Sheep scab is a parasitic allergic dermatitis that affects sheep worldwide and it is caused by the non-borrowing mite, *Psoroptes ovis*. It has extremely serious welfare implication for the affected animals (Figure 1) and a tremendous impact on sheep farming economics. An estimation on the cost of the disease to the UK sheep industry (Nieuwhof and Bishop 2005) found an annual cost of £8milion, with prevention accounting largely for this figure. Like for any other contagious disease, prevention should really focus on strict biosecurity, mainly through quarantine (and possibly treatment) of all incoming animals. Prophylactic treatments have been advocated as a cost-effective strategy, although only when there is a high risk of infection and mainly for upland farmers (Nixon, Rose Vineer et al. 2017). At present, two classes of antiparasitic drugs are licence in the UK for treatment and control of sheep scab. These are the organophosphapte (OP) dip diazinon and the injectable macrocyclic lactones (ML). The choice between these two classes is dictated by numerous factors, like labour requirements, flock type and size, time of the year and control of other ectoparasitic diseases (Milne, Dalton et al. 2007).

Irrespective of the drug chosen, it is of paramount importance that the treatment is carried out properly (Figure 2) and the compound is effective at killing all the mites. On this respect, Doherty and others have recently confirmed the first evidence of resistance to moxidectin, one of the injectable ML that can be used for both prevention and treatment of sheep scab. Using a laboratory assay in which mites collected from four farms with reported treatment failure were exposed to different concertation of the compound, they were able to demonstrate that these mites could survive even when exposed to very high concentration of the compound (100times higher than the expected plasma concentration) (Doherty, Burgess et al. 2018).

The implications of this report are clearly quite substantial, although the appearance of resistance to acaricidal drugs should not have come as a surprise. As we have learned too well from the development of antimicrobial resistance, it is only a matter of time before an organism repeatedly exposed to the same therapeutic drug will develop resistance, as selective pressure is facilitate by exposing the organisms to the same compound over time. Furthermore, as Doherty and others state in their article, the possibility of cross-resistance to the other ML compounds is unfortunately a likely possibility. If this was the case, there will be major limitations in the use of these compounds in the future. Among farmers, the use of injectable ML is still predominant (Bisdorff and Wall 2008) as these drugs have major benefits over the use of OP dips, being more operator-friendly, easier to administer and dispose of (Parker, O'Brien et al. 1999). They are also the only choice in case of heavily pregnant sheep, where it would not be recommendable to submerge sheep in advance stage of gestation. An additional complication comes from the fact that Injectable ML are also among the most commonly used drugs for nematode control (Morgan, Hosking et al. 2012). Knowing that anthelmintic resistance is now a widespread problem (Traversa and von Samson-Himmelstjerna 2015), we ought to start questioning if our control strategies are appropriate. In light of these problematics, there is definitely no space anymore for indiscriminate prophylactic treatments. On the contrary, an approach based on a wider use of diagnostics should be advocated. It would be very appropriate to make better use of the recently developed serum ELISA test for diagnosis of sheep scab (Burgess, Innocent et al. 2012) to the incoming animals, as part of biosecurity measures, looking for evidence of exposure to the disease and to avoid unnecessary treatment of animals.

Finally, a genuine collaboration between farmers, vets and the industry is also needed for effective control of this disease. The risk of introducing sheep scab into a flock is increased up to 10 fold when confirmed cases of the disease are diagnosed in a neighbouring flock or in cases where common grazing is used (Rose and Wall 2012). This reiterates that treating a sheep scab outbreak as a single entity will not allow for real control of the disease. Efforts should instead be put toward

coordination, both at regional and national level, to make sure that not only all animals are properly treated, but neighbouring farms are aware of the situation and the likely source of infestation can be identified. Also based on the report by Doherty and others, all cases of suspected treatment failure should always prompt further investigation, in order to prevent potentially resistance mites from infecting other farms and become more widely established.

What you need to know:

Correct treatment of sheep scab involves treatment of all in contact sheep and strict separation of treated and untreated sheep

If an outbreak of sheep scab is confirmed and treatment correctly performed, consider investigation of apparent treatment failure as resistance to injectable ML has now been reported

Control of sheep scab should focus on strict biosecurity measures and co-operation among flocks to treat at the same time

A better use of the available diagnostic techniques can reduce reliance on therapeutic drugs

Bisdorff, B. and R. Wall (2008). "Control and management of sheep mange and pediculosis in Great Britain." Veterinary Parasitology **155**(1-2): 120-126.
Burgess, S. T., G. Innocent, F. Nunn, D. Frew, F. Kenyon, A. J. Nisbet and J. F. Huntley (2012). "The use of a *Psoroptes ovis* serodiagnostic test for the analysis of a natural outbreak of sheep scab." Parasite & Vectors **5**: 7-17.
Doherty, E., S. Burgess, S. Mitchell and R. Wall (2018). "First evidence of resistance to macrocyclic lactones in Psoroptes ovis sheep scab mites in the UK." Veterinary Record.
Milne, C. E., G. E. Dalton and A. W. Stott (2007). "Integrated control strategies for ectoparasites in Scottish sheep flocks." Livestock Science **106**(2-3): 243-253.
Morgan, E. R., B. C. Hosking, S. Burston, K. M. Carder, A. C. Hyslop, L. J. Pritchard, A. K. Whitmarsh and G. C. Coles (2012). "A survey of helminth control practices on sheep farms in Great Britain and Ireland." Veterinary Journal **192**(3): 390-397.
Nieuwhof, G. J. and S. C. Bishop (2005). "Costs of the major endemic diseases of sheep in Great Britain and the potential benefits of reduction in disease impact." Animal Science **81**: 23-29.
Nixon, E. J., H. Rose Vineer and R. Wall (2017). "Treatment strategies for sheep scab: An economic model of farmer behaviour." Prev Vet Med **137**(Pt A): 43-51.
Parker, L. D., D. J. O'Brien and P. G. Bates (1999). "The use of moxidectin for the prevention and treatment of psoroptic mange (scab) in sheep." Veterinary Parasitology **83**(3-4): 301-308.
Rose, H. and R. Wall (2012). "Endemic sheep scab: Risk factors and the behaviour of upland sheep flocks." Preventive Veterinary Medicine **104**(1-2): 101-106.
Traversa, D. and G. von Samson-Himmelstjerna (2015). "Anthelmintic resistance in sheep gastro-intestinal strongyles in Europe." Small Ruminant Research.

Figure 1 – An advance case of sheep scab, where the lesions have spread across the entire body of the animal and there is evidence of poor body condition.

Figure 2 - Correct treatment of sheep scab involves gathering and treating all in contact sheep with an appropriate dose of the compound.