On-farm welfare monitoring of small ruminants

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ABSTRACT

The paper discusses assessment of animal welfare in small ruminant production systems and reports on developments regarding various monitoring schemes, which are used to assess small ruminant welfare at farm level. Further, welfare assessment protocols are presented; these have been derived as results in the Animal Welfare Indicators ('AWIN') project, which had been funded within the European Commission's 7th Framework Program. The role of the European Food Safety Authority (EFSA) in providing a scientific basis for future legislation on animal welfare is described. Finally, emergency medicine to reduce small ruminant suffering and support appropriate decisions to promote welfare of individual animals or populations of animals is also discussed.

Keywords: emergency medicine, EFSA, goat, monitoring schemes, sheep, welfare indicators

1. Introduction

Market demand from consumers for assurance schemes for high quality animal products (in terms of health, safety and respect for animal welfare) is increasing. In response to this demand, assessment of animal welfare at farm level is still an outstanding issue in the field of animal husbandry. Therefore, development of on-farm welfare monitoring schemes to assess welfare of farmed animals has become a need for production systems as an advisory and management tool for farmers, as a tool to verify compliance with legislation or regulatory standards and as a component of quality assurance schemes for consumers (Fraser, 2008).

Many different European Regulations have been issued regarding animal welfare. Although no rules specific to small ruminants have been implemented, Commission Decision 2006/778/EC (European Commission, 2006) has reported that inspections of animals kept for farming purposes should cover requirements laid down in specific acts, as well as general animal welfare requirements as laid down in Council Directive 98/58/EC which relates to all farmed species (European Commission, 1998). The animal welfare issue, however, is also addressed by the European Food Safety Authority (EFSA), which is required to provide scientific and technical support to Community legislation through development of scientific opinions on risk factors related to all fields with direct or indirect impact on food and feed safety, plant health, environment and animal health and welfare.

Since the beginning of the 21st Century, this topic has been widely discussed at international level, in international workshops (e.g., Sørensen and Sandøe, 2001; Webster and Main, 2003) and in specific working groups, e.g., the European Action 846 of the COST Framework 'Measuring and monitoring farm animal welfare' (Blokhuis et al., 2003). That COST action had led to the Welfare Quality® EU project, which had been funded by the European Commission in 2004 with the aim to developing on-farm welfare monitoring schemes. The project involved 43 establishments (from 13 European and four Latin American countries) and resulted in the publication of welfare assessment protocols for cattle, pigs and poultry; however, the development of on-farm welfare assessment protocols for small ruminants was not addressed. In 2011, the EU's 7th Framework Program for Research (FP7) funded the 'AWIN' (Animal Welfare Indicators) project, which aimed at improving animal welfare by

developing, integrating and disseminating information regarding animal welfare indicators in animal species that had not been previously covered in the Welfare Quality® project, including small ruminants.

Development of awareness and of regulations regarding farm animal welfare follows closely changes in under- and post-graduate teaching in the field in tertiary education. However, often animal welfare teaching is not associated with clinical skills and diagnostic or monitoring procedures in farms do not always take into account welfare considerations of individuals or populations under consideration (Illmann et al., 2014).

In order to develop effective welfare assessment schemes, the role of the scientific community should be enhanced through the involvement of the relevant stakeholders, e.g., producer associations, animal breeding organisations, retailer and consumer organisations, policy makers and veterinarians. In particular, veterinarians are required to evaluate, in cases of small ruminant emergency, which remedial options for sick animals or for animals at risk of becoming sick promote their welfare status. The present review discusses welfare assessment from various perspectives applied to small ruminants.

2. Monitoring schemes

According to Scott et al. (2001), monitoring schemes should include indicators that are valid, reliable and sensitive. In addition, they should be practically feasible to apply in the field. Two broad categories of indicators can be used to assess animal welfare at farm level (Main et al., 2003): (i) animal-based welfare measures (e.g., behavioural measurements, productivity, health issues) and (ii) resource-based influencing factors (e.g., stocking density, feeding regime, milking procedures).

Animal welfare monitoring schemes are generally based on the assessment of negative consequences of farming factors on animals, while there are only few examples of positive aspects being evaluated (e.g., the positive terms of qualitative behaviour assessment in the AWIN and Welfare Quality® protocols). However, possible links between these adverse effects on animal welfare and risk factors (e.g., poor flooring as risk factor for lameness) have seldom been investigated. Therefore, albeit valid and reliable, such schemes can only be used

to express a scientifically-based judgement on the welfare state of the animals, whereas little is done to promote a continuous process of animal welfare improvement (Whay, 2008).

Sheep welfare has been investigated in a number of studies, in which the effect of management stressors has been assessed. Conversely, on-farm monitoring schemes for assessing the welfare of small ruminants had not been available until a few years ago. Napolitano et al. (2009) have adapted a protocol scientifically validated for cattle, termed 'Animal Needs Index (ANI) 35 L 2000' (Bartussek et al., 2000), for the welfare evaluation of sheep. The protocol used resource measures, which included structural and technical elements (e.g., space allowance, feeding facilities) and showed to be feasible (mean time required to perform welfare assessment was 85 min. per farm, with no sophisticated equipment necessary in both time-consuming and financial terms) and reliable (inter-observer reliability of the scores was high). As the ANI was a system mainly based on resource variables, several animal-based variables were tested for possible inclusion in the protocol. Avoidance distance showed high levels of convergent and scientific validity and intra-observer reliability (defined by Waiblinger et al., 2006). Lameness, integument alterations and body condition score were not tested for validity, but showed excellent intra-observer reliability (Napolitano et al., 2011), whereas good inter-observer reliability was noted for integument alteration, hoof overgrowth, lameness and dirtiness (Napolitano et al., 2009). Subsequently, monitoring systems with animal-based measures, dealing with behaviour, health and physiology of the animals or a combination of resource- or animal-based measures, have been developed to obtain a valid assessment of animal welfare (Welfare Quality ® project).

The main objective of the AWIN was the development of animal welfare indicators in sheep, goats, horses, donkeys and turkeys. The overall research objectives were pursued through four work-packages (WP1: development of animal welfare protocols; WP2: study of the impact of pain and disease on animal welfare; WP3: study of the effects of pre-natal factors on development and welfare of the offspring; and WP4: promotion of research and education in animal welfare). These objectives focused on species that, although commercially relevant worldwide, had been overlooked in previous animal welfare assessments. Both for sheep and goats, the AWIN protocols were developed following a four-stage process: stage 1 included literature review (Battini et al., 2014a) and expert panel meetings to select the most promising candidate indicators for inclusion into the protocols, stage 2 included tests of selected

indicators for validity, reliability and feasibility, stage 3 included development and testing of prototype protocols in commercial farms in various European countries and stage 4 included refinement of the prototypes, taking into account the outcome of the tests and advice from stakeholders. Stakeholders were involved during all these stages, through participation in conference meetings and participation to direct or on-line surveys, in order to increase the acceptability of the final protocols (Battini et al., 2014b).

AWIN welfare assessment protocols for sheep and goats used a two-level approach; the first level welfare assessment protocol consisted of a quick screening of the flock, including a selection of robust and feasible animal-based indicators collected with no or minimal animal handling. Depending on the outcome of the first level assessment, a second level, which consisted of a more comprehensive and an in-depth assessment requiring restraint of the animals and collection of individual data, was recommended. That approach was chosen, in order to increase the feasibility of the assessment.

For both species, selection of the indicators was based on the four principles and twelve criteria defined by the Welfare Quality® project, which covered all aspects of animal welfare. Animal-based indicators were selected whenever possible; when no valid, reliable and feasible animal-based indicators were available to cover welfare criteria, resource-based indicators were used.

For sheep, the animal-based measures taken at the first level were: qualitative behaviour assessment, quantitative behaviour assessment (e.g., social withdrawal, panting, stereotypy, and excessive itching), fearfulness assessed using human approach (minimum distance, flight distance, time to resume normal behaviour), physical assessment of fleece (cleanliness, quality), tail length (full, docked well, docked short) and lameness, whereas the environment was assessed outdoors (in terms of water supply, shelter provision, landscape) and indoors (in terms of water supply and stocking density). In addition, lamb mortality was recorded. At the second level, the following aspects were evaluated: gingival and eye mucosa (colour), eyes (e.g., presence of ocular discharge), body and head lesions, respiratory quality (e.g., coughing), fleece quality (e.g., fleece loss), coat (cleanliness), legs (e.g., injuries), body-condition scoring (as described by Russell et al., 1969), udder lesions and mastitis, tail (length), faecal soiling (on a 5-point scale), lameness (on a 4-point scale) and overgrown hoof

(AWIN, 2015a;b). Details of welfare assessment indicators for first and second level assessment are described in Table 1 (sheep) or Table 2 (goats).

An innovative aspect of the AWIN protocols was the presentation of the outcome to farmers. First, in contrast to previous welfare schemes, the AWIN project decided to provide positive feedback to farmers by presenting the results of the assessment in terms of animals that did not present welfare problems. Further, the AWIN project aimed at giving results that could be of help to farmers to improve the welfare level, therefore the outcome was informative about the main welfare problems on the farm and did not produce an overall assessment score as in the Welfare Quality® project. For these reasons, the outcome consisted of a visual output that highlighted positive conditions and plotted the farm situation against that of a reference population, giving the possibility to the farmer to compare the welfare level of a farm with that of other farms and to immediately understand which were the strengths and weaknesses from a welfare point of view. This was aimed at promoting identification of best practices and implementation for welfare management and continuous improvement.

3. The European Union strategy on animal welfare: the role of European Food Safety Authority

Another approach in the development of tools for on-farm control and management of animal welfare was the use of the risk assessment (RA) methodology, which allowed identification of the major hazards that posed potential risks to animal welfare. This approach started with the identification of the hazards, the quantification of their likelihoods and the potential impacts in terms of intensity, duration and prevalence in order to rank the risks and prioritize areas of intervention where monitoring and managing of animal welfare risks may be needed (Ribó and Serratosa, 2009). The European Food Safety Authority (EFSA) can be asked by the various European Commission services, as well as also by the European Parliament, EU Members States or itself (‘self-mandate’), to provide a scientific assessment following, whenever possible, a RA approach. EFSA has developed RA methodologies for a number of farm animal species and production systems (e.g. dairy cattle, beef cattle, pig, chicken, fish). Risk assessment has been defined by the EFSA Panel on Animal Health and Welfare as a scientifically-based process consisting of exposure assessment (in terms of level, duration,

frequency and variability of exposure to hazards), consequence characterisation (i.e., evaluation of the nature of animal welfare effects caused by a hazard) and risk characterisation (estimation, including associated uncertainties, of the probability of occurrence and magnitude of adverse animal welfare effects) (EFSA Panel on Animal Health and Welfare, 2012d). Risk assessment is part, along with risk management and risk communication, of a wider process termed 'risk analysis'. The EFSA Panel on Animal Health and Welfare is composed by 21 independent scientific experts. Of these, approximately one third consists of experts in animal welfare issues, one third of experts in animal diseases and one third of experts in animal health and welfare horizontal issues related to risk assessment methodologies, epidemiology and modelling. The panel is responsible for all adopted scientific opinions and receives the full administrative support by EFSA staff. When EFSA receives a request to provide scientific advice, a working group is set up. The working group is composed of experts on the specific issue and a risk assessor in charge of defining the risk pathways and the risk assessment methodology. Through different meetings, the working group collects all available scientific data and information on the issue, performs the risk assessment when pertinent and possible and drafts conclusions and recommendations. The process results in a draft scientific opinion, sometimes opened for public consultation, which is finally discussed, reviewed and adopted by the experts' panel. In agreement with EFSA's policy on transparency, all scientific documents are published in the EFSA's website (www.efsa.europa.eu).

In particular, EFSA Panel on Animal Health and Welfare provides specific advice on risk factors related to animal diseases and welfare, mainly of food producing animals, including fish. The outcomes of the risk assessment methodology together with the identification of welfare indicators will allow the establishment and implementation of welfare control and monitoring plans at farm level and detection of poor welfare situations. Future legislative provisions based on appropriate scientific evidence should include animal-based welfare indicators or assessment systems, which will support decision making on the acceptable conditions for farmed animals and will be used to underpin control and monitoring of animal welfare at farm level (Ribó and Serratosa, 2009).

During the period 2003 to 2013, the EFSA Panel on Animal Health and Welfare delivered 109 scientific opinions regarding various animal diseases (n=60) or welfare (n=49) matters.

Other EFSA panels and units have also been involved in the delivery of opinions related to animal health and welfare (i.e., biological hazards, feed additives, contaminants, zoonoses). The main objective of the scientific opinions on animal welfare is the identification of hazards leading to negative welfare outcomes and make recommendations to reduce or eliminate these hazards. In 2006, EFSA was asked by the European Commission to include measurable welfare indicators, whenever possible, in the conclusions and recommendations of the future scientific opinions on animal welfare. In 2011, EFSA was further asked to identify how animal-based measures could be used to ensure fulfilment of the recommendations of the EFSA scientific opinions on animal welfare and how the assessment protocols suggested by the Welfare Quality® project covered the main hazards identified in EFSA scientific opinions and vice-versa. The Welfare Quality® protocols use animal-based measures to assess animal welfare by measuring the magnitude of the welfare outcomes. Therefore, the results of the welfare assessments would be used to take appropriate measures to improve welfare. These results will also provide crucial quantitative data to be used in future animal welfare risk assessments to identify additional welfare hazards. Consequently, the identification of welfare hazards in the scientific opinions will support further development of animal-based indicators for welfare assessment at farm level (Ribó and Blokhuis, 2012). Following this approach, in 2012, three scientific opinions regarding use of animal-based measures to assess welfare of pigs, cows and broilers were published (EFSA Panel on Animal Health and Welfare, 2012a;b;c). The three opinions commonly concluded that the Welfare Quality® protocols covered most of the hazards identified in the EFSA's scientific opinion and that animal-based measures were necessary to assess whether the recommendations for welfare improvement have been achieved. The work continued to cover all farm species. A scientific opinion on risk assessment for animal welfare (EFSA Panel on Animal Health and Welfare, 2012d) and a statement on the use of animal-based measures to assess animal welfare (EFSA Panel on Animal Health and Welfare, 2012e), establishing a common framework for future scientific opinions, were also published in 2012.

In December 2014, the EFSA Panel of Animal Health and Welfare adopted a scientific opinion on the welfare risks related to the farming of sheep for wool, meat or milk production (EFSA Panel on Animal Health and Welfare, 2014). In the same way as for the Welfare Quality® project, the welfare protocols developed in the AWIN project (AWIN, 2015a;b)

were used in this opinion as a basis to identify animal-based welfare measures in small ruminants. In this case, the working group on sheep welfare adopted a novel approach starting with the description of the main categories of management systems: shepherding (continuous presence of the shepherd with the flock), intensive (no outdoor access), semi-intensive (housing during the night and part of the day), semi-extensive (kept in fenced pasture and receiving feeding supplementation), extensive (no fencing but receiving feeding supplementation), very-extensive (no fencing and receiving no supplementation) or mixed system. Subsequently, in agreement with Phythian et al. (2011), a bottom-up approach had been followed with the identification of the main welfare adverse effects of farming as resulted from the analysis of a questionnaire circulated among over 300 sheep farming experts, including academics, practitioners or farmers. Overall, the main issues that were considered to adversely affect welfare of sheep were (i) for ewes: lameness, thermal discomfort, enteric disorders, mastitis and skin disorders and (ii) for lambs: pain induced by management procedures (e.g., castration), enteric disorders, thermal discomfort and mis-mothering. A restricted group of experts was then asked to associate the main risk factors to those adverse effects following the scheme reported in Table 3 (for the sake of brevity, only consequences for ewes are shown as an example). The identification of adverse effects and related risk factors was conducted within the framework set by the Welfare Quality® protocol, consisting of 4 welfare principles and 12 welfare criteria. The pitfall of the risk assessment approach is that it is not usually performed on individual farms, therefore it can be used as a tool to support scientifically driven policy making, while identifying and characterising risk factors potentially threatening sheep welfare. However, no indications regarding specific farm situations may be given in terms of animal welfare or as a tool for continuous welfare improvement.

4. Welfare considerations in small ruminant emergency medicine

In small ruminants, extensive and very extensive rearing systems are practiced frequently. These systems are often accompanied by lack of monitoring veterinarian programs. Hence, emergency medicine plays a key role in providing rapid and effective veterinary and nursing care in cases threatening the life of small ruminants and/or their health and production.

Further, in emergency medicine in small ruminant health management, financial constraints, as well as the welfare of sick or at risk to become sick animals, should always be taken into account.

Emergency medicine in individuals aims at treating disease problems with an immediate risk for the life of animals. These can refer to problems in young (e.g., neonatal hypothermia) or adult (e.g., dystocia, urethral obstruction) animals and can be dealt with by using knowledge from various veterinary specialities (e.g., anaesthesiology, obstetrics, neurology, surgery). Emergency medicine in populations aims to control various diseases with a risk to the animals of a farm or a geographical region. Moreover, it functions as a safety net for animal production. These diseases may be of endemic (e.g., cases of abortion), epidemic (e.g., bluetongue disease in Northern Europe) or emerging (e.g., Schmallenberg disease) nature and can be dealt with by using knowledge from various scientific fields (e.g., diagnostic medicine, epidemiology, preventive medicine) (Arsenos and Fthenakis, 2014).

In all circumstances, the welfare status of individuals must be maintained to a standard appropriate for those individuals at that moment. The traditional 'cost-benefit' analysis will need to be extended to take into account facets beyond the traditional financial implications, to a meaning that includes the degree of suffering acceptable by the affected animals, as well as taking into account that positive outcomes of treatment are by no means certain (Roger, 2014).

The peri-parturient period is a time in the life of a ewe or doe when most emergency problems would arise. This is mainly the effect of pressure in the metabolism of the pregnant animal and the specific financial circumstances at that stage. Pregnancy toxaemia, abortion, dystocia and hypocalcaemia (among others) require an immediate action from a veterinarian. Nevertheless, there are circumstances, in which the scientific literature indicates an unfavourable prognosis. For example, in pregnancy toxaemia, these include the development of neurological signs in the ewe and the *in utero* death of foetus(es) (Brozos et al., 2011). Therapeutic efforts need to take place for a long period and can often be unsuccessful; at the same time, veterinary expenses can be high, but unrewarding to the farmer. Moreover, in such cases, welfare status of the affected animal is reduced and, possibly, may never be restored. The attending veterinarian will need to take a professional decision, based on their scientific

background: is effective treatment a feasible option or is euthanasia the best approach for the welfare of the affected animal?

The first days of life of a sheep/goat will be the most stressful period in the life of that animal. A variety of adverse conditions, often caused or predisposed by inappropriate management (e.g., liver rupture, hypothermia, dislocation) can affect newborns, reducing their welfare status and requiring immediate veterinary care (Fragkou et al., 2010). Again, some of these disorders, depending on the severity of each condition, may have an adverse prognosis, which will require from the attending veterinarian a welfare evaluation. Moreover, in those scenarios, diseased animals have a small financial value and, further, have not produced any economic benefits to the farmer. The attending veterinarian will need to make a professional decision, based on its scientific and professional knowledge: is the treatment an option that would financially compensate the farmer in the future or is euthanasia the preferred approach for financial viability of the farm?

There are many examples of emergency medicine in animal populations (e.g. foot-and-mouth disease, sheep pox), in which healthy individuals, with generally acceptable standards of welfare, are accounted for euthanasia. This occurs within the appropriately defined surveillance areas. The attending veterinarian will need to make a professional decision, based on their scientific background: is euthanasia of the defined cohort a means to control the disease or, possibly, euthanasia of a much larger number of animals would be required in the future?

In all cases, accurate and rapid diagnosis of the problem is paramount. This should be followed by analysis of the situation and evaluation of the various remedial options. Assessment of the welfare status of the animals, coupled with prognosis of the probabilities for recovery, as well as the time-scale for achieving full recovery needs to be an integral element of the decision process. That way, emergency responses are correct and promote welfare status of individual animals or populations of animals.

5. Concluding remarks

The development of on-farm welfare assessment protocols is of great practical importance. Within the EU's 7th Framework Program for Research (FP7), the AWIN project had as a

main objective to promote the identification of best practices and their implementation for welfare management and improvement. The development of on-farm welfare monitoring protocols can contribute to markedly improve the quality standards on the management of small ruminants. Moreover, most of sheep and goat products are officially recognized in the European Union legislation with a protected designation, hence inclusion of a welfare monitoring system into the specifications of such products would further improve their market value. Within the general aim to promote the welfare of small ruminants, EFSA plays a central role in providing scientific basis for future legislation. In addition, emergency medicine is fundamental to minimize suffering and support appropriate decisions concerning medical treatments and euthanasia.

Further reports are needed about concerns and feelings of shepherds and goatherds with respect to welfare issues in their production systems. The delivering of the best practices identified and promoted within AWIN project and EFSA scientific advice could implement the diffusion of welfare management of small ruminants with the contribution of animal welfare experts.

Conflict of interest statement

None of the authors of this paper has a financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.

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Table 1. Animal welfare indicators of the AWIN welfare assessment protocol for sheep, divided according to principles and criteria (first or second level welfare assessment) (AWIN, 2015a).

Welfare principles	Welfare criteria	Welfare indicators	
		First level	Second level
Good feeding	Appropriate nutrition	Lamb mortality	Body condition score
	Absence of prolonged thirst	Water availability	
Good housing	Comfort around resting	Fleece cleanliness	Fleece cleanliness
	Thermal comfort	Panting, access to shade/shelter (only animals living outdoors)	
	Ease of movement	Stocking density (only housed animals)	Hoof overgrowth (only housed animals)
Good health	Absence of injuries		Body and head lesions, leg injuries
	Absence of disease	Lameness; faecal soiling; fleece quality	Lameness, faecal soiling, mucosa colour, ocular discharge, mastitis and udder lesions (lactating ewes only), respiratory quality, fleece quality
	Absence of pain and pain induced by management procedures	Tail length	Tail length
Appropriate behaviour	Expression of social behaviour	Social withdrawal	
	Expression of other behaviours	Stereotypy; excessive itching	
	Good human-animal relationship	Familiar human approach	

Table 2. Animal welfare indicators of the AWIN welfare assessment protocol for goats, divided according to principles and criteria (first or second level welfare assessment) (AWIN, 2015b).

Welfare principles	Welfare criteria	Welfare indicators	
		First level	Second level
Good feeding	Appropriate nutrition	Hair coat condition, queuing at feeding	Body condition score, hair coat condition, queuing at feeding
	Absence of prolonged thirst	Queuing at drinking	Queuing at drinking
Good housing	Comfort around resting	Bedding	Bedding
	Thermal comfort	Thermal stress	Thermal stress
	Ease of movement	Kneeling at the feeding rack	Kneeling at the feeding rack
Good health	Absence of injuries	Severe lameness	Severe lameness
	Absence of disease	Abscesses, hair coat condition, oblivion, overgrown claws, udder asymmetry	Abscesses, body condition score, faecal soiling, hair coat condition, nasal discharge, oblivion, ocular discharge, overgrown claws, udder asymmetry
	Absence of pain and pain induced by management procedures	Improper disbudding, severe lameness	Improper disbudding, severe lameness
Appropriate behaviour	Expression of social behaviour	Queuing at drinking, queuing at feeding	Queuing at drinking, queuing at feeding
	Expression of other behaviours	Oblivion	Oblivion
	Good human-animal relationship	Latency to the first contact test	Latency to the first contact test
	Positive emotional state	Qualitative behaviour assessment	Qualitative behaviour assessment

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482 **Table 3.** Example of association between the main welfare consequences identified in sheep
483 and the corresponding risk factors (hazards) in the main management systems.

Welfare consequence	**Management system**			
	Shepherding	**Intensive**	**Semi-intensive**	**Extensive**
Prolonged hunger	Poor pasture quality, lack of supplementation			Poor pasture quality, lack of supplementation
Thermal stress	Lack of shade/shelter, extreme climate	Inappropriate housing, stocking density, delay in shearing, extreme climate	Inappropriate housing, stocking density, delay in shearing, lack of shade/shelter	Lack of shade/shelter, extreme climate, winter shearing
Mastitis	Poor udder hygiene, teat lesions, inappropriate drying-off, inappropriate milking, udder conformation, maintenance of milking system	Poor udder hygiene, teat lesions, inappropriate drying-off, inappropriate milking, udder conformation, maintenance of milking system	Poor udder hygiene, teat lesions, inappropriate drying-off, inappropriate milking, udder conformation, maintenance of milking system	Poor udder hygiene, teat lesions, inappropriate drying-off
Lameness	Pasture conditions Poor biosecurity Improper hoof care	Improper hoof care, inappropriate nutrition, poor flooring	Improper hoof care, inappropriate nutrition, poor biosecurity	Soil conditions (wet), improper hoof care, inappropriate nutrition*, poor biosecurity**

484 * only in extensive or very extensive systems, ** only in semi-extensive systems.

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