**BREEDING A SCRAPIE RESISTANT INTERNATIONAL SHEEP FLOCK**

Scrapie is a transmissible spongiform encephalopathy (TSE) of sheep and goats. It is a disease of considerable economic consequence to the small ruminant farming industry. In the EU, scrapie is a notifiable disease with affected farms facing severe trading restrictions and loss of animals. Scrapie is also a listed disease in the OIE Terrestrial Animal Health Code (2008) and as such affects wider international trade.

Selection of sheep for classical scrapie resistance became a possibility after pioneering work by Professor Nora Hunter and Dr Wilfred Goldmann, of the University of Edinburgh’s Roslin Institute, demonstrated strong association between prion protein (PrP) genotype (PRNP) and scrapie susceptibility. Extended linkage information and epidemiological studies consolidated this association for natural scrapie outbreaks.

They showed that sheep with PRNP genotype VRQ/VRQ are highly susceptible to classical scrapie, whereas ARR/ARR animals are resistant.

The findings led directly to the implementation of the UK National Scrapie Plan, which ran from 2001 to 2009 and to similar programmes throughout the EU. These strategies were implemented with the twin aims of controlling classical scrapie and protecting the consumer from the exposure to BSE via sheep meat, should the national flock have become infected.

**IMPACT ON THE ECONOMY**

UK sheep meat exports are worth >£380 million (2011 figures). Breeding for resistance to scrapie and BSE, and the fact that it was being carried out, undoubtedly protected the sheep industry from similar damage to that inflicted by BSE on cattle and the UK economy. WHO estimates US$6 billion losses to the UK and in addition, EU paid out 4.7 billion euros in control measures for cattle BSE.

In June 2013, the USDA followed the example of UK and the EU and implemented a Scrapie Free Flock Certification Program.
IMPROVING SHEEP WELFARE THROUGH GENETIC SELECTION

The National Scrapie Plan, funded by the UK government, provided free genotyping of 1.8 million sheep in 11,000 flocks in an effort to control all TSEs. Sheep breeders both within and outside the EU (Directive 91/68/EEC) require genotyping and health certificates in order to trade their sheep (OIE Terrestrial Animal Health Code, 2008). Trade in affected animals or animals coming from a flock known to have had scrapie in the last two years is prohibited.

Selection for TSE resistance by PRNP genotyping has reduced the reported incidence of scrapie in sheep as a result of profound impact on the genetic structure of the entire UK sheep industry: between 2002 and 2006 the frequency of the susceptible VRQ allele decreased in ram lambs by 60% and the frequency of the ARR allele rose by 37% and as a direct result, the reported prevalence of sheep with scrapie has also decreased from 0.22% in 2003 to 0.04% in 2008. Voluntary PRNP genotyping continues, through the industry-funded Scrapie Monitoring Scheme (since January 2009), which issues certificates of sheep genotype for trading purposes.

Sheep welfare has been improved by selection against PRNP genotypes linked to susceptibility to scrapie and subsequent reduction in incidence of disease. There is under-reporting of scrapie but nevertheless, Defra statistics indicate over 200 classical scrapie sheep were reported to them in 2002, and three in 2011.

Our work that established the genetic basis of scrapie resistance has ensured continuous maintenance of the UK (and international) sheep flocks in the face of potential disease outbreaks.

SCRAPIE RESISTANT GOATS

Based on the success in the reduction of sheep scrapie following the implementation of the various sheep breeding strategies, EU and UK research effort in ruminant TSEs since 2006 has focused on goat scrapie genetics. This has led recently to the discovery of new resistant goat PRNP alleles (e.g. IRK), which are currently being tested in collaboration with the goat industry for their potential in breeding programs on commercial farms. Dr Goldmann is a member of the EU (UK) management team that has overseen the goat scrapie genetics.

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