

Change in PRP-genotype frequency in sheep after selection of Scrapie-resistant rams

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In 1998 the Dutch Scrapie Control Program started, which is based on selection of genetically resistant sheep. The growing concern about TSE resulted in 2002 in speeding up the program. The program now aims at breeding a sufficiently large number of scrapie-resistant breeding rams (ARR/ARR) to be able to make tupping with resistant rams compulsory on all sheep farms in the country by 2004. To accomplish this, an estimated 50.000 resistant rams will be needed by then.

To estimate the number of resistant rams available in 2004 in the breeding industry, a mathematical model has been developed to estimate the change in PrP-genotype frequency of the ram and ewe population in time. According to observed test results of 2001, the initial % of ARR/ARR rams differs among sheep breeds: 63% for Suffolk, 45% for Swifter, 33% for Ouessant, 29% for Hampshire Down, 21% for Texel, 13% for Blue Texel, 11% for Dutch Black Blaze and only 0.7% for Zeeland/Frisian Milk sheep.

We assume that allele AHQ, ARQ and VRQ are associated with susceptibility, and ARR with resistance, so in the model only 3 genotypes are distinguished: ARR/ARR, ARR/X, and X/X, where X stands for any susceptibility allele. The model is deterministic, age-structured, and discrete in time (birth pulse). Population size and age distribution of the ram and ewe population are assumed to be constant in time. For the selection scenario, we assumed a use of 50% ARR/ARR and 50% ARR/X rams in the first year (2001), and a use of 100% ARR/ARR rams in the following years.

Breed specific input data for the model to calculate the genotype frequency distribution are the age-dependent survival of ewes and of rams, the initial genotype frequency of ewes and rams and the sex ratio at birth. To calculate the absolute number of resistant rams, additional input is the absolute number of ewes in the breeding population, and the number of lambs per ewe per year. To check if sufficient resistant rams are available for a certain breed, additional input is the mortality of lambs, the average age of the reproducing ram, and the number of ewes for one ram.

Results will be shown for 8 sheep breeds. In general, the relative increase in ARR allele frequency is stronger when the initial frequency of the allele is low, and the ARR allele frequency in newborns increases the most in the first year of the program. The estimated total number of available ARR/ARR rams in 2004 is a little below the necessary number of 50.000 for the whole sheep industry in the country. This means that additional measures are needed, such as lower cull of resistant rams or selection of resistant ewes.