Italian Journal of Animal Science

ISSN: (Print) 1828-051X (Online) Journal homepage: http://www.tandfonline.com/loi/tjas20

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To cite this article: Monica Battini, Sara Barbieri, Ana Vieira, George Stilwell & Silvana Mattiello (2016): Results of testing the prototype of the AWIN welfare assessment protocol for dairy goats in 30 intensive farms in Northern Italy, Italian Journal of Animal Science

To link to this article: http://dx.doi.org/10.1080/1828051X.2016.1150795

ITALIAN JOURNAL OF ANIMAL SCIENCE, 2016
http://dx.doi.org/10.1080/1828051X.2016.1150795

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Results of testing the prototype of the AWIN welfare assessment protocol for dairy goats in 30 intensive farms in Northern Italy

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ABSTRACT

The AWIN project aimed at developing an on-farm welfare assessment protocol for adult dairy goats. A prototype protocol was tested in 30 intensive dairy goat farms to evaluate its feasibility in farms of different size. Time for applying the prototype was recorded and any other constraint was taken into account. Moreover, data collected during the prototype testing provided information on the prevalence of welfare issues in intensive dairy goat farms in Northern Italy. The prototype included 25 animal-based indicators (14 group- and 11 individual-level indicators). The prototype showed a good on-farm feasibility and it was highly accepted among stakeholders, as its application did not interfere with the daily routine. Approximately 2 h were required for the application of the prototype. When feeding racks were available, using them for locking the animals during the individual assessment resulted advantageous to speed the data collection and to reduce handling stress to the goats and disturbance to the farmers. Farm size and different management systems influenced the prevalence of some indicators, with small farms in general better welfare conditions compared to larger farms. The results of the present study represent an important starting point to set up an epidemiological database that may lead to improve the welfare status of goats.

ARTICLE HISTORY
Received 26 October 2015
Accepted 1 February 2016

KEYWORDS
Animal-based indicator; animal welfare; feasibility; goat; welfare assessment protocol

Introduction

In the last past decades, due to strong consumer demand (Blokhuis et al. 2013), welfare assessment schemes have been developed for different farm species: dairy and beef cattle, poultry and pigs (ANI-35L: Bartussek 2000; Welfare Quality® project: Welfare Quality® 2009a, 2009b, 2009c) and for different aims (to ensure high standards of animal welfare: Royal Society for Prevention of Cruelty to Animals 1998; to ensure sustainability and environmental protection: Soil Association 1999). Before the recent European Animal Welfare Indicators (AWIN) project, scarce research had been addressed to the development of a protocol to assess the welfare of dairy goats (Caroprese et al. 2015). However, goats are the third species bred in Europe for milk production, after cows and sheep, and dairy goat farming plays an important role in Southern Europe economy and contributes to maintain social activities (e.g. production and transformation industry, socio-cultural impact for the rural community, tourism, etc.), being frequently the only possible husbandry system in disadvantaged areas (De Rancourt et al. 2006). The Mediterranean area houses 6,709,156 dairy goats (Food and Agriculture Organization of the United Nations Statistics Division 2015), mainly distributed in Greece, Spain, France and Italy (3 300 000, 1 226 000, 885 559 and 565 000 heads, respectively; Food and Agriculture Organization of the United Nations Statistics Division 2015). A recent study on the impact of the Common Agricultural Policy on the sheep and goat sector highlighted a trend to concentrate animals in fewer and larger farms, with a progressive intensification of the production systems (European Commission 2011).

Although goat production is widespread all over the world (Dubeuf 2005), the whole goat sector (meat, milk or fibre) is less investigated and supported compared to other animal production sectors (cow milk, beef meat, poultry, pigs; Dubeuf et al. 2004; data confirmed by a reference search in Web of Science and Scopus in January 2016). Official data are difficult to be found and epidemiological information is also scarce. Data on the prevalence of welfare issues in the dairy goat sector are limited to very few specific studies, as the investigation conducted by Anzuino et al. (2010)

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Table 1. Indicators included into the prototype of the protocol.

Order of collection	Indicator	Description	Level[a]	Location[b]
1	Queuing at feeding (AWIN 2015)	The number of goats queuing at the feed rack is counted during feeding time, using a scan sampling method during 15 min/observation (1 min/scan). A goat is queuing if it is standing within 50 cm behind another goat that is feeding, with its head usually oriented towards the feed barrier.	G	O
2	Queuing at drinking (AWIN 2015)	The number of goats queuing at the drinker is counted during feeding time, using a scan sampling method during 15 min/observation (1 min/scan). A goat is queuing if it is standing within 50 cm behind another goat that is drinking (or queuing), with its head usually oriented towards the water place. All drinkers are simultaneously evaluated.	G	O
3	Hair coat condition (AWIN 2015; Battini et al. 2015b)	The number of goats with poor hair coat condition (described as: matted, rough, scurfy, uneven, shaggy hair coat, frequently longer than normal) is identified.	G	O
4	Improper disbudding (AWIN 2015)	The number of goats showing presence of residual horns (scurs) is recorded.	G	O
5	Kneeling at the feeding rack (AWIN 2015)	The number of kneeling goats (front legs flexed, the rear up) is counted while they are at the feeding rack.	G	O/I
6	Kneeling in the pen	The number of kneeling goats (front legs flexed, the rear up) is counted while they are in the pen.	G	O/I
7	Oblivion (AWIN 2015)	The number of oblivious goats is recorded. An oblivious goat is defined as an animal, which is physically or mentally isolated from the group.	G	O
8	Abnormal lying	The number of lying goats with front legs flexed and the sternum lifted off the ground is counted.	G	O
9	Panting Score (Battini et al. 2015c)	The number of animals showing signs of heat stress is recorded, using a 3-point scale of severity.	G	O
10	Shivering Score (Battini et al. 2015c)	The number of animals showing signs of cold stress is recorded, using a 3-point scale of severity.	G	O
11	Qualitative behaviour assessment (QBA; AWIN 2015)	The assessor integrates perceived details of behaviour, posture and context into the summarisation of an animal's style of behaving, or 'body language', using the following descriptors: aggressive, curious, fearful, agitated, sociable, alert, lively, irritated, relaxed, frustrated, content, bored, suffering.	G	O
12	Latency to first contact test (AWIN 2015)	The time elapsed from when the assessor stops in a pre-determined starting place in the pen and the contact with the first goat that nuzzles or touches any part of the assessor's body is recorded (max time: 300 s). After assessing the Latency to first contact test, the assessor leaves the pen before re-entering to perform the Avoidance distance test.	G	I
13	Avoidance distance test (Mattiello et al. 2010)	The reaction of each goat to an approaching assessor is evaluated as number of Contact (the goat withdraws after a contact of <3 s) and of Acceptance (the goat accepts gently stroking of the head for >3 s). The procedure to approach the goats is standardised: after standing at a starting distance of 200 cm, the assessor moves slowly (one step/s) towards the goat with the arm lifted and the hand palm directed downwards.	G	I
14	Severe lameness (AWIN 2015)	Goats are moved in the pen and the number of severely lame animals (based on abnormal gait, head nodding and spine curvature) is counted.	G	I
15	Body condition score (BCS; Vieira et al. 2015)	BCS is visually assessed on individual goats, using a 3-level scoring method.	I	R
16	Faecal soiling (AWIN 2015)	The presence of manure below the tail head is visually assessed on individual goats, as a sign of diarrhoea.	I	R
17	Vulvar discharge	The presence of brownish or white purulent effluent from the vulva frequently accompanied by a putrid smell is visually assessed.	I	R
18	Udder asymmetry (AWIN 2015)	The presence of one half that is at least 25% longer than the other is recorded.	I	R
19	Cleanliness	The presence of dirty areas (e.g. wet and yellowish hair, muddy) on both sides of hind quarters, lower legs (front and rear), and udder is recorded.	I	R
20	Abscesses	The presence of abscesses (ruptured or not) on both sides of body, udder, neck, hind quarters, head is recorded.	I	R
21	Lesions	The presence of lesions (skin damage as scab, wound with or without hair loss) on both sides of body, udder, neck, hind quarters, lower legs, head is recorded.	I	R
22	Overgrown claws (AWIN 2015)	The presence of claws that are deformed and/or with excess horn tissue is visually assessed on individual goats.	I	R
23	Knee calluses	The presence of calluses on both side of the front legs in evaluated using a 3-point scale.	I	R
24	Ocular discharge (AWIN 2015)	The presence of clearly visible flow from one or two eyes is visually assessed on individual goats.	I	R
25	Nasal discharge (AWIN 2015)	The presence of any mucous or purulent discharge from the nose is visually assessed on individual goats.	I	R

A more detailed description of each indicator can be found in the cited references when available.
[a]G = group level; I = individual level.
[b]O = outside the pen; I = inside the pen; R = restrained.

on 24 commercial UK farms and that carried out by Muri et al. (2013) on 30 commercial farms in Norway.

The AWIN project aimed to develop an on-farm welfare assessment protocol, using animal-based indicators (as recommended by European Food Safety Authority 2012), for lactating dairy goats in intensive farming systems. During the development of the protocol, special emphasis was given to its practical application in intensive farms. In this paper, we evaluated the on-farm feasibility of the prototype protocol during the testing conducted in farms of different size, in order to collect information for setting up the final version of the AWIN protocol, which has been recently released (AWIN 2015). The influence of the herd size on the on-farm feasibility of welfare assessment protocols was identified as a constraint also during the Welfare Quality® project (Knierim & Winckler 2009): the high number of animals may increase the time for the evaluation or data collection may become more complicated. Data collected while testing the prototype protocol also provided information on the prevalence of welfare issues in intensive dairy goat farms in Lombardy.

Materials and methods

The prototype was tested in 30 intensive dairy goat farms in Lombardy region (Northern Italy), which is the region with the highest concentration of intensive dairy goat farms in Italy (ISTAT 2010). Farms were selected with the help of technicians from the Regional Technical Advice Service for Farmers, S.A.T.A. (Servizio di Assistenza Tecnica agli Allevatori, under the supervision of ARAL – Associazione Regionale Allevatori della Lombardia). The participation of farmers to the research was on voluntary basis. Starting from a database of about 300 goat farms, we excluded farms for meat production and, among dairy farms, we selected 30 farms, based on farmers' availability, geographic location (to represent all the provinces) and farm size. Farms were classified according to their size as small (<50 lactating goats; $n = 10$), medium (51–100 lactating goats; $n = 10$) or large (>101 lactating goats; $n = 10$).

The prototype was tested during February–May 2014 by three assessors, who received a common training, in order to ensure the reliability of data collected. The one-week training session took place at the beginning of January; the training consisted of both theoretical and practical lessons, including on-farm visits. Each observer visited 10 farms, which were randomly chosen among the 30 farms.

The prototype included 25 animal-based indicators (14 group- and 11 individual-level indicators), which were collected following a strict order to avoid any influence of animal manipulation on behavioural tests (Table 1).

At the end of the assessment, information about structures, management and other details of the farm were collected by direct measurement or interviewing the farmer. The main characteristics and prevailing traits of the farms visited are summarised in Table 2. Only information that is relevant for the discussion of welfare results has been presented.

Only one pen per farm was assessed. This pen was chosen trying to identify the one that presented the highest risk for animal welfare, i.e. according to criteria that are likely to be related to welfare problems, such as highest density, low access to resources, presence of horned/hornless goats in the same pen. These criteria were based on the recent review by Battini et al. (2014a). During the group-level assessment, all the animals in the pen were evaluated, whereas a sampling strategy (specifying a suggested number and a minimum number of goats to be sampled) was adopted for the individual-level assessment (partly modified from Welfare Quality® 2009a; Table 3). For the individual-level assessment, goats had to be restrained either at the feeding rack (whenever available) or manually in the pen. After being assessed, each goat was marked. To assess the feasibility of the prototypes, the presence of possible practical limitations related to specific housing or management conditions was verified and, when the assessment required the help of the farmer, this was noted.

Data was collected using a tablet (Samsung Galaxy Tab 2 10.1) with Open Data Kit (ODK, Seattle, WA). ODK is a free and open-source set of tools, which manages mobile data collection solutions, developed by University of Washington, Department of Computer Science and Engineering. Forms in ODK were specifically created for collecting the indicators and the answers to the questionnaire (Dai et al. 2014); the results of the assessment were stored in a virtual server and Excel files were created and immediately made available for downloading on PC. The time to assess each indicator was automatically recorded by ODK and it was used for gathering information on feasibility; to this aim, mean ± SE was calculated for the time required to collect group-level indicators, individual-level indicators and for the overall assessment procedure.

Answers obtained from the questionnaire were elaborated as percentages or mean ± SE, when appropriate. The prevalence of group-level indicators was calculated as the proportion of goats showing the presence of welfare problems out of the number of goats in the assessed pen, except for Queuing at feeding and at drinking and Latency to first contact test.

Table 2. Main prevailing traits of the visited farms, according to farm size.

		Farm size		
Farm characteristics	Overall	Small	Medium	Large
No. of lactating goats in the farm (±SE; min–max)	124.67 ± 32.45 (18–912)	29.70 ± 2.60 (18–41)	68.50 ± 4.46 (50–92)	275.80 ± 79.13 (103–912)
No. of pens (±SE; min–max)	2.03 ± 0.22 (1–5)	1.60 ± 0.22 (1–3)	1.70 ± 0.26 (1–3)	2.80 ± 0.49 (1–5)
No. of lactating goats in the assessed pen (±SE; min–max)[a]	54.07 ± 7.39 (7–192)	21.00 ± 2.31 (7–32)	49.50 ± 4.78 (24–71)	91.70 ± 14.77 (43–192)
No. of individually sampled goats (±SE; min–max)[a]	29.77 ± 1.65 (7–50)	20.70 ± 2.20 (7–30)	31.10 ± 1.17 (24–38)	37.50 ± 2.03 (30–50)
Feeding places/number of goats ratio (±SE; min–max)[a]	1.15 ± 0.06 (0.63–2.00)	1.39 ± 0.11 (1.00–2.00)	1.03 ± 0.05 (0.74–1.20)	1.00 ± 0.10 (0.63–1.50)
Space at the feeding trough (±SE; min–max; cm)[a]	40.51 ± 2.84 (17–95)	46.83 ± 4.29 (17–69)	36.34 ± 2.54 (27–49)	38.37 ± 6.79 (24–95)
Breeds at farm	Saanen (76.09%) – Alpine (20.31%) – Other (3.15%)	Saanen (32.18%) – Alpine (45.98%) – Other (21.84%)	Saanen (45.18%) – Alpine (42.77%) – Other (12.05%)	Saanen (84.37%) – Alpine (14.80%) – Other (0.83%)
Average age (±SE; min–max; year)	3.47 ± 0.22 (1–6)	3.20 ± 0.39 (2–6)	3.50 ± 0.40 (1–5)	3.70 ± 0.37 (2–6)
Number of deliveries	2.80 ± 0.19 (1–5)	2.90 ± 0.38 (2–5)	2.70 ± 0.33 (1–4)	2.80 ± 0.33 (1–4)
Age at kidding (±SE; min–max; month)	12.50 ± 0.23 (11–17)	12.20 ± 0.25 (11–14)	12.10 ± 0.10 (12–13)	13.20 ± 0.59 (12–17)
Annual milk yield/head (±SE; min–max; kg)	581.31 ± 47.62 (279.83–1095.07)	596.69 ± 75.98 (344.00–986.56)	519.56 ± 70.96 (279.83–808.53)	616.65 ± 102.88 (343.67–1095.07)
Milking procedure	Mechanical	Mechanical	Mechanical	Mechanical
Number of milking places (±SE; min–max)	12.50 ± 1.74 (2–48)	6.75 ± 1.18 (2–11)	10.60 ± 0.73 (6–12)	19.00 ± 4.01 (6–48)
Bedding material	Straw	Straw	Straw	Straw
Frequency of bedding replacement	Every two months	Once a month	>Every two months	>Every two months
Frequency of bedding addition	Weekly	Daily	Weekly	Weekly
Frequency of claw trimming	No routine (20%) – Every three months (13.30%) – Every six months (30%) – Every year (36.70%)	No routine (10%) – Every three months (30%) – Every six months (30%) – Every year (30%)	No routine (30%) – Every six months (20%) – Every year (50%)	No routine (20%) – Every three months (10%) – Every six months (40%) – Every year (30%)
Presence of exterior pens (% of farms)	63.3%	60%	80%	50%
Access to exterior pen (days per year)	283.05 ± 20.20 (90–365)	333.33 ± 21.47 (240–365)	226.00 ± 35.00 (90–365)	314.00 ± 23.53 (240–365)
Access to exterior pen (hour per day)	22.16 ± 1.18 (3–24)	23.00 ± 1.00 (18–24)	23.00 ± 1.00 (16–24)	19.80 ± 4.20 (3–24)
Stockperson's workload (±SE; min–max)				
Number of permanent workers	1.97 ± 0.22 (0–5)	1.30 ± 0.21 (0–2)	2.00 ± 0.36 (1–4)	2.60 ± 0.45 (0–5)
Number of goats/permanent worker	54.68 ± 10.71 (12.50–304.00)	22.11 ± 2.89 (12.50–40.00)	46.29 ± 8.36 (17.00–92.00)	96.57 ± 27.33 (38.60–304.00)
Number of milkers	1.57 ± 0.11 (1–3)	1.70 ± 0.15 (1–2)	1.50 ± 0.27 (1–3)	1.50 ± 0.17 (1–2)
Number of goats/milker	84.91 ± 17.61 (9.00–456.00)	18.95 ± 2.67 (9.00–40.00)	55.38 ± 6.99 (17.00–92.00)	180.40 ± 36.75 (51.50–456.00)

Data are referred to lactating goats only.
[a]Data exclusively referred to the pen selected for the assessment.

Table 3. Sampling scheme adopted for the individual-level assessment (partly modified from Welfare Quality® 2009a).

Pen size (no. of goats)	Suggested sample (no. of goats)	Minimum sample (no. of goats)
<30	30	30
40	30	30
50	33	30
60	37	32
70	41	35
80	44	37
90	47	39
100	49	40
110	52	42
120	54	43
130	55	45
140	57	46
150	59	47
160	60	48
170	62	48
180	63	49
190	64	50
200	65	51
210	66	51
220	67	52

The number of goats to be assessed was calculated depending on the number of goats in the considered pen.

For Queuing at feeding and at drinking, the proportion of goats in the scan with the highest number of goats queuing out of the number of goats in the assessed pen was calculated, whereas Latency was expressed as seconds of elapsed time. Analysis of variance (one-way ANOVA) was used to compare results depending on farm size. Frequencies of individual-level indicators were calculated and Pearson's chi-squared test was used to compare results depending on the farm size. For those individual indicators that could be recorded on both sides of the animal (e.g. lesions or abscesses on neck, body, hindquarters and lower legs), the prevalence of each indicator on the left side was compared with that on the right side, using Pearson's chi-squared test. Principal component analysis (PCA) was used to explore results from qualitative behaviour assessment (QBA; Wemelsfelder & Millard 2009). Analyses were performed using SPSS Version 22.0 (IBM Corp. Released 2013).

Results and discussion

The average total assessment time was approximately 2 h and no statistical differences were found depending on farm size (Table 4). Group-level assessment lasted about one and a half hour, and also in this case no statistical differences were observed depending on farm size (Table 4). The time required for overall individual-level assessment was significantly higher in medium and large farms ($p < 0.01$; Table 4), due to the higher number of sampled animals in larger farms (Table 2). However, the average time for assessing each animal was not affected by farm size (Table 4).

During the prototype testing, some criticisms related to the sampling strategy for the individual-level assessment emerged (Table 3), emphasising the need of setting up a targeted strategy to be applied in intensive dairy goat farms. Particularly in relation to the number of goats to be sampled, in smaller pens it was always possible to sample the suggested number of animals, whereas in pens with more than 50 lactating goats sample size was often limited to the minimum number (Table 2).

For the individual-level assessment, the help of the farmer was always required except in one case. The farmers helped locking the goats at the feeding rack by giving some extra concentrate in 17 farms, and helped catching each goat in the pen for individual restrain in the 12 remaining farms. The time required for individual-level assessment per farm and per animal was higher when goats had to be manually restrained in the pen than when they were locked at the feeding rack (individual assessment/farm – locked: 50.35 ± 5.83 min; manually restrained: 56.33 ± 7.12 min; individual assessment/animal – locked: 103.47 ± 9.09 s; manually restrained: 120.08 ± 10.42 s), although the differences were not statistically significant. Therefore, locking the animals at the feeding rack resulted more advantageous for the individual-level assessment, reducing disturbance to farmers and goats and limiting changes in daily routine. During a previous consultation carried out within the AWIN project, stakeholders (e.g. farmers, veterinarians, technicians) stated that a total assessment time not exceeding 2 h and an individual assessment time of maximum 5 min per animal could be acceptable for on-farm welfare evaluation (Battini et al. 2014b). The whole prototype protocol lasted on average just more than 2 h, and the individual assessment required only a couple of minutes. Therefore, the prototype seems to be acceptable by the stakeholders in terms of feasibility related to the time required for its application.

Group-level assessment

Results obtained from the group-level assessment are summarized in Table 5. Statistical differences among farms of different size were found only for Queuing at feeding, Abnormal lying and Avoidance distance test – Acceptance.

The low percentage of goats recorded at Queuing at feeding (Table 5) in small farms may be explained by the differences in the number of feeding places and in the feeding rack length that were more favourable in small farms compared to medium and large farms (Table 2). Many studies have been conducted to

Table 4. Time required for the assessment (means ± SE; min–max).

		Farm size			
Time for the assessment	Overall	Small	Medium	Large	*p*
Whole assessment (min)	139.87 ± 8.13 (70–262)	130.00 ± 14.96 (70–200)	134.50 ± 6.20 (99–161)	155.10 ± 18.38 (78–262)	0.420
Group assessment (min)	83.93 ± 6.12 (40–170)	92.20 ± 12.68 (50–170)	77.60 ± 4.72 (58–100)	82.00 ± 12.89 (40–169)	0.623
Individual assessment/farm (min)	55.93 ± 5.31 (10–146)	37.80 ± 6.71[a] (10–89)	56.90 ± 4.94[b] (27–74)	73.10 ± 11.59[b] (30–146)	0.019
Individual assessment/animal (s)	111.97 ± 6.87 (46–178)	113.70 ± 13.13 (46–178)	109.40 ± 8.84 (67–143)	112.80 ± 14.31 (58–172)	0.967

The table shows overall results and comparisons among farm sizes. Values within a row with different superscript letters are significantly different (at least $p < 0.05$).

Table 5. Welfare problems (means ± SE; min–max) observed in 30 Italian farms, recorded during group-level assessment.

		Farm size			
Indicator	Overall	Small	Medium	Large	*p*
Queuing at feeding (% of animals)	7.23 ± 0.75 (0.00–14.00)	3.98 ± 1.45[a] (0.00–12.50)	9.08 ± 0.75[b] (4.35–11.76)	8.64 ± 1.04[b] (3.57–14.00)	0.005
Queuing at drinking (% of animals)	1.35 ± 0.48 (0.00–11.27)	0.71 ± 0.71 (0.00–7.14)	1.78 ± 1.11 (0.00–11.27)	1.55 ± 0.63 (0.00–6.00)	0.648
Hair coat condition (% of animals)	24.13 ± 2.83 (0.00–61.11)	24.92 ± 6.61 (0.00–61.11)	23.58 ± 4.66 (3.70–43.14)	23.88 ± 3.46 (9.68–45.24)	0.981
Improper disbudding (% of animals)	12.70 ± 3.00 (0.00–78.57)	9.97 ± 4.22 (0.00–42.86)	14.61 ± 7.36 (0.00–78.57)	13.52 ± 3.71 (0.00–30.61)	0.815
Kneeling at the feeding rack (% of animals)					
Outside the pen	2.55 ± 1.10 (0.00–29.17)	2.38 ± 1.74 (0.00–16.67)	3.96 ± 2.85 (0.00–29.17)	1.31 ± 0.53 (0.00–4.84)	0.633
Inside the pen	2.29 ± 1.10 (0.00–29.17)	2.38 ± 1.74 (0.00–16.67)	3.73 ± 2.86 (0.00–29.17)	0.78 ± 0.37 (0.00–3.28)	0.567
Kneeling in the pen (% of animals)					
Outside the pen	0.15 ± 0.73 (0.00–1.43)	0.00 ± 0.00 (0.00–0.00)	0.14 ± 0.14 (0.00–1.43)	0.30 ± 0.16 (0.00–1.25)	0.295
Inside the pen	0.18 ± 0.09 (0.00–2.17)	0.00 ± 0.00 (0.00–0.00)	0.36 ± 0.25 (0.00–2.17)	0.17 ± 0.12 (0.00–1.19)	0.262
Oblivion (% of animals)	0.06 ± 0.06 (0.00–1.96)	0.00 ± 0.00 (0.00–0.00)	0.20 ± 0.20 (0.00–1.96)	0.00 ± 0.00 (0.00–0.00)	0.381
Abnormal lying (% of animals)	0.36 ± 0.14 (0.00–2.33)	0.00 ± 0.00[a] (0.00–0.00)	0.14 ± 0.14[b] (0.00–1.43)	0.94 ± 0.33[c] (0.00–2.33)	0.007
Panting score (% of animals)	0.38 ± 0.32 (0.00–9.38)	0.94 ± 0.94 (0.00–9.38)	0.00 ± 0.00 (0.00–0.00)	0.20 ± 0.20 (0.00–2.00)	0.461
Shivering score (% of animals)	3.87 ± 1.04 (0.00–23.08)	6.90 ± 2.65 (0.00–23.08)	2.58 ± 1.12 (0.00–8.33)	2.12 ± 0.81 (0.00–6.12)	0.116
Latency to first contact test (s)	53.04 ± 18.20 (0.00–300.00)	97.57 ± 44.27 (0.00–300.00)	12.42 ± 5.53 (0.00–47.42)	49.15 ± 28.38 (4.86–300.00)	0.161
Avoidance distance test (% of animals)					
Contact	2.27 ± 0.74 (0.00–14.29)	4.59 ± 1.66 (0.00–14.29)	2.84 ± 1.27 (0.00–10.81)	0.73 ± 0.33 (0.00–2.86)	0.100
Acceptance	7.02 ± 1.65 (0.00–37.50)	11.36 ± 3.93[a] (0.00–37.50)	8.07 ± 2.23[a] (0.00–18.92)	1.62 ± 0.74[b] (0.00–6.25)	0.044
Severe lameness (% of animals)	3.05 ± 0.73 (0.00–14.81)	4.32 ± 1.76 (0.00–14.81)	2.22 ± 0.67 (0.00–5.88)	2.62 ± 1.18 (0.00–12.50)	0.481

The table shows overall results and comparisons among farm sizes. Values within a row with different superscript letters are significantly different (at least $p < 0.05$).

prove that a higher feeding space allowance may improve welfare status by reducing aggressions and frustration (Carbonaro et al. 1992; Jørgensen et al. 2007) and increase milk production (Barroso et al. 2000). Moreover, when horned and hornless goats are bred together, as we found in some medium (30% of the assessed pen) and large farms (60% of the assessed pen), a high feeding space allowance is fundamental, due to social relationships (horned goats are generally high-ranking compared to hornless goats; subordinate individuals may avoid approaching a feeding place where the minimum distance to dominant individuals cannot be kept; Aschwanden et al. 2009) and to space requirements (horned goats require at least 70 cm at the feeding rack; Loretz et al. 2004).

Abnormal lying was more frequently recorded in large farms than in medium farms; however, its prevalence was low and it was never observed in small farms (Table 5). This behaviour has never been reported in the existing literature and we could only hypothesize that it could be related to difficulties in respiration, attempts to dissipate heat, lesions to the sternum region or pain to the anterior legs. However, no clear relationship was found to support these hypotheses, and the origin and the meaning of this posture remain unknown. Based on these results, this

indicator has not been retained for the final welfare assessment protocol (Battini et al. 2015a). If the origin of Abnormal lying is clarified or if its prevalence results higher in other countries or husbandry systems, future refinements of the protocol may also include this indicator.

Results obtained for Avoidance distance test – Acceptance (Table 5) are in line with a study conducted by Mattiello et al. (2010), in which the human–animal relationship seems better in small farms due to the more frequent contacts between goats and farmers. The same trend was observed for Avoidance distance test – Contact (Table 5), although differences among farm sizes were not statistically significant.

All the other group-level indicators showed no statistical difference depending on farm size.

The prevalence of Kneeling when collected at the feeding rack was higher than when recorded in the pen (Table 5) and it was observed in 63.3% of farms. These results are similar to those reported by Anzuino et al. (2010), who observed this posture in 79.2% of farms visited in the UK. When Kneeling was recorded in the pen, farm prevalence was much lower (13.3%) than that recorded by Anzuino et al. (2010), who observed the presence of goats kneeling in the pen in 75.0% of farms visited. The meaning of kneeling as a welfare indicator differs depending on the location in which it is observed and its significance in terms of welfare criteria can be different. When a goat shows this behaviour at the feeding rack, it is likely to be assumed that the goats have to adopt abnormal postures that allow them to cope with errors in the facilities design, namely at the feeding trough (Anzuino et al. 2010); whereas when this posture is performed in the pen, it is most likely that the goat is experiencing pain in the locomotor system, as reported by Anzuino et al. (2010), who found a significant correlation between kneeling in the pen and severely lame goats.

Severe lameness was recorded in our study with the assessor inside the home pen, walking slowly across the pen and forcing goats to move if necessary. In comparison with other studies, the average prevalence was similar to that found by Anzuino et al. (2010) in UK farms (3.2%), but higher than the prevalence found in Norway by Muri et al. (2013), who observed only 1.7% of lame goats. The low prevalence of Severe lameness in Norwegian farms may be explained by the fact that lameness is strongly influenced by season: wet and rainy seasons negatively affect the quality of straw bedding and increase the occurrence of lameness (Christodoulopoulos 2009). Goats in Norway are conventionally kept indoors in insulated buildings (Simensen & Bøe 2003), which facilitate a good management of bedding that remains generally dry.

Results of PCA on QBA scores are shown in Figure 1. The emotional state of goats was described using 13 descriptors. PC1 represents the emotional state of goats. Farms with goats showing a more positive emotional state, described by descriptors such as content, relaxed and sociable, are scattered on the right side of Figure 1, whereas farms with goats in a negative emotional state, described by high levels of agitated and frustrated, are on the left side. PC2 is determined by descriptors indicating the level of activity: farms with a high level of activity, characterised by descriptors such as lively and curious, are scattered on the top of Figure 1, whereas farms with low levels of activity, characterised by descriptors such as bored, are on the bottom. PCA does not highlight any clear separation of farms depending on their size: this can be explained by the similar production system in which animals could exhibit a limited behavioural repertoire (Casamassima et al. 2001).

Individual-level assessment

During the individual-level assessment, 894 goats were evaluated (44.7% Saanen, 49.7% Alpine, 5.6% other breeds or crossbreeds). Analysis on individual-level indicators highlighted that no statistical differences were present in their prevalence between left and right side; hence, results are presented only considering the region assessed (Table 6). This result is important to further support of the on-farm feasibility of the prototype: the presence of any clinical problem can be randomly collected from either the left or the right side of the goats, provided that the side selection is done before the examination, in order to prevent biased results.

Statistical differences among farm size ($p < 0.001$) were found for most individual-level indicators, with the exception of lesions on hind quarters, lower legs, body, neck, head, abscesses on hind quarters and discharges (Table 6).

In large farms, the percentage of very thin goats was statistically lower and the percentage of very fat goats was statistically higher that in medium and small farms (Table 5). This can be probably explained by the different feeding strategy adopted. In fact, the roughage:concentrate ratio was never lower than 60:40 in small farms (as recommended by several authors; e.g. Pulina 2005; Bruni & Zanatta 2009), whereas 20% of large farms had a ratio of 50:50. Moreover, concentrate was never available during the day in small and medium farms, but it was found in 20% of large farms.

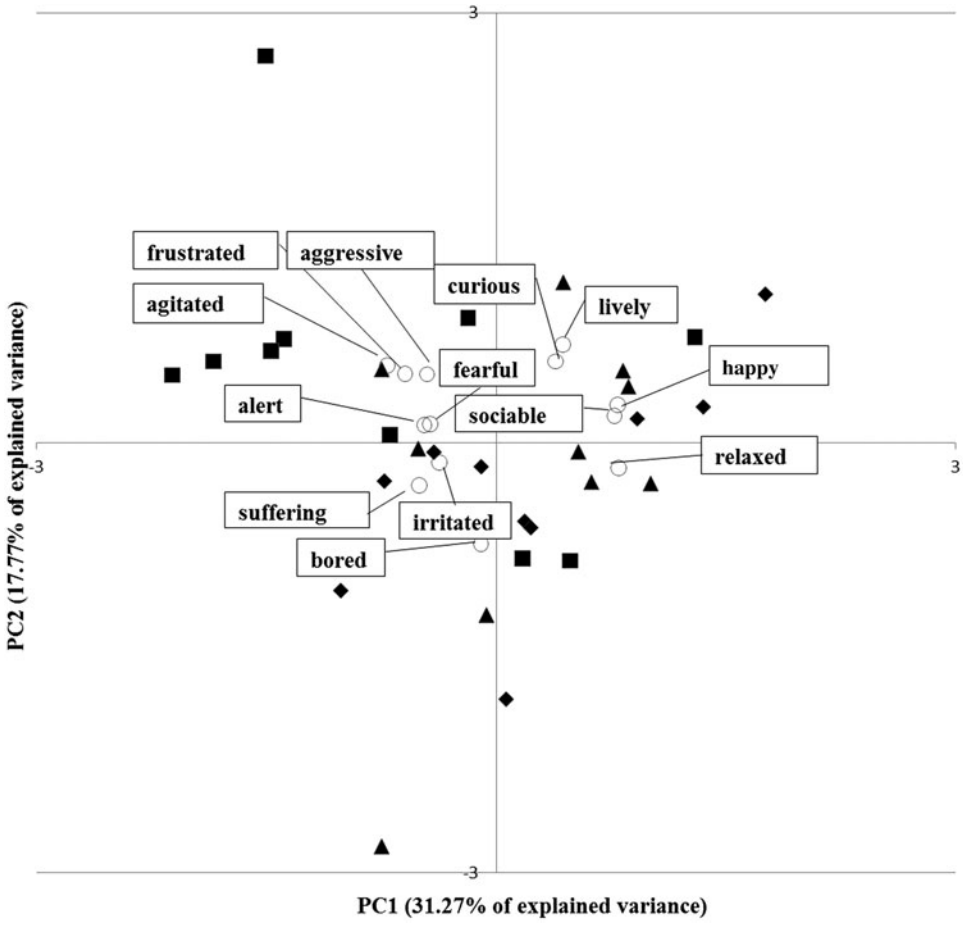

Figure 1. Biplot of principal component analysis scores (farms) and loadings (descriptors) on the first two PCs. ■ = small farms; ◆ = medium farms; ▲ = large farms; ○ = descriptors.

Table 6. Prevalence of welfare problems in 30 Italian farms (presented as overall, small, medium, large farms and significant differences) recorded during individual-level assessment.

Indicator	Overall (n = 894)	Small (n = 208)	Medium (n = 312)	Large (n = 374)	p
Very thin (% of animals)	13.0	15.9[a]	17.0[a]	8.0[b]	0.000
Very fat (% of animals)	6.2	2.9[a]	3.2[a]	10.4[b]	0.000
Faecal soiling (% of animals)	15.3	16.8[a]	20.5[a]	10.2[b]	0.001
Vulvar discharge (% of animals)	0.4	0.0	0.0	1.1	0.061
Udder asymmetry (% of animals)	3.8	1.0[a]	2.2[a]	6.7[b]	0.001
Cleanliness (% of dirty animals)					
Udder	4.3	1.0[a]	2.6[a]	7.5[b]	0.000
Hind quarters	32.7	12.5[a]	30.4[b]	45.7[c]	0.000
Lower legs	34.5	12.5[a]	37.8[b]	43.9[b]	0.000
Abscesses (% of animals)					
Udder	3.9	0.5[a]	2.2[a]	7.2[b]	0.000
Hind quarter	0.9	1.4	0.6	0.8	0.617
Body	8.4	5.3[a]	5.8[a]	12.3[b]	0.002
Neck	7.6	1.4[a]	3.8[a]	14.2[b]	0.000
Head	5.4	9.1[a]	5.8[a,b]	2.9[b]	0.006
Lesions (% of animals)					
Hind quarter	3.8	3.4	3.5	4.3	0.817
Lower legs	2.6	3.4	1.9	2.7	0.588
Body	11.5	11.1[a,b]	9.0[b]	13.9[a]	0.128
Neck	4.0	1.0[a]	4.2[b]	5.6[b]	0.023
Head	35.5	36.5[a,b]	40.1[b]	31.0[a]	0.045
Overgrown claws (% of animals)	55.5	31.3[a]	47.4[b]	75.7[c]	0.000
Knee calluses (% of animals)					
Slight	84.0	76.4[a]	88.1[b]	84.8[b]	0.000
Severe	8.9	9.1	7.1	10.4	0.792
Ocular discharge (% of animals)	0.9	0.0	1.3	1.1	0.282
Nasal discharge (% of animals)	5.7	5.3	4.5	7.0	0.366

Overall results were calculated out of the total number of assessed goats, whereas the prevalence for each farm size was calculated out of the number of assessed goats in that size category. Values within a row with different superscript letters are significantly different (at least $p < 0.05$).

BCS showed higher percentages of very thin and very fat goats compared to Anzuino et al. (2010), who recorded a prevalence of 3.4% very thin and 2.7% very fat goats.

Faecal soiling results may indicate problems related to diseases or nutrition (Smith & Sherman 2009) that need to be further investigated. Small and medium farms showed a higher prevalence of this indicator in comparison with large farms (Table 5) and, in general, Italian goats showed a higher prevalence if compared to UK (9.8%; Anzuino et al. 2010) and Norwegian (1.0%; Muri et al. 2013) goats.

The prevalence of udder asymmetry was lower in Italian farms, compared to UK (moderate asymmetry: 15.8%; severe asymmetry: 6.2%; Anzuino et al. 2010) and Norwegian (any udder asymmetry: 34.4%; severe asymmetry: 8.9%; Muri et al. 2013) farms. This may be partly due to the different scoring systems used to evaluate the presence of this problem in different countries, underlining the importance of a common scoring method to allow meaningful comparisons. Differences related to farm size were found: in large farms, a higher prevalence of udder asymmetry was recorded. Anzuino et al. (2010) suggest that the detection of early lesions (that might lead to infection and finally to mastitis) may be more difficult in larger farms, due to the highest number of goats per milker. This might be the case in our study, as larger farms actually had a considerably higher stockperson's workload (Table 2).

Small farms showed statistically lower prevalence of dirty goats (Table 6). A better bedding management in these farms can explain these differences (Table 2). A lower prevalence of dirty udders was recorded in Italian farms compared to UK (16.3% of dirty goats) and Norwegian (17.0%) farms, whereas the percentage of dirty hind quarters and lower legs recorded in our study was in line with that observed in UK (36.4% of goats, considering hind quarters and lower legs together; Anzuino et al. 2010), and higher than that recorded in Norway (17.5% of goats, considering hind quarters and lower legs together; Muri et al. 2013). However, the results obtained in different countries are difficult to be compared, because different scoring systems were adopted also for this indicator. Cleanliness in goats is a controversial issue, as goats are usually clean due to the dry faecal matter and the permanent straw bedding litter (Battini et al. 2014a). Further analysis of our results was conducted to gather information about this indicator. The frequency of dirty goats was statistically higher in Saanen than in Alpine breed (77.5% vs. 6.3%, respectively; $p < 0.001$). This result suggests that dirtiness is more clearly visible in white-coated animals than in dark-coated ones. As visual assessment seems to be influenced by the coat colour, the use of this indicator cannot be considered reliable.

Statistical differences were found for abscesses depending on farm size: small farms were generally in a better situation compared to medium and large farms (Table 6). The presence of external abscesses is commonly associated with caseous lymphadenitis caused by *Corynebacterium pseudotuberculosis* (Smith & Sherman 2009). The high number of goats in medium and large farms may compromise the early detection of goats with abscesses, facilitating the spread of this highly contagious disease, and the sanitary management of the animals is more difficult, due to the higher stockperson's workload (Table 2). Furthermore, larger farms usually need to purchase new replacement stock and therefore the risk of introducing infected animals might be higher, although we have no data to support this hypothesis.

Concerning overgrown claws, goats in small farms showed better results compared to goats in medium and large farms (Table 6). The overall prevalence of goats with overgrown claws is difficult to be compared to the prevalence recorded in other countries, since different point scales were used: Anzuino et al. (2010) in UK found 32% of goats with severe claw overgrowth and Muri et al. (2013) recorded 14.8% of goats with severe overgrowth, 2.0% with extreme overgrowth and 0.3% with deformed claws. All authors agree that the main problems affecting claw health are the lack of trimming routine and insufficient hoof wear when goats are housed on straw bedding all year round. Our results seem to confirm that the insufficient hoof wear might be one cause for the high prevalence of overgrown claws in medium and large farms, where the access to exterior pen is limited (Table 2). This seems to be confirmed also by the low prevalence of overgrown claws found by Muri et al. (2013) in farms where goats were housed on expanded metal grating or slatted floors. The more frequent lack of a trimming routine can also be responsible for the higher prevalence of claw problems in our medium and large farms (Table 2).

Conclusions

The prototype showed good on-farm feasibility. It could be performed in a reasonable amount of time and all the indicators could be collected. Based on our results, we recommended removing from the final protocol some indicators with low prevalence and limited variability (Battini et al. 2015a), in order to improve feasibility and acceptance among stakeholders. The main criticism encountered during testing was related to the

collection of data on individual animals, for which the help of the farmer was often required. Especially in absence of the feeding rack, restraining the goats was difficult and time consuming. Based on these results, in the final version of the protocol (AWIN 2015) the milking parlour was suggested as alternative location for restraining the animals for individual examination.

To date, data on the prevalence of welfare issues in Italian dairy goat farms were not available and the results of the present study represent an important starting point to set up an epidemiological database at national level. Some differences in the prevalence of welfare indicators were found depending on farm size. The welfare status in larger farms resulted worse than in smaller ones. This can probably be explained by the fact that larger farms are more difficult to manage, as the care of individual goats may be reduced due to the high number of animals to control and to the higher stockperson's workload. Problems that resulted widespread in the dairy goat farms assessed in the present investigation (e.g. overgrown claws, hair coat condition) should be carefully addressed by future research, in order to improve goat welfare and to promote a more efficient management of dairy goat farms.

Acknowledgements

We thank technicians from SATA who helped us with the selection of farms and always gave us valuable suggestions. Special thanks go to Elena Andreoli and Marta Conti who were actively involved in data collection. We are grateful to farmers whose help made this research possible.

Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

Funding information

The authors wish to thank the EU VII Framework program (FP7-KBBE-2010-4, grant number 266213) for financing the Animal Welfare Indicators (AWIN) project.

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