Lameness in small ruminants – economical and welfare impact

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Lameness is a behavioural indicator of pain that negatively affects ruminants' performance and welfare. Causes and prevalence vary between species, breed, production system, time of year, age etc… It is acknowledged that a correct diagnosis and prompt treatment when dealing with a flock lameness problem, is crucial.

We will revise some of our current work on small ruminant lameness scoring and on the main causes of lameness in dairy goats. We will additionally address the problem of sheep foot diseases and their economic impact.

Scoring lameness

It has been shown that farmers in the UK estimate lameness prevalence relatively accurately without the need for a standardized lameness scoring scale. However, for research, certification, monitoring and to calculate lameness welfare and economic impact, it is useful to have some sort of "universally" accepted scale.
Lameness in animals can be assessed by two methods: objective, based on the use of equipment that collects kinetic and kinematic data; or subjective, based on the observers' ratings using different scoring systems.[1] The most commonly used subjective scales are Numerical Rating Scales (NRS). However NRSs are artificial constructs as lameness intensity and severity should be seen as varying in a continuous trait. By only allowing the observers to make scorings based on a limited number of descriptors, it reduces sensitivity and allows for loss of valuable information. So we have been developing a modified Visual Analogue for lameness in goats that defines equal ranges along the scales' continuum, with thresholds representing NRS descriptors. For this we had to test whether existing NRS descriptors were equal spaced in the VAS continuum, as well as research the extent to which lameness intensity varies for different lameness and posture signs used to define NRS descriptors. Aiming to address these questions we collected and analysed lameness scorings using individual VASs to score three lameness and posture signs (gait, head nodding and arched-back). Lameness scorings were performed through a video-based web-survey. Our web-survey was designed to identify specific lameness signs to be included in the mentioned segments, and the position of the thresholds along the scale. To our knowledge this was the first published study in which a web-survey was used with the objective of assessing a health indicator in the veterinary field. We collected a total of 570 valid worldwide participations from respondents with different occupations and experience. Because of expected differences in the respondents' ability to assess lameness, we analysed answers by levels of cardinal consistency in line with consistency concepts from the decision analysis literature. To test if the lameness descriptors were evenly spaced in all the datasets analysed and considering the three signs separately, we compared two alternative regression models. Our results showed: 1) respondents' difficulties in recognizing and discriminating across some NRS descriptors; 2) these difficulties varied with the lameness severity and with the lameness sign; 3) gait, the basis for NRS lameness descriptors in goats, was not scored evenly spaced along the continuum of the VAS; 4) similar results were found for

the head nodding and arched-back signs. In view of these results we are reassessing the exact location of the thresholds along the continuum of the VAS, and whether to include other lameness and posture signs on new modified VASs.

With the hundreds of videos and photographs taken for this study we are now developing a method of automatic image collection of animals walking out of the milking parlour to identify and quantify locomotion by body movements and lines.

Lameness in goats

In contrast with sheep, infectious disease is not the main cause of lameness in goats in intensive systems. Although these animals are permanently kept in straw beds, sometimes wet and hot, footscald and footrot are rarely seen in our farms.

In dairy goat intensive farms lameness ranges from 9.1% to 24%. The AWIN project detected up to 5% of very severe lameness. It should be remembered that goats' locomotion is better when they walk on soft straw surfaces so assessments in the pens may underestimate the severity and prevalence of the problem. In the UK, Anzuino et al. (2010) report that out of 1,520 sample animals, 79.8% had overgrown claws and the problem was present at different levels of severity in all the farms surveyed.[2] Hill et al. (1997) reported percentages of overgrown claws between 83.1% and 95.5%, and Muri et al. (2013) described a lower prevalence, around 66%, but still considered it as one of the most prevalent health and welfare problems in Norwegian dairy goat farms.[3,4] The AWIN studies showed that more that 62% of goats had moderate overgrown claws and up to 12% had very long and severely deformed claws. We also found a positive relation between lameness score and the number of deformed claws. Anzuino et al. (2010) reported that overgrown claws had a correlation of 0.55 with the lameness score found in the farm.[2]

Thus, overgrown and deformed claws are the most prevalent cause of lameness in dairy goats. The wall horn grows at about 5mm a month and in more extensive environment the length varies naturally over the seasons. Over a year growth often matches wear so trimming is not necessary. So the causes of this overgrowth in dairy goats are a lack of claw wear when animals are housed on straw bedding associated with poor management, such as insufficient frequency of foot trimming.

Our studies with lameness scoring have shown that lameness increases with exercise on hard surfaces and that trimming will solve most lameness cases, with the exception of those in which deformation is very severe. This is the reason why early and frequent trimming is crucial. Hill et al (1997) have long ago stated that routine foot trimming was associated with a lower prevalence of lameness.[3] Another solution for claw overgrowth has been proposed and applied in some farms – environment enrichment by placing large stones or rocks or wooden structures onto which goats can climb.

Although the physiopathology of small ruminants foot diseases are generally well known, there is still a lack of knowledge on the effect of lameness on other structures such as joints and on the degree of pain present. Although it seems reasonable to think that claw overgrowth induces stress on joints, tendons and ligaments, nothing has been published to demonstrate this. One of the techniques that has been developed in other animals to evaluate the impact of biomechanical alterations on adjacent anatomical structures is comparative thermography before and after exercise. We have conducted two studies on the effect of goat claw overgrowth and deformation on joints, bones and tendons and the role these conditions can have on the incidence of other diseases, such as pregnancy toxaemia.

1. Thermographic images of goats' limbs before and after exercise and before and after claw trimming, show an increase in temperature of the distal interphalangeal joint after 5 minutes exercise and a significant difference in temperature between animals with overgrown claws and those for which natural weight bearing was regained by trimming.
2. Computerized Axial Tomography (CAT scan) images of the limbs of goats with different grades of deformation have shown alterations that are currently being analysed by computer software. We may find that overgrown/deformation is not only a mechanical problem or a temporary cause of pain but may cause long term suffering and musculoskeletal changes that reduces activity, performance, fertility… ultimately leading to premature culling.

Other causes of lameness such as caprine arthritis and encephalitis (CAE), caprine contagious agalactia, different types of arthritis, horn separation, white line lesions, abscess of the sole, foreign body and granulomatous lesions should be included in the differential diagnosis.[6]

Lameness in sheep

Lameness has a tremendous economic impact in sheep production – in the UK alone costs £84M per annum in lost production and treatments. In Europe footrot is the major cause of lameness in sheep. It is a highly contagious disease resulting from mixed bacterial infection with *Fusobacterium necrophorum* and *Dichelobacter nodosus* playing complementary roles. Disease prevalence and clinical signs can range from no to severe lameness depending on host, bacterial, environmental and climatic conditions, resulting in benign, intermediate or virulent forms of footrot.

It is consensual that footrot causes mild to very intensive pain. A study was developed by the AWIN team in Scotland to analyse the perceptions of farmers, veterinarians and students in relation to lameness and its associated pain in sheep. Participants were asked to watch video clips and complete a short questionnaire, which asked them to rate, using a 100mm visual analogue scale, the level of: i) lameness, ii) pain they felt the sheep was experiencing, and iii) their own emotional response. The main conclusions were: participants were able to distinguish between different lameness severities in sheep; lameness was considered to be a painful condition, the pain severity increasing with the severity of the lameness; although farmers were more compassionate than vets, these were more likely to agree that the provision of analgesia as part of lameness treatment was beneficial for sheep than were farmers. Another study showed that those treating the first mildly lame sheep in a group are also those reported to have the lowest prevalence of lameness in their flock.

Other studies have looked at ways to recognize and score pain in sheep affected by foot rot. For example, facial expression has proven to be a reliable and easy way to recognize animals in pain. For details see "Less frequent indicators of poor health and welfare in ruminants" in these Proceedings.

Treatment of footrot should include footbaths, topical and systemic antibiotic and analgesics. Recent research has shown that trimming sheep lame with footrot or scald is detrimental, because it delays healing and increases the risk of infection recrudescing. If trimming is absolutely necessary it should always be carried out with great care, removing only obviously loose horn and avoiding causing bleeding. Control and eradication should include biosecurity measures (e.g. animal entry, quarantine, pasture use, straw sources), vaccination, footbaths and culling of diseased animals. For control programmes to be effective it is essential that the pathogenesis and epidemiology of

footrot is understood and that control methods are implemented at appropriate times in the season, depending on climatic and pasture conditions. Recent research suggests that sheep farmers may be unaware of these methods and may allocate greater resources to treatment of footrot rather than to its prevention (Abbott et al, 2005). However, eradication of benign footrot may not be cost effective as measures may outweigh the economic return of disease. Even so, for welfare reasons, measures should always be taken to reduce the prevalence of footrot. In 2011 the Farm Animal Welfare Council recommended that the level of lameness in flocks should be an average of 5% by 2016, and 2% by 2021 using currently available management practices.

Resistance to footrot in some breeds is well known, although some research has shown no difference between Dorset, 1/2 Dorper, 3/4 or greater Dorper (DO), Gulf Coast Native, Katahdin, and St. Croix breeds when were exposed to a highly virulent strain.[7]

Evidence for within-breed genetic resistance to footrot is also clear as shown by the percentage of offspring affected by footrot according to their different sires. For example, infection can range from 1 to 24% for lambs reared in the same environment (farm) under natural challenge.[8] Genetic aspects of footrot for UK sheep are published and following the scoring system used for these publications, lameness became an integrated breeding goal trait in some breeding programme. The next step is the use of genomic predictions of genetic merit for footrot.[8] The AWIN project used data from the previous Footrot research led by SRUC (Scotland) to investigate the molecular basis to resistance to footrot. Early results suggest that there may be genes on two key chromosomes that are influencing susceptibility to footrot in some breeds potentially allowing selection for increased resistance in the absence of infection.

Also very important is the study on the genetic diversity of *D. nodosus* and *F. necrophorum*.[9] A study using PCR in conjunction with SSCP and sequencing to analyse swabs collected from the hooves of sheep, goats and cattle with symptomatic footrot found four different variants of the *F. necrophorum* leukotoxin gene lktA. Although the cattle samples matched the known type strain of *F. necrophorum* subsp. *necrophorum*, of the 14 samples from sheep none matched the known type strains and none of the footrot infections carried multiple variants of lktA, suggesting that only one strain of F. necrophorum is present in each case. This is in contrast to *D. nodosus* in footrot infections, which have been demonstrated to have up to seven strains infecting a single hoof.

Economic impact of lameness in small ruminants

Although in dairy cattle the economic impact of lameness has been extensively studied the same cannot be said for sheep and goats. For example, data on the effect of lameness on fertility is lacking. This may be due to difficulty in working with these species – seasonality, not very pronounced oestrus signs, male effect, low use of artificial insemination, low income from individual animals… – but most probably it results from the fact that the industry has not yet fully grasped the full effect of the losses.

Nevertheless there are some studies calculating the annual losses caused by lameness to be 15 M euros, $18.4 M and 6,35 M euros, in Europe, Australia and New Zealand, respectively.

Lame dairy goats will reduce milk yield, weight, fertility, wool quality as well as being more predisposed to pregnancy toxaemia and premature culling. One study showed that the mean kidding interval (15.2±0.78 months) in lame goats was significantly different from non-lame goats (10.87±1.48 months), while for sheep a mean lambing interval of

(14.59±1.53 months) recorded for lame animals was also significantly different from non-lame sheep (11.69±1.92 months).

Several other studies have also found differences in daily milk yield and total milk yield between lame and non-lame dairy ewes. For example in one study differences in total milk yield for non-lame and lame ewes was 318·9 and 268·0 kg, respectively. Christodoulopoulos (2009) diagnosed interdigital dermatitis in lame goats, consisting of cracks and erosions on the horn of the bulbs of the heel that in most cases extended along the internal side of the axial hoof wall. It was shown that annual milk yield was significantly affected by the type of foot disease present and was significantly lower in cases with foot lesions than in the animals that were not lame and also in the lame goats without foot lesions.[10] Another study looking at weight gain in Merino sheep artificially challenged with footrot when 10 months old and re-infected through exposure to footrot on pasture 33 weeks later. Animals with average footrot severity in the two trials suffered weight losses of 0.5 to 2.5 kg live weight. Animals with higher genotypic values for weights at the start of each trial appeared to cope better with infections, in terms of lower weight losses.

The results of all these studies demonstrate that significant financial losses are expected in dairy sheep due to lameness.

In conclusion, lameness in sheep and goat farms has huge economic and welfare impact. Early diagnosis and application of preventive measures are crucial. In dairy goat intensive farms claw overgrowth and deformation are the major problems, while in sheep production footrot is still the main disease. While trimming is essential for the first it is no longer recommended for the treatment of infectious diseases affecting the feet. Effective monitoring is essential and to accomplish this a standard scoring scale should be universally accepted.

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