3. Genetic parameter – coefficient of heritability

Hello everyone, I welcome you to another lecture from the Animal Breeding module, the topic of which is Genetic parameters – specially heritability.
In to basic genetic parameters include coefficient of heritability, coefficient of repeatability and genetic correlation. In this lecture, we will deal with the coefficient of heritability.
For selecting a suitable selection method and, as a result, for the entire breeding process, knowledge of how is heredity is involved in the manifestation of a quantitative trait is of fundamental importance. We are therefore interested in how far individual performance are heritable. It is expressed by heritability coefficient, which we understand as the proportion of genetic variability to total phenotypic variability. It is, therefore, represents the share of gene variability in phenotypic variability. Also, to what extent is the genetic similarity of related individuals accompanied by phenotypic similarity? Genetic similarity is determined by relationships. The heritability coefficient is denoted h^2 and indicates the proportion of genetic variability to phenotypic variability.
As already said, the heritability coefficient expresses the proportion of total genetic variability to total phenotypic variability. We refer to this coefficient of heritability in the broad sense because it includes the entire genetically determined component of variability, that is, the component of additivity, component of dominance and component of interaction. However, we can estimate only the additive proportion of genetic variability based on mathematical statistical procedures. In this case, coeficient of heritability is equal to the following formula. And that's why we talk about heredity in a narrower sense.
The heritability coefficient takes on values from 0 to 1. If we consider the first extreme, i.e. the heritability coefficient equal to 0, and if we told the total phenotypic variance equal to one, the genetic variability will be equal to zero, which means that the heritability coefficient will also be equal to zero, as follows from this formula.
If we consider the second extreme, i.e. the heritability coefficient equal to 1, we would not encounter any differential action of environmental effects, and all phenotypic variance would be conditioned only by genetic differences so that the heritability coefficient would be equal to one according to this formula.
If we only consider quantitative traits, both extremes are practically unattainable in the regular breeding of livestock. We could get a extreme value of 0 only in the case of studying clones where they have the same genetic background. The second extreme, when the coefficient of heredity is equal to 1, exist in the case of laboratory conditions, when we completely exclude different influences of environmental effects, or when it comes to qualitative traits that are not affected by the environment, i.e. traits is affected by genes of large effects and is governed by Mendelian laws.
In other cases, the quantitative traits are characterized by the heritability coefficient values, which range between the two mentioned extremes. Quantitative traits we can divided into three groups according to the level of the heritability coefficients value. The first group includes traits with low heritability, its means that heritability coefficient value is lower than 0.3, where we include sub-characters of reproduction and fitness. In the second group, included traits with medium heritability, its means heritability coefficient values ranged from 0.3 (including) to 0.6, in this group we include sub-traits of production traits. And finally, in the third group, highly heritable characters, a heritability coefficient of this traits is higher than 0.6 (including). In this group we include sub-traits of slaughter value.
As for the methods of determining the heritability coefficient, they are based on the assumption that the mutual similarity of the observed quantitative traits is more similarly between related animals than between unrelated animals. Generally, it is possible to use the following approaches: From the similarity of parents and offspring, which includes procedures using regression or correlation coefficients and selection procedures (experiments). Another method is From the similarity of sibs, which provides the analysis of full sibs, half-sibs and combination of analysis of full sibs and half-sibs, and analysis of identical twins. Further: From the features' repeatability and the similarity of bilaterally occurring traits on the same individual.

Here, we see an example of estimating the heritability coefficient using a realized effect of selection or genetic gain. In this method, we start from the relationship that the selection effect, or genetic gain, is a function of the heritability coefficient and the selection difference.

The heritability coefficient is a critical genetic parameter due to its importance in animal breeding. The value of the heritability coefficient predetermines the selection methods that can be used in breeding process. Roughly speaking, the trait with higher value of the heritability coefficient can be selected by the simpler selection methods, and conversely, the selection of trites with lower the value of the heritability coefficient, must be used more sophisticated selection method. For example, for trite with higher values of the heritability coefficient, can be possible selected based on own performance of individual. Conversely, for traits with low value of coefficient heritabilty, can be used a selection based on performance of a large number of offsprings.

The value of the heritability coefficient is further used for the prediction of similarity of genotype and phenotype of individuals, similarity in the performance of parents - offspring, and estimate of the performance of the offsprings. estimate of individual heterosis and specific heterosis (in general, crossbreeding effects).

This slide shows the average values of heritability coefficients for individual traits and species. As already mentioned, the heritability coefficient applies only to the populations on which it was estimated and is not transferable between populations. This is because each population shows different variability of phenotype and genotype.

This lecture presented the concept of the heritability coefficient and its importance in animal breeding. Thank you for your attention, and I look forward to seeing you in the following presentations.