is used as a welfare indicator in pigs (Scott and others 2007), poultry and cattle (Hughes 2001, Whay and others 2003b), and to assess the risk of mastitis in dairy cattle (Hughes 2001, Schreiner and Reugg 2003, Reneau and others 2005). There are no published studies of cleanliness scores being used to assess health and welfare in goats.

Although the scoring definitions used by different researchers vary, overall, the results of the present study support anecdotal reports that dairy goats are much cleaner than dairy cattle. In UK dairy cattle herds, Whay and others (2003b) found a median farm prevalence of 100 per cent dirty hindlimbs (IQR 93.3 to 100 per cent) and 22 per cent dirty udders (IQR 12.5 to 30.8 per cent), whereas the present study on dairy goats found a median herd prevalence of 48.8 per cent dirty limbs (IQR 17.6 to 64.7 per cent) and 14.4 per cent dirty udders (IQR 5.5 to 22.8 per cent). Whay and others (2003b) found 47 per cent of dairy cattle to have medium or severe soiling of the limbs, and Schreiner and Ruegg (2003) found 30 per cent of the cattle to have heavily soiled hindlimbs, whereas only 7 per cent of the goats in this study had very dirty limbs. Similarly, Schreiner and Ruegg (2003) found 22 per cent of cows to have heavily soiled udders, in contrast to 1 per cent of the dairy goats in the present study; also, only 20 per cent of cows had completely clean udders, compared with over 80 per cent of the goats in the present study. These findings are unsurprising, as a range of factors, such as housing design, bedding type and, in particular, faecal consistency, affect the cleanliness of cows (Ellis and others 2006). Goats generally have much drier faecal matter than dairy cattle and usually have a cleaner environment, being housed on straw bedding all year round. However, the present study identified dirt on all areas of the goats' body that were defined by the protocol (Table 1). This dirt could have animal health and welfare implications and should be investigated further. For example, dairy cattle with dirtier udders, teats and hindlimbs have a higher prevalence of intramammary infection (Schreiner and Ruegg 2003, Reneau and others 2005), and this may also be the case in dairy goats. The limbs were the most common site for dirt in dairy goats. The results showed significant correlations between dirty limbs and udders, similar to the correlations found between limb and udder hygiene in dairy cattle by Schreiner and Ruegg (2003). Dirt on the limbs might be an important indicator of mastitis risk in goats, as in dairy cattle, and should be investigated further.

In dairy cattle, some factors have been reported to influence limb hygiene more than udder hygiene, or vice versa. The main factors affecting the cleanliness of dairy cattle limbs have been reported to be frequency of cleaning of barn alleyways, the ease of moving cattle, the number of times animals are moved and whether animals are overcrowded (Hughes 2001, Schreiner and Ruegg 2003). Although manure management is much easier in goats than in cattle, goats are still often moved at speed in large groups to the milking parlour twice a day. It might be that small changes in how goats are moved and handled, as well as the cleanliness and dryness of walkways, significantly influence the cleanliness of herds.

Anal soiling was observed as a specific category, as it reflects problems with nutrition and digestion as well as cleanliness (Grove-White 2004).

Some goats on all the farms had visible skin lesions. The location and type of the lesions varied between farms and between goats on the same farm. Lesions on the skin of the body and the neck were most prevalent. This may be because these defined areas were large; further detail as to the location of lesions within these areas would have been useful. Most lesions on the neck and body consisted of hair

loss only. Such lesions might not be painful but could still be important indirect measures of welfare; for example, they may reflect the presence of physical obstructions to normal behaviours, such as bars restricting access to feed, or may arise from trauma. Most lower limb skin lesions consisted of skin damage as well as hair loss, and fitted the clinical description for ectoparasitic infections such as chorioptic mange (Smith and Sherman 1994c).

Observations of groups of goats revealed pruritus to be the most prevalent behaviour. For the group observations, the prevalence of excessive scratching correlated with the prevalence of body skin lesions. This is likely to be due to scratching activity causing lesions. Farms were visited at different times of the year and at varying times after routine management procedures, making direct comparisons between farms difficult, but the results indicate that excess scratching and skin lesions are generally not well controlled on goat farms and are a priority area for further research.

Full-thickness ear tears were most likely to result from ear tags being ripped from the ears. Some farms had a particular problem of goats with torn ears. The prevalence of ear damage relating to tags is likely to be much higher than the prevalence of ear tears in the present study, as other problems, such as sepsis or migration of ear tags within the ear tissue, were not recorded as part of the protocol. Unlike in cattle (Johnston and Edwards 1996) and sheep (Edwards and Johnston 1999, Edwards and others 2000), to date there have been no published observational studies of damage associated with ear tags in goats. Dedicated studies are needed, as goats differ greatly in their anatomy, behaviour and general husbandry from other more commonly farmed species, and direct extrapolation from these species is inappropriate.

Knee callusing was treated as a separate category of lesion, as it is considered a common, distinct lesion in dairy goats. Mild knee calluses are likely to be normal anatomical features. However, the raised callus tissue and broken skin of medium and severe calluses were likely to be pathological. Further study is needed to determine the stage at which such calluses become a welfare problem and the reasons why they progress. Severe lameness (score 2 and above) and severe knee callusing were positively associated. One possible reason for this is that severely lame goats spend more time kneeling, placing considerable pressure on the knees, which contributes to callus formation. However, moderate and severe knee calluses were also often found in animals that were not lame.

Goats with full horns were kept in groups with hornless goats on 21 per cent of the farms. This is contrary to the general advice given in goat texts that mixing should be avoided, as horned goats will bully and injure hornless goats (Smith and Sherman 1994d). Although this is a good general principle, this advice might be oversimplistic once groups of goats have been established. If the presence of both horned and hornless goats in a group is to be used as a measure of welfare, then other factors must be considered. Overall, very few goats on each farm had full horns. Factors that retain harmony within a group should perhaps be concentrated on, including grouping animals at an early age, keeping groups stable (Aschwanden and others 2008a, b, 2009a, b) and ensuring that all resources are easily accessible by all the goats in the group (Jorgensen and others 2007, Barroso and others 2000), rather than removing horned goats from established groups or dehorning adult goats. Further support for this comes from the evidence that horned goats tend to either avoid each other or threaten each other without physical contact, and are avoided by hornless goats. The behaviour of horned goats contrasts with that of hornless goats, which frequently head butt, and might sustain injuries as a result (Aschwanden and others 2008a, b). Hence, the presence of horns should not be considered in isolation from other parameters as a welfare measure, and further studies are needed.

Partial horns observed in this study were likely to have resulted from incomplete disbudding of goat kids. The welfare implications of partial horns have not been studied, but they may be more damaging than full horns both for the animal carrying them and for others in the group. Partial horns may harm the animal they belong to by growing at an angle that injures the head; they may injure other animals in the group, and goats with partial horns may not be respected or avoided in the same way as those with full horns.

When given the opportunity, goats feed predominantly by browsing, and oral behaviours are likely to be important for their welfare. In this study, goats on most farms were observed to direct oral behaviour at inert objects, such as the walls and bars of their pens. Studies of the motivations for and welfare consequences of this behaviour are needed. Possible motivations include normal investigatory behaviour, frustration or redirected feeding behaviour. Studies of captive giraffes, another browsing animal, suggest that a lack of roughage in the diet (Baxter 2001) and the method of feeding (Bashaw and others 2001) may contribute to the development of abnormal oral behaviours, and that these behaviours can become stereotypical (Bashaw and others 2001, Baxter 2001).

The goats were never observed directing oral behaviour at their teats. This could be due to difficulties in noticing this behaviour in large groups of animals, or the goats being observed outside the time they might perform this behaviour.

This study describes the results of an animal-based welfare assessment on 24 UK dairy goat farms. It has identified the main welfare issues and areas that should be prioritised for further study. The authors believe that the data presented can help guide dairy goat farmers on areas of weakness on their units, and also on areas of good welfare that should be maintained. However, it must be remembered that this study was an initial investigation into dairy goat welfare, including the practicality of carrying out a full range of observations.

The welfare assessments were performed by a single observer (KA), avoiding the problems of interobserver repeatability in scoring. The protocol was developed and practised on a large commercial farm, allowing the observer to develop their skills and check the repeatability of measures before undertaking the assessment on the 24 study farms.

The categories for each measure were simple, clearly defined and practical to use on the farms. However, most of the measures used need to be further developed. As discussed above, the evidence base underpinning the assessment is sparse compared with that for species that are more commonly farmed, and many areas require further investigation. In addition, the protocol was heavily biased towards physical observations. Although these are very important, the range of behaviours that are indicative of both good and poor welfare needs to be expanded in order to balance the protocol. Better understanding is also needed of the welfare implications of other behaviours (Rushen 2003). For example, potential measures of fearfulness in goats, such as flight distance (Waiblinger and others 2006), that work when animals are housed in large groups need to be developed. Finally, further work is needed to identify the husbandry measures used on farms with the highest standards of health and welfare and ways of effectively disseminating these approaches to other farms.

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