Chapter 9.1: Response to selection: an overview

A number of steps are required to achieve response to selection, and thus to make genetic progress or genetic gain. First of all the animals need to be ranked in order of their predicted genetic potential. How to obtain the most accurate estimates of the genetic potential (the EBV) was subject of the previous chapter. Now that the animals can be ranked, the next step is to select the best for breeding. Success of the selection decisions depend on a number of factors:

1. How heritable is the trait under selection (i.e. the trait in the breeding goal)?
2. How much genetic variation for that trait is there in the population?
3. What is the average accuracy of the EBV, and thus the accuracy of selection?
4. What proportion of the animals will be selected for breeding?
5. In case genetic gain is to be expressed per year, rather than per generation: how long is a generation?

The heritability and the genetic variance are population parameters and cannot be influenced by the breeder. This is assuming that the phenotypes that were collected for estimating the heritability was of good quality, and the pedigree was recorded without errors.

A factor that can be influenced by the breeder is the accuracy of selection. If sufficient number of offspring can be used for estimating the breeding value, then the accuracy will be higher than if only performance of a few sibs is available. However, a downside of waiting for many offspring to be born before selecting the animals is that it takes a very long time before sufficient information is collected.

In Figure 1 is an illustration of a population that is ranked according to their phenotype for a certain trait. Most animals have an average phenotype, few are scoring very low, and few are scoring very high. After ranking you can select the best animals. The size of the proportion of the population that will be selected will depend on the how many animals are required for breeding. The selected proportion is the factor that is easiest to influence. A smaller proportion results in larger genetic response because the selected animals will be more superior than with a larger selected proportion.

However, the selected proportion cannot be unlimitedly small for two main reasons: first of all the intention is to maintain population size. So if few animals are selected, these need to be able to produce sufficient number of offspring to replace the entire generation of animals. Especially in females the number of offspring can be a limiting factor. Second, few animals selected as parents with large number of offspring, results in many animals that are closely related in the next generation, and thus a rate of inbreeding that may exceed the limit of 0.5 to 1 % as advised by the FAO.

Even though the genetic progress PER GENERATION is increased, the genetic progress PER YEAR is not or even decreased. In other words: there is a balance between increasing accuracy of selection and the time required to achieve the information to achieve the largest genetic gain per year.

Figure 1. Illustration of a population with the fraction best animals selected. On the y-axis is the frequency of animals with that phenotype, and on the x-axis is the trait under consideration.

Thus:

To optimise the success of a breeding program it is important to balance the relatively short-term decisions: acquire high genetic gain, and the long term maintenance of the population: controlling rate of inbreeding.