



Assessment of sheep welfare using animal-based indicators

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Abstract. The welfare of sheep is of utmost importance for the quality of their meat, and therefore it is very important to assess the welfare of sheep with reliable and feasible methods. Animal-based measurements have typically been used as an early warning for animals with impaired welfare, as well as for immediate recognition of improved welfare to maximize benefits. In this review, we briefly discuss and outline the knowledge regarding sheep welfare, with particular reference to the animal-based indicators identified from three welfare protocols.

Key Words: animal-based, indicator, protocols, welfare.

Introduction. There are over 1.2 billion sheep in the world (FAO 2019) which are bred for meat, milk and wool production. Most of these animals spend a long period during the year (3 to 7 months) grazing on pasture without a close interaction with humans (EFSA 2014; Morris 2017; Nenadović et al 2020). The assessment of welfare in sheep farms is also needed to increase quality and hygienic standards of food production. In addition, consumers demanding high quality food also expect animal products to be obtained and processed with greater respect for the welfare of the animals (Caroprese et al 2010).

Animal welfare indicators can be sorted in three categories: (i) indicators assessed by the observation/examination of animals (animal-based); (ii) indicators that assess animal-related provisions like housing and grazing (resource-based); (iii) indicators that relate to farmers' policies and management practices (management-based) (Capdeville & Veissier 2001). The animal-based indicators selected for a sheep welfare assessment must respect some criteria: they must be valid (relevant to sheep welfare), reliable (produce consistent results when performed at different times or by different assessors) and feasible (efficient in terms of time, staff and materials) (Richmond et al 2017; Zufferey et al 2021).

Sheep may be reared under different livestock systems (only outdoors, partially outdoors, only indoors). This variety means that resource-based indicators are not very useful and, the welfare assessment for sheep must be performed using animal-based indicators (Richmond et al 2017). Animal-based (outcome-based) indicators of welfare use the direct assessment of the mental and physical welfare of an animal. These indicators are considered the most valid method of assessing animal welfare because they assess the animal itself, and not its resources, allowing the possibility to make comparisons across all breeding systems (Main et al 2003; Main et al 2007; Llonch et al 2015).

In this review, we briefly discuss and outline the knowledge regarding sheep welfare, with particular reference to the animal-based indicators identified from three welfare protocols. Analyzing the scientific literature, we identified three protocols, which were later named after their authors or after their names (Dwyer et al 2015; Caroprese et al 2016; Munoz et al 2018; Munoz et al 2019). These protocols consist of animal-based indicators and are declared to be practicable on-farm by the naming authors.

AWIN Protocol. The first protocols for the assessment of animal welfare were developed by the "Welfare Quality®" project for pigs, poultry, dairy and beef lot cattle (Welfare Quality® Protocol 2009a; Welfare Quality® Protocol 2009b; Welfare Quality® Protocol 2009c), and later, in 2011, AWIN (animal welfare indicators) developed a protocol for the improvement of sheep welfare indicators (Dwyer et al 2015). The "Welfare Quality®" project has developed a protocol uniting the needs of animals into four principles and twelve criteria, deemed necessary for the inclusion of all animal welfare criteria (Blokhuis et al 2010; Rushen & Passillé 2010; Richmond et al 2017). The AWIN protocol proposes an approach on two levels: the first level is represented by a prior herd-level approach and the second is based on an in-depth individual-level assessment (Dwyer et al 2015).

The first level implies a screening of the flock with robust and rapid animal-based indicators, eliminating animal handling or avoiding it as much as possible. The first level indicators are the following: lamb survival, water availability, fleece cleanliness, panting, access to shade/shelter (outdoors only), stocking density (housed animals only), lameness, fecal soiling, fleece quality, social withdrawal, stereotypy, excessive itching, qualitative behavior assessment, familiar human approach test.

The second level assessment is recommended to be performed when the current animal welfare legislation is not respected or if the assessment of a specific indicator results in the farm being in the lowest 5% of farms in the reference population. The second level is comprised of a more detailed and in-depth assessment, requiring the restraint of animals and collecting individual data (Dwyer et al 2015). The two-level approach has the advantage to reduce the stress of the animal and also the time needed for the assessment. Second level indicators are expressed as follows: body condition, fleece cleanliness, fleece quality, hoof overgrowth (housed animals only), body and head lesions, leg injuries, lameness, fecal soiling, ocular discharge, mucosa color, mastitis and udder lesions (lactating ewes only), respiratory quality, tail length.

The First and Second Protocols of Munoz. Two protocols described by Munoz, in 2018 and 2019, present animal-based indicators (Munoz et al 2018; Munoz et al 2019). The protocols were developed for sheep raised in the extensive system. First, the authors identified 17 indicators from the scientific literature and matched them to the five domains of welfare. Of the 17 measurements, 8 were selected and tested on field conditions for their validity, reliability and feasibility (Munoz et al 2018) to assess the welfare of ewes: body condition score (BCS), flight distance, skin lesions, fleece condition, dag score, tail length, lameness, mastitis.

The first protocol was carried out on 100 randomly selected ewes in Victoria, Australia. Each animal was studied in three different scenarios: pregnancy, lactation and weaning. The animals were grouped into 4 experimental groups of 25 animals each. Firstly, a group flight distance test was carried out to observe the ewe's response to an unfamiliar human. Afterwards, the ewes were placed in a single row and were individually examined. The indicators included in this protocol were able to detect impaired welfare and welfare risks, but their reliability and feasibility need further research (Munoz et al 2018; Zufferey et al 2021).

The second protocol, by the same authors is an adaptation of the first one, but only six animal-based indicators were kept: BCS, fleece condition, skin lesions, tail length, dag score and lameness (Table 1). The second protocol was tested on 32 commercial sheep farms in Victoria, Australia. Animal-based indicators were considered to be most important, but the authors mention that some relevant management- and resource-based indicators, such as nutrition management or shelter provision should also be included in future assessments (Munoz et al 2019; Zufferey et al 2021).

According to their opinion, a combination of animal-, management- and resource-based information may lead to better understand the potential problems of sheep welfare and how they could be either totally avoided or minimized best. In addition, this protocol seems to be able to identify and assess the main sheep welfare issues as the first one but with fewer indicators (Munoz et al 2019).

In our study, 18 animal-based indicators were identified, 6 of which are found in all three protocols and 8 are indicators found in the AWIN protocol and Munoz's first protocol (Table 1).

Table 1

Animal-based indicators included in different assessment protocols

<i>Indicator</i>	<i>Munoz</i>		<i>AWIN</i>	
	<i>2018</i>	<i>2019</i>	<i>First level</i>	<i>Second level</i>
Lameness/Gait score	+	+	+	+
Body condition score	+	+		+
Fleece cleanliness			+	+
Fecal soiling/Dag score	+	+	+	+
Tail length	+	+	+	+
Skin lesions/Integument condition/ Skin irritation	+	+		+
Fleece quality/Fleece condition	+	+	+	+
Familiar human approach/Flight distance	+		+	
Mastitis or other udder problems	+			+
Hoof overgrowth/Hoof condition				+
Foot-wall integrity/leg injuries			+	
Panting			+	
Social withdrawal			+	
Stereotypy, excessive itching			+	
Ocular discharge/Eye abnormalities				+
Respiratory quality				+
Mucosa color				+
Qualitative behavior assessment (QBA)			+	

The animal-based indicators were considered valid because they have been proven to be valid in previous studies, and the measures selected address main welfare concerns for sheep, like freedom from hunger, pain, injury or disease. The assessment criteria of the welfare indicators found in all three protocols are listed in Table 2.

In addition to the six indicators identified in the three studied protocols, there are two indicators specific only to the AWIN protocol and Munoz's first protocol: familiar human approach/flight distance and mastitis or other udder problems.

Flight distance was estimated by counting the steps between the observers' hand and the ewes' head at the moment of withdrawal (Napolitano et al 2009; Munoz et al 2017). The behaviour of the ewe was scored by using a 4-point score system: (0) the ewe behaved calmly when approached; (1) there was some avoidance; (2) there was marked avoidance and a struggle to escape; and (3) there were attempts to escape by jumping out of the pen (Stubsjøen et al 2011; Zufferey et al 2021).

Table 2

Description of evaluation methods for the identified animal-based indicators

<i>Welfare indicator</i>	<i>Assessment criteria</i>	
	<i>Munoz</i>	<i>AWIN</i>
Lameness	Scored on a 4 point scale: (0) not lame; (1) clear shortening of stride with obvious head nodding or flicking as the affected limb touches the floor; (2) clear shortening of stride with obvious head nodding and not weight-bearing on affected limb whilst moving; (3) reluctant to stand or move (Dwyer et al 2015).	Lameness is scored on four levels: not lame (0); minor lameness - clear shortening of stride with obvious head nodding or flicking (1); lame - very obvious head nodding and not weight-bearing on affected limb whilst moving (2); severe lameness- recumbency or reluctance to stand or move (3).
Body condition score	Scored on a 5 point scale from 1 (thin) to 5 (obese), using a quarter-unit precision. Sheep were assessed by palpation of the backbone, muscle and short ribs (Rusell 1984; Calavas et al 1998).	The BCS described by Russell et al (1969) can be used. Animals are considered thin if they score below 2.0, emaciated if they are at or below 1.0, and fat if they are above 4.0.
Fecal soiling/ Dag score	Scored on a 6 point scale: (0) no evidence of fecal soiling; (1) very light soiling on breech area; (2) moderate dag on breech area, ventrally; (3) severe dag predominantly on the breech area, ventrally and dorsally; (4) excessive dag on breech area and hind legs; (5) very severe dag on breech area and hind legs or below the level of the hocks (Larsen et al 1994).	The rear end of the animal is assessed and the degree of fecal soiling to the wool around the anus and tail is assessed (dag score). In the first level, welfare assessment scores 0, 1 and 2 are considered clean, and only the scoring of 3 or 4 are assessed. For the second level assessment, all scores should be used.
Tail length	Scored on a 2 point scale: (0) the tail covers the tip of the vulva when down; (1) the tail is over-shortened or almost absent, or if the vulva and anus cannot be covered (Munro & Evans 2009; Dwyer et al 2015).	Tail length considers whether the sheep have been tail docked or not. Tail length can be observed in unhandled animals (first level assessment) and verified in handled animals (second level assessment). The length of tails is evaluated on three levels: undocked, docked, and short docked tail.
Skin lesions/ Integument condition/ Skin irritation	Assessed by recording the number, location, type and size of the skin lesions. Lesions are classified as cuts, open wounds, old wounds or scars and abscesses.	The number of lesions for each area (both sides) is counted. Only lesions larger than a 1x2 cm area (at widest part) or more than 4 cm length (for linear lesions) are taken into considerations.
Fleece quality/ Fleece condition	Scored on a 3 point scale: (0) good fleece condition, the fleece has no lumpiness or signs of ectoparasites; (1) some fleece loss, small shed or bald patches of no more than 10 cm diameter; (2) significant fleece loss with bald patches of greater than 10 cm in diameter, clear evidence of ectoparasites (Dwyer et al 2015).	The inspection is carried out along the back and on both sides. Fleece quality is evaluated on three levels: good fleece quality; fleece loss - small shed or bald patches of no more than 10 cm in diameter; significant fleece loss - bald patches of greater than 10 cm in diameter.

The AWIN protocol presents the human-animal relationship as follows: the farmer should approach the sheep in a normal manner. The purpose of this assessment is to gauge whether stockworkers can feasibly approach their stock in order to carry out an inspection. Assessors should be as far away as is feasible to record the information without disturbing the sheep. The observer must note the closest approach distance before a flight response is elicited. It is marked with 0 m if no flight response is triggered (the sheep is motionless when the human approaches). It should also be recorded if the animals actively moves towards the stockperson (Dwyer et al 2015).

As for the mastitis or other udder problems, the Munoz protocol has a 5 point scale score: (0) normal udder; (1) a small fibrotic lesion with normal secretion; (2) a more extensive fibrosis of the udder - milk fluctuates from normal to purulent; (3) extensive swelling of the udder, which could be abscessed or ruptured; (4) peracute mastitis - complete udder involvement with severe inflammation and secretion from serum-like to purulent (Quinlivan 1968). For the same indicator, the AWIN protocol proposes the following approach: ewes should be restrained in a standing posture and the udder should be inspected from behind for color and symmetry. The udder is gently palpated on both sides, feeling for lumps, hardness and fibroids. Lesions to the udder or teats should also be counted. Mastitis and udder lesions are evaluated on three levels: no mastitis or lesions present, mild mastitis and/or minor lesions, mastitis and/or severe lesions.

The other ten indicators identified only in the AWIN protocol are listed and described below.

Fleece cleanliness should take into account the belly, legs, flanks, back and head, but the cleanliness of the breech area should be assessed separately. For the first level welfare assessment animals scoring 0 or 1 are considered clean, and only scores 2, 3 and 4 are considered. For the second level of welfare assessment, all the levels are used. Fleece cleanliness is scored a five-point scale: not present (0), very light soiling (1), light soiling and dags (2), soiling and dags (3), extensive soiling and dags (4) (Dwyer et al 2015).

Hoof overgrowth/Hoof condition - this indicator is only assessed in housed animals. A sheep is considered to have hoof overgrowth when at least one hoof is scored as overgrown (Dwyer et al 2015).

Foot-wall integrity/Leg injuries - each swelling, lesion or injury on all legs are counted (Dwyer et al 2015).

Panting - the number of animals with a respiration rate above 30 breaths per minute with a closed mouth, and the number of animals with open-mouthed panting should be counted. Panting should be evaluated on one of three levels: normal respiration, mild heat stress, panting (Dwyer et al 2015).

Social withdrawal - the undisturbed flock is observed for 20 minutes. The assessor should count the number of animals showing signs of social withdrawal (Dwyer et al 2015).

Stereotypy - the undisturbed flock is observed for 20 minutes. The observer will count the number of animals showing signs of stereotypy/excessive itching: repetitive pacing or circling, when the animal follows the same route back and forth or around the pen; repeated curving of the head back over the shoulders and looking upwards; repeated pulling, biting or plucking the wool along the back of another ewe/repeated or prolonged rubbing or scratching, which may be against the pen or paddock fixtures or with the hooves (Dwyer et al 2015).

Ocular discharge can reveal the presence of eye disease. This indicator should be assessed in handled animals and the presence or absence of ocular discharge should be recorded (Dwyer et al 2015).

Respiration quality considers the ease with which the animal is breathing, and the presence of discharge from the nostrils. To evaluate this indicator, the animals must be handled as follows: firstly, the sheep must be examined for hampered or audible breathing and persistent coughing. Then the sheep must be held gently to be able to

inspect the nostrils. The presence of any signs of audible breathing, persistent coughing or nasal discharge should be scored as respiratory problems (Dwyer et al 2015).

The mucosa is the lining of the mouth and eyes, and it is well supplied with blood vessels. A pale color of the mucosa indicates the presence of anemia. Very pale mucosa color suggests the presence of blood-feeding endoparasites, such as *Haemonchus contortus*. Evaluation of the color of the mucosa is an accepted method for assessing anemia from parasitic infestation (Bath & van Wyk 2009). This indicator should be recorded in handled animals. The sheep should be gently restrained to be able to expose the mucosa. The color of the conjunctiva should be inspected and evaluated (Dwyer et al 2015).

Qualitative behavior assessment, where the observer will score all 21 descriptors in the order to be presented on the visual analogue scales (VAS). Each VAS is defined by its left "minimum" and right "maximum" point. "Minimum" means that, at this point, the expressive quality indicated by the descriptor is entirely absent in the whole group under observation. "Maximum" means that, at this point, this expressive quality is dominant across all observed animals (Dwyer et al 2015).

Conclusions. The aim of this study was to review the scientific literature related to sheep welfare and to identify the animal-based welfare indicators from three established welfare protocols. This fast assessment of sheep welfare can be a useful tool to help farmers to improve animal welfare, meeting the current social demands. The development of on-farm welfare monitoring protocols can contribute in improving the quality standards on the management of small ruminants.

Conflict of Interest. The authors declare that there is no conflict of interest.

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